Research
Australian Mathematical Sciences Institute

Mathematics of Planet Earth 2013 AUSTRALIA

In Review

Maths of Planet Earth Australia

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MPE Partners

SSAI Statistical Society of Australia Inc.

IMAS Institute for Marine and Antarctic Studies | UTAS

Aust MS Australian Mathematical Society

THE SCIENCE OF EVERYTHING COSMOS www.cosmosmagazine.com

Australian Academy of Science

Australian Research Council Centre of Excellence for Mathematics and Statistics of Complex Systems

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MATHS + STATS BY EMAIL

Australian Government Geoscience Australia

Australian Bureau of Statistics

Australian Government Bureau of Meteorology

ARC Centre of Excellence for Climate System Science

acara Australian Curriculum, Assessment and Reporting Authority

CARMA

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What's up...
Maths of Planet Earth

67,375 visits to www.mathsofplanetearth.org.au from **150** countries

24 scientific workshops & public lecture

including a **5** day conference...

with **20** keynote speakers

3235 people attended events around Australia

150 photography competition entries received

2400 students have enjoyed our classroom resources

2731 people receive our MPE Australia newsletter

2290 people have joined us on social media

57 "Coffees with" ordinary people talking about maths

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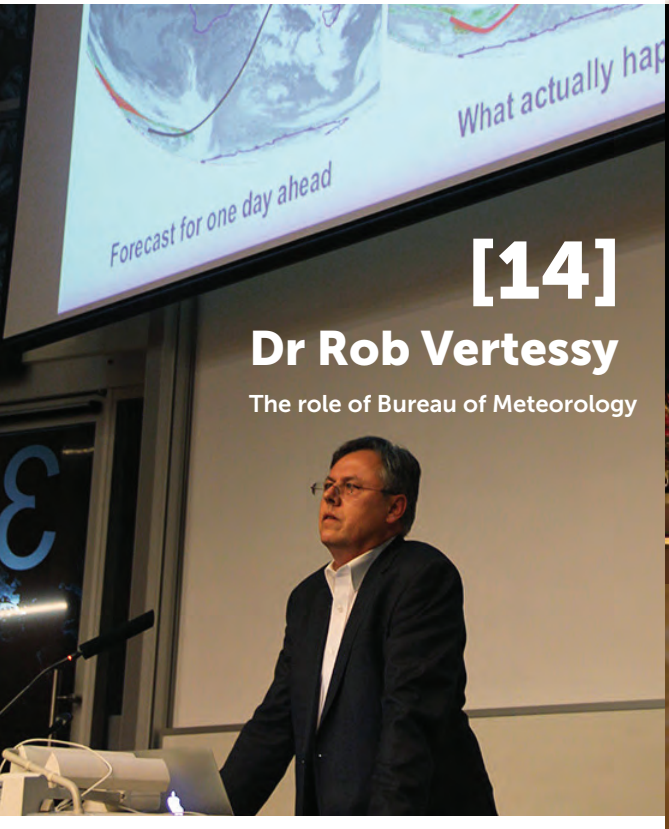

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Think beyond boarders, using mathematics to model biological systems.

About MPE2013

Mathematics of Planet Earth 2013

MPE2013 was the brainchild of Christiane Rousseau, professor of mathematics at Université de Montréal and vice-president of the International Mathematics Union.

Under the patronage of UNESCO, MPE2013 brought together over 140 scientific societies, universities, research institutes, and foundations from around the world to research fundamental questions about Planet Earth, nurture a better understanding of global issues, and help inform the public about the essential role of mathematics in the challenges facing our planet.

MPE2013 scientific activities included more than 15 long-term programs at mathematical research institutes all over the world, 60 workshops, dozens of special sessions at society meetings, public lecture series, Summer and Winter Schools for graduate students and research experiences for undergraduates.

The outreach components were just as important, with more than sixty public lectures on all five continents, an international competition for museum quality virtual displays, accessible daily blog posts, the development of curriculum materials, poster collections, special issues of mathematical magazines and other educational materials.

"MPE2013 allowed us to put together our love for our planet, our curiosity to understand it better, our passion for mathematics, our concern for the future of the planet and for the challenges to be faced by the next generations."

Message from the Patron

Our planet faces many challenges with many more yet to come.

Australia's mathematicians and statisticians play an integral role in identifying and solving these issues.

Whether it is addressing changes in our environment, minimising health risks for our population, securing adequate, nutritious food supplies, or building and powering infrastructure for this generation and the next, you will always find science and mathematics at the core of the solution.

Through MPE Australia, we recognised, supported and celebrated our mathematicians and statisticians.

Professor Ian Chubb
Chief Scientist of Australia and Patron of Mathematics of Planet Earth Australia

MPE2013 international themes

A planet to discover

Oceans; meteorology and climate, mantle processes, natural resources, solar systems

A planet supporting life

Ecology, biodiversity, evolution

A planet organised by humans

Political, economic, social and financial systems, organisation of transport and communications networks, management of resources, energy

A planet at risk

Climate change, sustainable development, epidemics, invasive species, natural disasters

safer & better planet

Professor Geoff Prince – AMSI Director

Mathematics of Planet Earth 2013 in Australia was a remarkable success. We have forged new partnerships amongst government agencies, universities and the private sector and inspired Australians with a truly international scientific perspective on their continent and their planet.

The Australian Mathematical Sciences Institute (AMSI) was privileged to lead such broad consortium of partners with Australia's Chief Scientist, Professor Ian Chubb, as its patron. I thank Professor Chubb and all of our partners and sponsors for the year's wonderful achievements. AMSI's MPE Manager, Simi Henderson deserves very considerable credit for the year's program and operation.

AMSI is Australia's national mathematical sciences institute; its headline mission is the radical improvement of mathematical sciences capacity and capability in the Australian community. MPE 2013 provided us with a wonderful opportunity to deliver on this mission and to create longer term programs focussed on building national capacity. That Australia has a national institute is a measure of the maturity of our mathematical sciences community and that we have led such a successful partnership over a full year is a credit to AMSI and its 34 members.

Like all scientists, mathematicians and statisticians are driven by concern for their fellow humans and for the planet. I was proud to be part of the midyear MPE Conference whose communique finished with these resounding lines:

"We will strive for a safer and better understood planet through the development and application of mathematical and statistical research. As a community of scientists and professionals we have the principal responsibility for the public awareness of our work, so important for the inspiration of tomorrow's researchers."

"Australian policy makers and governments must address declining interest in advanced mathematics and statistics in our schools and universities. All Australian children deserve to have qualified maths teachers and they should be engaged with the work that mathematically capable professionals perform, especially that which has an immediate and material benefit to the planet."

Simi Henderson

Maths of Planet Earth Australia Manager

MPE Australia was an exciting year for Australian mathematics and statistics. AMSI Members and MPE partners, 44 organisations and groups in total, joined together to present a broad program of scientific and outreach events throughout 2013.

The year provided a platform to illustrate the wide and varied role that mathematics plays in all aspects of our life - supporting and developing economic growth and government policy, regulating financial systems, building and refining communication and transport networks, managing biodiversity and invasive species, and ensuring effective natural disaster risk management - to name a few.

Around the country people got involved, attending and hosting events, contributing to the blog, entering competitions, taking part in interviews and developing classroom resources, posters and puzzles.

In January the year started off with a bang! Over 350 people attended the MPE Australia launch and reception. The launch featured the first in the Simons Foundation international MPE lecture series by Professor Simon Levin.

University, agency and industry researchers came together in July at the MPE conference, the full program consisted of 15 plenary speakers, 80 contributed talks and a special industry engagement session. With plenty of time for networking new research partnerships and collaborations were established throughout the week.

With visits from 150 countries over the year the regular blog ensured that Australian research news and researchers featured around the world.

Jørgen Randers, co-author of Limits to Growth, Graciela Chichilnisky, United Nations Kyoto Protocol, and Ken Henry, former Secretary of the Department of Treasury, and other leading thinkers brought the year to a close over a lively two days of presentations, panel discussions and debates about the sustainability of economic growth and the role of mathematical models in guiding future policy.

Over the course of the year new partnerships and networks were established. The formation of the MPE Network and extension of the blog ensures the continued impact of MPE Australia beyond 2013.

I would like to thank all of our partners, supporters and the MPE Australia team at AMSI - Jo Wilson, Mari Ericksen, Michael Evans, Janine McIntosh, Michael Shaw, Stephanie Pradiér and Daphane Ng without whose significant contributions, the year would not have been possible.

Maths of Planet Earth Australia

Launch

"Just the right mix of mathematics with a great sense of humour."

- Asha Rao, RMIT

29 January 2013, The University of Melbourne

With a packed lecture theatre and the atmosphere to match, the launch of Maths of Planet Earth Australia (MPE) was a red-carpet event for Australian maths!

Australian Chief Scientist, Professor Ian Chubb, opened proceedings, telling the audience that MPE Australia provided a platform to demonstrate to the public that mathematics underpins every aspect of our culture, science and economy. He commented that the year is timely with the growing demand for mathematical and statistical skills in the Australian workforce.

Following the official launch, Professor Simon Levin from Princeton University delivered the first in the international series of Mathematics of Planet Earth public lectures sponsored by the Simons Foundation.

The lecture, entitled The challenge of sustainability and the promise of mathematics, opened the audiences eyes to the parallels between financial systems, ecological systems and governments.

Professor Levin demonstrated the immense power—and limitations—of mathematics as a tool for predicting the behaviour of these systems, and hinted at how we might identify the signs of impending crisis. Many were amused by Levin's question posed in an early 2008 paper published in Nature asking, "Who knows, for instance, how the present concern over sub-prime loans will pan out?"

Levin concluded the lecture with a discussion about models of collective behaviour; with a view of applying them to achieve global consensus on environmental issues. Global cooperation, Professor Levin said—and we all agree—is the Holy Grail for achieving sustainability and it seems that mathematics will play a central role.

MPE partners and supporters had the chance to make and discuss plans for the year at a reception following the lecture.

350 ATTENDEES • 18 PARTNERS • 10 INTERNATIONAL LECTURES

MPE2013

Worldwide Simons Public Lecture Series

29 January 2013

The challenge of sustainability and the promise of mathematics

Prof. Simon Levin Princeton,
University Melbourne, Australia

4 March 2013

Climate disruption: What math and science have to say

Prof. Emily Shuckburgh,
British Antarctic Survey San Francisco,
United States of America

26 March 2013

Climate Math

Prof. Inez Fung,
University of California Cape Town,
South Africa

10 April 2013

Les mathématiques pour faire parler la Terre

Prof. Ingrid Daubechies,
Princeton University
Montréal, Canada

24 April 2013

The Public Health Impact of Air Pollution and Climate Change

Prof. Francesca Dominici,
Harvard University, Chapel Hill,
United States of America

23 May 2013

CliMathematics: Models, data, structures

Prof. Rupert Klein,
Freie Universität Berlin
Berlin, Germany

24 September 2013

On growth and form: Mathematics, physics and biology

Prof. L. Mahadevan,
Harvard University, Providence
United States of America

8 October 2013

The evolution of cooperation: Why we need each other to succeed

Prof. Martin Nowak,
Harvard University, Minneapolis,
United States of America

4 November 2013

Quantum mechanics and the future of the planet

Prof. Emily Carter, Princeton University,
Los Angeles, United States of America

January

Summer School

AMSI Summer School 2013

7 January – 1 February 2013, The University of Melbourne

AMSI students from around the country descended on Melbourne for four weeks of summer mathematics and statistics. A total of 132 students from 22 universities improved their mathematical skills with honours level courses.

Subjects on Mathematical Epidemiology and Complex Networks gave students a chance to explore the MPE theme at the school.

Program extras included a dinner talk from NPR's Maths Guy, Professor Keith Devlin, Stanford University, a specialist lecture from Professor Simon Levin, Princeton University, and an opening address from Professor Ian Ewing, Deputy Australian Statistician.

It wasn't all about maths though - during the School students also tested their skills at a quiz night hosted by Lily Serna former host of ABC's Letters and Numbers, networked with employers at the careers afternoon, improved their soccer skills and built lasting friendships at the weekly BBQ's and dinners.

The "Math Guy"

Professor Keith Devlin from Stanford University, known as National Public Radio's "Math Guy" and author of a number of a mathematics communication books gave an entertaining dinner talk on the life and enduring legacy of Leonardo of Pisa, better known today as Fibonacci.

Leonardo of Pisa was the first Westerner to recognise the power of the Hindu-Arabic number system (featuring the numerals 0 through 9) and his book Liber Abbaci (The book of Calculation) remade the West as the dominant force in science, technology, and large-scale international commerce. Today, he's best known for discovering the Fibonacci sequence of numbers.

Mathematical Models of Tumour-Immune System Dynamics

7 January – 10 February 2013, The University of Sydney

Recent progress in cancer immunology and the advances in immunotherapy suggest that the immune system plays a key role in defence against tumour growth, and could be utilised to prevent or cure cancer.

There are still many unanswered questions about the complex interaction mechanisms between the immune system and tumor growth. The nature of these complex interactions requires a cross-disciplinary approachto capture more realistic dynamics of the essential biology. Such approaches include combining cancer immunology with mathematics which leads to a fuller understanding of the complex interaction mechanisms between the immune system and tumour growth, and ultimately helps to capture more realistic dynamics of the essential biology.

Mathematicians, biologists and clinicians from the United States of America, Australia, New Zealand, South Africa, Saudi Arabia, Japan and Korea working in the field of cancer immunology came together at the meeting to advance the knowledge of research in this field by discussing and raising awareness of innovative mathematical approaches.

Mathematical Biology

An Essential Part of 21st Century Science

Professor Trachette Jackson, University of Michigan

In recent years we have witnessed unprecedented progress in the biosciences. To fully understand these new biological advances and to harness their intricacies for human benefit it requires a cross-disciplinary approach that incorporates computational and mathematical modeling techniques.

These strategies are essential to achieve rapid and significant progress on issues, in health and disease, which span molecular, cellular and tissue levels.

In her public lecture on 8 January Professor Jackson described the field of Mathematical Biology, highlighting historical successes, and showcasing some of the ways mathematics is currently being used to tackle some of the biggest biological challenges the world is facing.

Time to Party

17 million digits.

Did you know?

On 25 January the 48th Mersenne prime number - $2^{57,885,161}-1$ was discovered. It has over 17 million digits. Discovered by prolific Great Internet Mersenne Prime Search (GIMPS) contributor Dr Curtis Cooper, University of Central Missouri on 25 January, it is the first Mersenne prime discovered since 2009.

Primes are numbers that can only be divided by themselves and 1, such as 2, 3, 5, 7 and 11. Mersenne primes are extremely rare, only 48 are known, and were named for the French monk Marin Mersenne, who studied these numbers more than 350 years ago.

January

February BLOG

Maths is Everywhere

Maithili Mehta

After finishing her Ph.D. in Quantum Superalgebras in 2003, Maithili moved into private industry and became a software engineer. She loves reading, knitting, crocheting, music and of course Mathematics!

I grew up in a household that valued maths above all else. My father is a maths Ph.D., my mother studied tertiary level maths for fun and I practiced reading on the titles of my father's maths text books. At an age when most little girls aspire to be ballet dancers, I would amaze listeners by announcing that when I grew up, I wanted to be a "Poffessoor of Albega and topology" (sic).

Throughout my school years, I continued my love affair with mathematics. I developed a fascination with the Moebius strip and would often construct models and walk my fingers along the paper to confirm its unique topological properties. I remember being particularly impressed with one of my secondary school maths teachers, who used to bring interesting articles to school to show us. The one that really tickled my fancy was entitled "The transcendental number "e"".

University was great and I dabbled in the area of Partial Differential Equations before finally settling on a fairly pure algebraic problem in the field of Mathematical Physics as a Ph.D. topic. It was great fun to be surrounded by like-minded people – birthday cards always extolled the virtues of the special birthday number (35 is the last product of 2 consecutive primes until I turn 77!).

I have ended up working in private industry, at an optimisation research company. We build journey planning software and as part of my work, I get to delve into the shortest path problem and other networking algorithms.

As an adult with children of my own, I am still finding mathematical beauty everywhere – in the geometry of the Angry Birds app, in my daughter's music theory homework (who doesn't love fractions?) or in the arc of the winning goal in a soccer game. I love going into school and kindy and watching the children taking so much joy in learning to count, add and do algebra instinctively and without fear. The older I get, the more I realise, maths really is everywhere!

SPOM 2013

South Pacific Optimisation Meeting

9–12 February 2013, Noah's on the Beach, Newcastle

SPOM 2013 focused on optimisation with (potential) applications to ecology, sustainable development, finance and similar fields.

An impressive line up of speakers included Professor Terry Rockafellar, University of Washington, Professor Heinz Bauschke, The University of British Columbia and Professor Johannes Jahn, Universität Erlangen-Nürnberg.

The meeting comprised of 70 researchers and students from all over the world, providing an international forum for scientists to exchange ideas, share experiences in their research and to open new avenues of collaboration and research on topics related to optimisation and its applications.

SPOM 2013 was organised by the Priority Research Centre for Computer-Assisted Research Mathematics and its Applications (CARMA) in Newcastle.

Optimisation of Planet Earth Afternoon

"Optimisation is the mathematical science of how to do things well, better, faster, cheaper – whether applied to medical imagining, coal mining, airline scheduling, or management of large organisations"

Professor Jon Borwein, University of Newcastle

Teachers, local industry representatives and the public joined participants of SPOM2013 on Saturday 9 February for a special event designed especially for the curious.

The audience had the opportunity to hear from experts in the field including Professor Keith Devlin, Stanford University, who gave the audience some insight into the role of mathematics in keeping the United States of America safe from terrorists and Professor Radu Ioan Bot,Chemnitz University of Technology on the role of optimisation in medical imaging among others.

The afternoon was a great success and concluded with a reception at the Novotel Newcastle Beach.

1000 STUDENTS • 24 SCHOOLS • 200 PIES CONSUMED (THANKS GOOGLE!)

March Easy as Pi

Students celebrate Pi Day at Australian Museum

14 March 2013

Mathematicians love looking for patterns, and thanks to the North American custom of writing the date backwards, 14 March looks a bit like the circle constant pi: 3.14.

Over 1000 Australian primary and secondary students joined Simon Pampena either in person, or virtually to celebrate International Pi Day. The students from Years 6, 7, 8 and 9 participated in Pi Day workshops that explored the role of this mysterious number to get a grasp on just how important it is. Simon showed students how to have fun with Venn diagrams and Pi-ems, and taught them how to find approximations of Pi using rectangles.

Pi occurs in important fields of applied mathematics such as Fourier Analysis and image reconstruction. It is used throughout engineering, science and medicine and is studied for its own sake in number theory.

"Pi captures all the wonders of mathematics in one simple idea. Divide the outside of a circle by its width and you'll get a number. No matter if the circle was the size of your eye or the size of the sun, that number will always be the same... But you'll never know what that number is exactly. It's impossible. Pi goes on forever."

Simon Pampena – 2013 Numeracy Ambassador, National Literacy and Science Week

157 ENTRIES • 4 COMPETITIONS • 12 WINNNERS

April MPE Photo competitions

CATEGORY Winners!

Geometry

Circle - Luca Renoldi
Almost a perfect circle made of drops of water.

Singling out Symmetry

Fiji pool - Scott Goh
Serene view of the Hilton Hotel Pool. Refection of the water does show how blue the sky was. How well the symmetry is.

Probability & Chance

A crab standing on water - Roche Meggersee
What is the probability of a crab standing still long enough for a few shots while looking straight at you? At the same time it looks like the crab is standing on water which is by itself a chance.

Circle - Luca Renoldi

Fiji pool - Scott Goh

A crab standing on water - Roche Meggersee

Singling out Symmetry

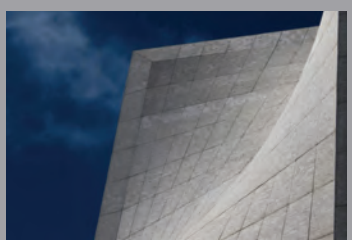
Flower Symmetry
- Rosie Shannon
I'm a Primary teacher, who really enjoys Maths and Science. I use this photo as a great starting point to introduce symmetry.

Probability & Chance

Taking chances with whale sharks
- Jill Boag
What is the chance of getting this close?

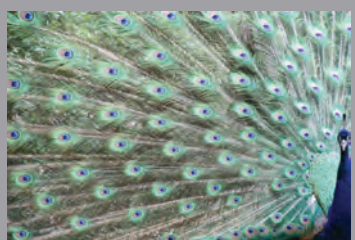
Moneyball - Ioannis Lachanis
Sport is about ability, performance, training, talent. But it's also about chances and statistics. Baseball is based a lot in the latter and the famous Fenway Park, home to the Boston Red Sox is a perfect setting for this.

Mathematical Concepts



Best concept

San Francisco Cathedral Detail
- Jude Watson
A cross detail is formed in the roof structure by 4 rising parabolic hyperboloids. This shot details one of the wings of the roof structure.



People's choice

Peacock Fractal Geometry
- Elizabeth Young
These peacock feathers are a stunning example of fractal geometry in nature be used not only to work out the shadows angles and dimensions but the person behind it in reality. Thus mankind, maths and the planet earth connect.

Mathematical Concepts

Man and Maths - Emma Shepherd
Mankind and mathematical concepts are intricately interwoven. In this picture the essence of mankind is represented in the shadow but underlaid with the geometrical pattern and symmetry of the paving. The paving then reflects the maths of trigonometry.

Geometry

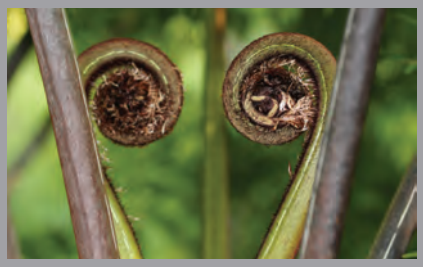
Wind farms - David Jaensch
The geometry of these rows of wind farms are enhanced by the sunset and movement.

Spirals in Darling Harbour - Elizabeth Young
This image is of a water feature in Darling Harbour, of spiral patterns radiating out from the centre of a circle, with parallel lined steps.

Highly commended

Progression - Vladimir Gordeev
Water is the Foundation of life. perfectly suitable for the search for manifestations geometric.

Twins - Aleksandra Srsa
Emerging twin fronds of a King Fern (Angiopteris evecta) displaying the Fibonacci sequence spiral.



The mathematics and economics of marine protected areas

BrisScience May

Professor Hugh Possingham, The University of Queensland

We have seen marine protected area systems appear in Queensland's Moreton Bay and across the Great Barrier Reef. Most recently the Federal Government created a system of marine reserves which added more than 2.3 million square kilometres to Australia's marine reserves estate.

In his talk on 20 May Professor Possingham discussed how mathematics, economics and ecology is used to design marine protected area systems that meet the needs of conservation and minimising the impact of recreational and commercial fisheries.

He also discussed some of the politics of marine reserve system design and how mathematics is used to target catchments for restoration to minimise the damage from nutrients and sediments that flow into our coastal ecosystems.

Watch the lecture here:
www.mathsofplanetearth.org.au/marine

Optimisation in Industry

3–5 June 2013 RMIT University, Melbourne

In early June, members of industry, academia and government agencies from Australia and the world, met to discuss the applications of mathematical optimisation techniques to industrial problems.

This three-day event bought together individuals with incredibly deep knowledge of different areas, including the mathematical details of optimisation, the use of these techniques in full-scale industrial problems, in a variety of industries, including transportation, mining and logistics.

The first day set the scene, giving everyone the flavour of industrial optimisation research, including impressive keynotes by Dr Brenda Dietrich,IBM Fellow and Vice President who spoke about the growth and directions of business analytics, and John Gaffney, ITS Business Development Manager at VicRoads who talked about the use of instrumentation and controls to bring traffic flow on the M1 to world-class standards.

For the remainder of the event a selection of speakers discussed in more detail, research projects and open questions facing researchers. These projects were in areas such as the Hunter Valley Coal Chain, Norwegian trains, less-than-truckload carriers, emergency evacuation, tax collection, mine production planning, LNG, hospital occupancy and supply chain emissions.

Mathematics of Transportation Networks Workshop

19–21 June 2013, Monash University

As populations increase, congestion on our roads and public transport networks becomes ever more severe. The annual cost of congestion to Victoria alone is estimated to rise from $3 billion to $6 billion by 2020. In addition to these economic costs, there is also the negative impact congestion has on the environment and on people's quality of life.

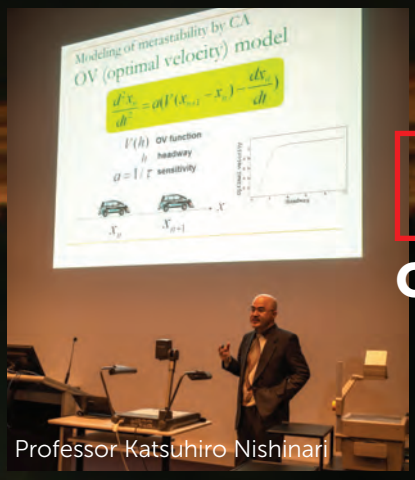
Tackling the transportation problem raises many mathematical challenges, particularly in the areas of optimization and stochastic modeling. The workshop brought together researchers from 10 universities and four industry organisations to discuss the application of mathematics to the design and operation of transportation networks.

Highlights of the workshop included Professor Travis Waller's,UNSW Australia discussion on recent work demonstrating that giving information about traffic congestion that encourage drivers to change their route can in fact increase, rather than reduce congestion and Professor Katsuhiro Nishinari, University of Tokyo who gave an overview of recent progress in highlighting similarities in the behaviour of vehicles, pedestrians and ants when they are considered as self-driven entities.

Recent breakthroughs in optimisation was the central focus, with talks from Professor Pascal Van Hentenryck, Dr Heng-Soon Gan and Dr Will Moase from The University of Melbourne, Dr Jörg Fliege, University of Southampton and Dr Hai Vu, Swinburne University of Technology.

"I am looking forward to future workshops like this one."

- Sarath Premachandra, Senior Traffic Systems Engineer, VicRoads



Professor Katsuhiro Nishinari

Public Lecture

Cheap solutions to the transport problem

Professor Mark Wallace, Monash University

The term "rush hour" is out-of-date: morning traffic congestion in Melbourne lasts from 6:30 until 9:30am. It is estimated that more than 20,000 trucks move through Melbourne's inner west each day. The proposed East-West Link project – an 18-kilometre inner urban road connecting the Eastern Freeway and the Western Ring Road – would help reduce this traffic, . but at a cost of $13 billion (so far the cost is currently sitting at $15m for just the writing of the business case). Mathematicians in Melbourne are exploring another way to keep traffic flowing on the existing roads and rails. Mathematical control of new traffic lights at the M1 freeway entrances has already increased the M1 capacity by 3000 vehicles per hour. This is merely a small improvement compared with the traffic revolution currently taking place.

The new generation of vehicle communication systems will enable vehicles to drive faster and closer together with lower risk. This could increase traffic throughput by a factor of four. A broader vision is to schedule all transport. Suppose you notified the transport system each time you started a journey, then it could schedule your road use to balance out traffic across the road system and minimise congestion. Simulations show that even with a small percentage of drivers using the system, users could reach their destination in half the time.

The majority of freight in Melbourne goes on small vans. Just by introducing a small number of transfer points, so that vans are used more efficiently, simulations indicate an immediate 25% reduction in van road usage. Public transport take-up in Melbourne is limited because buses are too few and far between, so mathematicians are developing adaptable bus schemes using communication devices and scheduling algorithms to make sure there's a bus where and when you need it.

In his talk on 18 June Professor Mark Wallace explained how mathematics will make it possible to solve Melbourne's transport problem without spending tens of billions of dollars on new infrastructure. The costs will be closer to just writing the business case for the infrastructure investment!

You can watch Cheap Solutions to the Transport Problem, a Public Lecture by Prof. Mark Wallace here: www.mathsofplanetearth.org.au/traffic

Winter School

2013 AMSI Winter School on the Mathematics of Planet Earth

24 June – 5 July, The University of Queensland

Students and researchers from across the country attended the 8th Annual AMSI Winter School, the Maths of Planet Earth theme allowed for cross-disciplinary attendance, with participants from earth sciences, computer science and physics as well as the mathematical sciences (of course). Topics discussed included mathematical modelling of infectious diseases; dynamics of earthquake rupture and optimisation for nature conservation.

Over the two weeks students had the opportunity to present their research, participate in courses delivered by world experts including Prof. Volker Michel from Universität Siegen and Prof. Hugh Possingham from the University of Queensland and network with their peers at social events.

PUBLIC LECTURE

Rob Vertessy

Environmental Intelligence for Australia

Dr Rob Vertessy, Director and CEO of the Bureau of Meteorology

Monitoring, assessing and forecasting environmental states and processes will be more and more important in a world facing global change and sustainability limits. Societies will be challenged to maintain, let alone improve, food security, water security and biodiversity, so situational awareness about the environment must be greatly enhanced.

In his talk, Dr Vertessy outlined the Bureau of Meteorology's role as a broad-based environmental intelligence service for Australia. He outlined the new functions that the Bureau has taken on over the last decade to set it on this path, including various new ocean, water resources and space weather services.

These developments come at a time when the planet is changing faster than ever before, society is demanding more of science and technological advances in environmental sensing and earth system simulation are occurring faster than our ability to appropriate them. Dr Vertessy argued that these are exciting and important times for scientific communities and operational agencies specialising in environmental intelligence, emphasising the importance of the mathematical sciences in underpinning these endeavours.

July BLOG

Maths and Penguins: the effect of climatic conditions on Little Penguin survival

By Dr Leesa Sidhu and Ms L. Billie Ganendran, Applied and Industrial Mathematics Research Group, School of Physical, Environmental and Mathematical Sciences, UNSW Canberra

The Phillip Island Penguin Parade is the second largest natural tourist attraction in Australia, with 525,000 tourists witnessing the captivating spectacle of up to 3000 penguins returning from the sea at dusk in 2012-13. In order to ensure the longevity of the Little Penguin (Eudyptula minor) colony, it is essential that we monitor trends in their survival probability in the wild. Predicting the potential effect of climatic conditions and climate change on Little Penguin survival, and ultimately on population size, is a major area of Australian research. And, this is where mathematics comes into play!

Little Penguins on Phillip Island have been marked since 1968, first with individually-numbered metal flipper bands and later with injected electronic transponders. This provides us with the rare opportunity to investigate the relationship between penguin survival and climate over a relatively long period. Using life-history data for Little Penguins, our group carried out a mark-recapture statistical analysis to examine if variation in sea-surface temperature and sea-temperature gradient, — defined as the east-west difference between two locations in Bass Strait — effect penguin survival probability in the first year of life.

Interestingly, we found that the east-west sea temperature gradient in the Bass Strait has a significant effect in the survival rates of the Little Penguins.

Projections suggest that global warming will increase both sea-surface temperatures in south-eastern Australia and the sea-temperature gradient in Bass Straight. However, the net effect on first-year survival is unknown. This is because an increased sea-temperature gradient in winter has a negative influence on penguin survival, while an increased sea-surface temperature in autumn has a positive influence on penguin survival. We require more data and more information concerning the relationship between these two variables to come to a solid conclusion.

Our group also examined the seasonal effects of wind strength and direction on the survival of Little Penguins. This study was based on two key hypotheses: the first, westerly winds bring cool nutrient-rich waters into the foraging grounds of the penguins, this has a positive flow-on effect on the penguins' food source. And the second, strong winds cause turbulence and mixing in the water columns of the penguins' foraging grounds – this has an adverse effect on the penguins' foraging success leading to a negative effect on their survival.

We found that an increasing number of days in autumn with strong westerly winds appears to have a negative effect on first-year survival — this is not surprising as autumn is a treacherous time for inexperienced newly-fledged birds. Adult survival was negatively associated with mean wind speed in autumn, which follows the annual moult when adults have to recover from fasting as they have been ashore for around three weeks.

Future research will consider the relationship between penguin survival, ocean temperature and wind speed, in combination with other compounding variables such as the amount of chlorophyll-a present. Chlorophyll-a is a chemical responsible for the absorption of light which provides energy for photosynthesis and is gives us a measure of marine productivity.

Stay tuned for further work in this area!

22 KEYNOTE SPEAKERS • 80 CONTRIBUTED TALKS • 200 PUBLIC LECTURE ATTENDEES

Maths of Planet Earth Australia Conference

8–12 July, Rydges Hotel Melbourne

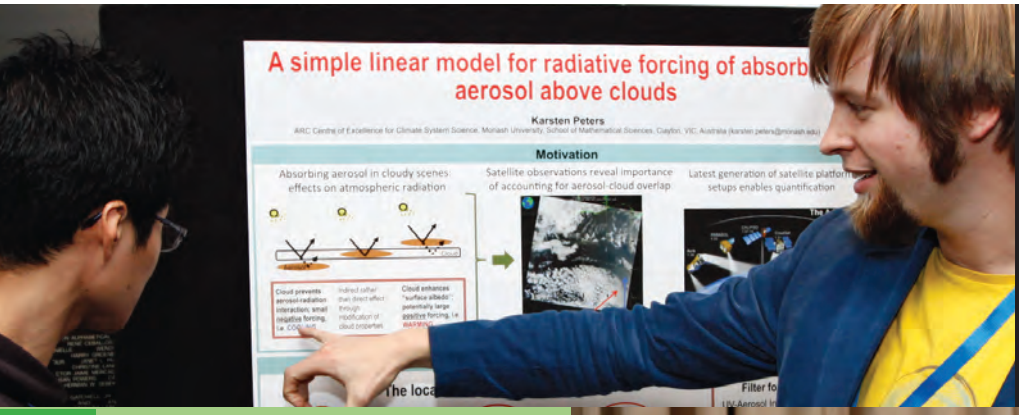
Five exciting days of new ideas, research and collaboration allowed us to examine the vital role of mathematics and statistics.

The conference brought together governmental agencies, experts from leading international and national research organisations, governmental departments and Australian centres of excellence to discuss critical challenges facing our planet, and how mathematics contributes to effort to address these various challenges.

As Australia's Chief Scientist and patron to the MPE year, Professor Ian Chubb AC, commented in his opening address events such as these are important to ensure Australia's mathematical capability to innovate and drive the economy forward.

During the week attendees participated in 15 plenary talks, 80 contributed talks, a public lecture delivered by the Chair of the International Council for Science's Future Earth Committee, panel discussions, dinners and poster sessions.

A communiqué released by participants of the conference pledges to communicate these points to the Australian community through a variety of channels.



"The chance to see mathematics at work in different applications, meet mathematicians and subject specialists and encounter challenging issues and avenues for advancing use of methods on practical problems"

- Mr Stephen Horn, SSAI

"Multiple disciplines in one conference"

- Dr Chris Allen, Royal Botanic Garden Sydney

PUBLIC LECTURE

A Future Earth for our children: maths for the planet

Dr Mark Stafford-Smith, Science Director Climate Adaptation Flagship, CSIRO

We live on a planet under pressure – accelerating human consumption collides with planetary limits and finite resources. As a species we are hugely innovative, but there is increasing evidence that we must alter our trajectory if our grandchildren are to enjoy the comforts we take for granted today.

Globally we are seeking a transition to a more sustainable future: the sciences and humanities have a major role to play in finding our way towards planetary stewardship.

In his talk on 10 July Dr Stafford-Smith outlined the challenges we face and the key role of the mathematical sciences.

He also introduced Future Earth, a new alliance of global change research organisations established in 2012. The explicit goal of the group is integrating across research disciplines and engaging with decision makers around the world to help deliver solutions from the resulting research.

July

"Everything ran like clockwork. The conference team members were all so friendly and helpful and the conference plenary speakers were excellent. The sessions ran smoothly too and the catering was amazing! Thanks for a great conference!"

- Dr Sandra Johnson, Queensland University of Technology

Plenary Speakers

- Dr Julie Arblaster, Bureau of Meteorology
- Prof. David H Bailey, Lawrence Berkeley National Lab, University of California
- Dr Simon Barry, CSIRO
- Mr Graeme Brown, Australian Bureau of Statistics
- Prof. Chris Budd, University of Bath
- Prof. Mark A. Burgman, Centre of Excellence for Biosecurity Risk Analysis
- Prof. Ian Chubb AC, Chief Scientist of Australia
- Dr John Cook, Global Change Institute
- Dr Kate Evans, Oak Ridge National Laboratory
- Dr David Fox, Environmetrics Australia
- Dr Bronwyn Harch, CSIRO
- Prof. David Karoly, ARC Centre of Excellence for Climate System Science
- Prof. Brian Kennett, Australian National University
- Dr Mark Lawrence, Mark Lawrence Group
- Mr Johann van der Merwe, Chevron Australia
- Dr Robert Muir-Wood, Risk Management Solutions
- Prof. Marc Parlange, Laboratory of Environmental Fluid Mechanics and Hydrology
- Prof. Terry Speed, Walter and Eliza Hall Institute
- Dr Mark Stafford-Smith, Climate Adaptation Flagship , CSIRO
- Prof. Peter Waterhouse, University of Sydney
- Dr Duncan Young, Australian Bureau of Statistics
- Dr Alex Zelinsky, Chief Defence Scientist and head of DSTO

"The variety of research topics, and the opportunity to hear from, and communicate with people from across a range of industries about current issues in Australia."

- Ms Josette Loomes, Australian Bureau of Statistics

"Great conference, lots of interactions, and this conference felt like being part of a mathematics family."

-Dr Steven Lord, DSTO

Industry Session July

Risk

Planning for the future

"Catastrophe models really are the application of mathematics into a commercial sector. What started out as a small university research project 25 years ago is now business activity worth a billion dollars a year,"

Dr Robert Muir-Wood, Chief Research Officer, RMS – Risk Management Solutions

Risk is a pressing global issue, whether it is financial, biological or environmental. The quantitative sciences have the expertise to assess, model and manage these matters.

To confront and command these issues we need to think outside the box.

Risk management professionals convened a special session on the 12 July to discuss and debate key topics applicable to all three disciplines

- What can we learn from successes in the environmental arena?
- How can we avoid history repeating itself?
- What have the mistakes from the global financial crisis taught us?

Plenary talks were followed by a lively panel discussion chaired by Dr Lawrence where the audience had the opportunity to quiz the experts on risk, the role of research and plans for future management.

Dr Mark Lawrence, Director of the Mark Lawrence Group, Mark currently advises major financial institutions and regulators on risk management, regulatory and strategic issues and reputational risks. He currently serves as a member of the Institute of International Finance's Committee on Governance & Industry Practices and the special committee on Effective Regulation.

In his talk he highlighted lessons learned from the risk management failures evident in the financial crisis and discussed some of the key challenges that financial industry participants and regulators are grappling with.

Johann van der Merwe, Chevron Australia, is considered an international authority on conservation planning and development, protected area management, and associated sustainable regional development.

He talked about the creation and implementation of the Barrow Island (Western Australia) Quarantine Management System (QMS) which has set new benchmarks in the management of biosecurity risks and received the Business Award for Environmental Best Practice Program at the 2012 United Nations World Environment Day Awards.

Professor Mark Burgman, Director of Centre of Excellence for Biosecurity Risk Analysis works on ecological modelling, conservation biology and risk assessment. His research has included models on a broad range of species and a range of settings including marine fisheries, forestry, irrigation, electrical power utilities, mining, and national park planning.

His talk examined the role that expert judgment plays in science and evaluated factors that affect the accuracy of estimates; in his talk he outlined new methods to improve judgment.

The vital role of maths and stats

Conference Communiqué

This week mathematicians, statisticians and scientists from the public and private sectors gathered to discuss many of the critical challenges facing our planet.

Although the time scales of these challenges are often very different, they are all materially and intellectually urgent. Along with our physical, biological and social knowledge of the planet, our mathematical skills are indispensable to progress.

The conference, led by the Australian Mathematical Sciences Institute [AMSI], brought together five government agencies, along with national and international researchers, government departments and centres of excellence.

Over five exciting days discussing new ideas, research and collaboration allowed us to examine the vital role of mathematics and statistics in areas such as

- Delaying the onset of Alzheimer's disease
- The detection of cells in terrorist networks
- Building the next generation of climate change models
- Managing the toughest biosecurity standards in the world
- Bullet-proofing the global financial system
- Modelling natural disasters to reduce human casualties

Some of the challenges we worked on are of humanity's own making and some are not, but collectively they affect our lives and those of our fellow species.

Earth system science, sustainability, financial risk modelling and management, climate change science, data mining, biosecurity, natural disaster mitigation, social policy—each of these areas is under intense development. Yet the fundamental role played by the mathematical sciences is generally unknown. Perhaps this is because the words "mathematics" and "statistics" do not appear once in the names of these areas, and the mathematical scientists who work in these areas are known by other titles.

The public, those learning mathematics in schools and universities and those making public policy must be made aware that mathematical scientists are pivotal to innovation.

Why is this important? Because without recognising the role of the mathematical sciences in meeting these challenges, we threaten the future supply of mathematically capable professionals able to work on current and future global challenges.

Australia cannot afford this loss of capacity.

We, the delegates in attendance, wish to make two important points to the Australian community:

21

We will strive for a safer and better understood planet through the development and application of mathematical and statistical research. As a community of scientists and professionals we have the principal responsibility for the public awareness of our work, so important for the inspiration of tomorrow's researchers.

Australian policy makers and governments must address declining interest in advanced mathematics and statistics in our schools and universities. All Australian children deserve to have qualified maths teachers and they should be engaged with the work that mathematically capable professionals perform, especially that which has an immediate and material benefit to the planet.

Recycling Rocks

Understanding sustainability in a dynamic earth

15–16 July 2013, The University of Melbourne

Significant advances in plate tectonic theory over the past 25 years have provided scientists with a better understanding of how nature continuously recycles itself. However, fundamental questions remain concerning the evolution of our planet and its dynamical processes. Taking into consideration Earth, and its status as a "human modified" environment

This joint MPE and Melbourne Energy Institute workshop brought together experts in the mathematics of complexity and dynamical systems with modellers and experimentalists. The focus was on how we can best integrate modelling and observation to further our understanding and predict with greater accuracy the dynamical processes of the Earth and strategies for efficient use of our natural resources toward obtaining a sustainable earth.

"I really enjoyed the workshop, both scientifically and socially. Everything was perfect ..."

- Professor Gary Froyland, UNSW Australia

The workshop highlighted effective strategies for sustainable development, emphasising the importance of an interdisciplinary approach to advance fundamental understanding and to solve real world problems.

Researchers from university, governmental and industry laboratories debated how to create a common language and an initial framework for discovery. This step is essential to the integration of data, methodologies, perspectives and concepts across the varied disciplines involved.

The maths of lab-grown livers

July

By Thomas Brown, Adelaide University

Scientists researching liver disease need a lot of liver samples for experiments. As such, it would be useful to be able to grow liver tissue in the lab. A new simulation, written by mathematician Thomas Brown, could help make lab-grown liver samples a reality.

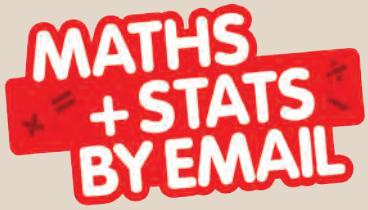
Currently, researchers put liver cells in flat dishes in the hope of forming tissue. Over time, these cells tend to clump together in groups called aggregates. However, scientists don't fully understand why or how these aggregates form. To investigate, Thomas wrote a computer program to simulate aggregation.

To represent the dish, Thomas started with a grid of squares. A single (simulated) liver cell fills exactly one of these squares. Then he worked out some rules to explain how liver cells might move.

He gave his cells a way to sense nearby cells. They could 'look' in four different directions (up, down, left, right) and count the cells in that direction. Each cell used that information to create a computer-simulated dice to choose which direction to travel in. For example, if the cell spotted more cells to the left, the virtual dice had left written on more of its sides. Each cell's movement was random, but they tended to move towards other cells.

Thomas put several simulated cells into his square grid dish. Then he made each cell look, make a dice, roll it and move in that direction. This process was repeated over and over to see what would happen. Over hundreds of cycles, Thomas' simulated cells moved together to form groups. These groups looked similar to the aggregates that real liver cells form. By adjusting how far his cells could 'see' Thomas was able to refine his model even further.

Running a computer program is a lot faster than growing a dish full of cells. So a good simulation of cell aggregation makes it easier to test different ways of growing liver aggregates. Thomas wrote his program in just five weeks, while studying at the Australian Mathematical Sciences Institute's Vacation Research School. With a bit more research time, this model might make a big difference for a lot of researchers.

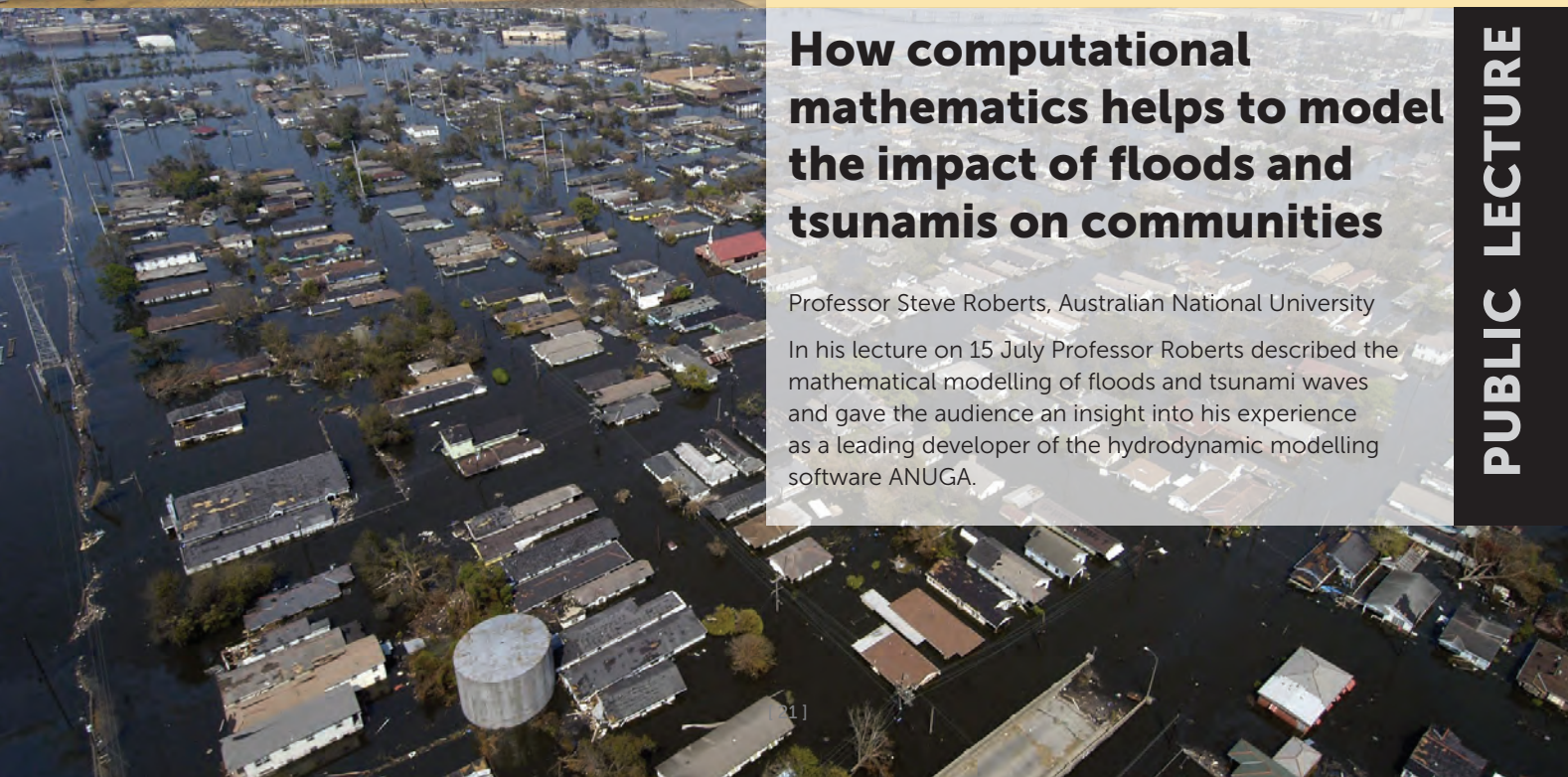


Australian Mathematical Sciences Students' Conference

15–17 July 2013, Australian National University

Over 75 students from around Australia converged on Canberra for the second annual Australian Mathematical Sciences Students' Conference.

During the conference 61 student presentated their research this covered a range of topics, from invariants of supermanifolds to the effect of climatic and oceanographic variables on penguin survival.



PUBLIC LECTURE

How computational mathematics helps to model the impact of floods and tsunamis on communities

Professor Steve Roberts, Australian National University

In his lecture on 15 July Professor Roberts described the mathematical modelling of floods and tsunami waves and gave the audience an insight into his experience as a leading developer of the hydrodynamic modelling software ANUGA.

August

A new language for a new biology

How SBML and other tools are transforming computer models of life

20 August 2013, Walter and Eliza Hall Institute (WEHI)

The event explored how biologists can use new languages and mechanisms to collaborate with others, what role developers can play in developing computational tools for biology and how an open-source approach could work in Australia.

At the event Mike Hucka, co-developer of Systems Biology Markup Language (SBML), advocated an open source approach to science and standardised tools for data-sharing; WEHI bioinformatician Gordon Smyth shared his experience using the package Bioconductor for his work and; bioinformatics pioneer Terry Speed lead a discussion on what Australia should be doing to adopt and contribute to the development of standards for computational modelling.

This Victorian Systems Biology Symposium was part of a series of events organised by SBI Australia and supported by the Victorian Government.

2013 AMSI-ANZIAM Lecturer

Professor Stephen Boyd, Stanford University

18 September – 4 October 2013

Author of several books and open source codes for modelling convex optimistic problems, fast model predictive control algorithms, amongst other programming and geometric problems, the 2013 AMSI-ANZIAM Lecturer, Professor Stephen Boyd is a highly regarded information systems and electrical engineer currently teaches at Stanford University. His cross disciplinary approach made him the ideal guest lecturer to join us in Australia for the MPE year.

Over 17 days, Professor Boyd toured the east coast of Australia delivering both technical seminars, many through the Access Grid Room network as well as public lectures. A highlight of the tour was the lecture given at the launch of the Monash Academy for Cross & Interdisciplinary Mathematical Applications (MAXIMA) on 25 September.

This lecture tour is an annual event sponsored by the Australian Mathematical Sciences Institute (AMSI) in partnership with the Statistical Society of Australia (SSAI) and the Australia and New Zealand Industrial and Applied Mathematics Group (ANZIAM).

15 SPECIALIST LECTURES • 8 PUBLIC LECTURES • 8 CITIES

"Professor Venkatesh is a young, inspiring and innovative mathematician"

- Peter Forrester, President of AustMS

2013 Mahler Lecturer

Professor Akshay Venkatesh, Stanford University

23 September – 11 October 2013

One of Australia's homegrown mathematical minds also toured Australia in 2013. Professor Akshay Venkatesh, winner of the SASTRA Ramanujan Prize in 2008 and Professor of Mathematics at Stanford, toured widely throughout Australia and delivered a mix of technical talks and public lectures to the mathematical community and members of the general public. His lecture, *How to stack oranges in three dimensions*, 24 dimensions and beyond proved very popular.

Professor Venkatesh's other claim to fame is that he became Australia's first and to this day only—Mathlete, and won medals at both the International Mathematics and International Physics Olympiads.

The Mahler Lecture Tour is a biennial activity organised by the Australian Mathematical Society, and supported by the AMSI.

Why should we care about your research?

"It is difficult to say something about my research specifically that is of broad interest. But you care because number theory provides many of the tools for modern cryptography, which is ubiquitous on the internet. For example, whenever you buy something securely online, your computer uses a little bit of number theory to ensure the safety of your information."

- Professor Akshay Venkatesh, Stanford University

A Planet at Risk

Bioinvasion and Biosecurity workshop

12–13 September 2013, CSIRO Discovery Centre – Canberra

Australia's physical isolation has fostered the development of our unique environment with its amazing diversity of plants and animals, many found nowhere else in the world. Our isolation also underpins our enviable position of being free from many serious pests and diseases that circulate around the world.

Australia is also a great trading nation. Our prosperity is built on the import and export of goods and services, but with them, can come pests and diseases.

Exotic animals, plants, pests and diseases have had significant impacts on Australian agriculture, the environment and economy. There are a number of iconic examples firmly in the national psyche – foxes, rabbits, prickly pear to name a few. Effective biosecurity will always be important in maintaining the efficiency of Australian agricultural industries and in protecting the environment.

For Australia, because of its unique fauna and flora, biosecurity is a key national priority. In 2013 CSIRO launched a new National Research Flagship focused on this critical area. The Biosecurity Flagship draws on the expertise of around 200 CSIRO staff contributing to work on biosecurity problems to help meet key national challenges. The mathematical and statistical sciences play a key role and Australia is well placed to innovate in this area.

Over 100 people came together to learn about Australian biosecurity risk and bioinvasion research. A variety of topics were highlighted and discussed, with the hope of inspiring a wider appreciation of the issues involved with this fascinating multi-disciplinary field of research.

This workshop was organised jointly by CSIRO Computational Informatics, the Mathematical Sciences Institute at the Australian National University and the Commonwealth Department of Agriculture, Fisheries and Forests.

September

"If we can target these dominant hubs for vaccination/removal then an epidemic might be brought under control faster or an outbreak prevented."

BLOG

Statistical models for wildlife contact networks—confronting theory with data

Shrupa Shah,
RMIT University

Recipient of a 2012/13 AMSI Vacation Research Scholarship.

Mathematical models for infectious diseases typically use contact rates e.g. the number of other people a person encounters per day, as one of their main elements in predicting the outcomes of an epidemic. The aim of my Vacation Research Scholarship project is to investigate the importance of spatial constraints and individual heterogeneity on the rate of contact of wildlife using field Voles (Microtus agrestis) as a case study.

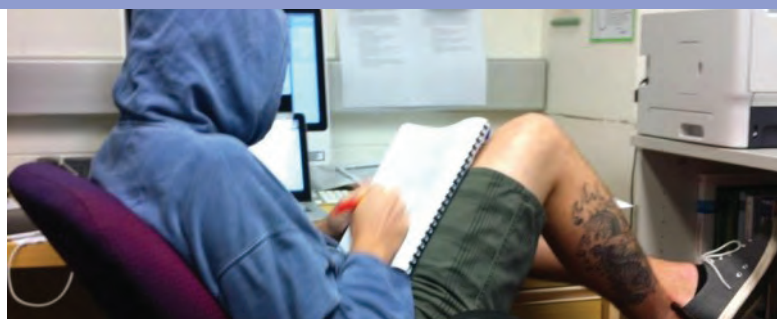
By spatial constraints, I mean the importance that spatial distance plays in the rate of contact. Furthermore, by individual heterogeneity, I mean the importance of characteristics such as mass and sex in determining the rate of contact.

We intuitively know that the further apart two individuals/Voles are from each other, the harder it would be for a pathogen to spread. But how far is far? Incorporating these spatial constraints into the rate of contact models would help us investigate this. Studying characteristics such as mass and sex would help us investigate the features of dominant hubs in the network.

I studied the contact networks of field Voles to better understand the characteristics of dominant hubs. Contact networks were formed such that each Vole trapped during a trapping session represented a node and since contacts were not directly observed they were inferred from trap sharing. In addition to that, each Vole was assigned an x-coordinate and y-coordinate to help calculate the Euclidean distance between two Voles. We used characteristics such as mass and sex to categorise the Voles into three groups, Big Males, Females and Small Males, the last having mass less than 25 grams.

We found significant evidence that the Big Males formed the dominant hubs in the network. If we can target these dominant hubs for vaccination/removal then an epidemic might be brought under control faster or an outbreak prevented.

Coffee with...



Associate Professor Dann Mallet

Academic Program Director, Mathematical Sciences
and Associate Professor, Queensland University of Technology

How do you introduce yourself at parties?

"Hi, I'm Dann." Now, in terms of my work, I usually say that I'm a mathematician. If it goes further than that I try to explain how I create equations and computer programs to mimic reality to try to answer questions that people have about systems involving biological cells and human interactions.

Why mathematics?

I always liked maths, numbers and solving problems. I originally intended to do business at university, but I received a scholarship to study maths in a science degree... I basically stuck with it from that point onwards because opportunities and various levels of successes just happened to come my way at the right time. I've been very fortunate and maths, via academia, has always provided very well for me.

Do you think that mathematicians deserve the "geek" tag?

Not so much if you mean like the Springfield University nerds on The Simpsons. Especially in Australia. And even more so in my experience with applied mathematics and statistics. We are pretty normal people really. We like sports, socialising with friends, partying (some of us a little too hard at times) – some of us are even good at sports! I work with about 25–30 other mathematicians and statisticians and I couldn't really identify any of them as "geeks".

What area of mathematics and why?

That I work in? I guess you would probably say modelling. In particular, modelling of biological cells in animals/humans. Even more specifically modelling of cancer and infectious diseases like chlamydia. I also model human interactions and how we alter each others' characteristics when we interact.

The why:

Originally I worked in computational mathematics, but for various reasons I took a detour into modelling... I got stuck there. One day I hope to spend time to get back into the more theoretical side of things too... but not now.

What has maths done for you lately?

Kept me and my family fed, clothed and enjoying ourselves. My wife,a PhD student modelling airports using Bayesian networks, my son, a 4 year old currently working on addition and subtraction of small integers and myself, working on development and implementation of Queensland University of Technology's new Bachelor of Mathematics degree, recently returned from 3 months in Hong Kong on study leave—I guess maths gave us that awesome opportunity to experience a different way of living.

Do you have a favourite application or theory of maths?

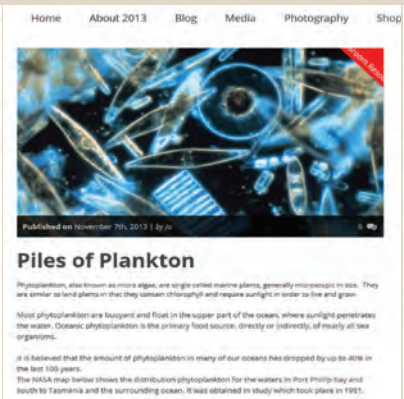
Wow – tough question. I would probably have to say anything to do with fluid flow – very cool stuff. Beyond me, but cool when someone good explains it to me in terms I can understand!

CLASSROOM RESOURCES

Throughout 2013, a team of mathematicians created a pool of classroom resources for teachers to incorporate into their teaching plans for the year and beyond!

These activities took topical, real life events and posed mathematical problems for students and teachers to work through. Highlighting the fact that maths truly is everywhere.

A special thank you to Chaitanya Rao, Daniel Mathews, Norman Do and Michael Evans for producing these resources for us.



PUBLIC LECTURE

"I love the way Professor Hiroaki Kitano guided the audience to his way of thinking."

- Mohd Nazri Kasuan

Hiroaki Kitano

Act Beyond Borders

Professor Hiroaki Kitano
President and CEO of Sony Computer Science Laboratories

President of the Systems Biology Institute in Tokyo

7 October 2013, RMIT University
10 October 2013, UNSW Australia

In the same way that systems biology uses mathematics to model biological systems, mathematics can help us understand economic systems, climate change and medicine.

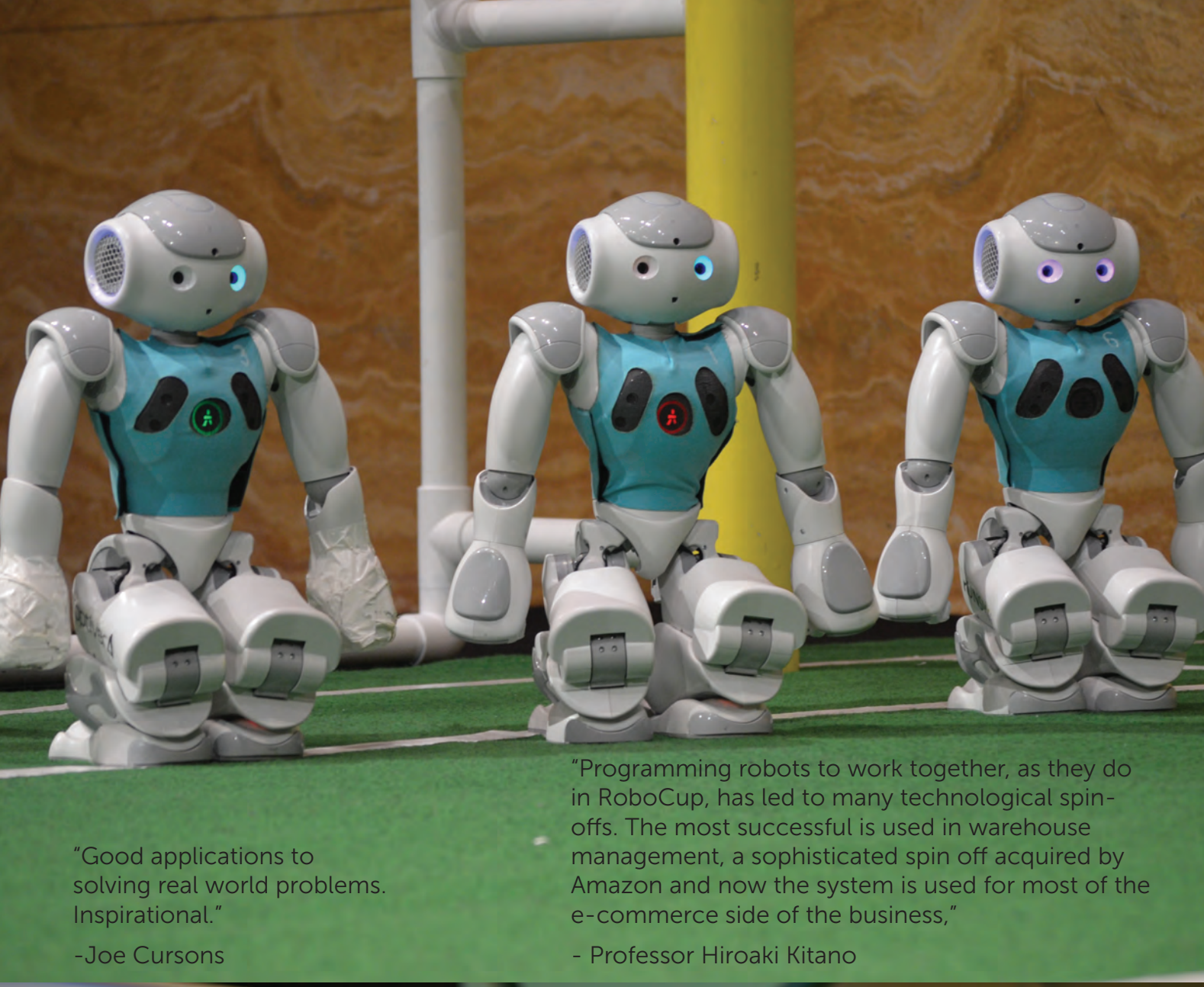
Professor Hiroaki Kitano visited Australia to deliver his popular lecture "Act Beyond Borders", in Melbourne and Sydney. In Sydney, UNSW Australia also showcased the rUNSWift soccer robots, which captured the attention of young and old.

His lecture showed how mathematics is essential for describing and understanding the complex world that we live in. The talk took the audience from AIBO the robotic dog, and RoboCup, the robotic world soccer challenge, to show how these seemingly frivolous projects enabled disaster response and recovery after the World Trade Centre attacks in 2002, and the Fukushima nuclear power plant disaster in 2011.

He then went on to demonstrate how mathematics underpins world economics and sustainability. With practical examples, he showed how mathematics can be used to develop a better quality of life. For example, a mathematical understanding of how beetles have adapted to the aridity of desert conditions, new technologies that mimic this natural adaption have been developed to produce clean water for arid communities. Also mathematics underpins new sustainable energy sources for developing countries, for example bringing energy to remote communities in Ghana. Sustainable energy sources are essential for improving health, wellbeing and education in developing countries, and this can all be enabled with mathematics, combined with creative vision.

The principle message from Professor Kitano is to think beyond borders, and act beyond borders, because we can change the world.

October



"Good applications to solving real world problems. Inspirational."

-Joe Cursons

"Programming robots to work together, as they do in RoboCup, has led to many technological spin-offs. The most successful is used in warehouse management, a sophisticated spin off acquired by Amazon and now the system is used for most of the e-commerce side of the business,"

- Professor Hiroaki Kitano

'Mathematics is the common language of science and technology. It is essential for describing, and defining, the fundamental principles of our universe. Maths is not only a tool to apply ideas practically, but it is a tool of thought,'

- Professor Hiroaki Kitano

Maths takes you places...

A PhD on interactions between Antarctic glacial-ice, the oceans and climate has led Dr Ben Galton-Fenzi to a career as a glaciologist.

Working at the Australian Antarctic Division and the Antarctic Climate and Ecosystems Cooperative Research Centre, Ben is using skills gained during his PhD to improve our understanding of the climate system.

'Mathematics is the language used by the natural world,' Ben says. 'It allows us to understand how the parts of the climate system work and fit together.'

'Maths allows us to make predictions, to both see where we are going and from where we have come.'

The CSIRO-UTAS PhD Program in Quantitative Marine Science (QMS) is offered through the University of Tasmania's specialist Institute for Marine and Antarctic Studies and CSIRO Marine and Atmospheric Research.

October

November

Phylomania 2013
Theoretical Phylogenetics Meeting

6–8 November 2013, University of Tasmania

Phylomania is an annual workshop in Theoretical Phylogenetics that brings together mathematicians and biologists to discuss recent progress on the development of mathematical and statistical methods for evolutionary biology and investigate the new biological challenges requiring mathematical input.

Phylogenetics is concerned with the problem of reconstructing the past evolutionary history of organisms from molecular data, such as DNA, or morphological characters.

There is ongoing interest in the further development of the mathematics that underlies computational phylogenetic methods. Hidden from view, in the software packages used by biologists, are algorithms performing statistical inference using Markov models on binary trees.

The mathematics involved represents a unique confluence of probability theory, discrete mathematics, statistical inference, algebraic geometry, and group theory. There are many important theoretical problems that arise, such as statistical identifiability of models, consistency and convergence of methods. These problems can only be solved using a multi-disciplinary approach.

Mathematical challenges
in finding the Tree of Life

Professor Mike Steel, University of Canterbury, New Zealand

On 6 November, Professor Steel highlighted some of the fascinating mathematical issues that arise in trying to infer either a Tree or Network of Life, showcasing the essential role of mathematics and statistics in the task of inferring evolutionary trees.

Ever since the publication of Darwin's The Origin of the Species, biologists have aimed to uncover the evolutionary history of the species that inhabit, or once inhabited, the Earth. This project of discovery has come to be known as the Tree of Life.

The Tree of Life model proposes that a branching process whereby one species can divide into two is used to describe the evolution of all species. Once divided, however, species can never reunite or share genetic material.

In recent years the Tree of Life as a paradigm for the evolution of all life on Earth has come to be seen as incomplete. Opponents to the model argue that it is far too simplistic, especially for the plant and bacterial kingdoms. For evolutionary biologists to make progress in uncovering the Network of Life a model that incorporates all the processes we can observe happening in the present is required.

Maths of Planet Earth

Festival of Mathematics at Fed Square

The Festival of Mathematics held throughout November was a collaboration between Mathematical Association of Victoria (MAV) and Melbourne's Fed Square. Associate Professor Burkard Polster and Dr Marty Ross presented three entertaining and thought-provoking lectures for highschoolers at the popular Deakin Edge Theatre at Fed Square.

Melbourne, the maths capital of the world

Presented by Assoc. Prof. Burkard Polster

Friday 8 November 2013

Melbourne is an amazing city for mathematically inspired architecture. Your guide Burkard will demonstrate with a whirlwind tour of mathematical Melbourne: explore the rep-tiles of Federation Square, cast a 5-dimensional shadow at RMIT's Storey Hall, experience life in a 1-sided holiday house, and much more.

Maths goes to the movies

Presented by Assoc. Prof. Burkard Polster and Dr Marty Ross

Friday 15 November 2013

This will be a truly unforgettable maths class. You'll sing and dance to Pythagoras, solve puzzles with Bruce Willis and be given lessons by Lisa Simpson, Russell Crowe and a host of other stars. Come learn some amazing mathematics, some real and some hilariously wrong.

Global warming in three easy lessons (and one difficult one)

Presented by Dr Marty Ross

Friday 22 November 2013

What is there to say about global warming? Way too much! Official reports run to thousands of pages and the naysayers are just as busy. What is a responsible citizen to do? Marty will attempt to provide you with a simple guide to the mountains of information and misinformation.

"In my opinion, this year was the most successful, not just in the large numbers that came along, but in the reach to different fields of science.

It wasn't just the mathematically-inclined people from universities and research institutes who came along, but others from health, agriculture and other bio-fields"

- Professor Terry Speed, recipient of the 2013 Prime Minister's Prize for Science

2013 BioInfoSummer

2–6 December 2013, The University of Adelaide

A record number medical researchers, statisticians, biologists and computer scientists attended BioInfoSummer 2013.

State-of-the-art technologies used in medical and biological research were discussed with experience ranging from diabetes research, phylogeny and molecular evolutionary studies to discovering genetic disorders through data analysis.

The scene was set on the first day with an opening lecture Bioinformatics before, during and after the era of genomics from Professor Terry Speed, recipient of the 2013 Prime Minister's Prize for Science, and introductory biology and statistics lectures to get participants up to speed.

The following days were designed to engage participants with the cutting-edge technologies used in bioinformatics research in evolutionary biology, systems biology, next generation sequencing and coding algorithms for Bioinformatics.

Each afternoon computing sessions were held, these were extremely popular among participants. The real data sets provided them with an opportunity to consolidate what they had been exposed to throughout the day.






PUBLIC LECTURE

Professor Steve Donnellan, South Australian Museum

On 3 December Professor Donnellan explored some of South Australian Museum's exciting findings beginning with his adventures in the field and moving onto the application of the latest technologies and the increasingly important contribution of bioinformatics—a pioneering combination of computing, statistics and biology.

Some of the big questions in evolution of life on earth, such as how did life begin, why did sex evolve, how do species

Evolution's mysteries unravelled with genomes and computers

"I left BioInfoSummer feeling motivated and inspired with new ideas."

- Pamela Ajuyah

form, are starting to be unravelled by the availability of genetic information from entire genomes.

South Australian Museum scientists are currently pursing major questions in evolution around the globe using the latest genetic technologies. In support of these endeavours, the South Australian Museum has one of the world's largest wildlife tissue collections and state of the art genetics facilities for extracting genetic information from the collection.

December

Fighting cancer by the numbers

Professor Terry Speed inspired attendees with his opening address and keynote presentation Bioinformatics before, during and after the era of genomics.

Professor Speed is one of Australia's eminent statisticians and head of Bioinformatics at the Walter and Eliza Hall Institute of Medical Research.

In May 2013 he was elected as a fellow of the Royal Society and in October he was honoured with Australia's highest award for excellence in science – The Prime Minister's Prize for Science, for his contribution to making sense of genomics and related technologies.

Professor Speed doesn't expect to see headlines reading "Statistician cures cancer" any time soon. But he knows that the right mathematics and statistics can help researchers understand the underlying causes of cancer and reduce the need for surgery.

A mathematician and statistician, he has written elegant theoretical papers that "almost no-one reads", but he has also testified in court, helped farmers and diamond miners, and given biologists statistical tools to help them cope with the genetic revolution.

Twenty years ago biologists looked at one or two genes in isolation. Today they can track thousands of genes in a single cell, but to understand the results they need tools of the kind that Terry develops.

Talking biscuits and maths with Professor Chris Budd

Have you ever thought about how your biscuits make it from the mixing bowl, to the production line, to the supermarket shelves? All without crumbling and breaking?

Mathematics. That is how.

Dynamical systems in the food industry is just one of the topics Professor Chris Budd dabbles in. The Professor of Applied Mathematics at the University of Bath and Professor of Mathematics at the Royal Institution spoke with us about the varied and wonderful things that maths does in our world.

Professor Budd cannot remember a time when he was not passionate about maths and science. He loves that mathematics not only helps us to understand the world now, but it can help us predict things into the future. And this has the ability to enrich people's lives.

'Mathematics is a powerful tool, and a beautiful one. It was the combination of this, with the fun and challenge of problem solving that drew me in, and has kept me mesmerised for all these years.' Professor Budd said when asked about his interest in the mathematical sciences.

The general public isn't aware of just how much of their world is powered by mathematics. It transmits information; it keeps this information secure and enables us to communicate—across the world—effectively. *"People don't realise just how much maths goes into a mobile phone and that their phones would simply not exist let alone work without maths."* Professor Budd said.

His favourite 'big' application of mathematics in modern society 'would have to be Google'. 'Invented by mathematicians, the search engine uses maths that many students learn at university. And they have no idea of the major application of this maths.'

December

Limits to Growth

Beyond the point of inflexion

11–12 December 2013, UNSW Australia

A little over forty years ago an international team led by Donella Meadows, Dennis Meadows, Jørgen Randers and William Behrens III carried out a major study of growth in five key areas: population, agricultural production, natural resources, industrial production and pollution.

The team concluded that, if current trends continued, limits to growth would be realised within one hundred years with a sudden and uncontrollable decline in population and industrial capacity. Many of the projections on resources and pollution proved to be incorrect, with technological advances reversing trends.

However the central mathematical result, that continued exponential growth is not sustainable indefinitely, is indisputable, and we have now entered an era, beyond the point of inflexion, where the rate of population growth is slowing.

Which poses the questions: Is economic growth forever sustainable? What impact would a stagnant or declining population have on GDP? Can mathematical models guide policy makers in answering these questions? What is the strategic plan for planet Earth?

Some of the world's leading thinkers including Randers, converged at the UNSW Australia in December to address these questions.

Panel Discussion

Limits to Growth: Beyond the point of inflexion

A panel discussion and question and answer session on the 12 December gave the wider community a chance to come in discuss, and debate the issues addressed during the day.

The panel facilitated by Ticky Fullerton, ABC journalist and presenter of The Business and comprised of conference speakers.

Professor Graciela Chichilnisky

Professor of economics at Columbia University and architect of the carbon market mechanism in the UN Kyoto Protocol.

Mr Ken Henry AC FASSA

Economist, Former Secretary of the Department of Treasury, Chair of Australia's Future Tax System Review and Chair of the White Paper on Australia in the Asian Century.

Professor Jørgen Randers

Professor of Climate Strategy at BI Norwegian Business School and prolific author, specifically the co-author of Limits to Growth and author of 2052.

Mr Graeme Maxton

Economist and author, specifically of The End of Progress and a regular contributor to The Economist's The World in publication and a Member of the Club of Rome.

Mr Peter Cosier

Director and a Founding Member of the Wentworth Group of Concerned Scientists, established in 2002 with the aim of connecting science to public policy.

Mr Ross Gittins AM

Australian political and economic journalist and author, currently Economics editor at The Sydney Morning Herald and economics columnist at The Age.

Professor Clive Hamilton AM FRSA

Professor of Public Ethics at the Centre for Applied Philisophy and Public Ethics and author of books including Growth Fetish, Requiem for a Species and Earthmasters.

Ms Gemma Van Halderen

Head of the Population, Education and Data Integration Division at the Australian Bureau of Statistics.

Professor Peter Victor

Professor in Environmental Studies, Former President of the Royal Canadian Institute for the Advancement of Science, author of Managing without Growth: Smaller by Design, Not Disaster and a Member of the Club of Rome.

Dr Julian King

Vice President of thev Pottinger Group, a leading independent financial and strategic advisory firm.

"I wish to thank AMSI for making Maths of Planet Earth Australia such a wonderful year; long life to Mathematics of Planet Earth!"

- Professor Christiane Rousseau, Université de Montréal and vice-president of the International Mathematics Union

In the media

Beyond 2013

"We commend this initiative and fully endorse the proposal to continue this programme beyond 2013."
Irina Bokova, Director-General of UNESCO

Mathematics of Planet Earth 2013 becomes Mathematics of Planet Earth

The objectives remain unchanged – to identify fundamental research questions about Planet Earth and reach out to the general public.

Mathematics of Planet Earth 2013 has been a great start and the level of cooperation demonstrated by MPE2013 is unprecedented. But identifying the research problems is not enough. Mathematics moves slowly, the planetary problems are very challenging, and we cannot expect great results in just one year.

The MPE Network

As a direct result of the success of MPE Australia 16 of our member universities and five government agencies have formed the MPE Network.

The network will be facilitated by AMSI and build connections between mathematical scientists from the Bureau of Meteorology, the Australian Bureau of Statistics, CSIRO, the Defence Science Technology Organisation, Geoscience Australia and our undergraduate and postgraduate students.

The exciting work of the agencies will be connected to the training of tomorrow's graduates through the network. A regular Agencies Meet Universities event will be held to discuss the program, enhance employment opportunities for our students and share research.

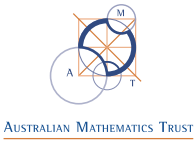
MPE Blog

Throughout 2013 we published 140 blog posts featuring Australian research and researchers. The blog was very popular receiving 75,000 visits from 150 countries over the year.

Beyond 2013, the blog will continue on the AMSI website providing a portal for Australian research and researchers to get information about their work to the wider community.

Media

AMSI Members



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The mathematics and economics of marine protected areas

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