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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 Fabien Montiel and Melissa Tacy. 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 nzmsnews@maths.otago.ac.nz. LaTeX templates are available upon request from the editors.

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EDITORIAL

Another newsletter, another lockdown! This is turning into a nice case study to teach students how to differentiate correlation from causation. In any case, we hope everyone is keeping safe during this difficult time.

Mathematics and mathematicians have played a huge role in the COVID response both here and internationally. The AustMS has developed a collection of articles/essays by mathematicians involved in their response. You can read those articles at https://austms.org.au/tag/covid-19-response/.

On a more positive note, we are happy to announce that registration is now open for the NZMS Colloquium, which will be held in Christchurch on 7–9 December and, if all goes well, in person. We may have to delay the December Issue of the newsletter to make sure of this! After last year's online event, this is a great opportunity for our community to catch up and discuss the latest research. Check out the conference website now to see the great line-up of invited speakers and submit your abstract.

As we are sure many of you are aware, the Ministry of Education is currently conducting a review of the National Certificate of Education Achievements (NCEA), including a full curriculum refresh. The President's Column and Education Column provide a good overview of the process and what is at stake here. In short, this is everyone's chance to contribute to this rebuild and the NZMS Education Group is seeking ideas and feedback on what has been proposed so far. As David Bryant pointed out in the April Issue, this should not only concern mathematician academics working in NZ universities, but students, people working in industry or recreational mathematicians should also feel included in this process as they can contribute unique, real-life perspectives that tend to evade the university realm. Contributions are sought by the NZMS Education Group by 3 September, so get to it quickly!

Finally, as discussed in the last issue of the newsletter, it will be our last year as co-editor of the newsletter. We just wanted to give the update that we have made good progress towards finding our successor(s), who will be properly introduced in the next issue.

Fabien Montiel and Melissa Tacy

PRESIDENT'S COLUMN

I was recently introduced to the videos of Nira Chamberlain, president of the UK Institute of Mathematics and its Applications. Listening to Nira is a bit like getting a shot of mathematical enthusiasm. He talks about his mathematical background and about the many and diverse projects he has been involved with. Some of those projects saved UK taxpayers huge amounts of money. Nira is incredibly enthusiastic about all branches of mathematics. It is clear he has a well-honed sense of its importance.

Being able to articulate the importance of mathematics is proving to be critical as we engage in the rewrite of the school curriculum and restructuring of NCEA. The Ministry of Education has discovered that the NZMS has a voice. This is thanks to the education group, especially former convenor Cami Sawyer, and new co-convenors Sione Ma'u and Julia Crawford. This rewrite and restructuring is the most important work that the NZMS is currently doing, and it needs to involve the entire mathematics community, not just the education group. Please keep an eye out for opportunities to provide input and discuss what should, and what shouldn't, be taught to the country's students.

Personally speaking, wading into education discussions can be intimidating and confusing. There are times when the Ministry of Education seems driven by an obsession for symmetry, program structure, and remarkably extended metaphors. But there are also really exciting developments. I think the challenge to decolonise education will create all sorts of opportunities and discussion. Through all, it is crucial for us to clearly articulate what is important and why.

Sadly, in Aoteroa-NZ, mathematics is not viewed as the queen of sciences; it is viewed as the broccoli of science. More than that, it is viewed as the broccoli of science that is potentially carcinogenic, at least according to something a friend's cousin read in a blog somewhere. The fact is, there really are many highly successful, highly creative people who have had wonderful careers without once having to confront the mathematical insecurities they acquired at primary school.

At my university, and I suspect at many others, you can complete a wide range of scientific degrees without having to take a single mathematics course. You can be a chemist, an ecologist, neuroscientist, biochemist, computer scientist or even doctor without any maths courses. Some of that might reflect back on the mathematics teaching on offer, and some on discipline nervousness about student numbers. However it is true that you can teach most science subjects in a way that steers around mathematical content like potholes in a road. Models can be plonked down and applied, rather than derived. Topics can be bypassed.

The problem with this kind of selective omission is that it cuts off opportunities. Mathematics is effective and important because it allows you to think differently, and more effectively, than you would otherwise. It creates opportunities to make impossible things possible, or at least more efficient. Not teaching the tools used to build a subject makes it far more difficult to adapt that learning to new contexts, and to push a subject forward. It also makes it difficult for students to compete with researchers, or workers, who did have access to these tools.

Nira Chamberlain enthused about all areas of mathematics, but demonstrated the importance of mathematics through his work with industry and the public sector. Following up what I promised in the last newsletter, I have been investigating how the NZMS might strengthen links between mathematics and industry in Aotearoa-NZ. I have been interviewing mathematicians up and down the country who have had significant experience applying their mathematics in industry.

Contrary to what is often spouted from commercialisation offices, meaningful academic-industry collaboration is not about helping smart boffins bring their ideas to market. Practical, real, mathematics in industry is founded on enduring relationships, mutual respect, and trust built up over time. Collaborators in industry must appreciate what mathematics can do for them, and collaborators in academia must appreciate what they can learn from industry. Building these bridges can be a long, slow process.

The environment that makes these links both possible and widespread is one in which there is a widespread understanding of what mathematics is and what it can do here in Aotearoa-NZ. Applied and pure (if you find that classification helpful). It means us being as thorough about our evidence and arguments about the importance of mathematics as we are about the proofs of our theorems. We can't just parrot the 25-year old AMS posters hanging in the faculty hallway. This is long game stuff, but mathematicians have seldom shirked from projects which might be a long time to fruition.

David Bryant

EDUCATION

Curriculum Refresh and NCEA Review

The Curriculum Refresh and NCEA Review are Ministry of Education projects which affect primary, intermediate and secondary education. To better understand what these projects involve, here is a short explanation of relevant terms.

Curriculum The *New Zealand Curriculum* comprises the 'front end' which sets out the direction of learning with a *vision*. This vision is unpacked by describing *values*, *key competencies*, along with a collection of *learning areas*. There are 8 learning areas, one of which is Mathematics and Statistics. Each learning area is split into levels (currently 8 levels, covering Years 1–13). A list of *achievement objectives* is specificed at each level eg. counting up to 100 would be part of a Level 1 objective; differentiating a function would be part of a Level 8 objective. Each school uses the NZ Curriculum as a framework to design their local curriculum. (Except for Māori medium schools who use a different curriculum, *Te Marautanga o Aotearoa*. We restrict to the NZ curriculum in what follows.)

NCEA The *National Certificate of Education Achievement* is the main national qualification for secondary school students in New Zealand. It indicates what level of education a student has attained in their subjects upon leaving secondary school. Each subject at Years 11, 12, and 13 consists of a list of *achievement* or *unit standards*. Each standard is worth a specified number of credits (currently an integer in the interval $[1,6]$). The level of each standard corresponds to the year (Level 1 $\leftrightarrow$ Year 11, ..., Level 3 $\leftrightarrow$ Year 13). Each standard is specified to be either internally or externally assessed. Students attain NCEA by accumulating the required number of credits across all their subjects. Eg. to qualify for NCEA Level 1 a student needs at least 80 credits at Level 1 or above; for NCEA Level 3 a student needs at least 60 credits at Level 3 and another 20 credits at Level 2 or above. Also, to be awarded NCEA at any level a student will have gained a minimum of 10 literacy credits and 10 numeracy credits. There are a number of ways this can be achieved (see https://www.nzqa.govt.nz/ncea/subjects/literacy-and-numeracy/level-1-requirements/).

NCEA achievement standards are supposed to be based on Levels 6–8 of the NZ curriculum. (Unit standards are not, so let us ignore them.) The relation between NCEA achievement standards and NZ Curriculum achievement objectives for mathematics is nontrivial—see eg. https://docs.google.com/document/d/1fTeTSFn7aFN-wGE5k7EUFiEsmUG8LmbL9YWF2cvfYOI. In practice, schools tend to ignore the NZ Curriculum for Years 11–13 and design their local curriculum around NCEA.

The Curriculum Refresh is a 5-year plan (2021–2025) to update the NZ Curriculum across all learning areas. According to Ministry documents "the NZ Curriculum will be refreshed so it is bicultural and inclusive, clear and easy to use". Mathematics and statistics will be refreshed in 2022 and trialled in a number of schools. By 2025 all learning areas will have been refreshed and implemented in schools.

The NCEA Review of mathematics and statistics will be a complete overhaul of the achievement standards. The number of standards at each level of mathematics and statistics will be reduced from around 15 standards down to 4 (2 internal and 2 external), with each Level 1 standard worth 5 NCEA credits. The drastic reduction in the number of achievement standards is to combat overassessment and encourage a more holistic approach to learning. The focus should be on teaching and learning, not assessment.

Getting involved

With so much change currently underway, it means that this is a good time to brainstorm and frame advice on any suggestions we have for the future of Mathematics and Statistics. The NZ Statistics Association Education Committee had significant influence on updating Statistics in the last curriculum rewrite in the early 2000s. *This is our chance to have a similar influence on Mathematics.*

At NCEA level 3 mathematics, students currently study a selection from: differentiation, integration, algebra (including complex numbers), trigonometry (identities and models), conic sections, linear programming, and networks (critical path analysis).

- Do you have ideas about what you want future students to learn?

- Can we design a subject that is engaging and interesting to a broad range of students?

In addition to calculus and statistics, the Ministry of Education has proposed a new course at NCEA Level 3 (tentatively called applied maths, but this shouldn't limit our thinking). This course could cover computational thinking, algorithmic thinking, discrete maths, operations research, data science, mathematical modeling, or something else. What are your ideas?

Please get together with a group of your colleagues and discuss these ideas. Ask someone to take notes and then send your ideas and feedback to nzmsed@gmail.com as soon as possible and no later than 3 September.

Here are some conversation starters:

1. What are the concepts and skills that you would like students to have after NCEA Level 2 Maths and Stats (year 12)?
2. What are the concepts and skills that you would like students to have after NCEA Level 3 Maths and Stats (year 13)?
3. Can you think of any areas or ideas from mathematics that are currently overlooked, but that you think students would benefit from?

Resources

1. The NCEA Standards Navigator: https://nsn.nz. This website links to all the current NCEA material at Levels 1–3 posted on official websites. It will give you a good idea of what students in years 11–13 are learning at school.
2. Blog post by Michelle Dalrymple on the opportunity to shape the new mathematics course at Level 3 https://drdalrymple.wordpress.com/2021/07/27/an-exciting-opportunity-draft-ncea-l3-subject-list/. (She strongly suggests Data Science.)
3. If you are on the NZMS Discord, please check out the Education group channels:

   `#education-discussions`, `#ncea-level-3-pi-in-the-sky`.

Other News

Cami Sawyer has stepped down as convenor of the Education Group to take up a position in the Ministry of Education as Learning Area Lead for Mathematics and Statistics. The Education Group thanks Cami for her tireless work faciliating discussions on maths education and building relationships between different stakeholders. We congratulate her on her new role in the Ministry. Replacing Cami are the new co-convenors, Julia Crawford and Sione Ma‘u.

Julia Crawford and Sione Ma‘u

MATHEMATICAL MISEPONYMY

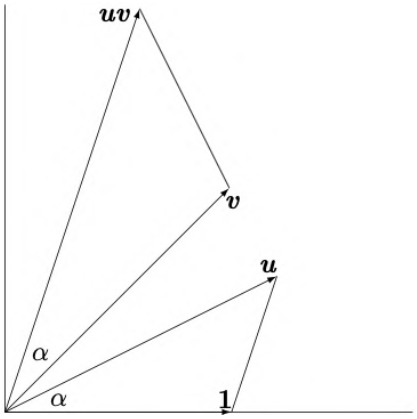
Argand Diagram

The Argand Diagram, of course, links the algebra of complex numbers to its geometry in the plane. It is named for the Swiss Jean-Robert Argand (1768–1822) who described it in his privately published essay [1]. However, Argand was beaten to the post by the Norwegian Caspar Wessel (1745–1818). Both of these men were amateur mathematicians: Argand ran a bookshop while Wessel was a surveyor.

Like some of his older siblings Wessel showed intellectual ability but could not attend a University in Norway for the simple reason that there was none. Since Norway was at the time part of the Danish kingdom he moved to Copenhagen and rather part-time completed a law degree at the University. Like so many modern students he simultaneously undertook part-time work to support himself. His older brother Ole had found himself a job as a surveyor helping produce a topographical map of Denmark and in 1764 Caspar joined in as Ole's assistant: thus began Wessel's life-time career as a surveyor[1], and his recognition of the need to understand better the related geometry.

Taking his cue from the situation on the real line, Wessel proposed in [5] a way of adding two points in the plane, really what we now call vector addition. He then thought of the addition of the vectors $\boldsymbol{u}$ and $\boldsymbol{v}$ in the following way: $\boldsymbol{u}+\boldsymbol{v}$ is to $\boldsymbol{v}$ as $\boldsymbol{u}$ is to $\mathbf{0}$.

Wessel's geometric idea of addition in the plane led him naturally to the idea of multiplication of points in the plane: having chosen $\mathbf{1}$ on the abscissa in the plane then $\boldsymbol{uv}$ is to $\boldsymbol{v}$ as $\boldsymbol{u}$ is to $\mathbf{1}$. You can express this by a pair of similar triangles in the plane, as in the figure. So in one go he told how far $\boldsymbol{uv}$ is from the origin and in what direction. He also came up with a geometric reason why $(-1)(-1)=1$.



Wessel gave the name ε to the point one unit up the ordinate and deduced that $\varepsilon^2=-1$. Of course we call this point i. Furthermore Wessel looked at the resulting field and found that multiplication and addition were just as in the complex numbers: his geometric description was exactly of the complex numbers, already well developed by Bombelli in his book *Algebra* published in 1572 as well as subsequent authors.

Why didn't Wessel get any credit? While his ideas were already discussed in a report for the Royal Danish Academy in 1787 they were unable to be presented in person to a meeting for another 10 years when the Royal Danish Academy of Sciences finally agreed that work of non-members could be presented. However, because he was not a member he could not do the presentation himself; indeed, he was not even allowed to be there for the presentation! To add to Wessel's lack of contemporary recognition, as Niels Nielsen noted in his 1912 book *Mathematics in Denmark, 1528–1800*, and quoted in [2], mathematics was "represented at the University only by the lowest mediocrity." Wessel's paper was published in Danish in Copenhagen in 1799 but seems to have not been noticed outside Denmark for a century. Sophus Lie republished Wessel's paper in 1895 with the comment "If the work of Caspar Wessel had been well known, it would long ago have earned its author a name at least as great in the empire of mathematics as that which his brother[2] obtained in Nordic literature." A French translation appeared in 1897, by which time Argand's name was well established. A partial translation into English appeared in 1929.

In addition to [2] I have found [3] and [4] valuable sources. The Wikipedia page of Caspar Wessel also gives some details. I didn't manage to find a copy of Webster Woodruff Beman, *A Chapter in the History of Mathematics,* in the Proceedings of the American Association for the Advancement of Science, 46(1897), 33–50, which seems to be an early English discussion of Wessel's work.

References

[1] Jean-Robert Argand, *Essai sur une manière de représenter les quantités imaginaires dans les constructions géométriques*, privately published manuscript, 1806.

[1] It would be a bit dishonest to claim a New Zealand association based on his accurate map of Zealand, a Danish island, given that NZ was named for the Dutch province of Zeeland.

[2] Yet another brother, Johan Herman Wessel, famous for parody and satirical wit.

[2] Viggo Brun, *Caspar Wessel et l'introduction géométrique des nombres complexes*, Revue d'histoire des sciences et de leurs applications, 12(1959), 19–24.

[3] Phillip S Jones, *Wessel, Caspar*, https://www.encyclopedia.com/science/dictionaries-thesauruses-pictures-and-press-releases/wessel-caspar

[4] J J O'Connor and E F Robertson, *Caspar Wessel*, https://mathshistory.st-andrews.ac.uk/Biographies/Wessel/

[5] Caspar Wessel, *Om directionens analytiske betegning, et forsøg, anvendt fornemmelig til plane og sphaeriske polygoners opløsning*, presented to the Royal Danish Academy of Sciences, 10 March 1797.

David Gauld

PROFILE

Jeffrey Joseph Hunter

Born in Otahuhu in 1941, Jeffrey Hunter was educated at King's College, Auckland (1954-1958). Following his result from the university scholarship examinations, he was awarded a Scholar's Tie by King's College. In 1959, he entered to the University of Auckland and graduated with a BSc degree and was awarded Senior Scholar in Mathematics in 1962. In 1963 he obtained an MSc degree, with First Class Honours in Mathematics from the University of Auckland. In 1964, Jeffrey was offered a Commonwealth Scholarship to Queen's University, Canada and a Fulbright travel grant. He decided to decline the offer to Queen's University and accept the Fulbright grant to attend the University of North Carolina at Chapel Hill, U.S.A., where he completed a PhD degree in Statistics in 1968. During his doctoral studies, Jeffrey worked as a research assistant (1964-1966) and a teaching assistant (1967-1968). He held the position of research associate (equivalent to a post-doctoral fellowship position) in 1968. Between 1965 and 1968, he also held various positions (analyst or statistician) at Research Triangle Institute, Research Triangle Park, NC, USA, in different short periods.

In 1969 Jeffrey returned to New Zealand and took a Lectureship in the Department of Mathematics and Statistics at the University of Auckland, where he was promoted to a Senior Lecturer in 1971 and then to Associate Professor in Statistics in 1986. Between 1969 and 1990, Jeffrey served various roles at the University of Auckland, including Acting Head of the Statistics Unit (1978-1979) and Chairman of the University Committee on Operations Research (1985-1990). In 1990 he accepted the Chair in Statistics at Massey University, Palmerston North Campus within the Department of Mathematics and Statistics. In 1991 he became the Foundation Head of the Department of Statistics and in 1995 became the first permanent Dean of the newly established Faculty of Information and Mathematical Sciences. Following the formation of College of Sciences at Massey University in 1998, he moved back to Auckland to become the Foundation Head of the Institute of Information and Mathematical Sciences on Massey University's newly established Albany Campus. He stepped aside from this role in 2001 to return to the position of Professor of Statistics. He was granted Professor Emeritus status on his retirement from Massey University in November 2007. He then joined AUT within the School of Computer and Mathematical Sciences and finally retired from AUT in December 2018 when he was granted the title of Profeesor Emeritus of Mathematical Sciences in recognition to his contribution to the university through shaping the Mathematical Sciences programme and his research contributions.

Jeffrey has published widely and is internationally recognized in the field of applied probability including Markov chains, semi-Markov processes, generalised matrix inverses, two-dimensional renewal theory – in the latter area his research has had wide applicability to warranty analysis. More recently, his research in Markov chains has seen him explore the properties and interpretation of Kemeny's constant and develop some pioneering innovative computational procedures. He has produced over 80 publications in these areas, including 46 journal articles and 8 books or book chapters. In 1983 Academic Press published his two-volume work on "Mathematical Techniques in Applied Probability". In 2005, he gained a Doctorate in Science from Massey University for his research in Applied Probability – the first of its kind in his field of research at the time in New Zealand. He has delivered over 50 plenary/keynote/invited talks at various conferences, and been the chair, an organizer or a committee member for over 30 conferences. In addition, he has also been invited to be an editor, a guest editor and a reviewer or referee for many journals and conference proceedings.

During his career he has held visiting positions at the Department of Statistics, University of North Carolina at Chapel Hill, (1973, 1988, 2001), Department of Industrial Engineering and Operations Research, Virginia Polytechnic Institute and State University, Blacksburg, (College of Engineering Visiting Professor 1980, 1987) and has been an academic visitor at the Department of Mathematics and Statistics, McGill University, Montreal, (1988), Mathematical Sciences Institute, Cornell University (1988), Statistical Laboratory, University of Cambridge, U.K (1992), Department of Industrial Engineering, Texas A & M University (1992) and Department of Statistics, University of Oxford, U.K., (2002).

In 1992 he was awarded a Claude McCarthy Fellowship to visit universities in the U.S., Canada, United Kingdom and South Africa. In 1992 he was the Distinguished Lecturer in Applied Probability, Department of Industrial Engineering, Texas A & M University. In 1993 he was elected as a Member of the International Statistical Institute.

Jeffrey has been the member of the NZ Mathematical Society, the NZ Statistical Association and the Operational Research Society of NZ for the duration of his career. He was President of the NZ Statistical Association (1995-97), elected a Fellow of the NZ Mathematical Society (2002), and served as Chair of the Royal Society of New Zealand Committee on Mathematical and Information Sciences (1997–2002). In 2003 he was awarded a Bronze New Zealand Science & Technology Medal, "for his significant contribution over an extended period to the public understanding of the role and importance that the mathematical and information sciences play in all spheres of the community including business and industry". In 2006 he was the recipient of the Campbell Award, the highest award given by the NZ Statistical Association "to recognize his contributions to statistical research and education, and his services to the profession of statistics". He was also given Honorary Life Membership of the NZSA. In 2015 he was appoined to the Advisory Board of Christ's University in Pacific, Tonga.

Jeffrey has been a member of the International Organizing Committee (IOC) of the International Workshops in Matrices and Statistics following his chairing of the Local Organising Committee for the Auckland Workshop held in 2005. He has chaired the IOC for three meetings in China – Shanghai in 2010, Haikou in 2015 and Shanghai in 2019. His 75th Birthday was recognised with a special session at the Madeira Workshop in 2016.

Over the 10 year period from 2008 to 2018, Jeffrey made significant contribution to the discipline and staff development in Mathematical Sciences at AUT. Through him, the Applied Statistics major was changed to Analytics in 2009. In 2014, Jeffrey worked together with Jiling Cao and Ajit Narayanan to set up the Master of Analytics at AUT, which was the first of its kind in the Departments of Mathematics and/or Statistics within New Zealand. After his retirement at AUT, Jeffrey still visits the Department of Mathematical Sciences from time to time, shares his vision and advises his colleagues. In April 2021, a group of his friends which included some colleagues from the University Auckland, Massey University and AUT met together at a gathering celebrating his 80th birthday.

Jeffrey enjoys travelling and is a great traveller and has been to many places in the world having visited over 85 countries. It has been a tradition for many years that he and his wife Hazel choose a new place to visit that year. I am sure that the couple will be on another cruise to a new destination once the international travel ban due to COVID-19 is lifted. Many of their colleagues and friends will extend best wishes to the couple. Also, I am sure that many of us look forward to Jeffrey's continued services and contribution to the mathematical sciences community within New Zealand and beyond.

Jiling Cao

Auckland University of Technology

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

New Appointments

In May, Emeritus Professor Graeme Wake (Massey University, Albany) was appointed Adjunct Professor of Industrial Mathematics within the Faculty of Design and Creative Technologies at AUT. Professor Wake will work closely with the colleagues in the Department of Mathematical Sciences within the School of Engineering, Computer and Mathematical Sciences.

Events

On 2 June, the 2021 NZ Data Science + Analytics Form was held at AUT. The event attracted over 250 participants nationwide, and it was jointly sponsored by the School of Engineering, Computer and Mathematical Sciences at AUT, and Precision Driven Health.

On the 29th of September, the Department of Mathematics Science will host a public lecture by Professor Dave Lowe who is the 2020 Wellingtonian of the Year Environment and the author of the bestseller: "The Alarmist: 50 Years Measuring Climate Change". Professor Dave Lowe is an atmospheric chemist and one of the lead authors of the 2007 Nobel Peace Prize-winning IPCC Fourth Assessment Report on Climate Change.

Figure 1: *Public lecture by Professor Dave Lowe*

In this public lecture, Professor Lowe will talk about his memoir "The Alarmist: Fifty Years Measuring Climate Change", which illustrates that the climate emergency has serious consequences for humans, involves complex science, system resilience, political leadership and action that depends on public support as with COVID-19.

Travel and Conference Participation

Dr Hyuck Chung's work was presented at the Acoustical Society of NZ conference in June. The paper titled 'Predicting the Sound Transmission Loss of Glazing' is a joint work with Dr. Grant Emms and Dr. Keith Ballagh of Marshall-Day Acoustics. Hyuck spent some of June at the University of Otago working with Dr. Fabien Montiel and Dr. Colin Fox continuing their research on wave scattering problems.

External Engagement

AUT academics have partnered with Manurewa High School to bring mathematical modelling to life, giving students a chance to use mathematical modelling to solve a long-standing community problem – the lack of affordable housing. The project, funded by SouthSci, was designed to make mathematical modelling tangible and relevant, and to help high school teachers build their teaching skills. Over the course of 10 weeks, Senior Lecturers Kerri Spooner and Junior Nomani have been leading a teaching unit on mathematical modelling on Manurewa High School's Wānanga Wednesdays, with the support of Manurewa High School teachers Aarthi Pilli and Lawarence Naicker. Students have been developing mathematical models to investigate issues affecting affordable housing and what that means for their future.

Graeme Wake, Adjunct Professor of Industrial Mathematics is a contracted lead researcher in a national team project entitled "Dynamic Nitrogen Modelling" funded through, and directed through Dairy NZ Ltd by the Agricultural and Marketing Research and Development Trust (AGMARDT). This is a pilot study for a year from May 2021. This interdisciplinary team is underpinning the development of decision support protocols for sustainable farming practices in NZ.

Visitors

Professor Jeong-Hoon Kim (Yonsei University, Republic of Korea) visited the Department of Mathematical Sciences in July-August. Professor Kim continued to work with Professor Jiling Cao and Dr Wenjun Zhang on using mathematical models to evaluate financial derivatives.

Seminars

Drs Alna Van Der Merwe, Sarah Marshall and Wenjun Zhang took sabbatical leave in 2020. Each of them presented a seminar talk reporting their activities and achievements during the leave period. The title for Alna's seminar is "Comparison of hyperbolic heat conduction models." The title for Sarah's seminar is "Modelling warranty claims from an ageing product using the alternating geometric process." The title for Wenjun's

seminar is “Pricing variance swaps under hybrid CEV and stochastic volatility.”

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF MATHEMATICS

I decided it would be a nice idea, since it is rare to have all staff in NZ at any given time, to organise a department photo on the day of our department meeting in July. Sadly I and a few others were sick on the day and, in compliance with university protocol, stayed home. But here is a photo of many of the academic and professional staff and PhD students in the department.

Figure 2: *Mathematics department of the University of Auckland, July 2021*

The senior management have decided that now is the ideal time for a Student Services Function Review and a Curriculum Transformation Project. So many of us have a few distractions from teaching and research at the moment. Nevertheless, we persist with teaching and research.

Staffing

The trans-Tasman travel bubble allowed Melissa Lee, Tomasz Popiel and Lauren Smith to finally move to Auckland. All three had been working remotely for varying lengths of time.

We hired three fixed-term teaching staff for semester 2. Amal Amleh will be known to some of you as she previously worked in Auckland and Otago, but she has more recently been at the American University in Dubai and the Paris-Sorbonne University in Abu Dhabi. Alastair Jamieson-Lane was until recently a post-doc in Oldenburg. Bartek Ewertowski is a PhD student in the department.

Sudeep Stephen has left to take a PTF job in the Computer Science department.

John Mitry has resigned and he will be leaving in February 2022.

Rod Gover, Eamonn O’Brien, and James Sneyd are taking research and study leave this semester.

Jeroen Schillewaert is a member of the Faculty Curriculum Transformation group. This means he is seconded to the Faculty for the remainder of the year.

Awards and News

Warren Moors has been made a Fellow of the Australian Mathematical Society.

Eamonn O’Brien received a 2021 University of Auckland Research Excellence Medal. His citation reads ”Eamonn O’Brien’s research has led to deeper understanding of the structure of (abstract) groups. His work explores mathematical structures using highly effective algorithms and computational algebra packages that have become unique tools to enable the wider research community to answer a range of challenging research questions.”

Dana Julio and Morgan Meertens were awarded best poster presentation prizes (Red Socks Awards) at the SIAM Conference on Applied Dynamical Systems.

John C. Butcher Visiting Scholars Programme (JBVSP)

A significant new visiting scholars programme, named in honour of Emeritus Professor John C Butcher, has been established.

The John C. Butcher Visiting Scholars Programme (JBVSP) will fund overseas-based scholars to come to Auckland to collaborate and work with Professor John Butcher ONZM, PhD, DSc, FRSNZ. The visiting scholars will be selected and invited to attend at the discretion of Professor Butcher. Each of them will have a distinguished background and international recognition in mathematics teaching and research.

Professor Butcher is an internationally renowned New Zealand mathematician who specializes in numerical methods for the solution of ordinary differential equations. His work in this field has resulted in the development of new mathematical techniques that have widespread practical application in the efficient use of computers, in solving problems that arise in modern technology and science. For the past 55 years the University of Auckland has been John’s teaching and research home.

Professor Butcher is recognised as the founder of the modern theory of Runge-Kutta methods. The Butcher group, the Butcher tableau, the Butcher product, and Butcher series are named in his honour. His most recent book, B-series: Algebraic Analysis of Numerical Methods, has been published by Springer-Verlag.

This year will be the first year of the programme and due to ongoing COVID-19 travel restrictions, international collaborators and JBVSP scholars will be unable to visit. Instead, 2021's scholar chosen by Professor Butcher is Dr. Saghir Ahmad, a Senior Lecturer at Auckland Institute of Studies. Professor Butcher supervised Dr. Ahmad in his PhD and will collaborate with him on the development of a software library based on the algorithms in the B-series: Algebraic Analysis of Numerical Methods book and assist in creating additional material to support the book.

The visiting scholars programme is generously supported by Dr. Leonid Frants, who is an alumnus of the University of Auckland and is now based in the United States. Dr Frants joined Goldman Sachs in 1996 and has accumulated more than 15 years of financial software and data management experience. He founded OneMarketData in 2004, which is a leading provider of software and data for the financial industry. His decision to provide the philanthropic support to create the programme was based on his wish to honour and thank John Butcher, to thank the University of Auckland for the education he received and, as the child of immigrants, to give back to New Zealand for giving his family a new home.

Other news

Clementine Gritti (U. Canterbury Computer Science) visited Steven Galbraith for a 2 week research visit.

Pedram Hekmati had a research visit to Adelaide and managed to get in and out of NZ without any trouble.

Melissa Tacy gave talks at a couple of online conferences (BIRNS workshop on analysis on singular spaces and the Mathematical Congress of the Americas spectral geometry session) and has been an instructor for an online summer school for this year's Séminaire de Mathématiques Supérieures based out of the University of Montreal (course was eigenfunction bounds and asymptotics).

Stephen Taylor and Jonny Stephenson have been developing a Capstone Course MATHS 399 that is being taught this semester.

Jeroen Schillewaert and Melissa Lee organised a very successful 3-day research retreat for the Algebra and Combinatorics group.

Arkadii Slinko organised an excellent Student Research Conference on Tuesday 8 of June. Prizes for the 4 best student talks went to David Dijkema (BSc(Hons)), Alex Elzenaar (MSc), Chris Pirie (BSc(Hons)) and Isabelle Steinmann (MSc).

Hinke Osinga organised on July 20 and 21 a great set of talks by our Honours and Masters students.

Steven Galbraith

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Paul Brown Dr. Paul Brown has recently been awarded an MBIE Science Whitinga Fellowship, a two-year fellowship designed to support early career researchers. The project, titled "Developing accurate preventative crime models that reduce systemic biases", uses recently developed fast Bayesian algorithms to construct spatiotemporal models of crime. An important feature of this work is to incorporate kaupapa Māori perspectives into the modelling process that may help reduce systemic biases that similar models have been known to perpetuate. This project is a continuation of part of his PhD which he completed in 2019 under the supervision of Chaitanya Joshi and Stephen Joe. Paul takes up his fellowship in November this year. A replacement position is described below.

Figure 3: Dr Paul Brown awarded a Fellowship

Muhammad Ejaz completes the PhD

In July, Muhammad Ejaz successfully defended his PhD thesis at his oral examination. A celebratory afternoon tea was held recently. His thesis title was "Adversarial Risk Analysis for First-Price Sealed-Bid Auctions" and he was supervised by Chaitanya Joshi and Stephen Joe. It was a 'PhD with Publication' with two papers accepted for publication and another one submitted.

Figure 4: Dr Muhammad Ejaz completes the PhD

Figure 5: Pa/Student Centre construction August 2021

Department news

Yet again we are carrying out a review of the engineering mathematics papers. This teaching is a major component of our educational activities. The new Pa/Student Centre building is progressing and not making too much noise. A view from the 3rd floor of G-building, where many of the Mathematic and Statistics staff have their offices, is below. The most recent "email storm" has been over the potential disposition options for a small sum of money which might have resulted from the ECNZ project of the mid 1990's, and which has to be spent before it evaporates!

Tutor position description

The Tutor provides quality lectures, teaching support in tutorials and workshops, oversees laboratories, and undertakes paper administration. The Tutor will be under the supervision of an academic staff member, who will retain personal responsibility for assessment of degree-credit work.

The main role of Tutor is to mark assignments, deliver lectures and workshops in statistics/data analytics, as well as support academic staff in teaching. The appointee is not required to do any research or complete higher degrees in their role, and the position is for two years only. It is intended that the person be appointed in time to stat work in the 2022 new year. Further details can be obtained from the Chair of Mathematics and Statistics, Assoc Prof Daniel Delbourgo: daniel.delbourgo@waikato.ac.nz

Kevin Broughan

MASSEY UNIVERSITY

SCHOOL OF FUNDAMENTAL SCIENCES

We are in a season of change at Massey University. Among these changes is that we've had to bid farewell to Dr Cami Sawyer, who has taken the role of Learning Area Lead for Mathematics and Statistics at the Ministry of Education. She will excel in this role where she will have a significant impact on mathematics education at a national level, and we wish her all the best. But she will certainly be sorely missed.

A recent highlight was the return of the annual M3S year 12 maths and stats quiz after a covid-enforced hiatus in 2020. We had a record number of teams attend from around the lower North Island, including teams from as far afield as New Plymouth, Wellington, and the Hawkes Bay. Congratulations to the winners from Scots College in Wellington!

Finally, congratulations to Dr Hammed Fatoyinbo who successfully defended his PhD entitled "Pattern Formation in Electrically Coupled Pacemaker Cells".

Hammed has now taken on a one year postdoctoral fellowship with Dr David Simpson.

Richard Brown

SCHOOL OF NATURAL AND COMPUTATIONAL SCIENCES

Emeritus Professor Graeme Wake is an invited plenary speaker at the International Seminar on Mathematics-In-Industry (ISIM21) to be held virtually from Malaysia at the University of Technology Malaysia in mid-August. This conference in embedded in a wider conference on Industry Innovation. His invited talk is entitled "Sustainable Farming: Modelling Catchment Pollution", covering in part a project sponsored by the Industry in NZ on Nitrogen pollution in our waterways arising from the intensification of farming.

Sasha Melnikov has left the Albany mathematics group to take up a role with Victoria University of Wellington.

As of 2022 the mathematics group will be part of the new School of Mathematical and Computational Sciences, along with their Manawatu colleagues.

Carlo Laing

VICTORIA UNIVERSITY OF WELLINGTON

SCHOOL OF MATHEMATICS AND STATISTICS

We have quite a few staff changes. The university has recently introduced teaching-intensive pathways "designed to provide a career for colleagues who wish to specialise in learning and teaching". Our long-term colleagues Steven Archer and David Cox are in the first cohort of staff to be appointed to these Professional Teaching Fellow positions. Congratulations Steven and David!

We are pleased that Brendan Harding, our new-ish Lecturer in Mathematics, physically joined us in May after working remotely from Australia. Also, Alejandro Frery, our new-ish Professor in Statistics and Data Science, has finally joined us in mid-July after arriving from Brazil and undergoing quarantine. In July we are also welcoming new colleagues Tanya Gvozdeva and Sasha Melnikov who are joining us as Professional Teaching Fellow and Associate Professor in Mathematics, respectively.

Mark McGuiness is taking a voluntary redundancy effective from the end of October after over 30 years at VUW. Mark joined the Department of Mathematics at Victoria University in February of 1991, moving down the corridor from his office in the Applied Mathematics Division of the DSIR where he had worked for eight years as a Research Scientist, mainly on geothermal reservoir modelling. Mark hopes to obtain Emeritus status at VUW, and to also continue with his Adjunct Professorship at the University of Limerick. He would like to continue to work with friends and colleagues here and in Ireland on mathematical modelling and industrial applied mathematics, and to continue to support mathematics in industry study groups locally and internationally.

Mark is a plenary speaker at the NZ Maths and Stats Postgrad Students conference in Tauranga in November. They are interested in the applications of mathematical techniques he has been involved with, including cooking crispy cereals, rice gelatinisation in beer production, the effects of footsteps on heart-rate detection, and weighing fast heavy fruit. He will probably also talk about detecting moisture levels in bauxite by hitting it with microwaves as it is offloaded from a ship in real time.

Astrid an Huef

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Michael Plank* for being awarded the EO Tuck Medal 2021 by ANZIAM. The award is in honour of the late Ernest Oliver Tuck and recognizes mid-career researches for outstanding research and distinguished service to the field of Applied Mathematics.

Huge kudos to *Alex James*, *Mike Plank*, *Giulio Dalla Riva* with UC graduate researchers Rachelle Binny, Nic Steyn, and Audrey Lustig who are part of a national collaborative team of academics and researchers, working with Te Pūnaha Matatini research centre for being awarded the Prime Minister's Science Prize 2020 for protecting NZ from Covid-19 through their mathematical simulation of Covid-19 infection modelling and their media communication work. The researchers' significant population modelling effort fed directly into daily official and ministerial briefings about how New Zealand would respond to Covid-19 and provided the scientific evidence to the Government for shaping its decision making in dealing with the global pandemic.

Congratulations to *Geertrui Van de Voorde* for receiving the College Of Engineering New and Emerging Researcher Award 2020. Geertrui started her research career 10 years ago in Belgium and has an outstanding list of publications. She has had a history of success with winning research grants and fellowships, including a Postdoctoral Fellowship from the FWO and a Marsden Fast Start grant.

Geertrui Van de Voorde receiving her trophy from PVC Jan Evans-Freeman

Alex Gavryushkin

In June the School welcomed two new staff members. *Kiel Hurley* joins our IT team. He had been at UC for 9 years and working as part of UC's IT-support for the central finance team. Kiel is a dedicated cyclist. His recent claim to fame is being the winner of the 'Most Number of Rides' during February's Love to Ride workplace bike challenge. He and his wife are passionate champions of public and pedal forms of transport, and happily navigate their daily life without a car, preferring to fill up their garage with bikes. Kiel is also a board game enthusiast, especially long play games of strategy and campaigning.

Alex Gavryushkin will be known from various research circles in New Zealand. He earned his PhD in Mathematics at Sobolev Institute of Mathematics, Russian Academy of Sciences in 2009, and held postdoc positions at the University of Auckland and ETH Zurich. A Rutherford Discovery Fellowship brought Alex back to Aotearoa in 2018, where he started a Biological Data Science (bioDS) lab at the University of Otago, which develops efficient algorithms for molecular data employing a range of novel mathematical tools from graph theory, probability theory, and geometry to do so. Alex is also an avid runner (particularly up steep slopes) and also is keen to resume cycling around flat(ter) Christchurch.

On 23 May the Christchurch Maths Craft Day was held in the Great Hall at The Arts Centre Te Matatiki Toi Ora. It was a vibrant and lively event with large swarms of enthusiastic crowds. TV3 and RNZ were also there to capture the energy and social media was abuzz with proud attendees displaying their efforts. Organized by director of Maths Craft New Zealand *Jeanette McLeod* and her team nine craft stations were set up with one goal - to engage as many people as possible in the subject and doing maths in disguise. A number of highly entertaining and engaging talks were given by among others Jeanette, *Michael Langton*, Bernd Krauskopf and Hinke Osinga (both University of Auckland).

Congratulations to *Jennifer Brown* who had won a silver medal in her age group and weight category in the 2021 World Masters Online Virtual Weightlifting Championship in May. The competition was held over Zoom and Jennifer performed in the UC high performance centre, cheered on by staff and students.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Xun Xiao has taken up his position as a Lecturer in Statistics. After completing his Bachelor of Science at the University of Science and Technology of China (2011), and a PhD at the City University of Hong Kong (2016), Xun was a lecturer at the Institute of Fundamental Sciences, Massey. His research interests include reliability, statistical process control, and industrial statistics. Welcome, Xun!

Congratulations to *Phil Wilcox* who received the Award for Excellence in Education from the Genetics Society of Australasia, which recognises his outstanding contributions to the genetics education in Australasia. Well done, Phil.

Our new Statistics Lecturer Xun Xiao

We are looking forward to Otago's next VC, *David Murdoch*, taking up the role early in 2022. He is a recognised world-leader in the prevention and treatment of infectious diseases, and currently the Dean and Head of Campus at the University of Otago, Christchurch. After the previous VC initiated the controversial Support Services Review and was supportive of the eventually successful cut of two mathematics positions, many colleagues feel that it was indeed about time for such a change.

Jörg Hennig

PhD SUCCESS

Joanne Knox (University of Auckland)

Title: How Primary School Students' Arguments Develop: Taking Initial Steps in a Deductive Discourse.

Supervisors: Igor' Kontorovich, Caroline Yoon, Fiona Ell

Abstract: How entry-level deductive reasoning may emerge in the discourses of young students and how they can be supported to take these steps is not typically well-understood by teachers nor researchers. Accordingly, this study maps out the mathematical journey of a number of year 4 students and reveals the ways in which formative empirical arguments about odd and even numbers are able to shift towards deductive arguments. Evidence for the findings is carefully grounded within the commognitive framework. The research highlights findings about what appropriate support of students' development might look like and signals the point that the mechanism of conflict among discourses, commonly suggested as motivation to adopt a new discourse, might be insufficient to prompt learning. Young children in this study required a mathematical reason – not just a social motivation – to change their discursive ways.

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Nur Atiqah Dinon (University of Auckland)

Title: The transport of Kuiper Belt Objects to the inner Solar System

Supervisors: Philip Sharp

Abstract: We use N-body simulations of the objects in the Kuiper Belt to investigate what percentage of objects are deflected into the inner Solar System and become a threat to Earth. Our model consists of the Sun, the giant planets and more than 100 thousand massless particles representing the Kuiper Belt objects. The simulations were performed using a very accurate integration method and optimized schemes for handling close approaches between bodies and collisions between them. We find a small percentage of the objects from the Kuiper Belt become a threat to Earth. In addition, our results offer explanations for the mechanisms that transport the objects from the Kuiper Belt to inside Neptune's orbit and then further in towards the Sun.

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Chris Wong (University of Auckland)

Title: Heat kernel estimates for elliptic operators with Robin boundary conditions

Supervisors: Tom ter Elst

Abstract: Consider the elliptic operator

$$A = -\sum_{k,l=1}^{d} \partial_l c_{kl} \partial_k - \sum_{k=1}^{d} \partial_k b_k + \sum_{k=1}^{d} a_k \partial_k + a_0$$

on a bounded connected open set $\Omega \subset \mathbb{R}^d$ where $d \geq 2$, subject to Robin boundary conditions $\partial_\nu u + \beta u = 0$. We show that the kernel for the semigroup generated by $-A$ satisfies Gaussian and Hölder Gaussian bounds given domain and coefficients regularities.

In particular we show that when the domain is Lipschitz and the principal coefficients are real, then the kernel is ν-Hölder continuous for some $\nu \in (0,1)$. We also show that if the domain is $C^{1+\kappa}$, where $\kappa \in (0,1)$, and the coefficients are κ-Hölder continuous, then the kernel is differentiable and the derivative is κ-Hölder continuous.

We use these kernel estimates to prove other properties of the semigroup, including holomorphy and irreducibility. Moreover, we prove lower bounds for the kernel if the domain is Lipschitz, all coefficients are real and A is self-adjoint.

As an application we also associate the elliptic operator with the Dirichlet-to-Neumann operator $\mathscr{N}$. We show that if Ω is $C^{1+\kappa}$, where $\kappa \in (0,1)$, $c_{kl} = c_{lk}$ are real κ-Hölder continuous, $a_k = b_k = 0$ and a_0 is real, then the kernel of the semigroup generated by $-\mathscr{N}$ has a Hölder Poisson bounds.

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Ielyaas Cloete (University of Auckland)

Title: Mathematical Model of Calcium Dynamics in Hepatocytes

Supervisors: James Sneyd and Vivien Kirk

Abstract: Calcium (Ca^{2+}) oscillations in hepatocytes control many critical cellular functions, including glucose metabolism and bile secretion. The mechanisms underlying repetitive Ca^{2+} oscillations and how these mechanisms regulate these oscillations is not fully understood. Recent experimental evidence has shown that both Ca^{2+} regulation of the inositol 1,4,5-trisphosphate (IP_3) receptor and agonist-activated Ca^{2+} regulation of IP_3 metabolism generates Ca^{2+} oscillations and co-exist in hepatocytes. Furthermore, agonist-activated Ca^{2+} oscillations in hepatocytes are shown to have a wide dynamic range. In particular, recent experimental evidence shows that agonist stimulation of the P2Y family of receptors leads to qualitatively diverse Ca^{2+} oscillations. We investigate the effects of the feedback mechanisms on the Ca^{2+} response in two parts.

First, we construct a mathematical model of the Ca^{2+} signalling network in hepatocytes. The model accounts for the biphasic regulation of Ca^{2+} on the IP_3 receptor (IP_3R) and the positive feedback from Ca^{2+} on IP_3 metabolism, via activation of phospholipase C (PLC) by agonist and Ca^{2+} Model simulations showthat Ca^{2+} oscillations exist for both constant [IP_3] and [IP_3] changing dynamically. We show, both experimentally and in the model, that as agonist concentration increases, Ca^{2+} oscillations transition between simple narrow-spike oscillations and complex broad-spike oscillations. The model predicts that narrow-spike oscillations persist when Ca^{2+} transport across the plasma membrane is blocked. This prediction has been experimentally validated. In contrast, broad-spike oscillations are terminated when plasma membrane transport is blocked.

Next, we present a new model of Ca^{2+} oscillations in hepatocytes based on the experiments to investigate the mechanisms controlling P2Y-activated Ca^{2+} oscillations. The model builds upon the previous model to include protein kinase C (PKC) regulation of multiple cellular substrates. Utilising the model, we suggest the activity and intensity of PLC and PKC necessary to explain the qualitatively diverse Ca^{2+} oscillations in response to P2Y receptor activation.

We conclude that multiple feedback mechanisms participate in regulating Ca^{2+} oscillations in hepatocytes.

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Hammed Fatoyinbo (Massey; School of Fundamental Sciences)

Title: Pattern Formation in Electrically Coupled Pacemaker Cells

Supervisors: Dr Richard Brown, Associate Professor Bruce van Brunt, and Dr David Simpson

Abstract: In this thesis we study electrical activity in smooth muscle cells in the absence of external stimulation. The main goal is to analyse a reaction-diffusion system that models the dynamical behaviour where adjacent cells are coupled through passive electrical coupling. We first analyse the dynamics of an isolated muscle cell for which the model consists of three first-order ordinary differential equations. The cell is either excitable, nonexcitable, or oscillatory depending on the model parameters. To understand this we reduce the model to two equations, nondimensionalise, then perform a detailed numerical bifurcation analysis of the nondimensionalised model. One parameter bifurcation diagrams reveal that even though there is no external stimulus the cell can exhibit two fundamentally distinct types of excitability. By computing two-parameter bifurcation diagrams we are able to explain how the cell transitions between the two types of excitability as parameters are varied.

We then study the full reaction-diffusion system first through numerical integration. We show that the system is capable of exhibiting a wide variety of spatiotemporal behaviours such as travelling pulses, travelling fronts, and spatiotemporal chaos. Through a linear stability analysis we are able to show that the spatiotemporal patterns are not due to diffusion-driven instability as is often the case for reaction-diffusion systems. It is as a consequence of the nonlinear dynamics of the reaction terms and coupling effect of diffusion. The precise mechanism is not yet well understood, this will be subject of future work. We then examine travelling wave solutions in detail. In particular we show how they relate to homoclinic and heteroclinic solutions in travelling wave coordinates. Finally we review spectral stability analysis for travelling waves and compute the essential spectrum of travelling waves in our system.

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Muhammad Ejaz (University of Waikato)

Title: Adversarial risk analysis for first-price, sealed-bid auctions

Supervisors: Dr Chaitania Joshi and Assoc Prof Stephen Joe

Abstract: Adversarial risk analysis for first-price, sealed-bid auctions (FPSB) have previously been found, but only under strong assumptions which make the model somewhat unrealistic. We use ARA (Amplified Run Average) methodology and model bidder's behaviours in FPSB auctions using more realistic assumptions. First we find ARA solutions by defining a new utility function and new risk aversion parameters. Then we find ARA solutions by defining new winning and losing regret parameters and a modified utility function.

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OBITUARIES

Peter Whittle, 1927-2021[3]

Peter Whittle, who died on 10 August 2021, at 94 years of age, will be remembered as a pioneer across the fields of probability, statistics and optimization. He wrote a number of important papers, but it is in his books that one can best appreciate the broad sweep of his achievements and the simplicity, unity and generality of his approach. His twelve major volumes covered times series, prediction, constrained optimization, dynamic programming, optimal control, stochastic systems, the foundations of probability theory and neural nets. Several of these works were ahead of their time: indeed some of his early works appear to have been written for the audience of today, such is the extent to which they anticipated subsequent developments.

Peter Whittle was born in Wellington, New Zealand, on 27 February 1927. His parents (Percy Whittle and Elsie Tregurtha) were both New Zealanders, of 19th century British and Irish extraction. His father, an orphan, joined the Post Office in 1914 and rose to become Assistant Postmaster for Wellington; and his mother was a schoolteacher. Peter spent his first 22 years in the spectacularly beautiful Island Bay, south of Wellington, facing onto Cook Strait. He graduated from the University of New Zealand with a B.Sc. in mathematics and physics in 1947, first across NZ in the exams for these subjects, and a M.Sc. in mathematics in 1948. He intended a career in mathematical physics, but vacation work in the NZ Department of Scientific and Industrial Research (DSIR) offered statistical problems from agriculture and biometrics that attracted his scientific interest, and his first paper was on the design of experiments.

[3]This is an edited version of an obituary published by the Royal Statistical Society

A travelling scholarship in 1949 took Peter to Uppsala, Sweden, for his doctoral work under Hermann Wold. A profound influence on Whittle was Maurice Bartlett, then working in Manchester. He began his work on time series analysis, and in his doctoral thesis and four papers following on from it he essentially solved the large-sample inference problem for a stationary time series generated by a linear Gaussian model. The terms "multivariate Whittle likelihood" and "Whittle estimation" are now common, but this early groundbreaking work was not at the time widely appreciated: Whittle remarked that, perhaps in unconscious emulation of the admired Bartlett, he wrote too gnomically. In marked contrast his corresponding analysis for spatial processes, published in 1954, had an immediate and sustained impact. His asymptotic inference theory for Gaussian processes and related spatial processes was ahead of its time in considering power law covariance functions, now central in image analysis.

After Uppsala, Peter returned in 1953 to New Zealand and the DSIR. The subsequent six years were to be deeply formative. Work on New Zealand rabbits (pests of the first order) produced the Whittle threshold theorem for stochastic process models of an epidemic. Oscillations in oceanographic data (from the Island Bay rock channels) uncovered non-linear effects. His time-series work led into the study and statistical analysis of spatial models. He was able to show for Fairfield Smith's collection of uniformity trial data the spatial autocorrelation functions behaved as inverse powers in their tails and that s-1 behaviour occurred dominantly. He showed that a spatio-temporal model explained the s-1 law; fractals and self-similar processes were as yet unthought of. During this period he also became interested in polymerisation and in reversibility, both topics he would return to later. Peter believed that his subsequent interests and career were largely shaped by his time in the NZ Department of Scientific and Industrial Research, working on problems from geophysics, agriculture and industry. His superior there later wrote "His genuine interest in people and their work, his boyish sense of humour and lack of pretension, made it possible for him to carry his own intellectual pre-eminence without exciting jealousy or antagonism."

Peter came back to Britain in 1959 as a lecturer in the Statistical Laboratory, Cambridge. In 1961 he moved to the Chair of Mathematical Statistics at Manchester, succeeding Maurice Bartlett. Peter's interest in optimization developed at Manchester; he kept his interest in spatial processes, with his student David Brook producing an early result on Markov random fields; and he obtained his first results on networks of queues and partial balance.

In 1967 Peter returned to Cambridge as the Churchill Professor of Mathematics for Operational Research, a newly established chair endowed by Esso. The position gave Peter the perfect platform for his vision that what needed developing was not just narrow sense operational research, but the whole area of what in Cambridge is now termed applicable mathematics. This includes, for example, probability, statistics, optimization, game theory and those aspects of disciplines such as control theory, communications theory and mathematical economics which might be pursued by someone technically based in probability and optimization. Developments in the US had convinced Peter of not only the practical importance of these topics but also the depth and coherence of the theory they generate. He felt that the subject of statistics itself is thoroughly penetrated by optimization concepts and is only viewed aright when embedded in this larger context (a view now taken for granted in statistics generally and in areas such as machine learning). Peter set about the task of creating the new courses to deliver this vision, and this began an evolution of the Mathematical Tripos at Cambridge that has continued to this day. He served as Director of the Cambridge Statistical Laboratory from 1973-1986.

By the time of Peter's second major work on time series (Prediction and Regulation, 1963, revised second edition in 1983) his interest had moved from inference to prediction and control. His four volumes on optimization marked his continuing interest in stochastic control, and in temporal optimization generally, using dynamic programming ideas. Optimization under Constraints (1971) is shot through with insight in a prose style combining power and economy. Notable in Optimization over Time (1983) is Peter's treatment of the multi-armed bandit problem. Despite its whimsical name this problem - the sequential allocation of effort in the presence of uncertainty - arises in areas as varied as the design of clinical trials or the choice of exploration avenues in artificial intelligence. The problem was first formulated during World War II and, as Peter famously remarked, efforts to solve it so sapped the energies of Allied analysts that the suggestion was made that the problem be dropped over Germany, as the ultimate instrument of intellectual sabotage. Later, in Risk-Sensitive Optimal Control (1991) the very complete theory for the linear/quadratic/Gaussian case is transferred to a significantly more general case.

His vision for the whole area of applicable mathematics was by now well established, providing the mathematical foundations for central areas of engineering and economics. Mathematicians often do not see the impact of their work on other fields. It is noteworthy that in the Foreword to the second edition of Prediction and Regulation, Thomas Sargent, later awarded the Nobel Prize in Economics for empirical research on cause and effect in the macroeconomy, writes on the importance of Peter's work for understanding dynamic economic phenomena.

His book Probability via Expectation (1970, expanded in 2000) is an exposition of probability theory which formulates its axioms in terms of expectation rather than measure, developing Peter's view that this approach has

advantages at many levels. One advantage is that probability theory and probability of quantum theory are seen to differ in only a modification of the axioms - a modification rich in consequences, but (as in so much of Peter's work) succinctly expressible.

Peter had a life-long interest in statistical/physical models, and the book Systems in Stochastic Equilibrium (1986) collects as one of its parts Peter's work on polymerization and random graphs, and also his work on partial balance in networks. His work on networks continued with Neural Nets and Chaotic Carriers (1998) and Networks: Optimization and Evolution (2007). In his final years he maintained his interest in neural nets, finding the notions of self-optimizing and self-organizing systems both fascinating and of enormous potential. But even he might have been surprised to see the pace of the ongoing realignment of mathematics, with statistics, optimization and machine learning permeating applied mathematics and leading to remarkable advances across swathes of physical, biological and social science.

He was awarded the Research Medal of the New Zealand Association of Scientists in 1954, and an Honorary D.Sc. by the Victoria University of Wellington in 1987. His many other distinctions included the Sylvester Medal of the Royal Society, the Guy Medal in Silver and Gold of the Royal Statistical Society, and the Lanchester Prize and the John von Neumann Theory Prize of the US Institute for Operations Research and Management Science. He was a Fellow of the Royal Society and an International Member of the US National Academy of Engineering.

Peter Whittle married Käthe Blomquist in 1951, and they had six children. Käthe was Finnish and they had met in Uppsala. They did their courting in Swedish, a second language to each and their only common language. He sometimes described himself as a "loner" and as far as his academic work was concerned he was certainly refreshingly away from the crowd. But it is hard to think of anyone who took such pleasure from his large family as really alone. The keenness of Peter's observation of personalities was another factor - to be read so clearly can be disconcerting.

At school in New Zealand Peter played the flute in the school orchestra, and he got pleasure from making and playing instruments throughout his life. He was particularly attracted to woodwind instruments, especially the oboe. In his middle years he learned the flamenco guitar, mastering the rasgueado - the continuous drum-roll achieved with the backs of the fingernails. He played the chanter - the part of the bagpipes that creates the melody, without the bag and drones. Languages were another interest: French, Swedish and Russian early in his life, and after retirement Scottish Gaelic whose evocative charms fascinated him. He was a talented runner and kept up distance running into his later years. He enjoyed carpentry, general DIY and toymaking, finding them a useful counterweight to his academic work. A poignant memory of a daughter is a necklace pendant with paua shell inlay. Music was all around the family, from Irish drinking songs, keening Gaelic laments, Swedish love songs and Māori hakas, to Bach concertos and Sibelius symphonies, reflecting not only the breadth of Peter's aesthetic sense and the richness of his mind, but also the shifting aspects of his interior life and personality. The music of Ravel, particularly, with its precision, refinement and elegance, accorded well with his mathematical mind.

Peter's wife Käthe died in 2020. He is survived by his children Martin, Lorna, Miles, Gregory, Jennifer and Elsie, seven grandchildren and one great granddaughter. Throughout his life he greatly missed New Zealand, and asked that his ashes be cast into the waters of Island Bay, Wellington, New Zealand, which he had grown up overlooking.

Frank Kelly

REPORTS ON EVENTS

43rd Mathematics Education Research Group of Australasia (MERGA43): student report

With the support of the NZMS Student Travel Grant I was fortunate enough to attend the 43rd annual conference of the Mathematics Education research Group of Australasia (MERGA 43), hosted by the National Institute for Education (NIE), Singapore, https://www.merga.net.au/Public/Publications/Annual_Conference_Proceedings/2021-MERGA-conference-proceedings.aspx. This conference was scheduled as an in-person conference for July 2020 and was postponed due to the COVID-19 pandemic. Due to the ongoing pandemic, the conference was rescheduled and held as a virtual conference from July 5-8, 2021.

MERGA is well regarded as the largest mathematics education group in Australasia and so it provided an important platform for participants to consider research in my field of research: proof and proving. Proof and proving are marginalised in Australasian schools and there is scant research in this area, especially the primary school sector (the focus of my research).

My conference paper and presentation were developed from my PhD research findings. My research uses Anna Sfard's (2008) commognitive framework to analyse how students engage in proving activity and develop proofs. Professor Anna Sfard (University of Haifa, Israel) is a distinguished scholar of international acclaim who is frequently sought after as a keynote speaker at major international conferences in mathematics education. For the first time at an Australasian mathematics education conference, Anna Sfard was the keynote speaker at MERGA43. This presented a fabulous one-off opportunity for me to learn from her personally in a face-to-face (albeit virtual) capacity. The conference also provided an opportunity for me to connect with other academic scholars and practitioners from Australia and New Zealand during research presentations, round table discussions and Q & A sessions.

My paper, *Why should we argue about the process if the outcome is the same? When communicational breaches remain unresolved* is now published in the conference proceedings, widening the impact of my research (https://www.merga.net.au/common/Uploaded%20files/Annual%20Conference%20Proceedings/2021%20Annual%20Conference%20Proceedings/MERGA%2043%20Proceedings(8-July-2021).pdf). I also entered the Early Career Research Award (an award for a new researcher in mathematics education for excellence in writing and presenting a piece of mathematics education research). Although I did not win this award, my presentation was attended by over 30 conference delegates and was thereby one of the most attended presentations during the conference. I have since also been selected as one of 14 authors from the conference proceedings to be invited to submit an extended abstract for MERGA's "Quick Reads". The purpose of Quick Reads is to illustrate the wide-range of research papers presented at a MERGA conference and, as such, it increases the reach of my research.

Participating in this conference and being able to discuss my research in this community of Australasian mathematics educators and researchers has enabled me to develop bridges and relationships. It has been an incredibly insightful experience for me and, I feel, hugely beneficial for my research and career development. I would like to express my gratitude to the New Zealand Society of Mathematics for their financial assistance towards this experience.

Jo Knox (University of Auckland)

Report on the 2021 AUCKLAND MATHEMATICAL OLYMPIAD held Saturday 08 May

After being cancelled due to the first lockdown in 2020, the AMO returned bigger than ever last Saturday with over 170 secondary school-aged participants from all over the Auckland region. The students had to solve ten challenging problems in two hours. The problems were once again devised by Professor Arkadii Slinko (Department of Mathematics), with support from Dr Sione Ma'u and Chris Wong. Students' solutions were graded from 0 up to 3, and this year's top Y9-Y11 or junior student scored an amazing 30 out of 30 possible marks. Not to be outdone, the two top Y12-Y13 or Senior students also achieved scores of 30 out of 30.

The better students stood out by working efficiently, then notifying a marker when they believed they had solved the problem. Each was only allowed to have two turns at having a solution checked per question by a marker, so they needed to be sensible when submitting their answers. With a team of eighteen markers split

between the Junior and Senior venues, the team amazingly managed to check every submitted solution offered by the students through two solid hours of the assessment. In the Senior room, Professor Slinko and Dr Ma'u provided expert interpretations of students' strategies while in the Junior room this task was handled by Dr Gabriel Verret and by Dr Jonny Stevenson. The picture below is of Junior students (MLT 1) working away while markers focus on individual questions.

Junior students working in MLT 1

At the end score sheets were collected, and the students were sent away to enjoy pizza and drinks while markers met to total then rank the scores. The top twelve senior and junior students emerged, with the odd demarcation discussion. However, the winners were eventually identified, and everyone was invited back into MLT 1 for the prize-giving. After a short message from HOD Mathematics Professor Steven Galbraith, each school was provided with students' certificates of participation before the winners of the individual major prizes receive their prizes. This picture is of Professor Galbraith handing the Senior winner, Rick Han of Macleans College, his prize.

Rick Han receives the first prize in the senior division

A special note of gratitude goes to our GSA, Dr Shamim Shadfar for organizing the catering, certification, and prizes for this event.

The highest scoring students in each division, and major prize-winners were:

JUNIOR (Y9-Y10) WINNERS

1. BUTAN ZHOU (ACG PARNELL COLLEGE)
2. ERIC LEE (MACLEANS COLLEGE)
3. BONING DAI (AUCKLAND GRAMMAR SCHOOL)
4. ERIC LIANG (RANGITOTO COLLEGE)
5. ANATOL COEN (MT ALBERT GRAMMAR SCHOOL)

SENIOR (Y11-Y12) WINNERS

1. RICK HAN (MACLEANS COLLEGE)
2. HE (JAMES) XU (KRISTIN SCHOOL)
3. BRENA MERZ (ST CUTHBERT'S COLLEGE)
4. ETHAN MILLER-GOULTER (KRISTIN SCHOOL)
5. OLIVER DAI (MACLEANS COLLEGE)

Phil Kane

GENERAL NOTICES

Systematic Feature Engineering for Time-Series Data Mining (SFE-TSDM)

SFE-TSDM Workshop at
21st IEEE International Conference on Data Mining (IEEE ICDM 2021)
December 7-10, 2021
Auckland, New Zealand

Time series are one of the most common data types in science, engineering, medicine, and economics. In many applications, not the sequential time-series values themselves, but their properties (e.g., autocorrelation structure, entropy, outliers, etc.) are important for analyzing and understanding the respective systems from which they have been recorded. These time-series features have the benefit that they are interpretable, provide valuable insights for domain experts and support explainable machine-learning models.

In recent years, a variety of time-series feature extraction software packages have been developed, including hctsa (Matlab), tsfresh (Python), and feasts (R).

These packages allow users to compute large numbers of univariate time-series features (e.g., up to 7700 features per time series in hctsa) by providing implementations of a wide variety of time-series analysis algorithms, including those developed in statistics, signal processing, time-series analysis, and non-linear dynamics.

The workshop on Systematic Feature Engineering for Time-Series Data Mining is organized as part of the 21st IEEE International Conference on Data Mining[3], which will be held from 7-10 December 2021 in Auckland, New Zealand. Due to the changing circumstances derived from the COVID-19 pandemic, the format may be updated to virtual only or a combination of virtual and in-person participation. Updates will be posted online[4].

The workshop organizers are seeking contributions on systematic time-series feature engineering (STSFE), including:

- time-series data mining,
- novel algorithms for time-series feature extraction, including algorithms using neural networks,
- explainable machine learning on STSFE,
- time-series feature-based dimensionality reduction, classification, and regression, and
- evaluating the performance of time-series feature sets,
- constructing reduced feature sets,
- pattern recognition on time series,
- domain-specific and industry applications,
- event sequences and other types of ordered data like language time-series.

Authors are invited to submit original papers, which have not been published elsewhere and which are not currently under consideration for another journal, conference or workshop. Submission instructions can be found at https://sfe-tsdm.github.io.

If you have any questions, feel free to contact the workshop organizers:

- Ben Fulcher (ben.fulcher@sydney.edu.au)
- Andreas W. Kempa-Liehr (a.kempa-liehr@auckland.ac.nz)

Andreas Kempa-Liehr

[3] https://icdm2021.auckland.ac.nz
[4] https://icdm2021.auckland.ac.nz/attending/

2nd New Zealand Workshop on Uncertainty Quantification and Inverse Problems

We invite researchers and practitioners at all levels to register for the New Zealand Workshop on Uncertainty Quantification and Inverse Problems (NZWUQIP), to be hosted by the Department of Engineering Science at the University of Auckland, Auckland, New Zealand. The workshop will take place November 16-19, 2021, at the University of Auckland in the central business district of Auckland.

This workshop aims to bring together experts from the fields of uncertainty quantification, inverse problems, and model calibration to network and exchange ideas. We welcome those working in all fields of application.

Participants are encouraged to give a thirty-minute presentation, though depending on the number of attendees, spaces may become limited. The workshop programme will be fairly relaxed with morning talks beginning at 9:30 am and afternoon talks finishing at 4:30 pm. This year's plenary speaker is Colin Fox (Otago). The programme also includes a dinner to be held on the evening of November 18th.

Student registration fee is $50 (NZD), while for other participants the registration fee is $100 (NZD). A fee waiver may be possible (considered on a case-by-case basis).

Anyone interested in attending this workshop or requiring further information should contact any of

- Ruanui (Ru) Nicholson (ruanui.nicholson@auckland.ac.nz),
- Oliver Maclaren (oliver.maclaren@auckland.ac.nz), or
- Prasad Babarenda Gamage (tp.babarendagamage@auckland.ac.nz),

before September 17th. Please indicate in your email whether you wish to give a presentation. Abstracts will be due shortly after September 17th.

Organisers:

- Ruanui (Ru) Nicholson (University of Auckland)
- Oliver Maclaren (University of Auckland)
- Prasad Babarenda Gamage (University of Auckland)

NZMS NOTICES

Notice of Annual General Meeting

The Society's AGM will be held on Tuesday 7th December 2021 as part of the New Zealand Mathematics Colloquium, hosted by the University of Canterbury. Please send any potential agenda items to the NZMS Secretary by 23rd November 2021 (phillip.wilson@canterbury.ac.nz).

Call for nominations for NZMS Council positions

Owing to the completion of elected terms, nominations are called for three positions on the New Zealand Mathematical Society Council. At least one vacant position must be filled by a member from the South Island. The term of office of a Council member is three years. Council members may hold office for two (but no more than two) consecutive terms. Please consider the current makeup of the Council and give particular thought to the nomination of candidates who will help maintain a diverse Council that represents the NZ mathematics community (eg. mix of career stages, areas of mathematics, geographic locations, genders, types of institutes). Existing Council members, and their terms, can be found on the website: http://nzmathsoc.org.nz/?membership.

Additionally, nominations are called for the position of Incoming Vice-President. The term of this position is one year, with the Incoming Vice-President then becoming President for a term of two years, followed by a one year term as Immediate Past President. Ordinary members (including existing Councillors) may be nominated for the position of Incoming Vice-President. If an existing Councillor is elected their vacant Council position will be filled by nominations for the vacant Council positions.

Nominations for Council and Incoming VP should be put forward by two proposers. The nominee and the two proposers should be current Ordinary members (including Student members) or Honorary members of the New Zealand Mathematical Society. There is no nomination form. Nominations, including the nominee's consent, should be sent by email to the NZMS Secretary, no later than 5 November 2021. The two proposers and the nominee should each send separate messages to the NZMS Secretary.

Calls for nominations for NZMS Awards and Fellowships

The NZMS recognises excellence in mathematical research and service to the NZ mathematical community through awards and an accreditation (fellowship) scheme. The Council asks that you all actively encourage eligible colleagues to apply for these awards and/or offer to nominate them, especially women, those of Māori ethnicity, or other members of the NZ mathematical community who are under-represented among past awardees and fellows.

Below are calls for nominations for the specific awards and for NZMS fellowships, along with their deadlines. Further details on all the awards, including past recipients, eligibility, and how to nominate someone (or self-nominate), can be found at: http://nzmathsoc.org.nz/?awards. Fellowship information and application forms can be found at: http://nzmathsoc.org.nz/?accreditation.

2021 Gillian Thornley Award for outstanding contribution to the cause or profession of mathematics

This annual award was established in 2020 to recognize outstanding contributions to the cause or profession of mathematics in New Zealand. 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.

Eligibility. Nominees need not be members of the NZMS but the award would normally be given for work that took place in New Zealand and contributed to NZ mathematics.

Nominations should be sent by email to the NZMS President, Prof David Bryant (david.bryant@otago.ac.nz) by 31 August 2021. Submissions should state clearly that they are for the Gillian Thornley Award.

2021 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.

Eligibility. Candidates may contact the NZMS President in confidence for clarification of how the following eligibility criteria apply to their particular circumstances: candidates should be within ten years of confirmation of PhD, but an appropriate adjustment to this time period can be made to take into account career breaks or periods of reduced workload; and, candidates must have worked or studied in NZ for at least 30 months in the three calendar years immediately prior to the award year, with an appropriate adjustment for career breaks (candidates who leave New Zealand during, or prior to, the award year but satisfy all other conditions remain eligible); and, candidates must be current members of the NZMS; and no person can receive the award more than once.

All nominations and applications should be sent by email to the NZMS President, Prof David Bryant (david.bryant@otago.ac.nz) by 31 August 2021. Submissions should state clearly that they are for the NZMS Early Career Award, and should follow the guidelines at http://nzmathsoc.org.nz/?awards.

2021 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 (2016–2020). This could include research published in books, journals, other peer-reviewed venues, or other types of high quality mathematical research. This assessment period may be adjusted to take into account an interrupted career pattern. Candidates may contact the NZMS President in confidence for clarification of how the adjustment of time period applies to the their particular circumstances.

Eligibility. To be eligible for the Award, a candidate must be a current member of the NZMS and must have been a resident of New Zealand for the last three years.

Nominations and applications should be sent by email to the NZMS President, Prof David Bryant (david.bryant@otago.ac.nz) by 31 August 2021. Submissions should state clearly that they are for the NZMS Research Award, and should follow the guidelines at http://nzmathsoc.org.nz/?awards.

2021 Kalman Prize for Best Paper

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: 2016–2020. 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.

Eligibility. A publication may be nominated for the Prize by any member of the NZMS who is not an author of that publication. To be eligible, the nominated publication must have at least one author who: (i) is a current member of the NZMS, and was a member in the calendar year of publication of the nominated work; and (ii) is a resident of New Zealand, and was a resident of New Zealand at the time when the research was carried out.

Nominations should be sent by email to the NZMS President, Prof David Bryant (david.bryant@otago.ac.nz) by 31 August 2021. Submissions should state clearly that they are for the Kalman Prize for Best Paper, and should follow the guidelines at http://nzmathsoc.org.nz/?awards.

Remaining deadlines for applications for Financial Assistance

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 2021 are: 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.

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Susanne C. Brenner, SIAM President and Boyd Professor, Louisiana State University

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