Volume 34 Number 5 2007

The Australian Mathematical Society

Gazette

Birgit Loch (Editor)

Dept of Mathematics and Computing
The University of Southern Queensland
Toowoomba, QLD 4350, Australia

Eileen Dallwitz (Production Editor)

E-mail: gazette@austms.org.au
Web: http://www.austms.org.au/Gazette
Tel: +61 7 4631 1157; Fax: +61 7 4631 5550

The individual subscription to the Society includes a subscription to the *Gazette*. Libraries may arrange subscriptions to the *Gazette* by writing to the Treasurer.

The cost for one volume consisting of five issues is AUD 90.20 for Australian customers (includes GST), AUD 106.00 (or USD 90.00) for overseas customers (includes postage, no GST applies).

The *Gazette* seeks to publish items of the following types:

- Mathematical articles of general interest, particularly historical and survey articles
- Reviews of books, particularly by Australian authors, or books of wide interest
- Classroom notes on presenting mathematics in an elegant way
- Items relevant to mathematics education
- Letters on relevant topical issues
- Information on conferences, particularly those held in Australasia and the region
- Information on recent major mathematical achievements
- Reports on the business and activities of the Society
- Staff changes and visitors in mathematics departments
- News of members of the Australian Mathematical Society

Local correspondents are asked to submit news items and act as local Society representatives. Material for publication and editorial correspondence should be submitted to the editor.

Notes for contributors

Please send contributions to gazette@austms.org.au. Submissions should be fairly short, easy to read and of interest to a wide range of readers. Technical articles are refereed.

We encourage authors to typeset technical articles using LaTeX 2_ε, $\mathcal{AMS}$-LaTeX or variants. In exceptional cases other formats may be accepted.

We would prefer that other contributions also be typeset using LaTeX 2_ε or variants, but these may be submitted in other editable electronic formats such as plain text or Word.

We ask that your TeX files contain a minimum of definitions, because they can cause conflict with our style files. If you find such definitions convenient, please use a text editor to reinstate the standard commands before sending your submission.

Please supply figures individually as postscript (.ps) or encapsulated postscript (.eps) files.

More information can be obtained from the *Gazette* website.

Deadlines for submissions to Volumes 35(1) and 35(2) of the *Gazette* are 1 February 2008 and 1 April 2008.

Volume 34 Number 5 **2007**

Editorial

Welcome to the final issue of the *Gazette* for 2007. We would like to thank everyone for their support, encouragement and suggestions (and patience) in our first year as the new *Gazette* editorial team. We are particularly grateful to our regular contributors, book reviewers and local correspondents, as well as all others who have been sending material for the *Gazette*.

In this issue's President's column, we learn about the Nepalese approach to problem-fixing and what this has to do with the mathematical sciences in Australia.

In the Classroom Notes, Leigh Wood talks about a study on the importance of transition to professional work for mathematics graduates. She suggests four assessment ideas to develop graduate attributes such as mathematical communication skills, rather than providing only a technical and discipline-specific education.

We are very pleased to include Peter Cameron's Maths Matters column in this issue. Peter discusses a topic that is vital to us all, particularly in the current climate of RQFs: publishing and assessing mathematics. He addresses three issues the mathematical sciences face: information overload, open access and assessment of research. Answers to Peter's questions can be sent to Peter directly, or to the *Gazette* address.

The winner of Puzzle Corner 3 is Codrut Grosu, a student from University Politehnica of Bucharest, Romania. Congratulations to Codrut, and it is very interesting to see that the *Gazette* is reaching such a wide audience! Please submit solutions to Norman Do's Puzzle Corner 5 to us by 1 March 2008. Good luck!

Tony Roberts writes about self-similar structures from the paragraph to the whole document in the Style Files. We also have a number of conference reports and information from the AustMS AGM and Council meetings, as well as Peter Johnston's annual paper on PhD, Masters and Honours completions in maths and stats. Last year's B.H. Neumann student prize winner, Benjamin Wilson, writes about his representations of truncated Lie algebras, and we have Michael Nyblom's paper on iterated sums of arithmetic progressions.

Phil Broadbridge writes about the special mentioning of mathematics in the *Quality of Education* report. This is a good step in the right direction, but more needs to be done! Phil also reports on AMSI's recent good funding news, ensuring that AMSI can continue its excellent work for a few more years.

And finally, we have happy news from Rachel Thomas, editor-on-maternity-leave of the *Gazette*. Elliot Thomas Trevelyan was born on Saturday, 13 October, a little bigger than expected at almost 9.5 lbs (about 4.3 kg). Congratulations to Rachel, Charles and Henry on the new arrival!

We wish you a restful end-of-year break, good festive season and all the best for 2008!

Birgit and Eileen

President's column

Peter Hall*

Different approaches to problem-fixing

Nepal Airlines operates just two jet aircraft, both of them Boeing 757s. They are essential to the airline's international services, which involve routes to cities as far from Nepal as Hong Kong and Dubai. So last September, when the flights of one of the 757s were repeatedly cancelled, or postponed, because of unfathomable electrical problems, the airline's management decided that serious measures were called for. Following local tradition, two goats were sacrificed to the Hindu sky god, Akash Bhairab, on the tarmac at Kathmandu, in front of the recalcitrant 757. The aircraft is now reported to be functioning well, carrying passengers reliably and safely.

The challenges that confront the mathematical sciences in Australia are at least as vexing as those that were faced by Nepal Airlines' perplexed engineers. In the last few years we have tried just about everything we can to draw these challenges to the attention of governments, bureaucracies, industry and other potential sources of support. Nevertheless, I'm sure we would all shrink from the Nepalese approach. When I mentioned to a colleague the Nepal Airlines solution, he wondered aloud who I had in mind to play the role of the goats.

We have certainly enjoyed successes this year, and they deserve to be celebrated. I'll say a little shortly about the successes. However, the predicament that we face is the result of more than a decade of a downwards spiral of university mathematics, and it is going to be tricky to claw our way back, even using the extra support we have gained.

The spiral is evident from data. For example, student numbers in mathematical sciences departments declined by 34% between 1989 and 2005[1], a period in which enrolments in Australian universities more than doubled. Staff numbers in mathematical sciences departments have fallen by at least a third during the last decade[2]. For those of us who work in universities, our experiences as lecturers, and as supervisors of graduate students, have made these trends painfully obvious. In particular, we know that in many areas of the mathematical sciences, employers can find attractive positions for all the good students we can train. But, in important respects, Australian schools are not producing the young men and women that universities need.

Of course, to a large extent the latter problem is due to another, interlinked, long-term spiral, connecting the supply of mathematically trained school teachers

*E-mail: President@austms.org.au

[1] Australian Council of Deans of Science, *Sustaining Science: University Science in the Twenty-First Century* (2007).

[2] Australian Academy of Science, *Mathematics and Statistics: Critical Skills for Australia's Future* (2006).

with the number of mathematically able high-school graduates. When I was a student there were essentially two jobs to which a university undergraduate with mathematics qualifications could aspire: becoming an actuary or a school teacher. Although other options existed, they did not have a high profile. Today, however, the employment horizon for mathematicians is vast. Jobs in many fields, for example in the banking, finance and insurance sectors, attract many mathematics graduates of whom some, in the past, would likely have become high-school teachers. There is now a 'recognised shortage of ... secondary school teachers in science and mathematics', and it is an established fact that these 'shortages have sometimes been accommodated by using teachers without adequate skills in these subjects'[3].

How we might break this nexus is one of the major challenges that we face. It needs partnership among state and federal governments to address the strategically debilitating skills shortage in mathematics. And it seems to require ingenious ventures by mathematical sciences departments in universities, to attract students who, in turn, could be attracted to careers as high-school teachers. No amount of slaughtering of helpless animals will help us.

One of the successes we have enjoyed in 2007 is an increase in government funding for mathematical sciences courses, including statistics, in Australian universities. However, to truly benefit from that development we must increase the number of students taking mathematics courses, and that is the point at which breaking the nexus becomes essential. Some of the increased number must go on to become high-school mathematics teachers, resisting the many attractions of positions in business and industry.

Another recent success is the government's announcement, in September, of a $2 million CASR grant to help support AMSI's activities over the next three years[4]. The long-term future of AMSI still needs to be guaranteed, but at least now we have a breathing space in which to address this problem. Also in September, the Senate Employment, Workplace Relations and Education Committee issued a thoughtful report[5] into the quality of Australian school education. The report's third recommendation was 'that schools and school systems take particular measures to improve teacher professional development in mathematics'. This gives still more strength to the hands that we must use to break the nexus.

These successes have been made possible only through hard work, over a long period, to bring to the attention of others the challenges that face the mathematical sciences in Australia. We should give thanks particularly to Hyam Rubinstein, Chair of the National Committee for the Mathematical Sciences; Phil Broadbridge, AMSI Director; Garth Gaudry, ICE-EM Director; Jan Thomas, AMSI Executive Officer; Jim Lewis, Chair of the AMSI Board; and Barry Hughes, Executive Director of the Strategic Review of Mathematical Sciences Research in Australia, to name just a few.

[3]Australian Government Productivity Commission, *Public Support for Science and Innovation* (2007).
[4]For details, see http://www.amsi.org.au/pdfs/CASR2007.pdf.
[5]Senate Standing Committee on Employment, Workplace Relations and Education, *Quality of School Education* (2007).

Classroom notes

The transition to professional work

Leigh Wood*

A couple of years ago I did an in-depth study of graduates of mathematical sciences and asked them about their roles as mathematicians in the workplace. These graduates suggested changes to content, learning methods and structure of university programs to assist with their transition to the workplace. Kent *et al.* [1] studied employer needs for mathematics in a range of disciplines and found an increase in the requirement for mathematical literacy amongst employers and for skills of mathematical communication in the workforce.

There are several ways that we could enhance the learning of mathematics at university in order to prepare students for professional work.

You can introduce a *Transition to the Workplace* subject, generally completed in the final year as done by UNSW [2], or a first-year subject to develop an orientation to mathematical work right from the beginning of a degree as done by UTS or you can build in opportunities to develop professional skills and attitudes throughout the degree. Depending on the circumstances it may be sensible to do all three!

There is a growing realisation that a majority of students learn better if they can see the relevance of their studies [3]. In these interviews with undergraduate students, we showed that many of them have little knowledge of what it would be like to work as a mathematician. Consider the following quote (Elly, third year, statistics major):

> A lot of people say to me 'oh well you are doing a maths degree, you going to be a mathematician or something?' and I'll say, 'I don't know, what does a mathematician do?' When I hear the word mathematician I think of, you know, Pythagoras, you know, someone who is sitting in a closed room proving theories and discovering things.

If students don't know what it will be like to work as a mathematician/statistician it is perhaps no wonder that it is difficult to encourage more students to study higher-level mathematics. Other factors which suggest the incorporation of professional skills into mathematics teaching include university policy about students developing graduate attributes and the changing nature of work, which nowadays requires less emphasis on content and more on generic skills.

While it is important that graduates are able to perform mathematical and computing techniques and know the relevant jargon and notations, it is essential that they are able to communicate their knowledge in a variety of circumstances and work in multidisciplinary teams in the workplace. The graduates who do well in

*Division of Economic and Financial Studies, Macquarie University, NSW 2109.
E-mail: lwood@efs.mq.edu.au

the workplace are able to align their knowledge with the goals of their organisation. In academia the goal of mathematics research is often beauty and simplicity whereas the goal of industry and business is to make money. The goal of graduates is to get a good job.

Assessment ideas

Here are a few examples of assessment tasks that can be adapted to different topic areas across the mathematics curriculum.

1. Teaching as learning

The first example considers teaching as learning. Many of the graduates I interviewed spend some of their time teaching others how to do technical processes. This opens ideas for assessment tasks that develop these teaching skills. Also, as many of us know, in order to explain an idea you really need to understand it. Example 1 looks at wavelets and asks students to write a handout to teach others in the class about the topic. Any topic can be substituted for wavelets. I have used this and similar assignments with engineering mathematics classes of 400 and smaller Linear Algebra classes. There are few issues of plagiarism as it is clear if copying has occurred. I also explain to students that this is important preparation for tasks in the workplace. The best examples can be posted on the Internet. This idea of teaching as learning is further developed in an article I wrote with Narelle Smith [4].

Example 1. Developing teaching skills

Please hand in your assignment in groups of 1 or 2 students.

Only hand in one assignment per group.

This assignment deals with WAVELETS. Wavelets are used in image processing and other areas. You will need to define terms used in your work. For example, if you find an example that uses a *sparse* matrix you would need to define what a sparse matrix is. You need to reference any material you have found on the Internet or in books — including definitions.

Question 1 (12 marks)

(a) What is a wavelet?
(b) Find an article that uses wavelets in an area that is interesting to you. Write a 500-word summary of the article. Hand in the summary and the article.
(c) Answer questions 1–7 in the attached handout. (Not attached here. These were mathematical exercises using matrices, including the process of finding wavelets.)

Question 2 (8 marks) (Bonus marks may be awarded for exceptional work)

Imagine you are the tutor teaching our class about wavelets. In about 2–4 pages, design a handout to teach this topic to the class. Consider your fellow students to be the audience for this handout.

2. Not teaching as learning

Another task mathematics graduates had to do soon after they graduated was learn new material, without the benefit of our teaching. They were required to use different mathematics or apply mathematics in a different way to how they had learnt it at university. One very successful assessment idea is *not* to teach a topic in the curriculum and either set an assignment, similar to Example 1 or, particularly if there is a good exposition of the topic in a textbook, to just state clearly that there will be a question on that topic in the final examination. We all know that what we teach is not necessarily learnt so why not go one step further and not even lecture it? Again, I always explain that we are preparing students for the workplace where they will have to learn by themselves. In the workplace students will have to learn without our teaching so it is good practice to help them along the way. The embarrassment is that students often perform best in this question on the examination!

3. Mathematics in context

A few years ago in Denmark, I attended a lecture by Gilbert Strang from MIT not long after Mary Donaldson married a certain Danish prince. Gilbert was introduced by Professor John Donaldson — Mary's father — much to the delight of the audience and Gilbert himself.

Gilbert said he often used tridiagonal matrices as examples for students because they had so many applications. This got me thinking, so I spent the next couple of lectures playing around with the following problem shown in Example 2 to make an assignment. Students also enjoy playing with this problem. It illustrates many of the properties of mathematics: the idea of definition, looking for patterns, conjecture and proof (a nice example of strong induction). Students then find an application, so putting the mathematics into a context and explaining the application in a form suitable for their colleagues. The process of mathematics is explored, put in context and communicated.

Example 2. Placing mathematics in context

Question 1 (10 marks)

(a) Define a tridiagonal matrix (reference your sources).
(b) Define a symmetric matrix.
(c) Define an upper triangular matrix.
(d) Consider the matrix $\begin{pmatrix} 2 & -1 \\ -1 & 2 \end{pmatrix}$.

- Find the determinant.
- Row reduce the matrix to upper triangular form and then find the determinant.

(e) Consider the matrix $\begin{pmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{pmatrix}$.

- Find the determinant.
- Row reduce the matrix to upper triangular form and then find the determinant.

(f) Consider the matrix $\begin{pmatrix} 2 & -1 & 0 & 0 \\ -1 & 2 & -1 & 0 \\ 0 & -1 & 2 & -1 \\ 0 & 0 & -1 & 2 \end{pmatrix}$.

- Find the determinant.
- Row reduce the matrix to upper triangular form and then find the determinant.

(g) Consider the $n \times n$ matrix $\begin{pmatrix} 2 & -1 & 0 & \cdots & \cdots & 0 \\ -1 & 2 & -1 & 0 & 0 & \vdots \\ 0 & -1 & \ddots & \ddots & 0 & \vdots \\ \vdots & 0 & \ddots & \ddots & -1 & 0 \\ \vdots & 0 & 0 & -1 & 2 & -1 \\ 0 & \cdots & \cdots & 0 & -1 & 2 \end{pmatrix}$.

- Find the value of the determinant.
- Prove your answer.

Question 2 (10 marks)

Search the Web and the library to find an application of a tridiagonal matrix. You may need to look at a few sources before you find one that you can understand.

(a) In about two A4 pages, summarise the application. You can use diagrams, mathematics and words. Consider that your classmates are the audience.
(b) Include references to the material you have used.

4. Mathematical communication as a graduate attribute

Being able to communicate mathematical ideas in the workplace is a critical graduate attribute for success. This not only requires general communication skills but the ability to communicate mathematically with those who are not mathematicians. We cannot leave this critical area to communication teachers; we need to integrate mathematical communication into the curriculum because the skills required are discipline specific.

Language teachers talk about the four macro skills of language: speaking, listening, reading and writing. Mathematics at university often emphasises listening and reading (receptive skills) rather than speaking and writing whereas in the workplace the opposite is needed. Clearly, all these skills are linked and in many cases should be taught in a linked manner. Nevertheless it is worth considering each separately and make suggestions for links between activities. The activities of the graduates will be used as examples of types of discourse to be modelled.

Speaking. Presentation of ideas:

- Miniconference. This task requires students to take given materials (such as a popular science book) and change the form of the material to make it suitable for a given audience. They then present the material as a miniconference to their peers and staff. This is generally a group work task with individual components.

- Miniconference (own materials). This is similar to the above except that students find their own materials for the conference. For example, they may be studying regression analysis so they will need to find data, analyse them and present their findings in a miniconference. This has been implemented at UTS for third-year regression students.
- Poster sessions. Similar to the above but presenting their findings in poster form.

Negotiating and selling ideas: One of the communication needs that is often mentioned by graduates is the need to sell ideas to a non-mathematical audience. Indeed one of the problems with even getting employment in the first place was the need to sell the degree to employers. Ways to deal with this range from debates (for example, 'Why is calculus essential in engineering?') to interview practice (How would your mathematics training add value to our organisation?; How would you use your mathematics in the Department of Defence?). These are real questions graduates were asked at interview.

Listening. Formal listening skills are developed in mathematics learning at university by attending lectures and tutorials. These are particular types of skills. Graduates in the workplace also need to be able to perform a broader range of listening behaviours, such as listening and then asking appropriate questions. Formal listening tasks could include:

- writing a summary of a talk and drafting suitable questions that could be asked;
- writing down the three main points after listening to a lecture.

Informal listening skills are also required and these are bound up with listening cues such as body language. It may be useful for lecturers to get in a guest lecturer for a session to discuss body language and other cues with final-year students. It may increase their success in gaining employment and succeeding when they are there.

Writing. Writing is an important part of professional life. For graduates in industry it is not as critical as Burton [5] found it to be for academic mathematicians; nevertheless, many graduates will be judged in part on their written work. Reports are commonly required as are writing manuals, help files and directions for others to follow.

A key area for graduates is the need to write quotes and responses to tenders. This is an area that has rarely been incorporated into mathematics teaching and learning and has outstanding potential for assessment tasks. It brings together ideas about the worth of mathematical knowledge, and project and time management and has a real connection with the workplace. In Example 3, I have shown an Excel spreadsheet of a simplified response to a tender. This was developed for the design of a questionnaire but could be adapted for a variety of situations. Ideally students could find an appropriate tender in the press and write a proposal for fulfilling the tender.

In a similar fashion, grant writing and ethics applications are good ways to show students that their mathematical knowledge has a value in the workplace.

Example 3. The value of mathematical work

Task	Hours	Hourly rate	Cost
Stage I: Survey design			
Literature search	24	$50.00	$1 200.00
Study design	8	$100.00	$800.00
Questionnaire design	12	$100.00	$1 200.00
Liaison	8	$100.00	$800.00
Stage II: Data collection			
Literature review/secondary	50	$50.00	$2 500.00
Phone questionnaire survey (based on four per hour)	100	$25.00	$2 500.00
In-depth interviews (5)	10	$50.00	$500.00
Training and supervision	30	$50.00	$1 500.00
Liaison	6	$100.00	$600.00
Stage III: Data analysis			
Data entry	50	$25.00	$1,250.00
Coding of questionnaires	16	$25.00	$400.00
Data processing (SPSS)	5	$25.00	$125.00
Analysis	16	$50.00	$800.00
Transcripts	20	$25.00	$500.00
Liaison	5	$150.00	$750.00
Stage IV: Report			
Recreational facilities review	16	$50.00	$800.00
Needs analysis	16	$50.00	$800.00
Draft report	16	$50.00	$800.00
Final report	12	$50.00	$600.00
Liaison	4	$100.00	$400.00
Supervision	4	$100.00	$400.00
Total hours	428		
Miscellaneous costs			
Printing (pages)	1200	$0.05	$60.00
Phone (number of calls)	1 700	$0.20	$340.00
Car (km)	250	$0.50	$125.00
Subtotal			**$19 750.00**
GST 10% flat rate			$1 975.00
Total cost			**$21 725.00**

Reading. Graduates require high-level reading skills. Firstly they need to be able to comprehend the materials and translate them into other forms, or summarise. Other critical reading requires graduates to be able to find appropriate reference materials for their purposes. In addition there is a need to distinguish between good and bad writing for a particular purpose. Appropriate learning tasks include comparing textbooks. This is a good task for first year students as it gets them to read different accounts of a topic and consider how they themselves learn.

Conclusion

Graduates require varied skills and knowledge to thrive in the workplace. We can make their transition easier by designing assessment tasks that develop graduate attributes. More than this, clever design of curriculum will also help with learning and the appreciation of mathematical ideas. Treating students as colleagues and initiating them to the delights of mathematics may encourage some of them to become part of our community of professional mathematicians.

References

[1] Kent, P., Hoyles, C., Noss, R. and Guile, D. (2004). Techno-mathematical literacies in workplace activity. *International seminar on Learning and Technology at Work, Institute of Education, London*. http://www.lkl.ac.uk/kscope/ltw/seminar2004/Kent-LTW-seminar-paper.pdf (accessed 19 October 2007).

[2] Franklin, J. (2005). A "Professional Issues and Ethics in Mathematics" course. *Gaz. Aust. Math. Soc.* **32,** 98–100.

[3] Reid, A., Wood, L.N., Petocz, P. and Smith, G.H. (2005). Intention, approach and outcome: university mathematics students' conceptions of learning mathematics. *International Journal of Science and Mathematics Education* **3,** 567–586.

[4] Wood, L.N. and Smith, N.F. (2007). Graduate attributes: teaching as learning. *iJMEST* **38,** 715–727.

[5] Burton, L. (2004). *Mathematicians as Enquirers: Learning About Learning Mathematics.* Kluwer, Dordrecht.

Leigh Wood is the Director of Learning and Teaching Studies in the Division of Economic and Financial Studies at Macquarie University. She is having fun teaching some large OR classes and supervising a couple of PhD students. Her current interests include investigating the transition to the professional workplace and professional development for lecturers in learning and teaching. Her next crazy adventure is a kayak trip in Antarctica.

Maths matters

Publishing and assessing mathematics

Peter J. Cameron*

Browsing the journals

'The past is a foreign country — they do things differently there', said L.P. Hartley. One thing they do differently is the dissemination of mathematics, which was more localised and more leisured than at present. The Oxford mathematics don Pedby in Max Beerbohm's *Zuleika Dobson* had achieved a European reputation for his work on short division of decimals; now any piece of mathematics is instantly available worldwide.

Cauchy went through a period of intensive work on group theory; he would write a long, discursive paper for the *Comptes Rendus* every week, and expect to see it in print the next week.

The style of writing was very different too. As a graduate student, I spent a lot of time reading Burnside's *Theory of Groups of Finite Order*. He would launch into several pages of close argument, at the end of which he would state his conclusion as a theorem. I have the impression that he would not have expected his readers to look ahead to see what was coming!

Now, things are much tighter. Any mathematician can tell you horror stories of papers which languished for years in the publication process. I wrote two articles and a short tribute for a journal volume dedicated to a mathematician for his 80th birthday; the volume came out just in time for his 85th.

As to the way we write, we train our students to write strictly in 'theorem–proof style'. Proofs must be clearly labelled as such, and should follow, not precede, the theorems; some journals even enforce the use of an end-of-proof symbol. It is usual to have the content of the paper summarised in an abstract.

Of course all this is necessary. I don't know by what factor the volume of mathematics published per annum has increased since the time of Cauchy and Burnside, but it is completely impossible for any mathematician to read more than a small sample of the papers in her field now. For dabblers like me, who work in several fields, things are even worse. At least, reading the abstract and the statement of the main theorem is usually enough to tell me whether I need to read the paper.

My older colleagues typically spend a period each week looking at the new journal issues in the library. Even older volumes are well worth browsing. My own observations suggest that if I take a journal volume from the library shelf to read a paper, the chance that it will contain at least one more interesting paper is very high. But my current students prefer to sit at their computers reading journals

*School of Mathematical Sciences, Queen Mary, University of London, Mile End Road, London E1 4NS, UK. E-mail: p.j.cameron@qmul.ac.uk

on-line or printing out preprints from various websites, and in some cases are quite reluctant to go to the library at all.

One thing that is lost here is an element of serendipity, which is crucial to research, in my opinion. Perhaps a paper on a very different subject will contain the clue to the problem I am stuck on at the moment.

Is all this a problem that needs addressing? It seems to me that it is related to three rather serious issues which are on the horizon for mathematics now.

Information overload

Where do I look for information about my field? The electronic catalogue in my library includes 14 journals with 'algebra' in the title, to say nothing of the *Journal of Group Theory*, *Semigroup Forum*, *Theory and Applications of Categories*, and so on and on.

Then there are the non-specialist journals such as *Crelle's Journal*, *Advances in Mathematics*, and national or local journals ranging from the *Michigan Mathematics Journal* to the *Journal of the European Mathematical Society.* Some of the best papers appear here, so I can't neglect them.

There are simply not enough hours in the day for a researcher to monitor the flood of new publications.

What about a keyword search? We have no agreement about what are relevant keywords. Apart from its widespread use in algebraic geometry, the term 'scheme' is used with an unrelated meaning in combinatorics and statistics. Even in these subjects, authors can't agree on the definition! It would not surprise me to learn of other unrelated uses of such a handy term.

We are on the horns of a dilemma here. Any method of searching or filtering this information which produces few enough results to be useful is also likely to miss out on some very relevant material. We can guarantee that what the search engine serves up to us will have a high proportion of nuggets, but we will have very little idea about what we have thrown away unpanned.

Open access

The second problem is open-access publishing. This new revenue stream for publishers took longer to reach us than some other subjects; it has been an issue in medical sciences for several years. The idea is simple. The results must be freely accessible to everyone. But someone must bear the cost, and publishers are not charities. So authors should pay.

It is now not uncommon for a mathematician to receive a letter from the publisher, when a paper is accepted, saying that on payment of a sum of money (typically a four-figure sum in US dollars), the paper will be available to all readers without charge. (This is not the same as page charges, which have been with us for some time. Page charges were always optional, and were a couple of orders of magnitude smaller.) We are supposed to feel good about this; we are making a donation to research in countries where the universities cannot afford the very high subscription charges that most publishers impose. The very name seems to echo such trends as open-source software and give us a warm glow.

New journals are starting up which make such payment a condition of publication. If this were to become common, a few prolific authors could break the budget of a small mathematics department.

The average mathematician laughs when asked for such a sum, and says 'I can put it on my web page, or on the arXiv, for nothing; why should I pay?'

A recent news item had the remarkable effect of making me feel, against my instincts, a little sympathy with open-access publishing. The issue was debated by the US Senate; it seems that the Senators were lobbied by traditional publishers claiming that this would be the death of refereeing and the rise of junk science. Of course, as long as somebody pays, journals can continue refereeing papers just as they do now (or more precisely, just as we do, for free, as another contribution to the publishers' income). So this was just a diversionary tactic.

But the scare tactic might be relevant to the alternative view, the one which advocates just putting everything on the arXiv and letting everyone read it there. Since this already happens (even published papers now cite preprints on the arXiv), it seems we may have been caught unawares. Do we have junk mathematics already?

Can you trust a paper on the arXiv? Can you trust a paper in a refereed journal, for that matter? Even such papers contain mistakes!

This is a serious problem in most parts of science. How can I trust a paper reporting an experimental result? Only by repeating the experiment myself to check the conclusions. Even if I have time, this may be quite beyond my resources. In parts of science where the theoretical basis for prediction is weak, I can't even know whether the result is reasonable unless it is in my specialist field.

Mathematicians, of course, have a different test. We can read the paper and check its claims ourselves (in effect, do a personal refereeing job). So is there a problem? Well, yes. In Cauchy's time I could have sat on the sofa and read the current *Comptes Rendus* from cover to cover. This is no longer feasible.

Even a single result may be out of reach. One of the most well-used theorems of recent times is the Classification of Finite Simple Groups. The proof has only recently been completed, but the result has been used for many years because of a premature announcement. But the proof covers very roughly ten thousand pages. I have often used the theorem, but I am simply incapable of checking the proof. I trust it because each piece has been read by many people. Important theorems such as Fermat's Last Theorem or the proof of the Poincaré conjecture will continue to receive such scrutiny, whether as formal refereeing or not. But a moderately interesting but quite long paper on the arXiv? Is there any estimate of how many readers such a paper might have?

We can't really have quality control without refereeing. Also, quality control depends on there being a definitive version of each paper, rather than a system where the paper can be updated at any time (attractive as that might be to authors, especially if a mistake is pointed out).

Assessment of research

This brings me to my final point, the assessment of mathematical research. We can't avoid this; our livelihoods depend on decent assessment of our work. The days when researchers were supported by family fortunes are gone, and we depend on funding agencies who are under many pressures, including shortness of funds and public accountability.

How is mathematics assessed?

The only sensible way is for someone to read it, and make the kind of judgement that referees make: is it correct? is it important? (and is it well-written? but the funding bodies seem less interested in this). At present, the best assessments do at least approximate to this ideal. (But the review panels are made up of people whose time, like ours, is limited, and so they tend to regard publication in a refereed journal as some kind of quality assurance, so that they can give a lighter touch. For this reason, the rules sometimes specify refereed publications.)

The current UK model of research assessment invites each researcher to submit four papers published during the review period. The panel read and judge the papers. At least, this is what used to happen; now they read a proportion of the papers (at most half) and assume that this allows a fair judgement of the others. This still involves each panel member reading several hundred papers over one summer; a very substantial commitment of time by people who are themselves among our best researchers.

This scheme does not go down well with the funding bodies, since such judgements are subjective. 'Transparency' has become the watch-cry; those who utter the word seem unaware that it is not synonymous with 'fairness'. The funders would prefer an 'objective' formula for their decisions. This requires numerical measures of the quality of a piece of mathematics.

Enter the metrics: citation index, impact factor. Couldn't we judge a paper on these numbers? In many parts of the academy, this already happens. Is maths really different?

A paper may be cited in order to refute it. In most of science, this is at least partly positive: the paper stimulated further investigations which showed that the original hypothesis is not confirmed. This is how science progresses, after all. But in mathematics, it is true to a first approximation that if a paper is wrong, it is worthless.

More seriously, the timescales are quite inappropriate for us. For the citation index, a window from one to two years after publication is examined. To our colleagues in science this might be reasonable: publication times are fast, and after two years the subject has moved on or died. Mathematicians look on with blank incomprehension at such debates. A paper which generalises my theorem is not likely to be in print within two years; and if my theorem is of any worth, people will still be citing it after 20 years (or two hundred, in the case of Gauss; or nearer two thousand, for Euclid).

A further problem is that any introduction of formulaic assessment will have the result that researchers will aim for the assessment targets rather than for real research quality (and we believe we know what that is!). In the first Research Assessment Exercise in the United Kingdom, papers were simply counted, each paper weighted in inverse proportion to the number of authors. Apart from discouraging collaborative research, this caused a big upsurge in 'salami-slicing', which could have been foreseen by anyone but the civil servants who designed the exercise. It was necessary to put some effort into undoing these effects. But the lesson has not been learned, of course.

A common problem

But at least we and our assessors have a common problem: how do you recognise good mathematics, without spending a lifetime on it?

Some pointers already exist. There are completely free journals on the web, run entirely by volunteers, which manage to achieve a high standard. (In my field, the Electronic Journal of Combinatorics is one such.) There is the Wikipedia model: anyone can publish, anyone can edit. This would not be appropriate for mathematics, where as we have seen a definitive version of a paper is required.

A halfway house is to invite comment on a paper (which may include refutation, or corrections). This is available in electronic journals now, but in my experience is not much used. Another proposal involves an archive with a facility for readers to vote.

Meanwhile, the learned societies continue to publish journals at reasonable prices, even though they depend on publishing for the vast bulk of their income. They are anxiously watching the publishing free-for-all and trying out different ways of dealing with it: starting their own specialist electronic journals with guaranteed high standards, allowing free access after an initial period of subscriber access, and so on.

Is there a better way? Is there a good solution to any of these problems? Answers on a postcard please; maybe the next Maths Matters column can publish the best . . .

Born and educated in Toowoomba, Peter Cameron attended the University of Queensland, where he gained first-class honours in Mathematics (and a University medal) in 1967. As the 1968 Queensland Rhodes Scholar, he set sail for England, where he has managed to remain. He took his D.Phil. from Oxford University in 1971, and after a period in Oxford as a Junior Research Fellow, he taught in Bedford College, University of London, and at Merton College, Oxford, until moving to Queen Mary College, London, in 1986, where he has remained.

He works in the area between group theory and combinatorics, particularly on permutation groups and the structures (graphs, designs, codes, etc.) that they act on, with occasional ventures into model theory, the theory of measurement, statistical design theory, and most recently Urysohn's universal Polish space.

He has seen assessment of mathematics research from both sides, having served on the Pure Mathematics panel for the United Kingdom's Research Assessment Exercise in 1996 and 2001.

His students and colleagues arranged a meeting for his 60th birthday in August 2007; the meeting included music and walking as well as mathematics, and about half his 33 doctoral students together with many friends and co-authors were able to attend.

Puzzle corner 5

Norman Do*

Welcome to the Australian Mathematical Society *Gazette*'s Puzzle Corner. Each issue will include a handful of entertaining puzzles for adventurous readers to try. The puzzles cover a range of difficulties, come from a variety of topics, and require a minimum of mathematical prerequisites to be solved. And should you happen to be ingenious enough to solve one of them, then the first thing you should do is send your solution to us.

In each Puzzle Corner, the reader with the best submission will receive a book voucher to the value of $50, not to mention fame, glory and unlimited bragging rights! Entries are judged on the following criteria, in decreasing order of importance: accuracy, elegance, difficulty, and the number of correct solutions submitted. Please note that the judge's decision — that is, my decision — is absolutely final. Please e-mail solutions to N.Do@ms.unimelb.edu.au or send paper entries to: Gazette of the AustMS, Birgit Loch, Department of Mathematics and Computing, University of Southern Queensland, Toowoomba, Qld 4350, Australia.

The deadline for submission of solutions for Puzzle Corner 5 is 1 March 2007. The solutions to Puzzle Corner 5 will appear in Puzzle Corner 7 in the May 2008 issue of the *Gazette*.

Pricey pills

A sick patient has been advised to take exactly one pill of Xenitec and exactly one pill of Yenitec every day. The patient has a full bottle of each type of pill. One day, he pours one Xenitec pill onto a table and accidentally pours two Yenitec pills onto the table as well. Unfortunately, the three pills look identical and the patient has no way of telling them apart. Furthermore, since the pills are extremely expensive, the patient would rather not have to discard any of them. How can the patient save all three pills, but still maintain a proper daily dosage?

Marching band

The members of a marching band are arranged in a rectangular array. In order to aid visibility, the leader of the band decides to rearrange each column so that the heights are non-decreasing from front to back. He then decides to rearrange each row so that the heights are non-decreasing from left to right. Prove that the columns are still in non-decreasing order of height from front to back.

*Department of Mathematics and Statistics, The University of Melbourne, VIC 3010.
E-mail: N.Do@ms.unimelb.edu.au

Silly soldiers

A row of freshly recruited soldiers is facing a sergeant who gives them the command to turn right. Some of the soldiers turn right, while the rest of them turn left. After one second of confusion, they all try to correct their mistake in the following way. If a soldier sees the face of their neighbour, they assume they have turned the wrong way and decide to turn around; otherwise, the soldier remains facing the same way. If any two soldiers are facing each other, then there is another second of confusion before they try to correct their mistake in the same way. This continues until the situation stabilises and no two soldiers are facing each other. If there are n soldiers, then what is the maximum length of time that it will take for the situation to stabilise?

The lazy fly

A rectangular room is 30 feet long, 12 feet in height, and 12 feet wide. A lazy fly is resting in the middle of a wall at the end of the room, at a point one foot down from the ceiling. In the middle of the opposite wall, one foot up from the floor is a tiny scrap of food. The fly is too lazy to fly and decides to walk to the food at the other end of the room. What is the minimum distance that the fly must walk?

Dinner party handshakes

My wife and I were invited to a dinner party attended by nine other couples, making a total of 20 people. A certain amount of handshaking took place subject to two conditions: no one shook his or her own hand and no couple shook hands with each other. Afterwards, I became curious and asked everybody else at the party how many people they shook hands with. Given that I received nineteen different answers, how many people could my wife have shaken hands with?

Counting the digits

You are given three infinite lists of numbers: A, B, and C. List A contains all numbers of the form 10^k, where k is a positive integer, written in base 10. Lists B and C contain the same numbers written in base 2 and base 5, respectively.

A	B	C
10	1010	20
100	1100100	400
1000	1111101000	13000
$\vdots$	$\vdots$	$\vdots$

Prove that for every integer $n > 1$, there is exactly one number appearing in lists B or C which has exactly n digits.

Tennis anyone?

(1) Suppose that 1000 tennis players want to play in a tennis tournament. In each round, they are paired up and the winner progresses to the next round. If the number of players in a round is odd, then one player is chosen to automatically progress to the next round before the pairing occurs. This continues until the final round which contains only one match and the winner of this match is crowned the champion. What is the total number of matches played in the whole tournament?

(2) You have been granted magical powers which have enabled you to reach the Wimbledon tennis final. However, you have been warned that your powers will run out during the match, after which your opponent will have a distinct advantage. What score do you want it to be when your powers disappear in order to maximize your chances of hanging on for a win?

(3) Alex and Bobbi are about to play a tennis match where the winner is the first player to reach twelve games. It has been decided that Alex will serve first but they are considering using one of the two following serving schemes: the alternating serves scheme in which the two players take turns to serve or the winner serves scheme in which the winner of a game serves in the next. It is known that Alex has 0.71 chance of winning his serve while Bobbi has only 0.67 chance of winning her serve. Which scheme should Alex choose to maximize his chances of winning the match?

Solutions to Puzzle Corner 3

The \$50 book voucher for the best submission to Puzzle Corner 3 is awarded to Codrut Grosu.

Milk and tea

Solution by Mike Hirschhorn: Note that the two cups contain the same amount of liquid before and after the mixing. Therefore, the amount of milk that has been displaced is equal to the amount of tea that has been displaced. It follows that the percentage of milk in the tea is equal to the percentage of tea in the milk.

Lockers

Solution by Gordon Clarke: The state of locker number n is toggled by student d if and only if d is a factor of n. Therefore, the final state of locker number n is open if and only if n has an odd number of factors. However, d is a factor of n if and only if $\frac{n}{d}$ is a factor of n, so the factors come in pairs unless $d = \frac{n}{d}$, in which case $n = d^2$.

Therefore, only the square numbers have an odd number of factors, so the lockers which remain open are numbered 1, 4, 9, 16, 25, 36, 49, 64, 81 and 100.

Irrational punch

Solution by David Angell: Of course, one application of the hole punch is not enough. It is also clear that two punches will not suffice, since there are infinitely many points on the perpendicular bisector of the centres which have the same rational distance from each.

Now we will show that three punches centred at the points $(0,0)$, $(\alpha,0)$ and $(0,\alpha)$ suffice, for some choice of the real number α. Note that the point (x,y) survives all three punches if and only if

$$x^2+y^2=r^2, \quad (x-\alpha)^2+y^2=s^2, \quad \text{and} \quad x^2+(y-\alpha)^2=t^2\,,$$

for some rational numbers r, s, and t.

However, it follows from the first and second equations that $x=(\alpha^2+r^2-s^2)/2\alpha$ and similarly, from the first and third equations, that $y=(\alpha^2+r^2-t^2)/2\alpha$. Now substituting these expressions for x and y into the first equation and clearing fractions yields

$$(\alpha^2+r^2-s^2)^2+(\alpha^2+r^2-t^2)^2=4r^2\alpha^2\,.$$

This implies that α satisfies a degree four polynomial with rational coefficients. Therefore, by choosing a value of α which is not a root of a degree four polynomial with rational coefficients (for example, $\alpha=\pi$) we can ensure that the three punches dispose of the entire plane.

Integral averages

Solution by Peter Pleasants: If $S\subseteq\{1,2,\ldots,n\}$ has integral average a then the set $n+1-S$ obtained by reflection in the midpoint $(n+1)/2$ has integral average $n+1-a$. Note that $n+1-S=S$ if and only if S is symmetric about $(n+1)/2$. Hence, the parity of T_n is the same as the parity of S_n, the number of non-empty subsets of $\{1,2,3,\ldots,n\}$ with integral average that are symmetric about $(n+1)/2$.

The average of any set symmetric about $(n+1)/2$ must of course be $(n+1)/2$. When n is even, this is not an integer, so $S_n=0$ and T_n is also even.

When n is odd, $(n+1)/2$ is an integer and the subsets of $\{1,2,\ldots,n\}$ that are symmetric about $(n+1)/2$ and have integral average come in pairs, where the sets of each pair differ only in the fact that one contains $(n+1)/2$ while the other does not. Once we discard the empty set, this shows that S_n, and hence also T_n, is odd. Therefore, in each case the parity of T_n is the same as the parity of n.

Silver matrices

Solution based on work submitted by Sam Krass:

(a) For each value of k, let us call the union of the kth row and the kth column a cross. Note that each off diagonal entry of the matrix belongs to exactly two crosses while each diagonal entry belongs to exactly one cross. Now suppose that one of the numbers occurs off the diagonal a times and on the diagonal

b times. Then since each number occurs in each cross exactly once, we have

$$2a + b = n.$$

Therefore, if n is odd, then $b \geq 1$ and every number from 1 to $2n-1$ must lie on the diagonal. So unless $n = 1$, there will be more numbers than diagonal entries and no silver matrix can exist. In particular, there is no silver matrix for $n = 2007$.

(b) We will show that whenever a $k \times k$ silver matrix exists, then a $2k \times 2k$ silver matrix also exists. Consider the matrix

$$X = \left[\begin{array}{c|c} A & B \\ \hline C & A \end{array}\right],$$

where A is a $k \times k$ silver matrix, B is a $k \times k$ matrix such that every row and every column contains the numbers $\{2k, 2k+1, \ldots, 3k-1\}$ in some order, and C is a $k \times k$ matrix such that every row and every column contains the numbers $\{3k, 3k+1, \ldots, 4k-1\}$ in some order. For example, we can construct B and C by placing the entries in the first row in numerical order and then cyclically shifting each subsequent row.

By construction, every cross of X contains a cross of A, a row of B and a column of C or a cross of A, a column of B and a row of C. So each cross contains $\{1, 2, \ldots, 2k-1\} \cup \{2k, 2k+1, \ldots, 3k-1\} \cup \{3k, 3k+1, \ldots, 4k-1\}$ as desired.

Now since a 1×1 silver matrix is easy to construct, it follows that silver matrices exist whenever n is a power of 2.

Puzzles for prisoners

Solution based on work submitted by Codrut Grosu

(1) Of course, no strategy is guaranteed to save all the prisoners, since there is no hope for the unlucky prisoner at the back of the line. However, we will show that the remaining 99 prisoners can be saved!

Note that each prisoner need only know their number modulo 100 in order to be freed. The prisoner at the back of the line calls out the sum of the remaining 99 numbers, modulo 100. (If the sum is 0 modulo 100, then the prisoner should call out the number 100.) The next prisoner can then calculate the modulo 100 sum of the 98 numbers before them and subtract this from the total sum, thereby calculating their own number. Subsequent prisoners will know the total sum of the 99 people to be saved, can see all of the numbers in front of them, and has heard the numbers of everyone behind them. Therefore, they can calculate their own number.

(2) Let us suppose, for ease of exposition, that the one hundred prisoners have names which are simply the integers from 1 to 100. Furthermore, we may assume that the boxes are also numbered from 1 to 100. Suppose that box k contains the number $P(k)$, so that P is simply a permutation of the numbers from 1 to 100.

The optimal strategy is actually quite simple! Each prisoner starts by opening the box with his or her number on it. They then open the box matching the number they found in the previous box. They continue in this way until they reach a box with their own name inside or have opened 50 boxes.

But why on earth does this strategy work? Since P is a permutation of the numbers from 1 to 100, we can write it as a union of disjoint cycles in the standard way. Now we simply note that every prisoner will find his or her name if and only if there is no cycle in P of length greater than 50. So all that is left for us to do is calculate the probability that a permutation of 100 elements contains no cycle of length greater than 50.

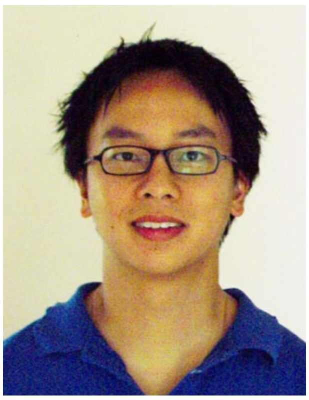
Let us begin by calculating the probability that a permutation on 100 elements contains a cycle of length $k > 50$. Well, there are $\binom{100}{k}$ ways to choose the elements of the cycle, $(k-1)!$ ways to put those elements in cyclic order, and $(100-k)!$ ways to permute the remaining elements. The product of these is $100!/k$ and since there are $100!$ permutations, the desired probability is simply $\frac{1}{k}$. Since it is impossible to have more than one cycle of length greater than 50, the probability of having no cycle of length greater than 50 is given by the expression

$$1 - \left(\frac{1}{51} + \frac{1}{52} + \cdots + \frac{1}{100}\right).$$

However, the reader is invited to show that for all positive integers n,

$$1 - \left(\frac{1}{n+1} + \frac{1}{n+2} + \cdots + \frac{1}{2n}\right) > 1 - \ln 2 \approx 0.307\,.$$

Therefore, using this strategy, the prisoners will be freed with a probability that exceeds thirty per cent!



Norman is a PhD student in the Department of Mathematics and Statistics at The University of Melbourne. His research is in geometry and topology, with a particular emphasis on the study of moduli spaces of algebraic curves.

The style files

Establish a self-similar structure

Tony Roberts*

Previous articles mainly addressed issues of words and sentences: prefer the present tense; clarify ‘this’; write actively; be explicit; and so on. Now let us move on to consider how to combine sentences into a document. I propose that structures from the paragraph to the whole document are similar.

Make the paragraph the unit of composition

Strunk beautifully describes the nature of a paragraph.

> Ordinarily, however, a subject requires subdivision into topics, each of which should be made the subject of a paragraph. The object of treating each topic in a paragraph by itself is, of course, to aid the reader. The beginning of each paragraph is a signal to him that a new step in the development of the subject has been reached. Strunk [5, Section 9]

But how do we decide what is a ‘topic’? What do we form into one paragraph? We are stymied until we understand what a ‘topic’ means to us. I suggest you consider a ‘topic’ to be something about which you can write a summary statement; perhaps a result that some algebra can establish, or perhaps something that might be labelled a mini-theorem or mini-lemma. Then such a summary statement serves as either the first or ending sentence of the paragraph. As Strunk recommends in the following quote, surround the argument of the body of a paragraph by summary statements or consequences.

> 1. the topic sentence comes at or near the beginning;
> 2. the succeeding sentences explain or establish or develop the statement made in the topic sentence; and
> 3. the final sentence either emphasizes the thought of the topic sentence or states some important consequence. Strunk [5, Section 10]

Example. The following paragraph, extracted from a module teaching writing, starts with a summary statement (italicised here) on the vital importance of technical communication, and ends with a statement (also italicised here) on the consequence that we grade their work explicitly on communication. The middle of the paragraph explains more details.

> *Developing technical communication is essential preparation for the workplace and advanced study.* In this module we help you to structure, prepare and deliver small documents of technical material. Study this module in parallel with the first few modules in preparation for your first assignment. In your assignments you will demonstrate your skills in technical writing for specific tasks. *Your assignment reports will not only be graded on mathematical content, but also on the style and manner of the technical and English expression.*

*Department of Mathematics and Computing, University of Southern Queensland, Toowoomba, QLD 4350. E-mail: aroberts@usq.edu.au

Self-similarity helps guide readers

Recognise shades of the well-known 'rule of three' in the above quote from Strunk [5, Section 10]: (1) tell them what you will tell them; (2) tell them; (3) tell them what you have told them. I prefer Strunk's expression. But pause just a moment: the 'rule of three' refers to the whole document, whereas Strunk refers to just one paragraph. The large-scale 'rule of three' and the paragraph scale recommended by Strunk are essentially the same. I recommend that you apply the same principle at *all* levels in a document.

> The principle that the start and end of a paper are more important generally applies at the smaller scale. In a long paragraph it is often worth explaining (in advance) what you're doing and why you're doing it. The hierarchy of purposes extends down to paragraphs; after each paragraph, ask yourself if you've achieved your immediate purpose. This principle applies even to sentences; if, for example, you are recapitulating, beginning the sentence with a phrase like "In short..." will prepare the reader. Garrett [1]

Garrett identifies that readers find the start and end of each component to be the most important. Readers typically pay most attention to the Introduction and Conclusion: reiterate important information there, together with a 'map' of the article. The start and finish of a section or subsection are the most important: reiterate and 'map' the section or subsection. The start and finish of a paragraph are similarly for summary and mapping. Surely documents must be self-similar with appropriate summary explanation at all levels.

References

[1] Garrett, A. (2000). *Principles of Science Writing*. Technical report. Scitext, Cambridge. http://www.scitext.com/writing.php (accessed 19 October 2007).

[2] Higham, N.J. (1998). *Handbook of Writing for the Mathematical Sciences*, 2nd edn. SIAM.

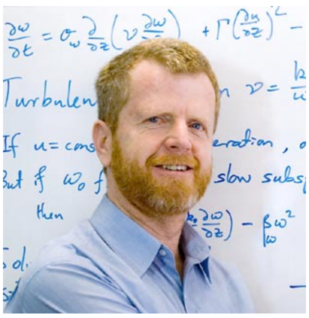
[3] McIntyre, M.E. (2005). *Lucidity Principles in Brief*. Technical report. http://www.atm.damtp.cam.ac.uk/people/mem/lucidity-in-brief/ (accessed 19 October 2007).

[4] Priestly, W. (1991). Instructional typographies using desktop publishing techniques to produce effective learning and training materials. *Australian Journal of Educational Technology* **7,** 153–163. http://www.ascilite.org.au/ajet/ajet7/priestly.html (accessed 19 October 2007).

[5] Strunk, W., Jr (1918). *The Elements of Style*. W.P. Humphrey. http://www.bartleby.com/141 (accessed 19 October 2007).

[6] Wheildon, C. and Heard, G. (2005). *Type & Layout: Are You Communicating or Just Making Pretty Shapes*, 2nd edn. Worsley Press.

[7] Zobel, J. (2004). *Writing for Computer Science*, 2nd edn. Springer, London.



Tony Roberts is the world leader in using and further developing a branch of modern dynamical systems theory, in conjunction with new computer algebra algorithms, to derive mathematical models of complex systems. After a couple of decades of writing poorly, both Higham's sensible book on writing and Roberts' role as electronic editor for the Australian Mathematical Society impelled him to not only incorporate writing skills into both undergraduate and postgraduate programs, but to encourage colleagues to use simple rules to improve their own writing.

Communications

Higher Degrees and Honours Bachelor Degrees in Mathematics and Statistics completed in Australia in 2006

Peter Johnston*

This report presents data relating to students who completed Honours or Higher Degrees in Mathematics during 2006. The data are part of an on going project for the Australian Mathematical Society and should be read in conjunction with previous reports [1], [2], [3], [4], [5], [6], [7] covering the period 1993–2005.

Appendix 1 presents data for students completing Honours degrees in 2006, at all Universities in Australia. Within each institution, the data are broken down into male and female students and into the three traditional areas of Mathematics: Pure; Applied and Statistics. There is also the general category 'Mathematics' for institutions which do not differentiate between the conventional areas. Finally, there is an 'Other' category for newer areas of mathematics such as Financial Mathematics. Each category is further broken down into grades of Honours awarded. The appendix shows that in 2006 there were 154 Honours completions in Australia, with 106 (69%) receiving First Class Honours (compared with 105 out of 152 (69%) in 2005 and 99 out of 138 (72%) in 2004). In the three years prior to 2004 there were approximately 160 Honours completions each year.

Figure 1 presents the total number of students completing Honours degrees in Mathematics over the period 1959–2006. It shows that in 2006 the number of graduates continues to climb back to the levels of the period 2001–2003. The figure also shows the numbers of male and female students who completed Honours over the same time period. For last year there was a large jump in the number of male students (115, up from 99). This increase was matched by a similar drop in the number of female students (39, down from 53).

Appendix 2 presents the data for Higher Degree completions in 2006. The data are broken down into Coursework Masters, Research Masters and PhD degrees, with the latter two divided into the three typical areas of Mathematics. These data are also represented in Figure 2, as part of the overall Higher Degree data for the period 1959–2006. The figure shows that: (1) the number of PhD completions has dropped slightly from the previous year and returned to levels typical of the 2000–2003 period — it is interesting to note that of the 69 completions in 2006, 45 were by male students and 24 by female students; (2) the number of Research Masters completions has increased after several years of decline; and (3) the number of Coursework Masters completions shows a large drop after the considerable increase in the previous year.

*School of Science, Griffith University, Nathan, QLD 4111.
E-mail: P.Johnston@griffith.edu.au

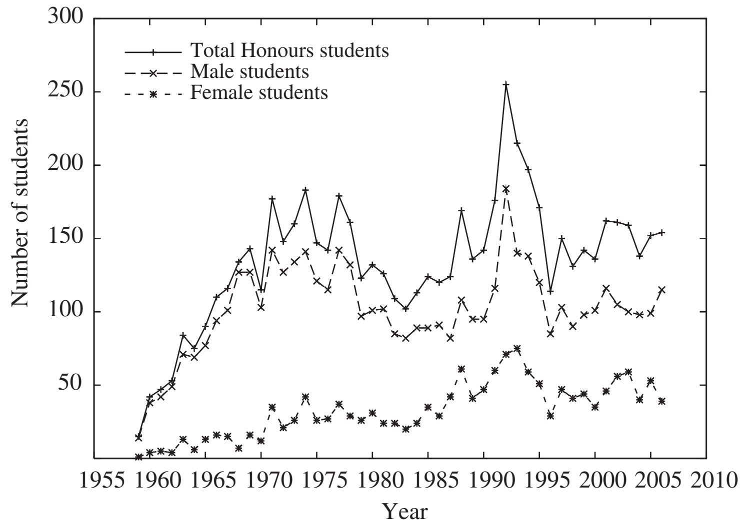


Figure 1. Number of Honours degrees completed in Mathematics and Statistics, 1959–2006.

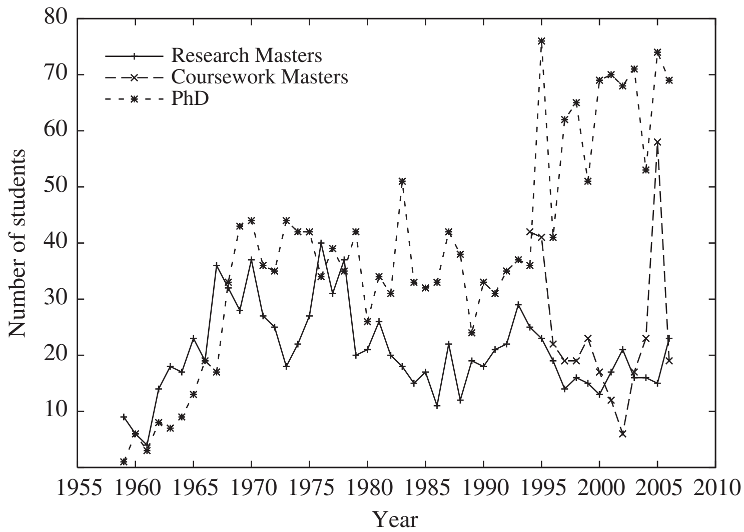


Figure 2. Number of research higher degrees completed in Mathematics and Statistics, 1959–2006.

Finally, Appendix 3 gives a list of completed Research Masters and PhD theses awarded in 2006.

For those who are interested in the finer details, the raw data are available from links on the website www.cit.gu.edu.au/maths. There is an Excel spreadsheet containing the complete data for 2006 as well as spreadsheets containing cumulative data from 1959 for Honours, Research Masters and PhD degrees.

I would like to thank the many people who took the time and effort to collect this data and forward it to me. It is pleasing to see that there were 31 out of a possible 38 responses to requests for data, an increase over recent years. Next year I will endeavour to obtain data earlier in the year, when the figures are still fresh in peoples' minds. Finally, if, having read this report, you would like to contribute missing data for 2006, I can add it to the data on the website.

References

[1] Petocz, P. (1996). Higher degrees and honours bachelor degrees in mathematics and statistics completed in Australia 1993. *Gaz. Aust. Math. Soc.* **23,** 123–133.

[2] Johnston, P. and Petocz, P. (2002). Higher degrees and honours bachelor degrees in mathematics and statistics completed in Australia in 1994 and 1995. *Gaz. Aust. Math. Soc.* **29,** 62–72.

[3] Johnston, P. (2003). Higher degrees and honours bachelor degrees in mathematics and statistics completed in Australia between 1996 and 2001. *Gaz. Aust. Math. Soc.* **30,** 42–44.

[4] Johnston, P. (2003). Higher degrees and honours bachelor degrees 2002. *Gaz. Aust. Math. Soc.* **30,** 315–320.

[5] Johnston, P. (2004). Higher degrees and honours bachelor degrees in mathematics and statistics completed in Australia in 2003. *Gaz. Aust. Math. Soc.* **31,** 314–319.

[6] Johnston, P. (2005). Higher degrees and honours bachelor degrees in mathematics and statistics completed in Australia in 2004. *Gaz. Aust. Math. Soc.* **32,** 320–325.

[7] Johnston, P. (2006). Higher degrees and honours bachelor degrees in mathematics and statistics completed in Australia in 2005. *Gaz. Aust. Math. Soc.* **33,** 249–254.

Appendix 1. Number of Honours degrees completed in Mathematics and Statistics, 2006.

Uni.	Sex	Maths				Pure				Applied				Statistics				Other				Honours
		I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	I	IIA	IIB	III	Total
ACU	M																					0
	F																					0
ADF	M									1												1
	F																					0
ANU	M	3	1																			4
	F	1																				1
BOU	M																					0
	F																					0
CDU	M																					0
	F					1																1
CQU	M																					0
	F																					0
CSU	M																					0
	F																					0
CUT																						0
																						0
DKU	M																					0
	F																					0
ECU	M																					0
	F	1																				1
FDU																						0
																						0
GFU	M																					0
	F																					0
JCU																						0
																						0
LTU																						0
																						0
MDU	M																					0
	F										1											1
MNU	M	4	1							1	1										1	8
	F	2																				2
MQU	M	2																				2
	F																					0
QUT	M					1								1								2
	F													2								2
RMT	M					1				2				1								4
	F					1				2												3
SCU	M																					0
	F																					0
SUT	M																					0
	F																					0
UAD	M					1	3		2	1				1								8
	F									2				2								4
UBR	M																					0
	F																					0
UCB	M																					0
	F																					0
UMB	M					3	1		2	2	2	1		4								15
	F					1		1		1	1	1			1							6
UNC	M	3	1	1																		5
	F																					0
UNE	M																					0
	F																					0
UNS	M					2	1			4	2				2							11
	F					1		1			1	1										4
UQL	M					9				3					1							13
	F					1				3				1								5
USA																						0
																						0
USN	M					7	1			6	2	1										17
	F					1				1				1	1							4
USQ																						0
																						0
UTM	M					2	1							1								4
	F					1																1
UTS	M									2	2					2						6
	F												1									1
UWA	M					4																4
	F					1																1
UWG	M					2				1	1				2			3				9
	F																		2			2
UWS	M										1							1				2
	F																					0
VUT	M																					0
	F																					0
Totals		16	3	1	0	40	7	2	4	32	14	4	1	14	7	2	0	4	2	0	1	154

Appendix 2. Number of research higher degrees completed in Mathematics and Statistics, 2006.

Uni.	Sex	Coursework Masters	Research Masters Pure	Research Masters Applied	Research Masters Statistics	Total	PhD Pure	PhD Applied	PhD Statistics	Total
ACU	M					0				0
	F					0				0
ADF	M					0				0
	F					0				0
ANU	M		1		1	2	1	1	2	4
	F					0		2	1	3
BOU	M					0				0
	F					0				0
CDU	M					0				0
	F					0				0
CQU	M					0		2		2
	F					0				0
CSU	M					0				0
	F					0				0
CUT						0				0
						0				0
DKU	M			1		1				0
	F					0				0
ECU	M					0		1		1
	F				1	1			1	1
FDU						0				0
						0				0
GFU	M					0				0
	F					0				0
JCU						0				0
						0				0
LTU						0				0
						0				0
MDU	M					0			1	1
	F					0				0
MNU	M			1		1		3		3
	F			2		2				0
MQU	M					0				0
	F					0				0
QUT	M	1		1		1		2	1	3
	F					0		2	1	3
RMT	M	12			4	4	1	2		3
	F	1			3	3				0
SCU	M					0				0
	F					0				0
SUT	M	2				0			2	2
	F	2		1	1	2				0
UAD	M		2			2		2	2	4
	F					0	1	1		2
UBR	M					0				0
	F					0	1			1
UCB	M					0				0
	F					0				0
UMB	M					0	2	4	1	7
	F				1	1		1	1	2
UNC	M					0	2			2
	F					0			1	1
UNE	M		1			1			1	1
	F					0				0
UNS	M					0		1		1
	F					0	1		1	2
UQL	M		1			1		4		4
	F					0		1	1	2
USA						0				0
						0				0
USN	M					0	2	2		4
	F					0	1		1	2
USQ						0				0
						0				0
UTM	M					0		1		1
	F				1	1		1		1
UTS	M					0				0
	F					0				0
UWA	M					0	1			1
	F					0	3		1	4
UWG	M	1				0				0
	F					0				0
UWS	M					0				0
	F					0				0
VUT	M					0			1	1
	F					0				0
		19	5	6	12	23	16	33	20	69

Appendix 3. Higher Degrees in mathematics and statistics, 2006.

Uni.	Sex	Degree	Area	Name	Title
ANU	M	MSc	Pure	K. Tong	Semifinite Index Theory and SUq(2)
	M	MSc	Pure	A. Sly	Self-semilarity, multifractionality and multifractality
	F	PhD	Applied	K. Manson	Modelling of accretion discs with smoothed particle Hydrodynamics
	F	PhD	Stats	J. Spate	Data mining as a tool for investigating environmental systems
	M	PhD	Pure	D. Brander	Isometric immersion of a flat manifold into a sphere as an integrable system
	F	PhD	Applied	K. Carpio	Long-range dependence of Markov processes
	M	PhD	Stats	M. Li	Nonparametric period estimation using the periodogram
	M	PhD	Applied	M. Oelkers	A class of energy minimisers for the rotating drop problem
	M	PhD	Stats	S. Hosseini-Nasab	On properties of functional principal components analysis
QUT	F	PhD	Stats	M. Forrester	Epidemic models and inference for the transmission of hospital pathogens
	F	PhD	Applied	M. Penny	Mathematical modelling of dye-sensitised solar cells
	M	PhD	Stats	S. Hoyle	Statistical methods for assessing and managing wild populations
	M	PhD	Applied	T. Moroney	An investigation of a finite volume method incorporating radial basis functions for simulating nonlinear transport
	F	PhD	Applied	E. McBryde	Mathematical and statistical modelling of infectious diseases in hospitals
SUT	F	MSc	Applied	A. Chakraborty	Numerical study of biological problems in a predator–prey system
	M	PhD	Stats	T. Barnett	Mathematical modelling in hierarchical games with specific reference to tennis
	M	PhD	Stats	D. Forbes	Dynamic prediction of Australian Rules football using real time performance statistics
UBR	M	PhD	Pure	K. Sugeng	Magic and antimagic graph labeling
UMB	F	PhD	Stats	J. Cain	Random graph processes and optimisation
	M	PhD	Pure	J. Coffey	3-manifolds built from injective handlebodies
	M	PhD	Applied	C. Fricke	Applications of integer programming in open pit mining
	M	PhD	Applied	C. Green	Dynamics of atomic force microscope cantilever beams in fluids
	M	PhD	Pure	D. Heard	Computation of hyperbolic structure on 3-dimensional orbifolds
	M	PhD	Applied	J. Looker	The electrokinetics of porous colloidal particles
	M	PhD	Stats	K. Prendergast	Steiner ratio for gradient constrained networks
	F	PhD	Applied	M. Ramakrishnan	Distributed approaches to capacity reallocation in networks
	M	PhD	Applied	S. Walsh	A thermomechancial approach for micromechanical continuum models of granular media
	M	MSc	Stats	X. Wang	Approximate distributions of the number of run occurrences
UNC	M	PhD	Pure	I. Gray	Construction methods for vertex-magic total labelings of graphs
	M	PhD	Pure	J. Kimberley	Classifying Burger*Mozes groups and the algebras generated from their actions
	F	PhD	Stats	E. Stojanovski	Statistical assessment of the relationship between life events and health
UNE	M	MSc	Pure	B. Bujeya	Some further remarks on the existence and uniqueness for the generalised logistic equation on R^N
	M	PhD	Stats	B. Carson	Beowulf applications in statistics
USN	M	PhD	Pure	P. O'Sullivan	The generalised Jacobson–Morosov theorem
	F	PhD	Pure	L. Ratliff	The alternating Hecke algebra and its representations
	M	PhD	Pure	G. White	Enumeration-based algorithms in linear coding theory
	M	PhD	Applied	A. Merrifield	An investigation of mathematical models for animal group movement, using classical and statistical approaches
	M	PhD	Applied	T. Schaerf	On contour crossings in countour-advective simulations of geophysical fluid flows
	F	PhD	Stats	D.Perera	Saddlepoint approximation methods in the analysis of panel time series data
UWA	F	PhD	Pure	S. Ambrose	Matrix groups: theory, algorithms and applications
	M	PhD	Pure	S. Brown	Finite reducible matrix algebras
	F	PhD	Stats	I. Casas Villalba	Statistical inference in continuous-time models with short-range and/or long-rang dependence
	F	PhD	Pure	F. Evans	Syntactic models with applications in image analysis
	F	PhD	Pure	J. Xu	On closures of finite permutation groups

Australian Students at the Graduate Industrial Maths Modelling Camp, Edmonton

Kaiser Lock*, **Ognjen Stancevic**** **and Philip Broadbridge*****

The 10th Graduate Industrial Mathematics Modelling Camp (GIMMC) and 11th Industrial Problem Solving Workshop (IPSW) were held by the Pacific Institute for the Mathematical Sciences (PIMS) at the University of Alberta, Edmonton, Canada, in June 2007. As a member of PRIMA, the Australian Mathematical Science Institute (AMSI) assisted one student from Macquarie University and one from the University of New South Wales (UNSW), to attend. PIMS provided free accommodation, meals and registration.

At GIMMC, experienced researchers work with groups of students on a number of industrial mathematics problems that have previously been advanced at other meetings. The aim is to give students some experience and confidence before the following week's IPSW, which is similar to the Australian Mathematics In Industry Study Group.

The following are personal accounts from the students.

Kaiser Lock (Macquarie University)

GIMMC and IPSW held by PIMS took place at the University of Alberta, Edmonton, Alberta. Canada is one of the furthest places from Australia but with the generous funding from both AMSI and Macquarie University, I was fortunate enough to be able to participate in this workshop and I have benefited greatly from it.

On the first day, all the camp participants (who I later found out came from educational backgrounds ranging from mathematics and biology through to computing and engineering) were gathered together. We were addressed by the faculty mentors who are experts in a wide range of mathematical theory and applications. They presented us with several industry problems, which aimed to give us the opportunity to learn mathematical modelling techniques under their supervision and to prepare for the following IPSW. The following problems were posed.

1. Natural frequency of a fluid-carrying plate (Robert Piche, Tampere University of Technology)
2. The early stages of atherosclerosis and the 'oxidative modification hypothesis' (Christina Cobbold, University of Glasgow)
3. Modelling health service usage for Canada's aging population (Warren L. Hare, Simon Fraser University)

*Department of Mathematics, Macquarie University, NSW 2109.
**School of Mathematics and Statistics, University of New South Wales, Sydney, NSW 2052.
***Australian Mathematical Sciences Institute, The University of Melbourne, VIC 3010.
E-mail: phil@amsi.org.au

4. Epidemiology (Abba Gumel, University of Manitoba)
5. Coagulation — Fragmentation Equations (Henry van Roessel, University of Alberta)
6. The Chemo tactic Paradox (Thomas Hillen, University of Alberta)

I was lucky enough to get my first preference, 'the early stages of atherosclerosis and the oxidative modification hypothesis'. Christina guided three other students and myself through the resolution and provided relevant knowledge (and the most organic chemistry I have seen since high school). This knowledge helped us to model the rate of lipoprotein oxidation at different concentration levels of anti-oxidants as under the 'Oxidative Modification Hypothesis', this is believed to be the main cause of deposition of cholesterol within the arterial wall. On the fourth day, our group delivered a presentation, which was the culmination of three full days of reading about low-density lipoprotein, disagreements and eventual agreements on modelling approach, computational debugging and analysis.

During the second week, the industry experts posed the following six problems.

1. Optimisation of drug structure for protein targets using molecular morphology characterisation (Cross Cancer Institute, Edmonton)
2. Optimisation of multi-drug composition for the most efficacious action (SinoVeda, Edmonton)
3. 3-D Analytical solution of air/water two-phase bubbly flows (Syncrude, Edmonton)
4. The two core statistical/mathematical challenges in epidemiology (US Smokeless Tobacco Company and Alberta Smokeless Tobacco Education, Edmonton)
5. Probabilistic assessment of television viewer demographics (Invidi, Edmonton)
6. How does landscape management affect the infection risk to zoonotic diseases? (Canadian Parks and Wilderness Society)

On the first day of IPSW, the industrial mentors Dr Carl Phillips and Dr Karyn Heavner explained the problems arising in epidemiology to our group, which comprised our mentor, Warren L. Hare, five other students and myself. The problem lies in the fact that epidemiological studies are characterised by study errors, including measurement errors, confounding, non-comparability of compared groups, and non-generalisability of results to the whole population. The nine of us spent the rest of the week aiming to develop methods to quantify the uncertainty resulting from the unknown levels of these various errors. Due to time constraints, we were only able to propose a possible approach to be used in epidemiological studies to fully demonstrate the uncertainty. On the fifth day, we presented and published a report on the proposed method, demonstrated numerically the effects of the uncertainty on the published result, and how the proposed method would be able to quantify the uncertainty.

Although the workload at the camp was quite heavy, we did manage to find some time for non-mathematical pursuits and to enjoy the peaceful University of Alberta campus and surrounding greens. When all of my GIMMC group mates and I decided to take full advantage of the summer weather in Edmonton by doing our group discussion and brainstorming in the nearby park by the water, we were introduced to the nice breeze, comforting summer sun and pesky mosquitoes (needless to say, we stayed in the computer lab for the rest of the camp). Over the weekend, we also managed a pleasant trip to the world's largest shopping centre, West Edmonton Mall, as well as an exciting one-day road trip to Drumheller. Here, our breath was taken away by the amazing view of the Canadian badlands, the dinosaurs and all the fossils. I really enjoyed myself despite the fact that the excursion ended with a disastrous canoe trip down the Red Deer River, which caused us to arrive back at University of Alberta at three in the morning.

This interactive, intensive two-week event has offered me such an excellent opportunity to gain experiences in learning some inventive and rigorous problem-solving techniques. I was able to tackle real-world problems using mathematical and statistical tools, and saw the application of mathematical knowledge to various industrial problems in the fields of medicine, government, etc. I have also built on my team skills considerably by working together with international students and researchers coming from very different educational and cultural backgrounds. Moreover, two coffee breaks each day not only provided us with the refreshing and much needed coffee and finger foods, but also the opportunity to socialise and network with industrial partners, experts and other researchers. Needless to say, it was also a great opportunity for me to see and explore Canada and to learn that 'entrée' does not always mean 'appetiser'.

I would like to thank my supervisor Professor Paul Smith for recommending this workshop to me. I am grateful to AMSI and Macquarie University for their travel grants, which made this trip to the other side of the world possible. Thanks also to Thomas Hillen from the University of Alberta, who did an excellent job of organising the workshop, PIMS for this educational and stimulating event and their support for the accommodation and meals during the camp. Finally, thank you to all the participants for the enjoyable times and valuable knowledge I have gained from every single one of them.

Ognjen Stancevic (UNSW)

As an undergraduate, I spent June of every year mostly alone, studying before the upcoming exams. June 2007 was different. Yes, I still studied, but it was some 13 000 kilometres from home, and for quite a different purpose — you could even say that it was for fun. And I surely wasn't alone — another 35 maths/science students studied with me. This June we attended the 10th GIMMC and 11th IPSW in the Canadian city of Edmonton.

I heard about the camp from my supervisor, Dr Gary Froyland, and he thought that it would be a valuable experience for me. As I had never been on a mathematics camp before, I wasn't sure what to expect. Well, the first thing I learned on the arrival to Canada is that their definition of the word 'warm' is very different from ours. Summer in Edmonton is almost comparable to Sydney's winter.

The first half of the event was the Graduate Industrial Mathematics Modelling Camp (GIMMC, pronounced 'gimmick'). On day one, six mentors presented and advertised their industrial problems. The students chose which problem they would prefer to work on, and so we formed six groups of four or five, plus the mentor who gave some guidance in modelling, analysis and computer simulations. Generally, the mentors already had a sufficient and working model, and the main purpose of GIMMC was to give us, the students, an opportunity for some real-world mathematical modelling. Most students were doing Masters or PhD degrees in mathematics, physics or computer science. Later I learned that because everyone's background was so different, we could all contribute something useful to the team.

My group modelled the mechanisms behind early stages of atherosclerosis; in particular, our job was to investigate the effects of Vitamins C and E on the disease. The task was to model all the chemical reactions occurring in the artery wall, together with the diffusion of chemicals in and out. A number of different approaches in modelling were possible, but the group opted for a dynamical systems version, mostly because we were all familiar with it. Straight away, after trying to write down some differential equations involving reaction rates, we ran into problems, because we wrongly assumed that the chemicals were homogeneously distributed throughout the wall. For example, several Vitamin E molecules group around an LDL (low density lipoprotein) particle, forming a barrier and making the chemicals inside the particle effectively less reactive. Aside from this, there were many other modelling problems along the way, as well as problems in the analysis and simulations. With some help from our mentor, Dr Christina Cobbold, we tackled each one very well, and considering the two-and-a-half-day time period, we made a lot of progress. There was a lot of hard work (one day we stayed up until 1 am working on the task), but we also had so much fun. Our 'brainstorming session' we spent in a park next to the river enjoying the sunny day, albeit only until mosquito bites became too much and we had to run back to our room at the university. Day four was the presentation day. We presented our methods and findings and we also saw the challenges that the other five groups had to face.

Day five was a much-needed break. For most of us this was a rare chance to get to see Edmonton, and some of Alberta's many national parks.

The second half of the camp was the Industrial Problem Solving Workshop (IPSW), where mentors and students work together on a real-world, unsolved industry problem. Again, we were presented the option of six new problems. These problems were yet unsolved (for a change), and the IPSW seemed much more serious, as if the GIMMC was only a practice run before the main event. My new group had the task of investigating the effects of fragmentation of the environment on biological populations, with particular reference to the spread of Lyme disease through tick populations. Other topics were just as interesting and important. Mathematical optimisation of drug structure, requested by the Edmonton Cross Cancer Institute, seemed like a very promising way of finding new drugs for cancer patients. Another interesting topic was the behaviour of bubbles in two-phase air/water turbulent flow through a pipe. This time the students didn't have to work alone. Our group was helped by two mentors and two members of the faculty who were experts in population modelling.

Even though my role in the group was less active than before, I learned just as much as I did in the first half of the camp.

This camp was a great experience for me and I would surely recommend it to any Australian student of applied mathematics. It shows you what your job could be like one day, and it is the best place if you want to hear so many (bad) maths jokes. Every single one of my days spent there was filled with excitement, either because of learning new things or meeting new friends, or seeing new places. If I ever get a chance to do something similar again, I will definitely not hesitate to take it.

I would like to thank my supervisor Dr Gary Froyland for encouraging me to attend the camp, and for helping me with the application. Many thanks to AMSI, PIMS and UNSW for financially supporting the visit, and to PIMS for great organisation.

The annual PIMS (Canada) Graduate Industrial Mathematical Modelling Camp and Industry Problem Solving Workshop will be held at University of Regina, June 9–20, 2008. AMSI will pay half return economy air fares for up to three Australian students to attend. Departments are expected to provide the other half but this may be from AMSI institutional travel accounts. The PIMS organisers have kindly agreed to reserve three places with free accommodation and registration. It is expected that these students will be active participants of the Australian Mathematics In Industry Study Group.

Mathematics and Statistics Heads of Discipline are invited to nominate up to two students, with CV and one-page statement on how the student and Australian mathematics might expect to benefit.

Submissions are required before 31 January 2008, as organisers must know numbers in advance.

The 2007 ICE-EM Australian Graduate School in Mathematics

Tony Bracken*

The 2007 ICE-EM Australian Graduate School in Mathematics (IAGSM) was the third in the series. As in previous years, the IAGSM was held at The University of Queensland, Brisbane, in July, during the mid-year break between semesters.

The meeting was officially opened on 2 July by Professor Stephen Walker, Executive Dean of the UQ Faculty of Engineering, Physical Sciences and Architecture (EPSA). Professor Walker gave a 10–15 minute talk about the importance of mathematical research, based on his own experiences with medical and environmental mathematics, and also his administrative roles with ARC and EPSA. Speakers on behalf of UQ included Professor Mark Gould, President of the Academic Board, and Professor Halina Rubinsztein-Dunlop, Head of the School of Physical Sciences. ICE-EM was represented by Director Professor Garth Gaudry, who also gave a short welcoming speech.

This year's IAGSM attracted a record number of 65 applications, with a final number of 59 attendees from 14 Australian and four overseas universities, chosen on academic merit.

The AMSI/ICE-EM Advanced Coursework Committee which planned the courses, consisted of Professor Neil Trudinger (Chair), Professor Nalini Joshi, Professor Matt Wand, Professor Kathy Horadam, Dr Markus Hegland, Professor Mike Eastwood and Professor Garth Gaudry.

As in previous years, two courses were offered in each of three streams. This year the chosen streams were Statistics, Lie Theory, and Algebra & Combinatorics. Seven distinguished international mathematics researchers were invited to present the six courses, each consisting of 15 hours of lectures, as follows:

Statistics (2 July – 13 July)

Likelihood theory: Professor Anthony Davison, Institute of Mathematics, Ecole Polytechnique Federal de Lausanne, Lausanne, Switzerland.

Statistical analysis of multivariate and longitudinal data: Professor Louise Ryan, Chair, Department of Biostatistics, Harvard School of Public Health, Boston, USA.

Lie theory (2 July – 20 July)

Methods and applications of invariant theory: Professor Nolan Wallach, Department of Mathematics, University of California, San Diego, California, USA.

Differential operators on homogeneous spaces: Professor Leticia Barchini & Professor Roger Zierau, Department of Mathematical Sciences, Oklahoma State University, Stillwater, Oklahoma, USA.

*Discipline of Mathematics, The University of Queensland, Brisbane, QLD 4072.
E-mail: ajb@maths.uq.edu.au

Algebra & combinatorics (2 July – 20 July)

Designs, code, cryptography: Professor Alexander Pott, Institut für Algebra und Geometrie, Otto-von-Guericke-Universität, Magdeburg, Germany.

Topics in graph theory: Professor Nick Wormald, Department of Combinatorics and Optimization, University of Waterloo, Waterloo, Canada.

The courses were supplemented by a range of social events: a welcome BBQ, a conference dinner and a fish 'n' chips night.

During the meeting, well-known mathematician and media identity Dr Clio Cresswell gave a public Lecture on *Mathematics and Sex*, which was well-attended.

Most attendees stayed at St Leo's College on campus, and all attendees and lecturers were invited to take lunch there each day of the meeting, to encourage interaction and discussion.

Overall, the event was a great success. Feedback from surveys conducted of both attendees and presenters indicated a high level of satisfaction with the courses and the event in general. By all accounts, the presenters found the IAGSM enjoyable and rewarding, and the attendees benefited both mathematically and socially.

Members of this year's Local Organising Committee based at UQ in Brisbane were Professor Tony Bracken (Chair), Professor Peter Adams (Deputy Chair) and Ms Lynda Flower (Coordinator).

For more details, see the IAGSM website: http://www.maths.uq.edu.au/IAGSM/ .

Technical papers

Representations of truncated current Lie algebras

Benjamin J. Wilson*

Abstract

Let $\mathfrak{g}$ denote a Lie algebra, and let $\hat{\mathfrak{g}}$ denote the tensor product of $\mathfrak{g}$ with a ring of truncated polynomials. The Lie algebra $\hat{\mathfrak{g}}$ is called a truncated current Lie algebra. The highest-weight theory of $\hat{\mathfrak{g}}$ is investigated, and a reducibility criterion for the Verma modules is described.

Let $\mathfrak{g}$ be a Lie algebra over a field $\mathbb{k}$ of characteristic zero, and fix a positive integer N. The Lie algebra

$$\hat{\mathfrak{g}} = \mathfrak{g} \otimes_{\mathbb{k}} \mathbb{k}[t]/t^{N+1}\mathbb{k}[t], \tag{1}$$

over $\mathbb{k}$, with the Lie bracket given by

$$[x \otimes t^i, y \otimes t^j] = [x, y] \otimes t^{i+j} \quad \text{for all } x, y \in \mathfrak{g} \text{ and } i, j \geqslant 0,$$

is called a *truncated current Lie algebra*, or sometimes a *generalised Takiff algebra* or a *polynomial Lie algebra*. We describe a highest-weight theory for $\hat{\mathfrak{g}}$, and the reducibility criterion for the universal objects of this theory, the Verma modules. Representations of truncated current Lie algebras have been studied in [2], [3], [5], [6], and have applications in the theory of soliton equations [1] and in the representation theory of affine Kac–Moody Lie algebras [8].

A highest-weight theory is defined by a choice of *triangular decomposition*. Choose an abelian subalgebra $\mathfrak{h} \subset \mathfrak{g}$ that acts diagonally upon $\mathfrak{g}$ via the adjoint action, and write

$$\mathfrak{g} = \mathfrak{h} \oplus \Big(\bigoplus_{\alpha \in \Delta} \mathfrak{g}^{\alpha} \Big)$$

for the eigenspace decomposition, where $\Delta \subset \mathfrak{h}^*$, and for all $\alpha \in \Delta$,

$$[h, x] = \langle \alpha, h \rangle x \quad \text{for all } h \in \mathfrak{h} \text{ and } x \in \mathfrak{g}^{\alpha}.$$

A triangular decomposition of $\mathfrak{g}$ is, in essence[1], a division of the eigenvalue set Δ into two opposing halves

$$\Delta = \Delta_+ \sqcup \Delta_-, \qquad -\Delta_+ = \Delta_-, \tag{2}$$

Received 15 June 2007; accepted for publication 10 October 2007.

*School of Mathematics and Statistics, University of Sydney, NSW 2006, and Instituto de Matemática e Estatística at the Universidade de São Paulo.
E-mail: benw@maths.usyd.edu.au

[1] There are additional hypotheses (see [4]) — in particular, there must exist some finite subset of Δ_+ that generates Δ_+ under addition. This excludes, for example, the imaginary highest-weight theory of an affine Lie algebra (see [7, Appendix B]).

Benjamin Wilson was the winner of the B.H. Neumann Prize for best student talk at the Annual Meeting of the AustMS, held in Sydney in September 2006.

that are closed under addition, in the sense that the sum of two elements of Δ_+ is another element of Δ_+, if it belongs to Δ at all. The decomposition (2) defines a decomposition of $\mathfrak{g}$ as a direct sum of subalgebras

$$\mathfrak{g} = \mathfrak{g}_+ \oplus \mathfrak{h} \oplus \mathfrak{g}_- \quad \text{where} \quad \mathfrak{g}_\pm = \bigoplus_{\alpha \in \Delta_+} \mathfrak{g}^{\pm\alpha}. \tag{3}$$

For example, if $\mathfrak{g} = \mathrm{sl}(3, \Bbbk)$, the Lie algebra of traceless 3×3 matrices with entries from the field $\Bbbk$, then the subalgebras $\mathfrak{h}$, $\mathfrak{g}_+$, $\mathfrak{g}_-$ are the traceless diagonal, upper-triangular and lower-triangular matrices, respectively. In analogy with the classical case, where $\mathfrak{g}$ is finite-dimensional and semisimple, $\mathfrak{h}$ might be called a *diagonal subalgebra* or a *Cartan subalgebra*, while the elements of Δ and Δ_+ might be called *roots* and *positive roots*, respectively.

The concept of a triangular decomposition is also applicable to many infinite-dimensional Lie algebras of importance in mathematical physics, such as Kac–Moody Lie algebras, the Virasoro algebra and the Heisenberg algebra. For example, the *Virasoro algebra* is the $\Bbbk$-vector space $\mathfrak{a}$ with basis the set of symbols

$$\{L_m | m \in \mathbb{Z}\} \cup \{c\},$$

endowed with the Lie bracket given by

$$[c, \mathfrak{a}] = \{0\}, \qquad [L_m, L_n] = (m-n)L_{m+n} + \delta_{m,-n}\frac{m^3 - m}{12}c,$$

for all $m, n \in \mathbb{Z}$, where δ denotes the Kronecker function. If $\mathfrak{g} = \mathfrak{a}$, then the subalgebras

$$\mathfrak{h} = \Bbbk L_0 \oplus \Bbbk c, \qquad \mathfrak{g}_\pm = \mathrm{span}\{L_{\pm m} | m > 0\},$$

provide a triangular decomposition.

The triangular decomposition (3) of $\mathfrak{g}$ naturally defines a triangular decomposition of $\hat{\mathfrak{g}}$,

$$\hat{\mathfrak{g}} = \hat{\mathfrak{g}}_- \oplus \hat{\mathfrak{h}} \oplus \hat{\mathfrak{g}}_+ \quad \text{where} \quad \hat{\mathfrak{g}}_\pm = \bigoplus_{\alpha \in \Delta_+} \hat{\mathfrak{g}}^{\pm\alpha},$$

where the subalgebra $\hat{\mathfrak{h}}$ and the subspaces $\hat{\mathfrak{g}}^\alpha$ are defined in the manner of (1), and $\mathfrak{h} \subset \hat{\mathfrak{h}}$ is the diagonal subalgebra. Hence a $\hat{\mathfrak{g}}$-module M is a *weight module* if the action of $\mathfrak{h}$ on M is diagonalisable. A weight $\hat{\mathfrak{g}}$-module is of *highest weight* if there exists a non-zero vector $v \in M$, and a functional $\Lambda \in \hat{\mathfrak{h}}^*$ such that

$$\hat{\mathfrak{g}}_+ \cdot v = 0; \qquad \mathrm{U}(\hat{\mathfrak{g}}) \cdot v = M; \qquad h \cdot v = \Lambda(h)v \quad \text{for all} \quad h \in \hat{\mathfrak{h}}.$$

The unique functional $\Lambda \in \mathfrak{h}^*$ is the *highest weight* of the highest-weight module M. Notice that the weight lattice of a weight module is a subset of $\mathfrak{h}^*$, while a highest-weight is an element of $\hat{\mathfrak{h}}^*$. A highest-weight $\Lambda \in \hat{\mathfrak{h}}^*$ may be thought of as a tuple of functionals on $\mathfrak{h}$,

$$\Lambda = (\Lambda_0, \Lambda_1, \ldots, \Lambda_N) \quad \text{where} \quad \langle \Lambda_i, h \rangle = \langle \Lambda, h \otimes t^i \rangle \quad \text{for all } h \in \mathfrak{h} \text{ and } i \geqslant 0. \tag{4}$$

All $\hat{\mathfrak{g}}$-modules of highest weight $\Lambda \in \hat{\mathfrak{h}}^*$ are homomorphic images of a certain universal $\hat{\mathfrak{g}}$-module of highest weight Λ, denoted by $\mathbf{M}(\Lambda)$. These universal modules $\mathbf{M}(\Lambda)$ are known as *Verma modules.*

A single hypothesis suffices for the derivation of a criterion for the reducibility of a Verma module $\mathbf{M}(\Lambda)$ for $\hat{\mathfrak{g}}$ in terms of the functional $\Lambda \in \hat{\mathfrak{h}}^*$. We assume that the triangular decomposition of $\mathfrak{g}$ is *non-degenerately paired*, i.e. that for each $\alpha \in \Delta_+$, a non-degenerate bilinear form

$$(\,\cdot\,|\,\cdot\,)_\alpha \colon \mathfrak{g}^\alpha \times \mathfrak{g}^{-\alpha} \to \Bbbk,$$

and a non-zero element $h_\alpha \in \mathfrak{h}$ are given, such that

$$[x, y] = (x|y)_\alpha h_\alpha,$$

for all $x \in \mathfrak{g}^\alpha$ and $y \in \mathfrak{g}^{-\alpha}$. All the examples of triangular decompositions considered above satisfy this hypothesis. The reducibility criterion is given by the following theorem, which we state without proof.

Theorem. [7] The Verma module $\mathbf{M}(\Lambda)$ for $\hat{\mathfrak{g}}$ is reducible if and only if

$$\langle \Lambda, h_\alpha \otimes t^N \rangle = 0$$

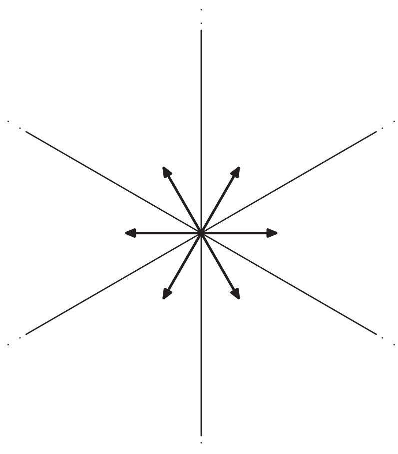
for some positive root $\alpha \in \Delta_+$ of $\mathfrak{g}$.

Notice that the reducibility of $\mathbf{M}(\Lambda)$ depends only upon $\Lambda_N \in \mathfrak{h}^*$, the last component of the tuple (4). The criterion described by the theorem has many disguises, depending upon the underlying Lie algebra $\mathfrak{g}$. If $\mathfrak{g} = \mathrm{sl}(3, \Bbbk)$, then $\mathbf{M}(\Lambda)$ is reducible if and only if Λ_N is orthogonal to a root. This is precisely when Λ_N belongs to one of the three hyperplanes in $\mathfrak{h}^*$ illustrated in Figure 1(a). The arrows describe the root system. If instead $\mathfrak{g}$ is the Virasoro algebra $\mathfrak{a}$, then $\mathbf{M}(\Lambda)$ is reducible if and only if

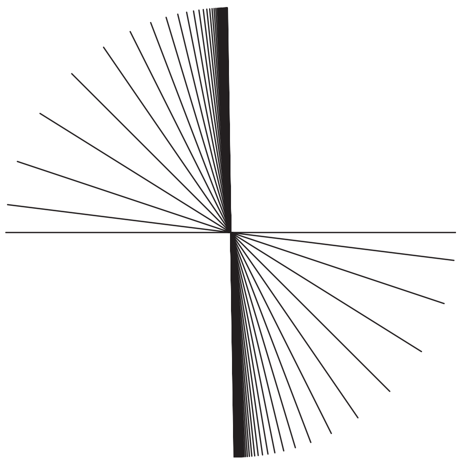
$$2m\langle \Lambda_N, L_0 \rangle + \frac{m^3 - m}{12} \langle \Lambda_N, c \rangle = 0,$$

for some non-zero integer m. That is, $\mathbf{M}(\Lambda)$ is reducible when Λ_N belongs to the infinite union of hyperplanes indicated in Figure 1(b). The extension of a functional in the horizontal and vertical directions is determined by evaluations at c and L_0, respectively.

It is remarkable that there exists a unified reducibility criterion for the Verma modules for truncated current Lie algebras $\hat{\mathfrak{g}}$, irrespective of the particular Lie



(a) $\mathfrak{g} = \mathrm{sl}(3, \Bbbk)$



(b) $\mathfrak{g}$ the Virasoro algebra $\mathfrak{a}$

Figure 1. Reducibility criterion for the Verma modules of $\hat{\mathfrak{g}}$

algebra $\mathfrak{g}$. The technology available for deriving reducibility criteria, called the Shapovalov determinant, is easier to operate for truncated current Lie algebras. To illustrate this, we construct the Shapovalov determinant in the special case where $\mathfrak{g}$ is finite-dimensional and semisimple. A Verma module is generated by the action of the subalgebra $\mathfrak{g}_-$ upon the highest-weight vector. We might visualise the weight lattice of a Verma module as a cone extending downwards from the highest weight Λ. The Poincaré–Birkhoff–Witt Theorem informs us that $\mathbf{M}(\Lambda)$ has a basis parameterised by the (unordered) downward paths in the weight lattice beginning at the highest weight; alternatively, these might be conceived of as multisets with entries from Δ_-. If we fix some weight $\Lambda-\chi$, there are only finitely many downward paths, say $\theta_1, \theta_2, \ldots, \theta_l$, extending from Λ to $\Lambda-\chi$. Dual to each downward path θ_i is the upward path θ^i from $\Lambda-\chi$ to Λ, obtained by reversing the direction of the arrows. The highest-weight space of $\mathbf{M}(\Lambda)$ is one-dimensional, spanned by the highest-weight vector $\mathbf{v}_\Lambda$. Hence descending from $\mathbf{v}_\Lambda$ via θ_i, and then ascending again via θ^j, results in a scalar multiple θ_i^j of $\mathbf{v}_\Lambda$. We consider all such values together, as a matrix T_χ^Λ:

$$T_\chi^\Lambda = (\theta_i^j)_{1\leqslant i,j\leqslant l} \quad \text{where} \quad (\theta^j \circ \theta_i)\mathbf{v}_\Lambda = \theta_i^j \mathbf{v}_\Lambda.$$

The determinant $\det T_\chi^\Lambda$ of this matrix is the *Shapovalov determinant* of $\mathbf{M}(\Lambda)$ at χ. Degeneracy of this matrix would indicate the existence of a non-zero element of weight $\Lambda-\chi$ that vanishes along all paths to the highest-weight space; such vectors generate proper submodules. In particular, the Verma module $\mathbf{M}(\Lambda)$ is reducible if and only if $\det T_\chi^\Lambda = 0$ for some χ.

In the case of the truncated current Lie algebras, there is a straightforward and unified approach to the derivation of a formula for the Shapovalov determinant. The nilpotency of the indeterminate t is such that many of the would-be non-zero entries of the Shapovalov matrix vanish. This permits the diagonalisation of the Shapovalov matrix by making a clever choice for the basis θ_i, and redefining the duality between the downward paths θ_i and the upward paths θ^j. The calculation of the determinant of such a matrix is only as difficult as the calculation of its diagonal entries.

References

[1] Casati, P. and Ortenzi, G. (2006). New integrable hierarchies from vertex operator representations of polynomial Lie algebras. *J. Geom. Phys.* **56,** 418–449.

[2] Geoffriau, F. (1994). Sur le centre de l'algèbre enveloppante d'une algèbre de Takiff. *Ann. Math. Blaise Pascal* **1,** 15–31 (1995).

[3] Geoffriau, F. (1995). Homomorphisme de Harish-Chandra pour les algèbres de Takiff généralisées. *J. Algebra* **171,** 444–456.

[4] Moody. R.V. and Pianzola, A. (1995). *Lie Algebras with Triangular Decompositions.* Canadian Mathematical Society Series of Monographs and Advanced Texts. John Wiley & Sons Inc., New York.

[5] Raïs, M. and Tauvel, P. (1992). Indice et polynômes invariants pour certaines algèbres de Lie. *J. Reine Angew. Math.* **425,** 123–140.

[6] Takiff, S.J. (1971). Rings of invariant polynomials for a class of Lie algebras. *Trans. Amer. Math. Soc.* **160,** 249–262.

[7] Wilson, B.J. Highest-weight theory for truncated current Lie algebras. http://arxiv.org/abs/0705.1203 (accessed 22 October 2007).

[8] Wilson, B.J. (2007). *Representations of infinite-dimensional Lie algebras.* PhD thesis, University of Sydney/Universidade de São Paulo. (Submitted.)

Iterated sums of arithmetic progressions

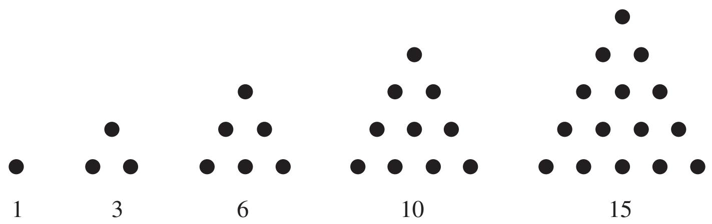
M.A. Nyblom*

Abstract

Using generating functions we obtain a closed form expression involving two binomial coefficients for the iterated or k-fold summation of an arbitrary arithmetic progression of real numbers. As a contrast we obtain the same closed form expression using an elementary method based on an examination of Pascal's triangle. Some combinatorial interpretations of the iterated sums are also provided.

1. Introduction

The triangular numbers namely, $1, 3, 6, 10, 15, \ldots$, whose nth term is given by the expression $n(n+1)/2$, are an example of a polygonal or figurative number sequence, as each term in the sequence counts the number of dots in an equilateral triangle having n dots in each side as pictured below.



Other examples of figurative number sequences are of course, the perfect squares $1, 4, 9, \ldots$ and the pentagonal numbers $1, 5, 12, \ldots$, which each count the arrangement of dots in ever increasingly larger planar geometrical arrays of squares and pentagons respectively. One can also construct a three dimensional figurative number sequence from the triangular numbers, by stacking the above planar equilateral triangles on top of each other to produce a tetrahedral pyramid of dots. Such a stacking results in what is known as a tetrahedral number sequence $1, 4, 10, 20, \ldots$ which by definition represent the successive partial sums of the triangular number sequence as follows $1, 1+3, 1+3+6, 1+3+6+10, \ldots$. Using some rather ingenious counting devices, Conway and Guy (see [1, p. 44]) showed that the nth tetrahedral number is given by the expression $n(n+1)(n+2)/6$.

Clearly the above process of sequentially adding partial sums of the natural numbers can be repeated ad infinitum, to produce an infinite family of higher dimensional figurative number sequences. Each such sequence represents an example

Received 4 April 2007; accepted for publication 7 October 2007.
*RMIT University, GPO Box 2467V, Melbourne, VIC 3001.
E-mail: michael.nyblom@rmit.edu.au

of what is known as an iterated or k-fold summation of the natural numbers. Formally a k-fold summation of a given sequence $\{a_n\}$ can be defined as follows. Beginning with the nth partial sum of the sequence $\{a_n\}$ denoted, $S_n^{(0)} = \sum_{i=1}^{n} a_i$, one can proceed with the construction of another sequence $\{S_n^{(1)}\}$, formed from the nth partial sums of the sequence $\{S_n^{(0)}\}$, that is $S_n^{(1)} = \sum_{i=1}^{n} S_i^{(0)}$. Repeating this procedure a further $k-1$ times, where $k \geq 1$, produces the resulting k-fold summation $S_n^{(k)} = \sum_{i=1}^{n} S_i^{(k-1)}$ of the original sequence $\{a_n\}$. With this definition in mind, one may naturally question whether, like the tetrahedral numbers, a closed-form expression for each of the k-fold summations of the natural numbers can be found.

In this article, we shall in fact show that for any arbitrary sequence of real numbers whose terms are in arithmetic progression, a simple algebraic expression exists for $S_n^{(k)}$, and moreover is given in terms of two binomial coefficients involving the parameters n and k. The question of determining such a closed-form expression will be tackled by two contrasting methods, each of which will solve the problem by first finding the k-fold summation of the natural numbers. One of these methods shall involve the use of a generating function, that is a power series and its associated functional representation. In particular for the sequence of natural numbers, we will identify, for each fixed $k \geq 0$, a function denoted $f_k(x)$, having $\sum_{n=0}^{\infty} S_n^{(k)} x^n$ as its corresponding power series expansion. As shall be seen, $f_k(x)$ will be given in terms of the function $(1+x)^{\alpha}$, from whose Maclaurin expansion the desired closed-form expression for $S_n^{(k)}$ can be derived. The second and more elementary method employs a result of binomial coefficients going back to the 1300s and is known today as the Hockey Stick Theorem (see [4]), to show that the k-fold summation for the sequence of natural numbers can be identified as an entry in Pascal's Triangle.

2. An elementary approach

To begin, we note that the problem of determining the k-fold summation for a general arithmetic progression can easily be reduced to that of determining the k-fold summation of the sequence of natural numbers. Indeed, if we denote the k-fold summation of the sequences $a_n = a_1 + (n-1)d$ and $b_n = n$ by $S_n^{(k)}$ and $T_n^{(k)}$ respectively, then it is easily proven by an inductive argument that for $k \geq 1$

$$S_n^{(k)} = dT_n^{(k)} + (a_1 - d)T_n^{(k-1)}. \tag{1}$$

To construct a closed form expression for $T_n^{(k)}$, let us first examine closely the diagonal rows of Pascal's Triangle pictured below.

Each diagonal labelled $D = k$ for $k = 0, 1, \ldots$ contains a sequence of positive integers whose first term is the number one. Indexing the terms of these sequences with say the variable i, where $i = 1, 2, \ldots$, the Hockey Stick Theorem states that the nth partial sum of the sequence in any diagonal $D = k$ is equal to the nth term of the sequence found in the neighbouring diagonal $D = k+1$ that is,

$$\binom{n}{0} + \binom{n+1}{1} + \cdots + \binom{n+k}{k} = \binom{n+k+1}{k}.$$

For example, the sum of the first four terms in diagonal $D = 3$ is $1 + 6 + 21 + 56 = 84$, but the number 84 is the fourth term of the sequence found in diagonal $D = 4$.

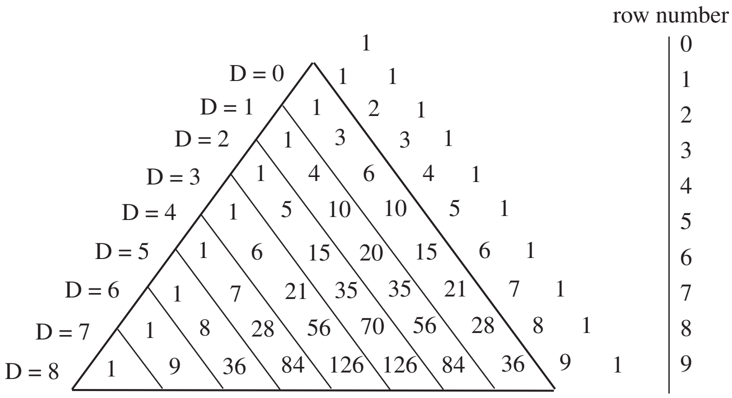


Figure 1. Pascal's Triangle

Now as diagonal $D = 0$ contains the sequence $T_n^{(0)} = n(n+1)/2$, the Hockey Stick Theorem implies that the nth term of the sequence found in diagonal $D = 1$ must be $T_n^{(1)}$, while the nth term of the sequence in diagonal $D = 2$ must be $T_n^{(2)}$. By applying the Hockey Stick Theorem k times, beginning at diagonal $D = 0$, we conclude that the integer $T_n^{(k)}$ must appear as the nth term of the sequence found in diagonal $D = k$. Consequently as each entry in the Pascal Triangle is a binomial coefficient, we conclude from the above observation that

$$T_n^{(k)} = \binom{r}{p} = \frac{r(r-1)\cdots(r-p+1)}{p!}\,, \tag{2}$$

where r and p are the row and position number along a row, of the nth term of the sequence in diagonal $D = k$, noting the convention that $\binom{r}{0} = 1$. Hence, to find a closed form expression for $T_n^{(k)}$, one must be able to determine r and p as functions of the parameters n and k. To this end, note that the first term of the sequence in any diagonal $D = k$, occurs as the leftmost element in row $k+2$ and that the row number of each subsequent term of the sequence in diagonal $D = k$ must increase by one. Thus $r = n + k + 1$ is the row number of the nth term of the sequence in diagonal $D = k$. Secondly, note that the nth term of the sequence in diagonal $D = k$, is located as the nth entry from the left in row $r = n + k + 1$. However, as there are $r + 1$ elements in row r whose position number p, counted from the left, assumes the values $p = 0, 1, \ldots, r$, we deduce that the nth term of the sequence in diagonal $D = k$ has a position number $p = n - 1$ along the row $r = n + k + 1$. Hence from (2)

$$T_n^{(k)} = \binom{n+k+1}{n-1} = \binom{n+k+1}{k+2}\,, \tag{3}$$

and so finally substituting the second binomial coefficient of (3) into (1) yields that the k-fold summation of an arithmetic progression $a_n = a_1 + (n-1)d$ is given by

$$S_n^{(k)} = d\binom{n+k+1}{k+2} + (a_1 - d)\binom{n+k}{k+1}\,. \tag{4}$$

In view of (3) it is of interest to note that there is a combinatorial interpretation of the k-fold summation of the natural numbers. Recall that the number of distinct decompositions of n into a sum of k nonnegative integers, is the number of solutions in nonnegative integers of the equation

$$x_1 + x_2 + \cdots + x_k = n\,.$$

A well-known result from combinatorics states that the number of decompositions is $\binom{n+k-1}{k-1}$ (see [2, p. 87]). Thus by writing $T_n^{(k)} = \binom{n-1+(k+2)}{k+2}$ we see that the k-fold summation of the natural numbers represents the number of distinct decompositions of $n-1$ into $k+1$ nonnegative integers.

3. A generating function approach

In establishing (3) we indirectly applied the Binomial Theorem with regards to the polynomial expansion of $(1+x)^n$ for positive integer n. In contrast, the second method to be employed, will involve the use of generating functions together with an application of the binomial series of the function $(1+x)^\alpha$, where α is an arbitrary real number. We begin by reviewing the concept of a generating function. If we have a sequence $\{a_n\}$ of real or complex numbers, then the function $f(x)$ defined by the power series

$$f(x) = \sum_{n=0}^{\infty} a_n x^n\,,$$

is referred to as the generating function of the sequence $\{a_n\}$. Many of the operations one performs on generating functions can be justified rigorously in terms of operations on formal power series, even when the series in question may not be convergent (see [3] for a comprehensive treatment of the theory of generating functions). One of these familiar operations that we shall exploit here, is that of the multiplication of power series. Specifically if given two generating functions of the form $f(x) = \sum_{n=0}^{\infty} a_n x^n$ and $g(x) = \sum_{n=0}^{\infty} b_n x^n$, then one can define their product as

$$f(x)g(x) = \sum_{n=0}^{\infty}\left(\sum_{r=0}^{n} a_r b_{n-r}\right)x^n\,.$$

In particular, when $f(x) = 1/(1-x) = \sum_{n=0}^{\infty} x^n$ for $|x| < 1$, then the above product $f(x)g(x)$ results in the generating function for the sequence of partial sums of $\{b_n\}$ as follows

$$\frac{1}{1-x}g(x) = \sum_{n=0}^{\infty}\left(\sum_{r=0}^{n} b_{n-r}\right)x^n\,. \tag{5}$$

We shall use (5) to first identify, for each $k \geq 0$, the generating function, denoted $f_k(x)$, for the sequence $\{T_n^{(k)}\}$. Indeed, we claim that $f_k(x) = x/(1-x)^{k+3}$ which can be established via the following inductive argument. Setting $g(x) = x/(1-x)^2$ observe after differentiating the series expansion of $1/(1-x)$ that $g(x) = \sum_{n=0}^{\infty} nx^n$. Substituting $g(x) = x/(1-x)^2$ into (5) and defining $T_0^{(k)} = 0$, for all $k \geq 0$, one deduces from definition of $T_n^{(0)}$ that $f_0(x) = x/(1-x)^3$. Assume $f_m(x) = \sum_{n=0}^{\infty} T_n^{(m)} x^n = x/(1-x)^{m+3}$, for some $m \geq 0$, and upon setting $g(x) = f_m(x)$ in (5), observe that

$$\frac{x}{(1-x)^{m+4}} = \sum_{n=0}^{\infty}\left(\sum_{r=0}^{n} T_{n-r}^{(m)}\right)x^n = \sum_{n=0}^{\infty} T_n^{(m+1)} x^n\,.$$

Consequently $f_{m+1}(x) = x/(1-x)^{m+4}$ and so the result holds for $k = m+1$. Having identified for each $k \geq 0$ the generating function for the sequence $\{T_n^{(k)}\}$, we can determine a closed-form expression for $T_n^{(k)}$ by examining the series expansion of the function $x/(1-x)^{k+3}$ via the binomial series of the function $(1+x)^\alpha$. Recall that if α is an arbitrary real number and $|x| < 1$ then $(1+x)^\alpha = \sum_{n=0}^{\infty} \binom{\alpha}{n} x^n$. Thus

$$f_k(x) = x \sum_{n=0}^{\infty} \binom{-k-3}{n} (-x)^n = \sum_{n=0}^{\infty} (-1)^n \binom{-k-3}{n} x^{n+1},$$

and so after equating coefficients of x^n one deduces for $n \geq 1$, that

$$T_n^{(k)} = (-1)^{n-1} \binom{-k-3}{n-1}. \tag{6}$$

However by definition

$$\begin{aligned}\binom{-k-3}{n-1} &= \frac{1}{(n-1)!}(-k-3)(-k-4)\cdots(-k-n-1) \\ &= \frac{(-1)^{n-1}}{(n-1)!}(k+3)(k+4)\cdots(k+n+1) \\ &= (-1)^{n-1}\binom{n+k+1}{k+2},\end{aligned}$$

from which we see (6) reduces down to the required expression in (3), hence (4) follows immediately again from (1).

Having now seen both methods at work, it would appear that the later method could be applied to the problem of constructing closed-form expressions for the nth partial sum or more generally the k-fold sum of other classes of sequences. Clearly the difficulty in using generating functions is finding, for a given sequence $\{a_n\}$, the correct functional representation for the power series $f(x) = \sum_{n=0}^{\infty} a_n x^n$.

References

[1] Conway, J. and Guy, R. (1996). *The Book of Numbers*. Springer-Verlag, New York.

[2] Lando, S.K. *Lectures on Generating Functions*. Student Mathematics Library, Volume 23, AMS.

[3] Niven, I. (1969). Formal power series. *Amer. Math. Monthly* **76,** 871–889.

[4] Weisstein, E.W. (2007). Christmas stocking theorem. From *MathWorld* – A Wolfram Web Resource. http://mathworld.wolfram.com/ChristmasStockingTheorem.html (accessed 15 April 2007).

Book reviews

Elements of real analysis

M.A. Al-Gwaiz and S.A. Elsanousi
Chapman and Hall/CRC, 2007, ISBN 1-58488-661-7

This new text provides a readable and solid treatment of real analysis. It is the basis of a two semester sequence taught at King Saud University. It would be ideal as a class text or for independent learning.

The style is friendly, maybe a little too wordy sometimes in motivating concepts, but students might appreciate this. The translation from Arabic is fine. On page 69 in an example on continuity we are told that *given* $\epsilon > 0$ *our burden is to find* $N \ldots$ which I thought was a nice way to put it. Limit points are called *cluster points*.

There is a decent spattering of exercises throughout which are at a good level, not too hard to start with. There are no solutions provided, which can sometimes be a drag for students wanting some positive reinforcement. The CRC Press website says there is an instructors solution manual. There are lots of worked examples in the text which demonstrate the techniques required.

I found the first two chapters to be a bit of a chore: some set theory which could be skipped, the reals defined axiomatically, loads of tedious results that come straight from the definitions. I would have preferred a more punchy start — for example, Rudin [2] starts by constructing reals from rationals using Dedekind cuts — something a bit different for students who have just progressed from years of calculus. Also Rudin defines metric spaces early on and frames his text in this generality.

But it definitely picks up from there. The rest of the chapters follow the standard treatment: sequences and series of reals, limits and continuity, differentiation, the Riemann integral, then sequences and series of functions. The final two chapters cover Lebesgue measure and integration carefully and rigorously and will appeal to more advanced students. They justify why the Riemann integral isn't sufficient.

Another recent text is Morgan [1], a short and direct treatment of all the highlights and cool examples, very readable and a good supplementary text students might really like. And relatively inexpensive.

References

[1] Morgan, F. (2005). *Real Analysis and Applications: Including Fourier Series and the Calculus of Variations*. American Mathematical Society.
[2] Rudin, W. (1964). *Principles of Mathematical Analysis*. McGraw-Hill Book Company, Inc., New York.

Murray Elder
Department of Mathematics, Stevens Institute of Technology, NJ, USA.
E-mail: melder@stevens.edu

Numbers at work: A cultural perspective

Rudolf Taschner (Translated by Otmar Binder and David Sinclair-Jones)
A.K. Peters Ltd, 2007, ISBN 1-56881-290-6

There can be no better way to begin this review than by quoting a sentence from the Translator's Note:

> Reading *Numbers at Work* is like walking down a great corridor lined with books: there is much to see on the shelves, much to learn from each individual book, and great benefit to be gained from reaching the end.

Incidentally, the translation team, Otmar Binder and David Sinclair-Jones, are to be congratulated on turning the original German text into clear and idiomatic English while preserving the intellectual spirit of the original.

Rudolf Taschner, named Scientist of the Year by the Austrian Association of Science Journalists in 2004 for his pioneering efforts to propagate mathematics to a broad public audience, is a mathematics professor at the Technical University of Vienna. This book began in 2003 as a series of presentations and workshops at the Vienna MuseumsQuartier intended to foster public awareness of mathematics as a cultural achievement. Published in German by Vieweg as *Der Zahlen gigantische Schatten* (The Gigantic Shadows of Numbers), it received wide critical acclaim and we owe thanks for the English version to the efforts of publishers A.K. Peters.

As a mathematician with interests in history, I did not expect to learn a great deal from such a popularisation, but was pleasantly surprised to have my expectations dashed. There are many gems to be found in this book that I have not seen elsewhere, and we owe a great deal to the formidable erudition of Professor Taschner.

For example the first chapter, on the early numerical works of the Greeks, compares the numerological mysticism of the Old Testament and the Kabbalah to that of the Pythagoreans. The second, ostensibly concerned with the patterns of intervals to be found in the works of Bach, presents a clear discussion of the difficulties of tuning a keyboard so that an octave is divided into 12 almost equal semitones. Mathematically, this boils down to inserting a geometric series of 12 terms between 1 and 2, and then finding the best rational approximation to each term.

Another chapter compares the concept of time among philosophers, physicists, (notably whether it makes sense to talk about what happened before the Big Bang), and poets, with particular reference to the work of Hugo von Hofmannsthal, the librettist of *Der Rosenkavalier.*

And so it goes: in the chapter devoted to metrisation of space we learn not only about Cartesian co-ordinates but also about geographical projections. In that concerned with numerical representation, the author considers not only the well known (even to the intended audience) decimal and binary systems, but also the ternary system, which has unexpected advantages over both of these. We even learn how it may be implemented in electronic systems.

In spite of my overall enthusiasm, I have some negative feelings about this volume. To mention a few, the explanation of Gödels *Incompleteness Theorem* is very curt and may be incomprehensible to anyone who is not well versed in the topic. Furthermore, Professor Taschner ignores advances in analysis and set theory of the past half century and objects to anyone who dares to mention infinity and numbers in the same breath. For example, he claims Dedekind was guilty not just of faulty logic, but of immorality for daring to calculate with infinite quantities! A related misgiving I have is that the author identifies any real number with its decimal (or binary or ternary) representation. This leads him to questionable claims about the mystery of π and other irrational numbers; for example, that they are forever beyond the reach of human knowledge.

A few typographical errors caught my eye. They scarcely detract from an otherwise finely produced volume. The many well-chosen and properly credited coloured illustrations add to the readability of the text. So too do the many pages of Notes and the adequate Bibliography and Index.

Phill Schultz
Department of Mathematics, The University of Western Australia, Nedlands, WA 6907.
E-mail: schultz@maths.uwa.edu.au

◇ ◇ ◇ ◇ ◇ ◇

Experimental mathematics in action

David H. Bailey, Jonathan M. Borwein, Neil J. Calkin, Roland Girgensohn, D. Russell Luke and Victor Moll
A.K. Peters Ltd, 2007, ISBN 978-1-56881-271-7

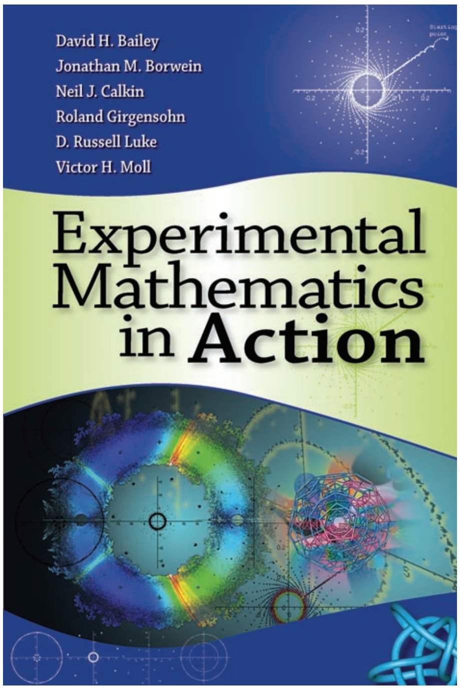
This book originated from a short course of the same name. It is perhaps true that, as the authors state in the preface:

> The last twenty years have been witness to a fundamental shift in the way mathematics is practiced. With the continued advance of computing power and accessibility, the view that "real mathematicians don't compute" no longer has any traction for a new generation of mathematicians that can really take advantage of computer aided research, especially given the modern computational packages such as Maple, Mathematica, and Matlab.

More and more evidence shows that the power of modern computers matched with that of modern mathematical software and the sophistication of current mathematics is changing the way we do mathematics.

Through eight examples, the authors re-emphasise the following roles for computation in Chapter 1: gaining insight and intuition, or just knowledge; discovering new facts, patterns, and relationships; graphing to expose mathematical facts, structures or principles; rigourously testing and especially falsifying conjectures; exploring a possible result to see if it merits formal proof; suggesting approaches for formal proof; computing replacing lengthy hand derivations; and, finally, confirming analytically derived results. Certainly, computer packages can make concepts more accessible.

An overview of some algorithms for experimental mathematics is presented in Chapters 2 and 3. In Chapter 2, the following topics are addressed through a number of examples. First, the integer relation detection methods, for instance PSLQ. These are very often employed in applications to recognise a mathematical constant whose numerical value can be computed to at least moderately high precision, with examples ranging from the BBP formula to applications in quantum field theory. The computation of multivariate zeta values and finally the Ramanujan-type elliptic series are described. In addition, Chapter 3 presents several interesting examples, covering prime number computations, roots of polynomials, various types of numerical quadrature approaches and infinite series summations.



Chapter 4 turns from questions or problems in pure mathematics to those in applied mathematics, particularly to the data analysis side of experimental mathematics. The authors concentrate mainly on the inverse problem of determining the model from an observation. The inverse scattering technique highlights the role of computational experimentation in the development of mathematical methodologies.

More interestingly, a number of 'strange' functions which could be explored on the computer are introduced in Chapter 5. The authors discuss some general properties of a general form of the Weierstrass no-where differentiable functions. Beginning with a system of functional equations, they provide a necessary and sufficient condition for the Weierstrass functional system to have a unique continuous solution. Here the computer can help us visualise the recursive solutions of the system, to point us in the right direction. An infinite Bernoulli convolution will lead to a Bernoulli measure. With the help of the computer to display different curves of different functions and different measures, the authors also show that the measure is singular under one kind of condition while it is absolutely continuous under another condition. In both cases, computer graphs help figure out the direction of mathematical structures and principles. This is extremely important to shorten the time spent on research.

The first paragraph of Chapter 6 summarises:

> Mathematics is often presented as a fait accompli, a finished result, with little attention being paid to the process of discovery or to the mistakes made, wrong turns taken, etc. However, especially where experimental mathematics is concerned, we can learn a great deal from experience,

> both our own and that of others. New directions can be suggested by previous mistakes.

A case-study on factoring integers using a random vector approach is discussed in this chapter. The authors turn one of the factorisation algorithms, the Quadratic Sieve, into an algorithm that produces a sequence of vectors with entries distributed in a quasi-random fashion. This chapter demonstrates that the behaviour of the Quadratic Sieve can be predicted based on the behaviour of a random model if the probabilistic model is chosen appropriately by experimenting.

The evaluation of definite integrals is one of the most intriguing topics of elementary mathematics. Nowadays, with the increasing application of mathematics in financial engineering, the evaluation, especially the numerical evaluation of definite integrals has a promising and important place in modern finance. Chapter 7 introduces the methods of experimental mathematics in the context of definite integrals. The authors emphasise the use of *Mathematica* in their approach to find various definite integrals and their properties. Hence, a number of definite integral evaluations are demonstrated using *Mathematica*.

Several real-life and pure-maths applications are provided in Chapter 8. Examples range from visual computing, visualising DNA strands, chaos games to Hilbert's inequality and Witten's Zeta Function. These successful applications of experimental mathematics very well conclude this fantastic book, with strong evidence of the increasing usefulness of computers in experimental mathematics.

The first eight sections of Chapter 9 contain exercises generally relating to the previous corresponding chapters, while the ninth presents a large compendium of extras. As the authors state in this chapter, these exercises

> ... do provide an interesting opportunity to see how the art of problem solving changes in the presence of modern computers and good mathematical software. In each case, a few lines of computer algebra code either provides the solution, suggests an approach, or at least confirms the answer.

David H. Bailey *et al.* have done a fantastic job to provide very comprehensive and fruitful examples and demonstrations on how experimental mathematics acts in a very broad area of both pure and applied mathematical research, in both academic and industry. Anyone who is interested in experimental mathematics should, without any doubt, read this book!

Boda Kang
Quantitative Finance Research Center, School of Finance and Economics, University of Technology, Sydney, PO Box 123, Broadway, NSW 2007. E-mail: Boda.Kang@uts.edu.au

AMSI News

Philip Broadbridge*

Will this upswell become a rising tide?

Mathematics and mathematics education are undoubtedly higher on the political agenda than they were even 12 months ago. I would recommend every maths department to have a tea-room copy of the September 2007 report of the Senate Standing Committee on Employment, Workplace Relations and Education, *Quality of School Education*. Mathematics is the only specific discipline that is mentioned in the seven major recommendations:

> Recommendation 3: The committee recommends that schools and school systems take particular measures to improve teacher professional development in mathematics.

There is also a shift in emphasis away from general issues of pedagogy and cultural settings towards curriculum content:

> Recommendation 2: The committee recommends that the Government consider ways of restructuring teacher training courses so as to encourage and require aspiring secondary teachers to commence their studies in arts, science and other relevant disciplines before undertaking specific studies in education by degree or diploma.

In response to a submission from the Australian Association of Mathematics Teachers, paragraph 4.78 of the report says,

> The committee agrees that the 'social context' of numeracy is all to the good at one level. But as students progress through the upper primary and early secondary years the enjoyment of learning maths will only become apparent when students can appreciate the measure of their own intellectual development.

The body of the report explicitly acknowledged the inputs of AMSI and ICE-EM, along with those of our allies Igor Bray, Kevin Donnelly, Wayne Read and others. In fact, by invitation, our own Jan Thomas, Garth Gaudry and Janine McIntosh appeared before the hearing of the committee in Melbourne.

The mathematical sciences have an important role to play in public policy debate. A good example, accessible to a general audience, is Ian Enting's book, *Twisted: the distorted mathematics of greenhouse denial*, http://www.amsi.org.au/twisted.php.

As further evidence that the role of mathematical science is appreciated, I was the only representative of academic science at Kevin Rudd's round table on manufacturing, in Parliament House on 10 September. I surmise that my invitation followed a visit from Senator Kim Carr, Opposition Spokesman on Innovation, Science and Research. However, I expected my voice to be in competition with

*Australian Mathematical Sciences Institute, The University of Melbourne, VIC 3010.
E-mail: phil@amsi.org.au

those of others from the biomedical and materials science disciplines. This was not the case. At the end of the day, the Leader of the Opposition repeated my figures that over the last eight years, there has been a 52% growth in demand for those qualified in mathematical sciences, along with a 34% decrease in science students taking a maths subject. Then followed a verbal promise to halve HECS charges for those entering science and maths degree programs and to further halve repayments for those subsequently employed in related areas. Should this eventuate, we have to make sure that it does not undo the positive measures undertaken by the present Minister Julie Bishop to increase funding for maths students to the universities.

Good news for AMSI

AMSI has recently been awarded a grant under the Minister's Collaboration and Structural Reform Fund, for the project, *National collaboration in the mathematical sciences: Integrating research, industry and education.* In effect, this will not only ensure the survival of AMSI for a few years but it will enable us to set up some important new initiatives such as a graduate industry internship scheme, similar to that of MITACS (Canada) that now annually places 120 graduate mathematics and IT interns in industry. In the same round of CASR, funding was approved for the project, *National collaboration in higher-level mathematics instruction using high-speed high-bandwidth internet-based communication technology*, based in the School of Mathematics and Statistics at the University of Sydney, but involving several other AMSI members. This application would not have eventuated without the access grid room infrastructure that AMSI/ICE-EM had already supported in 12 universities. Last year, the mathematical sciences were the beneficiary of another CASR grant for the project, *Applied Statistics Education and Research Collaboration*, based at the University of Wollongong. Again, their application planned for future use of the AMSI/ICE-EM access grid network. Over the next year, we must work together to ensure positive outcomes from this funding that totals around $4,000,000 for the mathematical sciences. Although, unlike in many other developed countries, there does still not exist a regular government funding scheme for a broadly based research/education/outreach institute, AMSI's very existence has led to some very important spin-offs that are important for sustainability of our discipline.

Director of AMSI since 2005, Phil Broadbridge was previously a professor of applied mathematics for 14 years, including a total of eight years as Department Chair at University of Wollongong and at University of Delaware.
His PhD was in mathematical physics (University of Adelaide). He has an unusually broad range of research interests, including mathematical physics, applied nonlinear partial differential equations, hydrology, heat and mass transport, and population genetics. He has published two books and more than 80 refereed papers, including one with 150 ISI citations. He is a member of the editorial boards of three journals and one book series.

News

General News

Maths in the Media

The *Weekend Magazine* of the *Weekend Australian* published the story ‘Beautiful Minds’ on Terry Tao and his family:
http://www.theaustralian.news.com.au/story/0,25197,22216398-5012694,00.html (August 11).

The Age published an article entitled ‘Genetic detectives seek codes to human illnesses’ about Peter Donnelly, Professor of Statistical Science at Oxford University, and his research. Peter completed an undergraduate degree at the University of Queensland:
http://www.theage.com.au/news/business/genetic-detectives-seek-codes-to-human-illnesses/2007/09/11/1189276719911.html (September 12).

Moyal Lecture

The 2007 Moyal Lecture will be held on 9 November at Macquarie University. It will be given by the 2007 Moyal Medallist, Professor Peter Drummond of the University of Queensland. Professor Drummond is being recognised for his contributions to physics. In the Lecture he will discuss quasi-probability distribution functions in quantum mechanics, including the positive P representation which is related to Joe Moyal’s phase space approach, as well as some of their many applications.

Professor Drummond is a Fellow of the Australian Academy of Science, the Australian Institute of Physics and the American Physical Society. He was awarded the Massey Medal of AIP/IOP in 2004.

The lecture will follow the presentation of the Medal at 7.00pm in the Mathematics Department. There will be a supper and time for discussion after the lecture. For more information please contact John Corbett (jvc@ics.mq.edu.au) or Christine Hale (02 9850 8947) in the Mathematics Department, Macquarie University.

Griffith University

Anand Tularam is taking over from Chris Matthews as the Griffith University correspondent.

Monash University

Professor J.J. Monaghan, School of Mathematical Sciences, has been invited to give the G.K. Batchelor Lecture at the Australian Fluid Mechanics Conference in December 2007. This lecture is in honour of the great Australian fluid dynamicist, George Batchelor FRS. He was also invited to give the first Australian and New

Zealand Industrial and Applied Mathematics (ANZIAM) plenary Lecture to the meeting of the Australian Mathematical Society in September 2007.

University of Queensland

ARC grants

Dr A.J. Richardson; Dr A.J. Hobday; Dr T.A. Okey; Dr R.J. Matear: Integrating climate and ecosystem models to predict climate change impacts on Australian marine systems ($285 300).

Dr J.M. Keith; Professor P. Adams; Dr G.F. Weiller: Statistical methods for detection of non coding RNAs in eukaryote genomes ($250 000).

Associate Professor G.J. Goodhill; Dr G.B. Ericksson: A new theory for retinotectal map formation.

Professor G.J. McLachlan; Dr S.K. Ng: Mixture models for high-dimensional clustering with applications to tumour classification, network intrusion, and text classification.

Dr C. Riginos; Professor H.P. Possingham: Approved coral reef connectivity: an empirical and theoretical synthesis.

Ms C.M. Hunter; Dr A.J. Richardson; Dr E.A. Fulton; Professor H.P. Possingham: The impact of climate change on the resilience of Australian marine systems: linking climate and ecosystem models.

Joint with ANU

Dr T.B. Sercombe; Dr A.P. Roberts; Dr J.F. Grotowski; Professor X. Wu; Professor M.H. Loretto: OBE Design and fabrication of custom titanium implant scaffolds produced by selective laser melting.

University of Southern Queensland

Dr Oleksiy Yevdokimov has been invited to be a member of the International Program Committee for the 19th ICMI (International Commission on Mathematical Instruction) study on *the role of mathematical reasoning and proving in mathematics education*. He will be the only Australian committee member.

University of Technology (Dept Mathematical Sciences), Sydney

Several members of the Department have received large grants. These are as follows.

Professor Eckhard Platen has been awarded a Discovery Project grant with Associate Professor Erik Schlogl ($340 000 over four years) starting next year.

Professor Alex Novikov and Dr Mark Craddock have been awarded a Discovery Project grant with Associate Professor A. Borovkov ($235 000 over three years) starting next year.

Professor Debbie Street has also been awarded a Discovery Project grant — with Professor Jane Hall (of CHERE) and Associate Professor Denise Doiron (in Economics at UNSW), worth $540 000 over five years.

Completed PhDs

Monash University

- Dr Simon Campbell, *Structural and nucleosynthetic evolution of metal-poor and metal-free low- and intermediate-mass stars*, supervisor: Professor John Lattanzio.
- Dr Justin Peter, *Aerosol processing by a cumulus band and a cold front*, supervisor: Dr Steven Siems.

RMIT

- Dr Nick Lombardo, *Properties of composites containing spherical inclusions surrounded by an inhomogeneous interphase region*, supervisors: Dr John Gear and Dr Yan Ding.

University of Melbourne

- Dr Anna Cai, *Multi-scale modelling of cell populations in experimental systems: migration proliferation and differentiation*, supervisors: Associate Professor Barry Hughes and Professor Kerry Landman.
- Dr Rogerio Manica, *Modelling hydrodynamic interactions between deformable droplets*, supervisors: Professor Derek Chan and Dr Steven Carnie.
- Dr Armando Rodado, *Weierstrass points and canonical cell decompositions of the moduli and Teichmüller spaces of Riemann surfaces of genus two*, supervisor: Dr Iain Aitchison.

University of New England

- Dr Alex Woolaston, *Statistical methods in genomics*, supervisors: Dr Bruce Tier and Dr Bob Murison.

University of South Australia

- Dr Luciana Magnano, *Mathematical models for temperature and electricity demand*, supervisor: Dr John Boland.

Awards and other achievements

Monash University

- Professor John Lattanzio, Centre for Stellar and Planetary Astrophysics, School of Mathematical Sciences, is to receive a Prize from the Physics Department, Lawrence Livermore Laboratory, for the best paper from their laboratory in 2006. The paper, *Deep Mixing of 3He: Reconciling Big Bang Nucleosynthesis and Stellar Nucleosynthesis*, was published in Science by John and his colleagues at Lawrence Livermore.

- Vice-Chancellor's Showcase on Teaching Excellence: Two lecturing staff made presentations to the Showcase in September at the Caulfield campus. Congratulations to Dr Leo Brewin and Dr Richard Wardle.
- Congratulations to Mrs Gertrude Nayak on being awarded the Monash University Travelling Fellowship to undertake further professional development. The fellowship fund will allow her to visit Australian and overseas universities.
- Dr Lyle Pakula was awarded an Early Career Researcher Grant from the Faculty of Science for the year 2008.
- Monash solar scientist, Professor Paul Cally, has been invited to become a Co-Investigator on a project to place a velocity and magnetic field imaging instrument VIM (Visible-light Imager and Magnetograph) on the Solar orbiter spacecraft, scheduled for launch by the European Space Agency (ESA) in 2015. The VIM project is lead by the German Max Planck Institute for Solar System Research.

University of Melbourne

- Norman Do was awarded the B.H. Neumann prize for best student talk at the annual AustMS meeting, together with Neil Saunders from the University of Sydney (see also p. 310).

University of Sydney

- Dr Bill Palmer was awarded the B.H. Neumann Award for 2007, by the Australian Mathematics Trust.
- Professor Nalini Joshi has been elected incoming president of the Australian Mathematical Society at the annual meeting in September.
- At the Annual Meeting of the Australian Mathematical Society Neil Saunders was awarded the B.H. Neumann prize, jointly with Norman Do from the University of Melbourne (see also p. 310). Tegan Morrison was given an honourable mention for her talk entitled 'Tronquee Solutions of Higher Order Painleve Equations'.
- Shona Yu won the G.B. Preston Prize for her talk 'The Cyclotomic Birman–Murakami–Wenzl Algebras' at the Algebra Conference of Victoria.

Appointments, departures and promotions

University of Technology, Sydney

- Alex Novikov has been appointed to the council of the Bernoulli Society.

Monash University

- Dr Christian Jakob commenced as Professor of Climate Modelling. His research interests are in cloud and convection parameterisation schools.
- Dr Todd Oliynyk commenced as Lecturer in Mathematics (Level B). His research interests are in mathematical physics, especially general relativity.

- Dr Lyle Pakula has been appointed Lecturer in Atmospheric Science (Level B). His research interests are in weather and climate of the equatorial region.
- Dr Ross Church commenced as Postdoctorate/Research Fellow working with Professor John Lattanzio (and Dr Pete Wood at Australian National University) on stellar nucleosynthesis.
- Dr Alina-Catalina Donea was promoted to Senior Lecturer Level C. Her research areas are solar physics: helioseismology, solar flares, solar quakes, suprathermal particles, ultra high-energy cosmic rays, active galactic nuclei (accretion disks and relativistic jets).
- Dr Kais Hamza was promoted to Senior Lecturer level C. His research interests are in general theory of stochastic processes, representation properties for martingales, Markov jump processes and applications of stochastic processes to modelling of financial markets.

RMIT

- Associate Professor Rob May retired from the School of Mathematical and Geospatial Sciences in February this year.
- Associate Professors Bill Blyth and Gary Fitz-Gerald retired from the School of Mathematical and Geospatial Sciences in August. This follows departures earlier in 2007 of Drs Dan Kildea, Max Hunter and Mirko Lukic.
- Associate Professors Panlop Zeephongsekul and Andrew Eberhard have been promoted to the rank of Professor.
- Dr Asha Rao is on sabbatical in India until 31 January 2008. As a recipient of the 2007 Endeavour India Research Fellowship, she is funded by DEST, Australia. She will spend four months at the Indian Institute of Science, Bangalore and one month at the University of Mangalore.

University of Melbourne

- Kerry Landman and Peter Forrester have been promoted to Professor.
- Kerry Landman has been awarded an Australian Professorial Fellowship.
- Dr Daniel Tokarev, Research Fellow (MASCOS), commenced 1 August 2007.
- Mr Kerem Akartunali, Research Fellow, commenced 1 October 2007.
- Dr Ben Binder, Research Fellow, commences 22 October 2007.
- Dr Aurore Delaigle, Maurice Belz Research Fellow, concluded 27 July 2007.

University of New South Wales

- Michael Hirschhorn is retiring on 2 November, after 33 years, and he will be an Honorary Associate for two years after that.
- Drs John Murray and John Roberts have been promoted to Associate Professor.
- Associate Professor Robert S. Womersley has been appointed to replace Professor Michael Cowling as Head of the School of Mathematics and Statistics for the period of one year.

New Books

University of Technology, Sydney

- Graeme Cohen, an adjunct professor with the Department, and Neville de Mestre (Bond University), have just published a book entitled *Figuring Sport*.

Monash University

- Michael Deakin, *The Name of the Number*, Australian Council for Educational Research Ltd, 2007.
- Michael Deakin, *Hypatia of Alexandria: Mathematician and Martyr*, Prometheus Books, 2007.

University of Melbourne

- Ian Enting, *Twisted. The Distorted Mathematics of Greenhouse Denial.* http://www.amsi.org.au/twisted.php.

Conferences and Courses

Conferences and courses are listed in order of the first day.

1st Asia-Pacific Summer School on Mathematical Physics and 21st Canberra International Physics Summer School

Date: 26 November to 7 December 2007
Venue: Australian National University, Canberra
Web: http://www.maths.anu.edu.au/research.programs/mathphys/sy2007/apss2007.html

This is the formal call for registration to attend the 1st Asia-Pacific Summer School on Mathematical Physics to be held at the Australian National University in Canberra from 26 November to 7 December 2007.

The purpose of the Summer School is to bring together honours and postgraduate students from the Asia-Pacific region, and to offer a series of lectures at the advanced undergraduate and beginning postgraduate level. The distinguished lecturers and their topics are: Sander Bais (Amsterdam): Topological quantum computing; Vladimir Bazhanov (Canberra): Quantum integrability; Peter Forrester (Melbourne): Random matrices; Greg Lawler (Chicago): Stochastic Loewner evolution; Soonkeon Nam (Seoul): String theory and black holes etc.; Guifre Vidal (Brisbane): Entanglement, tensor networks and the simulation of quantum many-body systems.

The Summer School will also include a special guest seminar by Ignacio Cirac (Max Planck Institute, Garching).

There is no registration fee for the Summer School. A number of Student Scholarships will be available to cover attendence of honours and postgraduate students. These scholarships will either be Travel Student Scholarships (travel + full board and lodging) or Student Scholarships (full board and lodging only). Preference for Travel Scholarships will be given to Australian and New Zealand honours students.

Theme program: Concepts of Entropy and Their Applications

Date: 26 November to 12 December 2007
Venue: University of Melbourne
Web: http://www.amsi.org.au/Entropy.php

Entropy concepts have been useful in a range of topics and this three-week program will cover many of them. The broad topics to be covered are: Thermodynamics, Entropy methods in PDEs, Entropy methods in statistical mechanics, Entropy methods in environmental data modelling, Entropy methods in dynamical systems, Entropy methods in information theory, Entropy methods in operations research and Entropy methods in signal processing.

Keynote speakers include Angus Hurst, Ingo Mueller, Derek Robinson, Rod Dewar, Denis Evans, Reuven Rubinstein, Michael Baake, Richard Kleeman, Benji Weiss and Tommaso Ruggeri.

The venue is the AMSI precinct, ICT Building, University of Melbourne, 111 Barry Street, Carlton.

Centre for Discrete Mathematics and Computing Workshops

Date: 27–30 November 2007
Venue: St Lucia Campus of the University of Queensland, Brisbane
Web: http://www.maths.uq.edu.au/~carloh/workshops2007/workshop-2007-11/
Contact: Diane Donovan (dmd@maths.uq.edu.au)

In 2007 the Centre for Discrete Mathematics and Computing at the University of Queensland is holding a series of three workshops on combinatorial mathematics. We wish to acknowledge the generous support of both AMSI and the University of Queensland in sponsoring these workshops.

The first two workshops were held in April and July, with invited speakers including: Nicholas Cavenagh, UNSW; Mike Grannell, Open University, UK; Terry Griggs, Open University, UK; Michael Hoffmann, University of Leicester, UK; Ian Wanless, Monash University; Roger B. Eggleton, Illinois State University, USA; Abdollah Khodkar, University of West Georgia, USA; Chris Rodger, Auburn University, USA; Emine Sule Yazici, Koc University, Turkey. Both workshops were well attended, with high-quality presentations, stimulating new collaborations and research.

The third workshop will be held from 27 to 30 November 2007, at the St Lucia Campus, Brisbane. The invited speakers for this workshop include Brian Alspach, University of Newcastle; Ebad Mahmoodian, Sharif University of Technology, Iran; Jennifer Seberry, University of Wollongong. For more details on the workshop please refer to the workshop website.

National Symposium on Mathematics Education for 21st Century Engineering Students

Date: 7 December 2007
Venue: Access Grid Room (AGR) at RMIT University
Web: http://www.amsi.org.au/Carrick_seminar.php

This one-day seminar will be the culmination of a Carrick-funded investigation into teaching the mathematical sciences to engineering undergraduates. It will be held in conjunction with the Annual Conference of the Australasian Association for Engineering Education. It should be of interest to mathematics and statistics academics who teach engineering students.

The venue will be the Access Grid Room (AGR) at RMIT University. Non-Melbourne delegates can join from elsewhere on the AGR network.

Keynote speakers are Martin Harrison from Loughborough University UK, which operates a Mathematics Learning Support Centre, and John Pelesko, Director of the Mechanics and Computation Lab at the University of Delaware.

Short talks and posters are invited from engineers or mathematicians involved in teaching mathematics or statistics to engineering undergraduates. The content should describe what you actually did by way of innovation and how it worked. Abstracts for contributed 15-minute talks (including question time) may be submitted by email to graham@amsi.org.au by 1 November 2007.

Annual statistical mechanics meeting and annual mathematical physics workshop

Date: 10–14 December 2007
Venue: Australian National University and Kioloa
Web: http://www.maths.anu.edu.au/research.programs/mathphys/sy2007/MPh2007.html

This is the formal call for registration and talks for the annual Statistical Mechanics Meeting and Mathematical Physics Workshop. This year the Statistical Mechanics Meeting is included as part of the workshop on Mathematical Physics to be held during the week of 10–14 December 2007.

The annual Statistical Mechanics Meeting, covering the usual range of topics related to statistical mechanics, will be held at the ANU on Monday 10 December and the morning of Tuesday 11 December. On Tuesday afternoon a shuttle bus will be organized to take workshop participants from Canberra to Kioloa on the NSW South Coast, where the Mathematical Physics workshop will be held from Wednesday through Friday.

The return bus will depart for Canberra on the morning of Saturday 15 December. Accommodation in Kioloa will be at the Kioloa Beach Holiday Park. Lectures will take place in the Kioloa Community Centre.

The Kioloa Beach Holiday Park has up to 30 self-contained cabins including kitchen, living area and two or more bedrooms. This accommodation will be provided for participants on a shared basis. Participants wishing to arrange individual cabins should contact the organizers for details. Catering (excluding breakfast) will also be provided as part of the workshop funding.

If you plan to attend either or both events please return the registration form to murray.batchelor@anu.edu.au .

AMSI 2008 Summer School

Date: 14 January – 8 February 2008
Venue: Monash University, Clayton Campus, Melbourne
Web: http://www.maths.monash.edu.au/amsiss08/
FAQ: http://amsiss.maths.monash.edu.au/faq.html
E-mail: amsiss08@sci.monash.edu.au

The Sixth ICE-EM/AMSI Summer School, which runs from 14 January to 8 February 2008, will be hosted by the School of Mathematical Sciences at Monash University, Clayton campus in Melbourne. The Summer School is designed for honours and postgraduate students in the mathematical and statistical sciences.

Travel and/or accommodation subsidies are available for students from AMSI member institutions, postgraduate students or early career academics from Asian and Latin American universities, and full-time postgraduate students from member institutions of the Pacific Rim Mathematical Association.

With the consent of their home university, students may take courses for credit towards their degree.

Topics: Knots and links (Iain Aitchison, University of Melbourne); Advanced methods for ordinary differential equations (Andrew Bassom, University of Western Australia); Martingales in discrete time (Kais Hamza, Monash University); Approximation theory (Markus Hegland, ANU); Partial differential equations (Jerry Kazdan, University of Pennsylvania); Measure theory (Marty Ross); The art and science of modeling, analysing and solving decision-making problems (Moshe Sniedovich, University of Melbourne); Lie groups (John Stillwell, University of San Francisco).

Workshop on Geometry and Integrability

Date: 6–12 February 2007
Venue: The University of Melbourne
Organisers: Jan de Gier (degier@ms.unimelb.edu.au) and Hyam Rubinstein
Web: http://www.ms.unimelb.edu.au/~degier/GandI08.php

The aim of this workshop is to investigate interactions between two- and three-dimensional integrable lattice models and geometry and topology. This meeting will feature lecture series by invited speakers on 6,7 and 8 February, and contributed talks by participants on 11 and 12 February. The organisers encourage early-career researchers and students to attend. Participants from AMSI member institutions can have their travel and accommodation expenses refunded through their department.

The 4th Australian Postgraduate Workshop on Stochastic Processes and Modelling

Date: 10–13 February 2007
Venue: Adelaide University
Contact: Giang.Nguyen@unisa.edu.au
Web: http://dis.maths.adelaide.edu.au/~apwspm08/

All postgraduate students in the area of stochastic processes and/or modelling are encouraged to attend; the main aim of the meeting is to give students the opportunity to present work in a conference situation and develop contacts with future colleagues from around the country. Even if you have just started your research and are not in a position to present new results, come along and tell us what you are working on and what you hope to achieve!

Plenary speakers include: Associate Professor Sean Connolly (James Cook University); Professor Jerzy Filar (University of South Australia); Professor Moshe Haviv (Hebrew University of Jerusalem); Professor Jean-Bernard Lasserre (LAAS-CNRS and the Institute of Mathematics of Toulouse); Professor Peter Taylor (University of Melbourne).

Additionally, a short course entitled ‘Moments, sums of squares and semidefinite programming’ will be given by Professor Jean-Bernard Lasserre.

The deadline for contributions (talks/posters) is Friday 14 December 2007.

The deadline for registration is Friday 18 January 2008.

If your university is affiliated with AMSI, please contact your Head of School to request AMSI travel support.

Computational Techniques and Applications Conference (CTAC)

Date: 13–16 July 2008
Venue: The Australian National University
Web: http://wwwmaths.anu.edu.au/events/ctac08

The Computational Techniques and Applications Conference will be hosted by the Australian National University from 13–16 July 2008. As a special event CTAC08 will also be honouring Professor Ian Sloan on his 70th birthday.

Early-bird registration opens on 13 February 2008 and abstracts are due on 1 March 2008.

The current list of invited speakers includes Linda Petzold, David Keyes, Wolfgang Wendland, Susanne Brenner and Larry Forbes.

Visiting mathematicians

Visitors are listed in the order of the last date of their visit and details of each visitor are presented in the following format: name of visitor; home institution; dates of visit; principal field of interest; principal host institution; contact for enquiries.

Dr Keiichi Shigechi; University of Tokyo; 3 to 14 October 2007; –; UMB

Prof Brian Alspach; University of Newcastle; 22 to 27 October 2007; –; UMB

Dr Pavel Pyatov; Joint Institute for Nuclear Research, Russia; 15 to 31 October 2007; –; UMB

Dr Eric Badel; INRA (French National Institute for Agricultural Research): Wood Material Laboratory (LERMAB) – Nancy, France; February to November 2007; –; QUT

Prof Jiang-Min Pan; University of Yunnan, China; 15 August to 1 November 2007; –; UWA; A/Prof Caiheng Li

Mr Markus Kirschmer; Lehrstuhl D Für Mathematik; 20 September to 3 November 2007; computational group theory; USN; J.J. Cannon

Prof Vyacheslav Futorny; University of São Paolo; 24 September to 3 November 2007; quantum groups and their representations; USN; R. Zhang

Prof Robert Liebler; Colorado State University, USA; 1 October to 11 November 2007; –; UWA; Prof Cheryl Praeger

Dominic Schuhmacher; University of Zurich; 26 October to 15 November 2007; –; UMB

A/Prof Yongzhao Shao; Iowa State University; 9 to 28 November 2007; asymptotic methods in statistics; USN; J. Robinson

Prof John Phillips; University of Victoria, Canada; 1 October to 30 November 2007; analysis and geometry; ANU; Alan Carey

Prof Elvezio Ronchetti; University of Geneva; 1 to 30 November 2007; statistical science; ANU; Alan Welsh

Dr Jiping Zhang; Peking University; 5 October to 5 December 2007; –; UWA; A/Prof Cai Heng Li

A/Prof Dimitri Leemans; Université Libre de Bruxelles; 15 September to 12 December 2007; computational finite geometry; USN; J.J. Cannon

Prof Pierre Milman; Toronto; 1 to 15 December 2007; algebraic Aspects of Singularities; USN; L. Paunescu

Dr Andrea Carbonaro; University of Milano; 15 September to 15 December 2007; analysis and geometry; ANU; Alan McIntosh

Prof Allen Rodrigo; University of Auckland; 8 August to 15 December 2007; Centre for Bioinformation Science; ANU; Sue Wilson

Prof Guji Tian; Wuhan Institute of Physics and Mathematics; 17 September to 17 December 2007; applied and nonlinear analysis; ANU; Xu-Jia Wang

Dr Joshua Ross; King's College Cambridge; 3 to 20 December 2007; mathematical biology; MASCOS, UQ; Prof Phil Pollett

Dr Alex Kitaev; Steklov Mathematical Institute; 25 August to 31 December 2007; singularities and other properties of integrable systems; USN; N. Joshi

Prof Alan Huckleberry; Ruhr-Universität Bochum, Institut Für Mathematik; 25 November to 21 December 2007; analysis and geometry; ANU; Alexander Isaev

Jan Saxl; Cambridge University; mid-November to December 2007; –; UWA; Cheryl Praeger

Dr Dharma Lesmono; Parahyangan Catholic University; 20 September 2007 to 20 January 2008; stochastic DEs and applications; MASCOS, UQ; Prof Phil Pollett

Dr Damien Stehlé; Ecole Normale Superieure de Lyon; 11 November 2007 to 20 January 2008; Computational aspects of lattices; USN; J.J. Cannon

Prof C.C. Lindner; Auburn University, USA; 15 January to 1 February 2008; combinatorics; UQ; Elizabeth Billington

Mr Mohamad-Reza Mohebbi; Tehran University of Medical Sciences, Iran; 18 March 2007 to 1 February 2008; –; UMB; –

Dr Tom Ter Elst; University of Auckland; 20 January to 16 February 2008; analysis and geometry; ANU; Alan McIntosh

A/Prof Andrea Previtali; University of Insubria-Como; 1 October 2007 to 28 February 2008; computational Group Theory; USN; J.J. Cannon

Dr M. Iranmanesh; Yazd University, Iran; 10 June 2007 to 10 March 2008; –; UWA; Prof Cheryl Praeger

Dr Tim Burness; University of Southampton; 21 January to 21 March 2008; –; UWA; Prof Cheryl Praeger

Dr Steen Andersson; University of Indiana; 13 March to 21 April 2008; –; UWA; A/Prof Les Jennings

Prof Philip Griffin; Syracuse University; 1 February to 30 April 2008; Centre for Financial Mathematics; ANU; Alan Welsh

Prof Cathy Baker; Mount Allison University, Canada; 3 January to 30 April 2008; combinatorics; UQ; Elizabeth Billington

Dominic Schuhmacher; University of Zurich; 16 November 2007 to 30 April 2008; –; UWA; Prof Adrian Baddeley

Dr Youyun Li; Hunan Changsha University; 1 May 2006 to 1 May 2008; –; UWA; A/Prof Song Wang

Dr Nader Tajvidi; Lund Institute of Technology; 1 January to 1 May 2008; Statistics; USN; M. Raimondo

Dr Ashraf Daneshkhah; Bu-Ali Sina University; 3 September 2007 to June 2008; –; UWA; Prof Cheryl Praeger

Ms Weiwei Ren; Yunnan University, China; August 2007 to August 2008; –; UWA; A/Prof Caiheng Li

Prof Alireza Ematollahi; Shiraz University; 15 September 2007 to 15 September 2008; –; ANU; Alan Welsh

Prof David Gubbins; Leeds; 20 September 2007 to 19 September 2008; magnetohydrodynamic dynamo theory and the geodynamo; USN; D.J. Ivers

Dr Frederic Robert; Université de Nice; 14 November 2007 to 3 November 2008; applied and nonlinear analysis; ANU; Florica Cirstea

Dr Alireza Nematollani; University of Shiraz; 15 December 2007 to 15 December 2008; multivariate analysis and time series; USN; N.C. Weber

AustMS Accreditation

The secretary has announced the accreditation of:

- Associate Professor John J. Shepherd of RMIT University as an Accredited Fellow (FAustMS).
- Mr Mitchell Wheat, of Winthrop, Western Australia, as a Graduate Member (GAustMS).

Report on the 51st Annual Meeting

The 51st Annual Meeting of the Society was held this year at La Trobe University from 25 to 28 September. There were more than 260 registrants, not including school teachers, of whom 60 were graduate students, making it the largest meeting of recent years. There were nine plenary lectures, 13 keynote talks in 14 special sessions and nearly 200 contributed talks, all in four days.

First of all, let me thank everyone who came to La Trobe for making it such a successful event. In particular, heads of department and postgraduate co-ordinators around the country responded very strongly to my requests and there was a real feeling of institutional participation at the meeting.

Tony Chan (plenary speaker).

Now let me explain how we tried to make the meeting a little different this year, because some of these features were well-received. The program committee wanted to make the plenaries as accessible as possible and at the same time increase the coverage of topics to include more of the mathematical sciences. I think that this worked, and I'd like to thank all the plenary lecturers for their commitment and involvement, and especially Steve Wright and Mark Kisin for giving great talks to the teachers. In addition, the Society and ANZIAM came up with the ANZIAM Lecturer idea which Joe Monaghan executed so well.

On the other hand, we reduced the number of special sessions, but mainly through combining smaller sessions from previous years such as differential geometry and geometry and topology. We did this because feedback from previous years indicated that a large number of sessions produced undesirable clashes and limited the exposure of participants to talks of peripheral but potential interest. The feeling from this year's meeting was that this worked, although, for example, the sheer size of the algebra and combinatorics session created its own problems. The small size of this year's general session also indicates that fewer, broader special sessions excluded fewer participants. Our sincere thanks go to the session organisers for working so well with the organising committee and for bringing in so many of their colleagues as keynote speakers and contributors.

Morning tea on Tuesday.

Of course, the experience of the actual meeting has thrown up many more novel ideas along with some thoughts about how we might have done better.

It was unfortunate that we didn't have a female plenary lecturer; the selection process was a long and arduous one, and there were women on our initial list. This list was generated by the program committee and by the nominations of the session organisers and at any given time a number of invitations were current. By chance, at the moment that all the slots were full, every woman on our list had declined. Rather than formally require that there be at least one female plenary lecturer, I suggest that future conference directors keep a closer watch on the invitation process than I did. For future meetings I recommend that a public lecture be included in the program along with a history of mathematics plenary. I would also like to see a student or ECR on the program committee and a student event on the social program. I tried (and failed) to bring in the many mathematical scientists working in Australia's financial sector, but we can't give up on our non-academic colleagues. Finally, I hope that we can find a better date for the meeting so that we can extend it to five days and increase the attendance.

I am certainly not best placed to identify the highlights of the meeting because I went to so few session talks, but I can't pass up the opportunity to say how much I enjoyed Paul Baum's consummate lecture on K-theory. It was Wojciech Szymanski's suggestion to invite Paul and it certainly paid off. I also enjoyed Tony Chan's energetic performance, although it was probably more interesting to the more administratively burdened in the audience. And then there was the dinner! I can only take limited credit for having a band — wasn't Diana Wolfe great? If you haven't worked it out, she was the Society's publicist for the event and stepped into the breech that very afternoon. I can't take any credit at all for Paul Baum's performance — what a character! I'm also pleased that the AustMS women's lunch went well — definitely worth making a fixture at future meetings.

(Left to right): Peter Hall, Tony Chan, Steve Wright, Joe Monaghan and Geoff Prince. Tony, Steve and Joe were plenary lecturers.

Last of all, thanks to Astrid an Huef, Liz Billington, Peter Hall and Mathai Varghese for all their help and co-operation. Also to the Program Committee: John Banks, Robert Bartnik, Phil Broadbridge, Grant Cairns, Michael Cowling, Kerry Landman, Gus Lehrer, Hyam Rubinstein, Neil Trudinger and Mathai Varghese; to the Organising Committee: John Banks, Grant Cairns and Paul Pontikis and to the many people at La Trobe who did the La Trobe thing so well.

There is a photo gallery of the meeting at
http://www.latrobe.edu.au/mathstats/maths/conferences/AMS2007/

Geoff Prince
Conference Director, AustMS 2007
E-mail: G.Prince@latrobe.edu.au

Some items from the recent AustMS AGM and Council meetings

After a most successful 51st Annual AustMS Meeting at La Trobe University, with Director Associate Professor Geoff Prince (many thanks to Geoff and his team!), those Society members who were unable to attend the AGM on Thursday 27 September may be interested in the following items.

(1) A Nominations and Publications Committee is being formed, in order to collect nominations for Council and various Committees, as well as to find new Editors for our journals when this is necessary.

A call for nominations to Council will appear in the Gazette early in 2008. Members are welcome to contact the Secretary at Secretary@austms.org.au at any time with suggestions, which will be passed on to the Nominations and Publications Committee.

(2) Dr Alan Jones is stepping down as *Bulletin* Editor in February 2008, and will be replaced by Associate Professor Don Taylor, in the first instance to 31 December 2010. Alan's editorial secretary, Mrs Ros Clothier, is also retiring after 22 years' work for the *Bulletin*. We wish them both well!

Professor Michael Murray is also stepping down as Editor of the *Lecture Series*, and will be replaced by Professor Cheryl E. Praeger AM FAA. Many thanks to both!

(3) As was reported in a previous *Gazette* (Volume 34(4), p. 213), Cambridge University Press (CUP) will be publishing our three research journals from 2008. CUP kindly provided a reception for conference delegates on Wednesday 26 September at La Trobe.

(4) The B.H. Neumann Student Prize this year was shared between Norman Do (University of Melbourne) and Neil Saunders (University of Sydney). Their talks were (respectively) entitled *A tourist's guide to intersection theory on moduli spaces of curves* and *The minimal permutation degree for a class of finite complex reflection groups*.

Also Tegan Morrison, Omar Rojas and Alison Thomson received honourable mentions for their conference talks.

Thanks are especially due to Dr Astrid an Huef who was Chair of the B.H. Neumann Student Prize Committee, and to all the Committee members.

(5) The Society should have a new-look professional web page by early next year. In due course, for 2009, this will also allow members to pay dues online and to update their details online.

(6) The new Council for the session 2007–2008 appears on the AustMS web pages at http://www.austms.org.au/AMSInfo/Office/office.html

(7) The 2008 annual conference will be held from 8 to 12 December 2008, at the University of Canterbury, Christchurch, joint with the New Zealand Mathematical Society, as the 7th Australia – New Zealand Mathematics Convention. We now have permission from the Registrar-General in the ACT (in which Territory the Society is incorporated) to hold our AGM during that same week in December, even though this falls outside the five-month period after the end of the Society's financial year. (See item 47(1) in our Constitution, http://www.austms.org.au/AMSInfo/Const/amsconst.html).

So your September 'common week' in 2008, for those of you whose institution keeps the late September/October common week, can be used for purposes other than the annual AustMS meeting!

AustMS Special Interest Meeting Grants: call for applications

The Australian Mathematical Society sponsors Special Interest Meetings on specialist topics at diverse geographical locations around Australia. This activity is seen as a means of generating a stronger professional profile for the Society within the Australian mathematical community, and of stimulating better communication between mathematicians with similar interests who are scattered throughout the country.

These grants are intended for once-off meetings and not for regular meetings. Such meetings with a large student involvement are encouraged. If it is intended to hold regular meetings on a specific subject area, the organisers should consider forming a Special Interest Group of the Society. If there is widespread interest in a subject area, there is also the mechanism for forming a Division within the Society.

The rules governing the approval of grants are:

(a) each Special Interest Meeting must be clearly advertised as an activity supported by the Australian Mathematical Society;
(b) the organiser must be a member of the Society;
(c) the meeting must be open to all members of the Society;
(d) registration fees should be charged, with at least a 20% reduction for members of the Society. A further reduction should be made for members of the Society who pay the reduced rate subscription (i.e. research students, those not in full-time employment and retired members);
(e) a financial statement must be submitted on completion of the Meeting;
(f) any profits up to the value of the grant are to be returned to the Australian Mathematical Society;
(g) on completion, a Meeting Report should be prepared, in a form suitable for publication in the Australian Mathematical Society *Gazette*, and sent to the Secretary;
(h) a list of those attending and a copy of the conference Proceedings (if applicable) must be submitted to the Society;
(i) only in exceptional circumstances will support be provided near the time of the Annual Conference for a Special Interest Meeting being held in another city.

In its consideration of applications, Council will take into account locations around Australia of the various mathematical meetings during the period in question. Preference will be given to Meetings of at least two days duration. The maximum allocation for any one Meeting will be $\$(1000 + 150n)$ where n is the number of AustMS members registered for and attending the meeting, and with an upper limit of about \$5000. A total of up to \$12 000 is available in 2008. There will be six-monthly calls for applications for Special Interest Meeting Grants, each to cover a period of 18 months commencing six months after consideration of applications. Please email Secretary@austms.org.au for an application form.

Elizabeth J. Billington
AustMS Secretary
E-mail: ejb@maths.uq.edu.au

The Australian Mathematical Society

Membership and Correspondence

Applications for membership, notices of change of address or title or position, members' subscriptions, correspondence related to accounts, correspondence about the distribution of the Society's publications, and orders for back numbers, should be sent to the Treasurer. All other correspondence should be sent to the Secretary. Membership rates and other details can be found at the Society web site: http://www.austms.org.au.

Local Correspondents

Publications

The Journal of the Australian Mathematical Society

Editor: Professor M. Cowling
School of Mathematics and Statistics
The University of New South Wales
NSW 2052
Australia

The ANZIAM Journal

Editor: Professor C.E.M. Pearce
Department of Applied Mathematics
The University of Adelaide
SA 5005
Australia

Bulletin of the Australian Mathematical Society

Editor: Dr A.S. Jones
Bulletin of the Australian Mathematical Society
Department of Mathematics
The University of Queensland
QLD 4072
Australia

The *Bulletin of the Australian Mathematical Society* aims at quick publication of original research in all branches of mathematics. Two volumes of three numbers are published annually.

The Australian Mathematical Society Lecture Series

Editor: Professor M. Murray
Department of Pure Mathematics
The University of Adelaide
SA 5005
Australia

The lecture series is a series of books, published by Cambridge University Press, containing both research monographs and textbooks suitable for graduate and undergraduate students.

ISSN: 0311-0729

Published by The Australian Mathematical Publishing Association Incorporated
Typeset in Australia by TechType, ACT
Printed in Australia by Instant Colour Press, ACT