Editorial

Welcome to the third issue of the Gazette in 2007.

As you will be aware, Norman Do, a contributor to the Gazette for many years, began his new Puzzle Corner with our first issue this year. Norman has assessed submissions for Puzzle Corner 1, and we have our first winner: our congratulations go to S. Krass from Dover Heights in NSW, who has won a $50 bookshop voucher! You can read some of the submitted solutions to Puzzle Corner 1 right after this issue's Puzzle Corner. We are looking forward to your submissions again — send in your solutions to this issue's problems by 1 September.

There is a lot of good news in this issue. We have a report on this year's successful ANZIAM conference in Fremantle, where the J.H. Michell Medal was awarded to Yvonne Stokes. In Maths Matters Frank de Hoog discusses the opportunities for the mathematical sciences arising from changes to the way research is done across all the sciences. And Jeff Kepert gives us a detailed look at the vital role mathematics plays in meteorology in this issue's Maths@work.

There was also good news for mathematics in the recent federal budget. This success is a direct result of the hard work put in by many members of the society in supporting the National Strategic Review, discussed in recent issues of the Gazette. Phil Broadbridge reports on the increase in funding in his AMSI news column, and the impact it may have on departments. More money is welcome, but as always there is more work to be done. Peter Hall discusses possible implications of journal ranking that might arise form the Research Quality Framework in his President's Column.

And Mike Hirschhorn's technical paper in this issue, giving simple proofs of upper and lower bounds for π, generated very positive responses from the referees:

> It should interest lecturers of good first year calculus courses and could easily be formulated as a challenge to good students, using, as it does, techniques of integration ..., some calculation with largish integers, and a little bit of number theory.

Finally, we would like to thank May Truong, the Society's Business Manager, for $8\frac{1}{2}$ years of service to the Society. May is leaving us on 29 June this year. We wish her all the best for the future!

Birgit, Rachel and Eileen

President's column

Peter Hall*

Ranking journals

Journal ranking, and more generally the potential for assessing the excellence of mathematical work in terms of where it is published, has become an important issue in connection with the Research Quality Framework (RQF). The Society enjoys a diversity of views on this subject. Some members are reasonably enthusiastic about the concept of journal-ranking (or placing of journals into bands), believing (as do more than a few people outside the mathematics profession) that the journal where a research paper is published can be used very effectively to benchmark the paper's excellence. At the other end of the spectrum there are concerns that the 'standing' of the journals where we publish is not directly or simply related to the 'standard' of individual research papers, and that suggesting the existence of a strong connection could cause serious problems for the profession.

In the middle, somewhere between these two viewpoints, a number of members of the Society see journal ranking as a necessary evil — as something which we might not strongly support but which we should nevertheless embrace, because we can rank our journals better than anyone else (for example, better than DEST — the Department of Education, Science and Training). This concern — that we should become actively involved in mathematics and statistics journal ranking, or otherwise it will be done by non-mathematicians and imposed on us from outside — has attracted some of my attention during the last few months.

The issue of journal ranking has been touched on by Society members in recent articles in the *Gazette* [1], [2]. John Ewing, the Executive Director of the American Mathematical Society, wrote in the AMS's *Notices* last October on the subject of journal impact factors, which have been suggested to the Society as a means by which we might tackle the journal ranking exercise. Ewing [3] commented:

> We should regard the impact factor as a way to measure the average quality of articles within a journal and nothing more. We should remember that measuring the quality of each article or even the entire journal itself requires much more information... The main conclusion is that we must stop seeking simplistic answers to complicated questions of judgment.

I particularly enjoyed the quotation, attributed to Einstein, that prefaced Ewing's paper: 'Not everything that can be counted counts, and not everything that counts can be counted.'

Journal ranking was also the subject of a recent article in *The Australian* [4], reporting on a ranking of marketing journals undertaken at the University of Technology, Sydney. The conclusion reached there was about as different as it

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

is possible to be from the one expressed by Ewing (and Einstein). According to *The Australian*, the UTS researchers came up with "a scale — 'like feet and inches' — that allowed meaningful comparisons of relative quality within...73 [marketing] journals". One of the authors of the UTS study reported that these findings 'should end the familiar spectacle of academics disputing the merits of publication in various journals'. Ominously, *The Australian* suggested that 'the method could find wider use with the research quality framework'.

Academic statisticians, too, have addressed these issues. Perhaps surprisingly, statisticians generally share a healthy scepticism of the extent to which it is feasible to extract accurate, meaningful information from numbers. In this regard they are different from marketers, and (in my experience) also from some mathematicians, who tend to place greater faith in the capacity of noisy data to divulge absolute truths. Writing in *The American Statistician* four years ago, Vasilis Theoharakis and Mary Skordia [5] pointed to major differences in the way applied and mathematical statisticians rank statistical journals, and to the significant impact which geographic location also has on perceptions of excellence. Theoharakis and Skordia's results show that four of the statistics and probability journals that were ranked in the top 10 (out of 110 journals) by theoretical statisticians, were given the much lower ranks of 21, 22, 33 and below 40 by applied statisticians. Of course, journal rankings by probabilists differed even more markedly from those by applied statisticians. The study included 273 applied statisticians, 169 mathematical statisticians and 119 researchers in probability or stochastic processes.

If there are such major differences in perceptions among statisticians and probabilists, it is not easy to see how we could gain meaningful information using journal rankings for much broader areas of the mathematical sciences, such as pure mathematics. Statisticians explain these difficulties by noting that each journal can be considered as a point in d-dimensional space, where d is very large and the various components represent the many different pieces of information we have acquired by reading journal papers. A ranking of n journals is obtained by projecting each member of a d-variate cloud of n points onto a line, L say, in d-space. Conceptually, there are different versions of L for applied statistics, theoretical statistics, probability theory, etc, and they have quite different orientations.

John Ewing [3] noted that in preparation for the UK's Research Assessment Exercise, on which Australia's RQF is loosely based, universities typically advise academic staff to put forward publications in high-impact journals. Despite this recommendation, the guidelines for the RAE explicitly exclude the 'formulaic' use of journal rankings or impact factors, as the following two points in the guidelines indicate:

> (19) In assessing excellence, the sub-panel will look for originality, innovation, significance, depth, rigour, influence on the discipline and wider fields and, where appropriate, relevance to users. In assessing publications the sub-panel will use the criteria in normal use for acceptance by internationally recognised journals. The sub-panel will not use a rigid or formulaic method of assessing research quality. It will not use a formal ranked list of outlets, nor impact factors, nor will it use citation indices in a formulaic way.

(20) The sub-panel will use its professional judgement (and external advice if necessary) to assess pedagogic and historical research, or teaching material embodying research outcomes, in mathematics[1].

Some of us would have reservations about the recommendations of UK universities that their research-active staff avoid submitting for the RAE any papers that are not from leading-edge journals. For example, that approach would have excluded the pioneering work of Australian Nobel Laureates Barry Marshall and Robin Warren, whose paper on the role of bacteria in gastritis and peptic ulcer disease was famously rejected by all high-impact journals in its field. Likewise, some (but not all) members of the Society would applaud the advice given to RAE panels that they eschew any formulaic attempt to assess excellence using journal rankings, impact factors or other metric-based methods.

Although I appreciate that not everyone in the Society would agree, in my view it would be helpful if RAE guidelines 19 and 20, quoted above, were incorporated into the RQF advice. At present the Society is coming under pressure from some quarters to produce agreed journal rankings that could be used by RQF panels to assess RQF submissions in the mathematical sciences. It has been suggested that we should produce a ranking (or 'banding') that would place all mathematics journals that have impact factors into one of four bands, or tiers: band 1, containing the top 5% of journals; band 2, the next 15%; band 3, the next 30%; and band 4, the bottom 50%. Journals for which impact factors are not assigned by Thomson Scientific should, it has been argued, be excluded altogether.

I have strong personal reservations about this proposal. I fear that, as an approach to assessing the research of an individual, it is flawed. If we endorse it then it will probably be institutionalised, and (for example) it will likely be used to assess future 'tenure' and promotion cases in Australian universities. I'm aware that some Society members have already been counselled over their failure to earn sufficient grant income (the current way in which DEST measures a university's research performance) or to produce four papers in five years (as required by the current RQF rules). The Society members to whom I'm referring here are internationally known mathematical scientists, and have received recent awards for their research, but do not meet certain rather arbitrary and pedantic criteria. The RQF, and the rules and criteria that govern it, will motivate further new, and narrow, ways for Australian universities to assess their academic staff.

Of course, mathematics, and the Australian Mathematical Society, are not the only field or professional society feeling the pressure to respond to calls to rank journals. If a ranking of mathematics and statistics journals that we suggest turns out to be more rigorous than those proposed in other fields, then the mathematical sciences will likely be penalised for that rigour. In particular, mathematicians and statisticians in our universities may have less access than they deserve to research funding that flows to universities in consequence of the RQF. And, for the reasons given earlier, promotions in the mathematical sciences will likely be impeded relative to those in other fields.

---

[1]These numbered points come from the current 'Template for Draft Criteria and Working Methods' in Applied Mathematics: http://www.rae.ac.uk/pubs/2006/01/docs/f21.pdf (accessed 17 June 2007). The template for Pure Mathematics is virtually identical; see: http://www.rae.ac.uk/pubs/2006/01/docs/f20.pdf (accessed 17 June 2007).

If we don't rank journals, will somebody else do it for us? The Society is keeping a close eye on this. There is no clear sign at present of a pressing need for a universal ranking, although some universities are actively second-guessing the Government's future requirements. However, there are also signs that other universities want to do things their own way, and either do not wish to use journal rankings or, if they do, would prefer to employ their own rankings, designed to reflect the research areas in mathematics and statistics where they are most active.

University managers differ widely too. One Deputy Vice-Cancellor (Research) to whom I've spoken said that he would find it very hard to accept a mathematical sciences journal ranking that was not based directly on impact factors. On the other hand, another implied that he felt that impact factors and journal rankings are not particularly informative when it comes to assessing the performances of individual scientists.

In April I circulated a message to both our Steering Committee and Council on the subject. The main response has been more of a non-response. I'm inclined to think that there will not, ultimately, be irresistible pressure for a uniform (i.e. used by all universities) ranking of mathematics journals, and that there will be no broad attempt by non-mathematicians (e.g. by DEST) to produce a ranking. If the Society had to propose a ranking then, on the basis of suggestions made by the Steering Committee, we would wish to depart substantially from the 5%-15%-30%-50% bands that have been suggested. We would prefer to use much wider bands at the first and second levels, and possibly reduce the number of bands. Narrower bands might be appropriate for a single institution, where they could be chosen adaptively to reflect local research strengths, but there seems to be agreement on Steering Committee that, in a national context, narrow bands allow too little variation in research areas.

In the meantime the Society will continue to monitor the situation closely.

References

[1] Hall, P. (2007). Measuring research performance in the mathematical sciences in Australian universities. *Gaz. Aust. Math. Soc.* **34,** 26–30.

[2] Carey, A., Cowling, M. and Taylor, P. (2007). Assessing research in the mathematical sciences. *Gaz. Aust. Math. Soc.* **34**, 84–89.

[3] Ewing, J. (2006). Measuring journals. *Not. Amer. Math. Soc.* **53,** 1049–1053.

[4] Lane, B. (2007). Ranking system for journals. *The Australian*, 25th April 2007. Available online at: http://www. theaustralian.news.com.au/story/0,20867,21615401-12332,00.html (accessed 31 May 2007).

[5] Theoharakis, T. and Skordia, M. (2003). How do statisticians perceive statistics journals? *Amer. Statist.* **57,** 115–124.

Peter Hall is a statistician, with interests in a variety of areas of science and technology (particularly the physical sciences and engineering). He got his first degree from The University of Sydney in 1974, his MSc from The Australian National University in 1976, and his DPhil from University of Oxford in the same year. Peter is interested in a wide variety of things, from current affairs to railways and cats.

Maths matters

Opportunities for the Mathematical Sciences?

Frank de Hoog[*]

I've always found it easy to agree to deliver in the distant future. Sadly though, the distant future has a habit of maturing into a pressing deadline and that has certainly been the case for this piece.

The writing instructions were to voice an opinion, preferably one that is provocative, which will stimulate debate. While it's flattering to be asked about one's opinion and it's easy to be provocative, I found the requirement to be stimulating rather more difficult and therefore turned to the past 'Maths Matters' columns in the *Gazette* for inspiration.

However, I found that these articles, with a few notable exceptions, paint a rather gloomy picture about the future prospects for our profession. Issues such as declining student numbers and funding within universities are clearly extremely serious and are already impacting on our ability to recruit quality mathematical scientists. Whilst the recent increases for funding of the mathematical sciences announced in the budget will help considerably, rebuilding these activities will take place from quite a low base in many universities. In addition, the imminent introduction of measures to quantify productivity will no doubt include citation rates and impact factors, which are both low for mathematics when compared to other disciplines.

Nevertheless, I believe that the long-term potential for the mathematical sciences is extremely high. The challenge for the profession will be to successfully exploit this potential. That is the subject of this 'Maths Matters'.

Biases

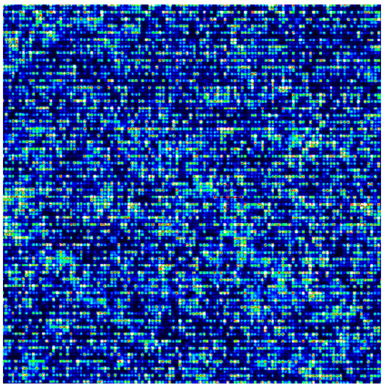
Before continuing, I need to declare some biases and introduce some nomenclature. In terms of biases, let me give a bit of background. My entire career has been concerned with the application of the mathematical sciences. Initially this was in the analysis and development of algorithms but now includes industrial process modelling in the minerals and manufacturing sectors, biological modelling and financial mathematics. My biases then are firmly at the applied end of the scale. In terms of nomenclature, the boundaries between the various disciplines such as applied and pure mathematics, statistics and operations research are often quite blurred when dealing with applications, so I'll use the term 'mathematics' in a generic sense to include all of the various disciplines that make up the mathematical sciences.

[*]CSIRO Mathematical and Information Sciences, GPO Box 664, Canberra, ACT 2601.
E-mail: Frank.deHoog@csiro.au

Potential

Whether we like it or not, the way we do science is changing in a number of ways. Improvements in instrumentation, data management, robotics, and communication technologies have resulted in huge productivity gains in the experimental sciences. In molecular biology, for example, the cost of analysing genomic data is predicted to exceed the cost of producing it within the next year or two. According to Szalay and Gray [8] this 'data explosion' will continue for some time. Specifically:

> Data volumes are doubling every year in most areas of modern science and the analysis is becoming more and more complex, ... Many predict dramatic changes to the way science is done, and suspect that few traditional processes will survive in their current form by 2020.



Statistical analysis of gene expression data generated by microarrays has identified biomarkers associated with more aggressive brain tumours (copyright CSIRO Australia)

Theoretical progress has been equally impressive. Many processes are now understood to the point where the underlying theory has been captured in software which is then used as a predictive tool. Such software tools are now common for physical or chemical processes such as stress analysis and reaction kinetics. Another example that we now take for granted is software for weather prediction. There are similar trends in the environmental and biological sciences where there is an increasing reliance on 'in silico' experimentation. A result of this is that future infrastructure planning for research organisations involves fewer wet labs, research stations and other experimental facilities and more information and communication related infrastructure.

These trends will impact substantially on the skills required to participate effectively in science. The 2020 Science Group [2], for example, believes that mathematical and computer sciences need to be completely integrated into science. They assert:

> Scientists will need to be completely computationally and mathematically literate, and by 2020, it will simply not be possible to do science without such literacy.

The final change I want to highlight is that scientific institutions are increasingly targeting investigations that deliver high impact through understanding at a system, rather than a component level. This invariably involves multi-disciplinary teams, which are often quite large, that work across disciplines and need to incorporate enabling technologies such as the mathematical sciences. The reasons for this are summarised succinctly by Donald J. Lewis [6], a former Director of the Division of Mathematical Science at the National Science Foundation (US), who states that:

> Today's challenges faced by science and engineering are so complex that they can only be solved through the help and participation of mathematical scientists. All three approaches to science, observation and experiment, theory, and modeling are needed to understand the complex phenomena investigated today by scientists and engineers, and each approach requires the mathematical sciences.

The changes to the way that science is being done, as described above, all indicate that there will be a sustained increase in the application of the mathematical sciences. Research institutions such as CSIRO (the Commonwealth Scientific and Industrial Research Organisation) have recognised this and have been actively seeking to increase their capability in these and related disciplines. Our experience in recruitment at CSIRO shows that career options for quality researchers in a number of areas of the mathematical sciences are substantial. Furthermore, history suggests that new applications will pose new theoretical questions, thereby reinvigorating the discipline. All of these suggest to me that the long-term potential for the mathematical sciences is extremely high.

Challenges

While I believe that the potential for the mathematical sciences is high, exploiting the potential presents a number of challenges. These are summarised in the following dot points and addressed in greater detail below.

- Mathematical scientists need to become better at expressing their 'value proposition'.
- The changes to the way that science is done will require much more domain knowledge and therefore incur a much greater initial cost for participation by mathematical scientists.
- Science and engineering is a competitive business and there are many scientists and engineers who will aggressively pursue new opportunities in the mathematical sciences.

Unless we effectively address these challenges, it is unlikely that those who consider themselves to be mathematicians will be able to realise the potential.

The easiest and perhaps most compelling argument for support of the mathematical sciences is the linkage with applications in the real world. This was certainly argued strongly, apparently with good effect, in the recent review of mathematical sciences research in Australia and at the forum at the Shine Dome in February. However the reality is more complicated.

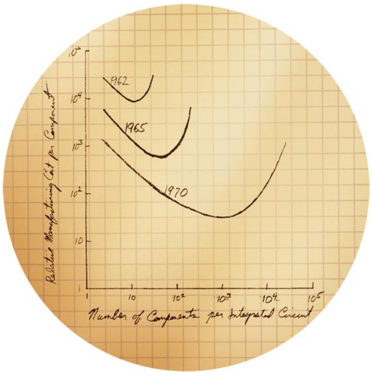
My suspicion is that many, perhaps the majority, of mathematicians have little experience in applying mathematics and consequently have unrealistic views about the paths to adoption. There is some support for this in the recent review of statistics [7], specifically the statement:

> Many teachers of mathematics in schools and universities clearly have had little experience of, knowledge of, or direct contact with, the vast range of applications of quantitative methods that have opened up in recent years in government and industry and in other academic disciplines.

There is further support in Larry Forbe's [3] experience that there is resistance to the idea that research in pure mathematics is necessarily a supporting role to the application of the mathematical sciences to real-world problems.

This should not come as a surprise. The fact is that applications are not the only drivers for developments in mathematics. Indeed, the links with applications for much of mathematics is tenuous or non-existent, as is to be expected from any mature discipline that deals with abstraction. Arguably, most of the drivers come from the discipline itself and many 'dialects' have been developed that can only be understood by the cognoscente. Whilst these specialised languages are absolutely essential to make progress in the various sub-disciplines of the mathematical sciences, they are also a barrier to communication. It is therefore very difficult for any individual to develop an in-depth understanding of the mathematical sciences. Consequently, many known results that are required for the solution of real-world problems are reinvented.

I am not trying to argue here that abstract mathematical results do not play a crucial role in the application of mathematics. There are many examples where they have played a crucial role. Nevertheless, most pieces of abstract mathematics will not be useful for solving applied problems and arguments that the results will be crucial in fifty or even a hundred years are at best optimistic and, at worst, dilute our credibility. It also dilutes the contributions that are not associated with applications.



Gordon Moore's original graph from 1965 (copyright Intel Corporation)

I am also not suggesting that mathematics does not play an important supporting role. Just one example of the importance of this role is the development and analysis of algorithms, much of which is based on earlier fundamental results in functional analysis. This has had at least as much influence on what is computationally feasible as Moore's law. What I am saying is that we need to be more discerning when articulating the value of the mathematical sciences to applications in order to increase our credibility. One size does not fit all!

As an aside, while I am enthusiastic about 'the mysterious process between theory and applications' [1], [3], [9], I don't believe that the only, or even primary, role of fundamental research in pure mathematics is to support the application of mathematics. Such a role is far too restrictive and, as far as I'm aware, there are not a lot of mathematicians who spend their time sitting by the phone in the hope that I, or someone else with a practical problem, will call about an application that will be solved by the theory they have developed. A lot of mathematics is done that is not intended to support anyone. I'm not suggesting that Hardy's toast — 'To Pure Mathematics, may it never be of use to anyone' — resonates with a large section of the mathematical community. Most mathematicians would be very pleased to find their work applied. It's simply that the drivers for research in mathematics are much broader than the applications of mathematics. We need to be much more assertive and proactive in articulating appropriate value propositions for all research in the mathematical sciences which should then be judged on its own merits.

I believe that changes in the way that science is done will also change the way that mathematics is applied. Much of my own work has been done on manufacturing processes that have been around for a long time. These are generally quite robust processes as this was all that manufacturing facilities a century or more ago could cope with. This robustness generally means that the process of interest is, at worst, only weakly coupled to its environment and that a reductionist approach, using simple mathematical models, will work well. Examples include rolling processes, painting, crystal growth, lens design and so on.

It's easy to participate in these problems because the models are relatively simple and well developed, and the context is easy to understand. Some domain knowledge is required but, by collaborating with a domain expert, it's possible to start making substantial contributions in a few months. However, the contributions that the mathematical sciences make to investigations that seek to deliver high impact through understanding at a system level are quite different. As mentioned previously, these investigations are tackled by multi-disciplinary teams that work across disciplines, and participation is usually as a team member rather than as an individual. Furthermore, the components of such systems are often strongly coupled and the analysis of individual components does not provide insight into the behaviour of the system. This means that the domain knowledge required to participate effectively can be very considerable.

Mathematics is ubiquitous in science and engineering. Everything that needs to be quantified needs mathematics at some level of sophistication and only a tiny proportion of all the application of mathematics is performed by those who consider themselves to be a mathematician. This is true even if we limit ourselves to sophisticated applications of mathematics. Much of science and engineering is about the application of mathematics and there are many scientists and engineers who will aggressively pursue new opportunities and directions.

The mathematical sciences have a history of being late adopters. Friedman [4] for example, argues that there are a number of useful methodologies that had seminal beginnings in Statistics which were, for the most part, subsequently ignored by statisticians. These include pattern recognition, neural networks, machine learning, graphical models (Bayes nets), chemometrics and data visualisation. Arguably, one might add data mining to the list. In addition, our infrastructure for dissemination of information is cumbersome. As a rule, the time required to publish a research finding in the mathematical sciences is at least a year, the impact factors of our journals are low and our web presence is usually minimal.

Competitive advantage

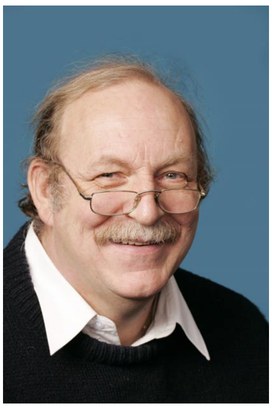
Despite the fact that applications are not the only drivers of innovation in the mathematical sciences, there is little doubt that they have been an important driver.

Larry Forbes [3] puts it well in a previous 'Maths Matters' column: 'Mathematics is the language of technology, and during the course of its history, much of it was invented precisely for that purpose'. Furthermore, this language can be stunningly powerful as exemplified by the phrase 'the unreasonable effectiveness of mathematics'. This phrase was originally coined by Wigner [10] and later expanded upon by Hamming [5]. A recurring theme here is that mathematics is precisely the right language for applications as evidenced by the seemingly irrational fact that the same mathematics turns up in many completely different applications.

Another concept that was considered to be fundamental was the notion of invariance. I am constantly amazed at how much insight can be gained simply by abstracting the key elements of a practical problem and then performing a dimensional analysis. Sometimes, this is all that is required! Mathematical scientists have the advantage of an overview of the mathematical sciences that enable them to exploit 'the unreasonable effectiveness of mathematics' and thereby provide the understanding and insight that is the hallmark of the application of mathematics at its best.

References

[1] Dooley, T. (2004). Math Matters. *Gazette Aust. Math. Soc.* **31,** 76–78.
[2] Emmott, S. (Chair) (2006). *2020 Science.* Microsoft Report. Available online at: http://research.microsoft.com/towards2020science/downloads/T2020S_ReportA4.pdf (accessed 31 May 2007).
[3] Forbes, L. (2005). How hard are the hard sciences. *Gazette Aust. Math. Soc.* **32,** 75–79.
[4] Friedman, J.H. (1997). Data Mining and Statistics. What's the Connection? *Proc. 29th Symposium on the Interface: Computing Science and Statistics*, May 1997. Houston, Texas.
[5] Hamming, R.W. (1980). The unreasonable effectiveness of mathematics. *The American Mathematical Monthly* **87**(2), February 1980.
[6] Lewis, D.J. (1999). In forward to A. Chorin and M.H. Wright (1999). Mathematics and Science, Division of Mathematical Sciences, National Science Foundation. Available online at: http://www.nsf.gov/pubs/2000/mps0001/mps0001.pdf (accessed 31 May 2007).
[7] Statistical Society of Australia Inc. (2005). Statistics at Australian Universities: An SSAI-sponsored Review.
[8] Szalay, A. and Gray, J. (2006). 2020 Computing: Science in an exponential world. *Nature* **440,** 413–414.
[9] Taylor, P. (2004). Math matters. *Gazette Aust. Math. Soc.* **31,** 285–287.
[10] Wigner, E. (1960). The unreasonable effectiveness of mathematics in the natural sciences. *Comm. Pure Appl. Math.* **13,** February, 1960.



Frank de Hoog is a Mathematical Scientist with over 30 years research and teaching experience. His role as Research Director in CSIRO Mathematical and Information Sciences is to help set the directions and implement frontier and strategic research.

Frank has lectured at UCLA and ANU on Computational and Applied Mathematics and has made a number of research contributions in these areas. Specifically, he has contributed to topics in the numerical solution of differential and integral equations, numerical transform techniques, computational linear algebra, solid mechanics, vibration of structures, stress analysis, heat and mass transfer and rheology. These have been documented in over 100 refereed journal papers and conference proceedings.

Since joining CSIRO in 1977, Frank has also worked on applying mathematics to industrial problems. Projects on which he has worked include modelling of blast furnaces, gravity separation, alumina precipitation, mill modelling, roll coating, structural vibrations, coil handling and financial risk. As part of this work, he has undertaken a number of secondments to industry.

Puzzle corner 3

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 3 is 1 September 2007. The solutions to Puzzle Corner 3 will appear in Puzzle Corner 5 in the November 2007 issue of the *Gazette*.

Milk and tea

Consider a cup of milk and a cup of tea, each containing precisely the same amount of liquid. Three tablespoons from the cup of milk are poured into the cup of tea, and the liquid is thoroughly mixed. Then three tablespoons of this mixture are poured back into the cup of milk. Which is greater now: the percentage of milk in the tea or the percentage of tea in the milk?

Lockers

School lockers numbered from 1 to 100 stand in a row. When the first student arrives at school, she opens all of the lockers. The second student to arrive then closes every second locker starting with locker number 2. The third student then toggles the state of every third locker starting with locker number 3. This continues until 100 students have passed by the lockers. Which lockers are now open?

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

Irrational punch

Consider a hole punch that can be centred at any point of the plane and removes those points whose distance from the centre is irrational. How many punches are required to remove every point?

Integral averages

Let $n \geq 2$ be an integer and let T_n be the number of non-empty subsets of $\{1, 2, 3, \ldots, n\}$ with the property that the average of its elements is an integer. Prove that $T_n - n$ is an even number for every value of n.

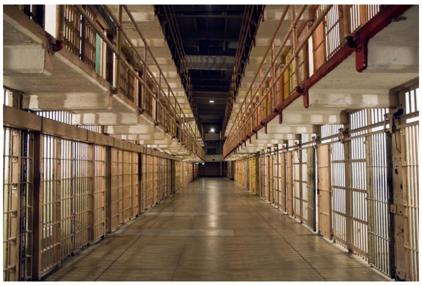
Silver matrices

An $n \times n$ matrix whose entries come from the set $S = \{1, 2, \ldots, 2n - 1\}$ is called a *silver matrix* if, for each k, the kth row and the kth column together contain all elements of S.

(a) Show that there is no silver matrix for $n = 2007$.
(b) Show that silver matrices exist for infinitely many values of n.

Puzzles for prisoners

(1) One hundred prisoners are on death row. Tomorrow, they will all be lined up in single file, one behind another. Each will have a number from 1 to 100, not necessarily distinct, written on their back. The prisoners can see the numbers on the backs of everyone standing in front of them. They will then be asked in turn, starting with the person at the back of the line, all the way to the person at the front of the line, what they think the number on their back is. If the prisoner answers correctly, then they are allowed to live, otherwise they will be put to death. Every prisoner is able to hear the answer of every other prisoner. Tonight the prisoners are allowed to meet and discuss their strategy. How many lives can the prisoners be guaranteed to save?



(2) Once again, one hundred prisoners are on death row. Tomorrow they will be asked, one by one, to enter a room which contains 100 boxes in a row. The boxes contain the names of all the prisoners, one name to a box. Once inside the room, each prisoner may look inside 50 boxes, but must leave the room exactly as it was before they entered. No further communication is allowed between the prisoners until they have all exited the room. The prisoners will all be executed unless every single one of them manages to find his or her own name inside one of the 50 boxes that they examined. Tonight the prisoners are allowed to meet and discuss their strategy.

Note that if each prisoner looks inside 50 boxes at random, then their probability of survival is a miniscule $\left(\frac{1}{2}\right)^{100} \approx 7.89 \times 10^{-31}$. However, show that if the prisoners choose the correct strategy, then they can all be freed with a probability that exceeds thirty per cent!

Solutions to Puzzle Corner 1

The $50 book voucher for the best submission to Puzzle Corner 1 is awarded to S. Krass.

Fun with fuses

Solution by Claire Hotan: To measure 45 seconds, light both ends of fuse A and one end of fuse B at the same time. When fuse A burns out precisely 30 seconds must have elapsed, and at this time light the unlit end of fuse B. When fuse B burns out, a further 15 seconds must have elapsed, thereby measuring a total of $30 + 15 = 45$ seconds.

Since one fire will cause a fuse to burn for 60 seconds, maintaining three fires will cause a fuse to burn for 20 seconds. To perform this task, light the fuse at some point in the middle and at one of the ends. Whenever two fires meet and extinguish, light a fire in the middle of an unburnt segment to maintain three fires. If a fire reaches an endpoint and extinguishes, we cut the fuse in an unburnt region and start a fire at one of the new ends. Of course, for this method to work, one may have to perform infinitely many operations infinitely quickly!

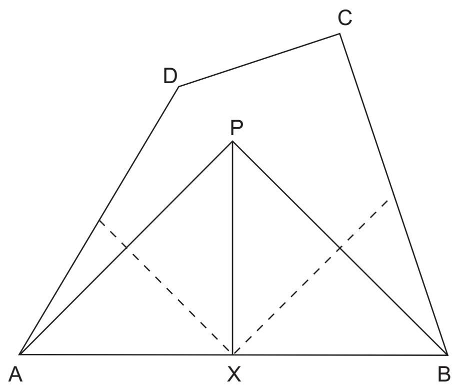
Fuel shortage

Solution by Peter Pleasants: We will solve the problem by induction on n, the number of fuel stations located on the circular route. The base case of one fuel station is entirely trivial. So suppose that the problem is true for n fuel stations and consider the case now that there are $n+1$ fuel stations. Note that there must be at least one fuel station A which contains enough fuel to reach the next fuel station B. Otherwise, it is clear that there would be insufficient fuel in total to make it around the circular route. Using this observation, we know that any car which can make it to A can then refuel and make it to B. Therefore, one may as well consider moving all of the fuel at fuel station B to fuel station A and removing fuel station B entirely. However, this reduces the problem to the case of n fuel stations, which is true by the inductive hypothesis. Therefore, the problem is also true for $n+1$ fuel stations and, by induction, is true for any finite number of fuel stations.

Alternative solution: Consider an imaginary car with a large tank containing more than enough fuel to complete one circuit. Suppose that it begins at some arbitrary point and drives around the circular route, buying up all the fuel at each station that it passes. Note that when the car has completed one circuit, its fuel gauge will read precisely the same amount as when the car began its journey. Therefore, at some point P along the route, the fuel gauge must hit a minimum value. Furthermore, this point P must be at one of the fuel stations. It should be easy to see now that a car starting at point P with an empty tank can make it around the route.

Folding quadrilaterals

Solution by S. Krass: Let us say that a quadrilateral admits a *nice folding* if it can be folded so that the corners all meet at the same point without overlapping. First, we observe that such a quadrilateral must be convex. Now suppose that $ABCD$ admits a nice folding so that the corners meet at a point P. Suppose that folding A to P creates a crease which meets AB at X. Then to avoid overlap, folding B to P must create a crease which meets AB at X also. Since AX folds to PX and BX folds to PX, we have the equalities $AX = PX = BX$. It follows that $\angle APB = 90°$ and by similar reasoning, we also obtain $\angle PBC = \angle CPD = \angle DPA = 90°$. Therefore, the diagonals AC and BD must meet at right angles. Conversely, we observe that any convex quadrilateral in which the diagonals meet at right angles admits a nice folding.



Although this gives a simple geometric condition which determines when a quadrilateral admits a nice folding, we are after a condition which only involves the side lengths of the quadrilateral. This is (almost) possible by the following result.

Lemma 1. *Four points in the plane A, B, C, D satisfy the condition*

$$AB^2 + CD^2 = BC^2 + DA^2$$

if and only if AC is perpendicular to BD.

Proof. Let $\mathbf{a}, \mathbf{b}, \mathbf{c}, \mathbf{d}$ be the position vectors of the points A, B, C, D, respectively. The following chain of equivalent statements yields the desired result.

$$\begin{array}{rrcl} & AB^2 + CD^2 &=& BC^2 + DA^2 \\ \Leftrightarrow & (\mathbf{a}-\mathbf{b})^2 + (\mathbf{c}-\mathbf{d})^2 &=& (\mathbf{b}-\mathbf{c})^2 + (\mathbf{d}-\mathbf{a})^2 \\ \Leftrightarrow & \mathbf{a}\cdot\mathbf{b} + \mathbf{c}\cdot\mathbf{d} &=& \mathbf{b}\cdot\mathbf{c} + \mathbf{d}\cdot\mathbf{a} \\ \Leftrightarrow & (\mathbf{a}-\mathbf{c})\cdot(\mathbf{b}-\mathbf{d}) &=& 0 \\ \Leftrightarrow & AC &\perp& BD. \end{array}$$

We have already noted that a quadrilateral admits a nice folding if and only if it is convex and its diagonals meet at right angles. Strictly speaking, it is not possible to determine whether or not this is the case given the side lengths alone. In particular, the same set of side lengths can be used to form both convex as well as non-convex quadrilaterals. Even if we restrict ourselves to the case of convex quadrilaterals, it is still not possible to determine whether or not the quadrilateral admits a nice folding from its set of side lengths. For example, if the side lengths are 1, 7, 8 and 4 in that cyclic order, then the quadrilateral admits a nice folding since $1^2+8^2=7^2+4^2$. However, if the side lengths are 1, 4, 7 and 8 in that cyclic order, then such a quadrilateral does not admit a nice folding since $1^2+7^2 \neq 4^2+8^2$.

Surprisingly enough though, we can determine whether or not a quadrilateral admits a nice folding given only the fact that it is convex as well as its side lengths in cyclic order. The precise statement is as follows:

> A quadrilateral with side lengths a, b, c, d in cyclic order admits a nice folding if and only if it is convex and $a^2+c^2=b^2+d^2$.

Self-referential aptitude test

Solution by Ian Wanless: Depending on your solution to question 20, the following five solutions are consistent.

(A) DADBEDDEDABADBADBEBA
(B) DADBEDDEDABADBADBAEB
(C) DADBEDDEDABADBADBEAC
(D) DADBEDDEDABADCADBEAD
(E) DADBEDDEDABADBADBABE

Of course, Jim Propp, the original proposer of the self-referential aptitude test, expected the correct answer to question 20 to be (E). Jim writes:

> It's no coincidence that this spells out an odd message if spaces are added appropriately. When I created the S.R.A.T. for a party in 1993 or so, it was one of a chain of puzzles, each of which gave clues for the next; in particular, the sentence DAD BEDDED A BAD BAD BABE was one of several hints to the identity of the movie *Fatal Attraction*.

Magic card trick

Solution by S. Krass: For the trick to work with $n \geq 3$ cards, we must have one of the following two arrangements.

- One box contains card 1, one box contains card n and the remaining box contains the cards from 2 to $n-1$.
- One box contains all cards congruent to 0 modulo 3, one box contains all cards congruent to 1 modulo 3, and the remaining box contains all cards congruent to 2 modulo 3.

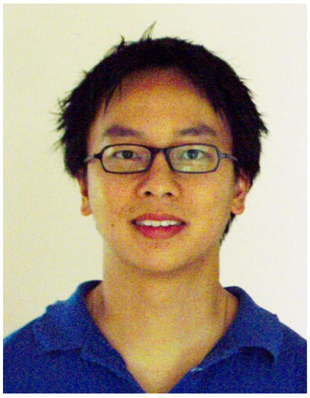
We will prove this by induction on n. Note that the base case when $n=3$ is trivially true, although the two solutions actually happen to coincide. Now suppose that the result is true for n cards and consider the case when there are $n+1$ cards.

Case 1: The card $n+1$ is alone in its box.
If 1 is not also alone in its box, then let N be the sum of the largest cards in each of the boxes not containing $n+1$. Note that $n+2 \leq N \leq 2n-1$, so we can achieve the same sum N using the card $n+1$ and the card $N-n-1$. Since these two

cards come from a different pair of boxes, we obtain a contradiction. Therefore, the card 1 must also be alone in its box, giving the first solution.

Case 2: The card $n + 1$ is not alone in its box.
Note that if we remove card $n + 1$, then we have a valid solution with n cards. By inspection, this solution must be of the second type. It is now easy to verify that card $n+1$ must then go into the box with all of the cards of the same residue modulo 3.

In conclusion, we note that for 100 cards, the magician has precisely 12 ways to arrange the cards in the boxes, 6 ways for each of the two solutions.



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.

Maths@work in Meteorology

Jeffrey D. Kepert*

The past few decades have seen a steady and dramatic improvement in our ability to forecast the weather. The Australian Bureau of Meteorology today issues seven-day forecasts for maximum temperature that are of similar accuracy to the four-day forecasts of 20 years ago, while modern four-day temperature forecasts are of comparable accuracy to the earlier one-day forecasts. Similar improvement is found for almost all forecasts — for example, the US National Hurricane Center extended the range of its tropical cyclone track forecasts to five days in 2003, and the verification skill scores show that these are as good as the two-day forecasts of the early 1980s.

Many would be aware, at least anecdotally, of these improvements, and could name improvements in satellites and computers as having played a large role. Using the ever-growing computer power to make the best use of the data from the satellites and other sources to produce forecasts in a timely manner remains a substantial problem, and one where mathematics plays a large role. The aim of this issue of maths@work is to outline one of the many areas in which mathematics is essential to modern meteorology, namely data assimilation.

The improvement in computer guidance, or numerical weather prediction (NWP), is illustrated in Figure 1, which shows the time series of the anomaly correlation[1] scores of three-, five- and seven-day forecasts at 500 hPa (about 5.5 km altitude) from the European Centre for Medium-Range Weather Forecasting (ECMWF) for the Northern and Southern Hemispheres. A significant part of the recent forecast improvements is due to improvements in the analysis algorithms, and particularly the treatment of satellite data. The growing utility of satellite data is illustrated by the elimination of the NWP skill difference between hemispheres in recent years — the Northern Hemisphere, with larger land masses and population, relies more heavily on in situ data from ground stations, balloons and aircraft, while the Southern Hemisphere contains much larger data-void oceans, so improvements in satellite data and its analysis have had a larger impact.

The numerical weather prediction problem falls into two parts. The prediction side of the problem is essentially computational fluid dynamics. Regional-scale models forecast out to 2–3 days and usually employ a finite-difference representation. Global-scale models are needed for longer forecast horizons, and use either a

*Bureau of Meteorology Research Centre, BMRC Data Assimilation Group, GPO Box 1289, Melbourne, VIC 3001. E-mail: J.Kepert@bom.gov.au

[1]The anomaly correlation is the correlation coefficient between the forecast and verifying analysis, both with climatology subtracted off. As a rule-of-thumb, 60% marks the threshhold of useful skill.

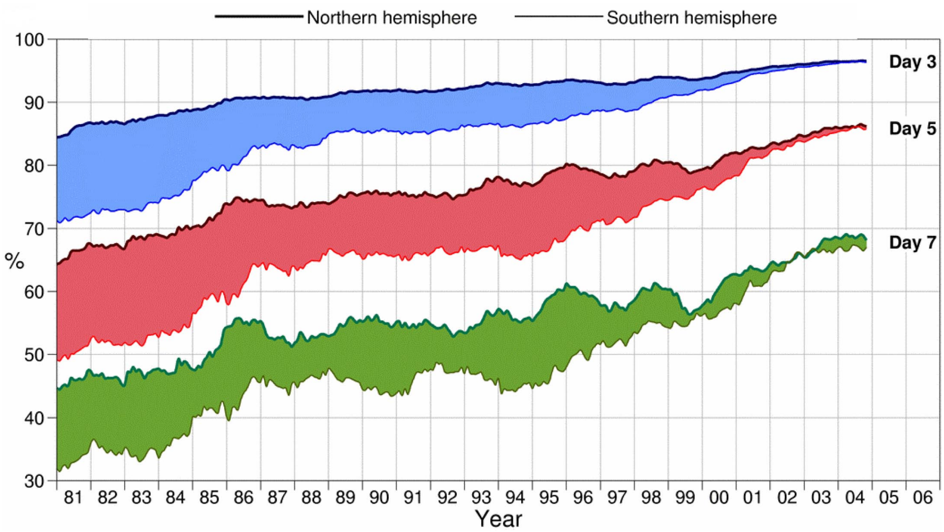


Figure 1. Anomaly correlation skill scores for the past 25 years for three-day (top), five-day (middle) and seven-day (bottom) forecasts by the ECMWF operational forecasting system, over the Northern (dark curves) and Southern (lighter curves) Hemispheres. Figure courtesy of Adrian Simmons, ECMWF.

finite-difference or a spectral (spherical harmonic) representation. As with other applications of computational fluid dynamics, it is necessary to include representations of physical processes that are not resolved by the fluid dynamics part of the model. In the atmosphere, these parametrised processes include turbulent diffusion, the fluxes of heat and water vapour to and from the underlying surface, radiation, and latent heat release due to evaporation and condensation of water. Accurately representing these processes is challenging. For instance, clouds come in many shapes and sizes, consist of some mixture of (possibly supercooled) liquid water droplets with various forms of ice, and interact strongly with radiation.

The other part of the prediction problem is finding the initial condition. Numerical weather prediction is a mixed initial value/boundary value problem — the forecast depends upon the initial atmospheric state, fixed boundary conditions such as topography, and variable ones such as sea surface temperature. Analysing the many disparate data sources to obtain the initial condition is known as data assimilation.

Data assimilation

In the Southern Hemisphere, satellite data are of paramount importance, since the large areas of ocean are nearly devoid of conventional observations. The satellite images seen on the television news are usually at 11μm wavelength, in the infrared. This is away from any absorption/emission lines in the atmospheric spectrum, and known as a window channel since the satellite sees essentially black-body radiation from the underlying surface or intervening cloud. In contrast, for frequencies within an atmospheric absorption band, upwelling radiation from the earth's surface is absorbed and re-emitted as it passes through the atmosphere. The outgoing radiation near the centre of the band where the atmosphere is opaque will be representative of the temperature in an upper layer of the atmosphere, whereas frequencies towards the edge of the band will be more sensitive to conditions lower in the atmosphere. Thus by taking many measurements at closely spaced frequencies across a peak in the atmospheric emission spectrum, information about the vertical temperature structure can be acquired.

Retrieving temperature profiles from such multiple radiance measurements is difficult. The radiative transfer equation is nonlinear, and each frequency is sensitive to a rather thick layer of the atmosphere. Mathematically, the problem is poorly conditioned and underdetermined, so a strategy of using extra information is beneficial. In fact, it is best to utilise the radiance data directly in the assimilation, rather than inverting the radiative transfer calculation to obtain temperatures and analysing those, as direct use implicitly utilises all the other data to help constrain the retrieval of temperature profiles from the radiances.

So how does data assimilation work? At each analysis time, we have two sources of information: a short-term numerical forecast from the previous analysis, and some observations. The problem of combining these disparate sources of information is approached by a least-squares minimisation,

$$J(\boldsymbol{x}) = (\boldsymbol{x} - \boldsymbol{x}_f)^{\mathsf{T}} \boldsymbol{B}^{-1} (\boldsymbol{x} - \boldsymbol{x}_f) + (\mathcal{H}(\boldsymbol{x}) - \boldsymbol{y})^{\mathsf{T}} \boldsymbol{R}^{-1} (\mathcal{H}(\boldsymbol{x}) - \boldsymbol{y}) \tag{1}$$

Here, the vector $\boldsymbol{x}$ is the analysis, $\boldsymbol{x}_f$ the short-term forecast, $\boldsymbol{y}$ are the observations, and the first term on the right-hand side measures the fit of the analysis to the short-term forecast, while the second measures the fit to the observations. $\mathcal{H}$ is an operator that produces the analysis estimate of the observed values. For observations of temperature, humidity or wind, $\mathcal{H}$ is just an interpolation from the model grid, but for satellite radiance measurements, $\mathcal{H}$ includes a radiative transfer calculation. The matrix $\boldsymbol{R}$ contains the variance of the random error in all the observations[2], together with the covariance of the error between all pairs of observations. Errors in observations are mostly independent, so $\boldsymbol{R}$ is nearly diagonal. Matrix $\boldsymbol{B}$ contains the error covariance of the short-term forecast, and is definitely not diagonal. Firstly, if the forecast is in error at a particular location, it is likely that similar errors apply nearby. Secondly, a forecast error in, say, pressure, is likely to be accompanied by errors in the wind, since wind and pressure are strongly coupled by atmospheric dynamics. Specifying $\boldsymbol{B}$ is a difficult but important task, since a well-formulated $\boldsymbol{B}$ allows the analysis to produce dynamically consistent results — wind observations are used not just to analyse the wind, but also to improve the depiction of the temperature and pressure fields.

Thus (1) is a very standard equation in statistics, that for finding the minimum variance estimate. With further assumptions, the analysis becomes the maximum likelihood estimate, with links to a large body of statistical theory and practice. Atmospheric data assimilation is different to other applications of these ideas in perhaps two ways: the enormous number of observations (currently millions per day), and the need to deal with highly correlated errors in the background forecast.

One approach to solving (1) is to differentiate and solve directly $\nabla J = 0$. This approach has gradually fallen into disfavour, since it involves directly inverting

[2]Random observation error includes instrument error, errors in the observation operator $\mathcal{H}$, and errors due to the instrument being affected by smaller scales of atmospheric motion than are resolved by the NWP system.

matrices whose dimension is the number of observations, and because it essentially replaces $\mathcal{H}$ by its first-order Taylor-series expansion, while the radiative transfer parts of $\mathcal{H}$ are quite nonlinear. Nowadays, we directly minimise (1) by a conjugate gradient algorithm or similar, called variational assimilation. Because we solve for the full three-dimensional structure of the atmosphere simultaneously, the specific algorithm is known as 3D-Var. Note that because observations of all types are considered simultaneously, together with the short-term forecast, a large amount of extra information is available to help constrain the poorly conditioned and underdetermined inversion of the satellite radiances.

Representing $\boldsymbol{B}$ is now important on two fronts. Apart from being necessary to produce a dynamically realistic result, $\boldsymbol{B}$ has a big influence on the conditioning of the problem, and hence the speed with which the minimisation algorithm will converge. Unfortunately, the naïve approach of calculating $\boldsymbol{B}$ in the model variables fails miserably. In this space, $\boldsymbol{B}$ is rank deficient to within numerical accuracy because it is representing highly correlated variables, and so direct minimisation of (1) will fail to converge. In addition, $\boldsymbol{B}$ contains the square of the number of model variables elements, and hence is too large to store, let alone operate on (the inverse is not required by minimisation algorithms, but it is necessary to be able to calculate the effect of multiplying a vector by $\boldsymbol{B}$).

Methods for representing $\boldsymbol{B}$ typically involve the following components:

- *Transform to less-correlated variables.* Writing the horizontal wind velocity (u, v) in terms of streamfunction ψ and velocity potential χ via

$$u = -\frac{\partial \psi}{\partial y} + \frac{\partial \chi}{\partial x} \tag{2}$$

$$v = \frac{\partial \psi}{\partial x} + \frac{\partial \chi}{\partial y} \tag{3}$$

  is helpful since forecast errors in ψ and χ are more isotropic and less cross-correlated than those in u and v. Similarly, there are quite accurate approximate balance relationships between ψ and the atmospheric pressure field, so replacing pressure by the residual unbalanced pressure eliminates the strong correlation between pressure and ψ.
- *Transform to spectral space.* Either a double Fourier representation (for a limited area model) or spherical harmonics (for a global model) are used in the horizontal. The vertical transformation may use empirical modes of some type, such as the leading eigenvectors of a covariance matrix calculated from a large sample of atmospheric columns. The variable transformations, and horizontal and vertical transformations, together make meteorologically reasonable parameterisations of $\boldsymbol{B}$ diagonal, giving the ultimate in good conditioning and computational efficiency. In fact, in variational assimilation, $\boldsymbol{B}$ is never defined in physical space, but rather in the transformed space.
- *Truncate the small scales.* The errors in the background forecast are known to be correlated over length scales of a few hundred kilometres or more. Equivalently, the error spectrum is red, with little power at small scales. Thus a lot of computer power can be saved by simply truncating $\boldsymbol{B}$ at some suitable scale, especially early in the iterative minimisation.

In practice, it is usual to replace (1) by the *incremental formulation*,

$$J(\boldsymbol{\delta x}) = \boldsymbol{\delta x}^{\mathsf{T}} \boldsymbol{B}^{-1} \boldsymbol{\delta x} + (\mathcal{H}(\boldsymbol{x}_f) + \boldsymbol{H}\boldsymbol{\delta x} - \boldsymbol{y})^{\mathsf{T}} \boldsymbol{R}^{-1} (\mathcal{H}(\boldsymbol{x}_f) + \boldsymbol{H}\boldsymbol{\delta x} - \boldsymbol{y}) \tag{4}$$

where $\boldsymbol{\delta x} = \boldsymbol{x} - \boldsymbol{x}_f$ and $\boldsymbol{H}$ is the Jacobian of $\mathcal{H}$. Here, the analysis estimate of the observation $\mathcal{H}(\boldsymbol{x})$ has been replaced by a first-order Taylor-series expansion $\mathcal{H}(\boldsymbol{x}_f) + \boldsymbol{H\delta x}$, which facilitates the truncation of the small scales in $\boldsymbol{B}$ since $\boldsymbol{\delta x}$ is only required at the reduced resolution. Note that this formulation does not involve extra coding, since calculating ∇J from (1) already required $\boldsymbol{H}$. A further refinement is to update the linearisation once or twice during the minimisation by replacing $\mathcal{H}(\boldsymbol{x}_f)$ with the current best estimate $\mathcal{H}(\boldsymbol{x}_f + \boldsymbol{\delta x}_n)$.

A matter of time

So far we have implicitly assumed that all the data occur at the analysis time. In practice, assimilation is usually done four times a day and all data in a six-hour window is assumed to occur at the middle of that window. This introduces some errors — weather systems move and develop! These errors can be reduced by assimilating more frequently, but that has its own problems. A better way is to introduce the time dimension into the assimilation, so-called four-dimensional variational assimilation (4D-Var). Suppose we have observations at two times (Fig. 2). The black curves show the state trajectory with independent 3D-Var assimilation at each time. But suppose we could use the observation $\boldsymbol{y}_2$ at time t_2 to adjust the state at t_1 in such a way that a forecast from t_1 to t_2 is now closer to the observation? We add another term to the cost function

$$J(\boldsymbol{x}) = \cdots + (\mathcal{H}_2(\mathcal{M}(\boldsymbol{x})) - \boldsymbol{y}_2)^\mathsf{T} \boldsymbol{R}_2^{-1} (\mathcal{H}_2(\mathcal{M}(\boldsymbol{x})) - \boldsymbol{y}_2) \tag{5}$$

where $\mathcal{M}$ is the model forecast from t_1 to t_2 and the subscripts 2 refer to the time t_2. Now the gradient ∇J, needed for the minimisation, has an additional term

$$\nabla J = \cdots + 2\boldsymbol{M}^\mathsf{T} \boldsymbol{H}_2^\mathsf{T} \boldsymbol{R}_2^{-1} (\mathcal{H}_2(\mathcal{M}(\boldsymbol{x})) - \boldsymbol{y}_2) \tag{6}$$

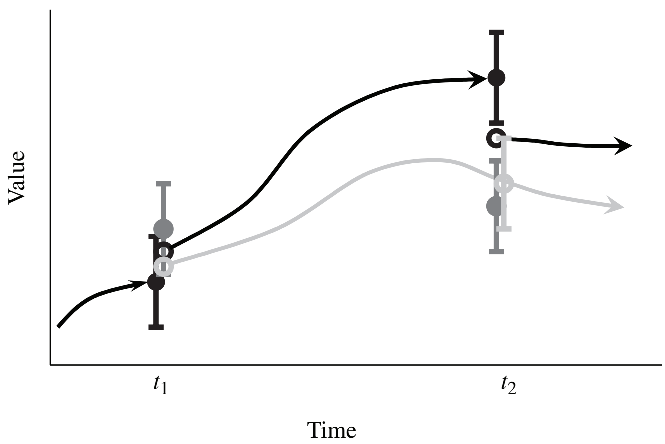


Figure 2. Schematic assimilation with two observation times. The 3D-Var assimilation is in black, with the curves representing the short-term forecast between analysis times. The analysis (open black circle) simultaneously minimises the sum of squared distances from the observation (filled dark-grey circle) and the short-term forecast (filled black circle). 4D-Var assimilation is in light grey. The analysed value at t_1 is close to the short-term forecast and observation at t_1, and initialises a forecast that is close to the observation at t_2.

that, by the chain rule of differentiation, contains the adjoint of the Jacobian of the observation operator, $\boldsymbol{H}_2^\top$, and the adjoint of the Jacobian of the model, $\boldsymbol{M}^\top$. $\boldsymbol{H}_2^\top$ takes information about the degree of misfit from radiance space back to analysis space, while $\boldsymbol{M}^\top$ propagates this misfit information backwards in time from t_2 to t_1. Minimising this J will produce an analysis at time t_1 that is close to the background and observation at that time, and that initialises a (linearised) forecast that is close to the observation at time t_2. Adding additional time levels is a straightforward extension, as is the incremental formulation.

To get 4D-Var to work on an atmospheric model in the order of 10^6 to 10^7 variables, assimilating millions of observations per day, within the limited time available under operational forecast constraints, is a major undertaking. The nonlinear atmospheric model consists of several hundred thousand lines of code, and 4D-Var requires the development of codes to represent operations by the Jacobian of the model and its adjoint. The minimisation itself benefits from research into very large optimisation problems. Even with all the computational tools in place, good results require careful attention to estimating the necessary statistics and to quality control of the observations.

Limitations of the current 4D-Var algorithm include the limited time frame over which the linearisation of the model is valid, and the failure to explicitly account for random error in the model. Accounting for the second will help with the first, and open up the possibility of performing assimilation over time windows of the order of a week long, with (hopefully) further significant improvements in forecast accuracy. The benefits include some theoretical links to other branches of mathematics: it can be shown with some reasonable assumptions that such 4D-Var schemes produce identical analyses to an extended Kalman filter (EKF). Although such a 4D-Var doesn't give the estimate of the analysis error covariance that the EKF does, our inability to even store this for the atmosphere means that it is hardly a limitation.

Maths@work

I have given a broad outline of one component of NWP that mathematics is having a big impact upon. Obviously it is not the only one — mathematics has a strong influence on the computational fluid dynamics aspects, as well as the efficient representation of radiative transfer, turbulence and clouds. A further area is in the growing field of probability forecasts, which require what is essentially Monte Carlo simulation of the atmosphere. Many questions arise here, and a great deal of work has been done on working out how best to perturb the initial conditions, represent model uncertainty, extract the probabilistic information, communicate it to users, and validate the forecasts. One successful approach has been to use the linearised and adjoint models to iteratively solve the eigen-problem of finding the most rapidly growing modes of the current atmospheric state. These unstable modes have many uses, including as a basis for Monte Carlo initial condition perturbations. A further promising field is in using an ensemble of background forecasts to produce 'errors of the day' that is, a $\boldsymbol{B}$ which reflects the varying accuracy of the background forecast in space and time, according to the difficulty of forecasting today's particular meteorological situation.

As well as having here considered only one aspect of NWP, it is important to remember that NWP is only one area in which mathematics is used in meteorology. In my career, apart from topics in data assimilation, I have worked on boundary layer flows, turbulence, tropical cyclone dynamics, forecast verification and the effects of evaporating sea-spray droplets. Mathematical tools used include the analytical and numerical solution of differential equations, Taylor and Fourier series expansion, linear algebra, multiple linear and nonlinear regression, Monte Carlo simulation, statistical significance testing, and symbolic algebra software. In my experience, many interesting problems have required several of these tools, so a breadth of knowledge has been important. I would also encourage young mathematicians that there remain many more interesting problems in meteorology upon which mathematics will have a large impact, and that the chaotic nature of the atmosphere and the ever-growing demand for meteorological services means that they should never be out of either a challenge, or a job!

Dr Jeff Kepert works in the Bureau of Meteorology Research Centre (BMRC), which undertakes research to improve scientific understanding of, and the ability to forecast, Australia's climate and weather.

Jeff originally studied at the University of Western Australia, majoring in pure mathematics and statistics. After joining the Bureau of Meteorology in 1984, he worked as a forecaster for a couple of years before returning to study for a MSc in dynamical meteorology at Monash University. This led to a couple of years working as an instructor in the Bureau's training centre, before moving to BMRC in 1992 to study the representation of clouds in numerical weather prediction systems. Since then, Jeff has worked on tropical cyclone dynamics, air–sea exchanges, turbulence, high-resolution wind prediction, and data assimilation. During this period, he completed a part-time PhD on tropical cyclone boundary layer winds at Monash University.

The style files

Write what you mean

Tony Roberts*

> The only proper attitude is to look upon a successful interpretation, a correct understanding, as a triumph against the odds. We must cease to regard a misinterpretation as a mere unlucky accident. We must treat it as the normal and probable event. *Practical Criticism*, I.A. Richards (1929)

Surely communication cannot be quite as difficult as Richards suggests. Yet consider this simple sentence which a few years ago appeared in the Review section of the *New Scientist* magazine: 'Mostly, I read the books I review on trains'. We know what the writer means: when he gets a book to review, he generally chooses to read them while travelling on a train, probably while commuting. But imagine a reader who does not share the same context as you, I and the writer; such a reader could easily and justifiably interpret the sentence quite differently. The sentence could mean that when the writer gets to review a book about trains, then the writer mostly chooses to read them. If such a simple little sentence can be subject to such different interpretations, then, yes, communication is difficult.

In this simple sentence, the problem lies in the chosen word order. Reorder the words:

Poor: Mostly, I read the books I review on trains.
Good: Mostly, I read on trains the books that I review.

This reordering is much harder to misinterpret. Carefully reordering words in a sentence will greatly clarify meaning. When revising, read each sentence you write and ask whether you could reorder the words to ensure that the sentence reads what you mean to write [2, Section 4.32].

Higham [2, Section 4.32] gives an example, with a misplaced 'only', where reordering strengthens a sentence and removes ambiguity.

Poor: The limit point is only a stationary point when the regularity conditions are satisfied.
Good: The limit point is a stationary point only when the regularity conditions are satisfied.

Strunk similarly advises us to keep related words together.

> The position of the words in a sentence is the principal means of showing their relationship. The writer must therefore, so far as possible, bring together the words, and groups of words, that are related in thought, and keep apart those which are not so related. Strunk [5, Section 16]

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

Strunk gives the following example.

Poor: Cast iron, when treated in a Bessemer converter, is changed into steel.
Good: By treatment in a Bessemer converter, cast iron is changed into steel.

Summary

Much confusion arises when words which relate to the same thing are separated by a significant chunk of the sentence. Consider word and phrase order carefully for each sentence.

Postscript

Since writing the previous article on typesetting documents for effective comprehension, I became aware that Colin Wheildon [6] recently published an updated report on his research. Those intrigued by typesetting for communication should read the details Colin describes in this recent book.

References

[1] Garrett, A. (2000). Principles of science writing. Technical report, Scitext Cambridge. http://www.scitext.com/writing.php (accessed 15 April 2007).

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

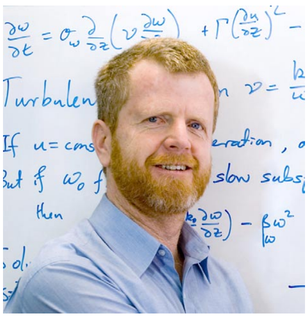
[3] McIntyre, M.E. (2005). *Lucidity Principles in Brief*. Technical report. http://www.atm.damtp.cam.ac.uk/people/mem/lucidity-in-brief/ (accessed 15 April 2007).

[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 15 April 2007).

[5] Strunk, W., Jr (1918). *The Elements of Style*. W.P. Humphrey. http://www.bartleby.com/141 (accessed 15 April 2007).

[6] Wheildon, C. (1986). *Communicating? Or Just Making Pretty Shapes*. Technical report. Newspaper Advertising Bureau, Australia.

[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.

ANZIAM 2007: 43rd Applied Mathematics Conference

28 January – 1 February 2007, Fremantle, Western Australia

Graeme Hocking*

The 43rd Applied Mathematics conference was held in Fremantle in Western Australia from 28 January to 1 February 2007. The dates were a week earlier than usual after a swap with the MISG (held in Wollongong) in order to get access to the excellent venue at the Esplanade Hotel.

Fremantle is the port of Perth in Western Australia and has a village atmosphere in spite of its proximity to a large city. It is a lively area with many restaurants and coffee shops available for mathematical discussions.

2006 ANZIAM medal winner, Graeme Wake

The conference was opened by Professor Graeme Wake from Massey University, the most recent recipient of the ANZIAM medal for distinguished contributions to the community. There were 127 delegates for the full conference and another 20 day-registrants for the statistics day. Of the total, 30 registered as students thanks partly to travel assistance provided by ANZIAM.

The first day of the conference was designated to be a statistics day to enhance collaboration and understanding of two closely related communities. Thanks go to Brenton Clarke and the WA Branch of the Australian Statistical Society for coming to the party! In the spirit of this, the first invited speaker was Adrian Baddeley from the University of Western Australia who gave an entertaining discourse entitled ‘Sampling theory for vegetables’, assuring us that the title did not refer to the audience but the subject matter. Before lunch, Nigel Bean spoke on ‘Markovian Binary trees; a model of the macro evolutionary process’. The successful day was concluded by Ian James from Murdoch University who spoke on ‘Estimation of natural HIV disease progression with unknown or uncertain dates of infection’. The day was attended by 20 day-registrants from the WA statistics community and was generally regarded to be successful with some significant cross-fertilisation.

*Director, ANZIAM 2007
Department of Mathematics and Statistics, Murdoch University, Perth, WA 6150. E-mail: G.Hocking@murdoch.edu.au

Tuesday began with Graeme Wake fulfilling his obligations as the most recent ANZIAM winner with his talk on ‘Modeling of cancer treatment’, and Phil Howlett took us to the afternoon break with ‘Inversion of analytically perturbed linear operators that are singular at the origin’. No particular excursion was organised for the rest afternoon due to the rich variety of possible activities within Fremantle itself. Several delegates did get ‘down and dirty’ by taking the underground tunnel tour of Fremantle Prison.

On Wednesday morning, Hinke Osinga from the University of Bristol spoke on ‘Global bifurcations of the Lorenz manifold’. Hinke is famous in the non-mathematical world (and within) for crocheting the Lorenz Manifold and this was picked up by the ABC during her visit to Australia giving mathematics some air time on ABC radio. She was an enthusiastic participant in the conference and was happy to show off her creation.

Mark McGuinness from the University of Wellington provided ‘A salty tale — modeling the growth of sea ice in Antarctica’ replete with computational display pyrotechnics, and Thursday morning’s speaker was Peter Clarkson from the University of Kent giving some ‘Rational solutions of the Painleve equations and applications to soliton equations’.

Hinke Osinga (with Natashia Boland, right) shows off her crocheted Lorenz Manifold


Andrew Bassom presents Sharleen Harper with the TM Cherry student prize

The conference dinner was ushered in by the music of a local string trio, ‘Angel Sounds’. The evening began with Ernie Tuck proposing a toast to the memory of Ren Potts who passed away in 2005 and was a dominant and much-loved member of ANZIAM for 40 years. Ren was awarded the first ANZIAM medal at the last Applied Mathematics Conference to be held in Western Australia, the 1995 Busselton Conference.

In addition to the invited talks there were 102 contributed talks, of which 24 were student presentations eligible for the TM Cherry Prize. Andrew Bassom from the University of WA chaired the prize committee that consisted of Robert Mckibbin, Yvonne Stokes, Hinke Osinga, Alex James, Scott McCue, Mark Lukas and Belinda Barnes. Thanks to all for their major contributions to this important activity. As usual the standard of talks was extremely high, threatening to embarrass some of us more seasoned campaigners, but after a tight vote, the TM Cherry Prize was awarded to Sharleen Harper from Massey University for her talk entitled ‘A continuum approach to modeling droplet interception by a shelterbelt’.

Another link to the 1995 conference was the Cherry Ripe prize for the best non-student talk, selected by the students. Initiated by the students, lead by David Marlow (see *Gazette* **22**(3), August 1995 for a transcription of his talk); this was devised at the 1995 conference as revenge for years of ‘torture’ of the students by the fraternity. The inaugural winner of this award, Natashia Boland, created an abridged version of the original speech which was read with great enthusiasm by Melanie Roberts. Kim Levy then presented this years winner, Geoff Mercer, with the award for his talk ‘Exact and approximate continuous methods for finding the minimal risk route through a minefield’ with the words ‘We have been *tracking* the best non-student speaker for the last three days according to *random* criteria. Given we only had *partial differential* observers, there is no guarantee the solution is *optimal*, or even *asymptotically stable*’.

The last formal activity of the conference dinner was the presentation of the best new researcher award, the JH Michell medal. Larry Forbes was the chair of the committee and announced this year’s winner to be Yvonne Stokes from Adelaide University.

As usual, it is the participants that make a conference a success, and the organising committee would like to thank all those that attended, and all of those who helped out in various ways as the week progressed. As the Director, I would like to conclude by thanking the other members of the committee and those staff of Murdoch University and of the University of Western Australia who helped in so many ways, in particular, Duncan Farrow, Des Hill and Andrew Bassom for their enormous efforts over the whole year. Modern conferences rely almost exclusively on the internet for communications and I must thank those organisers of earlier conferences who developed the software that we used. Special thanks also must go yet again to Bill Summerfield for his advice on many of the issues that arose during the year. His impending retirement as secretary of ANZIAM will leave a large hole not only in the continuity of knowledge for the conference but the Division as a whole.

J.H. Michell Medal awarded to Dr Yvonne Stokes

W. Summerfield*

The Executive Committee of ANZIAM endorsed the recommendation of the selection panel for the 2007 J.H. Michell Medal, for ANZIAM's Outstanding New Researcher Award. The medal was announced, and presented, at the Conference Dinner of ANZIAM 2007, held in Fremantle, WA, over 28 January – 1 February, 2007. The selection criteria for the award can be viewed on the ANZIAM website (http://www.anziam.org.au).

The Selection panel reported:

After careful consideration, the committee is unanimous in recommending that the J.H. Michell Medal be awarded to Dr Yvonne Marie Stokes from the University of Adelaide.

Yvonne Stokes, 2007 J.H. Michell Medal winner, and Chair of the selection panel, Larry Forbes

Dr Yvonne Stokes has interests in a broad variety of applications of mathematics. She has considered viscous fluid flow in curved pipes, the behaviour of glass slumping in the formation of optical lenses, the distortion of window panes over time and the behaviour of elongated viscous fluid drops. She has also worked in biological applications, including the behaviour of limbs in which there is a broken bone and the modelling of oxygen concentration in cells. She has demonstrated considerable determination and self-motivation in her research, with two single-author publications in the prestigious *Proceedings of the Royal Society*, and another single author paper in *Computers and Fluids*. She has 11 papers in refereed journals and a further seven refereed conference papers. Her work has also received media interest, with articles appearing in *The Economist*, *The Times*, and *The Australian*.

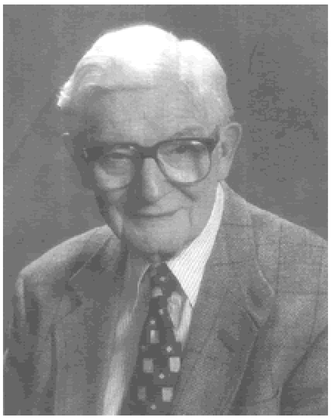
Yvonne Stokes has been active in seeking collaborations with industry and researchers in Israel, Scotland, the Netherlands and the United States. She has also recently worked with a research group in obstetrics and gynaecology. She is currently joint chief investigator on an ARC grant (with Professor Tuck).

Yvonne has been a very active member of ANZIAM since 1995 and the secretary of the South Australian branch since 1999. She has been a very prominent participant in the Mathematics in Industry Study Groups, where she has led the work on several of the industrial problems.

The Committee strongly recommends Dr Yvonne Stokes for the 2007 Michell Medal, and is confident that she will prove to be a future leader in Applied Mathematics.

*Honorary Secretary, ANZIAM
School of Mathematical and Physical Sciences, University of Newcastle, Callaghan, NSW 2308.
E-mail: Bill.Summerfield@newcastle.edu.au

Obituary



Leslie Colin Woods
6 December 1922 – 15 April 2007

Leslie Colin Woodhead was born on 6 December 1922 at Reporoa, a small settlement between Rotorua and Taupo in New Zealand. When Leslie was four years old his father became a fisherman at Mercury Bay, with the family living in an isolated tent by the mouth of Purangi Creek, 5 km from Whitianga. His father had to take the fish which he caught to Auckland in order to sell them, and so when Leslie was nine years old the family moved to Auckland.

In 1934 and 1935 he attended Brixton Road Primary School, where he received top marks in the Standard 6 examination (Year 8 today). His teachers urged him to go to a grammar school, but in 1936 Leslie's father instead sent him to Seddon Memorial Technical College to train as a mechanic. The boys in the engineering classes were taught some mathematics, by rote. Cyril Maloy taught those classes, where he recognised Leslie's potential, and in 1937 he suggested that Leslie should transfer to accountancy and prepare for the Matriculation examination. Leslie had no objection, and his father was not consulted.

In 1938 he easily passed the Matriculation examination and he hoped to enroll at Auckland University College the following year, but his father refused to pay the fees. Cyril Maloy then suggested that he return to Seddon Tech for a year and try for one of the 30 entrance scholarships, and Leslie's father agreed reluctantly. He sat the Entrance Scholarship examination in December 1939 and came 26th on the list of 30 winners — the first ever winner from Seddon Tech. He was jubilant and so were his teachers, and he looked forward eagerly to starting university study — but then his father refused to provide board for him. Thereupon Cyril Maloy declared that *he* would pay Leslie's board, and that noble offer shamed Leslie's father into agreeing to provide board for his exasperating son.

Leslie enrolled in 1940 to study engineering. He enjoyed the mathematics lectures by Professor Henry Forder and by Cecil Segedin, but was bored by Keith

Bullen's lectures. Leslie's home life became increasingly miserable, and in 1941 he told his father that he was going to leave home. Leslie became reconciled with his parents only when they had grown old.

Leslie resigned his scholarship, and volunteered to join the RNZAF. He trained at Ardmore Airfield, on Tiger Moth biplanes. At a dance in Ashburton he met Betty, and they married on 21 August 1943. He decided to resume extramural study for a BSc; and Cecil Segedin gave him very helpful advice. In November 1943 he went to Auckland University College and passed examinations in Pure and Applied Mathematics, giving him seven of the eight units required for BSc. A few months later he was invited to apply for a BSc immediately, under special regulations for servicemen, and so he gained his first degree. In December 1943 Leslie applied successfully for active service in the Pacific War, where RNZAF pilots flew American aircraft under US command. In three tours of duty at Bougainville, Flying Officer Leslie Woodhead flew 76 missions, with many dive-bombing raids on the Japanese fortress at Rabaul. Nine of his close friends were killed during that period, mostly in flying accidents. During home leave after his first tour of duty, with his first child due in three months, Leslie Woodhead changed his surname to Woods, to spite his father. On his second leave Leslie Woods saw his first daughter — eventually he had a family of five daughters. He sat his examinations and gained second-class Honours in Mathematics for his MSc, and he passed Philosophy 1. The Government announced generous provisions for rehabilitation of servicemen, and he decided to study for a BE, which he was qualified to complete in two years. In November 1945 he sat further examinations (at Christchurch) for his BA; and he was discharged from the RNZAF on 17 November 1945.

In 1946 Leslie resumed studying at Auckland University College School of Engineering, in the 'temporary' tin shed built in 1908. (It was finally demolished in 1979.) He augmented his income by teaching some evening classes at Seddon Tech. He applied for a Rhodes Scholarship to undertake research at Oxford for a DPhil in Engineering Science, and on 25 November 1947 he was awarded that prestigious scholarship. At the end of 1947 he completed his BE, and Professor Leech appointed him as Temporary Junior Lecturer to teach Fluid Dynamics and Aeronautics. The tin shed had ceased to be useable, and Professor Leech abruptly shifted the School of Engineering to the RNZAF base at Ardmore Airfield. Leslie lectured there until August 1948, initially traveling by motorbike 50 miles each day.

In August 1948 the Woods family flew from Auckland to Sydney on a Sunderland flying-boat, taking eight and a half hours for the flight. After a week in Sydney the family boarded the SS *Orion* for a five-week journey to London. Leslie had been accepted by Merton College, where the Secretary provided a room for him, but was bewildered by his request for accommodation for his family. Food was still rationed in the UK, and accommodation was desperately short around Oxford. In desperation, he took his wife and daughters to stay temporarily with a cousin of hers in West Bromwich. His encounter with the English class system, manifested in the hideous slums of the Black Country, was a startling experience for anyone coming from a tent by Purangi

Creek. Eventually his family joined him in a semi-detached house in Upper Wolvercote, and he splurged his funds to buy a motorcar.

Leslie joined the University Air Squadron, after negotiating the obstacles of his interview by a panel of RAF officers, one of whom surprised Leslie by asking what his father did. The answer 'He was a fisherman' nonplussed the officers, and so Leslie explained that 'He owns his boat'. 'Ah, a fishing manager', one of them said, smiling! The Wing Commander asked Leslie about the games that he played, and he replied that he had played football in NZ and now played for Merton College. 'Football?'. 'Yes'. 'He means rugger, Sir!'. More smiles of approval, and he was accepted in December 1948. Initially he flew Tiger Moths, but on 13 July 1950 he flew a Meteor jet. The next day he gave instruction on a Harvard, on his final flight as a pilot of powered aircraft. He had joined the New Zealand Defence Corps, which supported his further study and research, but he had to resign from the University Air Squadron.

At the Engineering Laboratory, Leslie studied under Alexander Thom and worked on transonic flow around a two-dimensional aerofoil, laboriously solving finite-difference equations with the aid of a Brunsviga calculator. He earned some much-needed money by teaching Mechanics at Oxford Technical College. In 1950 he was awarded a DPhil for his thesis *The flow of a compressible fluid about a body*, which resulted in seven publications and an auspicious start for his academic career. In preparation for the degree ceremony he met the Dean of Degrees, who asked Leslie whether he had a degree. He explained that he had a Master of Science and a Bachelor of Engineering from the University of New Zealand; to which the Merton Dean responded flatly 'You have no degree'! Leslie then created something of a precedent by taking an Oxford BA after gaining his DPhil — the First Class which he gained in 1951 obscured his Second-Class MSc (NZ). After the farce of his unearned MA (Oxon) he gained a DSc (NZ) and DSc (Oxon), and in 1983 the University of Auckland awarded him an honorary DSc at its centennial celebrations.

In 1951 the NZDC seconded Leslie to the National Physical Laboratory at Teddington, where he worked on aerofoil theory and published many papers. He applied for a Senior Lectureship in Applied Mathematics at Sydney University, and he was appointed to start in February 1954. Only after he had accepted did he learn of the internecine warfare in that Mathematics Department, between the Professor of Pure Mathematics T.G. Room and the Professor of Applied Mathematics Keith Bullen. The Woods family greatly enjoyed living in Sydney, but the fraught conditions within the Department made working there very difficult. The relations between Leslie and Keith Bullen steadily deteriorated, culminating in March 1956 in a blazing row in Bullen's office. Leslie finished by telling Bullen that he would take the first available university post at whatever level, to leave this petty domination. In May 1956, at the age of 33, Leslie became the second Nuffield Research Professor of Mechanical Engineering at the University of Technology at Sydney. When the Australian Mathematical Society was founded in 1956 he was elected a member of the first Council, and in 1958–1959 he became the vice-president. His extensive research on aerofoil theory was summarised in his treatise *The Theory of SubsonicPlane Flow* (CUP, 1961), which remained in print for 25 years. In 1958 he became acquainted with plasma physics, and he gave some lectures on controlled thermonuclear fusion in his nuclear engineering course. His lecture notes on reactor physics got published as the Methuen monograph *An Introduction to Neutron Distribution Theory.*

At the end of 1959 the Woods family sailed cheaply to England, where he was to become an associate of the 'Controlled Thermonuclear Reaction Division of the Atomic Energy Research Establishment' at Harwell, for 1960. Enormous sums of money have been spent since 1950 by many governments on attempts to generate power by controlled thermonuclear fusion, with plasma confined by magnetic fields. Leslie started work at Harwell on investigating the basic magnetoplasma problem of why, in all attempts to confine plasma, it escaped across the magnetic field at *thousands* of times the rate predicted. The early optimistic forecasts of the imminence of power production by controlled thermonuclear reactions looked increasingly improbable, as physicists failed to cope with that fundamental problem. Then Balliol College invited him to become their Foundation Fellow in Engineering. That provided the opportunity to continue in plasma physics research, perhaps with a consultancy at Harwell; and so he accepted the invitation. Leslie returned to Sydney to make the (very difficult) arrangements for his departure, and then visited his parents and friends in Auckland. *The New Zealand Herald* published a story (30 November 1960), in which he estimated that 'It might be 50 years before the enormous energy in the hydrogen bomb can be brought under control'. In 2000, he described that as an underestimate.

Leslie began his duties as Balliol Tutor in January 1961, and he was appointed as a consultant in plasma physics for Harwell. Until 1977 he spent one day a week at the Laboratory (situated at Culham from 1963), studying mostly instabilities in plasmas. In 1965 he was promoted to Reader in Applied Mathematics, and in 1969 he was appointed as Professor of the Mathematics of Plasma. From 1953 Leslie had attended some international conferences, and the frequency with which he attended conferences increased steadily from 1960 to 1980. Also he accepted many visiting professorships and visiting fellowships at universities around the world, including visits to NZ.

The marriage of Leslie and Betty had mostly been happy, but he had persistent difficulties with her mother. In 1973 those problems escalated and the marriage broke down, with an expensive divorce in 1977. And two later marriages also ended in divorce for Leslie Colin Woods.

Leslie worked in the tradition of British applied mathematics, devoted to the solution of real problems arising in physical or technological contexts. His writings are distinguished by critical care and independence in the mathematical formulation, and in his interpretation of the results. He could employ an impressive mastery of technique, where that was appropriate. He clearly presented his views on applications of mathematics in his articles 'Beware of Axiomatics in Applied Mathematics' (*Bulletin of the IMA* **9**, 40–44), and 'The Bogus Axioms of Continuum Mechanics' (*Bulletin of the IMA* **17**, 98–102), both of which stimulated intense discussion. Leslie was a vigorous participant in scientific controversy.

The favourite device for fusion research is the Tokamak, with the Joint European Tokamak (JET) at Culham being the largest, looking like a set designed for an extravagant science-fiction film. It was designed to generate power by heating deuterium and tritium to 300 million K and confining that plasma for 25 minutes, so that the nuclei would react to produce helium and neutrons. The use of radioactive tritium introduced significant radiation hazards, since all isotopes of hydrogen diffuse through iron and other metals. If that D-T reaction ever did occur, then it would produce a flux of neutrons at least as dangerous as that from a fission reactor of comparable power. But, after several European governments have provided several hundred million pounds over nearly 50 years, only in recent years has JET succeeded in confining plasma for a period approaching 1 second. Many types of instability have been discovered by Leslie and others, and attempts were made to patch up the apparatus to cope with them.

Leslie wrote *The Thermodynamics of Fluid Systems* (OUP, 1975). In 1979 he found that a basic equation used by plasma physicists is incorrect — the pressure used in that formula does not correspond to the collision of particles. He explained that to the Director of Culham Laboratory, who told Leslie that he was wrong and refused to renew Leslie's consultancy. Leslie then wrote three major texts on plasma physics: *Magnetoplasma Dynamics* (OUP, 1987), *Kinetic Theory of Gases and Magnetoplasmas* (OUP, 1993) and *Thermodynamic Inequalities with Applications to Gases and Magnetoplasmas* (Wiley, 1996). Those texts were reviewed dismissively by the thermonuclear establishment, but many other physicists have appreciated them. Leslie commented that

> The evident failure of the fusion programme will never be admitted by those whose careers and livelihoods depend on maintaining the myth of 'steady progress'.

In 1984, Leslie became Chairman of the Mathematical Institute at Oxford University — he described that as simply being his turn, as the most senior professor available. In 1985 and 1986 he was in Muscat to create a mathematics department, as the Foundation Professor of Mathematics for the Sultan Qaboos University. He resigned as Chairman of the Mathematical Institute in October 1989, and his Professorial Fellowship in Balliol terminated in 1990. He continued with some consultancy work and with visiting appointments at various universities. He resumed playing his clarinet, and in 1996 (aged 73) he took up gliding as a hobby. And he continued research into solar physics.

In 1990, *The New Zealand Mathematical Society Newsletter* **48** published a Centrefold article *Leslie Colin Woods*, by Brian Woods. In 1998 Leslie was the New Zealand Mathematical Society Lecturer at the Mathematics Colloquium at the Victoria University of Wellington, where his memorable lecture on *The Tokamak disaster* was much appreciated. He then gave lectures at other universities in NZ. Auckland Institute of Technology (which later became the Auckland University of Technology) was a successor to Seddon Memorial Technical College, and in 1998 the AIT fêted Leslie as *their* Rhodes Scholar. He gave there a seminar on the philosophy of science, and he was delighted to be able to pay tribute to his patron Cyril Maloy, who had recognised Leslie's potential 62 years previously, and who was there in the audience.

When Leslie's eldest daughter Coral was dying of cancer at the age of 49, he wrote for her a brief account of his early life in New Zealand. She urged him to continue writing the story of his life, and he dedicated that autobiography to her memory. It was published as *Against the tide: An autobiographical account of a professional outsider*, Institute of Physics Publishing, Bristol & Philadelphia, 2000.

On a visit to Auckland in 2003 Leslie visited the aerodrome at Ardmore, where he was delighted to find one of the Tiger Moth biplanes on which he had trained in 1941, revving on the tarmac, ready to take him for a spin.

Leslie summarised his experience with Tokamak in his treatise on *Theory of Tokamak Transport: New Aspects for Nuclear Fusion Reactor Design* (Wiley, 2006).

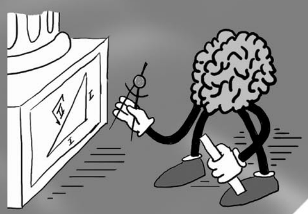
On 15 April 2007, Leslie Woods died in his sleep at Oxford, aged 84.

Garry J. Tee[1] and Graeme C. Wake[2]

> Graeme first met Leslie in 1970 when he went to Oxford as a post-doctoral scholar. Leslie treasured his ANZ roots and took many of us Aussies and Kiwis under his wing. They became close friends and met frequently after Graeme returned to NZ in late 1971. Graeme last dined with Leslie in July 2006 when revisiting Oxford. In March 2007 Leslie gave an invited lecture on the tokamaks at the University of Western Ontario in Canada, which was well received.
>
> Garry was nine years after Leslie as a student at Brixton Road Primary School, Seddon Memorial Technical College and Auckland University College. Like Leslie, he is an alumnus and retired faculty member of the University of Auckland, and is a leading writer on science and mathematics history.

[1]Department of Mathematics, University of Auckland, Private Bag 92019, Auckland, New Zealand. E-mail: tee@math.auckland.ac.nz

[2]Institute of Information and Mathematical Sciences, Massey University at Albany, PB 102904, North Shore MC, Auckland, New Zealand. E-mail: g.c.wake@massey.ac.nz



More on π

Michael D. Hirschhorn*

Abstract

We give simple proofs of the facts that $\pi < \frac{355}{113}$ and $3\frac{10}{71} < \pi < 3\frac{1}{7}$.

It has been known since Archimedes (c. 250BC) that π is roughly $\frac{22}{7}$, and that $\pi < \frac{22}{7}$. A really neat proof of these facts was found, perhaps by Kurt Mahler in the 1960s, and that is

$$\int_0^1 \frac{x^4(1-x)^4}{1+x^2}\,dx = \frac{22}{7} - \pi. \qquad (*)$$

It is clear that the integral is positive, and since the denominator of the integrand is at least 1, the integral is less than $\frac{1}{630}$.

It has been known since Zhu Chongzhi (5th century) that an approximation to π, better than $\frac{22}{7}$, is $\frac{355}{113}$, which also is in excess. (π and $\frac{355}{113}$ agree to 6 decimals.)

In a recent article, Stephen Lucas [1] sought a simple integral which is obviously positive, and whose value is $\frac{355}{113} - \pi$. Perhaps the nicest he came up with is

$$\int_0^1 \frac{x^8(1-x)^8(25+816x^2)}{3164(1+x^2)}\,dx = \frac{355}{113} - \pi.$$

I noticed that the idea involved in $(*)$ can be extended to prove not only the desired result, but more.

Consider

$$\int_0^1 \frac{x^{4n}(1-x)^4}{1+x^2}\,dx.$$

To evaluate this integral, we use partial fractions:

$$\frac{x^{4n}(1-x)^4}{1+x^2} = x^{4n+2} - 4x^{4n+1} + 5x^{4n} - 4x^{4n-2} + 4x^{4n-4} - + \cdots + 4 - \frac{4}{1+x^2}.$$

It follows that

$$\begin{aligned}\int_0^1 \frac{x^{4n}(1-x)^4}{1+x^2}\,dx &= 4\left(1 - \frac{1}{3} + \frac{1}{5} - + \cdots - \frac{1}{4n-1}\right) + \frac{5}{4n+1} \\ &\qquad - \frac{4}{4n+2} + \frac{1}{4n+3} - \pi \\ &= \text{rational } - \pi,\end{aligned}$$

Received 23 February 2007; accepted for publication 1 June 2007

*School of Mathematics and Statistics, UNSW, Sydney, NSW 2052.
E-mail: m.hirschhorn@unsw.edu.au

where the denominator of the rational is (before any cancellation) divisible by all primes up to $4n+3$.

Thus, for example,

$$\int_0^1 \frac{x^{112}(1-x)^4}{1+x^2}\,dx = \frac{P}{113Q} - \pi,$$

where, using my trusty computer I find

$$\begin{aligned} P &= 46\,922\,045\,053\,712\,930\,642\,150\,903\,262\,788\,670\,879\,977\,081\,355\,826,\\ Q &= 132\,174\,785\,996\,436\,457\,344\,235\,486\,484\,552\,040\,071\,436\,191\,175,\\ P < 355Q &= 46\,922\,049\,028\,734\,942\,357\,203\,597\,702\,015\,974\,225\,359\,847\,867\,125 \end{aligned}$$

and

$$0 < \int_0^1 \frac{x^{112}(1-x)^4}{1+x^2}\,dx < \frac{355}{113} - \pi,$$

which gives

$$\pi < \frac{355}{113}.$$

In a similar vein,

$$\int_0^1 \frac{x^{4n+2}(1-x)^4}{1+x^2}\,dx = \pi - \text{rational},$$

where the denominator is (before any cancellation) divisible by all primes up to $4n+5$. In particular,

$$\int_0^1 \frac{x^{70}(1-x)^4}{1+x^2}\,dx = \pi - \frac{R}{71S},$$

where

$$\begin{aligned} R &= 3\,100\,473\,885\,152\,861\,164\,004\,910\,599\,081,\\ S &= 13\,900\,161\,851\,314\,672\,380\,764\,590\,350,\\ R > 223S &= 3\,099\,736\,092\,843\,171\,940\,910\,503\,648\,050 \end{aligned}$$

and

$$0 < \int_0^1 \frac{x^{70}(1-x)^4}{1+x^2} < \pi - \frac{223}{71},$$

from which

$$\pi > \frac{223}{71} = 3\frac{10}{71},$$

a fact known to Archimedes.

References

[1] Lucas, S.K. (2005). Integral proofs that $355/113 > \pi$, *Gaz. Aust. Math. Soc.* **32,** 263–266.

Book reviews

Master Classes in Mathematics*

W.M. Stephens (Ed.)
The Mathematical Association of Victoria, 2006, ISBN: 978 1 87694 932 7

In the volume 'Master Classes in Mathematics' Max Stephens has assembled a record of nine selected talks given to the Mathematical Association of Victoria (MAV) by active teachers and mathematicians during the mid- to late-1950s. For some of the reproduced talks the original notes of the author have been typeset: for others, handwritten notes taken by an MAV member present at the talk have enabled the reconstruction.

The volume provides an interesting snapshot of the Mathematical Association of Victoria at the middle of its one hundred year history. In his 'Foreword' to the volume, Max Stephens states: 'One reason for the decision to publish this selection is that they show the vitality and energy of the MAV at a specific period of time. The nine papers selected for publication in this book were chosen from a much larger set of talks and presentations given to the MAV . . . '. Max also writes: 'The whole collection (of talks) shows that the MAV's current goal of Valuing Mathematics in Society was seen as fundamentally important fifty years ago'. The transcripts of the talks themselves very much support Max's assertion, which is indeed a remarkable observation because 50 years ago the MAV did not have even a room as a dedicated office yet alone a publications base.

A very brief description of each of the talks follows. As is obvious from their titles, the talks ranged from the mathematically quite technical to observations about mathematics teaching and usage.

Professor M.H. Belz (Statistics and Genetics, April 1954): Maurice Belz demonstrated the calculation of the probability of a genetic characteristic being passed on, and talked about the propagation of haemophilia. The talk is remarkable for its insight at a time when the development of the science of genetics was gathering pace.

A.E. Schruhm (The Teaching of Algebra, June 1954): Bert Schruhm advocated a shift away from a junior secondary algebra curriculum designed 'as a training for the benefit of the mathematical specialist', and some of his proposed changes did occur decades later. In this talk, he gave several examples of practical problems and their algebraic formulation.

K.S. Cunningham (Mathematics as a Subject in the School Curriculum, April 1955): Taking a different approach from Schruhm, Ken Cunningham reviewed the history of mathematics in the school curriculum and argued 'that we need to pass under rigorous scrutiny almost all that we do in the teaching of mathematics, that

*A slightly shorter version of this review was published in *Vinculum* **43**(4), p. 32 (2006).

our approach is still too formal'. Apparently the time allocated to mathematics in the curriculum was an issue then, as it is today.

R.T. Leslie (A Career in Statistics, August 1955): Rupert Leslie talked about employers of statisticians, and the nature of statistical endeavours in each of the chemical industry, CSIRO and other industries, giving examples of sampling required (for example, in testing early TV tubes), and gave an optimistic picture of employment prospects for statisticians. His talk pre-dated the growth in the Australian Bureau of Statistics.

M. Lester (Some Mathematics of Orchestral Wind Instruments, March 1957): Attendees at Meg Lester's talk on orchestral wind instruments would have been required to have an undergraduate mathematics background including a working knowledge of partial derivatives and Fourier series. The talk must have been entertaining, with a 'supporting act' musician demonstrating tuning, overblowing and harmonics.

Professor T.M. Cherry (Mathematics in the International Geophysical Year, April 1958): There was much classical applied mathematics in this talk, which a well-prepared Year 12 Specialist Mathematics student could appreciate in 2006. Satellite orbits were analysed: Tom Cherry showed his audience how they might calculate the radius and period of a satellite orbit with the aid of a rotary clothes hoist.

Professor E.R. Love (Infinity, August 1959): Russell Love's talk on Infinity (1959) was clearly aimed at Year 12 students. He gave a nice treatment of the paradox of rotating the curve $y = 1/x$ about the x-axis, leading to a 'trumpet' of finite volume but infinite surface area. His treatments of arithmetical processes and infinite series are still very relevant for Year 11/12 students in 2006.

B.I. Merz (Notation, June 1959): Blanche Merz's talk was really about the history of mathematical notation (for example, the origins of the plus and minus signs), from the ancient to the relatively modern notations of the last three or four centuries. Blanche observed: 'Many symbols are made, few are chosen. The list of discarded mathematical signs would fill a volume'. Given that almost no new notation has been popularly adopted in elementary school mathematics in the last fifty years, this talk is quite fresh for present day readers.

J. Bennie (Mathematicians in Industry, October 1959): James Bennie pondered the prospects for mathematicians to be employed in large industrial and business organisations. His remarks are of considerable historical interest: in the decades that followed his talk, the use of non-trivial mathematics in business, economics, networks and communications increased dramatically.

Readers of 'Master Classes in Mathematics' will be surprised both by things that have changed since the 1950s, and by other things that have not. In collecting these talks, Max Stephens has produced a gem that is a very appropriate commemoration of 100 years of MAV activities.

Frank Barrington
Department of Mathematics and Statistics, University of Melbourne, VIC 3010.
E-mail: f.barrington@ms.unimelb.edu.au

Measure Theory, Volumes 1 and 2

V.I. Bogachev
Springer, 2007, ISBN 978-3-540-34513-8

The art of writing book reviews is changing with technology. I assume that you too can find this book on the publisher's web site, obtain the basic facts about the book, browse through the table of contents, and examine sample pages. So, in this review I will concentrate on providing extra information.

This is a two-volume work on measure theory. Volume 1 deals with classical measure theory and Volume 2 deals with more recent ideas in the subject. Many ideas in Volume 1 are contained in Halmos' classical *Measure Theory* or other works on real analysis or probability. On the other hand there are relatively few text books that focus on the ideas in Volume 2. In keeping with modern scholarship, there is more emphasis on probability in Bogachev's work than you would tend to find in books on real analysis, and also more emphasis on topology, set theory, and functional analysis than you would tend to find in books on probability. I liked the balance.

A quick look at MathSciNet will establish the author's standing as a distinguished scholar. This book suggests that V.I. Bogachev is also a dedicated teacher.

I enjoyed tips from Bogachev the teacher. Here is an example. It's only natural that a student will want to have a mental picture of a typical element of a σ-algebra generated by a given class of sets. On page 5, the author warns us about the futility of this exercise.

> One should not attempt to imagine the elements of a σ-algebra generated by the class $\mathcal{F}$ in a constructive form by means of countable unions, intersections or complements of the elements in $\mathcal{F}$. The point is that the above-mentioned operations can be repeated in an unlimited number of steps in any order. For example, one can form the class $\mathcal{F}_\sigma$ of countable unions of closed sets in the interval, then the class $\mathcal{F}_{\sigma\delta}$ of countable intersections of sets in $\mathcal{F}_\sigma$, and continue this process indefinitely. One will be obtaining new classes all the time, but even their union does not exhaust the σ-algebra generated by all the closed sets (the proof of this fact is not trivial; see Exercises 6.10.30, 6.10.31, 6.10.32 in Chapter 6).

When I first read this paragraph, I imagined that I was in Bogachev's class in snow-covered Moscow and he turned around from writing on the blackboard and gave us this warning. And, when something is not immediately clear to me, I love to be told that 'this fact is not trivial' — it's so reassuring.

The structure of the book contributes to its accessibility. Each section of each chapter is only a few pages — about the length of a lecture. Thus I could approach reading a section without being daunted by the task in front of me.

At the end of each chapter, there is a section 'Supplements and exercises'. In the supplementary remarks, the author sketches different directions in which the ideas in the chapter have been extended. These remarks whet my appetite for more.

There are many, many exercises. I did not notice any that I would describe as drill exercises. On the other hand exercises seem to be manageable, especially the many exercises that are specifically recommended for the student reader. If you solved all these problems, you'd know a lot about measure theory. The author has generously offered hints to most of the 850 exercises. Again we see the careful writing of a good teacher.

There is an appendix entitled 'Bibliographic and Historical Comments'. For each chapter of the text, there are several pages of such comments. Without wanting to spoil your reading pleasure, let me say that it appears that Bogachev enjoyed writing these sections. They are scholarly, extensive, sometimes humorous. Many comments here might well be a springboard for a research project in some aspect of the history of measure theory.

The bibliography is immense. It has the helpful feature that each item in the bibliography is accompanied by the list of those pages where the item is cited. I wish that more authors did this.

In another appendix, Bogachev gives us an outline of his course on real analysis in Moscow and its connections with sections of the text. As a teacher, I particularly enjoyed this glimpse of how a teacher with Bogachev's expertise approaches his subject.

Overall, Bogachev's *Measure Theory* is an impressive work of scholarship.

The cover states that 'the target audience includes graduate students seeking to acquire deeper knowledge of measure theory'. However, the price is likely to be beyond the means of most Australian university students. One cannot buy the volumes separately. On the other hand, it is good value for money in terms of dollars/page. The work comes in a well bound, hardcover edition and each volume has a lovely blue ribbon as a book mark. A nice touch by Springer!

This is a big book and demands time for enjoyment and careful study. There is no point in writing a book, unless there are readers. In this sense, readers are as important as authors. And the sorts of people who can read this book are people like us, readers of the *Gazette*. Unfortunately, academic life is dominated by 'sciometrics' that encourage us to write, write, write. Imagine having the time to read, read, read — 'wouldn't it be lovely'?

Let me conclude with this simple recommendation. If your university library contains Halmos' *Measure Theory*, then it should also contain Bogachev's *Measure Theory*.

T.M. Mills
Department of Mathematics and Statistics, La Trobe University, PO Box 199, Bendigo, VIC 3552.
E-mail: t.mills@latrobe.edu.au

◇ ◇ ◇ ◇ ◇ ◇

Leonhard Euler

Emil A. Fellmann
Birkhäuser Verlag 2007, ISBN 978-3-7643-7538-6

In 1995, a biography of Leonhard Euler by the Basel historian of science Emil A. Fellmann appeared as a paperback in the series 'Rowohlts Monographien'. This copiously illustrated, small volume, written in German and directed to a general readership, has since gone through enormous success and, hence, not surprisingly, is out of print. In 2002 Springer Tokyo published a Japanese translation. The book was translated into English by Erika and Walter Gautschi of Purdue University. At last, occasioned by Euler's tercentenary, Birkhäuser Basel brought it out as hardcopy in December 2006. To my knowledge, it is the first monograph on Euler available in English.

Euler's life can be 'naturally' divided into four periods and, accordingly, the book is organised in four chapters: 1. Basel 1707–1727; 2. the first Petersburg period 1727–1741; 3. the Berlin period 1741–1766; 4. the second Petersburg period 1766–1783. What is remarkable, even amazing, is the wealth of information on Euler's life and work that is covered by less than 200 pages while, at the same time, the book makes pleasant reading. Citations from his autobiographical writings and from sources intimately close to him convey a lively picture of Euler's personality. Thus, the first chapter opens with Euler's curriculum vitae as of 1767 that he dictated to his first-born son Johann Albrecht. Then we learn of his family background, his early years and the important role Johann I Bernoulli played in his mathematical upbringing.

Chapter 2 first looks at the founding of the Petersburg Academy by Peter I and Catherine I, the appointment of numerous Germanophone scholars and scientists as academicians, including the Basel mathematicians Jakob Hermann and Bernoulli's sons Niklaus II and Daniel, and Euler's 'first years in the tsardom'. Three of Euler's great, and big, books from these years, *Mechanica*, *Scientia navalis* and *Tentamen novae theoriae musicae* ..., receive special attention. And we obtain first-hand knowledge, directly from Euler's pen, about his first marriage and start of a family and the circumstances under which he left Petersburg for Berlin.

Chapter 3 deals with Euler's role as the Director of the Mathematical Class of the Royal Prussian Academy under its president Maupertuis. During his quarter-century in Berlin, Euler produced one compendious work after another; the biography focuses upon: *Methodus inveniendi ...* (with his 'calculus of variations'), *Neue Grundsätze der Artillerie* (ballistics), where Euler recognises Benjamin Robins' achievements, *Introductio in analysin infinitorum* (the beginnings of function theory), which preceded his fundamental works on differential calculus and on integral calculus, his largely natural philosophical *Lettres à une Princesse d'Allemagne* and his optics culminating in his *Dioptricae*. One section is devoted to Euler's interest in chess (he had been taught by a Jewish chess expert) and to his subsequent occupation with the knights move, another to the enlargement of the Euler family (he fathered thirteen children). Also discussed are his not always easy relations with King Frederick II and the circumstances of his departure from Berlin.

The fourth chapter depicts Euler's second Petersburg period, during which about 50% of his opus was made ready by him for the press. Still being "the best introduction into the realm of algebra for a 'mathematical infant' ", Euler's *Algebra* and its origination is briefly mentioned as are a few of his astronomical accomplishments, including his lunar theory that earned him a prize from the Royal Society. Perhaps little known are the somewhat dramatic events surrounding the aging Euler's second marriage, which are narrated in one section by Gleb Mikhailov. The chapter concludes with Euler's rather well-documented last days of his life. In an epilogue, impressive statistics of Euler's enormous productivity, compiled by

Adolf Yushkevich, is displayed; it has been rated as not ranking behind that of Voltaire, Goethe, Leibniz and Telemann.

Fellmann, in the prologue to the book, attributes Euler's phenomenal productivity to three factors: his possibly unique memory (he still knew protocols of the Academy meetings by heart 10 years), his ability to concentrate (creating his immortal works with 'a child on his knees and a cat on his back'), and simply his routine of steady and quiet work. What makes this brief biography so readable and likeable is that at no point does it degenerate into a hagiography, which in the case of Euler is quite a feat. As the author uses original sources, Euler's correspondence in particular, with careful consideration, we gain a lively impression of Euler's character, activities and ways of thinking. Moreover, certain myths that have developed over the last two-and-a-half centuries, for example various stories about Euler's eye problems, are deservedly debunked.

There is considerable demand for a definitive work biography of Euler. Yet such an undertaking would, as the author muses, be synonymous with preparing a universal history of the mathematical sciences in the entire 18th century. One may therefore suspect that some time will pass for this to occur. Of course, everybody engaging in serious Euler research must go to the sources. The huge edition *Leonhardi Euleri Opera Omnia*, begun in 1911, is now, after a century of compilation, nearing its completion. Meanwhile, for further reading, the present book offers an excellent bibliography.

Hans Lausch
School of Mathematical Sciences, Monash University, VIC 3800
E-mail: hans.lausch@sci.monash.edu.au

◇ ◇ ◇ ◇ ◇ ◇

Colossus: The Secrets of Bletchley Park's Code-breaking Computers

Jack Copeland
OUP, 2006, ISBN 978-0192840554

Colossus: Bletchley Park's Greatest Secret

Paul Gannon
Atlantic, London, 2006, ISBN 978-1843543305

The two books being reviewed have considerable merit. Although both were published 61 years after the end of WW2, they are equal first in presenting reasonably complete accounts of the determination of the structure of the Lorenz SZ40 Geheimschreiber encrypted teleprinter that was used for high level German communications from 1941 to 1945. A contemporary report (1 December 1944) to the American Army cryptologic agency summarised the situation: 'Daily solutions to Fish (the SZ40) messages at GC&CS (the British cryptologic agency) reflect a background of British mathematical genius, superb engineering ability and solid common sense'.

The Colossus and associated machinery should not be confused with the bombe electro-mechanical devices used to handle Enigma traffic. In fact the work on the Enigma was Bletchley Park's second biggest secret and is not covered in either book. Credit for earlier work (1932–1939) on Enigma must be awarded to three mathematicians employed by the Polish Security Bureau. Arguably the third biggest secret consisted of the insecurities detected in the JN-25A cipher used as a general operational communications system by the Japanese Navy in 1939–1940. Its successors JN-25B, JN-25C, etc, maintained the principal weakness, but that is another story.

To return to Fish, the reconstruction of the device was due to Bill Tutte, a chemistry undergraduate working at Bletchley Park in 1942. He used some work by the senior cryptologist John Tiltman — who played a major role in the work on JN-25A — and Gerry Morgan, head of the Bletchley Research Section. Tutte's account 'FISH and I' (1998) is available in at least one book as well as various web sites. Both books give other versions of it. The Report of the Director of the GC&CS for 1942 describes 'the elucidation and reconstruction of the German teleprinter from scratch' as the 'most sensational feat' of the Bletchley Research Section.

The SZ40 was known to use the standard Baudot code to represent letters by quintuples of what we would now call binary digits. One of the 32 quintuples was used for 'shift to digits mode' and another for 'reverse the shift'. The machine encrypted by generating a long apparently random sequence of quintuples that was added (mod 2 vector addition) to the message sequence. The other side committed the gross error of sending two virtually identical messages with the same starting point in the apparently random sequence of additives. This gave Bletchley Park around 4,500 consecutive additives. Tutte eventually worked out that one component in the construction of the first element of the quintuples was periodic of period 41. Similar components with periodicities 31, 29, 26 and 23 were then found for the second, third, fourth and fifth elements. Even though the complementary components were appreciably more complicated they could be and were understood. And so the SZ40 stood revealed.

The reconstruction can be sensibly compared only with the analogous achievement (1940) against the Japanese diplomatic cipher machine now generally called 'Purple' after the colour used for folders containing files on it. Here the credit goes to William Friedman, Frank Rowlett and others of the US Army cryptologic unit. Some aspects of the Polish work on Enigma may well be close to the level of the SZ40 and Purple breaks.

The early cryptanalytical work on the SZ40 had been assisted by the practice of transmitting 'indicators' — instructions specifying the initial setting of the machine — with each message. This practice was discontinued in 1943 with indicators being sent by courier in sealed parcels in advance instead. Some special tricks had to be invented to exploit statistical features of the plain text of the traffic. Jack Good, the resident statistician, played a key role. Given this, long messages could be attacked, but the process needed massive calculation. And here Max Newman came in. He was involved in designing first the non-electronic 'Robinson' devices and then the Colossus. Various others deserve great credit for the 'superb engineering', particularly the communications engineer Tom Flowers. Colossus was at least partly electronic and so technology had passed into the computer era.

Thus General Eisenhower was able to launch the invasion of France in June 1944 confident that the other side expected it would happen near Calais rather than in Normandy. Systematic deception about the location was not enough: there had to be knowledge that the deception had worked.

The handling of some later JN-25 cipher systems and certain others did produce some problems similar to those involved in handling SZ40 output. However the calculations involved were decimal rather than binary. This was just too difficult to process electronically in 1944–1945.

Peter Donovan
School of Mathematics and Statistics, University of New South Wales, Sydney, NSW 2052.
E-mail: p.donovan@unsw.edu.au

AMSI News

Philip Broadbridge*

A good federal budget outcome for mathematics and statistics

The Priority 1 recommendation of the The National Strategic Review of Mathematical Sciences Research, reporting in December 2006, was to raise mathematics and statistics to a higher-funded cluster within the Department of Education, Science and Training (DEST) Relative Funding Model (RFM). This objective has now been achieved following the Minister's review early in 2007 of the RFM and the adjustments subsequently announced in the federal budget.

The national strategic review was partly funded by AMSI, using members' contributions. This was one of the main reasons why, unlike the national discipline review of 10 years ago, university mathematics departments were not asked to share the costs. Following the release of the report by the Review Working Party, there were many follow-up meetings and discussions. For several months, the AMSI Executive Officer devoted most of her time to this work.

All members of the Review Working Party, as well as the Chair of its Advisory Council must be thanked for this major contribution.

A year of domestic undergraduate education in mathematics now attracts at least $2700 extra funding from DEST to the universities. The funding increase from even a modest enrolment of 100 equivalent full-time student units will pay for approximately three salaries. Of course, this increase reflects an acknowledgement by the government that more money should actually be spent to educate a student in mathematics and statistics. We should be very interested to see if and how this money actually flows on to its intended purpose.

Universities will have some flexibility in how this money is distributed internally. However, even if the increase merely shows a healthier balance on the universities' internal accounting systems, it will help to reduce some pressure.

Events

The ICE-EM (International Centre of Excellence for Education in Mathematics) Industry Short Course, Mathematics of Electricity Supply and Pricing, was held in Surfers Paradise during the ANZAC week. The workshop, organised jointly by AMSI, MASCOS (Centre of Excellence for Mathematical and Statistics of Complex Systems) and MITACS (the Mathematics of Information Technology and Complex systems), was an outstanding success. Sixty-five people attended and more than half of those were from industry. A number of very interesting topics arose and lectures are available at http://www.amsi.org.au/Electricity.php

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

From 26 November to 14 December, AMSI and MASCOS will run a joint theme program, 'Concepts of Entropy and their Applications'. Invited speakers so far include Ingo Müller (Berlin), Frank van Hollander (Leiden), Reuven Rubinstein (Technion, Haifa), Richard Kleeman (New York) and Angas Hurst (Adelaide).

The early part of the theme will re-examine the historical foundations in thermodynamics. The second part will be linked to information theory, including topics such as quantum computing, computational complexity, coding, genetics, approximation theory and forecasting. On 10 December, there will be a one-day symposium on the 'Cross Entropy Method' for rare-event simulation and combinatorial optimisation. At other times, we are hoping to run sessions on other loosely related topics. These may include genetics, simulated annealing and entropy-based theory of partial differential equations. I invite anyone interested to contact me — the structure of the program will be determined by your interests.

Please consult the AMSI and ICE-EM web sites (http://www.amsi.org.au and http://www.ice-em.org.au) for upcoming events.

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 is 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 147 ISI citations. He is a member of the editorial boards of three journals and one book series.

News

General News

Griffith University

Chris Matthews has taken over from Hans Gottlieb as local correspondent.

Monash University

Dr Burkard Polster will be taking over from Simon Clarke as the Monash correspondent.

University of Sydney

Applications for the University of Sydney Postdoctoral positions are open. Up to 10 awards will be offered in 2008.

Web: http://www.usyd.edu.au/research/fellowships/postdoc.shtml.

The closing dates are

- 10 August: final day for applicants to contact Head of School;
- 14 September: closing date for full applications and referee reports to Research Office.

Note that all applicants should contact the Head of School well in advance of the final closing date.

In the news

From Slashdot:

> The BBC is reporting that students in the UK are being encouraged to drop math at the senior levels. It seems that schools are seeking to boost their standing on league tables by encouraging students not to take 'hard' subjects like mathematics, in favor of easier subjects in which they are assured good grades. The result is Universities being forced to provide remedial math classes for science students who haven't done math for two years. The BBC provides a comparison between Chinese and UK university entrance tests — a comparison that makes the UK look woefully behind.

Web: http://science.slashdot.org/article.pl?sid=07/04/25/1625216&from=rss
http://news.bbc.co.uk/2/hi/uk_news/education/6588695.stm
http://news.bbc.co.uk/2/hi/uk_news/education/6589301.stm

Chair of the ICM 2010 Program Committee

The chair of the next ICM Program Committee has been announced in the 22nd issue of the IMU electronic newsletter, IMU Net (http://www.mathunion.org/Publications/Newsletter):

> ICM 2010 Hendrik W. Lenstra has been appointed Chair of the Program Committee of the International Congress of Mathematicians 2010 in Hyderabad, India, 19–27 August 2010 by IMU President L. Lovasz. His coordinates are as

follows: Professor Hendrik W. Lenstra, Mathematisch Instituut, Universiteit Leiden, Postbus 9512 2300 RA Leiden The Netherlands (hwlicm@math.leiden-univ.nl). If you have proposals concerning the scientific program of ICM 2010 please contact Professor Lenstra by email.

Completed PhDs

Macquarie University:

- Dr Elango Panchadcharam had his PhD conferred in absentia on 26 May 2007 under the supervision of Ross Street. The thesis entitled 'Categories of Mackey Functors' was submitted in December 2006. Elango has returned to a lecturing position at the South Eastern University of Sri Lanka.

University of Newcastle:

- Dr Ian Gray, *Construction methods for vertex-magic total labelings of graphs*, supervisor: Dr Jim MacDougall.
- Dr Jason Kimberley, *Classifying Burger–Mozes groups and the algebras generated from their actions*, supervisors: Professor Guyan Robertson and Dr Jacqui Ramagge.
- Dr Elizabeth Stojanovski, *Statistical assessment of the relationship between life events and health*, supervisor: Professor Kerrie Mengersen.

University of Sydney:

- Dr Timothy Schaerf, *On contour crossings in contour-advective simulations of geophysical fluid flows*, supervisor: Associate Professor Charlie Macaskill.
- Dr Devindri Perera, *Saddlepoint approximation methods in the analysis of panel time series data*, supervisor: Dr Shelton Peiris.
- Dr Leah Ratliff, *The alternating Hecke algebra and its representations*, supervisor: Associate Professor Andrew Mathas.

Appointments, departures and promotions

Griffith University:

- Associate Professor Hans Gottlieb has taken a voluntary redundancy. He has accepted an appointment as Honorary Professor in the School of Biomolecular and Physical Sciences.

Macquarie University:

- Emeritus Professor John Loxton, Adjunct Professor in the Mathematics Department and former Deputy Vice-Cancellor (Academic), is now Deputy Vice-Chancellor (Academic and Services) at the University of Western Sydney.
- Dr Tanya Schmah resigned from the Department at the end of 2006 and moved to Canada. Tanya returned briefly to Sydney to teach differential geometry at the ICE-EM/AMSI Summer School in Mathematics (January–February 2007).

- Professor William Chen retired from the Mathematics Department at the end of 2006. Macquarie University awarded William the title of Emeritus Professor.
- Professor Ross Street will retire in July 2007 after 37 years in the Department.

University of Melbourne:

- Dr Heping He has been appointed Research Fellow.
- Mr Russell Jenkins, Lecturer A has left the University.
- Dr Xiangwen Li, Research Fellow has left the University.
- Dr Ning Li has been appointed Research Fellow.
- Dr David Odell, Research Fellow (MASCOS) has left the University.
- Dr David Rolls has been appointed Research Fellow.

University of Newcastle:

- Professor Iain Raeburn, Dr David Pask, Dr Jacqui Ramagge and Dr Aidan Sims have all resigned to take up positions at the University of Wollongong.
- Dr Venta Terauds has been appointed to a fixed term position. Her research interest is in functional analysis.
- Mr Rohan Cattell has been appointed to a fixed term position. His research interest is in graph theory.

University of Western Australia:

- Seyed Hassan Alavi commenced postgraduate studies under the supervision of Professor Cheryl Praeger.
- Dr Thomas Stemler commenced as a Research Associate.

University of Wollongong:

- Iain Raeburn has been appointed as Professor.
- Jacqui Ramagge and David Pask have been appointed as Associate Professors.
- Aidan Sims has been appointed as Lecturer.
- A plaque commemorating Professor Austin Keane, the foundation Professor of Mathematics at the University of Wollongong and a Deputy Vice-Chancellor of the University, was formally unveiled in the Austin Keane Building at the University of Wollongong at a ceremony on 5 June 2007.
- Song-Ping Zhu has been promoted to the position of Professor.
- Professor Matthew Wand has been elected as a Fellow of the Institute of Mathematical Statistics.

Awards and other achievements

Professor Terence Tao was elected Fellow of the Royal Society on 17 May 2007.

Professor Eugene Seneta, University of Sydney, has been awarded the Hannan Medal by the Australian Academy of Science.

New Books

University of Western Australia:

Gao, J. (2007). *Nonlinear Time Series: Semiparametric and Nonparametric Methods*. Chapman & Hall/CRC, London.

Conferences and Courses

Symposium on Learning Support for Mathematics and Statistics

This symposium will be held at Queensland University of Technology, 19–20 July, 2007.

Learning support in mathematics and statistics is taken to mean any facility or programs available to students that support their learning in mathematics and/or statistics and exists outside of the regular classes provided as part of an enrolled program (lectures, practicals, tutorials, etc.).

Learning support in mathematics and statistics is increasingly important in universities and the Symposium will provide an excellent opportunity for all interested in such learning support — whether associated with mathematics and statistics departments, specific or more general learning support centres, teaching support centres, or university management — to come together to share information and experiences, and to develop networks, strategies and plans.

The symposium is part of a Carrick Leadership Project held by Professor Helen MacGillivray and entitled 'Quantitative diversity: disciplinary and cross-disciplinary mathematics and statistics support in Australian universities'. A report on the project to date will be presented at the Symposium.

As well as keynote speakers, the program includes opportunities for discussion groups, and short presentations by individuals or representatives of universities or groups. If you would like to give a presentation, please contact Helen MacGillivray (h.macgillivray@qut.edu.au).

Support from the Carrick grant and the QUT School of Mathematical Sciences has enabled a low registration fee that includes morning and afternoon teas and lunches on both days. A symposium dinner, with payment separate to registration, will be held on the Thursday evening at a city riverside restaurant.

Web: http://www.carricksymposium07.qut.edu.au

BioInfoSummer2007: ICE-EM Summer Symposium in BioInformatics

This symposium will be held 10–14 December, 2007, at the Centre for Bioinformation Science, Australian National University, Canberra.

Theme: Sequence, Structure, Evolution and Networks

The BioInfoSummer Symposium comprises both a research meeting in bioinformatics, and a summer school, aimed at promoting bioinformatics as an interdisciplinary research area to interested researchers and students. The fist day consists of introductory lectures in biology. Each subsequent day starts with educational lectures followed by keynote and contributed presentations. Specialised workshops are also given.

Speakers (confirmed to date): Lloyd Allison (Monash University); Hans Binder (University of Leipzig, Germany); Conrad Burden (Australian National University); John Mattick (University of Queensland); Rafael Najmanovich (EBI, UK); Rasmus Nielsen (University of Copenhagen, Denmark); Allen Rodrigo (University of Auckland, New Zealand); Gordon Smyth (WEHI); Terry Speed (WEHI); Matthew Wakefield (WEHI).

Travel scholarships are available to students (advance undergraduate/honours and postgraduate) from Australian and New Zealand universities, and to postgraduate students and early career researchers from South American and Asian universities. Partial scholarships are also available, including students from institutions associated with the Pacific Rim Mathematical Association (PRIMA).

Note: the 2007 International Symposium on Computational Models for Life Sciences follows immediately, 17–19 December, Gold Coast, Queensland, Australia.

Web: http://wwwmaths.anu.edu.au/events/BioInfoSummer07

Email: BIS07committee@maths.anu.edu.au

Recent advances in asymptotic probability and statistics with time series applications

10–12 December 2007, University of Sydney.

Organisers: Rafal Kulik, Qiying Wang and Neville Weber.

Web: http://www.maths.usyd.edu.au/u/SemConf/StatWorkshop/

1st Joint Meeting of the American and New Zealand Mathematical Societies

Incorporates the 2007 NZ Mathematics Colloquium. Victoria University of Wellington, 12–15 December 2007.

Registration for this meeting is now open.

Plenary speakers: Marston Conder, University of Auckland; Rod Downey, Victoria University of Wellington; Michael Freedman, Microsoft Research; Gaven Martin, Massey University; Assaf Naor, Courant Institute; Theodore Slaman, University of California, Berkeley; Matt Visser, Victoria University of Wellington.

The following special sessions will run: Computability Theory; Dynamical Systems and Ergodic Theory; Geometric Numerical Integration; Group Theory, Actions and Computation; History and Philosophy of Mathematics; Hopf Algebras and Quantum Groups; Infinite-Dimensional Groups and their Actions; Integrability of Continuous and Discrete Evolution Systems; Mathematical Models in Biomedicine; Matroids, Graphs, and Complexity; New Trends in Spectral Analysis and PDE; Quantum Topology; Special Functions and Orthogonal Polynomials; Water-Wave Scattering Focusing on Wave-Ice Interactions.

Potential speakers in any of these areas are asked to contact one of the session organizers first (details at website). There will also be a stream of general contributed talks.

Web: http://www.mcs.vuw.ac.nz/~mathmeet/amsnzms2007/

LA TROBE UNIVERSITY

Aust MS
Australian Mathematical Society Inc.

The 51st Annual Meeting of the Australian Mathematical Society

25–28 SEPTEMBER 2007

La Trobe University Melbourne

Featuring the 2007 Mahler Lecturer

Plenary Lecturers

Paul Baum (Penn State)

Peter Bouwknegt (ANU)

John Cannon (Sydney)

Tony Chan (National Science Foundation – US)

David Hill (ANU)

Mark Kisin
Mahler Lecturer (Chicago)

Joe Monaghan
ANZIAM Lecturer (Monash)

Panagiotis Souganidis
(U.Texas Austin)

Stephen Wright (Wisconsin)

CELEBRATING 40 YEARS 1967–2007

Special Sessions

- Algebra and Combinatorics
- General Session
- Geometry (including Topology and Differential Geometry)
- Lie and Representation Theory
- MASCOS Presents
- Mathematical Physics
- New Applications of Mathematics
- Noncommutative Geometry and Operator Theory
- Number Theory
- Optimisation
- PDE's and Analysis
- Probability and Statistics
- Smooth and Discrete Dynamical Systems
- Teachers Session

Registration

http://wt.maths.latrobe.edu.au/register/conferences/AMS2007
Early-bird registration closes on Friday 27 July

Conference Director: Geoff Prince g.prince@latrobe.edu.au

www.latrobe.edu.au/mathstats/maths/conferences/AMS2007

5th Asian Mathematical Conference

Universiti Sains Malaysia and the Malaysian Mathematical Society will be organizing the 5th Asian Mathematical Conference in November 2009. The areas of focus are: algebra; algebraic geometry; analysis; operator algebra and functional analysis; lie group and lie algebras; number theory; combinatorics; logic and foundations of mathematics; ordinary differential equations and dynamical systems; partial differential equations; topology; mathematical aspects of computer science; numerical analysis and scientific computing; control theory, optimisation and operations research; probability and stochastic process; statistics; application of mathematics in sciences; mathematics education.

Web: http://math.usm.my/amc2009/

Contacts: amc2009@cs.usm.my; dean_mat@usm.my

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 Peter Brooksbank; University of Oregon; 14 June 2007 to 2 July 2007; computational group theory; USN; J.J. Cannon

Prof Bjorn Stanstede; Surrey; 30 June 2007 to 4 July 2007; travelling waves; USN; M. Wechselberger

Dr Vivien Kirk; University of Auckland; 2 to 6 July 2007; travelling waves; USN; M. Wechselberger

Prof Jean Michel; University of Paris VII; 2 to 7 July 2007; geometry and lie theory; USN; A. Henderson

Prof Anthony Davison; Ecole Polytechnique Federal de Lausanne, Geneva; 2 to 13 July 2007; modelling of statistical extremes, higher order asymptotics, and statistical modelling, particularly for applications in biology; UQ; Tony Bracken

Prof Louise Ryan; Harvard School of Public Health, USA; 2 to 13 July 2007; statistical methods related to environmental risk assessment for cancer, developmental and reproductive toxicity, and other non-cancer endpoints; UQ; Tony Bracken

Prof George Bluman; University of British Columbia, Vancouver, Canada; 23 June to 14 July 2007; differential equations and symmetry; MQU

Prof Cedric Bonnafé; University of Science and Technology Besancon; 1 to 14 July 2007; geometry and lie theory; USN; A. Henderson

Prof Corrado De Concini; University of Rome; 8 to 14 July 2007; geometry and lie theory; USN; A. Henderson

Prof Tonny Springer; Utrecht; 2 to 14 July 2007; geometry and lie theory; USN; G.I. Lehrer

Prof Lynne Billard; Department of Statistics, University of Georgia, USA; 16 June to 15 July 2007; UMB

Dr Emmanuel Letellier; Concordia University; 6 to 16 July 2007; geometry and lie theory; USN; A. Henderson

Dr Oliver Ruff; University of Toledo; 13 June 2007 to 18 July 2007; modular representation theory; USN; A.P. Mathas

Prof Leticia Barchini; Oklahoma State University, USA; 2 to 20 July 2007; representation theory of real reductive lie groups; UQ; Tony Bracken

Prof Alexander Pott; Otto-von-Guericke-University Magdeburg, Germany; 2 to 20 July 2007; coding theory and cryptography (binary sequences, Boolean functions); UQ; Tony Bracken

Prof Nolan Wallach; University of California; 2 to 20 July 2007; methods and applications of invariant theory; UQ; Tony Bracken

Prof Nick Wormald; University of Waterloo, Canada; 2 to 20 July 2007; combinatorics, graph theory and random graphs; UQ; Tony Bracken

Prof Roger Zierau; Oklahoma State University, USA; 2 to 20 July 2007; representation theory of real Lie groups and related geometry; UQ; Tony Bracken

Prof Claudio Processi; University of Rome; 8 to 21 July 2007; geometry and lie theory; USN; A. Henderson

Dr Serguei Novak; Middlesex University, London, UK; 2 to 23 July 2007; UMB

Dr Richard Samworth; Statistical Laboratory and Department of Pure Mathematics and Mathematical Statistics, University of Cambridge, UK; 8 to 27 July 2007; UMB

Dr Tatiyana Apanasovich; School of ORIE, Cornell University, USA; 11 June to 28 July 2007; UMB

Prof Francois Digne; Universite de Picardie Jules-Verne; 25 June to 29 July 2007; geometry and lie theory; USN; A. Henderson

Prof Anthony Davison; Institute of Mathematics, Ecole Polytechnique Federale de Lausanne, Switzerland; 16 to 31 July 2007; UMB

Inessa Epstein; University of California; 15 January to 31 July 2007; –; UMB; –

Prof Buyung-Moo Kim; Chungju National University; 31 July 2006 to 31 July 2007; integral theory; USN; D.E. Taylor

Prof Hitoshi Koike; –; 1 to 31 July 2007; bilipschitz homeomorphisms; USN; L. Paunescu

Dr Toshio Ohnishi; Institute for Statistical Mathematics, Tokyo, Japan; 5 February to 31 July 2007; –; USQ; Dr Peter Dunn

Prof Dorette Pronk; Dalhousie University, Halifax, Canada; July 2007; MQU; Dr Simona Paoli

Prof Raymond Carroll; Department of Statistics, Texas A&M University, USA; 23 June to 4 August 2007; UMB

Prof Nick Wormald; Department Combinatorics and Optimization, University of Waterloo, Canada; 21 July to 6 August 2007; UMB

Prof Xianhua Li; Suzhou University, China; 10 March to 10 August 2007; –; UWA; A/Prof Caiheng Li

Dr David Juher; Department d'Informatica i Matematica Aplicade, Universitat de Girona, Spain; –; 30 July to 12 August 2007; UMB

Prof Robert Behringer; Department of Physics, Duke University, Durham, USA; –; 12 to 24 August 2007; UMB

Mr Degui Li; Zhejiang University; 23 July 2007 to 24 August 2007; –; UWA; Prof Jiti Gao

Prof Lluis Alseda; Department de Matematiques, Universitat Autonoma de Barcelona, Spain; 30 July to 30 August 2007; –; UMB

Dr Paul Yip; Department of Statistics and Acturarial Science, University of Hong Kong; 10 July to 31 August 2007; UMB

Prof Ejaz Ahmed; Statistics, U Windsor, Canada; approximately 12 August, 2007 for three weeks; –; MQU

Dr Tobias Beck; Austrian Academies of Sciences; 4 August 2007 to 2 September 2007; computational algebraic geometry; USN; J.J. Cannon

Dr Ciprian Coman; University of Glasgow; 25 July 2007 to 2 September 2007; –; UWA; Prof Andrew Bassom

Dr Alexander Chervov; Institute for Theoretical and Experimental Physics, Moscow; 23 July 2007 to 7 September 2007; quantum groups and their representations; USN; A.I. Molev

Dr James Parkinson; Cornell University; 4 June 2007 to 19 October 2007; buildings and Hecke algebras; USN; D.I. Cartwright

Mr Mikael Johansson; Mathematisches Institut, Fakultät für Mathematik und Informatik, Jena, Germany; 10 September to 20 October 2007; computational aspects of group cohomology; USN; J.J. Cannon

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 2007 to 1 November 2007; –; UWA; A/Prof Caiheng Li

Prof Vyacheslav Futorny; University of San Paolo; 24 September 2007 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

Dr Akira Yasuhara; Tokyo Gakugeu University; 1 July 2007 to 30 November 2007; classical links; USN; J.A. Hillman

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

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

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

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

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

Dominic Schuhmacher; University of Zurich; 1 April 2006 to 31 May 2008; –; UWA; Prof Adrian Baddeley

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

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

AustMS Accreditation

The secretary has announced the accreditation of:

- Sally Freeman, of Maunsell Australia Pty Ltd, as a Graduate Member.

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 organizer 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 2007. 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

Elizabeth has been at The University of Queensland since 1971, when she came out from England intending to stay for a couple of years. She is a Reader/Associate Professor at UQ. Elizabeth is also Editor-in-Chief of the Australasian Journal of Combinatorics, as well as being AustMS Secretary. She still tries to keep her research in discrete mathematics going.