



AMSI SUMMER SCHOOL 2017

IN THE MATHEMATICAL

SCIENCES

The University of Sydney

9 January to 3 February 2017

AMSI Summer School 2017 would like to thank the following sponsors for their support:



Australian Government
Department of Education and Training



THE UNIVERSITY OF
SYDNEY



**CHOOSE
MATHS**



Australian Government
Department of Defence



AMSI Summer School 2017

in the Mathematical Sciences

The University of Sydney

9 January to 3 February 2017

INTRODUCTION	5
COURSE PROGRAM	7
PARTICIPATION BREAKDOWN	17
GRANTS	18
PROGRAM EXTRAS	20
FEEDBACK ANALYSIS	24
STUDENT PROFILE	25
MEDIA RELEASE	26
DIRECTOR'S REPORT	29
EVENT COMMITTEES	30



INTRODUCTION

AMSI Summer School 2017 was held for the fifteenth year in January at The University of Sydney, with a record number of 168 students attending the school. As one of the Australian Mathematical Sciences Institute's (AMSI) flagship higher-education events, the Summer School featured eight honours-level courses delivered by eminent lecturers from around Australia, offering students the opportunity to study one or two courses, and areas of mathematics and statistics that may not have been available at their home university.

The four-week program, designed for honours and postgraduate students, also attracted undergraduates, early-career researchers and industry professionals in the mathematical sciences and cognate disciplines. Attendees were encouraged to meet and build collaborative networks throughout the School, which was achieved through the diverse lecture and tutorial/lab course program, as well as a variety of program extras from a public lecture through to a careers afternoon and a number of social events.

Dr Ron Sandland, Chair of the AMSI Board, officially opened the school at The University of Sydney's MacLaurin Hall with an inspiring address on the discipline and climate of mathematics and statistics in today's society, and wished all attendees a stimulating and engaging experience, encouraging all to make the very most of the opportunity to be there. The University of Sydney's Deputy Vice Chancellor (Education) Professor Philippa Pattison warmly welcomed the attendees, lecturers and invited guests to the University and AMSI Summer School 2017 program.

Eight courses were delivered by 11 senior lecturers from around Australia, continuing the tradition of a collaborative program, attracting leaders in their fields to share expertise and specialist knowledge with a national cohort of students. These courses were delivered over the intensive four-week program through a lecture, tutorial and lab academic program, with 84 students taking a course for credit towards their degree.

The fifteenth annual Careers Afternoon was a popular feature of the School, where attendees were given the chance to hear about career opportunities from employers specifically seeking mathematics and statistics graduates, highlighting prospective careers of which students are often unaware. Attendees were further invited to get involved in an exhibition networking session with industry specialists over afternoon tea. In 2017, the School was pleased to have eight companies represented, including Google, the Commonwealth Bank of Australia and the Australian Bureau of Statistics.

Additional program extras created a diverse timetable of activity throughout the four weeks including a Women in the Mathematical Sciences Panel Event, a public lecture by Dr Genevera Allen (Rice University) on "Networks for Big Biomedical Data", four Lunchtime Lectures and a number of social events.

AMSI Summer School 2017 was jointly funded by the Australian Mathematical Sciences Institute and the Australian Government's Department of Education & Training, with support from The University of Sydney, AustMS, ANZIAM, the BHP Billiton Foundation through the CHOOSEMATHS program, the Australian Signals Directorate and Optiver.

“AMSI Summer School 2017 was an exciting start to the year, again providing an unmatched opportunity for mathematical sciences honours and postgraduate students to network and develop essential skills. As Director of AMSI, I wish to acknowledge the efforts of Event Director Professor Anthony Henderson and the University of Sydney organising committee and lecturers in helping coordinate such a successful event.

AMSI Summer School 2017 was made possible through the efforts of AMSI staff and the generous support of sponsors, AustMS, ANZIAM and the Department of Education & Training. On behalf of AMSI, I thank all those involved in AMSI Summer School 2017 and invite potential partners to join us in supporting future events.”

Professor Geoff Prince

Director

Australia Mathematical Sciences Institute

“No other AMSI event exemplifies so well the core idea of friendly cooperation between Australian universities, combining their resources to provide advanced education to a far greater number of students than any university could muster on its own.”

Professor Anthony Henderson

AMSI Summer School 2017 Event Director

The University of Sydney

COURSE PROGRAM

The academic program consisted of eight courses throughout the intensive four-week timetable. Students were given the opportunity to enrol in up to two courses, and had the option to take one course for credit, completing assessment tasks including a final examination, and obtaining a passing grade.

Courses offered could be roughly categorised as follows:

Category Theory and Computer Science* (Pure Mathematics)

Dr Richard Garner, Macquarie University

Professor Dominic Verity, Macquarie University

Computational Bayesian Statistics (Statistics)

Professor Scott Sisson, The University of New South Wales

Computational Mathematics (Applied Mathematics)

Professor Markus Hegland, The Australian National University

Geometric Group Theory and Harmonic Analysis (Pure Mathematics)

Dr Lawrence Reeves, The University of Melbourne

Dr Anne Thomas, The University of Sydney

Harmonic Analysis (Pure Mathematics)

Dr Pierre Portal, The Australian National University

Mathematics and Statistics of Big Data* (Statistics)

Professor Kerrie Mengersen, Queensland University of Technology

Associate Professor Tomasz Bednarz, Queensland University of Technology / CSIRO Data61

Mathematical Biology* (Applied Mathematics)

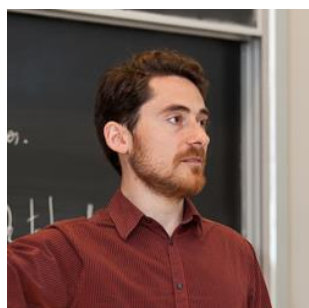
Professor Mary Myerscough, The University of Sydney

Optimisation (Applied Mathematics)

Dr Michelle Dunbar, The University of Sydney

** Indicates that the course had a close relationship with cognate disciplines.*

Category Theory and Computer Science



Dr Richard Garner
Macquarie University
Prof. Dominic Verity
Macquarie University

FoR code: 010103 | MSC number: 18

Theoretical computer science enables us to reason in a mathematically rigorous way about computation: for example, proving that a given program is error-free. Much of this reasoning makes use of category theory, an abstract meta-language for mathematical discourse. This course was an introduction to category theory, with an emphasis on various kinds of monoidal categories.

- Basic notions of category theory.
- Braided and symmetric monoidal categories.
- Internal homs and duals.
- Traced monoidal categories.
- Concurrent systems.
- Linear logic and *-autonomous categories.
- Monoidal categories of games.
- Girard's geometry of interaction.

Course Completions: 36

Passed Course for Credit: 10

Computational Bayesian Statistics



Prof. Scott Sisson

The University of New South Wales

FoR code: 010401 | MSC number: 62

Bayesian statistics could be described as the systematic application of probability to decision-making in the face of uncertainty. After describing the fundamentals of Bayesian inference, this course examined specification of prior distributions, Bayesian model-comparison, Bayesian computational methods and links between Bayesian and classical frequentist inference.

- General introduction to Bayesian statistics and Monte Carlo methods.
- Conjugate, improper and Jeffreys priors.
- Univariate and multivariate models.
- Monte Carlo integration, inversion sampling, rejection sampling, importance sampling.
- Loss functions.
- Predictive inference.
- Posterior asymptotics.
- Markov chain Monte Carlo, Gibbs sampling, adaptive rejection sampling, Metropolis-Hastings sampling, auxiliary variable samplers.
- Conditional independence graphs.
- WinBuGS/OpenBuGs software.
- Bayesian hypothesis testing.
- Bayes Factors and marginal likelihoods.
- Bayes factors with improper priors, imaginary observations, partial Bayes factors, intrinsic Bayes factors, fractional Bayes factors.
- Hierarchical models, mixture models, changepoint models.

Course Completions: 32

Passed Course for Credit: 14

Computational Mathematics



Prof. Markus Hegland
The Australian National University

FoR code: 0103 | MSC number: 65

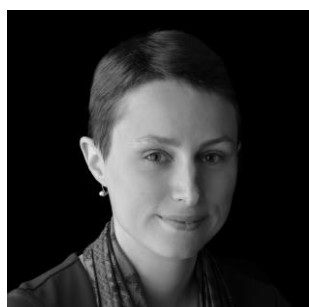
Numerical techniques are used very widely in modern industrial societies in medical image processing, computer games, the control of autonomous vehicles, the design and production of vehicles, the analysis of big data, the understanding of weather and climate, and the assessment of the effect of tsunamis and the spread of introduced species and diseases. This course explored some of the fundamental methods that underpin all numerical techniques.

- Expression-evaluation and floating-point arithmetic.
- Solving systems of equations: Gaussian elimination with pivoting, Gauss-Seidel method, SOR and the conjugate gradient method, fast Fourier transform.
- Function approximation and quadrature, polynomial interpolation and its applications, trapezoidal rule, higher order rules, Gaussian quadrature and Romberg extrapolation.
- Non-linear equations: bisection method and Newton's method, error bounds and convergence theory.
- Ordinary differential equations: explicit and implicit methods, stability, one-step and multi-step methods, convergence theorem.

Course Completions: 21

Passed Course for Credit: 8

Geometric Group Theory and Harmonic Analysis



Dr Lawrence Reeves

The University of Melbourne

Dr Anne Thomas

The University of Sydney

FoR code: 010105 | MSC number: 20

Groups and geometry are ubiquitous in mathematics. This course introduced students to the study of infinite groups from the geometrical viewpoint, drawing on ideas from low-dimensional topology and from hyperbolic geometry, while making connections to analysis and algebra as well.

- Free groups, presentations.
- Decision problems.
- Cayley graphs, word metrics and coarse geometry.
- Hyperbolic groups.
- Amenable groups.
- Right-angled Coxeter groups.

Course Completions: 30

Passed Course for Credit: 8

Harmonic Analysis



Dr Pierre Portal

The Australian National University

FoR code: 010106 | MSC number: 42, 43

Harmonic analysis is a branch of analysis inspired by the decomposition of square integrable functions on the circle into Fourier series. It includes a range of methods to decompose functions defined on certain metric measure spaces (e.g. Euclidean space, Lie groups, Riemannian manifolds) into pieces in such a way that various properties of these functions (e.g. smoothness, integrability, oscillations) can be easily uncovered. This is helpful for a range of problems, from PDE to geometry to number theory. This course concerned the foundations of harmonic analysis on Euclidean space, concluding with Mihlin-Hormander's Fourier multiplier theorem.

- L^p spaces.
- Distributions.
- Fourier transform.
- Maximal functions.
- Interpolation.
- Calderon-Zygmund decomposition.
- Fourier multipliers.

Course Completions: 23

Passed Course for Credit: 9

Mathematical Biology



Prof. Mary Myerscough

The University of Sydney

FoR code: 010202 | MSC number: 34, 92

Mathematics has a plethora of applications to biological systems. This course covered some of the models and techniques of classical mathematical biology, including population biology, epidemiology, oscillating systems and neural action potentials, and associated mathematical techniques.

- Basic techniques of nonlinear ODEs: phase planes and linear analysis of steady states.
- Limit cycles, the Hopf bifurcation theorem, the Poincare-Bendixson theorem, limit cycle stability.
- Slow-fast systems, excitable kinetics and relaxation oscillators.
- Stationary bifurcations. Classifying bifurcations using singularity theory.
- Travelling wave analysis.
- Travelling waves in excitable media.
- Epidemiological models. SIR models and extensions. Endemic disease and R_0 .
- Continuous age/size population models and McKendrick-von Foerster equations. Discrete age- or stage-structured. Leslie matrices. Coates graphs. The Perron-Frobenius Theorem.

Course Completions: 11

Passed Course for Credit: 5

Mathematics and Statistics of Big Data



Prof. Kerrie Mengersen, Queensland University of Technology

A/Prof. Tomasz Bednarz,

Queensland University of Technology & CSIRO Data61

FoR code: 010401 | MSC number: 62

What is this thing called “big data”? What does it mean for the world in general, and for mathematical scientists in particular? What skills do mathematical scientists need to develop in order to engage effectively in the “big data era”? This course addressed these questions and covered some of the theory, methods and computational tools that are useful in modelling, analysis and visualisation of big data.

- Big data: what, where and why?
- The Big Data Wheel.
- Big data papers that changed the world.
- Managing big data.
- Big-data management tools 1: SQL, HDFS and Hadoop.
- Big-data management tools 2: MapReduce, Apache Pig, Apache Spark.
- Big-data methods: classification, clustering, regression and dimension reduction.
- Popular algorithms for big-data analysis.
- Software tools for big-data analysis.
- Visualisation: science visualisation, information visualisation, communication, aesthetics and design approaches to visualisation.

Course Completions: 57

Passed Course for Credit: 19

Optimisation



Dr Michelle Dunbar
The University of Sydney

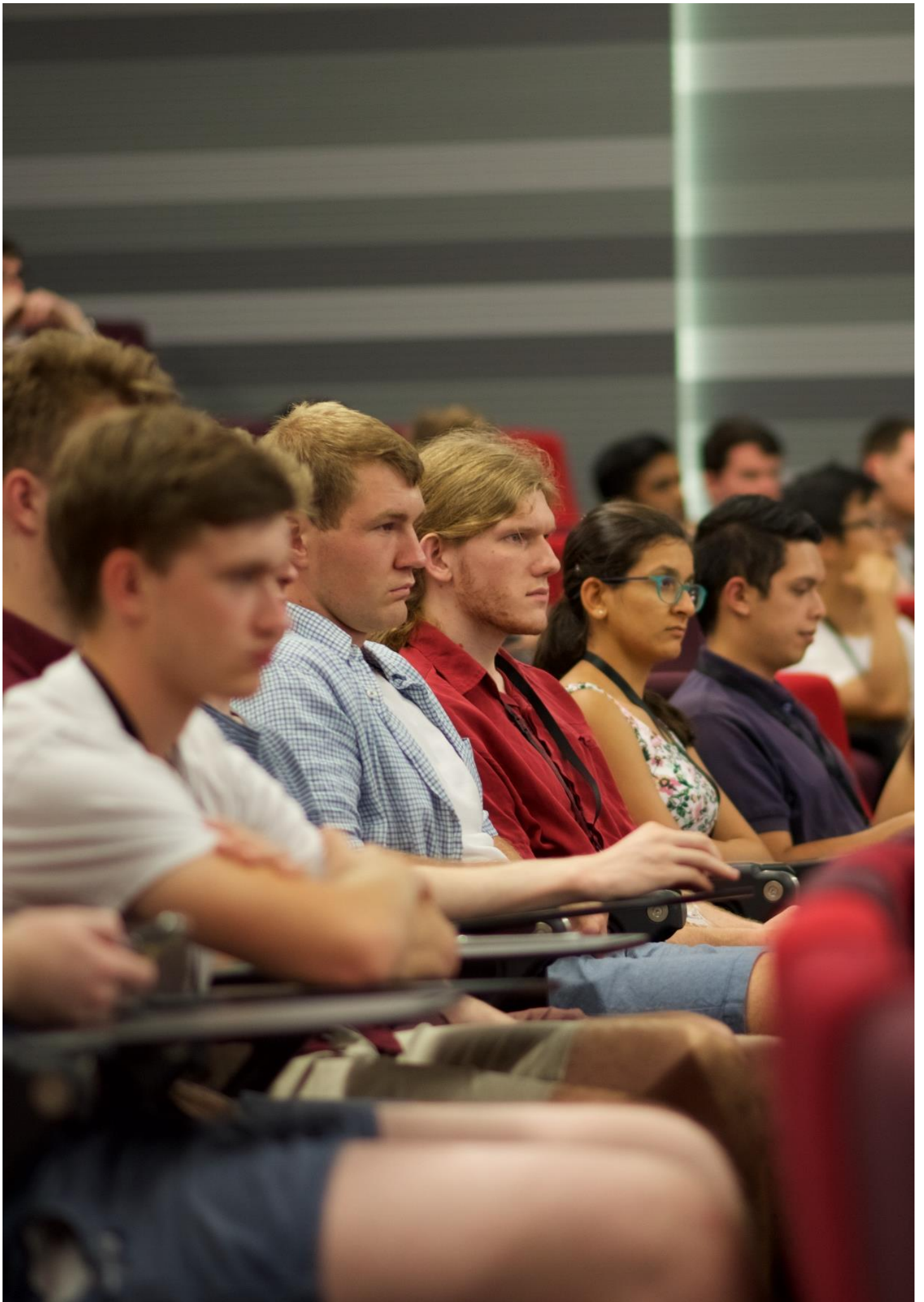
FoR code: 010206, 010303 | MSC number: 49, 90

In many real-world problems, we wish to seek the best possible solution under a given set of constraints. How do we achieve this? The answer is optimisation! This course investigated the art of translating real-world problems into mathematics, and developed the mathematical tools and techniques to solve these problems efficiently in practice, considering real-world examples from medicine and industry.

- Linear programming: formulations, graphical solutions.
- The simplex method for solving linear programs.
- Duality.
- Network optimisation: link and path-flow formulations for networks.
- Shortest-path algorithms.
- Integer programming.
- Introduction to non-linear optimisation.
- Real-world applications.

Course Completions: 20

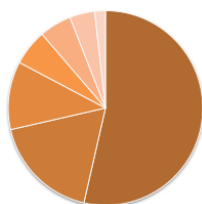
Passed Course for Credit: 11



PARTICIPATION BREAKDOWN

UNIVERSITY/INSTITUTION

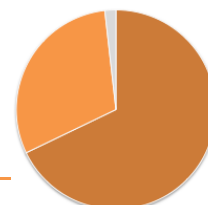
Charles Sturt University	1
Curtin University of Technology	3
Deakin University	3
Flinders University	2
James Cook University	1
Macquarie University	2
Monash University	12
Queensland University of Technology	1
RMIT University	4
The Australian National University	19
The University of Adelaide	7
The University of Melbourne	11
The University of New South Wales	31
The University of Newcastle	10
The University of Queensland	8
The University of Sydney	29
The University of Western Australia	4
University of South Australia	1
University of Tasmania	3
University of Technology Sydney	6
University of Wollongong	6
Other, inc. Industry Professionals	4
TOTAL	168



STATE/TERRITORY

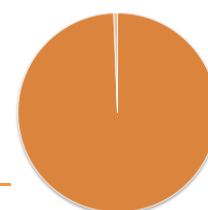
NSW	90	54%
VIC	30	18%
ACT	19	11%
SA	10	6%
QLD	9	5%
WA	7	4%

TAS	3	2%
-----	---	----



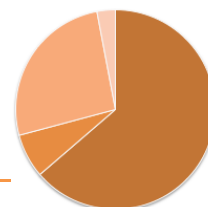
GENDER

Male	114	68%
Female	51	30%
Prefer not to disclose	3	2%



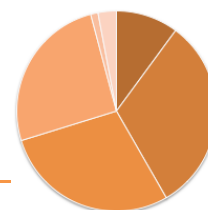
ATSI STATUS

No	167	99%
Prefer not to disclose	1	1%



RESIDENCY STATUS

Australian Citizen	107	56%
Permanent Resident	12	8%
Student Visa	44	27%
Other	5	3%



ACADEMIC STATUS

Undergraduate	17	10%
Honours	53	31%

Masters	48	29%
PhD	43	26%

Early-Career Researcher	2	1%
Other	5	3%

GRANTS

AMSI Travel Grants

AMSI Travel Grants are offered to support AMSI Member student travel and accommodation to attend flagship higher-education events. AMSI Summer School 2017 grants were funded by AMSI, The University of Sydney and the Australian Government's Department of Education & Training, and were determined on a competitive basis.

In 2017, AMSI Travel Grants were awarded to 56 students from 12 AMSI Member Universities:

- Mahdi Abolghasemi, The University of Newcastle
- Carmine Babis, Curtin University of Technology
- Alexander Baker, The University of Queensland
- Michael Bardsley, Monash University
- Jasper Barr, The University of Queensland
- Abhishek Bhardwaj, Australian National University
- Alexander Bishop, The University of Newcastle
- Jacob Bradd, University of Wollongong
- Sindri Chapman, University of Tasmania
- Hanz Martin Cheng, Monash University
- James Clift, The University of Melbourne
- Ziyi Cong, The University of Melbourne
- Zanning Dai, Australian National University
- Geordie Dalzell, RMIT University
- Kaustav Das, Monash University
- Zachary Downton, Australian National University
- Saul Freedman, The University of Western Australia
- Yoong Kuan Goh, The University of Newcastle
- Souveek Halder, Australian National University
- Layne Hall, Monash University
- Ahmed Faisal Haris, Monash University
- Robert Hill, University of Tasmania
- Thomas Hindle, University of Tasmania
- Daniel John, The University of Adelaide
- Muhammad Kamran, Curtin University of Technology
- Yasith Kariyawasam, The University of Western Australia
- Musashi Koyama, The University of Melbourne
- Patrick Laub, The University of Queensland
- Andrew Liangv, The University of Queensland
- Samuel Lyons, The University of Melbourne
- Ming Ma, Monash University
- Benjamin Maldon, University of Wollongong
- Thomas McCallum, The University of Newcastle
- John McCarthy, The University of Adelaide

- Sam Mills, The University of Adelaide
- Archer Moore, RMIT University
- Connor O'Sullivan, The University of Newcastle
- Cameron Powell, The University of Western Australia
- Ainsley Pullen, The University of Queensland
- Youyang Qu, Deakin University
- David Quarel, Australian National University
- Cale Rankin, The University of Queensland
- Rommel Real, Australian National University
- Kyle Rosa, The University of Western Australia
- Jacob Ross, Australian National University
- Kai Striega, Curtin University of Technology
- Thomas Taylor, The University of Newcastle
- Benjamin Thompson, Australian National University
- William Troiani, The University of Melbourne
- Aaron Varga, Monash University
- Ivo De Los Santos Vekemans, Australian National University
- Shiyi Wang, Monash University
- Joshua Williams, The University of Newcastle
- Cheng Xue, Australian National University
- Shuiqiao Yang, Deakin University
- Yumiao Zhou, University of Wollongong

CHOOSEMATHS Grants

CHOOSEMATHS Grants are designed to offer full or partial support for Australian female mathematical sciences students and early-career researchers to participate in the AMSI higher-education programs and/or assist with caring responsibilities. The BHP Billiton Foundation, as an initiative of the CHOOSEMATHS program, funded these grants to help females build and extend mathematical skills and professional networks.

In 2017, CHOOSEMATHS Grants were awarded to 20 female students from 9 AMSI Member Universities:

- Amani Alahmadi, Monash University
- Catherine Attard, Monash University
- An Ran Chen, Australian National University
- Diclehan Erdal, The University of Adelaide
- Alexandra Grant, Australian National University
- Vanessa Haller, James Cook University
- Jingya Han, Australian National University
- Maria Kleshnina, Flinders University
- Aline Kunnel, Flinders University
- Xuemei Liu, University of South Australia
- Georgina Matta, RMIT University
- Nicolev Mckenna, RMIT University
- Rachel McLean, The University of Adelaide
- Jessica Penfold, The University of Adelaide
- Jie Ren, The University of Melbourne
- Olga Shulyarenko, The University of Melbourne
- Aashima Thukral, The University of Melbourne
- Jiali Wang, Australian National University

- Hui (Alice) Yao, The University of Queensland
- Yan Yu, The University of Melbourne

PROGRAM EXTRAS

Opening Ceremony

An official opening ceremony was held at the historic MacLaurin Hall at The University of Sydney. Professor Philippa Pattison (Deputy Vice-Chancellor, Education) welcomed attendees to the university, before Dr Ron Sandland (AMSI Chairman) officially declared the Summer School open.

Professor Anthony Henderson (Event Director) introduced the lecturers of the eight courses, and Professor Markus Hegland (AMSI Deputy Director and AMSI Summer School 2017 Lecturer) provided his thoughts and advice, encouraging students to take full advantage of the opportunities of the intensive four-week program.



In addition to the students and lecturers, invited guest dignitaries and University of Sydney administration staff, attendees included the respective mathematics and statistics department heads of The University of Sydney, The University of New South Wales, Macquarie University and The University of Newcastle. All in attendance enjoyed morning tea after the ceremony, and local PhD students led group tours of the campus as an orientation for visiting students to the University ahead of the four-week program.

Lunchtime Lectures

At lunchtime on Wednesdays the AMSI Summer School featured a special lecture at the start of the lunch break in the timetable, followed by sandwiches provided thanks to the Gold Sponsorship of the Australian Signals Directorate.

This lecture series introduced students to a range of aspects of mathematical research and careers, giving them the opportunity to network and discuss the lecture with their peers.

Hamilton cycles in random hypergraphs

Associate Professor Catherine Greenhill (The University of New South Wales)

Non-rigid body dynamics, twisting somersault, and geometric phase

Professor Holger Dullin (The University of Sydney)

The AMSI Intern program

Mark Ovens (AMSI Intern), Associate Professor Wendy Davis (The University of Sydney) and Wenye Hu (The University of Sydney)

Science in Australia Gender Equity (SAGE): plugging the leaking pipeline

Professor Robyn Overall (The University of Sydney)

The Lunchtime Lecture Series was hosted by the AMSI Summer School and The University of Sydney, and sponsored by the Australian Signals Directorate.

CHOOSEMATHS Networking Event

The AMSI Summer School supported and hosted the first CHOOSEMATHS Networking Event at an AMSI Flagship event, and invited all female students at the School to attend. This event created a unique forum to meet and discuss issues facing women in the mathematical sciences and the goals of the CHOOSEMATHS program, as well as providing the opportunity for attendees to network with their fellow female peers.

The Australian Mathematical Sciences Institute and the BHP Billiton Foundation are empowering Australian students to pursue mathematics through a five-year national program, CHOOSEMATHS. The program aims to turn around public perceptions of mathematics, and will contribute to the health of the mathematics pipeline in Australia from school through university and out to industry and the workplace.

Women in the Mathematical Sciences Panel Event

This panel discussion and networking event focusing on women in the mathematical sciences was held over dinner at the Grandstand, with 74 AMSI Summer School students (of both genders) opting to register and attend the event, along with invited guests including representatives from Optiver (Silver Event Sponsor), the Australian Mathematics Society's (AustMS) Women in Mathematics Special Interest Group (WIMSIG), AMSI's CHOOSEMATHS program and The University of Sydney.

The panel consisted of the four female AMSI Summer School Lecturers — Dr Michelle Dunbar, Professor Mary Myerscough, Professor Kerry Mengersen and Dr Anne Thomas — as well as Professor Jacqui Ramagge and Professor Andrew Mathas, Head and former Head (respectively) of the School of Mathematics and Statistics at The University of Sydney. As MC for the event, Professor Ramagge ensured an entertaining and thought-provoking discussion, which involved the attendees formulating both questions and answers. A number of frank and useful pieces of career advice were given by the panel, which were collected for a University News and Opinion story written by Chris Angwin of the Faculty of Science, entitled "What is a career in maths really like?".



Hosted by the AMSI Summer School in conjunction with the AustMS Women in Mathematics Special Interest Group (WIMSIG), the event was sponsored by the School of Mathematics and Statistics and the Faculty of Science at The University of Sydney.

Careers Afternoon

The Careers Afternoon was an extremely popular feature of the AMSI Summer School, where students attending the School had the chance to hear about career opportunities from employers specifically seeking mathematics and statistics graduates, and get involved in a networking session with industry specialists.

The event began with an employer and early-career researcher presentation session, which was emceed by AMSI Director Geoff Prince. Company representatives talked students through their personal career development and pathways within their organisation, highlighting the importance of and need for advanced mathematical and statistical backgrounds. These presentations opened the door for lively discussion during afternoon tea (followed by the exhibit networking session) by highlighting prospective careers of which students are often unaware, and giving students the opportunity to speak one-on-one with representatives from the following companies:

- Allan Gray Australia
- Australian Bureau of Statistics
- Australian Signals Directorate (Department of Defence)
- Commonwealth Bank of Australia
- Defence Science and Technology Group
- Google
- Optiver
- Reserve Bank of Australia



Mid-School BBQ

An informal social BBQ was held on the middle Friday of the Summer School at Sancta Sophia College, a residential college situated in the grounds of The University of Sydney. This was a very casual affair, encouraging attendees, lecturers and the event team to socialise, relax and reflect on their Summer School experience mid-way through the program. Unfortunately, poor weather forced the event indoors, but it was still thoroughly enjoyed — and delicious!



Public Lecture

Assistant Professor Genevera Allen (Rice University and Baylor College of Medicine) delivered this year's AMSI Summer School Public Lecture, "Networks for Big Biomedical Data", as part of the Sydney Ideas Lecture Series at The University of Sydney's Eastern Avenue Auditorium.

Engaging an audience of over 300 including AMSI Summer School students, visiting academics and the general public, Dr Allen presented problems faced by researchers in medical science who analyse vast amounts of data, and explained how statistical theory of network models can help solve these problems. The lecture stimulated a lively Q&A session, with discussion continuing into the reception and the night.

The Public Lecture was featured in a news article published in *The Australian* on 1 February 2017, and Dr Allen actively engaged with the local media, including an interview with ABC Radio, promoting the AMSI Summer School and the importance of women in mathematics.

Hosted by the AMSI Summer School in conjunction with the Sydney Ideas Lecture Series, the event was sponsored by the School of Mathematics and Statistics at The University of Sydney.

Closing Dinner

To celebrate the end of AMSI Summer School 2017, a dinner was hosted by The University of Sydney in the Dining Hall at the Sancta Sophia College. Bringing together students, lecturers, sponsors and representatives from The University of Sydney for the last time, it was the perfect occasion for reflection and to celebrate the successes of the event.



After speeches of thanks from Professor Markus Hegland (AMSI Deputy Director and AMSI Summer School 2017 Lecturer) and Professor Anthony Henderson (Event Director), special invited guest Professor Simon Clarke announced that Monash University was honoured to be hosting the next AMSI Summer School in 2018.

FEEDBACK ANALYSIS

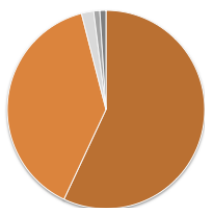
57 per cent of attendees at AMSI Summer School 2017 completed the online survey to provide their feedback and comments on the event. In rating their overall experience at the event on a scale of 1 to 10, where 1 is Poor and 10 is Excellent, the respondents' average rating was 8.5.

Overall, the responses received were extremely positive, with over 93 per cent of the attendees indicating that they "Strongly Agreed" or "Agreed" that the event was well-organised and of a high standard, and that they would recommend the event to others.

To further understand the primary motivation or reason for attending AMSI Summer School, 52 per cent of respondents indicated they wanted to broaden their knowledge, while 43 per cent wanted to gain course credit towards their degree.

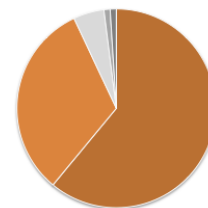
OVERALL, SCHOOL WAS OF A HIGH STANDARD

Strongly Agree	57%
Agree	39%
Neutral	2%
Disagree	1%
Strongly Disagree	1%



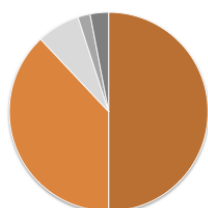
OVERALL, THE SCHOOL WAS WELL-ORGANISED

Strongly Agree	61%
Agree	32%
Neutral	5%
Disagree	1%
Strongly Disagree	1%



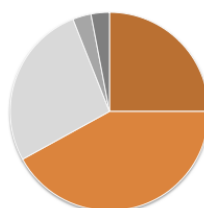
THE COURSES OFFERED PROVIDED A GOOD VARIETY OF SUBJECTS

Strongly Agree	50%
Agree	38%
Neutral	7%
Disagree	2%
Strongly Disagree	3%



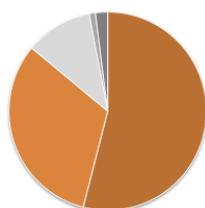
I MADE USEFUL CONTACTS AND NETWORKS AT THE SUMMER SCHOOL

Strongly Agree	25%
Agree	42%
Neutral	27%
Disagree	3%
Strongly Disagree	3%



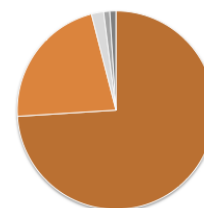
I WILL APPLY KNOWLEDGE GAINED FROM THE SCHOOL TO MY CURRENT AND FUTURE STUDIES/ACTIVITIES

Strongly Agree	54%
Agree	32%
Neutral	11%
Disagree	1%
Strongly Disagree	2%



I WOULD RECOMMEND THE SUMMER SCHOOL TO OTHERS

Strongly Agree	74%
Agree	22%
Neutral	2%
Disagree	1%
Strongly Disagree	1%



STUDENT PROFILE

FROM EUCLID AND BOOLE TO SUMMER SCHOOL

Diclehan Erdal, The University of Adelaide



A visit to her local library in Year 11 changed Diclehan Erdal's life forever when she discovered her future in a book on mathematicians and their breakthroughs.

"I remember reading about Euclid, George Boole and Alan Turing and trying read Euclid's elements and being really drawn to the idea of studying mathematics. I decided to study as much of the subject as I could in Year 12," she says.

Fast forward to 2017 and recent University of Adelaide mathematics and computer science graduate Diclehan is full of excitement and refreshed enthusiasm following her recent AMSI Summer School experience.

"It not only offered a number of courses aligned with my potential interests but allowed me to meet other students from a wide range of pure mathematics disciplines," she says.

The pure maths major also relished the opportunity to explore research and techniques beyond the scope of her academic studies, knowledge she hopes to apply to her future master's research.

"Summer School introduced me to areas of mathematics I would not have been exposed to otherwise and spiked my interest to learn more about these fields," she says.

With the four-week training course hosted by The University of Sydney, Diclehan's attendance was funded by a Choose Maths grant.

"Choose Maths assisted me financially to cover accommodation and travel costs. Without this support I would not have been able to attend," she says.

In addition to the main program, Diclehan found inspiration and new networks at the Women in Mathematics events.

"As well as raising awareness of the lack of women pursuing mathematics, these events promote the opportunities available to those who do. They are also a fantastic way to meet more women in a male-dominated discipline."

Now a long way from that Year 11 girl in the library, Diclehan plans to make the most of her new knowledge and networks as she wishes to pursue a master's degree and doctorate in mathematics, and ultimately a career in academia or software development.

Who knows? Maybe one day, a high-school student will happen upon a book including her work and they too will be inspired to explore the possibilities and beauty of mathematics.

MEDIA RELEASE

AUSTRALIA RISKS HEAVYWEIGHT REPUTATION AS DATA LEADS HEALTH RESEARCH

Sydney, New South Wales — 31 January 2017

The role of mathematics and statistics in medical discovery is set to grow as researchers use big data to unlock new insights into human biology, says Assistant Professor of Statistics and Electrical and Computer Engineering Genevera Allen.

Speaking ahead of her AMSI Summer School 2017 Public Lecture sponsored by The University of Sydney's School of Mathematics and Statistics, Assistant Professor Allen, who is based at Rice University in Texas, says Australia needs to develop the skills to lead in data-driven discovery.

"Globally, we critically need more people trained in statistics and data science. Australia needs to be equipping its workforce to tackle the exciting opportunities created by this data deluge," says Assistant Professor Allen.

According to the Australian Mathematical Sciences Institute (AMSI) the proportion of Year 12 students choosing maths has fallen by 32 per cent since 1995. Confirmed by recent international rankings, this decline is putting Australia's medical science leadership at risk.

Australia doesn't need to look far to see the impact and potential of advancing biotechnologies and data science, with the work of researchers such as Assistant Professor Allen already opening doors to discovery.

"The capacity to measure multiple aspects of systems in finer detail than ever before is deepening our understanding of human biology and revealing new avenues for tackling disease," she says.

Visualising Neural Activity

For Assistant Professor Allen, this includes arming neuroscientists with never-before-seen insights into brain function and the ways in which different regions communicate with each other within the active brain.

"Representing the brain as a network allows us to visualise the brain's neural activity and explore changes linked to neurological diseases and decline," said Assistant Professor Allen.

While data is opening avenues for discovery, it is also presenting new challenges — in particular the need to separate true discoveries from possibly spurious findings. This task is made more complex as new technology generates greater amounts of data than ever before. Assistant Professor Allen describes this process using an example of coin tossing:

"If heads came up 27 times in a row out of 100 coin tosses, you may conclude this isn't a fair coin. If you went on to flip the coin a thousand, ten thousand, or a million times, would this initially interesting finding still be indicative of the coin being unfair? No! As data becomes bigger and more complex, we need to use statistics and mathematics to ensure that seemingly interesting findings are actual true discoveries and not due to chance alone."

Members of the public are invited to join Assistant Professor Allen on 31 January from 6.30pm at The University of Sydney, as she discusses the revolutionary impact of data science on health discovery.

Setting New Standards for Research Training and Networking

Australia's leading residential mathematical sciences training event, AMSI Summer School is a four-week program providing research students with access to advanced courses, as well as opportunities for networking and career development.

"We are excited to welcome Assistant Professor Allen to Summer School. Outreach continues to play a critical role in reinforcing the value and impact of mathematics and statistics," says AMSI Director Professor Geoff Prince.

A key event in the Institute's flagship training calendar, AMSI Summer School is jointly funded by the Department of Education & Training and the Australian Mathematical Sciences Institute, with support from The University of Sydney, AustMS, ANZIAM, the BHP Billiton Foundation (supporting the **CHOOSEMATHS** Initiative), the Australian Signals Directorate and Optiver.



EDUCATION

Maths set to hold back jobs in big data

STEFANIE BALOGH
The Australian | 12:00AM February 1, 2017



A 30-year decline in the rate of senior students studying mathematics has put Australians at risk of missing out to foreigners in securing high-paying, in-demand jobs analysing big data, including working on a cure for cancer.

Urging the nation to future-proof its skills base and attract more students to maths, Genevera Allen, one of America's most influential young statisticians, has warned that "data is everywhere, and the people who can tackle data challenges will be the ones who excel in our information-based economy".

"Australia's maths enrolment has been declining for the past 30 years. This will have major consequences — it will slow innovation and some of the best jobs — for example, data science — will go to foreigners."

Dr Allen, who is assistant professor of statistics and electrical and computer engineering at Rice University in Texas and is visiting Sydney, also weighed into the debate over the "feminisation" of physics.

Renowned quantum physicist Michelle Simmons, one of the nation's leading scientists, used an Australia Day address in Sydney last week to decry attempts to "feminise" the high-school physics curriculum by replacing maths formulas with essays, labelling it a "disaster" that had left students unprepared for university.

Professor Simmons warned against the dumbing down of high-school science and urged authorities to "set the bar high" for students to encourage them to excel. Her criticism of the science curriculum won support from teaching experts who said university physics courses were being altered to compensate for students leaving high school with limited maths skills.

"There are no female or male disciplines or skill sets," Dr Allen said. "Math is math and anyone, from any background, and with varying strengths can make contributions. It is imperative that we have both diversity of people and ideas in maths.

"We need everyone to help tackle some of the biggest societal challenges — discovering cures for diseases such as cancer and Alzheimer's disease, finding clean energy solutions, and tackling climate change — all of these challenges require maths skills."

Dr Allen, who featured in *Forbes* magazine's influential 30 under 30: Science and Healthcare list in 2014, focuses on developing statistical methods to help scientists make sense of data. The use of maths and statistics is set to grow as medical researchers use data to unlock insights into human biology. "Globally, we critically need more people trained in statistics and data science. Australia needs to be equipping its workforce to tackle the exciting opportunities created by this data deluge," she said.

Data scientists are highly sought after. The 2016 skills and salary survey of the Institute of Analytics Professionals of Australia, which represents 7500 people, showed the median salary was \$130,000 and the top 5 per cent earned \$275,000 or more.

DIRECTOR'S REPORT

PROFESSOR ANTHONY HENDERSON

The University of Sydney



AMSI Summer School 2017, the fifteenth Summer School overall and the second to be hosted by The University of Sydney, will be remembered for extremes: a record total number of 168 attendees; a record number of 57 students completing one course; and, equally memorable, the record temperatures of Sydney's hottest month in history. Students, lecturers, and organisers were all tested but ultimately unscathed by these extremes, learning many valuable things over the four weeks.

The AMSI Summer School is the largest annual event for Australian students in the mathematical sciences. Indeed, despite all the other important events that AMSI organises, for many people "AMSI" simply means the AMSI Summer School. This is not entirely a mistake: no other AMSI event exemplifies so well the core idea of friendly cooperation between Australian universities, combining their resources to provide advanced education to a far greater number of students than any university could muster on its own.

One of the main themes of the Summer School was the importance of recognising and supporting the contribution of women to the mathematical sciences. I cannot claim that the percentages of female students (30 per cent, 51 of 168) and female lecturers (36 per cent, 4 of 11) were any more than an acceptable reflection of the current gender imbalance in the discipline. However, the issues raised by this imbalance were at the forefront of three Summer School events – the CHOOSEMATHS reception, the Women in the Mathematical Sciences panel discussion, and Professor Robyn Overall's lunchtime lecture on the SAGE initiative – which all generated vibrant discussion. Student feedback showed that this aspect of the Summer School was widely appreciated.

The aspect of the Summer School of which I, as Director, am most proud was the excellence and variety of the eight courses on offer. The subjects struck an ideal balance between core areas of theoretical mathematics and developing areas of applications to other disciplines. The lecturers, whether international leaders in their fields or rising stars, delivered well-planned and exciting classes that kept students engaged. The quality of the course offerings must have been largely responsible for the record attendance, but numbers were also swelled by students from biology, computer science and physics who seized the opportunity to learn relevant skills in mathematics and statistics. I often heard from such students that they wished their own disciplines had events like the AMSI Summer School.

It was a privilege to work with the superb AMSI staff in planning the event, and a privilege to meet all the students I encountered over the four weeks. I am delighted that the future of the mathematical sciences in Australia is so bright.

To finish, let me suggest that the most remarkable single day of AMSI Summer School 2017 was Monday 13 February, after students had returned home. On that day, near-simultaneous exam sessions were held at 16 AMSI Member Universities (thought to be another record), who set aside their rivalries to enable a common assessment for some of our country's best students. For me, this epitomised the ideal of cooperation that AMSI represents.

EVENT COMMITTEES

AMSI wishes to acknowledge the generous donation of time and scientific advice of the following committees, without whose contribution this event would not be a success:

Standing Committee

- **Committee Chair:** Anthony Henderson, The University of Sydney
- Aurore Delaigle, The University of Melbourne
- Andrew Eberhard, RMIT University
- Murray Elder, The University of Newcastle
- Simi Henderson/Anne Nuguid/Paul Ulrick (Program Manager, Research and Higher Education), Australian Mathematical Sciences Institute
- Jeff Hogan, The University of Newcastle
- Kerrie Mengersen, Queensland University of Technology
- Geoff Prince, Australian Mathematical Sciences Institute
- Stephen Roberts, Australian National University
- Joshua Ross, The University of Adelaide
- Stephen Tillmann, The University of Sydney

Organising Committee

- **Event Director:** Anthony Henderson, The University of Sydney
- Lamiae Azizi, The University of Sydney
- Simi Henderson/Anne Nuguid/Paul Ulrick, Australian Mathematical Sciences Institute
- Susan Liddell, The University of Sydney
- Andrew Mathas, The University of Sydney
- Catherine Parsons, Australian Mathematical Sciences Institute
- Jacqui Ramagge, The University of Sydney
- Jean Yang, The University of Sydney

AMSI SUMMER SCHOOL 17

IN THE MATHEMATICAL SCIENCES

9 JAN - 3 FEB 2017

THE UNIVERSITY OF SYDNEY

CATEGORY THEORY & COMPUTER SCIENCE

Richard Garner & Dominic Verity, Macquarie University

COMPUTATIONAL BAYESIAN STATISTICS

Scott Sisson, The University of New South Wales

COMPUTATIONAL MATHEMATICS

Markus Hegland, The Australian National University

GEOMETRIC GROUP THEORY

Lawrence Reeves, The University of Melbourne
& Anne Thomas, The University of Sydney

HARMONIC ANALYSIS

Pierre Portal, The Australian National University

MATHEMATICAL BIOLOGY

Mary Myerscough, The University of Sydney

MATHS & STATS OF BIG DATA

Kerrie Mengersen, Queensland University of Technology

OPTIMISATION

Michelle Dunbar, The University of Sydney

REGISTER:

AMSI.ORG.AU/SS

AMSI RESEARCH