

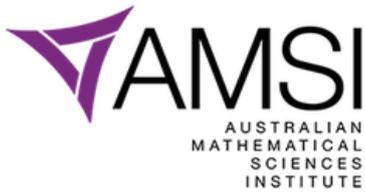
AMSI **WINTER** 17  
**SCHOOL**  
ON **COMPUTATIONAL**  
FOUNDATIONS OF **DATA SCIENCE**

**26 JUNE – 7 JULY**

QUEENSLAND UNIVERSITY OF TECHNOLOGY

**EVENT REPORT**

AMSI Winter School 2017 would like to thank the following partners for their support:



# AMSI Winter School 2017

## On Computational Foundations of Data Science

Queensland University of Technology  
26 June to 7 July 2017

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# FOREWORD

The AMSI Winter School is one of five premier flagship events hosted each year around Australia and forms part of the Securing Australia's Mathematical Workforce: 2016-2020 agreement between AMSI and the Department of Education and Training. Now in its 12<sup>th</sup> year, this key program has become an integral part of the events calendar for PhD and postgraduate students, as well as early career researchers in the mathematical sciences and cognate disciplines.

Hosted over two weeks, this program offers a range of specialist topics with an overarching theme. The aim of the AMSI Winter School is to develop the next generation of mathematical scientists who can thrive in tomorrow's information age. This program draws upon the knowledge of national and international lecturers at the forefront of their fields, and attracts students from all around Australia.

The complete program, comprising course content and extra activities, is designed to align with the project objectives of the agreement to:

- Strengthen research training and the work-readiness of advanced mathematical sciences graduates;
- Promote university-industry collaborations that will encourage the private sector employment of mathematical sciences graduates;
- Attract and improve the retention of senior undergraduate students in the mathematical sciences, with particular attention to women and Aboriginal and Torres Strait Islanders.

AMSI Winter School 2017 was jointly funded by the Australian Mathematical Sciences Institute (AMSI) and the Australian Government's Department of Education and Training, with support from QUT, the Australian Centre of Excellence for Mathematical and Statistical Frontiers (ACEMS), the Queensland Cyber Infrastructure Foundation (QCIF), Silicon Graphics International Corp (SGI), TechnologyOne, The Simulation Group, the Australian Signals Directorate and the BHP Billiton Foundation through the Choose Maths program.

# DIRECTOR'S REPORT

Professor Ian Turner, AMSI Winter School 2017 Event Director



The 2017 AMSI Winter School was held at the Queensland University of Technology (QUT) Gardens Point campus from Monday 26 June to Friday 7 July in the world-class facilities available in the Science and Engineering Centre. There were 70 participants who attended the school from across the nation, comprised of 45 PhD students, 12 Masters students, one Honours student, one undergraduate student, one academic and 10 researchers from industry. We also had four international PhD students attend from China, India\* and the USA. The final breakdown is summarised in the following table.

Institution	No. of attendees
Australian National University	6
University of Technology Sydney	3
University of Melbourne	7
Queensland University of Technology	11
The University of Queensland	9
The University of Western Australia	1
Monash University	5
The University of New South Wales	1
University of Wollongong	2
Griffith University	1
La Trobe University	1
University of Sydney	1

Institution	No. of attendees
Flinders University	1
The University of Adelaide	2
Curtin University of Technology	1
Macquarie University	3
University of Newcastle	1
Defence Science and Technology Group	2
Australian Bureau of Statistics	2
Geoscience Australia	1
Massachusetts Institute of Technology	2
Others	7

Approximately 64 per cent of the participant cohort was male and 67 per cent was either studying or working in a mathematical sciences school, with the remaining 30 per cent associated with a cognate discipline such as engineering, science, computing and information technology, economics and finance. This flagship AMSI program attracted considerable attention as a result of the topical and popular theme of data science. The timing of the Winter School was perfect given the hot career prospects currently available in data science within industry.

On Day One we opened with Theme One on Inverse Problems delivered by Associate Professor Youssef Marzouk and Theme Three on Numerical Linear Algebra delivered by Dr Linda Stals. Later in the day we welcomed the Honourable Karen Andrews MP, Assistant Minister for Vocational Education and Skills and Federal Member for McPherson, to officially open the Winter School. We were joined by the QUT Vice-Chancellor Professor Peter Coaldrake, AMSI Director Professor Geoff Prince, QUT Head of School for Mathematical Sciences Professor Troy Farrell, representatives from our industry sponsors, and distinguished guests from QUT, Industry, and other AMSI Member Institutions. Professor Prince also provided the participants with information on AMSI and APR.Intern.

On Day Two we continued Themes One and Three, and the highlight was attendance at the QUT Vice-Chancellor's Forum with Sir Timothy Gowers (Fields Medallist, Royal Society Research Professor and holder of the Rouse Ball Chair in Mathematics at the University of Cambridge). Sir Timothy spoke on open repositories, a topic he is very passionate about, and then followed this with a targeted Q&A session with staff from the School of Mathematical Sciences and the AMSI Winter School cohort, chaired by Professor Troy Farrell. On Wednesday we continued Theme Three and commenced Theme Two on Bayesian Inference and Data Assimilation, which was delivered as two short courses by Dr Kody Law and Dr Chris Drovandi. We also held the Theme Three workshop in a collaborative learning space where students broke into groups to brainstorm together and apply MATLAB to solve their worksheet questions. A highlight of Day Three was the Women in Mathematical Sciences Panel Event held in the evening. We welcomed Amy Hawke, Olivia Hutchinson, Professor Kerrie Mengersen and Dr Linda Stals to address the audience on their career pathways. The event provided an ideal opportunity for networking and was a great night of celebration for the Mathematical Sciences.

We ran 66 participant talks over the two mornings of Days Four and Five. The presenters were divided into 11 groups of six and each group had an allocated chair. All group members ranked each other's presentations. The group finalists were then chosen to present their work to the entire cohort in Week Two. The quality of the talks was outstanding and it proved a very challenging task to decide on the finalists. The initial plan was to have just five finalists but in the end, we decided to expand this to eight.

Theme Two continued on Days Four and Five and two workshops were held in the collaborative learning spaces. A highlight of Day Five was the visit to the QUT Cube, which is one of the world's largest digital interactive learning and display spaces, dedicated to providing an inspiring, explorative and participatory experience of QUT's Science and Engineering research. On Friday evening, we held a social event and dinner at Southbank where participants enjoyed each other's company and discussed the events of the week.

On Day Six we commenced Theme Four on Machine Learning, which was delivered as two short courses by Dr Hanna Kurniawati and Dr Brendan van Rooyen, and Theme Five on Nonlinear Optimisation delivered by Professor Steve Wright. We also held a workshop in the collaborative learning space for Theme Four. The public lecture was presented on Monday evening in the Kindler Theatre on the topic of Models, Maths and the Revolution in Weather Forecasting by Dr Peter May, Head of Research at the Bureau of Meteorology. There were around 120 people in attendance at the event, including the Executive Dean of the Science and Engineering Faculty, Professor Gordon Wyeth and the Head of the Mathematical Sciences School, Professor Troy Farrell. The lecture was extremely interesting and highly engaging, covering a broad range of topics that were easily accessible to the audience. Peter's lecture was very well received by all and the reception that followed provided another excellent opportunity for networking and a chance to ask Peter further questions.

Themes Four and Five continued on Day Seven and we held the finalist presentations in the afternoon. All participants attended this event and were asked to rank each of the finalists. A committee then identified the winner of the presentations, Ms Elizabeth Qian, for her outstanding talk on Multifidelity Global Sensitivity Analysis. Later during Tuesday evening AMSI ran the Choose Maths Networking Event. On Day Eight, lectures continued for Themes Two and Five and we commenced Theme Six on high-dimensional statistics delivered by Dr Davide Ferrari. We also held the workshop for Theme Five in the collaborative learning space.

Themes Five and Six continued into Day Nine and we offered interested participants a tour of the ACEMS facilities at the QUT node. Later that day we held the final workshop for Theme Two. The end of school dinner was held that evening at the QUT Gardens Point campus in Old Government House, which is one of Queensland's most important heritage buildings. The ambience was excellent and the Winter School participants enjoyed each other's company as well as the great opportunity to discuss with the organisers, our industry sponsors, the QUT Head of School of Mathematical Sciences and other distinguished guests. The dinner also provided a chance for us to thank the lecturers and present them with gifts. We also presented the award for the best participant presentation to Elizabeth.

The final day of the school saw Themes Four and Six conclude and we held the closing on Friday afternoon. The feedback received from the participants at the closure was very positive. They really enjoyed the short courses and other events held. They commended the high quality of the lecturers and the topical and relevant nature of the course material delivered. They couldn't believe the superb winter weather in Brisbane, where the temperature rarely fell below 24°C during the day for the entire two weeks.

As Director, I thoroughly enjoyed the opportunity to organise the 2017 AMSI Winter School. I sincerely thank and acknowledge all the hard work from the administrative staff at QUT and from the scientific committee to ensure that this was a successful program. I particularly acknowledge Andree Philips for assisting me with the entire event organisation and helping to make this a very special occasion for QUT. I also wish to thank the AMSI team, particularly Geoff Prince and his staff who worked alongside us throughout the early stages of planning, and through the organisation and running of the Winter School. It was a true partnership and they were a delight to deal with. Finally, to the lecturers and participants at the school, I thank you for making the Winter School such a great success. I feel that I have made many new friends and collaborators and I hope we find the opportunity for our paths to cross again at some time in the near future.

Ian Turner, Winter School 2017 Event Director

\*Students from China and India were visiting QUT at the time and attended the Winter School program

## COURSE PROGRAM

### Theme 1: Inverse Problems

#### Bayesian Approaches for Inverse Problems and Optimal Experimental Design

Associate Professor Youssef Marzouk, Massachusetts Institute of Technology

### Theme 2: Bayesian Inference & Data Assimilation

#### Computational Algorithms for Bayesian Statistics

Dr Chris Drovandi, School of Mathematical Sciences, Queensland University of Technology

#### Data Assimilation: A Mathematical Introduction

Dr Kody Law, Oak Ridge National Laboratory

### Theme 3: Numerical Linear Algebra

#### Large-Scale Matrix Problems

Dr Linda Stals, Mathematical Sciences Institute, Australian National University

### Theme 4: Machine Learning

#### A Decision-Making View of Machine Learning

Dr Hanna Kurniawati, School of Information Technology and Electrical Engineering, The University of Queensland

#### Martingales, Mcdiarmid and Machine Learning: How to Validate Models Like a Pro!

Dr Brendan van Rooyen, ACEMS, Queensland University of Technology

### Theme 5: Nonlinear Optimisation

#### Optimisation Techniques for Data Analysis

Professor Stephen Wright, University of Wisconsin-Madison

### Theme 6: High-Dimensional Statistics

#### Model Selection and Inference for High-Dimensional Data

Dr Davide Ferrari, School of Mathematics and Statistics, The University of Melbourne

## Bayesian Approaches for Inverse Problems and Optimal Experimental Design

### Associate Professor Youssef Marzouk, Massachusetts Institute of Technology



Inverse problems formalise the process of learning about a system through indirect, noisy and often incomplete observations. Casting inverse problems in the Bayesian statistical framework provides a natural framework for quantifying uncertainty in parameter values and model predictions, for fusing heterogeneous sources of information, and for optimally selecting experiments or observations.

This course presented fundamentals of the Bayesian approach to inverse problems, covering both modelling issues—e.g. prior distributions, likelihoods, hierarchical models—and computational challenges—e.g. computing posterior expectations via Markov chain Monte Carlo sampling or principled approximations. Participants discussed methods that expose low-dimensional structure in inverse problems, that attempt to mitigate the computational cost of repeated forward model evaluations, and that exhibit discretisation-invariant performance in large-scale problems.

Also presented were Bayesian approaches to optimal experimental design, which attempted to answer ubiquitous questions of what or where to measure, what experimental conditions to employ, etc. Here they introduced a decision theoretic Bayesian design formulation and linked it to more classical alphabetic optimality criteria, then focused on computational issues, e.g. how to estimate and maximise expected information gain in various quantities of interest.

## Computational Algorithms for Bayesian Statistics

### Dr Chris Drovandi, School of Mathematics, Queensland University of Technology

Statistical inferences in a Bayesian framework are obtained through the posterior distribution, which quantifies the uncertainty in model parameters based on information from observed data and prior knowledge. To make these inferences it is often necessary to generate samples from the posterior distribution, but this can generally not be done perfectly. AMSI Winter School 2017 participants had already been introduced to one of the foundational methods, Markov chain Monte Carlo (MCMC), for approximate sampling from the posterior. This part of the Winter School described some more advanced MCMC methods that are more efficient when the posterior distribution has a complex landscape to traverse. An alternative and complementary method to MCMC called sequential Monte Carlo (SMC) was also covered. SMC methods are easier to adapt than MCMC, are more suitable to implementation on parallel computing devices and can straightforwardly estimate quantities required to compare models in a Bayesian framework. The methods were illustrated with MATLAB code.



## Data Assimilation: A Mathematical Introduction

### Dr Kody Law, Oak Ridge National Laboratory



These lectures provided a systematic treatment of the mathematical underpinnings of work in data assimilation, covering both theoretical and computational approaches. Specifically, participants developed a unified mathematical framework in which a Bayesian formulation of the problem provides the bedrock for the derivation, development and analysis of algorithms. Explicit calculations, numerical examples, exercises and MATLAB code were provided in order to illustrate the theory. The lectures also included an introduction to some state-of-the-art algorithms.

## Large-Scale Matrix Problems

### Dr Linda Stals, Mathematical Sciences Institute, Australian National University

What do data compression and image recognition have in common? How does different soil composition affect the flow of a liquid? How much water can the dam hold before it bursts? The common tool needed to address these problems and countless more arising in industry and academia is the solution of large-scale matrix problems. Some estimates say that 70 per cent of supercomputer time is spent on the solution of such large problems.

The techniques that we are most familiar with cannot be applied to these large systems. For example, suppose it takes 1 second to solve a  $100 \times 100$  sized matrix using Gaussian Elimination, then a quick analysis based on the number of operations implies that it would take about 11.5 days to solve a  $10,000 \times 10,000$  sized matrix.

In this course, participants were introduced to new solution techniques to deal with these large-scale problems. They focused on the solution of linear system of equations using iterative methods. They were introduced to the nomenclature used to measure the efficiency and accuracy of these method. They also defined and developed the theoretical properties of the algorithms and then determined their practical use by studying their stability.



## A Decision-Making View of Machine Learning

### Dr Hanna Kurniawati, School of Information Technology and Electrical Engineering, The University of Queensland



This course covered recent advances in decision-making under uncertainty and its application to machine learning, in particular reinforcement learning. Participants were provided with an overview of current work on Markov Decision Processes (MDPs), Partially Observable Markov Decision Processes (POMDPs) and Bayesian Reinforcement Learning. They focused on both basic concepts and state-of-the-art algorithms and computational techniques that made these approaches become practical. This course also included a hands-on demo using available software tools.

## Martingales, Mcdiarmid and Machine Learning: How to Validate Models like a Pro!

### Dr Brendan van Rooyen, ACEMS, Queensland University of Technology

In this course, participants explored the underlying mathematics of model validation, where they laid bare the underlying assumptions underpinning learning. They were provided with an introduction to concentration inequalities, martingales and found out what Colin Mcdiarmid has to do with Machine Learning.

Not limited to Machine Learning model validation, concentration inequalities have broader application across computer science and mathematics, where they facilitate a powerful set of tools for creating efficient algorithms.



## Optimisation Techniques for Data Analysis

### Professor Stephen Wright, University of Wisconsin-Madison

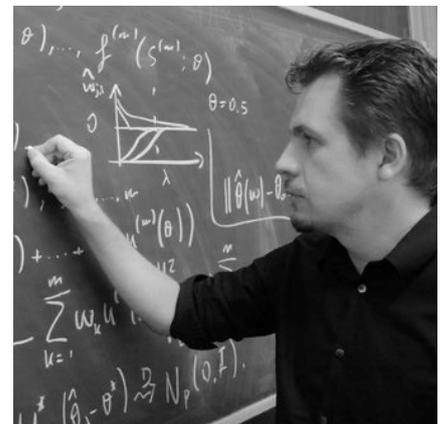


Optimisation techniques have become a mainstay of data analysis and machine learning. Many problems in these domains can be formulated and solved naturally as optimisation problems. The explosion of interest in data applications has led to renewed focus on optimisation techniques that are relevant to this area, and thus to re-examination and enhancement of many techniques that were in some cases previously thought to be of limited interest. Many important discoveries have been made over the past 5–8 years about the properties of such fundamental approaches as first-order methods, accelerated gradient, stochastic gradient, coordinate descent and augmented Lagrangian techniques. Advances have been made too in the sophisticated implementation of these techniques to key problems in data analysis, and in their parallel implementation. This course reviewed basic optimisation techniques, their application in data analysis problems, and their fundamental theoretical properties.

## Model Selection and Inference for High-Dimensional Data

### Dr Davide Ferrari, School of Mathematics and Statistics, The University of Melbourne

Modern data sets are increasingly large and complex due to the rapid development of data acquisition and storage capabilities. This course focused on developing a rigorous understanding of modern statistical learning methods needed to model large data sets, assess the reliability of the selected models, and obtain accurate predictions. This course covered recent methodological developments in this area such as inference for high-dimensional regression, model-selection and model-combining methods, and post-selection inference methods.



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*“The lecturers at the 2017 AMSI Winter School were world-class. The data science focus was rigorous and the methods were well-explored, especially the sampling and optimisation algorithms. Lecturers were accommodating, patient and interested.”*

**Laurence Davies, Geoscience Australia**

# PARTICIPATION BREAKDOWN

UNIVERSITY/INSTITUTION	
Australian National University	6
University of Technology Sydney	3
The University of Melbourne	7
Queensland University of Technology	11
The University of Queensland	9
The University of Western Australia	1
Monash University	5
The University of New South Wales	1
The University of Wollongong	2
Flinders University	1
The University of Adelaide	2
Curtin University	1
Macquarie University	3
The University of Newcastle	1
Defence Science and Technology Group (DST Group)	2
Australian Bureau of Statistics	2
Geosciences Australia	1
Massachusetts Institute of Technology	2
Griffith University	1
The University of Sydney	1
La Trobe University	1
Others: DDNT Consultants Department of Health Department of Defence QIMR Berghofer Medical Research Institute	7
<b>TOTAL</b>	<b>70</b>

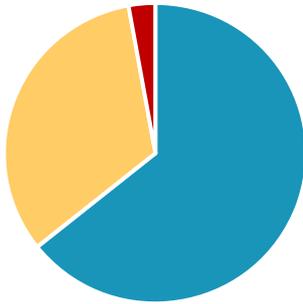
*“I enjoyed the wide variety of topics covered that opened my eyes to of interesting applications of probability and statistics that I had not previously encountered.”*

**Alexander Baker, Masters student, The University of Queensland**



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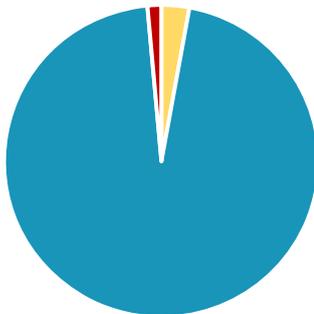
## Gender



Gender	Number	%
Male	45	64%
Female	23	33%
Prefer not to disclose	2	3%

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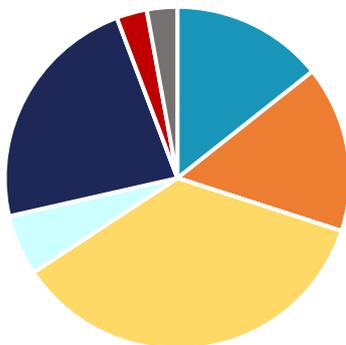
## ATSI Status



ATSI Status	Number	%
Yes	1	1%
No	68	98%
Prefer not to disclose	1	1%

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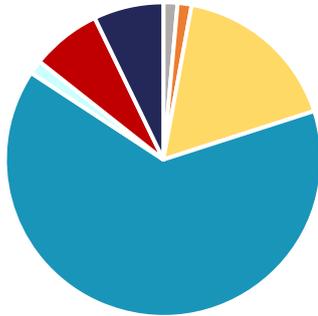
## State/Territory



State/Territory	Number	%
QLD	25	36%
VIC	16	23%
NSW	11	15%
ACT	10	14%
SA	4	6%
WA	2	3%
TAS	0	0%
NT	0	0%
International	2	3%

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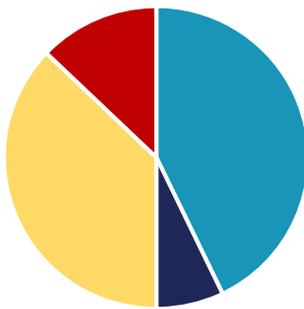
## Academic Status



Academic Status	Number	%
Undergraduate	1	1%
Honours	1	1%
Masters	12	18%
PhD	45	65%
Academic	1	1%
Early Career Researcher	5	7%
Other	5	7%

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## Residency Status



Academic Status	Number	%
Australian Citizen	30	43%
Permanent Resident	5	7%
Student Visa	26	37%
Other	9	13%

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*“The Winter School was an experience I shall cherish forever. The course content highlighted the importance of mathematics and statistics in data science and also broke down abstract concepts into simpler ones. Networking with participants from diverse academic backgrounds and industry experience gave me a valuable insight.”*

**Indraneel Yeole, Masters student, The University of Queensland**

# GRANTS

## AMSI TRAVEL GRANTS

AMSI Travel Grants are funded by AMSI, The Australian Department of Education and Training, and QUT. These grants allow students to travel interstate and from rural areas to attend the Winter School program. They offer both travel and accommodation support to students who would otherwise be unable to attend the event, and are awarded on a competitive basis. In 2017, AMSI Travel Grants were awarded to the following 21 Winter School participants:

Anil Savio Kavuri, The Australian National University  
Lishan Fang, The Australian National University  
Rommel Real, The Australian National University  
Yuancheng Zhou, The Australian National University  
Mehdi Ghasem Moghadem, Curtin University of Technology  
Robert Qiao, Flinders University  
Andrew Locke, Macquarie University  
Ding Ma, Macquarie University  
Aaron Chong, The University of Melbourne  
Ali Mahmoudi, The University of Melbourne  
Lachlan McIntosh, The University of Melbourne  
Sobia Amjad, The University of Melbourne  
Armin Pourkhanali, Monash University  
Ziwen Zhong, Monash University  
Yoong Kuan Goh, The University of Newcastle  
Christopher Bull, The University of New South Wales  
Brent Giggins, The University of Sydney  
Jeremy Yee, The University of Technology Sydney  
Tiffany Knowles, The University of Western Australia  
Elisa Jagar, The University of Wollongong  
Yumiao Zhou, The University of Wollongong



*"[I most enjoyed] the profound knowledge from the lecturers and the energetic discussion with the participants, which broaden[ed] my knowledge of maths."*

**Shanlin Qin, PhD student, Queensland University of Technology**

## CHOOSE MATHS GRANTS

Choose Maths Grants are designed to encourage female participants from the mathematical sciences and cognate disciplines to attend AMSI Flagship events. These grants offer travel, accommodation and carer support to those travelling from interstate and rural areas. At Winter School 2017, registration fees for grant recipients were also covered. Funded by AMSI and the BHP Billiton Foundation (out of the Choose Maths initiative), the following students were awarded support to attend the 2017 Winter School program:

Caitlin Gray, The University of Adelaide  
Aya Alwan, Macquarie University  
Marzhieh Rahmani Moghadam, Macquarie University  
Sohelia Ghane Ezabadi, The University of Melbourne  
Lin Jiang, Monash University  
Mahrita Harahap, The University of Technology Sydney

## ACEMS GRANTS

ACEMS awarded grants to two students, funding their travel and accommodation at the Winter School.

Abhishek Bhardwaj, The Australian National University  
Tui Nolan, University of Technology Sydney

*"I most enjoyed the social and networking aspects of it as being a PhD student doesn't always allow for those kind of opportunities, and coming from a different background (ecology) it was very useful to discuss with mathematics-based students."*

**Anonymous attendee**



# PROGRAM EXTRAS

## Opening Ceremony

The Opening Ceremony was held at 2:30 pm on 26 June in the Atrium at the QUT Gardens Point campus. Our official guest speaker was the Honourable Karen Andrews MP, Assistant Minister for Vocational Education and Skills and Federal Member for McPherson.

The Minister is an alumna of QUT and one of the university's first female engineering graduates. Other distinguished guests included then QUT Vice-Chancellor Peter Coaldrake; sponsors Will Vandenburg from The Simulation Group and Phil Gurney from QCIF; Dr Richard Wardle from the Bureau of Meteorology; Professor Joe Grotowski, Head of the University of Queensland's School of Mathematics and Physics; AMSI Director Professor Geoff Prince; Professor Troy Farrell, Head of the School of Mathematical Sciences at QUT; AMSI Winter School lecturers and participants; and fQUT Staff. Winter School 2017 Director Professor Ian Turner acted as MC and the ceremony concluded at 3:30 pm.



The Opening Ceremony was followed by an afternoon tea on The Terrace, where the Assistant Minister mixed with Winter School participants.



## VC Forum

The VC Forum was presented by Sir Timothy Gowers on Tuesday 27 June at 12:30 pm in Room 360 of Y Block. QUT Vice-Chancellor Peter Coaldrake extended an invitation to the AMSI Winter School cohort to join other mathematicians and interested parties in attending the lecture given by Sir Timothy on his career pathway and the highlights of his career.

After the Forum, Sir Timothy was interviewed by Professor Troy Farrell in a Q&A-style session with AMSI Winter School participants. The Winter School cohort

had a great opportunity to get up close with and ask questions of an extremely accomplished mathematician. The event concluded with an afternoon tea.

## Women in Maths

The Women in Maths Networking event is an informal social event highlighting the contribution of women in the mathematical sciences. This year we had four dynamic speakers: Amy Hawke from Brisbane State High School and Olivia Hutchinson from Boeing (both QUT alumnae), Professor Kerrie Mengersen from ACEMS and Dr Linda Stals (AMSI Winter School 2017 Lecturer from ANU). The event was a great success, with over 70 guests enjoying the chance to learn more about these women and their mathematical journeys.



## CHOOSE MATHS NETWORKING EVENT

Several staff from AMSI joined the AMSI Winter School female participants for an informal dinner and discussion session aimed at women working in or studying the mathematical sciences.

This was a chance for participants to share experiences and advice, hear from others at different points in their careers, develop support networks and to find out more about the work of the Choose Maths program.

## Cube Visit

The Winter School cohort had the opportunity to have a one-hour guided tour to explore this interactive learning space as part of the science and engineering research centre. It took place on Friday 30 June in P Block.

## Participant Talks

The initial Participant Talks were held on the Thursday and Friday mornings of the first week, with the final talks held on the Tuesday afternoon of the second week. Winter School participants were broken up into groups of six with one participant selected as the group captain to collate information and keep time. Each participant gave a 15-minute talk on the area of their research and was allowed five minutes for questions. After participants had voted on the talks and a robust discussion had been held on the best method to determine the finalists, eight participants presented to the whole cohort for a chance to win the prize. Elizabeth Qian from the Massachusetts Institute of Technology was voted to have given the best Participant Talk.

## Friday Night Social

The Friday Night Social was held at the HooHa Bar in South Brisbane on 30 June. This informal event gave the Winter School participants the opportunity to come together in a social atmosphere at the end of their first week of lectures. Almost 60 of the 70 participants joined the Winter School organisers and lecturers on the night for pizza and burgers. It was an excellent chance for the cohort to mix and mingle and get to know each other better.

## Public Lecture

The Public Lecture, held on Monday 3 July in the Kindler Theatre at the QUT Gardens Point campus, was given by the Bureau of Meteorology's Dr Peter May. Dr May gave a very interesting talk on the quiet revolution in weather forecasting over the past few decades driven by big computers, big data and lots of maths.

The event was well attended and a light supper was served afterwards.

## Conference Dinner

The Conference Dinner was held on Thursday 6 July. This formal event was a sit-down dinner in the Old Government House at the QUT Gardens Point campus.

Our guest speaker for the event was Chaitanya Oehmigara from the Department of Defence's Australian Signals Directorate, a Winter School 2017 sponsor. The Participant Talk award was given by Will Vandenburg from sponsor The Simulation Group. Several other distinguished guests attended: Troy Farrell, Head of the School of Mathematical Sciences at QUT; sponsors from SGI; a representative from ACEMS; and Troy Holmes, who had helped with the QUT registration process. All guests enjoyed the evening and welcomed the opportunity to meet the Winter School 2017 cohort.



The catering was universally praised, and it was a very successful and enjoyable final dinner to close out the conference.

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*“Seeing what everyone else is working on, and seeing what their ideas are, broadens your own knowledge base”*

**Anonymous attendee**

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# FEEDBACK ANALYSIS

Fifty-three per cent of attendees at the 2017 Winter School completed the feedback survey. Much of the feedback data suggests that the Winter School program is becoming an increasingly important event in the Australian mathematics calendar for postgraduate students and early-career researchers. In rating their overall experience, with 1 being Poor and 10 being Excellent, participants rated the event an average of 8.8.

Of those who completed the survey, 46 per cent stated that their main motivation for attending was to broaden their knowledge, and an additional 46 per cent indicated that the Winter School theme related to their overall research interest. A further 8 per cent noted that they had attended to help their career prospects.

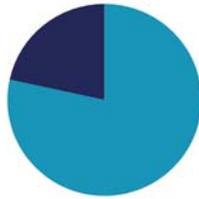
There was overwhelmingly positive feedback among attendees, who reported that they came away from the program with a wider skill set that could be applied to their everyday mathematical activities (43 per cent agreed; 46 per cent strongly agreed), including the strengthening of their ability to conduct individual research outside of the program (51 per cent agreed; 22 per cent strongly agreed).

The data also revealed the program's importance in giving attendees an opportunity to network and form friendships and professional relationships with others in their cohort (in an environment that can otherwise be isolating). Twenty-four per cent strongly agreed that they had made useful contacts with whom they would potentially collaborate, and an additional 49 per cent agreed with this statement.

Attendees found the Winter School program informative and useful. Most felt that the course had strengthened their mathematics credentials (46 per cent agreed; 38 per cent strongly agreed), and that it had exposed them to other research fields that they may not have otherwise known about (43 per cent strongly agreed; 43 per cent agreed). Ninety-seven per cent of participants said that they would recommend AMSI Winter School to their friends and colleagues.

**OVERALL, THE SCHOOL WAS OF A HIGH STANDARD**

Strongly Agree	78%
Agree	22%
Neutral	0%
Disagree	0%
Strongly Disagree	0%



**OVERALL, THE SCHOOL WAS WELL-ORGANISED**

Strongly Agree	89%
Agree	11%
Neutral	0%
Disagree	0%
Strongly Disagree	0%

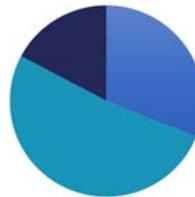


**WOMEN IN MATHS EVENT WAS A REWARDING EXPERIENCE**



Strongly Agree	18%
Agree	50%
Neutral	32%
Disagree	0%
Strongly Disagree	0%

**THE PUBLIC LECTURE WAS INTERESTING AND INFORMATIVE**



Strongly Agree	31%
Agree	52%
Neutral	17%
Disagree	0%
Strongly Disagree	0%

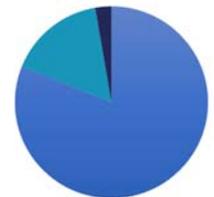
**THE SCHOOL STRENGTHENED MY MATHEMATICAL CREDENTIALS**

Strongly Agree	38%
Agree	46%
Neutral	13%
Disagree	3%
Strongly Disagree	0%



**I WOULD RECOMMEND THE WINTER SCHOOL TO OTHERS**

Strongly Agree	81%
Agree	16%
Neutral	3%
Disagree	0%
Strongly Disagree	0%



*“All of the short courses provided are enjoyable as an excellent opportunity to expand my knowledge and depth of understanding of data science. We got really good lecturers. Friday's social time and Thursday's dinner were fantastic. It is a great way to meet new friends.”*

**Fanzi Meng, Masters student, Australian National University**

# STUDENT PROFILES

## Winter School Confirms Industry Ambition



*Choose Maths Grant recipient Marzieh Moghadam*

La Trobe University student and AMSI Winter School 2017 participant Marzieh Moghadam is well aware of the commercial value of mathematics, particularly within the biomedical sector.

Currently completing a PhD, she is focusing her research on machine learning and deep learning approaches to optimise cell recognition accuracy. In an area of increasing focus to researchers grappling with large volumes of data, this work is maximising capacity to apply this critical information.

Rapidly identifying and accurately tracking cancer cell types to improve diagnostics and test treatment effectiveness, Marzieh's work also plays a role in managing immune diseases.

"My work has a range of applications including cancer and immune disease. The ability to track the immune system, for example, means we can check the trend of immune cells in patients with conditions such as HIV," she says.

With her specialist expertise of significant value to commercial laboratories, Marzieh plans to pursue an industry career and mentor others.

"In 10 years I see myself as a high-level industry researcher mentoring new employees at all levels," she says.

AMSI Winter School 2017, one of Australia's leading residential postgraduate training schools, gave her a taste of why such role models matter for those laying the foundations for a research career, in particular women.

"This is a male-dominated field, it was great to have interactions with other women and build additional networks," she said.

Not just about networking, the annual training school also proved the ideal platform for Marzieh to immerse herself in new areas of her field and to exchange ideas.

“Exposure to so many relevant subjects in a timely, super-efficient way was so beneficial. I also enjoyed exchanging ideas during the machine learning sessions. I was able to give advice and share approaches from my own research,” she said.

As a student with budget constraints, Marzieh was only able attend Winter School 2017 thanks to the support of a Choose Maths Grant.

“I wouldn’t have been able to attend without this support, particularly the assistance to cover travel and accommodation,” she says.

Marzieh, whose interest in maths started when she was a child and grew in high school, believes that Australia has work to do on its mathematical pipeline.

“It is essential that Australia strengthen mathematics, particularly research linkages to industry,” she says.

For now, Marzieh has her sights on an APR.Intern placement, something she sees as essential to her entry into commercial research.

“Next year I hope to complete an APR internship as part of the final year of my PhD. I am really keen to do this, as I think it is an essential way to better understand industry careers and how to achieve [them],” she says.

Hosted by the Queensland University of Technology, AMSI Winter School 2017 focused on the computational foundations of data science.

## Opening Possibilities: Removing Barriers to Maths



### *Choose Maths Grant recipient Aya Alwan*

Growing up with a GP in the house, maths was always on the cards for Macquarie University student Aya Alwan.

“I was raised in a family that appreciated science and knowledge. My father was always my mentor and guide and helped me at every stage of my study,” she says.

The hard work has paid off for the AMSI Winter School 2017 participant and Choose Maths Grant recipient, with Aya currently completing her PhD in mathematical and statistical modelling.

Used extensively across many industry sectors, these approaches allow estimation of performance variables in systems and processes. Aya points to transport as an example.

“Essential in transport planning, these models help variables such as traffic flow to simulate urban transportation systems. This helps in reducing issues such as traffic congestion,” she explains.

With dreams of using her specialist skills to drive industry research, Aya found AMSI Winter School the perfect combination of networking and exposure to cutting-edge scientific techniques within her field.

“Many of the courses and presentations had a direct or indirect relationship to my work. This represents a fortune to me. There is no other way to receive this amount of knowledge within such a short time,” she says.

Instrumental to this experience was a Choose Maths grant funded by BHP Billiton Foundation. With Winter School falling at school holiday time, Aya would not have been able to attend without this support and the ability to bring her family.

“I would not have been able to leave my four kids at home for four weeks. Even if I could organise care, I would struggle to concentrate being away from them,” she says.

As maths grapples with a significant gender challenge, she believes that barriers such as family separation contribute to the low number of women currently in high-level maths positions.

“Maths is an interesting area to work and research in, but lack of finding support, flexibility and time and space to concentrate is contributing to women leaving the field,” she says.

Events like Winter School not only provide access to learning and development but also to support and mentorship from other women within the discipline.

“I believe it is extremely important for women to have access to support. I have found other women in the field to be a tremendous support. Opportunities such as Winter School provide access to build these essential networks,” she says.

Hosted by Queensland University of Technology, AMSI Winter School 2017 focused on the computational foundations of data science.

# MEDIA RELEASE

## Weather Forecasting: The Quiet Revolution Saving Lives

A weather forecasting revolution 50 years in the making is saving lives and helping industry make better decisions in the face of chaotic weather and climate change.

AMSI Winter School 2017 Public Lecturer Dr Peter May (Head of Research at the Bureau of Meteorology) says that computer modelling and data science have dramatically transformed forecast accuracy and extended weather prediction capability.

“These tools have changed the scale and capability of our research; we now produce five-day forecasts as accurate as three-day forecasts were just 10 years ago. The Bureau’s modelling ranges from hours to two years and climate projections over the next 100,” he says.

With climate change leaving greater concentrations of people in vulnerable locations and increasing stress on agricultural industry and water supply, long-term outlooks and understanding of impact on communities and economies are critical.

“Providing ever-finer detail means we can provide increasing accurate modelling to inform long-term planning. Working on time scales of as little as a day, we can also link critical flood risk and fire forecasts to their impact for those down at the farm or catchment,” says Dr May.

A leader in understanding the physics of thunderstorms and tropical cyclones, Dr May warns of the risk posed by floods of data without long-term mathematical, social science and advanced computing capability.

“Long-term, it is vital we maintain the tools and workforce to turn this data into information to make better decisions, otherwise we risk drowning our forecasters in data with little impact where it is needed,” he says.

Dr May delivered the AMSI Winter School 2017 Public Lecture at the Queensland University of Technology (QUT) from 6:30 pm on Monday, 3 July 2017.

AMSI Director Professor Geoff Prince said that the Institute was excited to partner with QUT and event sponsors to showcase the multi-discipline impact of mathematics to the broader community.

“This research illustrates the power of mathematics and statistics to deliver real community and economic impacts that will benefit Australians now and into the future,” says Professor Prince.

AMSI Winter School 2017 ran over two weeks from 26 June to 7 July. Headlined by national and global field leaders, the program will provide students with cutting-edge insights into computational data science.

AMSI Winter 2017 was sponsored by AMSI, QUT, the Department of Education and Training, the BHP Billiton Foundation, SGI, ACEMS, TechnologyOne, QCIF and the Simulation Group.

# MEDIA REPORT

High global stakes in weather and climate science and in forecasting resulted in strong media coverage of Dr Peter May's AMSI Winter School 2017 Public Lecture with a total reach of over **120 million**. In addition to live state-wide broadcast over ABC Brisbane Radio 612, a News Limited article achieved national and international reach of almost **53 million** with the piece published on news.com.au and syndicated through websites for all major News Limited national dailies—the *Herald Sun*, *Courier Mail*, *Daily Telegraph*, *Northern Territory Times*, *Townsville Bulletin*, *The Advertiser*, *The Mercury*, and the *New York Post*. International coverage through the *Daily Mail* (UK and Australian editions) reached over **53 million**, as well as an article in the *Independent*. A piece published on US platform Newsmax reached a further **14 million**. While not measurable, strong social media integration of many of these sites also significantly added to reach with a presence in popular news feeds associated with key platforms such as Facebook and Twitter.

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*"The Winter School increased my knowledge of data science and I will apply knowledge gained from these courses into my current research. I am sure that it will provided better job opportunity for me in the future. I am very thankful for what Ian Turner and Andree Phillips did during AMSI Winter School 2017."*

**Mehdi Ghasem Moghadam, PhD student, Curtin University of Technology**

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# EVENT COMMITTEES

AMSI would like to acknowledge and thank all the individuals who contributed their time and expertise to making Winter School 2017 a resounding success:

## STANDING COMMITTEE

**Ian Turner (Chair and Event Director)** – Queensland University of Technology

**Hans De Sterck (Scientific Director)** – Monash University

**Aurore Delaigle** – The University of Melbourne

**Troy Farrell** – Queensland University of Technology

**Joseph Grotowski** – The University of Queensland

**Markus Hegland** – The Australian National University

**Phillip Isaac** – The University of Queensland

**Geoff Prince** – Australian Mathematical Sciences Institute

**Paul Ulrick** – Australian Mathematical Sciences Institute

**Cate Parsons** – Australian Mathematical Sciences Institute (Committee Secretary)

**Stephanie Breen** – Australian Mathematical Sciences Institute (Committee Secretary)

**Sarah Wilde** – Australian Mathematical Sciences Institute

## EVENT ORGANISING COMMITTEE

**Ian Turner (Event Director)** – Queensland University of Technology

**Troy Farrell** – Queensland University of Technology

**Andree Phillips** – Queensland University of Technology

**Amanda Kolovrat** – Queensland University of Technology

**Tiangang Cui** – Monash University

**Paul Ulrick** – Australian Mathematical Sciences Institute

**Cate Parsons** – Australian Mathematical Sciences Institute

**Stephanie Breen** – Australian Mathematical Sciences Institute

**Sarah Wilde** – Australian Mathematical Sciences Institute

AMSI 17

**WINTER  
SCHOOL**  
ON  
**COMPUTATIONAL  
FOUNDATIONS OF  
DATA SCIENCE**

26 JUNE – 7 JULY

QUEENSLAND UNIVERSITY OF TECHNOLOGY

**THEMES INCLUDE**

BAYESIAN INFERENCE & DATA ASSIMILATION

HIGH-DIMENSIONAL STATISTICS

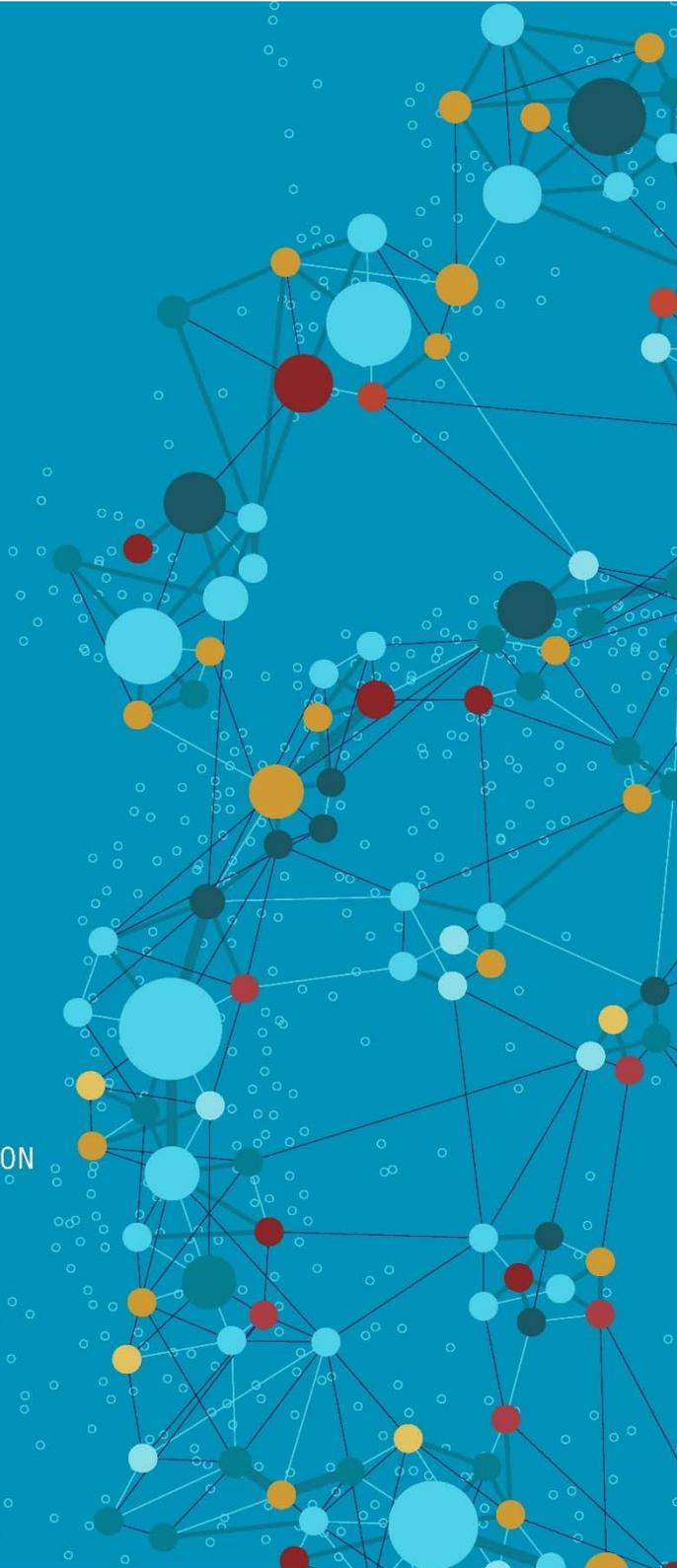
INVERSE PROBLEMS

MACHINE LEARNING

NONLINEAR OPTIMISATION

NUMERICAL LINEAR ALGEBRA

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AMSI RESEARCH

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