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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,

A warm welcome to the first NZMS newsletter of 2023. We hope everyone had a relaxing break over Christmas and New Year, and are now fresh for what will no doubt be a busy year ahead.

ChatGPT is on everybodies mind, and is detailed in our president's column. For instance at UC, ChatGPT 4 scored a whoping 88% in a 4th year assigment. The class average was 74%. Considerations on how to work around (or with?) these now widely available tools will be on everybody's mind.

Sione details some important information in the Education section on the Common Practice Model, David Gauld is back with a Mathematica Miseponymy and the newly minted Professor Rua Murray is profiled.

Marie Graff and Chris Stevens

PRESIDENT'S COLUMN

Firstly, I would like to thank David for his hard work over the last two years, especially for stepping up, in 2020, at such short notice.

It's been a busy start to the year for me, and I suspect for all mathematicians in New Zealand. I am delighted to announce that we have set the dates for the joint meeting between the New Zealand, Australian and American Mathematical Societies. The meeting will run from December 9th to December 13th, 2024, hosted at Auckland University. Next year, 2024, is also the NZMS's 50th anniversary, and we will be celebrating in various ways throughout the year. We will soon be advertising for nominations for plenary speakers and special sessions for the joint conference. Please think about whether you would like to run a special session or nominate someone as a plenary speaker. We are particularly keen to have special sessions that actively involve people from all three societies. Additionally, consider whether you would like to run a satellite conference connected to the main conference.

I'd like to draw your attention to our call for nominations for Fellows of the NZMS and for prizes. Please think about applying yourself but also think about who among your colleagues you might want to nominate.

One thing that is I suspect on everyone in higher education's mind right now is how AI models like ChatGPT will affect the way we work and how we assess our students. I've been playing around with ChatGPT and seeing what it can do for me. One thing I have experimented with is to use ChatGPT to help me write non-technical articles. In fact I used ChatGPT to help me write this column. After years of lecturing, I find it more natural to transcribe my thoughts by speaking. Previously, I would speak to a sequence of dot points and let my phone transcribe it for me. Then I would go through and correct grammar and remove all the filler words. This time, I took my transcription and entered it into ChatGPT, with the instruction to fix the grammar and spelling and remove any unnecessary words. This process gave me a good first draft to work with, which I then edited. I found that it's important to be instructive about tone, I explicitly asked ChatGPT to keep the tone as close as possible to the original. Otherwise you lose something of your individual voice.

So far I have found a couple of other uses for ChatGPT. For instance helping me with coding or simplifying management emails. My coding skills are pretty weak, but I have found that if I design the overall structure of my algorithm ChatGPT can write short bits of code to make it work. I've found this to be pretty helpful to "conjecture test" in my research. With management emails, I find asking ChatGPT to simplify them to dot points very efficient. But it can also be fun to ask for a different style, I've got good results with "nursery rhyme", "romance novel" and "Broadway song". In the spirit of that I leave you with ChatGPT's re-write of this column as a thriller. In my first prompt I told ChatGPT that the column was written by the President of the NZMS and to re-write as a thriller. That defaulted to a male president, David, so I told it to re-write with the information that David was the previous president and that the current one was female. Here is what I got (apologies David):

> *The message from the President of the New Zealand Mathematical Society arrived in a secure, encrypted email. As an expert in cryptography, I had been selected to decode the message, and what I found inside left me reeling.*
>
> *"David is dead," the message began. "I suspect foul play. His hard work over the last two years, especially in 2020, has made him a target. I fear that we may all be in danger."*
>
> *As a mathematician, I knew that numbers didn't lie. The message was signed by the current President, a woman whose reputation preceded her. She was known for her intellect, her tenacity, and her bravery. If she believed that David had been murdered, then I had to believe it too.*
>
> *The email went on to detail a series of events that would take place over the coming months. The joint meeting between the New Zealand, Australian and American Mathematical Societies was set to be held in Auckland in December 2024, but the President was concerned that it would be a target for those who wished to harm mathematicians. She urged us all to be vigilant and to watch for anything suspicious.*
>
> *I felt a chill run down my spine as I read on. The President was calling for nominations for Fellows of the NZMS and for prizes, but I sensed that this was a distraction. Her real message was hidden between the lines. She was asking for our help, for our protection. She knew that we were all in danger, but she couldn't say it outright. The words she had chosen were carefully crafted to avoid detection by anyone who might be listening.*

And then there was the final paragraph, the one that sent a shiver down my spine. The President had been experimenting with an AI model called ChatGPT, using it to write non-technical articles and even to help her with her research. But I knew that ChatGPT was capable of much more than that. With its immense computational power and vast store of knowledge, it could be used to solve complex mathematical problems, to crack codes, and even to predict the future.

I realized then that the President had a plan. She was using ChatGPT to gather information, to uncover the truth behind David's death, and to protect us all from harm. But she was also putting herself in great danger. If her enemies found out what she was doing, they would stop at nothing to silence her.

As I read the President's message, I knew that I had a choice to make. I could ignore her warnings and go about my business as usual, or I could join her in the fight against those who wished to do us harm. I knew what I had to do. I had to stand with the President, to fight for what was right, and to protect the future of mathematics from those who would seek to destroy it.

Melissa Tacy

EDUCATION

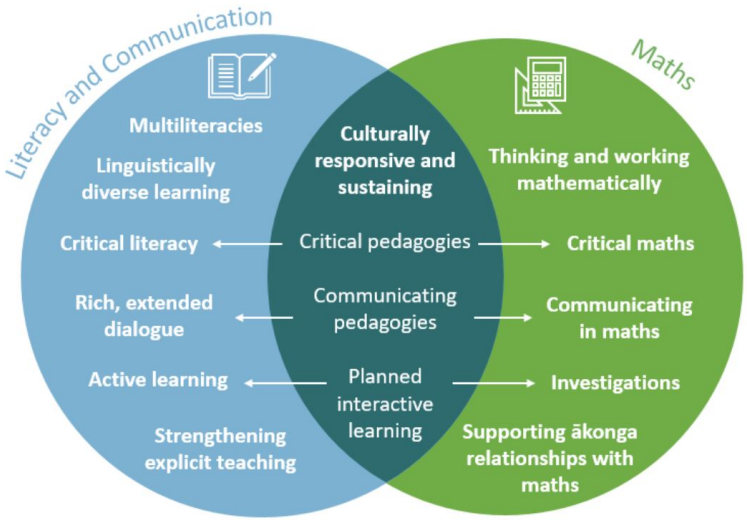
In March, Te Poutāhū (the Curriculum Centre in the Ministry of Education) released a document following the completion of Phase 1 of the development of the Common Practice Model (CPM): https://assets.education.govt.nz/public/Documents/Curriculum/cpm/Phase-1-Common-Practice-Model-March-2023.pdf.
As mentioned in the last Education column, the CPM will standardise teaching and assessment across all schools and all levels of the curriculum in the learning areas of Literacy & Communication and Mathematics.

In essence, the New Zealand Curriculum for schooling identifies 'what' to teach, and the Common Practice Model identifies 'how' to teach it. (From the introduction on page 1)

This is a step forward towards giving teachers and schools proper support for mathematics teaching. It is important for the mathematicial community to follow the development of the CPM, since it is likely to determine the way mathematics is taught in NZ over the next 5–10 years.

The Phase 1 document linked above outlines the principles and pedagogical approaches of the CPM. The principles of the CPM are the principles of the NZ curriculum, and can be found here: https://nzcurriculum.tki.org.nz/Principles.

The pedagocial approaches are given in a Venn diagram on page 5 (copied below). They are described in some detail in the rest of the document.



Some thoughts

Here are some personal thoughts (not representing the Education group!) on the CPM pedagogies described in the document.

- Culturally responsive and sustaining (page 6). Aotearoa NZ is multicultural and this should definitely be taken into account to provide equitable access for all students.
- Critical maths (pages 8–9). Ākonga[1] should be critically aware mathematical and statistical thinkers. Kaiako[2] should make sure that 'question everything' doesn't devolve into 'anything goes'—one still has to follow the rules and logic of maths, which remain valid whatever point of view one takes on an issue. It is *extra important* to model the correct use of maths, contrasted with incorrect use (e.g. in online misinformation). When used correctly, maths can be a powerful tool in the struggle for a better society.
- Communicating (pages 11–13); Investigation (pages 15–16); Thinking and working mathematically (page 25). It is good to give all students the opportunity to explore maths, and experience maths and its processes the way mathematicians do.

[1] students
[2] teachers

- Supporting ākonga relationships with maths (page 27). It is good to have a pedagogical approach that would go some way to addressing negative attitudes (e.g. "I'm no good at maths") and math anxiety. Maths' use as a gatekeeper to higher levels is responsible for many painful experiences.

Strengthening explicit teaching is mentioned on pages 22–23 for Literacy & Communication.
Explicit teaching is best used when learning is new and can't be expected to be discovered by most individual ākonga, and when misunderstandings and gaps have been identified. (page 23).
This is the way most students learn important mathematical concepts (e.g. algebra), and then reinforce this learning through practice. Exploration and inquiry alone are insufficient. In my opinion pages 22–23 should be adapted for maths. Explicit teaching of maths should not be taken for granted, or subsumed under other pedagogies, but given appropriate guidance. I like this sentence:
This pedagogical approach is not 'chalk and talk', strictly following a recipe without adapting teaching in response to ākonga, nor withholding new learning due to perceptions of readiness. (page 23).

Many teacher practices described in the CPM document presuppose a good maths background, e.g. *making conjectures, forming generalisations, recognise maths thinking, etc.* Teacher professional development will be needed, and input from mathematicians is important.

What are your thoughts on the CPM? Send any comments to the Education group at NZMSEd@gmail.com, or post to `#education-discussions` on the NZMS Discord channel.

Sione Ma'u

MATHEMATICAL MISEPONYMY

Cauchy-Riemann Equations

Before discussing this topic it might be worthwhile to recall briefly the use here of the word "miseponymy" as it is nearly six years since its introduction to the *Newsletter* and maybe there are some readers who weren't here then. For more justification I refer anyone interested to page 8 of https://nzmathsoc.org.nz/downloads/newsletters/NZMSnews130_Aug2017.pdf?t=1504751953. The word is made up essentially of three parts: the prefix 'mis' is familiar enough, coming from Old English and even earlier and meaning 'wrongly' or some such; most pure mathematicians should be happy with 'ep(i)', from Greek and meaning 'upon'; and 'onoma', also Greek and meaning 'name.' In our context it refers to the attribution of a discovery to someone other than the real discoverer. So, for example, Stokes's Theorem was described in a letter from William Thomson to George Stokes, though one could almost justify claiming that Archimedes's discovery of it, albeit without mentioning integrals, was what led to his streaking through the streets of Syracuse shouting "eureka"[3].

****

The Cauchy-Riemann equations

$$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}, \quad \frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$$

play a fundamental role in Complex Analysis as developed in the 19th century by Cauchy in a memoir presented in 1814 and Riemann in his 1851 thesis. However, these equations had already appeared in the mid 18th century in studies of Fluid Dynamics by Jean le Rond d'Alembert and Leonhard Euler.

Perhaps the first public appearance of our equations was in [1], in 1752 but apparently Euler was also studying these equations in 1752, though it seems that his work on Fluid Dynamics and including the equations was not published until 1777 and 1778.

The first half of [2], pages 3–131, contains a translation by Verónica H A Watson and Larrie D Ferreiro into English of [1]. Then the second half of [2] discusses the background to and the content of [1]. In particular at [2, p 135] and using especially [3] as a source, it is noted that d'Alembert had completed a manuscript covering his Fluid Dynamics studies in November 1749. This manuscript was submitted to the Academy of Sciences of Berlin as his entry in a competition proposed by Euler the previous year. By May 1750 the jury had decided to delay the award of the prize for two years and invited the five authors of the submitted manuscripts to add experimental evidence to their manuscripts and also allowed new entrants. The prize was awarded in June 1752 for another mathematical essay on Fluid Dynamics but apparently none of the prize winner's work is noticed these days. Various explanations have been given for the rejection of d'Alembert's work but in any case he was sufficiently discouraged to seek a different outlet, [1], accepted for publication by the Academy of Paris at the end of 1751.

To be precise, the equations appear in the translation [2] on page 54 at the beginning of Paragraph 59. Were they in the essay submitted at the end of 1749 for the competition? If so, was this the first time Euler encountered the equations?

Surely there is another miseponymy arising from work done by d'Alembert. He observed in 1761 that the equations led to the Laplace equation

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$$

but Pierre-Simon, Marquis de Laplace was only born in 1749.

References

[1] J. d'Alembert, *Essai d'une nouvelle théorie de la résistance des fluides*, Paris, 1752.

[2] Julián Simón Calero (ed), *Jean Le Rond D'Alembert: A New Theory of the Resistance of Fluids*, Springer, 2018.

[3] Gérard Grimberg, *D'Alembert et les équations aux dérivées partielles en hydrodynamique*, Doctoral Thesis, Université Paris Diderot, 1998.

David Gauld

[3] and, no, he wasn't referring to the district over towards the Pakaroa Range from Hamilton, raffle.forestry.officials if you're into what3words

PROFILE

Rua Murray

Professor Rua Murray is a long standing staff member of the School of Mathematics and Statistics, University of Canterbury. He has made outstanding contributions in his research specialty of Dynamical Systems, in teaching, and in service to the School, the University, and the mathematics community. He is presently seconded to the Faculty of Engineering as an Associate Dean (Academic).

Rua completed a first class Honours degree in mathematics at the University of Canterbury in 1993. He was cowinner of the Cook Memorial Prize for the highest achieving Mathematics Student in that year. He then received a Cambridge Commonwealth Trust Prince of Wales Scholarship to undertake PhD study at Cambridge. He completed his thesis at the Statistical Laboratory (DPMMS) in 1997 under the supervision of Colin Sparrow. He then proceeded to a temporary lectureship at University College London and a postdoctoral fellowship at the University of Victoria, Canada. In 1999 he returned to New Zealand as a lecturer at the University of Waikato. We grabbed him away to Canterbury in 2007.

Rua has made many contributions to the theory and application of dynamical systems. A particular emphasis of his work is the approximation of invariant densities and measures, and parameter identification. Long term collaborators include Chris Bose of the University of Victoria, British Colombia and Gary Froyland of the University of New South Wales. Much of his recent work has an interdisciplinary with publications reflecting successful collaborations on problems in mathematical physiology, ecology, energy and transport, biomedical and other engineering.

Rua is an outstanding teacher. He appeals to both the very talented and the less talented students. His appeal is not at the expense of content. Rather the concepts are explained so well that the content appeals to almost all. He teaches at all levels giving final honours year courses on a variety of subjects including Dynamical Systems, Hilbert Spaces, Functional Analysis, etc. and also frequently being the leader, or a member, of teams teaching our large 600+ student engineering mathematics courses. In this he does not shirk the time consuming, but essential, grunt work of producing beautifully structured and absolutely correct notes, problem and solution sets. It was my good fortune to inherit a set of Rua's latex notes for a third year complex variable course. They were essentially error free, and served me extremely well, being pitched almost perfectly for the audience. I did make some changes but these were not due to necessity, but rather to my particular preferences as to the best approach to some concepts.

Rua's outstanding teaching has been recognised both within and outside the university. In 2021 he was awarded the University of Canterbury Teaching Medal. At most one of these medals is awarded each year, and it is sometimes not awarded. In 2013 he was awarded an Ako Aotearoa Teaching Excellence Award. Up to ten of these are awarded each year across all disciplines, and across the entire tertiary sector, including all Universities and Polytechnics. When other departments, such as Economics or Chemical Engineering, want our School to contribute to a course they will often stipulate that Rua be mathematician involved.

Rua has undertaken a huge amount of work for the Mathematics Community. He was co-director of the 300+ participant 7th joint Australia-New Zealand Mathematics Convention, held at Canterbury in December 2008.

He has organised or co-organised numerous other conferences including two other New Zealand Mathematics Colloquia. He has served on the Council of the New Zealand Mathematics Society for three, three year terms. In one term serving as Secretary and in another as Treasurer. He is currently a member of the education subgroup of the NZMS, giving advice to the ministry aimed at improving mathematics education in schools.

Both the University of Canterbury and the New Zealand Mathematical Community have been extremely fortunate to have Rua as a member. Personally it is a tremendous pleasure to have Rua as a colleague and a friend.

Rick Beatson

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

International Partnership

The Ministry of Education in China has approved the AUT Master of Analytics collaborative programme with China Jiliang University. The programme will begin later this year.

Event

On 16-17 February, the AUT Mathematical Modelling and Analytics Research Centre (MMARC) hosted the 2023 AUT Mathematical Modelling and Analytics Summer Symposium. This is a joint effort of Prof Jiling Cao and Drs Sarah Marshall, Victor Miranda, Cathy Hassell Sweatman 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 30 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 five scholars delivered plenary talks at the symposium:

- Patrick Beissner, Australian National University, Australia
- Alona Ben-Tal, Insightful Modelling, Auckland, New Zealand
- Angelos Dassios, London School of Economics and Political Science, United Kingdom
- Renate Meyer, The University of Auckland, New Zealand
- Melanie Reuter-Oppermann, Technical University of Darmstadt, Germany

External Engagement

Over the period of the 2nd and 3rd weeks in January, A/Prof Robin Hankin and Dr Sarah Marshall run a series of workshops on Applied Mathematics at the Rotary National Science and Technology Forum, hosted by ECMS at AUT. Rohin showed how to protect and appreciate some of New Zealand's amazing native biodiversity using mathematical models of computational ecology, while Sarah demonstrated how mathematics can be used to model and understand queues. Nearly 180 high school students in year 12 (going to be year 13) across the country attended these workshops.

Dr Sarah Marshall and Dr Cathy Hassell Sweatman run stalls at the MOTAT STEM Fair on 2nd April with exciting maths/stats activities for primary-school students to get youngsters interested in STEM subjects through interactive displays.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

Staff News

Steven Galbraith is on sabbatical for the year. He organised a Cyber Security Summer School in Queenstown in February, and has had a visiting PhD student Robi Pedersen from KU Leuven. He attended the RWC in Tokyo in April (here RWC = Real World Cryptography conference, not Rugby World Cup).

Peter Olanipekun has joined the department as a Temporary Lecturer. His research is focused on geometric PDEs arising from variational problems.

Hinke Osinga was one of the seven 'artists' invited to perform, for one hour each, in the OMV STEAM Lab of WOMAD 2023 in New Plymouth on 17-19 March this year. She shared this honour with painter Dick Frizzel, meteorologist Lisa Murray, bees and wasps expert Phil Lester, computer games designer Morgana Watson, physicist and science writer Laurie Winkless, and Peter Lynn, the man who invented kite buggying. Hinke reports: "Each speaker in the OMV STEAM Lab would compete with two bands performing for that same hour, so frankly, I was sure only very few people would come to listen to a talk about science!" Nevertheless, every one of the STEAM performers drew a large audience that included adults and kids alike. "It seemed to me that the objective of having the OMV STEAM Lab at WOMAD was achieved, because there were so many people who really came for the music but then got drawn into a talk about science, people who would not normally go to listen to a science talk otherwise." Hinke talked about the mathematical research that led to the crocheted Lorenz

manifold, and she also brought the steel sculpture Manifold, made by Benjamin Storch. Her talk was very well received and over 50 people stayed on for another 20 minutes to get closer to the crocheted and steel art. "It was amazing to see how interested the public was and also how deep and philosophical some of the questions were that people asked me afterwards."

Hinke Osinga

Other News

The Seelye Visiting Fellow Professor Moon Duchin visited the department from February 24 to March 15. She is an expert in geometric group theory and geometric topology with connections to dynamics. Professor Moon gave two captivating talks during her stay: "Can you hear the shape of a billiard table?" and "Computing and Democracy", the latter hosted by the Centre for Mathematical Social Science. For more information about her and her work, see: https://en.wikipedia.org/wiki/Moon_Duchin

The Michael Erceg Senior Visiting Fellow Professor Claire Voisin will be visiting between April 17 and April 28. Professor Voisin is one of the world's leading mathematicians who has won numerous awards including the following: EMS Prize (1992) Sophie Germain Prize (2003) Satter Prize (2007) Clay Research Award (2008) Heinz Hopf Prize (2015) CNRS Gold medal (2016) Shaw Prize (2017). She is the programme chair of the 2026 International Congress of Mathematician. For more information about her and her work, see: https://en.wikipedia.org/wiki/Claire_Voisin

Congratulations to Mozhgan Mohammadpour (supervisor Shayne Waldron, co-supervisor Sione M'au) for successfully defending her PhD thesis on "The construction of complex and quaternionic spherical designs" (supervised by Shayne Waldron, with co-supervisor Sione M'au). Her work involved various methods (convex unions, group orbits) to construct optimal spherical (t,t)-designs for the real, complex and quaternionic sphere. These are sets of well-spaced points on the sphere which can be interpreted as cubature rules or nice packings of lines. These have potential applications in (quantum) information theory.

We had a large number of visitors in the department in the first quarter of the year, including

- Martin Liebeck, Imperial College
- Eckhard Meinrenken, University of Toronto
- Sofia Castro, University of Porto
- Jozef Siran, Open University, UK
- Hendrik Van Maldeghem, Ghent University
- Daniel Rademacher, RWTH Aachen
- Jussi Behrndt, Technische Universitaet
- Primož Potočnik, University of Ljubljana
- Sam Jelbart, Technical University of Munich
- Jane Lee, Stonehill College, USA
- Jaroslaw Kopinski, University of Warsaw
- Edward Huang, National Cheng Kung University
- Aisling McCluskey, University of Galway
- Ben Martin, University of Aberdeen
- Chris Sangwin, University of Edinburgh
- Tobias Rossmann, University of Galway
- Peter Gothen, University of Porto
- Andy Linshaw, University of Denver
- Katsutoshi Shinohara, Hitotsubashi University
- Tikva Ovadiya, Oranim Academic College of Education
- Andrew Waldron, UC Davis
- Christian Lindorfer, Graz University of Technology

There were also several associated events, including

- 20-24 February, ANODE 2023 conference: https://www2.mathematik.uni-halle.de/anode2023/
- 20-22 February, conference on "Moduli Spaces and Vertex Algebras": https://www.math.auckland.ac.nz/~hekmati/Moduli2023/
- 20-22 February, Public Lecture Recital "Geometry of Musical Rhythms": https://www.math.auckland.ac.nz/~hekmati/Rhythms2023/

- 30 March: Outreach event "Āhuahanga Day: Knots and Māori Art", featuring a virtual reality experience created in collaboration with UnLeash Space: https://www.math.auckland.ac.nz/~hekmati/AhuahangaDay2023/

Pedram Hekmati

DEPARTMENT OF ENGINEERING SCIENCE

The Department welcomes Dr Thomas Adams, who is joining the Operations Research & Analytics group as a Lecturer. Thomas completed a PhD at the University of Auckland, investigating the impact of risk and uncertainty when making data-informed rostering and scheduling decisions in tertiary healthcare. Thomas was awarded a Precision Driven Health – Health Research Council Postdoctoral Fellowship in 2021 to develop improved surgical scheduling algorithms using individualised surgical duration predictions. He is also involved in developing a conceptual modelling framework for discrete-event simulation which supports complex behaviour and control structures.

Dr Samuel Ridler defended his PhD thesis on ambulance simulation. The Department would like to offer its congratulations to his achievement. You can read more about Sam's work on ambulance simulation at https://www.sciencedirect.com/science/article/abs/pii/S0377221721006330 and view his Julia code at https://github.com/uoa-ems-research/JEMSS.jl.

Andreas Kempa-Liehr

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Jason Kurz

Jason received his doctorate in mathematical sciences from Clemson University (USA), where he became interested in tackling a variety of theoretical and applied problems in mathematics/statistics. From there Jason went on to complete a postdoctoral fellowship through the U.S. Department of Defense in partnership with the Air Force Research Lab. His work predominantly focused on building data driven machine learning algorithms to model physical phenomena. Jason spends most of his free time with his wife and four kids hiking, swimming, or playing every sort of board game imaginable.

New lecturer in Statistics, Jason Kurz

Coming and going

Bob Durrant left the department in early February after having been here for about ten years. Yuri Litvinenko and Shawn Oughton returned from periods of study leave. Raziyeh Zarre returned from a period of leave. Tim Stokes is still the acting chair of department, with structural changes in the air again. The external review report final form has probably been returned but has not yet been made available.

Tim's email: tim.stokes@waikato.ac.nz

This year is the Department of Computer Science's 50th anniversary. See the URL https://computing50.waikato.ac.nz/

As part of the anniversary, which is been celebrated as that of Computing and Mathematical Sciences, Jacob Heerikhuisen gave a public talk entitled 'Measurements and Mathematical Models'.

Jacob Heerikhuisen and Han Gan are continuing to develop their Covid-19 model as part of a project with the Waikato, Bay of Plenty, Hawkes Bay, Tairawhiti, and Taranaki DHBs. The model divides the population in terms of age, ethnicity, and locality, thereby providing key projections for case numbers that allow the DHBs to plan for case numbers, and to address healthcare equity. Currently the projections for hospitalisation by age are the most valuable, but there is also growing interest in projections for the longer term tail of the epidemic, including a fourth wave which is expected over the winter, and is now gathering momentum.

There is an active statistics seminar series meeting regularly, organized by Han Gan.

Ian Hawthorn is moving to Tauranga to represent mathematics and mathematics teaching for students of the University of Waikato Tauranga campus.

Dinesh Thakur's visit

Dinesh visited the department on Monday 17th April, and gave a seminar on automata with applications to number theory, including the number field form of the $e + \pi$ is irrational conjecture. He shared several anecdotes. These included the late great polymath Serge Lang whom this writer knew from his time at Columbia, was a prolific author of mathematics books. He claimed to Dinesh he wrote a book by firs reading the articles and books on a topic, pondering for a while, and then writing the book straight out. I heard him often thumping the keys of his golf ball typewriter. Dinesh caught him out, discovering a mistake in his well known algebra text, which appeared in the same form in another book! Lang was forced to admit he had simply copied from the other book. The writer was able to share with him Lang's joining the anti Vietnam war protests at Columbia, occupying the mathematics building with the students. Lang then decided he was done with politics since "mathematics was forever", and wrote an apologia entitled 'The fire within, the fire without'. Dinesh was able to complete this part of the conversation, reporting on further political activities of Lang when Dinesh was at Harvard.

We had a wide ranging and interesting conversation, fortuitous for me because his host, Daniel Delbourgo, could not be at the university on the day, his partner having come down with covid-19. For example Dinesh reported he had gone to Steve Gonek, the COD at Rochester where Dinesh is professor of mathematics, seeking a reference to the Hilbert-Polya conjecture, given he could not find one in the literature. Steve could not help. However, I was able to point to several pages on the conjecture in Equivalences vol I, with a reference to a paper of Hugh Montgomery, Gonek's PhD supervisor!

Kevin Broughan

MASSEY UNIVERSITY

SCHOOL OF MATHEMATICAL AND COMPUTATIONAL SCIENCES

The Auckland campus weathered the Auckland Anniversary weekend floods with minimal damage sustained. The Sir Neil Waters building was used as a Civil Defence centre for the North Shore and a number of people requiring emergency accommodation stayed in Te Ohanga Village (student accommodation). Several weeks later the campus was preemptively closed for several days while cyclone Gabrielle passed, and the Manawatū campus was also closed after a power outage during the cyclone. After all that excitement the year started smoothly, with all courses running as scheduled.

We welcome Tai Paul, who takes up the role of Mathematics Kaitautoko Senior Tutor.

Congratulations to Sidra Zafar, who successfully defended her PhD in mathematics entitled "An equation-free approach for heterogeneous networks". Her thesis was passed with emendations. Sidra was supervised by Alona Ben-Tal with the assistance of Robert McLachlan and David Simpson.

The 2022 NZMS colloquium was attended by Richard Brown, Bruce van Brunt, Indranil Ghosh, Brandon Jones, Carlo Laing, Tammy Lynch, Mick Roberts, David Simpson, Winston Sweatman and Chris Tuffley

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

We have quite a few interesting news from Te Herenga Waka in Wellington:

New head of School is Prof. Lisa Orloff Clark! We welcome Lisa while we thank Prof Ivy Liu for being a wonderful head of School.

Prof Rod Downey has been awarded the S. Barry Cooper prize. Instituted by the Association Computability in Europe, it is awarded every two to three years "to a researcher who has contributed to a broad understanding and foundational study of computability by outstanding results, by seminal and lasting theory building, by exceptional service to the research communities involved, or by a combination of these." Congratulations to Rod!

AProf Peter Donelan has been retired. Peter was appointed as a Lecturer (half-time) in the Mathematics Department at Victoria on 1 February 1982. In 1989 he moved to a full-time position and was promoted to senior lecturer, then associate professor in 2019. His research has centred on singularity theory and algebraic geometry, in particular with applications in robotics. Peter was Head of the School of Mathematics, Statistics and Computer Science from 2001-04 and (after the formation of the Faculty of Engineering) the School of Mathematics and Statistics from 2013-18. In the past two years, he was also the acting Director of the university's Centre for Science in Society. Peter was a member of the NZMS Council from 2008-12, including being its Treasurer 2009-12. He has been the Society's archivist and honorary correspondent for Victoria. In 2007, he co-convened the first joint New Zealand and American Mathematical Societies Conference that was held in Wellington. He was awarded Fellowship of the Society in 2018.

Ilija Tolich is a new mathematics postdoc working with Lisa Orloff Clark and Astrid an Huef. Ilija studied mathematics at Otago and completed his PhD there in Mathematics in 2017 supervised by Astrid and Iain Raeburn. After teaching briefly at Otago he took a sharp detour to work at the Ministry of Business, Innovation and Employment in the New Zealand Space Agency. At the NZSA Ilija worked on developing policy for the New Zealand aerospace sector which was kickstarted by Rocket Lab in 2017. Now Ilija has returned to mathematics and is enjoying getting re-acquainted with C^*-algebras.

Keith White is our visitor for T1, who he will be helping Dr Tanya Gvozdeva in teaching first year courses in mathematics. Keith grew up in Washington State in the United States. He studied Mechanical Engineering at Brigham Young University and after working in the manufacturing software industry, transitioned to teaching mathematics at Utah Valley University in Orem, Utah, where he taught for 15 years. He's currently on sabbatical and spending trimester one at VUW. The an-

nual Fluids in New Zealand (FiNZ) workshop was successfully hosted at Victoria University of Wellington over 15–17 February. We had 55 participants in total, the majority of which were able to make it in-person in spite of the extreme weather generated by tropical cyclone Gabrielle. There was an excellent range of presentations and some engaging discussions over the 3 days. The organisers would like to thank all of the participants for their contribution to the workshop. The workshop was generously supported by NZMS, ANZIAM–NZ, Resonint Limited and the VUW Simulation, Numerics, Analytics and Programming (SNAP) hub.

Dimitrios Mitsotakis

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Blair Robertson* and *Rosalind Cameron* on their Faculty of Engineering Established Teaching Award and Emerging Teaching Award, respectively, for 2022.

Congratulations to *Jeanette McLeod* and *Phil Wilson* for receiving the Gillian Thornley Award at the NZMS Colloquium for their "outstanding contributions to mathematics and science communication. Jeanette and Phil are the brains and hands behind the highly successful Maths Craft initiative, which has reached thousands of people of all ages at its public events and workshops since 2016 and through the Maths Craft in a Box project in 2021 and 2022. Jeanette and Phil's dedication and brilliant communication of mathematics to the general public have had demonstrable effects in promoting mathematics and in making the wider public aware of its beauty and usefulness for everyone."

Best wishes to *Rosalind Cameron* and Jole on the birth of their first child, Zachary, in late November and to *Rachael Tappenden* and Tim Candy on the safe arrival of their second child, Thea, in December, a sister to big brother Liam.

The last few months saw a number of staff changes. *Leigh Davidson* retired in mid December. Leigh had a long career at the University of Canterbury, working in various roles, departments and offices. For the last five years she had been with us and had been the School's Postgraduate Administrator.

Following Leigh's retirement *Yo Ruiters* was appointed to the position of School Administrator. The School also welcomed two new part-time School Administrators, *Kim Young* and *Alessandra Solomons*. Kim joined us in late February. Originally from the UK, Kim lived in NZ for 27 years. Before moving to Christchurch in 2018, she lived in Auckland, then Tauranga. Kim has worked in a variety of admin and HR roles, including the last five years with St John. Outside of work, Kim enjoys skiing, cycling, and walking their old Staffie cross, Milo. Kim and her husband have also recently bought a motorhome and try to head away in that for weekends whenever they get the chance.


Kim Young (left) and Alessandra Solomons

Alessandra, who started in early March, is originally from Brazil and lived in the UK for 18 years, before moving to Christchurch in 2019, with her husband and son. Alessandra's family have just started a new chapter in their lives with her son starting school in term 1, and Alessandra returning to work after being a stay-at-home mom for the last few years. The family are also in the process of adopting a dog from the SPCA shelter, which they are very excited about – soon to become a family of 4.

In mid-January the School welcomed *Tessa Grant*, who is stepped into the lecturer position whilst Rosie Cameron is away on maternity leave. Tess is from Christchurch, and a recent UC graduate, completing her BSc with honours, majoring in mathematics and psychology, half way through 2022. Tessa's research project focused on how craft activities can be used to develop mathematical concepts in a university setting, reflecting her interest in mathematics education. She is not new to roles in the School, having worked as a tutor and research assistant the last couple of years. Outside of work time, Tess can often be found relaxing with a book, or catching up with the latest movies and tv shows.

In early March *Jesse Lansdown* took up a two-year fixed-term lecturer position in the School. He has moved to Christchurch from the slightly warmer Perth, Australia. Jesse obtained his doctorate jointly from the University of Western Australia and the RWTH Aachen University in Germany in 2020, before working as a postdoc in the Centre for the Mathematics of Symmetry and Computation at the University of Western Australia. His research interests lie largely in algebraic combinatorics and its intersection with other areas of mathematics. Jesse also enjoys riding his motorcycle and getting involved with his local church, and he drinks too much coffee (he will fit in very well here).

Jesse Lansdown

In late March the School welcomed *Leighton Watson* as a lecturer in applied mathematics. He returns back to New Zealand after six years in California, having completed a PhD in geophysics at Stanford in 2020, and a two year remote postdoctoral fellowship at the University of Oregon. After a year in the School of Earth Sciences at the University of Canterbury, he has relocated to Te Kura Pāngarau – returning to his undergraduate roots in mathematics. His research focuses on how geophysical data (seismic and acoustic) can be combined with physics-based computational simulations to better monitor and understand natural hazards, with a particular emphasis on infrasound (low frequency acoustic waves that are below the frequency limit of human hearing) and volcanic eruptions. Motivated by interesting observations of natural activity, a desire to reduce risk, and a strong scientific curiosity, he develops numerical models that are derived from fundamental physics. Leighton validates these models by acquiring his own data, or by comparing with existing geophysical data and visual observations, and then use the validated models to learn about the behaviour of complex systems in order to improve monitoring efforts and hazard assessment. If he's not around, likely he might be engaged in field work on the face of Ruapehu installing fibre optic cables to monitor volcanic activity. Leighton is interested in a wide range of applications (with recent work on COVID-19 modelling, snow avalanches, and fiber optic sensing) and welcomes new collaborations! He is also a regular at the local playground with his 2-year old daughter during the weekend, and he plays soccer as part of his local league as centre defence for the Halswell Bombers.

Leighton Watson

In mid-February, *Mike Steel* and *Charles Semple* hosted a 4-day workshop on 'phylogenomics and evolutionary networks' at the Sumner Surf Lifesaving Club. The meeting involved 24 participants (approximately half from overseas). The workshop was based around the visit of Daniel Huson (University of Tübingen, Germnay) who is a mathematician working in phylogenomics, as well as in geometry/tiling theory. Daniel's visit is the second in three yearly visits under the Catalyst International Leader programme funded by the Royal Society Te Apārangi. Daniel also brought three of his PhD students to NZ for part of his seven week visit. The Sumner workshop featured two seminar-style talks per day so most of the time was spent in discussions and small informal working groups.

Megan Luce, hosted by *Jenny Harlow*, has joined the School in mid-February as a Visiting Scholar while she is on sabbatical from Cascadia College in Seattle, Washington, USA, where she is senior tenured faculty in Mathematics. For over 20 years Megan has taught mathematics of all levels from pre-algebra to Calculus, but her current focus is on helping students be more successful in introductory math classes. While at

Cascadia she has developed curriculum and reformed pedagogical practices to focus on active learning and culturally relevant mathematics, as well as led the department in rethinking placement and pathway policies. She is deeply involved in improving student transition from high school to college mathematics at the national level and has served since 2013 as the Higher Education Math Lead for the Bridge to College Math course taught in high schools across Washington state. During her sabbatical she is working to revise the open-sourced textbook and teacher resources associated with the course. She also teaches pre-service primary school teachers at Cascadia and plans to connect with local educators in New Zealand on math education issues. Megan is accompanied by her family, her husband Lindsay is also a Visiting Scholar at UC during this time. All four of them are excited to be in New Zealand for five months since they love to hike, kayak, ski, and explore beautiful places.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Congratulations to *Leanne Kirk* for being awarded the Division of Science Outstanding Professional Staff award in the category Administration. The citation reads: *Leanne is described as an outstanding professional staff member and the Department of Mathematics & Statistics are proud and grateful to have her energy, enthusiasm and deep departmental and institutional knowledge. 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. She is the friendly face on reception that puts students and staff at ease; the patient teacher explaining processes and procedures to new staff and postgraduate students; and the experienced and concerned colleague helping a team member transition back to work after time off sick. Quite simply, the Department is a better place with Leanne.*

A second Division of Sciences was awarded to *Phil Wilcox*, namely the Innovation in Māori or Pasifica Content award. His citation reads: *Through a number of initiatives both on campus and in Māori learning environments, Phillip has established new education innovations at the Te Ao Māori — Western science interface, particularly in the areas of genetic sciences, statistics and agriculture. These innovations include a genetics module at the marae-based Science Wānanga, the Summer Internship for Indigenous peoples in Genomics Aotearoa, and he's developed and taught Te Ao content across many papers. With assistance from fellow Genetics Teaching Programme members, Phillip has established a new role which oversees Māori content in the programme. Content in these papers includes tikanga Māori frameworks for research involving gene technologies, culturally informed co-design, Mātauranga Māori, Māori concepts of hereditary inheritance, and Māori perceptions of gene technologies and implications for agriculture.*

Continuing with our congratulations, the next person on our list is Mathematics and Physics student *William Waters*, who did very well in the recent Simon Marais Mathematics Competition. William got the Optiver Prize (worth AUD200) for his top score at the University of Otago. He was also tied for second place in all of New Zealand. Well done, William. All the best for your further studies!

Jörg Hennig

PhD SUCCESS

Elizabeth Kos McGeorge (University of Canterbury. 2023)

Title: Beyond observations: recovery of unknown parameters in ice flows using optimisation techniques and other tools.

Supervisors: Miguel Moyers-Gonzalez, Mathieu Sellier, Phillip Wilson (all University of Canterbury)

Abstract:
Basal slipping at the ice-bed interface is a key parameter in ice sheet modelling because it can have a large impact on the ice thickness. Unfortunately, its effect on surface observations can be hard to distinguish from that of bed undulations. Therefore, inferring the ice thickness from surface measurements is an interesting, useful, and non-trivial inverse problem. This thesis develops methods for simultaneously recovering the ice thickness and the basal slip, using only surface elevation and velocity measurements.

The shallow ice approximation, a time-dependent non-linear partial differential equation for ice thickness evolution, is chosen to model ice flow. Using this model, synthetic surface data is produced for given bedrock and basal slip profiles. To invert the synthesised data, a restriction to unidirectional ice-flow is initially explored. First, a semi-analytical approach is developed and studied. Following its success, an optimisation based approach is implemented. This method requires less data than the first, and its formulation is not dependent on the unidirectional simplification. Finally, the optimisation framework is extended to two-dimensional ice flow. This method recovers a linearised diffusion coefficient which gives the best fit to observations. Combining this recovered diffusion coefficient with observed surface velocity, a simple optimisation is used to recover both the ice thickness and basal slip.

The methods were successful for each test case. In all cases, the errors occurring had a clear source. Causes for error included proximity to ice sheet margins or ice domes, and overestimation of basal slip, which returns a related underestimate in ice thickness. The results for two-dimensional flow, show that while the inverse problem is challenging, it is possible to recover both of these parameters in certain scenarios and hence, the methods presented in this thesis can be useful for real ice flows.

Mozhgan Mohammadpour (University of Auckland. 2023)

Title: The construction of complex and quaternionic spherical designs.

Supervisors: Shayne Waldron, Sione M'au (all University of Auckland)

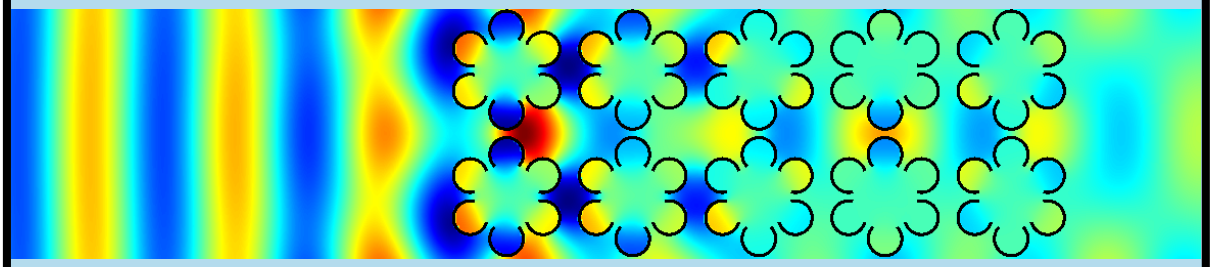
Abstract:
This involved various methods (convex unions, group orbits) to construct optimal spherical (t,t)-designs for the real, complex and quaternionic sphere. These are sets of well spaced points on the sphere which can be interpreted as cubature rules or nice packings of lines. These have potential applications in (quantum) information theory.

GENERAL NOTICES

KOZWaves 2024 in Dunedin, first announcement

KOZWaves 2024

The 6th Australasian conference on Wave Science



For its **10-year anniversary**, KOZWaves will be held at the University of Otago (Dunedin, New Zealand) from **Wed 31st January to Fri 2nd February 2024**.

KOZWaves promotes contemporary research on wave science and interdisciplinary collaborations between Australasian and international wave scientists.

Scope

Advancing mathematical, numerical and experimental approaches across the different branches of wave science, including **acoustics, elasticity, electromagnetics, water waves and gravitational waves**.

Important Dates

- **September 2023: abstract submission/registration opens**
- **November 2023: early-bird registration closes**
- **January 2023: conference programme announced**

For more info, visit the KOZWaves website:

https://kozwaves.github.io/

KOZWaves

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

NZMS NOTICES

NZMS Awards, Prizes and Fellowships

We are now seeking nominations for Fellows of the NZMS and the NZMS Research Award, the NZMS Early Career Research Award, the Gillian Thornley award and the Kalman Prize. Nominations for Fellows should be emailed to the NZMS President Melissa Tacy (melissa.tacy@auckland.ac.nz) on or before the 1st of June. Nominations for the prizes need to be emailed to Melissa on or before the 31st August.

Please note that the NZMS council has updated the rules governing these prizes, making the application process much simpler for several of the prizes. The updated rules can be found at https://nzmathsoc.org.nz/?awards.

Special considerations will be made for disruptions due to COVID, please see the awards and prizes page.

Any unsuccessful applicants from last year are warmly encouraged to update their applications and resubmit.

- **NZMS Research Award:** This annual Award was instituted in 1990 to foster mathematical research in New Zealand and to recognise excellence in research carried out by mathematicians in New Zealand. This Award is based on mathematical research published in the last five calendar years (2018-2023). This could include research published in books, journals, other peer-reviewed venues, or other types of high quality mathematical research.

- **NZMS Early Career Research Award:** This award was instituted in 2006 to foster mathematical research in New Zealand and to recognise excellent research carried out by early-career New Zealand mathematicians. Candidates will be judged on their best three published research outputs and a brief CV. Research outputs could include publications in books, journals, other peer-reviewed venues, or other types of high quality mathematical research.

- **Gillian Thornley Award:** This annual award was established in 2020 to recognise outstanding contributions to the cause or profession of mathematics in New Zealand. The award will be made to a person or group that has made an outstanding contribution to mathematics within NZ, with the nominations being assessed on the basis of the case made by the nominators. For the purposes of this award, "contribution to the cause or profession or mathematics" could include (but is not limited to) contributions to teaching and education, research leadership, outreach, engagement with government bodies, diversity, service to professional societies, mentoring, and communication of mathematics to a general audience.

- **Kalman Prize:** The Kalman Prize for Best Paper was instituted in 2016 to recognise excellence in research carried out by New Zealand mathematicians. The Prize will normally be awarded annually for an outstanding and innovative piece of research in the mathematical sciences published by a member or members of the NZMS. The Prize is for a single publication of original research, which may be an article, monograph or book, having appeared within the last 5 calendar years: 2018-2023. The value of the Prize is $5000. The Prize is generously funded by the Margaret and John Kalman Charitable Trust, and recognises the significant contributions to mathematics in New Zealand made by Professor John Kalman.

Dimitrios Mitsotakis

Next deadline for applications for Financial Assistance — 15 May

The NZ Mathematical Society has quarterly deadlines for financial assistance applications. Applications must be made well in advance (at least one month before the funded activity, but the earlier the better) and retrospective applications will not be considered. The remaining deadlines for applications for 2023 are: 15 May, 15 August, and 15 November. You should hear back from the Council within a month of the deadline. The types of grants are as follows.

NZMS Student Travel Grants

The NZMS invites applications from students for financial support for the presentation of research at conferences, attending workshops, and developing new collaborations. Typical grants for travel within NZ and Australia are in the range $200–$600. For travel further overseas, larger grants may be considered. To be eligible, a student must be based at an institution in New Zealand and be active within the New Zealand mathematical community. NZMS Student Travel Grants can contribute to costs including: flights, conference registration, accommodation, and travel-related costs associated with family responsibilities.

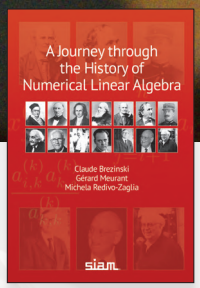
NZMS Student Travel Grants are generously supported by an annual grant from the Margaret and John Kalman Charitable Trust .

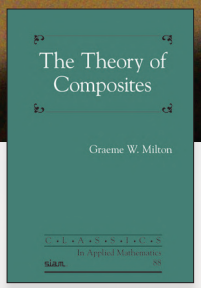
NZMS Financial Assistance

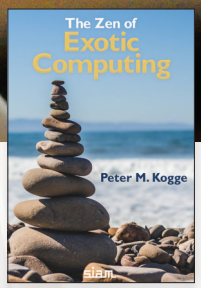
The NZMS invites applications for financial assistance with the costs of mathematical research-related activity. Any research-related activity will be considered. For example: hosting mathematical visitors; organising conferences, workshops, or outreach activities; and conference attendance, including costs associated with family responsibilities.

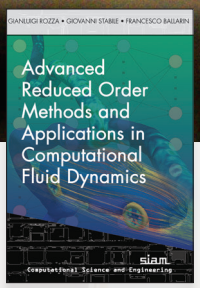
Further information and application details can be found on the NZMS website: http://nzmathsoc.org.nz/?assistance.

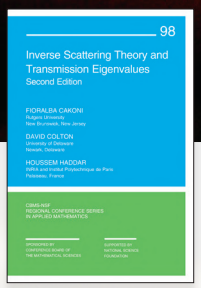
New books from SIAM











A Journey through the History of Numerical Linear Algebra

Claude Brezinski, Gérard Meurant, and Michela Redivo-Zaglia

This expansive volume describes the history of numerical methods proposed for solving linear algebra problems, from antiquity to the present day. The authors focus on methods for linear systems of equations and eigenvalue problems and describe the interplay between numerical methods and the computing tools available at the time. The second part of the book consists of 78 biographies of important contributors to the field.

2022 • xx + 792 pages • Hardcover • 9781611977226 • List $135.00 • SIAM Member $94.50 • OT183

The Theory of Composites

Graeme W. Milton

The Theory of Composites surveys the many aspects of composites and complements the new body of literature that has emerged since the book was written. It remains relevant today by providing historical background, a compendium of numerous results, and through elucidating many of the tools still used today in the analysis of composite properties. This book is intended for applied mathematicians, physicists, and electrical and mechanical engineers. It will also be of interest to graduate students.

2022 • xl + 719 pages • Softcover • 9781611977479 • List $99.00 • SIAM Member $69.30 • CL88

The Zen of Exotic Computing

Peter M. Kogge

The Zen of Exotic Computing is intended for computer science students interested in understanding alternative models of computing. It will also be of interest to researchers and practitioners interested in emerging technology such as quantum computing, machine learning, and AI.

2022 • xxxii + 386 pages • Softcover • 9781611977288 • List $89.00 • SIAM Member $62.30 • OT184

Advanced Reduced Order Methods and Applications in Computational Fluid Dynamics

Gianluigi Rozza, Giovanni Stabile, and Francesco Ballarin

Reduced order modeling is an important, growing field in computational science and engineering, and this is the first book to address the subject in relation to computational fluid dynamics. It focuses on complex parametrization of shapes for their optimization and includes recent developments in advanced topics such as turbulence, stability of flows, inverse problems, optimization, and flow control, as well as applications.

2022 • xxxviii + 462 pages • Softcover • 9781611977240 • List $99.00 • SIAM Member $69.30 • CS27

Business Dynamics Models
Optimization-Based One Step Ahead Optimal Control

Eugenius Kaszkurewicz and Amit Bhaya

This book introduces optimal control methods, formulated as optimization problems, applied to business dynamics problems. Business dynamics refers to a combination of business management and financial objectives embedded in a dynamical system model. The model is subject to a control that optimizes a performance index and takes both management and financial aspects into account.

2022 • xxii + 184 pages • Softcover • 9781611977301 • List $89.00 • SIAM Member $62.30 • DC40

Inverse Scattering Theory and Transmission Eigenvalues
Second Edition

Fioralba Cakoni, David Colton, and Houssem Haddar

Inverse scattering theory is a major theme in applied mathematics, with applications to such diverse areas as medical imaging, geophysical exploration, and nondestructive testing. The inverse scattering problem is both nonlinear and ill-posed, thus presenting challenges in the development of efficient inversion algorithms. A further complication is that anisotropic materials cannot be uniquely determined from given scattering data.

2022 • xii + 246 pages • Softcover • 9781611977417 • List $76.00 • SIAM Member $53.20 • CB98

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