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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 Florian Lehner. 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 newsletter@nzmathsoc.org.nz. LaTeX templates are available upon request from the editors.

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EDITORIAL

Welcome to the April edition of the NZMS newsletter.

One of the highlights of this newsletter is the mathematical artwork from the annual art competition held at the University of Auckland in celebration of the International Day of Mathematics, commonly known as Pi-Day. We also get to peek behind the scenes of the making of one of the artworks, Knitting Circle: a twisted challenge by The Valkyries.

The profile focuses on Stephen Marsland speaks about his life, the current state of AI, and of course his research which covers an impressive range from pure mathematics and machine learning to mobile robotics, medical imaging, and recognition of kiwi calls.

On a final note, the editorial team is seeking for a motivated soul to take over Marie, who will be stepping down as an editor after an impressive 5 years of service.

Marie Graff and Florian Lehner

PRESIDENT'S COLUMN

It has been Easter and almost a third of the New Year has passed already. Many thanks to editors Marie Graff and Florian Lehner for putting together this issue of the NZMS Newsletter, and also to all contributors.

While it has been reasonably quiet as far as internal NZMS matters are concerned, there are some larger issues that I would like to update you on.

On 16 April, the Save Science Coalition, of which the NZMS is a member, released its latest publication "Underfunding our future: the human face of science cuts." This is a report that outlines the stories and real experiences of scientists who have been affected by the cuts within the science system. It also contains excerpts from a 2024 report that outlines how much funding was recently lost across the sciences; you can access the report from http://scientists.org.nz/Save-Science-Coalition. While none of the featured ten scientists are mathematicians, these recent changes have affected our community just the same. In particular, the looming end of the Marsden fund as we know it, and the reduction in the funding available already this year, are stark reminders of a much more challenging funding landscape, especially for fundamental research.

This is a special year for Mathematics: the International Congress of Mathematicians (ICM) will take place in Philadelphia in July. This is supposed to be a celebratory event, and you may already be curious who will be the recipients of the Fields Medals. Unfortunately, the 2026 ICM falls into a time of increasing turmoil, so much so that the Executive Committee of the International Mathematical Union (IMU) felt it necessary to issue a statement to address concerns that have been raised within the mathematical community about attending this event; to quote:

"Promoting international exchange is at the core of the IMU's mission. At a time when international collaboration and science face serious challenges, we strongly believe that holding the ICM in person in Philadelphia is especially important. We understand the concerns about entering the United States, as well as about feeling safe and welcome in Philadelphia and at the Congress. The Local Organizing Committee is fully committed to providing a safe and welcoming environment for all participants and has recently made additional arrangements to help mitigate risk."

The NZMS is a constituent organisation of the IMU (via the Royal Society Te Apārangi) with voting rights at the General Assembly (GA), which will take place just before the ICM. I am grateful to Council member Priya Subramanian (UoA) for representing our society in person at the GA and the ICM. Clemency Montelle (UC) will attend both these events as well, namely, as chair of the IMU's International Commission for the History of Mathematics and as invited Section Leturer in Section 20 — History of Mathematics.

All the best,

Bernd Krauskopf

Partial Sequence Match

PARTIAL SEQUENCE MATCHING

Comparing polynomial coefficients in a given partial sequence match with those that arise in a companion sequence of inverse terms

The business of seeking to determine the next term in a partial sequence of numbers is a popular past time that is promoted rightly to encourage students in getting to grips with notions of relationships between numbers. The purpose of this note is to exhibit a relationship between coefficients in polynomial matches to partial sequences when there is a specific relationship between the respective terms of each sequence.

A polynomial representation approach, whereby some consecutive terms in a sequence are matched/reproduced by output from a polynomial-fit was described in The Mathematical Gazette (Vol. 108 No. 573, November 2024). This process resulted in the use of simple concepts arising in elementary matrix theory to find requisite coefficients of the polynomial together with its order, depending on the number of terms to be matched. Briefly, the points to appreciate from the above reference is that, for terms of the sequence S, viz., $\{S : T_1; T_2, T_3, \ldots, T_{m+1}, \ldots\}$, it is possible to match the first $(m+1)$ terms by a sequence $\{F(1), F(2), F(3), \ldots, F(m+1)\}$, where $F(p)$ is a polynomial expression (of order m in p) in the form

$$F(p) = T_1 + \sum_{i=1}^{m} A_i (p-1)^i \tag{1}$$

and where the coefficients A_i $(i = 1, 2, \ldots, m)$ that are required to support the match are secured by imposing the the constraint condition $F(p) = T_p$; $p = 1, 2, \ldots, m+1$. This leads immediately to a matrix equation for the determination of the coefficients A_i $(i = 1, 2, \ldots, m)$. Thereafter, the terms $F(m+2), F(m+3), \ldots$, of the polynomial generated sequence will in general be different to those in the sequence S. It is likely that other polynomial type representations exist, but the one proposed here can be employed to capture the surprise next term value of “31” in the particular sequence $\{1, 2, 4, 8, 16, \ldots\}$, which was a result established earlier by the Mathematician Leo Moser, using other methods.

The matrix equation drawn from (1) can be presented in the form

$$[\mathbf{M}]\ \underline{\mathbf{A}} = \underline{\mathbf{b}}, \tag{2}$$

where, in the usual matrix notation of i for rows and j for columns, the elements $m_{i,j}$ of the $(m \times m)$ matrix $[\mathbf{M}]$ are simply

$$m_{i,j} = i^j \quad (i = 1, 2, \ldots, m; j = 1, 2, \ldots, m). \tag{3}$$

The unknown elements of the column vector $\underline{\mathbf{A}}$ are the A_i terms cited above, and the known elements in the column vector $\underline{\mathbf{b}}$ are the terms $[T_2 - T_1, T_3 - T_1, \ldots, T_{m+1} - T_1]$. A solution to (2) is given formally by

$$\underline{\mathbf{A}} = [\mathbf{M}]^{-1} \underline{\mathbf{b}}. \tag{4}$$

The superscript “-1” denotes the matrix inverse. Such appreciations should be well within the grasp of an undergraduate or aspiring sixth former who is familiar with the elements of matrix multiplication and associated mathematical manipulations using, say, a spreadsheet of the excel variety or some other software package.

Now, to meet the brief, it will be assumed that the reader is familiar with the above so that its formats can serve to address also another, related partial sequence of $(m+1)$ terms, denoted by $\{S' : T'_1; T'_2, T'_3, \ldots, T'_{m+1}\}$. The corresponding column vectors for this sequence will be denoted by $\underline{\mathbf{A}'}$ and $\underline{\mathbf{b}'}$ in the above, rather than $\underline{\mathbf{A}}$ and $\underline{\mathbf{b}}$, but the matrix $[\mathbf{M}]$ will perforce be unchanged. In the case of this second sequence, the elements will be chosen to be the inverse of those in the first sequence, that is to say, the respective elements are related by $T_p T' * p = 1$; $p = 1, 2, \ldots, m+1$. There will thus be a matrix relationship between the corresponding column vectors $\underline{\mathbf{b}}$ and $\underline{\mathbf{b}'}$, in the form

$$\underline{\mathbf{b}'} = [\mathbf{P}] \underline{\mathbf{b}}, \tag{5}$$

where the matrix $[\mathbf{P}]$ is purely diagonal with elements given by

$$p_{i,i} = -(T_1 T_{i+1})^{-1}, \quad i = 1,2,\ldots,m. \tag{6}$$

It is thus now possible to exhibit from the above a straightforward matrix relationship between the respective column vectors $\underline{\mathbf{A}}$ and $\underline{\mathbf{A}}'$, in the form

$$\underline{\mathbf{A}}' = [\mathbf{M}]^{-1}[\mathbf{P}][\mathbf{M}]\underline{\mathbf{A}} \quad \text{or equivalently} \quad \underline{\mathbf{A}} = [\mathbf{M}]^{-1}[\mathbf{P}]^{-1}[\mathbf{M}]\underline{\mathbf{A}}'. \tag{7}$$

This relationship is not necessarily a simple one. As an example, consider the above mentioned partial sequence of five terms, viz., $\{S: 1,2,4,8,16\}$[1] Equipped thus with data to determine the elements of matrices $[\mathbf{M}]$ and $[\mathbf{P}]$ (from (3) and (6)), spreadsheet facilities can be used to reduce the matrix formulation in (7) to that of a single matrix, viz.,

$$\underline{\mathbf{A}}' = \frac{1}{96}\begin{pmatrix} -90 & -24 & 48 & 48 \\ 53 & -40 & -124 & 52 \\ -12 & 18 & 30 & -54 \\ 1 & -2 & -2 & 10 \end{pmatrix}\underline{\mathbf{A}}. \tag{8}$$

It can be seen from this example that the relationship between respective $\underline{\mathbf{A}}$-type column vectors is somewhat complicated. It is possible of course to determine the "next term" in the match for both the sequence in hand and its inverse by determining explicit solutions to equation types corresponding to (4) for use in (1). It is a straightforward exercise and for the first sequence, the well known surprise "Moser" result concerning the sixth term is recaptured, i.e., $\{S: 1,2,4,8,16,31,57,99,\ldots\}$; the sixth term is 31 not 32 as might be expected. For the second sequence of inverse terms, the result is $\{S': 1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{16}, \frac{3}{16}, \frac{9}{16}, \ldots\}$. Interestingly, the polynomial match to five terms for this sequence shows the sixth term to be the same as the fifth term (not the anticipated "$\frac{1}{32}$"), which is a case specific coincidence because such does not appear to carry over when more or less terms are matched, but nonetheless it is maybe just as surprising a result as for the first sequence. The exercise can be extended by considering, say, either more terms in the partial sequences or a different type of relationship, other than an inverse one, between the respective terms of each sequence.

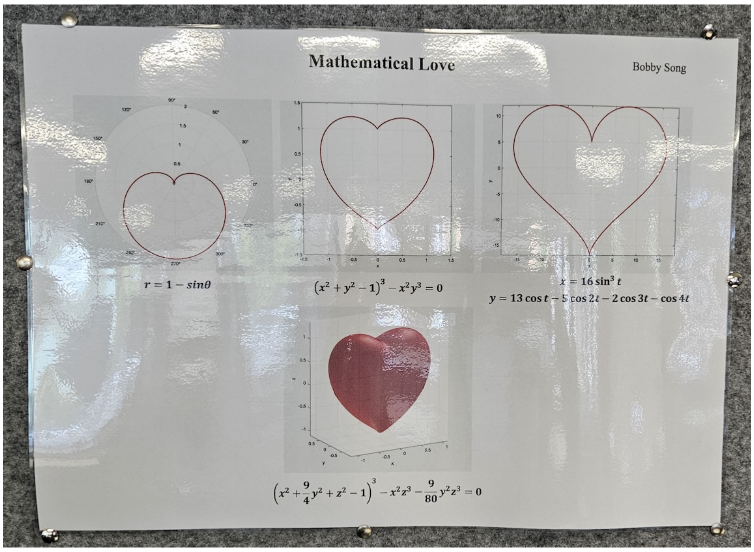
John D Mahony

[1] The corresponding partial sequence of inverse terms is $\{S': 1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}\}$.

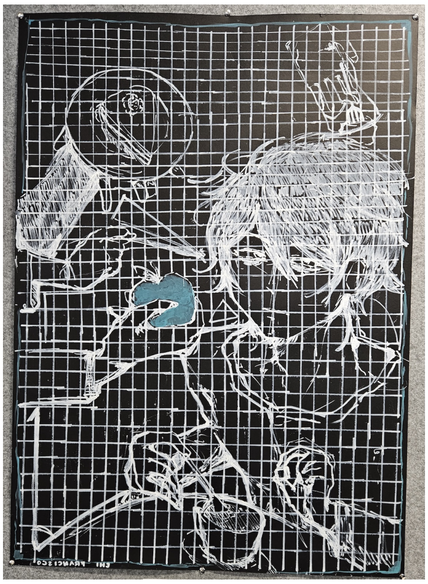
π-DAY: MATHS & ART COMPETITION AT UOA

March 14th (3.14) is π-day, a symbolic date for us Mathematicians. As last year, Nicolette and Jonny decided to organise a contest of the best art piece about mathematics at the University of Auckland. 2026 is the third issue of this contest, the premiere having been launched in 2024. Staff and students were invited to participate by submitting their artwork, which was displayed during a week and subject to votes.

This year, no less than thirteen wonderful entries have been presented with very diverse techniques: sculptures, drawings, collages... each depicting some mathematical concepts or situations. Enjoy the gallery!



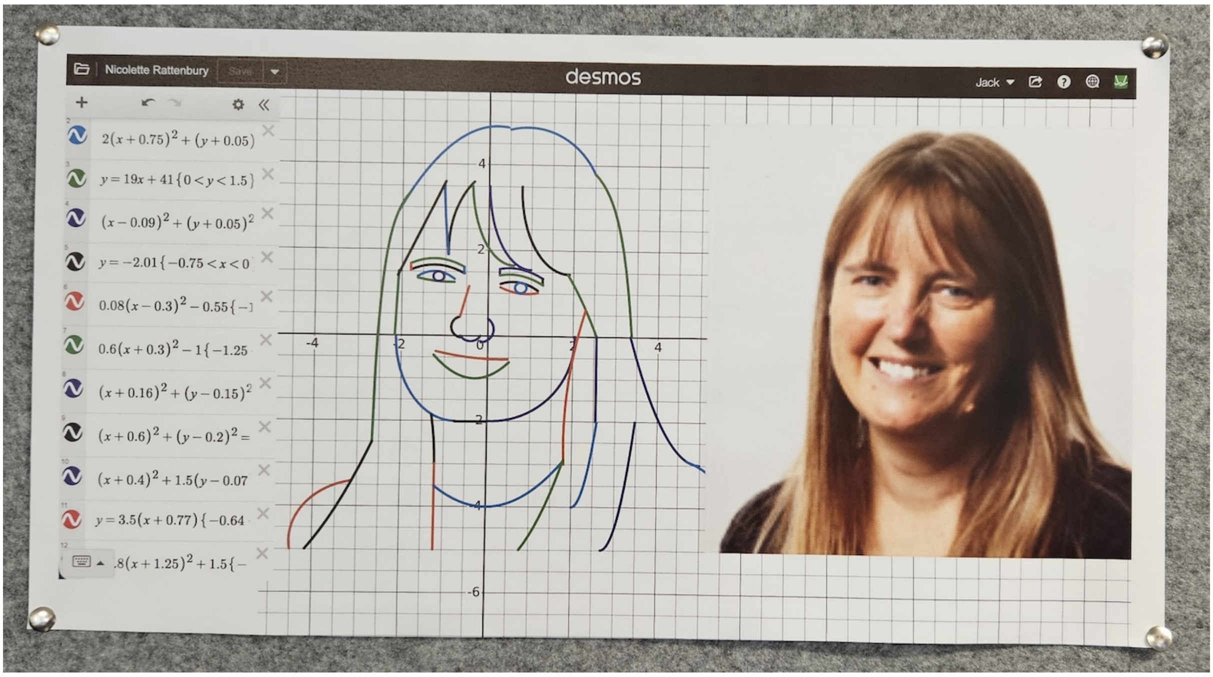
Mathematical Love
by Bobby Song



All gridded
by Chi Francisco

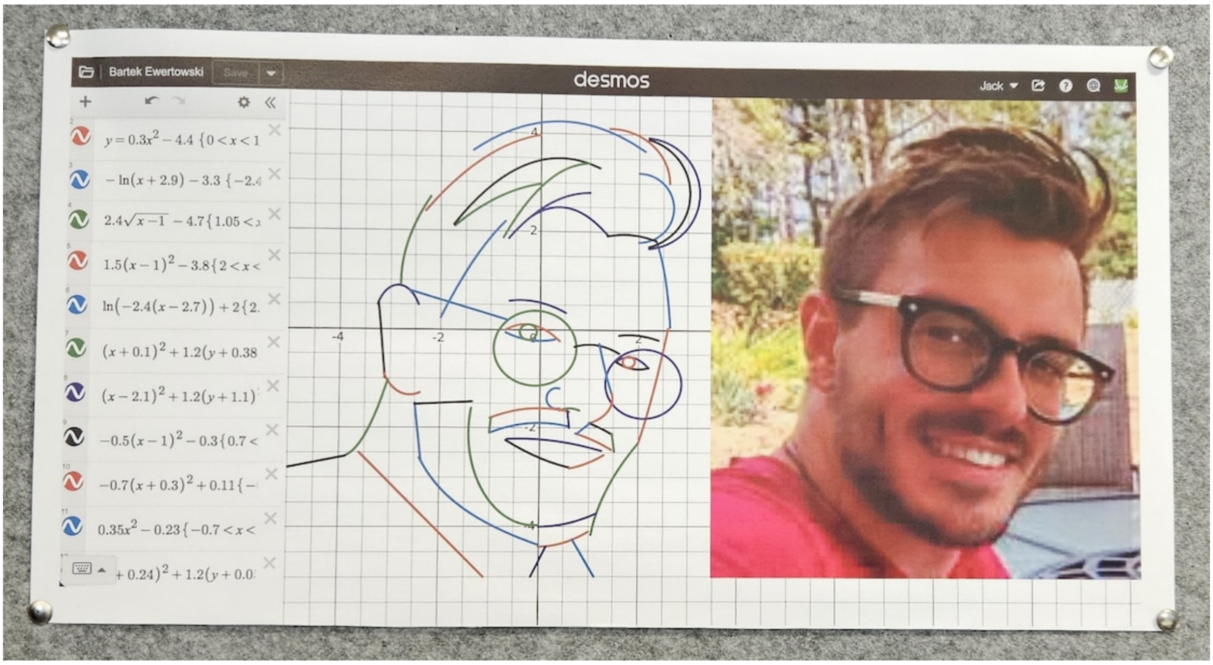
Lords of the Π
by Rhea

$4 \times 4 \times 4 \times 4 \times 4(0)$
by Iliana (4) & Amber (40)

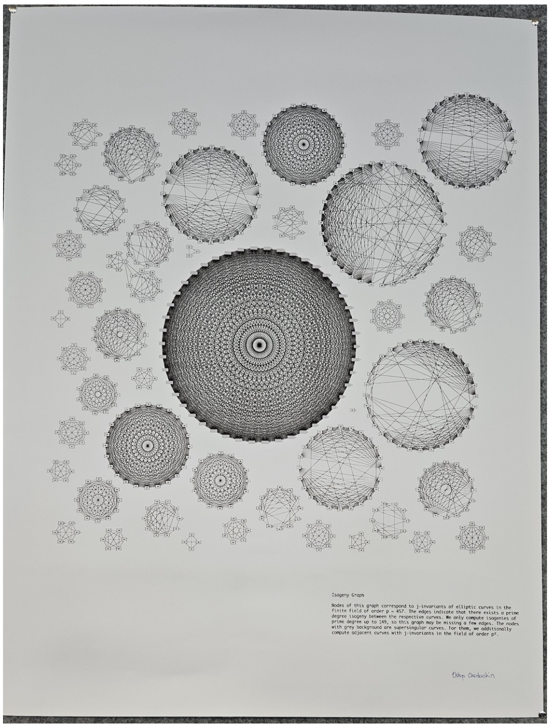


Scan to view on Desmos :)

Bartek Nicolette



Desmos Drawings
by Jack Chen



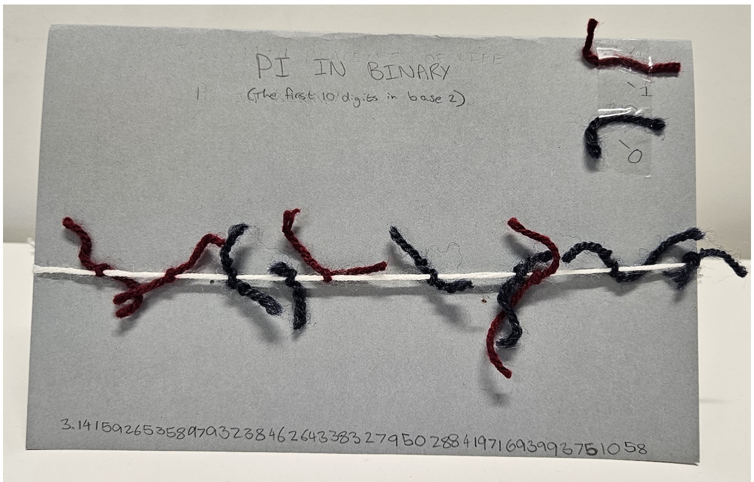
Isogeny graph
by Ostap Cherkashin

Large Discriminant Orientations
by Ostap Cherkashin

The Wanderer
by Aimee Lew

Knitting Circle: a twisted challenge
by The Valkyries (see dedicated section)

"Diamond window cube" origami earrings
by Claire Postlethwaite



Pi in Binary
by Alice Donovan

*The Upside-Down Table (Proof beyond sight)**
by Elizabeth Esscher

**A mathematical solution can sometimes feel, confusing and utterly strange- not making much sense. Sometimes we simply aren't at the level needed to understand it yet. But that does not mean it isn't still there.*

Mathematics still stands, structurally perfect and absolutely solid (even if it seems like it's all just tipped on its head). Perhaps, like if you were to try observe something in a higher dimension. Imagine a good simple table form. An object resembling a table stands on its legs by itself. It does not need us to hold it up. In the same way, mathematics supports itself. We do not make it stand; we discover it and learn to make use of it's beautiful properties.

Sometimes we cannot see the solution from where we are but hopefully- later, with effort and new capabilities, we will. Just keep looking.

At the end of the voting period, congratulations and prizes were awarded to "Isogeny Graph" by Ostap Cherkashin.

Nicolette and Jonny plan to run this event again next year and hope to see even more entries!

Marie Graff

KNITTING CIRCLE: A TWISTED CHALLENGE

Entry for the International Day of Mathematics 2026

Dynamical systems workshops do not usually feature any craft, but they do tend to act as a fertiliser for original mathematical ideas. In November last year, Claire Postlethwaite, Hinke Osinga, Lauren Smith, and Vivien Kirk found themselves together at Sydney airport waiting for their flights to Auckland after the fruitful, kangaroo filled workshop *SDG Kioloa 2025*[2]. At least two people in this party regularly knit, which may be why the fertilising effect of SDG shifted its focus to the crafty side of mathematics: would it be possible for more than one person to be knitting on the same project, at the same time? Claire, in particular, got rather excited by the idea and proposed to start an experiment: have several people knit in the round, each with their own circular needles, but such that these needles, together, carry one large circle of stitches that can, thus, be knitted without changing or swapping needles.

Some of *The Valkyries* involved in the knitting project.

The experiment was successfully conducted in December, during the annual Women in Maths, Physics and Stats networking meeting at Vaughan Park, Auckland. Claire had brought five balls of yarn and, with the help from fellow crafters, we also had five circular kneedles of reasonably similar thickness. As the project got started, we realised that the yarn used for each of the five circular kneedles creates its own circle of stitches, producing five parallel rounds each time everyone completes one full circle. The meeting at Vaughan Park lasted only one day, and was packed with other sessions and activities from noon on the 9$^{\text{th}}$ till noon on the 10$^{\text{th}}$ of December; in order to ensure completion of the knitting project, knitters were swapping in an out on a near-continuous basis. So much so, that we cannot even recall exactly how many women were involved in the end. . . . The entire group of knitters was given the name *The Valkyries* and the photograph shows, clockwise starting front right, Hinke, Claire, Parul Tiwari (barely visible), Alys Clarke, and Tammy Lynch; other identified members of *The Valkyries* are Erin Leitao, Jeanette McLeod, Laura Burn, Talia Xu, and Vivien Kirk, but there may have been others.

With about 1000 stitches in total, *The Valkyries* managed to complete four rounds, after which one of the balls of yarn had been depleted. With a total of 20 rounds on the circular strip, we were satisfied that the project had been a success. Claire was tasked with casting off all stitches, and Hinke would finish the work by weaving in any loose ends of yarn. The final product has a circumference of about 4 m, so just casting off took an entire weekend.

[2]Here, 'SDG' technically stands for Syndey Dynamics Group, but the acronym has represented Dynamical Systems in Australia and New Zealand since 2015.

On Sunday 14 December, when Claire had finished casting off, she made a surprising discovery: while the knitted strip was topologically a cylinder, it turned out to have a non-trivial embedding in $\mathbb{R}^3$! Unwittingly, a twisting of the cast-on stitches must have been introduced before joining into a circle. This is a common mistake when knitting in the round, and the chances of it occurring were multiplied by five in this five-needle experiment. Which person, or persons, made the error shall never be known, but spirits were low when Claire realised what had happened. Her daughter Alice found a plausible use for the knitwork, nevertheless, and the picture on the right sees Alice modelling the finished work as a scarf that would more likely serve as an intriguiging accessory to a modern outfit than offer any warmth for the coming winter months.

Alice models the non-trivial topological cylinder.

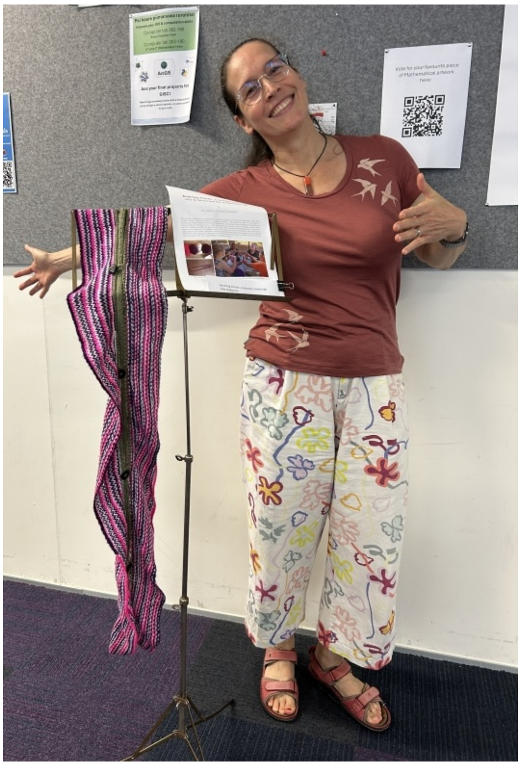
When Claire handed the strip to Hinke, they discussed a mathematical representation that is well known in dynamical systems: the unstable manifold of a periodic orbit, just after a period-doubling bifurcation, is topologically equivalent to a Möbius band, but this manifold is, in fact, an orientable surface with non-trivial embedding in $\mathbb{R}^3$ when the periodic orbit is removed. The two crafter mathematicians managed to control the unwieldy knitted strip and decided that it should be possible to twist it into a Möbius band.

The addition of a periodic orbit can transform the knitted strip into a Möbius band.

Hinke pressed the knitted work into a presentable flat strip and spent another weekend, and a couple of evenings, knitting a ‘periodic orbit’ of the required length; she then crocheted along the ‘inner’ boundary of the knitted strip, attaching 19 buttons and an equal number of small loops uniformly distributed along the 4.30 m edge. By knotting the loops to the buttons alternatingly over and under the closed loop, the periodic orbit becomes attached to its unstable manifold and the combined objects form a Möbius band.

Quite a few curious observations were made along the way:

- Indeed the odd number of 19 buttons can alternatingly be tied over and under the closed loop, precisely because the resulting object is a Möbius band;
- The assembly of the unstable manifold with its periodic orbit seems easy at first glance, but this puzzle has proved to be a lot more challenging; the knitted strip must be untwisted in a special way to create an unknotted surface;
- The periodic orbit and its unstable manifold must be linked, which means that the untwisting of the knitted strip can cause a non-trivial knot with the closed loop, creating another level of orientation that must be adhered to during assembly.



‘Knitting Circle: a twisted challenge’ at π-day.

In all, it is highly recommended to use at least two persons, preferrably more, to solve the puzzle of the twisted circular knitwork.

The final work was entered in the art competition for the International Day of Mathematics 2026, also known as π-day, that was organised by Nicolette Rattenbury and Jonny Stephenson. The exhibit opened on Friday 13 March and a total of 11 entries were on display for one week. Despite vigorous advertising in the postgraduate Dynamical Systems course, the entry by *The Valkyries*, titled ‘Knitting Circle: a twisted challenge’ did not win; given the superb quality of all entries, this can hardly be considered an defeat and The Valkyries gracefully bow to PhD student Ostap Cherkashin whose winning entry ‘Isogeny Graph’ was a striking visual illustration of number theory.

The Valkyries

PROFILE

Stephen Marsland

Photo provided: Stephen and Tashu

Can you tell us something about your early life and education? How did you get into mathematics?

Both of my parents were maths teachers! I have two mathematical memories from that. We (my sister and I) were only allowed to play computer games if my sister and I did our times tables first. My dad would say: do your 17 times table or something, each time it was our turn to play.

The other one was from both parents. We were going on holiday to France, and we were talking about the length of the drive. I wanted to know if we were going the shortest way. One of them said, maybe, and if this is the shortest route, can you prove it? And apparently I sat silently in the back of the car for about three hours. It was my first idea that there was something like mathematical proof. I got the idea that there was a correctness and the idea that it wasn't science, because there was a true right answer. It's been useful for me twice—once as a mathematician and once in my current career as half a biologist, where I keep on thinking, "I can't prove this, and it won't be true for everything." Useful!

I studied mathematics at Oxford, then part III in Cambridge, and then PhD (2002) in Manchester, which included time at the Santa Fe Institute in the US. My PhD has a title with the words "mobile robotics" in it, bit weird for a mathematician.

It is actually the idea to look at if you took data that was infinite dimensional and looked at lower dimensional projections of it, how do you decide what distance information is preserved. So if you have data points that are far apart in the original space, do they stay far apart after projection? And whether you can define projections that preserve the right properties. It's part of information geometry now.

And I had a friend who was making maps with a robot, and that seemed a pretty cool way of trying out the ideas a bit. Finite dimensional, too, so you could actually compute things. So from my PhD, I have some maths papers, one on machine learning, and one on mobile robots. I declare myself to be as eclectic as I can be from that.

Yes, looking at your list of publications, eclectic is the word that comes to mind. I do remember that at that time the Santa Fe Institute was hot, everyone was talking about complexity theory and how they were going to be discovering fundamental laws of nature. What was it like at the Santa Fe Institute?

It was wonderful. People were visiting all the time. I like ideas, and somebody new would come and I'd go, that's really exciting. Jump on it, try and understand it. It was a lot of fun.

What do you think of complexity theory now?

Sadly, I think it's never lived up to the promise of what it could be. A lot of smart people have spent a lot of time thinking that there's something there, and it often ends up as being some quite simple little bit of graph theory or a little bit of dynamical systems theory, and not much else. The things that grew out of complexity theory, they're all nice, but... either we need another 100 years of development of stochastic calculus, or perhaps we're taking the wrong approach entirely.

And after Santa Fe?

I wasn't enjoying being in the US; I wanted to move back to Europe, and I ended up back in Manchester. Which was close enough to where I grew up that I was thinking, I don't want to stay here. Good things came of it, though. I met Carole Twining, a fellow postdoc who was working in medical imaging. I'd started thinking about diffeomorphism groups and Carole said, "I want to use that for medical imaging". We worked some stuff out and wrote a paper and the referee said, "you should have found these four other papers already". Oh, right.
I learned that David Mumford was also doing this, and Peter Michor in Vienna, and that's when I started to talk to those people and discover that there was some really cool maths there.

How did you come to move to New Zealand?

I was looking for a permanent job and to escape England. I applied for a computer science position at Massey, thinking, the worst that can happen is they tell me no. And if I got the job and hated it, then I can always move back. I got to New Zealand and discovered it was somewhere that made me really happy, I met a whole lot of people that made my both intellectual and personal life fantastic, and I've never looked back. I moved to Vic in 2018, because of the trouble at Massey then and because of the pull of Wellington.

And now your main research area is the study of bird song, ironically using machine learning which is where you started with your PhD.

That was never originally a machine learning project. It was actually an application of shape spaces. My idea was to compare contours from time-frequency plots using shape metrics. Unfortunately, that turned out not to work as well as using a neural network treating the spectrogram as an image which is still extremely depressing to me. Even worse, the invariance properties of the net are all wrong – it treats time and space on an equal footing.

Can you now recognise birdsong?

We can. We can recognize 78 species that are present in New Zealand. One of the interesting caveats is the noise really matters. Different recorders, even of the same manufacturer, have different noise profiles, and different places have different noise profiles. It's called domain adaptation in the machine learning literature, and it's really hard for sound. The other thing we're looking at is, can we recognize individuals? At the moment, this is mostly kiwi because I have the data for kiwi, we put spy microphones on the birds, so we know it's that bird calling. We've got the calls for 18 individuals, and we're trying to pick those out of background recordings and recognize them reliably.

You've also done a lot of field work with wildlife ecologists like Isabel Castro. Is that just for fun? How does that fit in with your research?

It is fun. It's amazing. When I was a kid I was interested in birds and did some bird handling. So I did know a bit about what might be involved, and then Isabel said, do you want to come on a field trip to Ponui Island? And obviously I said yes. I was hooked straight away. I started talking to Isabel about: Do we know this? For kiwi, do we understand this? Because we could measure that. And I think she was enthusiastic about having somebody who wasn't an ecologist, but wanted to be one. Now we co-lead the Ponui Island kiwi project, and birds seem to be taking over my life.

There's a lot of talk about the state and direction of research funding in New Zealand currently, and you're involved with Te Pūnaha Matatini, a Centre of Research Excellence. How important are centres like this?

I came to New Zealand just as the NZIMA was winding down. So I didn't have the experience of what it was like to be in a more mathematical CoRE, although I did benefit from some of their meetings, which were great. When TPM was being set up I read it as something like a nationwide Santa Fe Institute, lots of people thinking about complexity. Perhaps it started that way, but it spread into lots of things which were more aimed at science communication, science for societal benefits, Antarctica... Important things, but not what I, as a mathematician, wanted to be involved with. There were only a few mathematicians and they were all at the most applied end. However, we're a small country, so things that keep us talking and collaborating are important.

More important, though, is funding science, and blue skies science in particular. We're lucky that our jobs aren't directly linked to funding, but it certainly makes life easier, and we need it for students, post-docs, and for applied areas, field-work costs and similar. University researchers should have the freedom to try and fail, play with interesting ideas, get excited about odd things. Not just turn the handle on something that needs a bit of development that a company doesn't want to invest it.

With your background in machine learning, how do you feel about the current state of AI?

Amazed. I was always a skeptic about whether it would ever work. And even the authors of the transformers paper [that triggered GenAI] were surprised. It's just amazing, the power of the right representation. And maybe this is the power of a mathematical idea: you get the right representation and things work. And we're still stumbling around to find the right representation of things.

It's another example of the unreasonable effectiveness of applied mathematics.

I think it probably is. My problem with all this is it feels like we're in the same place that thermodynamics was in. We can build a steam engine, but it's obviously not efficient. If we had the laws of thermodynamics for machine learning, the stochastic calculus for it, we could presumably do better and understand how to make things improve and possibly where they're telling us to go and kill our grandmothers or whatever.

Do you think this is changing the value and purpose of studying maths?

Yes. It's already changed, and it's changed in some ways the same way that every other subject has changed, that generative AI can give you the answers. I tell my students, if you use ChatGPT, at least you have to know if it's correct and understand where it's coming from. I would have thought, but apparently I'm very wrong with this, that it would also persuade people that maths is worth studying. Writing computer code isn't going to be something that's around us long as people thought. But people are still flocking into computer science.

Your publication record shows an impressively large number of collaborators in many different fields. It's hard to summarise. Are there any general themes?

I think there are. I think the general theme is geometry. That meant I had to learn enough analysis and topology to avoid trouble. The machine learning that I've done followed from the shape work, and the way I think about shape is geometric. It's not quite as obvious with the bird song, although that started as an application of shape space.

I like doing maths, but I like it to have some purpose. I could spend my life being extremely angry about the biodiversity crisis. Instead I've managed to turn it into something where I feel like I'm making a difference.

Robert McLachlan

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Event

SECMS Students Shine at SCUDEM 2025 Math Modelling Competition

Ten undergraduate students from the School of Engineering, Computer, and Mathematical Sciences (SECMS) participated in the SCUDEM 2025 International Mathematical Modelling Competition, held from 18 October to 11 November 2025. Under the guidance of Dr Hammed Fatoyinbo and Dr Kerri Spooner, four SECMS teams competed in the event, with all teams earning recognition for their outstanding performances. Team Einstein and Team Laplace received Outstanding Awards, Team Euler earned a Meritorious Award, and Team Fourier achieved a Successful Award. These achievements highlight the strong analytical and computational skills, creativity, and determination demonstrated by our undergraduate students, and reflect the high quality of mathematical modelling education within SECMS.

SECMS teams and coaches, Dr. Hammed Fatoyinbo and Dr. Kerri Spooner, at the SCUDEM 2025 International Mathematical Modelling Competition celebration.

Staff Awards

Two staff members from the Department of Mathematical Sciences received awards at the 2025 AUT School of Engineering, Computer and Mathematical Sciences (SECMS) Awards.

Heather Ricketts was honoured with the Learning & Teaching Excellence Award, which recognises academic staff for excellence in teaching pedagogy, curriculum development, and student satisfaction with their learning experience.

Dr. Hammed Fatoyinbo received the Early Career Research Award, which recognises outstanding research achievements by early career staff. This award is presented annually to a candidate of demonstrated excellence, based on research achievements and related scholarly activities.

Staff from the Department of Mathematical Sciences at the 2025 AUT SECMS Awards, with award recipients Heather Ricketts and Dr. Hammed Fatoyinbo.

Conference attendance

Dr. Yiming Ma co-organised a workshop with Dr. Elisabetta D'Anastasio (Science Operations Technical Lead at Earth Science New Zealand) at the ESNZ office in Wellington, focusing on automatic detection of slow slip events (SSEs) using GNSS time series.

The workshop had two parts. In the first session, Yiming presented his newly developed statistical detection methods at ESNZ's internal forum GeoNet Show and Tell, with around 20 staff attending both in person and online. The second session featured a smaller, focused discussion on SSE detection, where Dr. Florent Aden (R&D Data Scientist at Earth Science New Zealand) and our Master's student Huong (Anna) Hoang shared their progress on applying machine learning to detect SSEs in New Zealand. The workshop led to a productive exchange of ideas and highlighted opportunities for future collaboration.

Seminars of the Mathematical Modelling and Analytics Research Centre

Dr. Parul Tiwari delivered a talk "Mathematical Modelling: From Understanding Complex Phenomena to Wine Quality Prediction" on 17th April 2026.

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

The Mathematics Department has been ranked 80th (tied in 80th place) in the 2026 QS World University Rankings. While all such rankings are dubious and problematic, it is great that New Zealand Mathematics is recognised at this level.

There are plenty of changes in Auckland, including a new Vice Chancellor starting later in the year. Student enrolments are up, and it has been challenging to cope with the growth (eg supervising the mid-semster tests for our large service courses MATHS 102 and MATHS 108 was a stretch). In the middle of the year we will welcome our first cohort of students on our trans-national education agreement with Northeastern University in Qinhuangdao.

The Mathematics Department has been successful in our application for a Faculty of Science EDI (Equity, Diversity, Inclusion) Bronze Award.

To celebrate International Day of Mathematics on March 14th we held a Mathematical Art competition. The winner was "Isogeny Graph" by Ostap Cherkashin.

There was a large presence of staff and students from the department at the MOTAT STEM Fair on March 28-29.

Harm Derksen (Northeastern University) was supported by the Margaret and John Kalman Charitable Trust as a Michael Erceg Senior Fellow, and he presented the Michael Erceg public lecture "Invariant Theory" on 5 March.

Mima Stanojkovski (University of Trento) is the 2026 Kalman Fellow, also supported by the Margaret and John Kalman Charitable Trust.

Other recent visitors to the department include:

- Benjamin Blum-Smith (Johns Hopkins University),
- Andreas Cap (University of Vienna),
- Sofia Castro (University of Porto),
- Ivan Cheltsov (Univ. of Edinburgh),
- Heiko Dietrich (Monash),
- Alexandros Dimitriou (Cyprus),
- Adam Dor-On (Haifa University),
- Veronika Eclerova (Masaryk University),
- Bettina Eick (Braunschweig),
- Mate Farkas (University of York),
- Chris Good (Birmingham),
- Peter Gothen (University of Porto),
- Scott Harper (University of Birmingham),
- Emily King (Colorado State University),
- Igor Krylov (IBS Pohang, Korea),
- Martin Liebeck (Imperial College),
- Stephen McKeown (University of Texas at Dallas),
- Dustin Mixon (Ohio State University),
- Courtney Quinn (University of Tasmania),
- Mary Silber (University of Chicago),
- Georg Sprenger (Masaryk University),
- Jianzhong Su (University of Texas at Arlington),
- Guenter Toerner (University of Duisburg-Essen),
- Victoria Wright (Quantinuum),
- Maxim Zabzine (Uppsala University),
- Jiwen Zeng, Xiamen Univ (China).

Staff news:

Bartek Ewertowski was interviewed on TV for "Crowd Goes Wild" about ice hockey during the Winter Olympics. To be clear: He was not competing in the Winter Olympics.

Steven Galbraith is a Partner Investigator of an ARC Centre of Excellence MathQuEST, directed by Nalini Joshi. https://mathquest.edu.au

Rod Gover has co-authored a paper "The GJMS operators in geometry, analysis and physics" in the special issue celebrating 100 years of the Journal of the London Mathematical Society https://www.lms.ac.uk/JLMS100

Pedram Hekmati ran a successful workshop “Algebra at Akaroa" and gave an invited talk at the TianYuan Mathematics Research Center in March.

Claire Postlethwaite gave an invited keynote at the NetSci-X conference in Auckland in February. The title was "From networks in physical space to networks in phase space”.

Lauren Smith wrote a paper about a hypothetical unethical daycare, which was profiled in PhysicsWorld: https://physicsworld.com/a/the-physics-of-an-unethical-daycare-model-that-uses-illness-to-maximise-profits/

Finally, colleagues may be interested to read the paper "The Hunting of the Babbages: A Decade in the Life of Garry Tee" by Brian E. Carpenter. It is published in IEEE Annals of the History of Computing, 48(1) 7-16 (2026). DOI: 10.1109/MAHC.2025.3596923. For those who do not have access, there is a preprint at https://cs.auckland.ac.nz/~brian/draft-hunting.pdf

Steven Galbraith

DEPARTMENT OF ENGINEERING SCIENCE AND BIOMEDICAL ENGINEERING

The department is honored to share that Prof Andy Philpott is a newly elected Fellow of the Academy of the Royal Society Te Apārangi for his *leading research in the field of optimisation in electricity markets and other industries*[3]. Andy’s work on stochastic optimisation has been cited more than 6,100 times. One of its most important applications is the modelling of electricity markets[4], which is currently applied in New Zealand, Chile, Brazil, France, and Canada. Other applications include route planning in yacht racing, the pulp and paper industry, and the rollout of broadband in New Zealand.

Congratulations, Andy! Well deserved!

Andreas Kempa-Liehr is Guest Editor for the *Time-series Analytics* collection at Springer’s journal *Discover Analytics*[5]. In analytics, a significant source of information stems from data collected over time. These time-series data might be event sequences, aggregated event sequences (e.g., sales data), or measurements of physical quantities (sensor data). In typical analytics applications, at least two of these different types of time-series data are combined with univariate attributes to gain insights into complex systems and guide decision-making. Consequently, three major challenges have to be solved frequently for data-driven models in time-series analytics:

- The models need to be robust against disproportional availability of different time-series data types.
- The models need to be interpretable to support the decision-making of domain experts.
- The output of the data-driven models needs to be combined with decision models.

The submission deadline for this collection is 26 November 2026.

Andreas Kempa-Liehr

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

It has been business as usual in both Mathematics and Data Analytics. However, Nick Cavenagh has replaced Sean Oughton as the Programme Lead in Mathematics. Meanwhile, Han Gan continues as Programme Lead in Data Analytics. Han was the driving force behind the Master of Data Science degree that has been introduced this year. Students in this degree are able to include an endorsement from a choice of six including one in Mathematics.

Belated congratulations to Tanvi Chandel, Teaching Fellow in Data Analytics, for the successful defence of her PhD thesis last year. The PhD was completed at AUT with the thesis title being ‘Impact of Blood Pressure Measurement Errors on CVD Risk Prediction in New Zealand’.

Tori Stanton has now arrived to join the staff in Data Analytics. As reported in the last column, she has been appointed as a Lecturer in Statistical Consulting. She completed a PhD and two Master’s degrees (one in Integrated Plant and Soil Science and one in Statistics) at the University of Kentucky. Her Bachelor of Science degree in Environmental Studies was completed at the University of North Carolina Asheville.

She and her partner have already made a large contribution to the quiz night that is held monthly at the University staff club. We usually field a team of four to six

[3] https://www.royalsociety.org.nz/news/latest-cohort-of-nga-ahurei-fellows-announced#AndyP

[4] https://www.youtube.com/watch?v=RBr7NIYMvBU

[5] https://link.springer.com/collections/ebfdecajic

people from mathematics and data analytics for each quiz night. Thanks to the newcomers' contributions, our team came second in the March quiz night and then in the April quiz night, came first for the very first time. This first place yielded a $100 voucher at the staff club.

Stephen Joe's ten-month contract as Acting Division Director in the Division of STEM was extended by four months to the end of 2025. He is now back in full retirement.

Stephen Joe

MASSEY UNIVERSITY

SCHOOL OF MATHEMATICAL AND COMPUTATIONAL SCIENCES

Christine Burr retired from the maths group at Massey on 20 February. We wish her well in her retirement.

Winston Sweatman, David Simpson and Graeme Wake gave talks at the ANZIAM meeting in Canberra in February.

All staff and PhD students of the School of Mathematical and Computational Sciences have now moved into a single open plan office, with about 70 desks in it. Most staff have been allocated a single desk in a cluster of six, with a small amount of storage space. This new arrangement is not conducive to working in a quiet environment, having private conversations, or teaching online. Students can no longer approach staff in their "office", as it has swipe-card access. Staff have been offered noise-cancelling headphones.

Massey has a new vice-chancellor — Pierre Venter was formerly the Director of Research and Development at Fonterra. A new Massey strategy is to be developed by the end July 2026.

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

We have some interesting news from Te Herenga Waka in Wellington:

The 47th Australasian Combinatorics Conference (47ACC) was held at Victoria University of Wellington – Te Herenga Waka (VUW-THW), from 1-5 December 2025. There were 84 registered participants from around the world: 26 from Australia, 22 from New Zealand, 24 from Asian countries, 8 from European countries, and 4 from Canada. As well as 8 invited talks, there were 66 contributed talks, which included 22 student talks, on a variety of topics in combinatorics. The conference excursion involved a trip to Matiu/Somes Island, in the middle of Wellington harbour. Despite bad weather, 39 hardy souls were able to explore the island without too much discomfort. The conference was organised by Nick Brettell (VUW-THW) and Dillon Mayhew (University of Leeds), who were ably supported by several VUW-THW student volunteers.

Dimitrios Mitsotakis was awarded the 2025 Nikolaos K. Artemiadis Prize for Outstanding Research in Mathematical Analysis by the Academy of Athens, Greece's highest intellectual institution. Conceived as a modern successor to Plato's Academy, the Academy of Athens is dedicated to the advancement of the sciences, humanities, and fine arts. The Artemiadis Prize is awarded annually to mathematicians of Greek descent in recognition of an exceptional contribution in mathematics. Dimitrios received the distinction for a groundbreaking paper co-authored with Dionysios Mantzavinos, Associate Professor at the University of Kansas. Their article, "Extended water wave systems of Boussinesq equations on a finite interval: Theory & Numerical Analysis", published in the Journal de Mathématiques Pures et Appliquées in 2023, reveals fundamental properties of some water wave models and provides significant theoretical foundations for the study of such models in bounded domains. This work, together with Dimitrios' broader research contributions, establishes a rigorous framework for the mathematical and numerical analysis of various systems of water waves theory. The award was presented in person at a special ceremony held in Athens in December 2025.

Professor Nic Smith, Vice-Chancellor of Te Herenga Waka–Victoria University of Wellington, will step down from his role after leading the university with distinction through a challenging period. He will take up the position of Vice-Chancellor at the University of Auckland. His final day at Te Herenga Waka will be Friday, 12 June. The School of Mathematics and Statistics expresses its sincere appreciation for his dedicated service and extends its best wishes for success in his new role.

Finally, congratulations to Wawan Syaifudin, who successfully defended their PhD thesis titled *"Optimal stopping rules in the valuation of variable annuity guaranteed lifetime withdrawal benefits with embedded options"*. Wawan was supervised by Dr Budhi Surya. Part of the results of this thesis has been published in the journal Insurance: Mathematics and Economics.Ruofei's PhD is "Computability, Randomness, and Analysis". Congratulations to Ruofei!

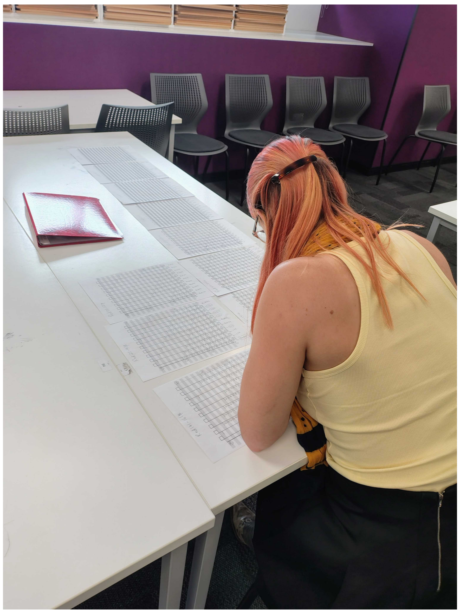
Dimitrios Mitsotakis

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Pi counting

UC celebrated pi day with Ross Atkins together with MathSoc, who calculated a lot of digits of pi by hand!



Fellowship Success

A huge congratulations to Vincent Lomas for securing one of two inaugural fellowships from the NZUK Link Foundation to provide opportunities for Māori health research.

Vincent's PhD is titled 'Modelling the interaction between ethnicity and infectious disease transmission dynamics'.

"Mathematical models of how an epidemic spreads through a population are important to understand the likely effect of different public-health interventions and to inform policy decisions. Despite stark historical inequities in disease health outcomes since the founding of Aotearoa New Zealand, many models do not include important variables such as socioeconomic status and ethnicity."

"My research aims to create modelling methods that allow us to explicitly consider ethnic effects (and other sociodemographic effects) in disease spread [...] With this information we can run simulations of disease-spread and target high-risk groups with intervention policies," Vincent says.

Click here for the full article.

Grant success

Congratulations to Professor Felipe Voloch who has just received a collaboration grant from the Canadian Research Council for CAD $25000 together with Professor Antonio Lei from the University of Ottawa in Canada.

Erskine visitors Semester one has got off to a great start with the support of Drs Trent McDonald and Alex Vañó Viñuales visiting Blair Robertson and Chris Stevens respectively.

Chris Stevens

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

We are pleased to announce that *Ting Wang* and *Phil Wilcox* have been promoted to professors.
Ting is a statistician whose research sits at the interface of statistics and geophysics, advancing the forecasting of natural hazards. Her work focuses on developing novel statistical models to better understand and forecast earthquakes, volcanic eruptions, and extreme geomagnetic storms. She has led and contributed to major research programmes funded by the Marsden Fund, MBIE Endeavour, EQC, and the National Science Challenges. Ting's work has been recognised with several honours, including the New Zealand Statistical Association Early Career Research Award, the University of Otago Early Career Award for Distinction in Research, and the New Zealand Statistical Association Littlejohn Research Award.
Phil is a geneticist and bioethicist, and his work bridges statistical genomics with mātauranga and tikanga Māori. During the past decade, he has become a leading figure in Indigenous genomics, co-leading major national initiatives such as the Aotearoa Variome and Rakeiora Pathfinder projects, which develop genomic resources grounded in Māori values and Indigenous data sovereignty. He is Deputy Director (Māori) of the Maurice Wilkins Centre, co-chair of the Ira Tātai Whakaeke Trust, and a senior leader in the international Summer Internship for INdigenous

peoples in Genomics (SING) network. Recently, Phil received the Genetics Otago Award, which is awarded to individuals who have shown sustained excellence in genetics.

We have farewelled *Alex Fowler* and *Bethany Macdonald*.
Alex started his position as a Teaching Fellow in 2022. Since then, he has provided invaluable support with maths & stats tutorials, and he maintained and developed the online assignment system STACK. We wish him all the best for his new position as a Professional Teaching Fellow at the University of Auckland!
Bethany joined the Department in 2021, first as a PhD student and then as a postdoc. Recently, she did fantastic work helping to organise the NZSA conference. Bethany leaves us to take up a lectureship in statistics at the University of Canterbury. We wish her every success in her new role!

We have welcomed our new Teaching Fellow *Jess Allen*. Jess has already studied at the Department since 2017, starting with an undergraduate degree, followed by Honours, Masters and PhD. We are very happy to have found someone who is already very familiar with the Department and its processes. A warm welcome to you, Jess!

Finally, the University of Otago has taken the important step of making sensitivity labels in staff emails mandatory. We can now devote some of our abundant spare time to the crucial task of choosing between different levels of confidentiality. Thank you! Our everyday work now feels so much safer!

Jörg Hennig

PhD SUCCESS

David Cornelis Groothuizen Dijkema (University of Auckland.)

Title: Analysis of dynamics near heteroclinic networks using projected maps.
Supervisors: Claire Postlethwaite and Vivien Kirk

Abstract:
Heteroclinic cycles and networks are flow-invariant structures in a dynamical system composed of saddle-type objects and connecting heteroclinic orbits. Near an attracting heteroclinic cycle or network, trajectories spend increasingly long periods of time near each equilibrium without converging to any one of them. A trajectory near a heteroclinic cycle always follows the same sequence of equilibria, whereas near a heteroclinic network trajectories can switch between subcycles, and so their analysis is more complicated.

In this thesis, we present a new methodology to analyse heteroclinic networks: the projected map, a piecewise-smooth discrete map that reduces the complexity of analysing a network. We use this projected map to study the Kirk–Silber, Δ-clique, and tournament networks in $\mathbb{R}^4$. Our analysis resolves a claim from 1994 that there is no regular or irregular cycling near these three networks. We prove that previously identified conditions for stability of a heteroclinic cycle can be determined at the network's switching equilibrium, and that stability loss of the cycle can correspond to a border-collision bifurcation in the projected map. We extend this result to arbitrary heteroclinic networks in higher dimensions and prove a general result about stability loss of component cycles in a network.

We also consider the continuity of the projected map at its switching manifold. We prove that, for the Kirk–Silber network, the projected map is discontinuous due to the presence of a separatrix near the network. For the Δ-clique and tournament networks, no such separatrix exists, and the projected map is therefore continuous.

Lastly, we consider larger networks that exhibit regular and irregular cycling between subcycles. We construct the projected map of these networks. To do so, we describe how to resolve complications that arise if the switching equilibrium has multiple incoming heteroclinic orbits. We relate regular cycling near these networks to periodic orbits in the projected map, and changes in stability to border-collision bifurcations. We find that irregular cycling corresponds to an apparent strange attractor. We expect this analysis will allow us to prove the structure of regular and irregular cycling near these and other networks.

Rox-Anne L'italien-Bruneau (University of Auckland.)

Title: How doctoral students construe their mathematics when communicating their research.
Supervisors: Ofer Marmur, Caroline Yoon, Lisa Darragh

Abstract:
Communication plays a crucial role in doing, learning, and teaching mathematics, and spoken and written communication skills are essential for academics, including mathematicians, when conducting research and disseminating results. Building on the role of communication in mathematics and in the process of becoming mathematicians, this study investigates how mathematics doctoral students communicate their research beyond the written format.

I use commognition and systemic functional linguistics to explore how three doctoral students communicated their research to a doctoral student in mathematics education and their peers. I focus on how participants implemented five communication strategies largely investigated by researchers in applied linguistics and related to aspects of teaching, learning, and doing mathematics. Additionally, I investigate the messages that doctoral students implicitly conveyed about the nature of mathematics when communicating their research.

Findings illustrate that students implemented the strategy defining in a broad variety of ways, often different from formal definitions usually found in written communication. In the case of analogising, students used this strategy as a means of referring and talking about objects, their properties, and their behaviour without technical terminology. For exemplifying, participants used examples from various discourses to bring clarity and support claims, but

also to introduce terminology. When reformulating, participants moved across various forms of talk, implicitly reformulated, and summarised detailed explanations into one or two sentences. Finally, for the strategy concretising, I reframed it as omitting as a result of the preliminary analysis of concretising. When omitting, students explicitly signalled to their audience that they were leaving out details from their research and omitted their specialised discourse or concepts altogether. As for the messages students implicitly shared about the nature of mathematics, participants construed mathematical objects as acontextual entities, as outcomes of humans' manipulations, and as discursive constructs, and they implicitly described doing mathematics as involving discursive, observational and material activities.

Findings about the implementation of each strategy contribute to describing how doctoral students communicate their research, which is a first step towards supporting them in developing their communication skills. Findings also contribute to a better understanding of the process of becoming mathematicians from an onto-epistemological perspective.

Renzo Mancini (University of Auckland.)

Title: Bifurcation study of a two-delay model for the Atlantic Meridional Overturning Circulation.

Supervisors: Bernd Krauskopf and Priya Subramanian

Abstract:
Renzo studied a conceptual mathematical model for the Atlantic Meridional Overturning Circulation (AMOC), which is an important ocean current system that transports warm water from the tropics to the northern polar regions, particularly through the Gulf Stream. Specifically, he performed a thorough bifurcation analysis of a conceptual AMOC model in the form of a scalar delay differential equation (DDE) with two time delays, τ and σ, as the only parameters. These delays arise from the positive temperature feedback between the North Pole and the Equator, and the salinity exchange between surface and deep water at the Pole, respectively. A novel feature is that the two feedback terms interact in a multiplicative way. Renzo discovered fascinating dynamics, including complicated oscillations associated with homoclinic connections, and identified where in the (τ,σ)-plane different types of attractors can be found. These results are of interest in the climate context and also beyond, because this DDE model can be seen as an extension of the well-known Hutchinson-Wright equation with a second delay.

Lorenzo Anoè (University of Auckland.)

Title: Mission design via ballistic capture using the energy transition domain.

Supervisors: Lorenzo Armellin (Mechanical Engineering), Bernd Krauskopf and Hinke Osinga

Abstract:
Lorenzo's thesis presents a comprehensive framework for the systematic generation, classification, and exploitation of ballistic capture (BC) trajectories in the circular restricted three-body problem, with direct applications to low-energy mission design in the Earth–Moon system. After the analytical characterisation of the energy transition domain, a tailored algorithm is then introduced to compute full BC sets for both planar and spatial dynamics. This generates an extensive database of trajectories enriched with dynamical descriptors relevant for mission design, which is then applied to a case study involving NASA's Lunar Trailblazer mission. On the theoretical side, high-order numerical continuation techniques based on differential algebra (DA) are used to construct continuous representations of distant retrograde orbits, periodic orbit (PO) families and high-order transfer maps. They offer a global view of phase space and enable the identification of manifold structures, stability regions, and new POs. Finally, a unified DA-based optimisation framework is developed to compute bi-impulsive transfers from BCs to target specific PO families. The results are fed back into the database to support further analysis and mission planning.

Juan Patiño-Echeverría (University of Auckland.)

Title: Transitions to wild chaos in a four-dimensional Lorenz-like vector field.
Supervisors: Bernd Krauskopf and Hinke Osinga

Abstract:
Juan studied a four-dimensional extension of the classic Lorenz system, which has recently been shown to exhibit a so-called wild pseudohyperbolic attractor for a specific choice of parameters. This new type of chaotic dynamics is charcterised by: (1) every trajectory in the attractor having a positive maximal Lyapunov exponent, and (2) that that this property persists under small perturbations. Juan analysed the global bifurcation structure in the (ρ, μ)-parameter plane of the standard (Rayleigh) parameter ρ of the Lorenz system and the new parameter μ that introduces spiralling dynamics near the origin. Juan extended the bifurcation structure inherited from the Lorenz system and, moreover, combined kneading diagrams, Lin's method and Lyapunov spectrum calculations to uncover additional sequences of bifurcations leading to the onset of wild chaotic dynamics.

Shai Levin (University of Auckland.)

Title: Constructing Secure Protocols from Proofs of Knowledge and Isogenies.
Supervisors: Steven Galbraith and Jeroen Schillewaert

Abstract:
Constructing efficient isogeny-based protocols is an active area of research in post-quantum cryptography. An important building block in constructing such protocols is non-interactive zero-knowledge proofs of knowledge, which convince a verifier that a prover possesses some secret information about an isogeny without revealing it.

Prior proofs of knowledge of an isogeny based on sigma-protocols suffer from various deficiencies. They require computing large degree coprime N'-isogenies, which means they must either work over larger field extensions or choose a prime large enough to have rational N'-torsion. Further, they suffer from poor performance due to their small challenge space, resulting in many parallel repetitions to achieve negligible soundness error.

This thesis presents new techniques for constructing isogeny proofs of knowledge by constructing generic instances which encode isogeny relations. These instances can then be implemented with a generic proof system (i.e. a zk-SNARK) to produce non-interactive arguments for isogeny relations, such as proving knowledge of a cyclic 2^n-isogeny. Compared to prior approaches, zk-SNARKs allow for several orders of magnitude improvement to prover and verification times, and proofs are additionally succinct, they scale sublinearly with the witness size. To motivate our approach with an application, we construct a variant of the CGL hash function, requiring trusted setup, along with an associated proof of honest evaluation via generic techniques. Given the function satisfies a conjectured notion of unpredictability, we use it, along with its evaluation proof to construct a verifiable random function (VRF), in the random oracle model. As an independent contribution, we prove the security of the associated generic VRF transformation.

As an orthogonal contribution, we explore the shortcomings of various works which construct proofs of knowledge in modern literature in a dedicated cryptanalysis section. In particular, we show that a peer-reviewed variant of SeaSign is not zero-knowledge, leading to a key recovery attack; that a proof of knowledge of a commitment to an elliptic curve discrete logarithm is not sound (and propose a fixed protocol), and that the CROSS identification protocol does not satisfy their claimed level of zero-knowledge.

Wawan Syaifudin (Victoria University Wellington.)

Title: Optimal stopping rules in the valuation of variable annuity guaranteed lifetime withdrawal benefits with embedded options.

Supervisors: Dr Budhi Surya

Abstract:
This thesis proposes new features in the valuation of variable annuity by introducing embedded options. Particularly, we consider embedded top-up option and surrender option in the valuation. These options allow the holder to change parameters of the existing contracts such as withdrawal rates, fees and early termination of the contract. The options can be exercised at anytime during the duration of the contract. Assuming the holder being risk neutral, i.e., maximizing monetary value of the contract, valuation is performed using optimal stopping theory. The value function of the corresponding optimal stopping problem represents early exercise premium of the option. Under Black-Merton-Scholes dynamics of equity price process, the underlying investment vehicle of variable annuity, a closed form solution of the optimal stopping problem is found. Harmonic and majorant properties of the value function are established using martingale theory by incorporating the continuous and smooth pasting conditions. These properties are used to show optimality of the value function. Some numerical examples are discussed.

REPORTS ON EVENTS

Student report

I am a third-year doctoral student in data science at the University of Canterbury. As part of the bioAI lab, my research focuses on inference of macro-evolutionary diversification rates and phylogenetic trees.

Thanks to funding from NZMS, in September I had the wonderful opportunity to visit Sydney for a week. As two of my PhD supervisors are now based in Australia, it was fantastic to visit them and have some rare in-person meetings.

I am thankful to my supervisor Dr. Varvara Vetrova for hosting me at her new position as Associate Professor at the Australian Catholic University (ACU). I would also like to acknowledge my supervisor Dr. Sasha Gavryushkina for travelling from the University of Adelaide for the visit.

As Varvara is part of a team at ACU setting up a new program for Computer and Data Science, the trip gave me a new appreciation for all the background work required to set up effective and engaging university courses and wider departments.

Traditional methods of inferring evolutionary histories and the associated rates of speciation, extinction and sampling are complex and time-consuming. Bayesian analysis also requires that we must assume a birth-death process used to generate a phylogenetic tree. Examples of birth-death processes include those with constant, piecewise constant, or time-dependent diversification rates. Recent publications have successfully used neural networks to infer trees given molecular data or to infer diversification rates given a tree and a specific birth-death process.

One of my research projects aims to use graphical neural networks to infer the birth-death process which best describes a phylogeny in addition to the diversification rates. As Varvara's expertise in deep learning and Sasha's guidance in phylogenetics are both invaluable to this project, it was really beneficial to be able to discuss which birth-death processes we are considering, how they can be represented in graph neural networks, the technical requirements of using PyTorch to implement this and the potential benefits of hyper graphs and graph attention networks to our problem. After months of remote meetings, simply being able to draw diagrams on the same whiteboard and chat over meals felt like a special highlight.

I was also fortunate to visit the Molecular Ecology, Evolution and Phylogenomics lab in the School of Life and Environmental Sciences at the University of Sydney with Sasha. The lab, led by Professors Nate Lo and Simon Ho, was very welcoming and I enjoyed presenting my research to the group and discussing it over lunch.

My 20-minute presentation "Inferring the evolutionary history of crocodilians with the Skyline Stratigraphic Range Fossilised Birth-Death model" covered results currently in preparation for publication. The project aims to infer skyline (or piecewise constant) diversification rates while allowing multiple fossils from the same species to be included in the analysis. I presented diversification estimates for crocodilians assuming either constant diversification rates, piecewise constant rates which changed every 25 million years, or piecewise constant rates which changed at established boundaries of the geologic time scale (chronostratigraphy).

Of particular interest to the audience was the differing results obtained using either equal length skyline intervals or interval boundaries informed by chronostratigraphy. I am grateful for the helpful suggestions of further analyses using different skyline interval boundaries.

The trip was highly productive for my research. It can be difficult to obtain travel funding, which is not for conferences, so I am especially thankful to NZMS for your support of my trip.

Kate Truman
(University of Canterbury)

NZMS NOTICES

NZMS Colloquium 2026 – Save the date!

Dear NZMS members,

The 2026 NZMS Colloquium will be held in the St David Complex at the University of Otago. There will be a reception on the evening of Monday November 30th, and the conference will take place Tuesday December 1st through Thursday December 3rd.

We look forward to meeting you there.

Dominic Searles (for the organising committee)

NZMS Financial assistance

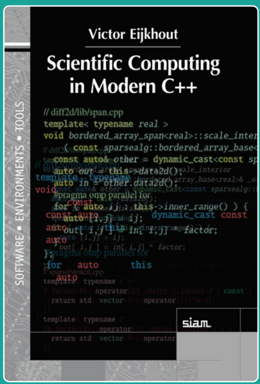
The NZ Mathematical Society offers two kinds of funding for NZ mathematicians: NZMS Student travel grants (financial support etc.) and NZMS Financial Assistance grants (funds for mathematical related activity).

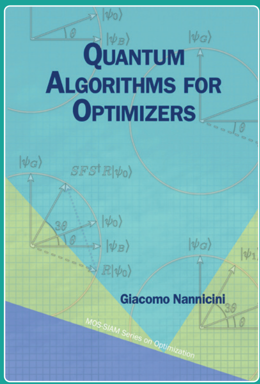
There are quarterly deadlines for applications. The deadline for applications for 2026 are February 15, May 15, August 15, and November 15.

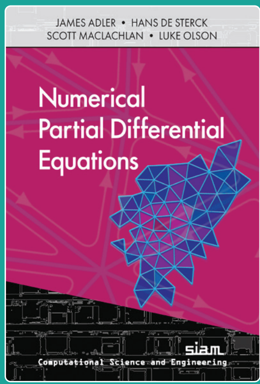
Applications must be made at least 1 month in advance of the travel or event. Please contact the secretary secretary@nzmathsoc.org.nz to get the application forms, and guidelines on how to apply.

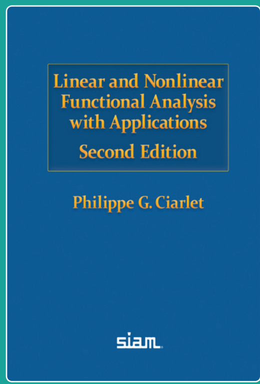
Geertrui Van de Voorde (Secretary)

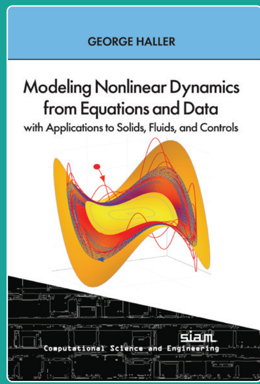
New books from SIAM

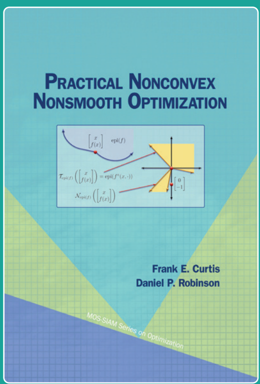


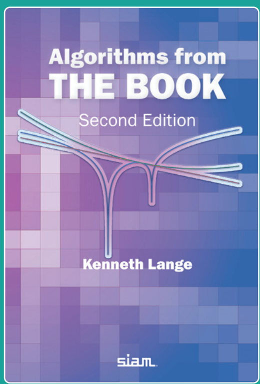


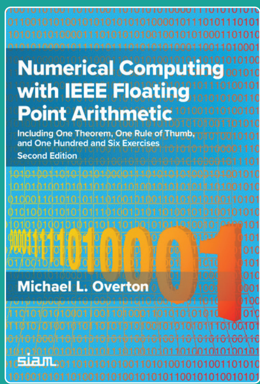


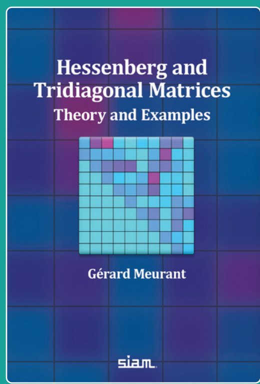


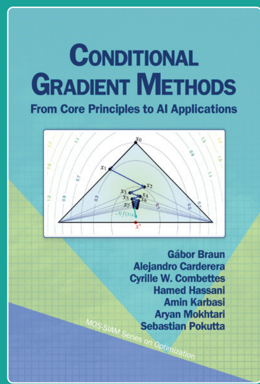












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