Number 129 April 2017

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 Miguel A Moyers González and Phillip L Wilson. 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 phillip.wilson@canterbury.ac.nz. LaTeX templates are available upon request from the editors.

The official address of the Society is:

The New Zealand Mathematical Society,
c/- The Royal Society of New Zealand,
P.O. Box 598, Wellington, New Zealand.

However, correspondence should normally be sent to the Secretary:

Emily Harvey
M.E
PO Box 331297
Takapuna 0740
Auckland
New Zealand
emily.harveyNZ@gmail.com

NZMS Council and officers

PRESIDENT	Astrid an Huef
VICE PRESIDENT	Vivien Kirk
SECRETARY	Emily Harvey
TREASURER	Bruce van Brunt
COUNCILLORS	Astrid an Huef (2011–2018), Florian Beyer (2014–2017), Bruce van Brunt (2011–2017), Shaun Cooper (2013–2019), Emily Harvey (2013–2019), Vivien Kirk (2015–2020), Stephen Marsland (2016–2019), Mark McGuinness (2012–2018), Rua Murray (2014–2017), Bruce van Brunt (2011-2017).

Other positions of responsibility

MEMBERSHIP SECRETARY	John Shanks
NEWSLETTER EDITORS	Miguel Moyers and Phil Wilson
LEGAL ADVISOR	Peter Renaud
ARCHIVIST	Peter Donelan
WEBMASTER	Boris Baeumer

Correspondents

Alona Ben-Tal	ANZIAM
Kevin Broughan	University of Waikato (Mathematics)
Richard Brown	Massey University (IFS)
Richard Clarke	University of Auckland (Engineering Science)
Shaun Cooper	Massey University (INMS, Albany)
Peter Donelan	Victoria University of Wellington (MSOR)
Jörg Hennig	University of Otago (Mathematics and Statistics)
Steffen Klaere	University of Auckland (Statistics)
Günter Steinke	University of Canterbury (Mathematics)
Garry Tee	University of Auckland (Mathematics)
Wenjun Zhang	AUT (SCMS)

Web Sites

NZMS homepage: nzmathsoc.org.nz (Webmaster: bbaeumer@maths.otago.ac.nz)

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

ISSN 0110-0025

EDITORIAL

Welcome to 2017.

In this first issue of 2017, you will find a small variation on the idea of the Profile. When we ask members of the community to write a Profile about someone, sometimes the ensuing chat gives the person being profiled the opportunity to explore some issues about which they feel passionate. When that is the case, both the interviewer and the interviewee might agree that an interview format feel more appropriate than a standard Profile. For this reason, in the present issue, we feature an Interview with Hinke Osinga, and we thank her and her interviewer Steven Galbraith for the first Interview of an NZ mathematician to be featured in this way.

We believe that both the Profile format and the Interview format have their advantages, but we feel that both should be of equal value and standing in the Newsletter. We also want to give people flexibility in their approach to this central feature of the Newsletter. We know that everyone is busy and asking for contributions to the Newsletter can be a daunting task. We want to remove as many constraints as possible in order to make life easier for everyone. Your feedback is very welcome.

Remember that we have a fully electronic version now, so encourage as many contributions as possible from the community.

Miguel Moyers and Phil Wilson

PRESIDENT'S COLUMN

The 2017 Maclaurin Lecturer is Ken Ono from Emory University; he will be touring New Zealand this October. I am grateful to Shaun Cooper for coordinating Ken's tour. The Maclaurin Lectureship is a reciprocal exchange between the New Zealand and the American Mathematical Societies, and the agreement we have with the AMS for it expires at the end of 2017. While the AMS views the exchange as a success, they don't want to extend the agreement. Instead, the AMS has expressed interest in a second joint AMS/NZMS conference (the first was in 2007 at the Victoria University of Wellington).

So Ken Ono will be the last Maclaurin Lecturer. The discontinuation of the Maclaurin Lectureship is a loss especially for the smaller departments who get fewer international speakers. Since the larger departments have a lot more international visitors, it would be beneficial for the community to find ways of "sharing" visitors. Perhaps this is a good time to revive the list of mathematical visitors to NZ on the NZMS website at nzmathsoc.org.nz/?visitors.

There are several events to look forward to. Mathematics-in-Industry NZ (MINZ) will be held 26–30 June at Massey University in Palmerston North. The NZMS Colloquium will be held 4–6 December at the University of Auckland; the convenors are Tom ter Elst and Hinke Osinga. The 2018 NZMRI Summer Meeting "Algebra and Representation Theory" will be held 7-13 January 2018 at Thunanui Beach near Nelson; the organisers are Eamonn O'Brien, Marston Conder and Gabriel Verret. The website for the meeting is nzmri-conferences.blogs.auckland.ac.nz/.

Valerie Isham from University College London has been chosen to be the 2018 Forder Lecturer. I am grateful to Mick Roberts for coordinating Valerie's tour.

Thank you to all who responded to our survey about the Colloquium. Some key points that Council took from the survey are:

1. Most respondents found the informality and the "break" times very valuable.
2. Most respondents thought that more discussions (formal and informal) about issues the community is facing and shared experiences would add value to the colloquium.
3. Some wanted contributed talks in special sessions, but others didn't.
4. There was support for holding joint meetings with NZSA, ORSNZ or other mathematical societies.

It's clear that to make joint meetings possible we will have to do much more forward planning than we currently do.

Finally, I'd like to draw your attention to the NZMS Notices at the back of this Newsletter. There you will find calls for nominations for Fellowship of the NZMS, nominations/applications for the NZMS Research Award, applications for the NZMS Early Career Research Award and nominations for the Kalman Prize. There is also a call for applications for financial assistance, including student-travel grants.

Astrid an Huef

INVITED ARTICLE

Randomness and Anti-randomness in Computability Theory

Adam R. Day
Victoria University of Wellington
adam.day@vuw.ac.nz

Random is a commonly used adjective in mathematics. Often this alludes to some underlying measure e.g. a random variable has its associated law. It is rare to describe something like a specific real number x as being random. Nevertheless, computability theorists do this all the time. In this article, I will explain their justification for doing so and highlight some recent research on the interaction between random and anti-random real numbers.

Computability theorists view mathematics from the perspective of what can be computed with unbounded resources. For example, we define $E \subset \mathbb{R}$ to be a *computable open set* if there is a computer program that outputs a possibly infinite sequence of rationals $a_1, b_1, a_2, b_2, \ldots$ such that

$$E = \bigcup_{i \in \mathbb{N}} (a_i, b_i).$$

When dealing with a countable collection of computable objects, we usually require the collection to be computable as well as the individual elements. For example, a set $N \subset \mathbb{R}$ is a *computable null set* if $N = \bigcap_{i \in \mathbb{N}} E_i$ where each E_i is a computable open set, the Lebesgue measure of E_i is less than $1/i$, and further there is a computable map that outputs E_i given i.

There are only countably many computable programs, so there are only countably many computable null sets. As this union is also null, computability theorists feel justified in calling *random*, any real number that is not contained in a computable null set.[1]

Regarding a real number as random if it avoids certain null sets is an old idea in mathematics. For example, Borel's work showing almost all real numbers are normal can be seen as an attempt to define a property that a random real number should have [7]. It turns out that if we replace Turing machines with automata, and define a random real number in a similar manner to that above, then we can characterise the normal real numbers [3].

An alternative approach

In order to define anti-randomness, I need to briefly sketch an alternative approach to defining randomness.

Let $w : \mathbb{Q} \to \mathbb{N}$ be a function. You should think of this function as assigning every rational a weight. We will restrict w by requiring that

$$\sum_{q \in \mathbb{Q}} 2^{-w(q)} < \infty.$$

Among other things, this prevents w mapping infinitely many rational numbers to the same natural number. We can consider how well the weights approximate a fixed $x \in \mathbb{R} \setminus \mathbb{Q}$ by looking at the function defined by

$$W(x,n) = \min\{w(q) : q \in \mathbb{Q} \cap B(x; 1/n)\}$$

i.e. the minimum weight of a rational in the open ball of radius $1/n$ around x.

If we fix $x \in \mathbb{R} \setminus \mathbb{Q}$ we can consider how the function $n \mapsto W(x,n)$ grows. This function is unbounded as any rational is avoided by a small enough ball around x. The slower this function grows, the better we can regard w as approximating x.

It is possible to define a w such that[2]

A real number x is random if and only if $n \mapsto W(x,n)$ grows as fast as possible.

[1] This particular type of randomness is known as Martin-Löf randomness.
[2] Define w to be a universal function of the above form such that the set $\{(q,n) \in \mathbb{Q} \times \mathbb{N} : w(q) \leq n\}$ is computably enumerable.

Once w has been defined, it is natural to define a real number x to be *anti-random* if $n \mapsto W(x,n)$ grows as slowly as possible. While I will use the term anti-random for this article, the standard term is K-trivial.

If you work through the details of the definition of an anti-random real number, it becomes clear that any computable real number is anti-random. What is not obvious is that there are anti-random real numbers that are not computable. This was originally shown by Bob Solovay in unpublished work.

In the study of random real numbers, anti-randomness keeps turning up in different settings. We will see examples below but it is worth mentioning a deep result of André Nies that showed that anti-random real numbers are precisely the real numbers that have no derandomisation power. If you have come across oracle computation before, then here is a statement of this result. First note that an object is computable in an oracle x, if the object can be computed by a Turing machine with access to the binary expansion of x written on an extra tape. If x is an anti-random real number, then any null set computable with x as an oracle, is contained in a computable null set i.e. x cannot make any additional real numbers non-random [10].

Randomness and Computational Power

Computability theorists have long been interested in the computational power of real numbers. To explain this concept, for any $x \in [0,1]$, let $p_x : \mathbb{N} \to \mathbb{N}$ be the characteristic function of a set E where[3]

$$x = \sum_{n \in E} 2^{-n}.$$

Let $\mathbf{d_x}$ be the smallest class of functions from $\mathbb{N}$ to $\mathbb{N}$ including p_x, and closed under computable operations.[4] Consider the following set.

$$\mathscr{D} = \{\mathbf{d_x} : x \in [0,1]\}$$

We can place an upper semi-lattice structure on this set with the order defined by inclusion (i.e. $\mathbf{d_x} \geq \mathbf{d_y}$ if $\mathbf{d_x} \supseteq \mathbf{d_y}$.) There is also a join operation denoted by $\vee$.

The details of this join operation are not important for this article but briefly, $\mathbf{d_x} \vee \mathbf{d_y}$ is $\mathbf{d_z}$ where z is obtained by encoding all the information contained in x and y e.g. take z such that $p_z(2n) = p_x(n)$ and $p_z(2n+1) = p_y(n)$.

We call $\mathbf{d_x}$ the degree of x and the structure $(\mathscr{D}, \leq \vee)$ is known as the Turing degrees. This structure has a least element $\mathbf{d_x}$ where x is any computable real number. We will denote this element by $\mathbf{0}$. The other element of interest for this article is $\mathbf{0'}$. This is the degree of a real number than encodes the halting problem.

Some basic questions we will look at are the following:

- How are the degrees of random real numbers distributed in $\mathscr{D}$?
- How are the degrees of anti-random real numbers distributed $\mathscr{D}$?
- How do these degrees interact?

Distribution of random degrees

There is an interesting dichotomy in the distribution of the degrees of random real numbers (random degrees for short). Most random degrees, i.e. Lebesgue measure one, are computationally weak in the sense that their degree is not above $\mathbf{0'}$.

However, the Kučera-Gács Theorem states that every degree above $\mathbf{0'}$ is a random degree [8, 9]. This is surprising as one would not expect computationally powerful degrees to be random. Denis Hirschfeldt suggested that one way to think of this result is to imagine a person being given an ignorance test. There are two ways to pass an ignorance test. The first is to be truely ignorant and the second is to be smart enough to know how an ignorant person would answer.

[3] The choice of E in the case that x is a dyadic rational does not matter.

[4] This means the class must contain all computable functions and be closed under composition, primitive recursion and minimisation.

Distribution of anti-random degrees

The distribution of the anti-random degrees is easier to understand. They are all computationally weak, in fact every anti-random degree is strictly below $\mathbf{0}'$. Additionally the anti-random degrees have a strong downwards closure property. If x is an anti-random real number and $\mathbf{d_y} \leq \mathbf{d_x}$, then y is a anti-random real number.

Interactions between randomness and anti-randomness

A important result in computability theory is the Posner-Robinson Theorem [12]. This theorem states that if $\mathbf{d}$ lies strictly between $\mathbf{0}$ and $\mathbf{0}'$, then there is a degree $\mathbf{e} < \mathbf{0}'$ such that $\mathbf{d} \vee \mathbf{e} = \mathbf{0}'$. This theorem and its variants have many important applications. One question to ask is what happens if we place restrictions on the degree $\mathbf{e}$. For example, could require $\mathbf{e}$ to be a random degree?

This motivates the following definition. A degree $\mathbf{d}$ can be *cupped by a random*, if there exists a random real number r such that $\mathbf{d} \vee \mathbf{d_r} \geq \mathbf{0}'$. (To avoid trivial solutions, we also require that $\mathbf{d_r} \not\geq \mathbf{0}'$.)

In fact, not all non-zero degrees can be cupped by a random, but we can nicely characterise them.

Theorem 1 (Day, Miller [4])**.** *The anti-random degrees are the complement of the degrees that can be cupped by a random.*

Our last theorem relates to the computational power of random sets. A degree $\mathbf{d}$ can be *capped by a random*, if there exists a random real number r, such that $\mathbf{d} \leq \mathbf{d_r}$ and $\mathbf{d_r} \not\geq \mathbf{0}'$ (again this second requirement avoids trivial solutions).

Significant effort was put into understanding the computably enumerable degrees that can be capped by a random. A degree $\mathbf{d_x}$ is computably enumerable if the zero bits of the binary expansion of x can be listed (not necessarily in order) by a computable function. Early work in computability theory focused heavily on the computably enumerable degrees and these are comparatively well understood. Two papers, one by Joseph Miller and myself and the other by Laurent Bienvenu, Noam Greenberg, Antonín Kučera, André Nies and Dan Turetsky resolved this problem. Again the characterisation is given using anti-randomness.

Theorem 2 ([1, 2, 5])**.** *The anti-random c.e. degrees are precisely the random cappable c.e. degrees.*

To find out more about randomness and computability I would recommend the following two books (both with New Zealand-based authors) "Algorithmic Randomness and Computability" by Rod Downey and Denis Hirschfeldt and "Computability and Randomness" by André Nies [6, 11].

References

[1] Laurent Bienvenu, Adam R. Day, Noam Greenberg, Antonín Kučera, Joseph S. Miller, André Nies, and Dan Turetsky. Computing K-trivial sets by incomplete random sets. *Bull. Symb. Log.*, 20(1):80–90, 2014.

[2] Laurent Bienvenu, Noam Greenberg, Antonín Kučera, André Nies, and Dan Turetsky. Coherent randomness tests and computing the K-trivial sets. *J. Eur. Math. Soc. (JEMS)*, 18(4):773–812, 2016.

[3] Chris Bourke, John M. Hitchcock, and N. V. Vinodchandran. Entropy rates and finite-state dimension. *Theoret. Comput. Sci.*, 349(3):392–406, 2005.

[4] Adam R. Day and Joseph S. Miller. Cupping with random sets. *Proc. Amer. Math. Soc.*, 142(8):2871–2879, 2014.

[5] Adam R. Day and Joseph S. Miller. Density, forcing, and the covering problem. *Math. Res. Lett.*, 22(3):719–727, 2015.

[6] Rodney G. Downey and Denis R. Hirschfeldt. *Algorithmic randomness and complexity*. Theory and Applications of Computability. Springer, New York, 2010.

[7] M. Émile Borel. Les probabilités dénombrables et leurs applications arithmétiques. *Rendiconti del Circolo Matematico di Palermo (1884-1940)*, 27(1):247–271, 1909.

[8] Péter Gács. Every sequence is reducible to a random one. *Inform. and Control*, 70(2-3):186–192, 1986.

[9] Antonín Kučera. Measure, Π^0_1-classes and complete extensions of PA. In *Recursion theory week (Oberwolfach, 1984)*, volume 1141 of *Lecture Notes in Math.*, pages 245–259. Springer, Berlin, 1985.

[10] André Nies. Lowness properties and randomness. *Adv. Math.*, 197(1):274–305, 2005.

[11] André Nies. *Computability and Randomness*. Oxford University Press, 2009.

[12] David B. Posner and Robert W. Robinson. Degrees joining to $\mathbf{0}'$. *J. Symbolic Logic*, 46(4):714–722, 1981.

MATHEMATICAL MINIATURE

MM42: Łukasiewicz decoded

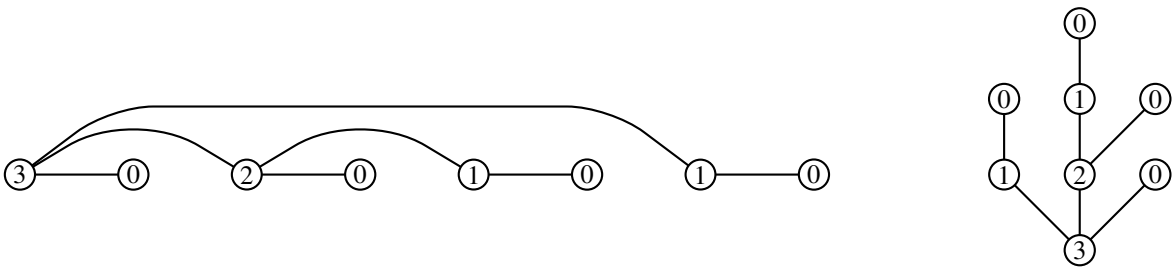
In MM41 I referred to Timothy Swan who lived near me and who left behind a large number of notebooks which were passed on to me when Timothy died aged 53. At the end of my piece I asked a number of questions and received an answer to some of them from Rob Goldblatt. Phil Wilson also told me what he had found out about the Polish logician who lived his later years in Dublin.

My first question was about Timothy himself, whom nobody else seems to have heard of. I asked what truth there might be in my story about him. Whether I have remembered his name correctly or not, I am sure many people like him exist and are known to many of us. There are amateur mathematics enthusiasts everywhere, many of whom are untrained but highly talented.

The person I called Wukashevich, because that is what Timothy called him, is really Jan Łukasiewicz. After the second World War he settled in Dublin and became a professor at University College. His most famous work was in collaboration with the renowned mathematician and logician Alfred Tarski of Banach-Tarski paradox fame. In our context Łukasiewicz is known for the invention of Polish notation, in which brackets can be dispensed with by writing binary operations in prefix form. For example, $(3+2)\times(4+7)$ would be written as $\times+3\,2+4\,7$. As Rob correctly decoded, the letter from Łukasiewicz to Timothy consisting of the single line $=\times x+y\,z+\times x\,y\times x\,z$ is, in conventional notation, $x(y+z)=xy+xz$. Phil gave me an English sentence which is in Polish-notation word order, although not, as far as I know, in Polish word order. It was nice because it contained a universal quantifier as well as a verb acting on an object. I have adapted Phil's sentence by changing both the verb and the object and adding a further unary operator:

I believe everyone loves Mathematics.

The "treeish" wukacode I ended with last time, that is the sequence 30201010, was illustrated by a graph. It looks like a tree blown over in the wind. Here it is again followed by an upright version of the same picture



We can now interpret the numbers attached to the vertices of this diagram as the number of its children. In Polish notation, n attached to a factor indicates that this is an n-ary operator with operands consisting of the n treeish sub-codes which follow it. However, if an n-ary operator is not followed by a sufficient number of treeish sub-codes, then the wukacode is stumpy.

In answer to question 4 from MM41, the 14 treeish codes of length 5 are as follows. The parentheses shown are not part of the Polish notation — how could they be — but are intended to show where some of the treeish sub-codes begin and end.

40000	300(10)	30(10)0	3(10)00	20(200)	20(110)	2(10)(10)
2(200)0	2(110)0	1(3000)	1(2010)	1(2100)	1(1200)	1(1110)

In question 5 it was asked how many these reduce to. The answer is 9 but what are the equivalent classes?

I think it is possible to convince yourself that the treeish wukacodes represent planar trees and the reduced codes are rooted trees. A study of Timothy's notebooks led me to find a recursion for the number of treeish codes. Denote a_n for the number of treeish codes of length n so that $a_1 = 1$. Here is the formula I found in the notebooks

$$a_n = \sum_{i=1}^{n-1} a_i a_{n-i}.$$

I read through many pages looking for Timothy's formula for a_n itself. After a lot of hard work, he seems to have settled on the result

$$a_n = \frac{2(2n-3)!}{n!(n-2)!}, \qquad n \geq 2. \tag{1}$$

I couldn't see any evidence that he had worked this out rationally; rather he seems to have found a fit empirically. Careful reading led me to what looked like an attempt to find a generating function but that was all. However, I was able to find my own derivation of the result. I hope some readers can give me their own individual proofs of (1).

I have left many questions for you to think about from both MM41 and from the current MM42, I look forward to receiving any comments, questions or answers. Meanwhile I am still struggling through more of Timothy's notebooks and I will have something further to say about the efforts of this gifted and ingenious self-taught mathematician next time.

J.C. Butcher

butcher@math.auckland.ac.nz

CYBERMATH

This column takes a break from its recent heavy focus on publication reform to list a few interesting links more related to mathematical research and other professional issues. It is a partially fenced stream of consciousness, but may be useful all the same.

Laci Babai made a bold claim, which generated substantial publicity, that determining whether two graphs are isomorphic can be solved in quasipolynomial time. Harald Helfgott found a flaw while reading the paper deeply in order to present it to Séminaire Bourbaki, which I had no idea still existed. Babai retracted the claim on 4 January 2017, and reasserted it after fixing the proof on 7 January 2017. How long would this process have taken under the current journal system — would the error have been spotted at all? (Sorry, couldn't resist that). This is an important theoretical breakthrough and shows how well mathematics can work in the internet age.

Speaking of internet mathematics, there is a journal of that name, devoted really to the mathematics of complex networks (what we used to call graphs before the marketers took over). Not only is the journal interesting and apparently well run, it uses the new platform Scholastica (as does Tim Gowers's Discrete Analysis). Another interesting fact is that the journal was formerly published by one of the traditional publishers (Taylor & Francis), and they gave it up to the editors (not, however, before charging them for the back issues).

Getting back to mathematics on the internet, Polymath is still active, although generating less publicity than a few years ago. They are currently focusing on Rota's basis conjecture: if $B_1, B_2, \ldots, B_n$ are disjoint bases of an n-dimensional vector space V then there exists disjoint bases $C_1, \ldots, C_n$ such that each C_j contains one element from each B_i.

The arXiv has become very important to mathematicians. At my urging my university will become a financial supporter. I challenge other readers to get their institutions to do the same, rather than freeload as seems to be NZ policy in so many areas in recent years. Although it is cheap to run per paper, the total cost is nontrivial because there are so many papers. It is a challenge to keep up with new postings, so if you trust recommendation algorithms, try arXivist ("your personal guide to the arXiv") or Scirate to navigate it. An alternative is to visualise its million-plus papers as a complex network using Paperscape.

The arXiv idea has recently spread to disciplines with very little preprint tradition. The Center for Open Science has developed a preprint platform used by psychology, engineering, sociology and other fields. Maybe journals will change radically soon, after all.

Springer made many old volumes in its Graduate Texts in Mathematics series available for free download in late 2015. The direct links can be found easily by searching although they have apparently revoked the free deal. If they were serious, presumably they would remove the links.

If you want to attend a mathematical meeting in person rather than do everything via the internet, try Math-Meetings.Net which aims to be a complete list.

I recently read (much of — far too many letters and namedropping for my taste to finish all of it) The Autobiography of Bertrand Russell. A controversial figure but certainly a mathematician (for part of his life) who followed his conscience wherever it took him. The American Mathematical Society is awarding the Bertrand Russell Prize every 3 years from 2018, for "research or service contributions of mathematicians or related professionals to promoting good in the world and recognizes (*sic*) the various ways that mathematics furthers human values." Thomas Hales has apparently funded the prize. It would be good to see nominations (which close 30 June 2017) from this part of the world.

Of course, political activity by mathematicians can cause problems and muddy reputations, as the recently deceased great mathematician Igor Shafarevich found out. Other nonagenarians who have left us recently, in mathematics or related fields, include Kenneth Arrow, Joseph Keller, Howard Raiffa and Thomas Schelling. Going back a year, there is also Christopher Zeeman (whom I am sure visited NZ sometime), Fields Medallist Klaus Roth, while Felix Browder made it to 89. Best wishes to all readers aiming to make 100 while still doing mathematics! The longest-lived mathematician that I am aware of is Leopold Vietoris who not only lived during three centuries, but has quite a few concepts named after him.

Mark C. Wilson

INTERVIEW

Hinke Osinga

Hinke Osinga was awarded her masters and PhD degrees at the University of Groningen in the Netherlands and then had post-doc positions at the Geometry Center (University of Minnesota) and CalTech. She became a lecturer at the University of Bristol in 2001 and moved to Auckland in 2011. A nice summary of her mathematical influences can be found by listening to her interview with Kathryn Ryan (Radio NZ, Nine to noon): radionz.co.nz/national/programmes/ninetonoon/audio/201824228/royal-society-fellow-hinke-osinga-on-maths-and-crochet.

In the last few years Hinke has been the recipient of a number of significant honours, including an Invited Lecture at the International Congress of Mathematicians (ICM) in Seoul (2014), Fellowship of the Society of Industrial and Applied Mathematics (2015), NZMS Research award (2015), Fellow of the Royal Society of New Zealand (2016), Fellow of the NZMS (2016), Marsden grant (2016), and most recently being selected by the London Mathematical Society and the NZMS as the 2017 Aitken lecturer.

I caught up with Hinke recently and, after congratulating her on these successes, asked her which of them she is the most proud of. Without hesitation she replied that it was the ICM talk "because it came out of the blue. It was something I never dreamed I would ever be invited to. Suddenly I got noticed by different people so that made it very special. It was not my usual friends."

She describes attending the ICM as incredible: "I'd never been at an ICM before. This was the one where we had the first female Fields medal, awarded by the first female president of the IMU, and presented by the female president of the Republic of South Korea. That was unheard of. It really made you feel you were part of a historical moment.

"As an invited speaker you get to sit in the front block of seats. You get special treatment as you have this big nametag. You are right there. That alone really made it."

She had the opportunity to meet all of the Fields Medalists. "I congratulated all of them in person. Some people I spoke to more than just 'congratulations.' It was a shame Maryam Mirzakhani was there for only a short period. She had to cut her visit short and her lecture was cancelled. So I never heard her speak, which was a real shame. I was glad that I had the courage to walk over and just say that I wanted to shake her hand and congratulate her."

I then asked about her plan for her Aitken lectures this year. She is going to visit the UK both in May and October for short visits. In May she will visit Bath, Cambridge, Exeter and Oxford. In October she'll be in Bristol, Kent, Newcastle and Warwick. Regarding her talks, there is a choice of three titles, two of which can be given as public lectures. She intends to present work that has developed in the five or six years since she moved from the UK. "The public lectures are either on the Lorenz system or on research that I have been developing in collaboration with earthquake engineers. It is on buildings in an earthquake, which is much more New Zealand flavoured. Of course, if I go anywhere people are like 'Where's the crochet?' so you have to anticipate that this is what people actually want to hear. Of course, many people have already seen the crocheted Lorenz manifold, but that is a long time ago. If people want the crochet talk then fine, I can give a talk on the crocheted Lorenz manifold with new details on recent developments."

She found the move from Bristol to New Zealand liberating, mainly due to changing from an Engineering Science department to a Mathematics department. It means that she can pursue all her mathematical interests, both the applied and the theoretical, and feel that all aspects are equally valued in the department. "Coming here, Lorenz was suddenly allowed. We really made a huge advance into combining this pure theoretical stuff, where people get a bit stuck, and the numerical investigations which show which direction you should think of if you want to advance the theory further. This combination is what I like about the research that I do. Really giving an insight." The warnings that she was moving to the middle of nowhere have proven to be completely false: with its many international visitors, she finds the Mathematics Department at Auckland an extremely vibrant research environment, and indeed, most of her international collaborators are always willing to visit New Zealand.

We also talked about the low participation of women in mathematics. "The Department of Mathematics at Auckland has quite a large number of women staff members and several of us are engaged in activities to encourage women pursuing careers in mathematics and science." In particular Vivien Kirk is instrumental in fostering a Women's Network across all of NZ; this initiative is also heavily supported by NZMS President Astrid An Huef. Furthermore, Claire Postlethwaite and Anna Barry have started the Undergraduate Women in Science (UWIS) network in the Faculty of Science, with activities to help undergraduate women meet each other and give them an opportunity to meet women role models. "I am always happy to volunteer to do a session, present a talk or participate in a panel discussion." Hinke was very active on that front in England already. She was involved with the Athena Swan initiative, which is a way of quantifying a University or Department's efforts to create a gender-equal work environment; A medal is awarded, and reviewed on a regular basis, as a measure of how effective these efforts are. "A similar scheme is now hopefully coming to NZ and particularly Astrid is trying to make this happen. My involvement is more in the background, I know quite a bit about what the pitfalls are and what is good and bad about Athena Swan from my experience in the UK."

We discussed the conference pledge (to accept talk invitations only from conferences that have made serious efforts to include women). "I'm married to another mathematician in a similar field. We've been through a bit of a change. In the beginning my husband would be invited and then I would come along and think 'Why didn't I get invited? I could give that talk too.' During the next wave, suddenly I was being invited but Bernd would be expected to come along and he was a bit like 'Oh well it's a good thing there is a female speaker,' but you could see he was a bit disappointed. Now, if it is all male speakers then I say 'Well they clearly don't want me there so I'm not going.' It has even gone as far that participants asked Bernd 'where's Hinke? We thought that an invite to you would automatically mean she'd come to the meeting too' and he's like 'well, there were no female speakers and that's why she's not here.'"

The conference pledge is not an easy pledge to make. "I can see how difficult it is to hold onto the pledge, because conference attendance is of fundamental importance for career development. This pledge is something for the senior people to make. Junior people need to take every opportunity. It's part of the collective effort that we should think about this more. We should at least raise awareness." For example, Hinke mentions the Butcher-Kalman talk at the NZMS colloquium. "This is a recent initiative to invite an early-career researcher to give a talk, and I really like that a lot. At ANZIAM they have medals. The big ANZIAM medal for the senior person, well that person just gets the medal. But the Michell Medal for someone within ten years of their PhD, that person is

an invited speaker at the next meeting. At the NZMS colloquium it is exactly the other way around: The NZMS Research Award winner is invited to speak, while the NZMS Early Career Research Award winner just gets the award.

"It is very difficult to think how much having been at certain meetings impacts your career. But I would say, for me, it has been absolutely instrumental. I have been at certain meetings and I can trace back a lot of early-career successes from the fact that I was at that meeting and I met these people, and then those people knew I existed. I would even want to trace the ICM invitation directly back to having had very early-on exposure, meeting lots of people, working hard at it. You know that's part of it: you don't just go to the meeting but you try to talk to people. And then realising that these people talk to other people, and other people get to know you exist, and you get on people's radar, which then maybe gets fed by the fact that you then give talks elsewhere. I do think that being a successful mathematician, if you think in terms of PBRF measures and having international leadership etc, is something that comes from being at conferences. The thing that marks us as successful is not that we run a lab, it's that we've been a keynote speaker at some conference. So it means that collectively we find those conferences very important."

Steven Galbraith

PEOPLE

Robert McKibbin becomes Professor Emeritus

With Head of Institute Professor Dianne Brunton.

Robert McKibbin joined Massey Palmerston North in 1991, and became Professor of Applied Mathematics in 1996. He moved to Albany in 2001, and was head of the Institute of Information and Mathematical Sciences from 2002 until 2007. This was a period marked by substantial growth in student and staff numbers on the Albany campus. He has served as the Chair of the College of Sciences Research Committee, and as a convenor of PhD oral examinations. He was the director of the Centre for Mathematical Modelling, and was instrumental in setting up the Centre for Mathematics in Industry. He has supervised or co-supervised sixteen Massey University PhD students, as well as a number of masters and honours projects. He became Professor Emeritus at the end of 2016.

Robert has been very active in the mathematics community in Australia and New Zealand. He was chair of ANZIAM in 2004/5. He has been chair and treasurer of the New Zealand branch of ANZIAM, on the New Zealand Mathematical Society Council, and chair of the North Shore Branch of the Royal Society of New Zealand. Robert was awarded the ANZIAM medal in 2012. The medal is presented every two years for an outstanding contribution to applied mathematics in Australasia, and to ANZIAM. In the citation, the selection committee said "There are few other Applied Mathematicians in New Zealand who have shown more devotion and service to the field than has Robert. Through his enthusiasm, energy, and sustained achievement, he has demonstrated a lifelong commitment to the Applied and Industrial Mathematics profession, to the extent that he well and truly meets the criteria for this award."

Roberts research focuses on the theory and application of heat and mass transfer. We are talking: fluid mechanics including geothermal fluid mechanics; hydrogen diffusion in metals; reservoir modelling; water-rock interaction and oxygen isotope transport in hydrothermal systems; non-condensable gas effects in geothermal reservoirs; hydrothermal eruptions; volcanic ore-forming brines; and modelling the dispersion of particles by the atmosphere. Way back in 1984 as an early career researcher he was awarded the Hamilton Memorial Prize. He is a regular participant in the Mathematics in Industry Study Groups held annually in Australia and New Zealand, and has been frequently invited to similar meetings overseas. In particular he has developed strong links with counterparts in Japan through many visits, one as a recipient of an award from the Japan Society for the Promotion of Science. He has been heavily involved in the activities of the Institute for Mathematics for Industry, formed in the University of Kyushu, leading to links in the newly formed Asia-Pacific Consortium for Mathematics for Industry. These served to assist New Zealand to be a founder member country of this grouping.

We hope that Robert continues to contribute to Massey as an Emeritus for a long time, and if and when he finally departs we wish Robert and Helen a long and happy retirement.

Adapted from INMS Newsletter, 3/3/17, by Mick Roberts and Graeme Wake

Retirement of David Gauld

David Barry Gauld was born at Inglewood on 1942 June 28. At the Primary School in that farming region, in one year David and his two brothers comprised half of the student enrolment, with the other half consisting of a girl and her brother, plus another boy. In David's final year there the teacher couldn't think of much for David to do, and so he set David the task of teaching a new pupil to read. That was David's first experience of teaching! After that he boarded for a year at Wanganui Technical College, then Inglewood High School opened and David spent three years there. His father sold the farm and the family moved to New Plymouth, where he spent a year at New Plymouth Boys High School.

In 1961 he enrolled at the University of Auckland, where he was very active in the Tramping Club, becoming its Captain and then its President for about 10 years and later a Life Member. As a student in the Tramping Club he carried loads of building materials up to the summit of Ruapehu for building the shelter hut on the crater rim[5]. On 1963 July 3 a DC3 en route from Auckland to Tauranga crashed on the Kaimai Ranges. That was New Zealand's worst domestic air disaster, killing all 23 people. David was one of the searchers and he, with two other people, had the job of constructing a rough track to the crash site for the Inspector of Air Accidents to get there, two days after the crash. He tells that "The sight of the burnt plane and the victims is seared in my brain more than half a century on. I was back at the crash site 50 years to the minute after the crash and, while the topography remains much the same, the gulch is now covered with attractive native plants."

In the Department of Mathematics David was a student tutor for two years, then a Junior Lecturer for 7 months. He graduated as M.Sc. in Mathematics in 1965 (after studying for that degree in 1964) and then went to UCLA. In 1969 he gained his PhD in Mathematics, and was appointed as Lecturer in the University of Auckland Department of Mathematics. His research interests are in set-theoretic topology, especially applications to non-metrisable manifolds, and topological properties of manifolds near the limit of metrisability. He has published many papers in numerous prominent journals and in Proceedings of many conferences, and he has given many invited addresses at conferences worldwide. He was very active on the Editorial Boards of various journals, including the *Mathematical Chronicle* and its continuation as *The New Zealand Journal of Mathematics*, *Far Eastern Journal of Mathematics*, *Topology Atlas*, *et cetera et cetera*. His first book **Differential Topology, an Introduction** was published by Marcel Dekker in 1982 (re-published by Dover in 2006), and his second book **Non-metrisable Manifolds** was published by Springer in 2014.

The *Mathematical Intelligencer* set in 1983 a contest, to write a speech for a mathematician who had been captured by cannibals. Those cannibals were interested in mathematics, and so when they learned that their intended meal was a mathematician they offered to release him if he could give them a proof which they could

[5]That shelter was destroyed when a minor eruption of Ruapehu occurred near midnight on 2007 September 25, seriously injuring a tramper (William Pike) and trapping him in the ruins. His companion (on his first mountain climb) managed to descend at night from the crater rim and contact a snow-plough driver, who notified a rescue team which rescued William Pike.

understand, of some striking and novel theorem. David won the prize with a short speech (written in Māori), giving a proof of the topological theorem that there must be at least one point in the ocean at which the mean tidal range is zero. David's speech was published in *The Mathematical Intelligencer* vol.**5**, no.4 (1983), together with his own free translation of that speech from Māori into English.

He became Head of the Department of Mathematics for 1981–1990, 1993–1994 and for 2001–2005: an unprecedented total of 15 years. In addition to his three main periods as HOD he has been Acting Head on various occasions. In 1991, with Alastair Scott as Head of the Department of Mathematics and Statistics and Ivan Reilly as Acting Head, David was the Acting Acting Head, with George Seber as Acting Acting Acting Head and Chris Triggs as Deputy Acting Acting Acting Head. He was the assistant Vice-Chancellor (Research) for 1994–1997. David was President of the NZMS in 1981–1982, he was the Founding Secretary of the New Zealand Mathematics Research Institute and he organized the first summer camps at Huia on Knots (1994) and at Tolaga Bay on Statistical Mechanics (1996). He facilitated the appointment of Vaughan Jones as Distinguished Professor of Mathematics at the University of Auckland. David helped to transform the UoA Department of Mathematics from one which concentrated largely on teaching, with a small number of active researchers, to a world-ranked department known for the quality of its teaching and its research, as well as the quality of its graduates. He facilitated initiatives to support Māori and Pacific students, including Aldis scholarships and the Tuakana programme.

He has supervised several research students, and he has been awarded various honours, including Fellow of the New Zealand Mathematical Society and also the New Zealand Science and Technology Medal (in 1997), Honorary Member of the New Zealand Mathematical Society (2015) and Officer of the New Zealand Order of Merit (2016).

David is renowned for his enthusiasm (still continuing) for bush and stream tramping, especially in the Waitakere Range and the Hunua Hills. Vaughan Jones has gone tramping with David on various occasions, and he was impressed by David climbing mountains with bare feet. David was active in the Royal Forest and Bird Society of New Zealand, and he organized annual excursions to the bird sanctuary on Tiritiri-Matangi Island.

David Barry Gauld retired on 2017 February 22, after having been employed by the Department of Mathematics for just over $49\frac{1}{2}$ years (including student tutor and Junior Lecturer).

Garry J. Tee

LOCAL NEWS

AUCKLAND UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING, COMPUTER AND MATHEMATICAL SCIENCES

Staff news

Craig Sole is a recently appointed lecturer for the Certificate in Science and Technology programme within the School of Engineering, Computer and Mathematical Sciences. Craig completed a mechanical engineering degree at the University of Auckland and worked as a graduate at New Zealand Steel and New Zealand Steel Mining Ltd. After an OE with his wife to the UK, he worked at an aerial surveying firm that used geographic spatial imagery to produce maps and other services. Craig then spent two and a half years as a home dad for his two children before attending the AUT teacher training course. 13 years of secondary teaching followed at three schools where he taught science and mathematics. An interest in renewable energies lead to a Masters of Energy course at the University of Auckland which included projects on home solar solutions and storing energy with super-capacitors. Craig enjoys helping young, and old, people understand science and mathematics and all the great things you can do with it.

Dr. Catherine Hassell Sweatman is a recently appointed lecturer for the Certificate in Science and Technology programme within the School of Engineering, Computer and Mathematical Sciences. Previously, she was a Research Fellow at the Liggins Institute, at the University of Auckland, and before that, a Research Fellow in the Department of Electronics and Electrical Engineering, at the University of Edinburgh. She is interested in the modelling of diabetes and the methionine cycle, as well as signal processing applications and differential geometry.

Shaun Wason is recently appointed as a lecturer for the Certificate in Science and Technology programme within the School of Engineering, Computer and Mathematical Sciences. Shaun is a Massey University Engineering Honours graduate who has been teaching on the certificate at AUT for 5 years now. Shaun also has a post-graduate certificate in Secondary Teaching and worked for one year teaching at a high school level in Palmerston North. He enjoys teaching a wide range of STEM subjects. He also completed a post-graduate certificate in Computer Information Science at AUT, and is looking forward to further study.

Event

On 1-2 December 2016, the Mathematical Science Research Group (MSRG) continued the annual AUT Mathematical Sciences Symposium. This is a joint effort of Profs Jiling Cao and Jeffrey Hunter, with the assistance of Drs. Kate Lee, Sarah Marshall and Wenjun Zhang. The Symposium attracted over 40 participants from New Zealand and overseas, with 26 talks including 6 invited plenary ones. Three "out of town" keynote Symposium speakers (Prof Geoff McLachlan (University of Queensland), Prof Mark McGuinness (VUW) and Prof Tak Kuen Siu (Macquiarie University)) were funded from MSRG Research Fund. The Symposium focused mainly on some areas in Applied Mathematics and Analytics/Statistics. The main purpose of this event is to develop and promote opportunities for AUT academic staff working on these areas to collaborate with colleagues from other universities. It was an remarkable success with many favorable comments from the external participants.

Figure 1: *From left to right*: Craig Sole, Catherine Hassell Sweatman and Shaun Wason.

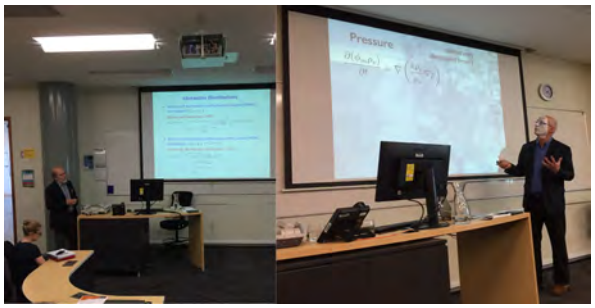


Figure 2: *From left to right*: Geoff McLachlan and Mark McGuinness

Travel and Conference Participation

In December-January, Prof Jiling Cao visited Minnan Normal University (where he was appointed Min Jiang Scholar and Visiting Professor for 3 years), where Jiling gave two talks: "Oscillation revisited" and "Aumann's equivalence theorem". On 22 February, Jiling attended the symposium in honour of Prof David Gauld, hosted by the Mathematics Department at the University of Auckland. At the Symposium, Jiling talked about David's pioneer contributions on Volterra spaces and his interaction with David on this topic.

In January, Dr. Kate Lee visited the Dauphine Universite in Paris, France and gave a talk on "Reference prior for Gaussian mixture models" in the Department of Statistics, the University of Oxford.

In January, Dr. Wenjun Zhang visited the University of Otago in Dunedin and presented a talk on "Pricing variance swaps in a hybrid model of stochastic volatility and interest rate with regime-switching".

During January, Dr. Alna van der Merwe spent two weeks working with Prof. Nic van Rensburg at the Department of Mathematics and Applied Mathematics at the University of Pretoria in South Africa. This ongoing collaboration deals with various aspects of vibration models.

In February, Dr. Hyuck Chung visited Dr. Fabien Montiel and A/Prof. Colin Fox at the University of Otago to continue his work on acoustical waves and their interaction with elastic structures. They were joined by a PhD student from The University of New South Wales, who is a part of ongoing project with A/Prof. Nicole Kessissoglou. This collaboration has produced several journal papers, and has several more in the pipeline. Dr. Chung plans to visit the University of New South Wales in April to continue the work.

Visitors and Seminars

Nuttanan Wichitaksorn (Thailand Development Research Institute), "On the matrix copula with applications to portfolio analysis"

Atikur Khan (CSIRO, Australia), "Balancing disclosure risk with utility for generating synthetic data"

Wenjun Zhang

UNIVERSITY OF AUCKLAND

DEPARTMENT OF ENGINEERING SCIENCE

Two Engineering Science doctoral students have recently defended their theses. Guillermo Cabrera's thesis was titled "Combining heuristics and mathematical optimization to solve hard multi-objective combinatorial optimization problems" and was supervised by A/Prof. Andrew Mason, Dr Andrea Raith and Prof. Matthias Ehrgott (Lancaster, UK). Pavel Sumetc defended his thesis "Modelling the endothelial glycocalyx layer" and was supervised by Drs Richard Clarke, John Cater and David Long.

During his visit to the Department, Dr Reza Zamani (University of Wollongong) gave two seminars. One titled "Operations Research in Engineering (with Emphasis on Metaheuristics and Evolutionary Computation)" and a second titled "Network Design Problems with their applicability, classification, complexity, and solution strategies". Dr Peter Stewart (Glasgow) also gave a seminar on "A non-invasive method for estimating intracranial pressure".

Finally, the fifth edition of Don Nield's book (D.A. Nield and A. Bejan, *Convection in Porous Media*, 5th ed., Springer, 2017) has just been published. In its various editions dating back to 1992 the book has now been cited over 7000 times.

Richard Clarke

DEPARTMENT OF MATHEMATICS

Josephina Ah Sam is our new permanent Professional Teaching Fellow for the Tertiary Foundation Certificate and Unibound programmes. She started at the beginning of February. She has rich and diverse teaching experiences in secondary–school mathematics.

Marston Conder has been elected to the Council of the Institute of Combinatorics and its Applications (the ICA).

David Gauld retired on February 22, and a farewell Departmental Reception was held for him. An article about him is published elsewhere in this *Newsletter*. The 15th Devonport Topology Festival was held in honour of David, with the following contributions: Kevin Broughan (University of Waikato) Equivalents of the Riemann hypothesis; Following in David's footsteps, Jiling Cao (AUT) From Volterra and Baire to Gauld, Marston Conder (University of Auckland) Some curiosities about surfaces, Sina Greenwood (University of Auckland) The frontier of a non–metrisable manifold, Gavin Martin (Massey–Albany) Ahlfors and Teichmuller revisited, Abdul Mohamad (University of Nizwa, Oman) Topological models for DNA; DNA and its replication.

Vaughan Jones gave a series of 4 lectures from January 31 to February 3, on "Representations of Richard Thompson's groups F and T inspired by physics".

Vivian Kirk has been appointed as Associate Dean Doctoral in the Faculty of Science.

Eamonn O'Brien made a successful bid for a Trimester Programme at the Hausdorff Institute of Mathematics in Bonn, on the theme "Logic and algorithms in group theory". His programme co–organisers are Prof. Andre Nies from Computer Science and Prof. Katrin Tent from Universität Münster. The programme will run from September to December 2018. It supports a range of workshops and collaborative activities for groups of mathematicians at the Institute.

Masina Po'e-Tofaeono is our Departmental Teaching Fellow for 2017, from the beginning of January. He has rich and diverse teaching experiences in secondary–school mathematics, He taught MATHS 102 over summer, and will teach MATHS 108 and MATHS 102 in semesters one and two.

Claire Postlethwaite has been promoted to Associate-Professor.

Jeroen Schillewaert took up a Lectureship in the Department in early March. Jeroen's main interests are in finite geometry, combinatorics and algebraic groups. His partner Emma is from Geraldine. Following his PhD from Ghent University (Belgium) in 2009, Jeroen was a postdoctoral fellow at the University of Canterbury, a Visiting Assistant–Professor at the Free University of Brussels and at the University of California San Diego, a Marie Curie Fellow at Imperial College London, and an Alexander von Humboldt Fellow at Universität Münster. He also worked for Goldman Sachs in London for 18 months. Dr. Schillewaerdt will be an invited speaker in the workshop "Buildings and Symmetry", 2017 September 25 to 29, hosted at the School of Mathematics and Statistics of the University of Western Australia.

Prof. Marty Golubitsky (Ohio State University) volunteered to give a series of lectures in the first half of Semester 1, entitled "An Overview of Singularity Theory and Applications".

The Department did very well at the 2016 New Zealand Mathematical Society Colloquium's Awards and Prize Dinner. Saeed Farjami, PhD student with *Hinke Osinga* and *Vivien Kirk*, received the ANZIAM Prize for best poster with his poster "Geometry of a Response". Naomi Gendler, masters student with *Bernd Krauskopf* and Neil Broderick (from the Department of Physics), received the Aitken Prize for best student presentation with her talk "Pulse Dynamics of Fibre Lasers with Saturable Absorbers". There were two recipients of the NZMS Award for Mathematical Research. *Bernd Krauskopf* received the Research Award for "Outstanding contributions to dynamical systems, especially bifurcation theory and its applications to diverse physical phenomena". The other recipient was *David Bryan*t from the University of Otago, who was previously a member of our Department. Finally, *Vivien Kirk, Bernd Krauskopf* and *Hinke Osinga* were accredited as Fellows of the NZMS "in recognition of their contributions to mathematics and their professional standing in the New Zealand mathematical community".

A Curious Minds grant of $120,598 has been awarded to support Maths Craft Festivals across the country. This grant even got a mention in the press release at beehive.govt.nz/release/2-million-engage-young-kiwis-science. The PIs are *Jeanette McLeod*, *Phil Wilson* and *Sarah Mark* from the University of Canterbury, and Nicolette Rattenbury from The Department of Physics at the University of Auckland. The Experts on the grant were Shaun Hendy from Physics (Auckland), and *Bernd Krauskopf* and *Hinke Osinga* from our Department. The Curious Minds grant is based on the successful Maths Craft Festival held in September 2016 at the Auckland Museum, which had a large number of student helpers from our Department.

We took advantage of the presence of many visitors to hold a 2-day workshop broadly in group theory at the University of Auckland on February 15–16. The speakers were Derek Holt (Warwick) on Computation in finite matrix groups, Bettina Eick (Braunschweig) on Metabelian p-groups, Heiko Dietrich (Monash) on Group embeddings of partial Latin squares, Cheryl Praeger (UWA) on Coprime actions of finite groups, Jozef Širáň (Open University UK & Slovak Technical University Bratislava) on Regular maps from twisted linear fractional groups, George Havas (Queensland) On counterexamples to the Hughes conjecture, Ruth Kellerhals (Fribourg) on Growth of hyperbolic Coxeter groups, and Alastair Litterick (Bielefeld) on Representation zeta functions of Heisenberg groups.

Sean Curry and Andrew Keane have both been awarded a 2016 Vice-Chancellor's Prize for Best Thesis. This is a tremendous success for them and it also reflects well on the quality of our PhD programme, given that only 5 Best Thesis prizes are awarded each year across the University. The judging panel, comprised of members from the Board of Graduate Studies, reviewed all nominations and ranked them according to the demonstrable significance of the thesis in its field, the originality and excellence of the research, exceptional academic and intellectual achievement, and timely completion. Sean Curry received the prize for his thesis *Submanifolds in Conformal and CR Manifolds and Applications*. There were significant open problems of how to treat structures called submanifolds, and Sean resolved many of these in the thesis. In particular, he found a new and very effective way to identify the 'fingerprint' of the geometry. Andrew Keane won the prize for his thesis entitled *A dynamical systems approach to understanding the interplay between delayed feedback and seasonal forcing in the El Niño Southern Oscillation*. Andrew introduced advanced mathematical techniques to provide fundamental insights. For example, he shewed that the irregular and unpredictable nature of El Niño events does not require external stochastic input. Well done to Sean and Andrew, who will each receive a certificate and a monetary prize at the Celebrating Research Excellence reception on May 9. Their achievements will also be recorded on their academic transcripts.

Dhanya Surith had her PhD oral examination. The recommendation is that she be awarded the degree, subject to some revisions to the thesis. Pun Wong has successfully defended his PhD thesis at his Oral Examination, and he will be awarded the degree of PhD subject to minor modifications. Wei-Juan Zhang successfully completed her PhD oral examination, and her very good thesis (on "Constructions for Chiral Polytopes") requires no further revisions. One paper from her thesis has been accepted for the *Journal of Algebra*, and

another is likely to be accepted soon for the *Bulletin of the London Mathematical Society*. Wei-Juan was co-supervised by *Dimitri Leemans*.

Tristan Pang (now aged 15) is studying mathematics and physics, and he is scheduled to graduate B.Sc. next year. The science journalist Jamie Morton has written a long article about him "What's next for New Zealand's teenage genius?", which was published in *The New Zealand Herald* on 2017–3–24. Here is an excerpt from that article:

> He credits much of what he's been able to achieve to some of the great minds he's met along the way. Tristan was just 11 when he first approached Professor *Eamonn O'Brien*, the former head of the university's Department of Mathematics. O'Brien could have ignored him, but instead promised to help him thrive and clear any hurdles in his way. "Professor O'Brien probably had foreseen my admission pathway might not be as smooth as normal due to my very young age," he said. "I feel surreal to have such a great mathematician who is unconditionally supporting me. He is the man, the man who walks the talk".
>
> About the same time, he met one of New Zealand's leading scientists, Associate Professor Cather Simpson, whose revolutionary work has led to a sperm-sorting laser that can effectively choose the sex of calves. Simpson, the first scientist he'd met, inspired him to try reading research papers, something he says gave him a deeper understanding of the topic and reassurance that nothing was impossible. Her mentoring led to his joining the Science Scholars Programme and a role as an undergraduate researcher with Simpson's Photon Factory.
>
> He credits others: physicist Professor Richard Easther, who regularly sits down with him to talk about goal-setting, and his summer research supervisor. Associate Professor *Igor Klep*, who has already given him a taste of postgraduate work with a tough assignment.

Recent visitors include:

Dr. Dieter Armbruster (Arizona State University), Dr. Hendrik De Bie (University of Ghent), Prof. Leonard Peter Bos (University of Verona), Prof. Andreas Cap (University of Vienna), Dr. Heiko Dietrich (Monash), Prof. Gabor Domokos (Budapest University of Technology and Economics), Dr. Maciej Dunajski (University of Cambridge), Prof. Bettina Eick (Universität Braunschweig), Prof. Piotr Faliszewski (Krakow Institute of Technology), Prof. Marty Golubitsky (Ohio State University), Prof. Markus Grassl (Max Planck Institute for the Science of Light), Prof. Matthias Hammerl (Universität Greifswald), Dr. Andy Hammerlindl (Kalman Visiting Fellow, from Monash), Prof. Judy Kennedy (Lamar University, Beaumont, Texas), Prof. George Havas (University of Queensland), Prof. Derek Holt (University of Warwick), Prof. Ruth Kellerhals (Université de Fribourg), Prof. Barbara Keyfitz (Ohio State University), Dr. Florian Lehner (Universität Hamburg), Dr. Alastair Litterick (Universität Bielefeld), Dr. Tobias Moede (TU Braunschweig), Prof. Abdul Mohamad (University of Nizwa, Oman), Dr. Kirill Morozov (Tokyo Institute of Technology), Dr. Jiawang Nie (Kalman Visiting Fellow, UCSD), Prof. El Maati Ouhabaz (University of Bordeaux), Dr. James Eldred Pascoe (Washington University at St. Louis), Dr. Helmut Podhaisky (Universität Halle), Prof. Cheryl Praeger (UWA), Prof. Brian Raines (Baylor University, Waco, Texas), Prof. Alastair Rucklidge (University of Leeds), Dr. Katsutoshi Shinohara (Hitotsubashi University, Tokyo), Dr. Jan Slovak (Masaryk University), Prof. Stefan Siegmund (Technische Universität Dresden), Prof. Jozef Širáň (Open University UK & Slovak Technical University Bratislava), Dr. Neset Ozkan Tan (Usak University, Turkey), Dr. Yuntao Wang (Kyushu University) and Dr. Marcus Waurick (University of Bath).

Garry J. Tee

UNIVERSITY OF WAIKATO

DEPARTMENT OF MATHEMATICS AND STATISTICS

Enrolment data and programme developments

The total Maths and Stats EFTS at the current time are slightly up (about 1.4%) compared to the same time last year. Treated separately, Maths is up about 1.5% and Stats up about 1.3%. Computer Science is not doing as well and down over 4%.

One issue that may affect Stats EFTS is that there is uncertainty about STAT160 Management Statistics in Semester B. If Management doesn't require its students to take the paper in Semester B, then up to 28 EFTS from currently enrolled students could be lost.

At undergraduate level, Stats are proposing to rename the Statistics major as the Data Analytics major and also introduce this major into the Bachelor of Computing and Mathematical Sciences with Honours degree. This proposal will be going to CUAP this year.

Cecelia's running success

Cecelia had a podium finish in the World 2017 Tarawera Ultramarathon. To quote from her comments: "The weekend was amazing. I raced against world champions from all over the world but manly USA and Olympian athletes. It was a professional race. I managed to arrive 3rd only 1 and a half minutes behind second!! I'm so happy with my result and being such a competitive race I got lots of recognition interviews invitations to races etc. So happy!!!

She was interviewed by a reporter from a top running magazine in the USA. You can watch the interview on Youtube

Number theory workshop

Waikato will host the Third NZ Number Theory Workshop, to be held at the University of Waikato on April 19th, 2017. Talks will take place in the Department of Mathematics and Statistics, 3rd Floor, G-Block, Room G.3.33. Those speaking are: Shaun Cooper (Massey), Steven Galbraith (Auckland), Alex Ghitza and Nora Ganter (Melbourne), and Kevin Broughan (Waikato).

No registration is required, and the principal local contact is Daniel Delbourgo.

Comings and goings

Wiremu Solomon retired from his position in the Statistics group at the end of last year. Tim Stokes presented a seminar to the Tasmanian branch of ANZIAM (TANZIAM!) in January entitled "Flows in a fluid of finite depth with a submerged point sink".

Kevin Broughan

MASSEY UNIVERSITY

INSTITUTE OF NATURAL AND MATHEMATICAL SCIENCES

Robert McKibbin attained the rank of Emeritus Professor on December 23, 2016. The mathematics group at Albany celebrated with a barbecue, and Robert's new status was marked formally by the Institute at a function on March 1. It was nice to see former colleagues Jeff Hunter and Adrian Swift, our colleague Tammy Lynch from Palmerston North, as well as staff from all over the Albany campus at the function. A profile of Robert is in issue 97 of this newsletter (August, 2006), and an up-to-date article appears separately in this issue of the newsletter. Robert has been a source of wisdom and inspiration to students and to academic and administrative staff alike. We wish Robert all the best in the new emeritus position, and look forward to continuing to see him on campus as his schedule permits.

Graeme Wake was one of two invited keynote speakers at the mid-February Symposium hosted by the MAXIMA grouping in the School of Mathematical Sciences in Monash University in Melbourne. This meeting was intended to showcase how mathematical tools have solved problems in interdisciplinary research, and demonstrate capabilities in this respect. His talk was entitled "How Mathematics can benefit Agriculture: the New Zealand Experience". He also was a member of the panel on "Mathematics-Industry Partnerships and the Future Scope in Australia". The panel was chaired by the other keynote speaker Professor John Ockendon from The University of Oxford.

Valeriia Chopovda, *Carlo Laing*, *Mick Roberts* and *Graeme Wake* attended and gave talks at the ANZIAM 2017 meeting at Hahndorf, South Australia, February 5–9.

Robert McKibbin attended the ANZIAM Maths-in-Industry Study Group at UniSA in Adelaide, 13–17 February; he was the only participant from NZ. He co-moderated a problem from the Australia's Defence Science and Technology Group on estimating transonic drag.

Visitors

Recent visitors include Marty Golubitsky (Ohio State University), Barbara Lee Keyfitz (Ohio State University), and Pee Choon Toh (National Institute of Education, Singapore).

Shaun Cooper

UNIVERSITY OF CANTERBURY

SCHOOL OF MATHEMATICS AND STATISTICS

Congratulations to *Jeanette McLeod* and *Phil Wilson* who were successful in their MBIE bid to the 2017 Unlocking Curious Minds contestable fund. Their project is 'Raising interest in mathematics through a Maths Crafts Festival' that will introduce people to mathematical concepts by demonstrating the way these concepts are integrated into craft activities. Following the success of their inaugural 2016 Maths Craft Festival, which entertained almost 2,000 people at the Auckland War Memorial Museum, Jeanette and Phil together with UC PhD student Sarah Mark and Dr Nicolette Rattenbury of the University of Auckland, will be touring New Zealand cities this year, raising interest in maths through their quirky brand of maths outreach.

Using the government grant, they aim to introduce people to mathematical concepts by demonstrating the way these ideas are intertwined with crafts. The mathematicians will invite people to join them to learn how to knit a mathematical knot, crochet a Möbius strip, fold an origami tetrahedron, or colour a Latin square, and experience mathematics in a whole new way.

Jeanette, who has knitted and crocheted various mathematical objects, from Möbius strips to intricate coral-like hyperbolic planes, is keen to share her passion for maths as the language of science. While she is usually dealing with combinatorics, in particular asymptotic enumeration, Latin squares, graph colouring and random graphs, she is also an accomplished crafter and crocheter.

Phil is more usually found working in theoretical fluid dynamics and mathematical modelling in biology and industry. He loves explaining the fun and excitement of mathematics to all sorts of audiences, from school kids to lifelong knitters. It amazes him seeing people realise that maths is everywhere. Whether it is crafts, technology, business, science, social science or education, maths is vital.

Maths is often overlooked as a subject of beauty and imagination, with many people viewing it as boring, irrelevant, and downright unpleasant. However, by using craft as a medium, adults and children alike will be introduced to a new way of engaging with mathematics.

The idea began after a serendipitous encounter with Julia Collins from the University of Edinburgh who was on holiday in Christchurch early last year. Both are avid knitters and crocheters and wanted to find a way to share the beautiful mathematics behind craft with the public. This inspired the 2016 Maths Craft Festival.

This year, in addition to the Maths Craft Festival in Auckland scheduled for the weekend of 9–10 September, there will be events in Christchurch, Dunedin and Wellington. Through these events, the team will show the public how maths underpins almost every aspect of today's society. For more information see page 31 of this issue, and visit the Maths Craft website at www.mathscraftnz.org.

Mike Plank

Congratulations to *Mike Plank* who received the College of Engineering Established Researcher Award 2016. The citation describes Mike as an applied mathematician with a highly interdisciplinary research record characterised by impressive productivity, prodigious quality and impact. He has published on ecological networks in Nature (the worlds highest-ranking journal) and his review paper on random walks is the second most cited paper ever published in the Royal Society of London journal Interface. Mike's research has impact beyond academia, leading to proposed changes in fisheries policy being discussed at the European Parliament. He is active in communicating science to the public, and has a strong record of recognising and nurturing talent, having supervised more than 30 student or postdoctoral research projects.

Varvara Vetrova

In December *Varvara Vetrova* joined the School as a statistics lecturer. She gained her PhD from Waikato University in 2016. Her research interests are in applied machine learning and statistics in environmental domain. She is currently a science team leader of a funded MBIE Endeavour project 'Biosecure-ID'. The 3-year project is focused on developing novel methods for biological species recognition utilizing deep neural networks.

Geertrui Van de Voorde

In March *Geertrui Van de Voorde* took up a con-

tinuing mathematics lecturing position in the School. Geertrui received her PhD from Ghent University, Belgium, in 2010. Since then she held postdoctoral positions and teaching contracts at Free University Brussels and Ghent University. Her research interests are in finite projective geometry and its links with coding theory and graph theory.

At the end of February the last of *Maarten McKubre-Jordens's* various fixed-term contracts expired. He had been with us for seven years after receiving his PhD from Massey University in 2010. Maarten is still involved in the supervision of thesis students and remains associated with the School as an Adjunct Fellow.

In February the School welcomed two Erskine Fellows. Markus Stroppel comes to us from the Faculty of Mathematics and Physics at the University of Stuttgart. He is a familiar face in School having visited us before in 2012. This time he stays with us for ten weeks. His fields of special interest are Geometry, locally compact groups, and Mathematics for engineering students. Markus is hosted by *Günter Steinke* and teaches into our 300-level algebra course, MATH321.

Bianca Viray was a visiting Erskine Fellow at UC for five weeks, during which she has been teaching into our second year linear algebra course. She received her PhD from Berkeley, was an NSF postdoctoral fellow at Brown University and is now at University of Washington in Seattle. Her research is in Number Theory and Algebraic Geometry. She was hosted by *Brendan Creutz*.

Günter Steinke

Abstracts of PhD theses

Rosalie Hosking, University of Canterbury

Supervisors: Clemency Montelle, John Hannah

Date: November 2016

Title: **Sangaku: A Mathematical, Artistic, Religious, and Diagrammatic Examination.**

Between the 17th and 19th centuries, mathematically orientated votive tablets appeared in Shinto shrines and Buddhist temples all over Japan. Known as sangaku, they contained problems of a largely geometrical nature.

The 18th century also saw the Japanese mathematician Seki Takakazu develop a form of algebra known as *tenzan jutsu*. To date, much of the literature regarding *sangaku* employs modern mathematical notation and techniques to solve their problems. In this research I solve problems from nine *sangaku* using modern techniques. As well as this, I also illustrate how *sangaku* can be solved using the traditional Japanese *tenzan jutsu* of Seki. I compare seven problems taken from *sangaku* with similar problems solved using *tenzan jutsu* from the 1810 Japanese text the *Sanpo Tenzan Shinan*. I show the *tenzan jutsu* technique can be applied to solve the *sangaku* problems.

The question of whether these tablets had purely communicative and mathematical functions is also still debated by researchers. In this thesis I argue that an examination of the creation, location, and writings on these tablets by their authors shows *sangaku* had multiple functions and should be considered artistic, religious, as well as mathematical artefacts. I also examine the role of diagrams on *sangaku*, and argue that they are a vital element of determination for the problems on these tablets.

Günter Steinke

UNIVERSITY OF OTAGO

DEPARTMENT OF MATHEMATICS AND STATISTICS

David Bryant, jointly with Bernd Krauskopf (University of Auckland), has received the NZMS Research Award "for work developing mathematical, statistical and computational tools for evolutionary biology, and work drawing on evolutionary biology to develop new theories in mathematics." Congratulations!

Vee-Liem Saw, who is a PhD student in the Department's General Relativity Group, has earned an honourable mention in the Aitken student prize competition at the NZMS Colloquium. In his talk, Vee-Liem's presented a mathematical description of the "Mass-loss of an isolated gravitating system due to energy carried away by gravitational waves with a cosmological constant". This is particularly interesting in view of the recent first direct detection of gravitational waves. Well done, Vee-Liem.

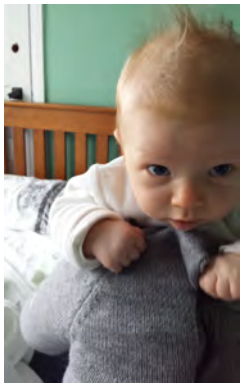
The past few months were very productive on the social side. We are happy to congratulate *Ting Wang* and her husband Marco, as well as *Tilman Davies* and his wife Andrea on their respective weddings. Moreover, we are very pleased to announce the birth of Sophie, daughter of *Chris Stevens* and his wife Jess, as well as Clara Ioana Licht, daughter of *Petru Cioica-Licht* and his wife Christine. All husbands, wives and parents appear to be very happy, and we very much wish them to remain happy and to enjoy their new lives (as much as their partners and children let them).

Our former postdoc *Leon Escobar Diaz* and our former PhD student and summer school lecturer *Chris Stevens* have left to take up new positions. Leon will be offering lectures in English at the German University of Tübingen, as part of the programme Teach@Tübingen. Chris is taking up a postdoctoral position at Rhodes University Grahamstown, South Africa. All the best for your future. Keep in touch!

Ting and Marco

Andrea and Tilman

Sophie



Clara

We have welcomed four new staff members.
After spending several years as a Research Scientist at Clark University, Worcester (USA) and Lecturer in Statistics at the University of New England (Australia), *Peter Dillingham* is now back at Otago and has taken up his position as a Senior Lecturer in Statistics. Peter had been at Otago previously, first as a PhD student and then as a Lecturer until 2010, and we are very happy that he is back.
We are also delighted to welcome back *David Fletcher*, Associate Professor in Statistics, a veteran performer at Otago, who has been here for numerous years before. After a short time in Britain, where he expectedly observed that there is no better place to live than New Zealand, David is luckily back at the department.
James Fletcher and *Julia Wilson* have taken up their positions as Postdoctoral Fellows. James has joined us from from the University of Wollongong (Australia), where he has just completed his PhD. He is working with the Department's Operator Algebra Group and funded from their Marsden grant. Julia, after completing her PhD at Otago, was a Teaching Fellow at the Otago Medical School. Now she joined the Quantitative Genetics group to work with *Phil Wilcox*.
A warm welcome to Peter, David, James and Julia!

We have celebrated our Department Manager *Lenette Grant's* remarkable 70th birthday, even though she is much too youthful to make us believe that 70 can be her true age. Lenette has been at the department since 1980, and she worked at Otago long before that. Every single day she does an excellent job in running the department and helping everyone with thousands of little things. We are truly grateful that we can always come to her, and she is not only a dear colleague but a good friend. Lenette, we wish you well and hope that all your birthday wishes come true.

The department's good soul, Lenette.

Visitors

Aidan Sims from the University of Wollongong (Australia) visited the Operator Algebra Group for one week in January. Another guest of the Operator Algebra Group is Johannes Christensen, a PhD student at Aarhus University (Denmark), who is working with the group for several months.

Lisa Orloff Clark is hosting Lia Vas from the University of Sciences , Philadelphia (USA), for a week in April. They will be working on Steinberg algebras and C^*-algebras associated to groupoids.

Fabien Montiel has hosted Hyuck Chung from the Auckland University of Technology and Daniel Eggler from the University of New South Wales (Australia) in February, and Maciej Floryan from the University of Western Ontario (Canada) and Matthieu Sellier from the University of Canterbury in March. Fabien is working with Hyuck and Daniel on developing numerical techniques to achieve broadband active cloaking/extinction of sound waves in the presence of an array of cylinders.

Jörg Hennig

REPORTS ON EVENTS

New Zealand Mathematics and Statistics Postgraduate Conference 2016

From the 20th to the 23rd of November 2016 a total of 42 New Zealand postgraduate students joined the annual New Zealand Mathematics and Statistics Postgraduate (NZMASP) conference hosted by the University of Otago in Queenstown. Organised by students for students, NZMASP provides an opportunity for postgraduates (Honours, Masters and PhD students) throughout New Zealand to network, practice presentations, and gain experience of conference etiquette in a relaxed and supportive environment.

A wide range of topics from Statistics and Pure Mathematics to Applied Mathematics were presented and discussed by students from six major New Zealand Universities (see Figure 3). The competition for the best speaker prizes was fierce, as all talks were of high quality and had been well prepared. The organizing committee weighted the number of votes by the size of the audience for each speaker, thereby enabling a fair competition in a setup with two parallel sessions. In the end prizes were given to

- Emma Greenbank (Victoria University) for Applied Mathematics,
- Ben Lawrence (University of Auckland) and Sarah Mark (University of Canterbury) for Pure Mathematics, and
- Chuen Yen Hong (University of Otago) for Statistics.

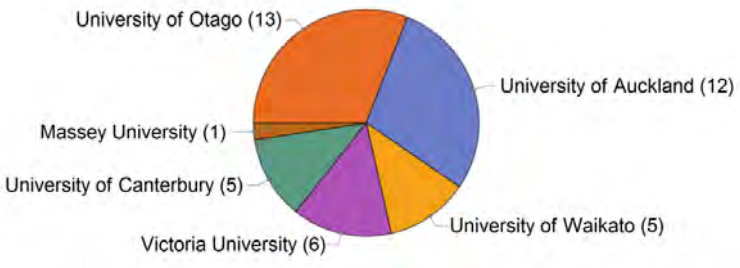


Figure 3: Number of participating students form the various New Zealand Universities.

NZMASP was a valuable experience for all participating students, and an opportunity to test out and refine their talks ahead of the New Zealand Statistics Association Conference and the New Zealand Mathematics Colloquium. In addition to the student presentations we invited Dr Florian Beyer, Dr Ting Wang, and Dr Matthew Parry from

the University of Otago who gave very insightful talks detailing their research and life in academia. We are very thankful for their contributions!

We would also like to thank our generous sponsors: The New Zealand Mathematical Society (NZMS), the New Zealand Institute for Advanced Study (NZIAS), Beef and Lamb New Zealand, the Australian New Zealand Institute for Applied Mathematics (ANZIAM), MathWorks, and of course the participating New Zealand Universities! We would also like to express our gratitude to the Department of Mathematics and Statistics of the University of Otago for their support in organizing the conference — a special thanks to Marguerite for her help and advice. We are happy to have received overwhelmingly positive feedback from the participants and invited speakers (see Figure 4).

We now look forward to NZMASP 2017!

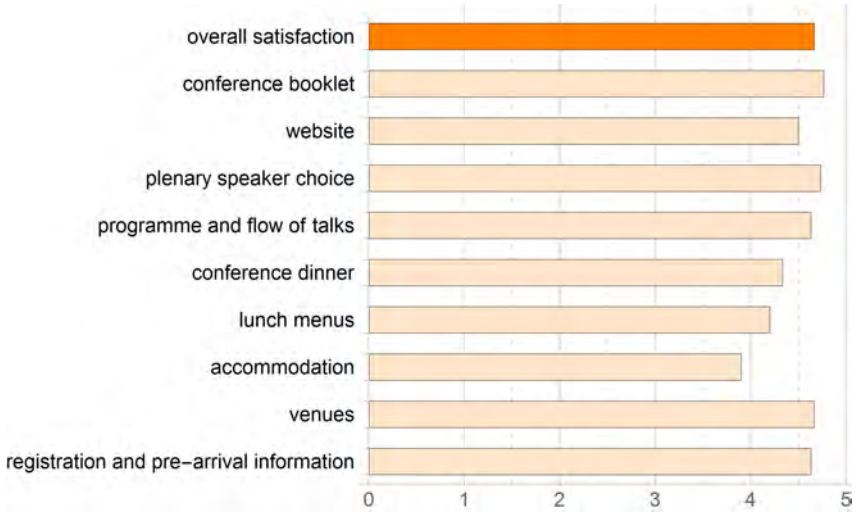


Figure 4: Survey results of 2016 where 1 is "poor" and 5 is "very good".

The NZMASP'16 Organising Committee:

Johannes E.M. Mosig

Chuen Yen Hong

Paula Bran

Jerome Cao

Vee-Liem Saw

60th Annual Meeting of the Australian Mathematical Society, 2016

In December 2016 I attended the Australian Mathematical Society's annual conference in Canberra, Australia. The AustMS meeting is a large conference for mathematicians from all over Australia (and internationally) working in various parts of the domain that is mathematics. As such, there were many special sessions catering for specialized areas in mathematical research. The atmosphere was stimulating and infectious with energy and ideas. Besides the plenary sessions I attended the special session on "Functional Analysis, Operator Algebras and Noncommutative Geometry". I also presented in this session with a talk titled "Classifying type I groupoid C*-algebras".

My talk was about characterizing groupoid C*-algebras. The idea, as with many speakers in our session, is to obtain information about the groupoid by studying its C*-algebra and vice versa. We study and classify the C*-algebras through their representations. I believe my talk was well received, and this was confirmed by positive feedback from members of the audience.

In the special session I met and talked to mathematicians, some whose names I have often come across in papers. Through these conversations I learned that an example I had in mind for my PhD is indeed relevant. I also had the opportunity to see talks by and meet other postgraduate students, and hopefully future collaborators. In

particular, I met a student, Michael Mampusti, working broadly in the same field as I do. We discussed how our work might be related, and I wonder if some of my results are applicable to his work.

One of the highlights for me was a plenary session. The speaker was Matthew Kennedy who also works on C*-algebras. His motivation is similar to ours, where he uses group C*-algebras to get information about the groups and vice versa. What I admired was how he presented his work to a general audience. Having knowledge of group C*-algebras, I understand to some extend the depth and technical details that he deals with.

But, he broke down and explained what he did in such a way that most, if not everybody, understood and followed him until the end. Matthew's talk, and others in our special session, made me reflect on the importance of giving a good talk, and what 'good' means. As a whole I thoroughly enjoyed the conference, the people that I met, the exposure to various flavours of mathematics, and the opportunity to present my work. Thank you NZMS for awarding me with a travel grant to attend and present work from my PhD.

Danie van Wyk (University of Otago)

Dynamics Days Latin America and the Caribbean (LAC)

I would like to thank the New Zealand Mathematical Society for their financial support of my participation in Dynamics Days Latin America and the Caribbean (LAC) held in Puebla, Mexico from October 24 to November 1, 2016.

Dynamics Days LAC are held every two years to gather experts in the field of dynamical systems from all over the world, particularly North America and Europe. This year, it was held in the city of Puebla, close to the Cholula archaeological site. The conference mainly covered computational, experimental and theoretical research in all areas of applied dynamical systems, non-equilibrium statistical physics, granular materials, fluid dynamics and many other related fields.

Around 250 people attended the conference and I was one of few PhD students who gave a talk. My presentation focused on approximating and computing the stable manifold of a saddle slow manifold (SSM). The stable manifold of an SSM is a locally invariant object which plays an important role in the local and global dynamics of multiple-time-scale systems. My talk was part of the mini-symposium "Applications of dynamical systems in biology", organised by Pablo Aguirre and Víctor F. Breña Medina.

Significantly, about 25 people were present at my talk including professors Edgar Knobloch, Sebastian Wieczorek and Uwe Thiele. I received good feedback from the audience; particularly some of the questions were very helpful and are of great benefit now that I am writing of the associated paper. Also, I had a fruitful conversation after the talk with Alessio Franci about my work and his presentation on the extension of Fenichel theory to systems with more than two time scales.

Saeed Farjami (University of Auckland)

Real algebraic geometry with a view toward moment problems and optimization (Oberwolfach workshop)

The workshop was organized by the Mathematisches Forschungsinstitut Oberwolfach in Oberwolfach, Germany, in March 2017. It was the latest in the series of workshops on real algebraic geometry organized every three years by this prestigious institute, situated in solitude amidst the hills of the German Black Forrest. Among the 54 invited participants were all the leading experts on this topic from around the world. The New Zealand mathematical community was represented by Igor Klep, Christoph Hanselka and myself (all from the University of Auckland), thanks to the financial support of NZMS.

The talks were roughly divided in four sessions, focusing on sums-of-squares representations of polynomials positive on varieties or semialgebraic sets, (infinite) moment problems, (convex, semidefinite, hyperbolic) optimization and positivity in operator and control theory. Following the tradition, the speakers were determined during the workshop. Due to the nature of the workshop organizers aimed at a smaller number of talks to allow sufficient amount of time for discussions about open problems in the field and informal exchange of insights between participants.

I am pleased to report that our Auckland group contributed two talks. Igor Klep gave a plenary talk on the recent advances in free real algebraic geometry, which intertwines the methods of real algebraic geometry, free analysis and operator theory to provide prominent results in convex optimization and control theory. My talk on free loci of linear matrix pencils and their real points was a more specialized contribution to the understanding of the boundary of a free semialgebraic set and Hilbert's 17th problem in the free skew field, which was developed in the last two years in collaboration with Igor Klep and James Pascoe (Washington University in St. Louis) as a part of my PhD research.

My overall experience was extraordinary. At first it is a bit overwhelming to meet mathematicians who set the foundations of modern real algebraic geometry and have so many theorems named after them. However, during the meals, coffee breaks and long evenings one realizes that the reason for their success lies in their infinite string of new ideas and preparedness to share them with the community. I am looking forward to see the outcomes of these new acquaintances (one of which will lead to my future postdoctoral position) and I would be glad to reunite with the whole community in three years.

Jurij Volčič (University of Auckland)

Canadian Annual Symposium in Operator Algebras

The 44$^{\text{th}}$ Canadian Annual Symposium in Operator Algebras and their Applications was held on the campus of the Université de Montréal, June 13–17, 2016. I attended the symposium with the aid of an NZMS travel grant.

I presented a result of my published paper entitled "Realising the Toeplitz algebra of a higher-rank graph as a Cuntz-Krieger algebra". This talk has benefited me in several ways: I received helpful feedback and broadened my research connections, to name just two. In addition, I was also able to introduce my other papers which might be interesting to operator algebraists.

Overall, the conference was an amazing experience which gave me a chance to share ideas with the experts and to see the latest research development in operator algebras. It was my first conference outside New Zealand and I would like to thank the New Zealand Mathematical Society for the grant.

Yosafat Pangalela (University of Otago)

2017 Public-Key Cryptography Conference

With the help of the New Zealand Mathematical Society I was able to attend the 2017 PKC (Public-Key Cryptography) conference which took place in Amsterdam on March 28–31, 2017. I gave a talk titled "On the Bit Security of Elliptic Curve Diffie-Hellman". This is a recent work of mine, which was also published in the conference proceedings, that gives the first bit security result for elliptic curve Diffie-Hellman. The result states that a portion of 5/6 most significant bits of (elliptic curve) Diffie-Hellman keys are as hard to compute as the entire keys. Diffie-Hellman key is the shared key that two parties derive using the Diffie-Hellman Key Exchange, where in my work I consider this scheme over elliptic curves. I thank the New Zealand Mathematical Society for giving me this opportunity.

Barak Shani (University of Auckland)

GENERAL NOTICES

MATHEMATICS-in-INDUSTRY for NEW ZEALAND 2017

Mathematics is more relevant today as it has ever been. Educators looking for ways to inspire the youth of today in the importance of maths should look no further than the Mathematics in Industry NZ study week. Now in its third year, it is being held at Massey University, Palmerston North on June 26th–30th. The study week concept has been going now for over half a century around the world.

In fields such as Engineering and Biology it is easy to see their influence in civilisation through bridges or phones, medicines and food. Conversely, the field of mathematics is often invisible in real-world applications despite being, the backbone of practically everything we do. MINZ is an event which aims to promote the benefits and diverse applications of mathematics by linking mathematicians with industry problems. Many academics, students and industry representatives will converge to solve challenges from NZ industry.

This year we are extremely excited to have challenges from six of NZ leading businesses, Fonterra, Zespri, Transpower, Fisher & Paykel Appliances, Sanford Ltd and the Horizons Regional Council. The last tweaks are being made to this years challenges, which will be posted on the MINZ web site soon (minz.org.nz). The first four of these businesses have experienced MINZ before, and keep coming back because they get such great insights and the opportunity to meet remarkable students and academics from up and down the county. We have had exceptional students participate one year, be snapped up by a business and present a new challenge the next year! Register now: minz.org.nz — it is free.

To begin to see the range of topics covered at MINZ, and where mathematics is front and centre of new innovations we can look back to review a few interesting examples. The first comes from Compac, a NZ based fruit sorting company growing strength to strength. One of their earliest stand out offerings was the ability to extremely accurately sort fruit for packaging. To be fair they are talking about thousands of fruit being bounced and moved on multiple high speed conveyor belts — not normally conducive conditions for obtaining accurate weights. The information that the mathematicians proved while at the study week provided Compac the evidence needed to build a state of the art machine, supporting their efforts to be a world leader in fruit sorting equipment.

Fonterra has supported the use of mathematics, and the MINZ event for many years as they have on multiple occasions found extremely useful information after posing a challenge to the MINZ group. Fonterra is continually trying to better understand techniques and methodology to extract higher values from its milk products. Cheese is a growing high value export but to make this workable in the volumes Fonterra works with they need to get a handle on the dynamics of the process. One challenge needed to figure a way to predict cheese quality months ahead of when it would be ready for distribution. Mathematics provided multiple models taking in all types of variables which allowed the cheese producers the information they needed to make the best decisions, providing costs savings and delivery options to maximise profits.

From white gold to whiteware, today's consumer whiteware is getting smarter and smarter. With multiple sensors, switches and connections it can be complicated to decipher the amount of information being collected and then turn that into useful results. Fisher & Paykel produce some of the most fetching and user friendly devices in the world. One such device, used by millions of people is the clothes dryer. We blindly throw in bunched wet clothing, flick a switch and trust that an hour later perfectly dry laundry comes out. How this happens is not magic, but mathematics. It is mathematics that provides the computer in the machines the smarts to decipher all

the information being thrown at it, tracking this over time and providing the answer to stop the machine at the correct time. Fisher & Paykel challenged MINZ to obtain a solution to eliminate false cut offs caused by bunched clothes for a new dryer product in development, and were extremely pleased at the results, but equally, those at MINZ can look forward into walking into Noel Lemmings and knowing their smarts helped that shiny new F&P dryer stand out from the rest.

These examples only scratch the surface of the challenges at MINZ. The industrial mathematics, engineering and statistical community are keen to hear what challenges await them in June. Registrations to attend are now open and can be found on the MINZ web site minz.org.nz. So join us (it is free) as we further prove the relevance of mathematics in our daily lives, and show direct evidence of its worth to business, industry and society.

Seumas McCroskery
(KiwiNet Innovation) seumas@kiwinet.org.nz

Graeme Wake
(Massey University) g.c.wake@massey.ac.nz

Maths Craft New Zealand

We are delighted to announce that we have been awarded a prestigious Unlocking Curious Minds grant to take Maths Craft on the road around New Zealand in 2017. Armed with our knitting needles, crochet hooks, and origami paper, our mission to bring maths to the masses has just gone national, and we have a brand new logo to go with it.

Our new logo reflects the fact that in addition to a flagship Festival at the Auckland Museum, we will hold events in Wellington, Christchurch and Dunedin this year, along with a series of workshops. To hear us talking about this grant and our Maths Craft plans for the year, you can listen to Jeanette's recent Radio New Zealand National interview at radionz.co.nz/national/programmes/afternoons/audio/201835180/maths-and-crafts-using-crochet-and-origami-to-teach-mathematics.

The Maths Craft Festival at the Auckland Museum will be on the weekend of 9th & 10th September, and will be even bigger than in 2016. The Museum were so thrilled with the success of our 2016 event that this year they are very generously giving us their beautiful Event Centre, a circular, fully glazed room on the roof of the museum with 360 degree views of the city and harbour, and lots of natural light, perfect for crafting!

We are also thrilled to announce that we have been invited to be a part of the Space & Science Festival spacesciencefestival.org in Wellington on 13th May. This amazing event attracts thousands of people to a day of science, mathematics, competitions, and space. Were excited to be bringing Maths Craft to this festival, and to Wellington. Please have a look at the Space & Science Festival website for details about the event on 13th May as well the other events they have planned. Tickets are on sale now, and we hear they sell out fast.

In addition to these events, we will be running workshops for teachers. On 25th March we ran two workshops at the Primary Mathematics Association's PMA Seminar Day in Auckland, an event attended by primary maths teachers from across New Zealand. Later in the year we are hoping to run a similar event for secondary maths

teachers. There are also plans in the works for other public events, including a Maths Craft Day in Christchurch on 18th June, so please keep an eye on our website mathscraftnz.org and sign up for our email newsletter. On our website you can also find information on how to connect with us on social media.

We are grateful to all of our sponsors who make Maths Craft New Zealand possible. In particular, we are thrilled to receive a $120k grant from the Unlocking Curious Minds fund administered by the New Zealand Government. Curious Minds seeks to encourage and enable better engagement with science and technology across all sectors of New Zealand, to bring about a nation of Curious Minds, where science is inspiring, recognisable, highly valued and personally relevant to all New Zealanders. It is guided by A Nation of Curious Minds — He Whenua Hihiri i te Mahara, A National Strategic Plan for Science in Society, and was launched in 2014, following the creation of the National Science Challenges. Curious Minds is jointly managed by the Ministry of Business, Innovation and Employment, the Ministry of Education and the Office of the Prime Minister's Chief Science Advisor.

Jeanette McLeod & Phil Wilson (University of Canterbury)

jeanette.mcleod@canterbury.ac.nz & phillip.wilson@canterbury.ac.nz

ANZIAM Membership

NZ Mathematical Society Members can join ANZIAM (the Australian and New Zealand Industrial and Applied Mathematics organisation) as members — through the NZMS. A simple arrangement is available through the Membership Secretary of our Society to pay both subscriptions together. This is a unique operation available as a nice gesture from our Australian counterparts. ANZIAM is a two-country organisation designed to foster Applied and Industrial Mathematics in, and with, both countries, and internationally. With joint conferences and the parallel operation of Mathematics-in-Industry Study Groups in each country, many interactions have been fostered. Our NZ operation (MINZ) is described at minz.org.nz. More can be found on the ANZIAM website at anziam.org.au.

Graeme Wake (Massey University) g.c.wake@massey.ac.nz

NZMS NOTICES

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 NZMS is aware that some members of the NZ mathematical community are under-represented in past awardees and fellows. To help us address this problem, we would ask that you all actively encourage eligible colleagues from under-represented groups, especially women and those of Māori ethniticity, to apply for these awards and/or offer to nominate them.

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: nzmathsoc.org.nz/?awards. Fellowship information and application forms can be found at: nzmathsoc.org.nz/?accreditation.

2017 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. Applicants should be within seven years of confirmation of PhD, but an appropriate adjustment to this time period can be made to take into account an interrupted career pattern. The candidate will be judged on their best three papers and a two-page CV. To be eligible, the candidate must be a current member of the NZMS, and must have completed a significant part of their research in New Zealand.

All nominations and applications should be sent by 31 July 2017 to the NZMS President Astrid an Huef. Submissions should be made by email to astrid@maths.otago.ac.nz, stating clearly that they are for the NZMS Early Career Award.

2017 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 books or recognised journals in the last five calendar years: 2012–2016. This assessment period may be adjusted to take into account an interrupted career pattern. 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.

All nominations and applications should be sent by 31 July 2017 to the NZMS President Astrid an Huef. Submissions should be made by email to astrid@maths.otago.ac.nz, stating clearly that they are for the NZMS Research Award.

2017 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 five calendar years: 2012–2016. 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.

All nominations should be sent by 30 September 2017 to the NZMS President Astrid an Huef. Submissions should be made by email to astrid@maths.otago.ac.nz, stating clearly that they are for the Kalman Prize for Best Paper.

Fellowships of the NZMS

The New Zealand Mathematical Society, like many other societies, has an accreditation scheme. In particular, members may be recognised with the award of Fellowship of the NZMS. The NZMS would encourage members to consider applying, and to encourage and nominate their colleagues who meet the criteria. Some people are unsure what is involved. Here are the complete criteria, all three of which are to be satisfied.

1. Shall normally have been a Member of the NZMS for a period in excess of three years.
2. Shall have had the qualifications of an Accredited Member for a period in excess of three years (i.e. have completed a postgraduate degree in mathematics at a recognised university or other tertiary institution, or shall have equivalent qualifications, and shall have been employed for the preceding three years in a position requiring the development, application or teaching of mathematics.)
3. Shall have satisfied criteria 3.1 or 3.2, and 3.3 or 3.4 or 3.5:
   3.1. have demonstrated a high level of attainment in mathematics;
   3.2. have demonstrated a high level of responsibility in mathematics;
   3.3. have made a substantial contribution to mathematics;
   3.4. have made a substantial contribution to the profession of mathematician;
   3.5. have made a substantial contribution to the teaching or application of mathematics.

Members' applications are encouraged before 1 June 2017. Proceeds from fellowship applications will be put into a Fellows Fund.

Next deadline for applications for Financial Assistance — 15 May

The NZ Mathematical Society has changed to 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 deadlines for applications for 2017 are: 15 February, 15 May, 15 August, and 15 November. You will hear back from the Council within a month of the deadline. The types of grants are as follows.

NZMS Student Travel Grants To support postgraduate students presenting their 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. Costs that can be covered include: flights, conference registration, accommodation, and travel-related costs associated with family responsibilities.

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.

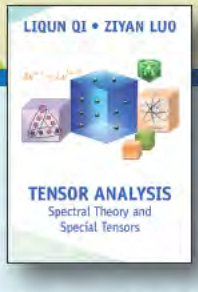
Further information can be found on the NZMS website: nzmathsoc.org.nz/?assistance.

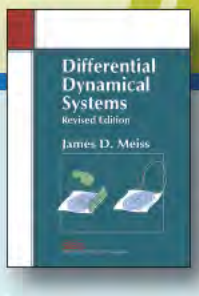
Scholarship and job listings on NZMS website

Based on feedback from members, the NZMS now has a section on the website where NZ academic and research institutes can post job and scholarship listings free of charge. This page can be found under the 'Opportunities' tab of the website: nzmathsoc.org.nz/?opportunities.

In the future there will be someone in each institute/department who can post these directly, please contact the Secretary emily.harveyNZ@gmail.com if you would like to volunteer to be able to do this. In the interim, until this is set up, please contact the Secretary directly emily.harveyNZ@gmail.com if you would like to list a job or scholarship listing.

New & Notable Titles from SIAM





Tensor Analysis: *Spectral Theory and Special Tensors*

Liqun Qi and Ziyan Luo

Tensors, or hypermatrices, are multi-arrays with more than two indices. In the last decade or so, many concepts and results in matrix theory—some of which are nontrivial—have been extended to tensors and have a wide range of applications (for example, spectral hypergraph theory, higher order Markov chains, polynomial optimization, magnetic resonance imaging, automatic control, and quantum entanglement problems).

2017 • xiv + 305 pages • Softcover
978-1-611974-74-4 • List $84.00
SIAM Member $58.80 • OT151

Differential Dynamical Systems, *Revised Edition*

James D. Meiss

Mathematical Modeling and Computation 22

Differential Dynamical Systems begins with coverage of linear systems, including matrix algebra; the focus then shifts to foundational material on nonlinear differential equations, making heavy use of the contraction-mapping theorem. Revisions include simplified and clarified proofs of a number of theorems and additional exercises.

2017 • xviii + 392 pages • Softcover
978-1-611974-63-8 • List $87.00
SIAM Member $60.90 • MM22

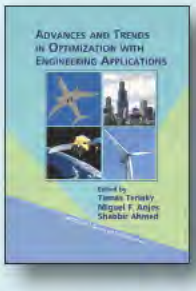
Advances and Trends in Optimization with Engineering Applications

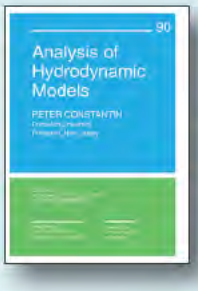
Edited by Tamás Terlaky, Miguel F. Anjos, and Shabbir Ahmed

MOS-SIAM Series on Optimization 24

This new overview of state-of-the-art optimization techniques reviews 10 major areas of optimization and related engineering applications. It provides a solid foundation for engineers and mathematical optimizers alike who want to understand not only the importance of optimization methods to engineering but also the capabilities of current methods.

2017 • xxxiv + 696 • Hardcover
978-1-611974-67-6 • List $99.00
SIAM Member $69.30 • MO24





Analysis of Hydrodynamic Models

Peter Constantin

CBMS-NSF Regional Conference Series in Applied Mathematics 90

Analysis of Hydrodynamic Models presents a concise treatment of a number of partial differential equations of hydrodynamic origin, including the incompressible Euler equations, SQG, Boussinesq, incompressible porous medium, and Oldroyd-B. This concise, unified approach brings readers up to date on current open problems.

2017 • x + 63 pages • Softcover
978-1-611974-79-9 • List $39.00
SIAM/CBMS Member $27.30 • CB90

Iterative Solution of Symmetric Quasi-Definite Linear Systems

Dominique Orban and Mario Arioli

SIAM Spotlights 03

Numerous applications, including computational optimization and fluid dynamics, give rise to block linear systems of equations said to have the quasi-definite structure. This book discusses the connection between quasi-definite systems and linear least-squares problems, the most common and best understood problems in applied mathematics.

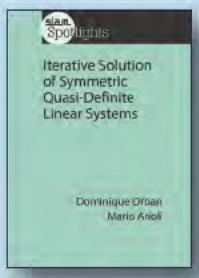
2017 • xiv + 93 pages • Softcover
978-1-611974-72-0 • List $39.00
SIAM Member $27.30 • SL03

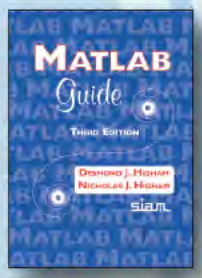
MATLAB Guide, *Third Edition*

Desmond J. Higham and Nicholas J. Higham

This third edition of *MATLAB Guide* completely revises and updates the best-selling second edition and is more than 25 percent longer. The book remains a lively, concise introduction to the most popular and important features of MATLAB® and the Symbolic Math Toolbox.

2017 • xxvi + 476 pages • Hardcover
978-1-611974-65-2 • List $62.00
SIAM Member $43.40 • OT150





TO ORDER: Shop online at bookstore.siam.org

All prices are in US dollars.

Use your credit card (AMEX, MasterCard, and VISA) by phone: +1-215-382-9800 worldwide or fax: +1-215-386-7999.
Or send check or money order in US dollars to: SIAM, Dept. BKNZ17, 3600 Market Street, 6th Floor, Philadelphia, PA 19104-2688 USA.
Members and customers outside North America can also order through SIAM's distributor, the Eurospan Group, at www.eurospanbookstore.com/siam.

SIAM. SOCIETY FOR INDUSTRIAL AND APPLIED MATHEMATICS

4/17