AMSI SUMMERSCHOOL 21
IN THE MATHEMATICAL SCIENCES

VIRTUAL EVENT HOSTED BY
THE UNIVERSITY OF ADELAIDE **11 JAN – 5 FEB 2021**

EVENT REPORT

AMSI AUSTRALIAN MATHEMATICAL SCIENCES INSTITUTE

Australian Government
Department of Education, Skills and Employment

THE UNIVERSITY of ADELAIDE

Thank you to the following Summer School 2021 sponsors

AMSI Summer School 2021

in the Mathematical Sciences

The University of Adelaide
11 January – 5 February 2021

FOREWORD

AMSI Summer School is one of five premier flagship events hosted each year around Australia, and forms part of the Securing Australia's Mathematical Workforce: 2016-2021 agreement between AMSI and the Department of Education, Skills and Employment. Now in its 19th year, AMSI Summer School is one of the most important national events for honours and postgraduate students in the mathematical sciences and cognate disciplines.

Hosted over four weeks, the program offers eight distinct subjects and gives students the opportunity to learn from highly experienced lecturers 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 Islander students

AMSI Summer School 2021 was jointly funded by the Australian Mathematical Sciences Institute (AMSI) and the Australian Government's Department of Education, Skills and Employment, with support from The University of Adelaide, the Australian Mathematical Society (AustMS), Australian New Zealand Industrial and Applied Mathematics (ANZIAM) and the Statistical Society of Australia (SSA).

"Beyond the learning and the research, AMSI Summer School provides an opportunity for participants from diverse universities nationwide to come together and share an amazing experience."

Professor Tim Marchant, AMSI Director

DIRECTOR'S REPORT

Associate Professor Thomas Leistner
The University of Adelaide

AMSI Summer School is the most important annual event for Australia's honours, masters and PhD students in the mathematical sciences. It gives students the opportunity to get a head start on the coursework component of their degree, to attend courses that are usually not offered at their home university, and to meet fellow students from all over the country to form friendships and become part of a network that will be invaluable throughout their career.

The preparations for this year's summer school were overshadowed by the developing COVID-19 pandemic, and after careful consideration of the options we concluded that the only way Summer School could take place in a safe and predictable environment was to hold it as a virtual event. This posed many uncertainties and challenges: how would participants react to a virtual event, was there a coherent way for the different types of courses to be presented in an online format, how could the many social events of a residential summer school be replaced? But the virtual format also offered exciting new opportunities, in regards to the way both the courses and program extra events were delivered.

The 2021 AMSI Summer School hosted by the University of Adelaide had a record 191 participants from 21 Australian universities, mostly honours and masters students, but also the large number of 32 PhD students. Since this year no travel grants were required, we were able to provide 53 AMSI Scholarships to cover the registrations fees. Of the 191 students, 89 students took a course for credit, while an additional eight students sat the examinations for their own interest.

The eight intensive courses ranged over a variety of topics: from very topical and high in demand subjects such as the modelling of infectious diseases and deep learning, to cutting edge pure mathematics and theoretical physics courses such as algebraic topology and string theory. All courses were delivered in online mode using a combination of live streamed lectures, instructional course videos and live streamed tutorials and practice sessions. New assessment methods that enabled students to stay on top of the material in a timely manner, such as frequent online quizzes, became essential parts of the assessment. Even though overall the event feedback showed that a face-to-face Summer School has many advantages for the learning experience, it also showed that the participants appreciated the flexibility that was provided with a high quality virtual event.

In addition to the eight courses the school featured several special events. The opening ceremony on day one included a special address by South Australia's Chief Scientist Professor Caroline McMillen. This was followed in the second week by a Diversity in STEM panel discussion chaired by Professor Benjamin Burton. The third week offered an exciting careers

day: six potential employers presented their companies and institutions in a well-attended webinar, which was then followed by a panel discussion. One of the highlights of the special events was the public lecture entitled Deriving Insights from New Data Sources by Distinguished Professor Kerrie Mengersen from the Queensland University of Technology. The public lecture was very popular with students as well as members of the public.

The online special events were accompanied by face-to-face social events in the state's capitals where students could meet and get together for networking. Moreover, some universities provided study hubs for the duration of Summer School, where students could work together, watch the course videos and discuss assignments and quizzes. In addition, the students could meet in a virtual version of the University of Adelaide campus.

I would like to thank everyone who made this event possible: our sponsors who provided vital financial foundations for this event, the Program Standing Committee for their insightful suggestions and decisions which ensured that the school offered a well-rounded set of high quality courses and for their engagement in the local social events, and the lecturers, without whom this event would not have been possible, who did not shy away from the increased workload that came with the move to a virtual event, and who worked extremely hard to provide the students with a first-class learning experience.

My thanks also go to everyone who was involved in the special events: speakers, presenters and panellists. Finally, I would like to thank everyone at AMSI who was involved in helping to organise the summer school, most importantly Anna Muscara and Angela Coughlin, who worked tirelessly for the organisation of the Summer School. Without their knowledge, enthusiasm and good humour this event would not have been possible. I would also like to thank Marisa Schult and Matthias Fresacher for setting up the virtual campus of the University of Adelaide and the team at the University of Adelaide, above all Melissa Smithen and Pavel Simcik, for the enormous administrative support.

"I've found that the relationships I've made with academics during my AMSI program have been as close as any that I've made at university, and I would now feel confident approaching them to collaborate or ask for advice in the future."

Aditya Ganguly, UNSW

STUDENT PROFILE

Christina Tait
The University of Adelaide

Christina has always been passionate about improving education. When she decided to pursue a Master of Philosophy in Statistics, focused on improving student assessment models, she applied to attend AMSI Summer School to broaden her mathematics skill set.

Over the four-week event program, Christina engaged in new subjects that equipped her with deep learning tools she says she may not have developed otherwise.

"Summer School was an extremely worthwhile experience. I now have a larger repertoire of mathematics techniques that I can potentially implement as part of my research and other projects," Christina said.

Initially studying a double degree in Teaching and Mathematical Computer Sciences, Christina later transferred into a Bachelor of Mathematical and Computer Science with a major in statistics so she could undertake a masters.

"When starting out at university I aspired to become a high school mathematics teacher. I have always had a passion for teaching and encouraging people to engage with mathematics. Throughout my time at university, however, I realised that I thoroughly enjoyed my studies in mathematics and wanted to further pursue them. I also discovered that I could make an impact in education through studying statistics and participating in research on how we can better assess students to identify the gaps in their knowledge" Christina explained.

Being awarded an AMSI Scholarship meant Christina could participate in Summer School without worrying about the financial impact.

"During an intensive course, such as Summer School, the workload can be quite heavy. The financial support meant I could fully participate without worrying about what I was spending," Christina said.

Familiar with AMSI's flagship events, Christina has previously participated in AMSI's Vacation Research Scholarships program as an undergraduate, where she spent six weeks working on a supervised research project and realised her passion for applied mathematics.

"AMSI events are a fantastic opportunity to discover and advance your research passions – I highly recommend them to other mathematics students", said Christina.

STUDENT PROFILE

Matthew Pudig
UNSW

Matthew is an applied mathematics honours student at UNSW, whose research focuses on oceanography – specifically, the effects of global warming on the ocean.

To broaden his knowledge of mathematics, Matthew applied to attend AMSI Summer School 2021, curious to learn from a variety of mathematicians around Australia.

"Summer School was an opportunity to gain fresh, unique perspectives on applied mathematics, which was invaluable. I learnt new techniques from some incredible lecturers," Matthew said.

An AMSI Scholarship covered the event fees for Matthew, which he says allowed him to focus fully on the coursework.

"Summer School is a great event that should be accessible to everyone, and the scholarship program helps. The event is an opportunity to meet other mathematics students, learn from new lecturers, and diversify your mathematics training," he added.

Despite his interest in mathematics, Matthew didn't always plan on pursuing it at university – originally planning to enrol in a fine arts degree.

"In my final year of high school, I had a fantastic maths teacher who inspired me to pursue mathematics and I'm very glad I did. The world of mathematics is a privilege to be a part of and I've met some wonderful people," said Matthew.

He believes one of the challenges holding students back from pursuing mathematics is the way it's taught in schools.

"Maths can be inherently creative, yet it's often taught in a way that stifles creativity. It wasn't until my final year that I experienced the benefits of learning maths through creative processes, rather than rote-learning methods. I hope there is a move towards this in schools, to encourage more young people to pursue it," Matthew said.

Where does Matthew see himself in 10 years' time? "If 2020 taught me one thing, it's that plans change! After my honours, I'd like to continue my research through a PhD. Then, I'm not sure. Hopefully I'm working on something interesting and valuable in the field of applied mathematics."

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.

Practical Asymptotics
Dr Michael Chen, The University of Adelaide

Stochastic Modelling
Dr Giang Nguyen, The University of Adelaide

Algebraic Topology: First Steps in Cohomology
Dr David Roberts, The University of Adelaide

Permutation Groups
Professor Michael Giudici, The University of Western Australia

Multivariate Statistical Analysis *(Sponsored by SSA)*
Dr Sharon Lee, The University of Adelaide

Mathematical Modelling of Infectious Diseases
Associate Professor Roslyn Hickson, CSIRO and James Cook University

The Mathematical Engineering of Deep Learning
Associate Professor Yoni Nazarathy, The University of Queensland
Professor Benoit Liquet, Macquarie university and UPPA, France
Dr Sarat Moka, The University of Queensland

Introduction to String Theory
Dr Johanna Knapp, The University of Melbourne

"The courses offered at Summer School were highly relevant to my current studies and MPhil research. Furthermore, the variety of courses gave different flavours of maths that I had never seen before, and so I feel as though my world got a little bigger after participating in Summer School."

Wills Ton Minh Nguyen, The University of Adelaide

Practical Asymptotics

Dr Michael Chen
The University of Adelaide

Synopsis: Differential equation models of real world problems are often very complex. Perturbation methods and asymptotic techniques can be used to systematically derive simpler versions of these models by exploiting the presence of small (or large) parameters; the idea being that the new model is mathematically tractable and still describes the behaviour of the original. This is useful, for example, in problems which involve slender geometries, or for situations where both small and large time scales are important.

This course is a broad introduction to asymptotic techniques and their application. Topics covered include: asymptotic evaluation of integrals; perturbation methods; boundary-layer theory; asymptotic matching; multi-scale analysis and asymptotics beyond all orders. Case studies will be used to demonstrate the utility of these techniques for problems from fluid mechanics, biology and industry.

Course Overview:

- Introduction to asymptotics
  - Notation
  - local behaviour of ODEs
- Regular perturbation methods
  - examples from fluid mechanics and biology
- Boundary layer theory and matching
  - singular perturbation problems
  - boundary layers in ODEs/PDEs
- Multiple scales
  - oscillators
  - homogenisation
- Evaluation of integrals
  - Laplace's method
  - Method of steepest descent

Number of students who completed the course:	18
Number of students who passed the course for credit:	7
Agreed the course was of a high standard:	86%

Stochastic Modelling

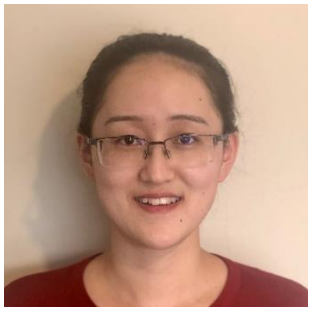
Dr Giang Nguyen
The University of Adelaide

Synopsis: Randomness is an important factor in modelling and analysing various real-life situations. This course covers some key aspects in stochastic modelling, including the theory underlying Brownian motions and diffusion processes, as well as techniques for numerical simulations.

Course Overview:

- Preliminaries from measure-theoretic probability
- Modes of convergence
- Brownian motion
- Simulation algorithms
- Filtration, martingales, and stopping times
- Basics of Ito calculus

Number of students who completed the course:	37
Number of students who passed the course for credit:	9
Agreed the course was of a high standard:	91%



"This experience was very important to me. The course was very relevant to my research, and it has broadened my view in this field, and the public lecture and the keynote talk were very inspiring. They do make me more confident in my research and showed me the possibility and potential my work may bring to the future."

Jiahao Wu, Monash University

Algebraic Topology: First Steps in Cohomology

Dr David Roberts, The University of Adelaide

Synopsis: Algebraic topology is one of the key areas of pure mathematics to be developed in the middle of the 20th century, with techniques leaking out to many other areas of mathematics aside from its origin in topology. These days it is even showing up in applied mathematics, with topological data analysis becoming a larger field every year. This course aims to give a first treatment of algebraic topology using cohomology, taking both a combinatorial and topological point of view, and treating the basics of homological algebra used to do computations. We will also cover the basic ideas of category theory to take advantage of functoriality of cohomology.

This course should be suitable for a first introduction to modern ideas of topology, homological algebra, algebraic topology and the basic language of category theory.

Course Overview:

Delta-sets as combinatorial models for spaces and their cohomology, homological algebra, topological spaces and constructions, singular cohomology of topological spaces, simplicial sets as an improvement of Delta-sets, the Eilenberg–Steenrod axioms, cup products, applications.

Number of students who completed the course:	42
Number of students who passed the course for credit:	12
Agreed the course was of a high standard:	89%

"On top of the well-structured coursework, I found the mentoring and networking aspect of the summer school extremely valuable."

Jiaxin Yu, UNSW

Permutation Groups

Professor Michael Giudici
The University of Western Australia

Synopsis: Permutation groups embody the notion of a group being a measure of symmetry and are an important tool for exploring geometric and combinatorial structures. This course will look at the modern theory of permutation groups which takes advantage of recent advances in abstract group theory such as the Classification of Finite Simple Groups.

Course Overview:

The course will cover topics such as group actions, wreath products, multiply transitive groups, primitive groups, the O'Nan-Scott Theorem, and will look at applications to study the symmetry of graphs such as Cayley graphs and 2-arc-transitive graphs.

Number of students who completed the course:	29
Number of students who passed the course for credit:	8
Agreed the course was of a high standard:	100%

"The most valuable component of this year's Summer School for me was the realisation that so many seemingly disparate areas of mathematics are actually connected, and in simple, fundamental ways. I can now see that the skills acquired in my undergraduate studied are widely applicable to many different fields."

Zachary Groth, University of Newcastle

Multivariate Statistical Analysis

Dr Sharon Lee

The University of Adelaide

(sponsored by Statistical Society of Australia)

Synopsis: Multidimensional data arise frequently in many fields of scientific research, from engineering, computer science, finance, medicine, to social sciences. Multivariate statistics provide powerful and flexible tools to extract meaningful information from these data.

This course provides an introduction to various classical statistical methods for analyzing multivariate data, including multivariate extensions of univariate techniques and other tools that are specific for multidimensional data. Students gained a conceptual understanding and the mathematical underpinnings of the procedures, and be able to applied these to datasets using R.

Course Overview:

- Introduction to multivariate data, distributions, and analysis
- Inference about multivariate means and regression
  - Inference for a single population
  - Comparison of multiple populations
  - Multivariate regression
- Analysis of a covariance structure
  - Principal component analysis
  - Factor analysis
  - Canonical correlation analysis
- Clustering, classification, and grouping
  - Discriminant analysis
  - Hierarchical clustering
  - k-means and mixture models
  - Multidimensional scaling
  - Correspondence analysis

Number of students who completed the course:	25
Number of students who passed the course for credit:	4
Agreed the course was of a high standard:	75%

Mathematical Modelling of Infectious Diseases

Associate Professor Roslyn Hickson
CSIRO and James Cook University

Synopsis: Infectious disease transmission is a nonlinear process with many subtleties and complications more sociological in nature (e.g. how people behave). Mathematical modelling of infectious disease transmission has substantial potential real world application, as highlighted by the recent COVID-19 pandemic.

This course explores key topics in infectious disease modelling, including the development of appropriate models, parameterisation from data using Bayesian Inference, and using models as a "what-if" scenario tool or as a tool to increase understanding of fundamental epidemiological processes. We will start with quite simple mathematical models that yield important insights to disease dynamics and control, and build to more complex models that better reflect complicated infectious disease dynamics. The focus will be on simulation of these models, as opposed to analytical analysis.

Course Overview:

- What is modelling? Introduction to epidemiology
- Compartmental modelling
- Parameterisation of models: What to do with data?
- Controlling infectious diseases, including a case study
- Spatial models
- Introduction to agent-based approaches

Number of students who completed the course:	25
Number of students who passed the course for credit:	7
Agreed the course was of a high standard:	100%

"Meeting with peers from a diverse range of backgrounds and interest fields, and hearing their academic pathway stories has greatly impacted my future study decision-making. One of the most valuable lessons I learned was from my lecturer about future possible careers and employability. She taught me and the whole class how to think ahead and expand the possibilities of our academic and social lives."

Mung Suan Pau Dulihan, RMIT

The Mathematical Engineering of Deep Learning

Associate Professor Yoni Nazarathy, The University of Queensland
Professor Benoit Liquet, Macquarie University and UPPA, France
Dr Sarat Moka, The University of Queensland



Synopsis: In the last few years deep learning has seen explosive growth and even dubbed as the "new electricity". This is due to its incredible success in transforming and improving a variety of automated applications. At its core, deep learning is a collection of models, algorithms, and techniques, such that when assembled together, efficient automated machine learning is executed. The result is a method to create trained models that can detect, classify, translate, create and take part in systems that execute human like tasks and beyond.

In this course we focus on the mathematical engineering aspects of deep learning. For this we survey and investigate the collection of algorithms, models, and methods that allow the statistician, mathematician, or machine learning professional to use deep learning methods effectively. Many machine learning courses focus either on the practical aspects of programming deep learning, or alternatively on the full development of machine learning theory, only presenting deep learning as a special case. In contrast, in this course, we will aim to focus directly on deep learning methods, understanding the engineering mathematics that drives this field.

Course Overview: A student completing this course will possess a solid understanding of the fundamental models, algorithms, and techniques of deep learning. These include feedforward networks, convolutional networks, recurrent neural networks, autoencoders, generative adversarial networks, first order methods of learning (optimization), second order method of learning, regularization techniques, and general benchmarking methods. Students will also gain some hands-on experience with machine learning frameworks such as TensorFlow (R and Python), Keras (Python), PyTorch (Python), and Flux (Julia).

Number of students who completed the course:	61
Number of students who passed the course for credit:	28
Agreed the course was of a high standard:	97%

Introduction to String Theory

Dr Johanna Knapp
The University of Melbourne

Synopsis: String theory is a physical theory that unifies the known fundamental forces of nature at the quantum level. Point particles are replaced by fundamental strings. This concept has far reaching consequences, including extra dimensions, "stringy" dualities, and intricate mathematical structures. This course will cover the basic concepts and is intended to provide the foundations for further (self-)study and research projects in string theory. The course aims to be mostly self-contained and should be suitable also for students who do not necessarily have a background in physics.

Course Overview:

- The classical bosonic string: Polyakov action, symmetries, equations of motion and their solution
- The quantised bosonic string: quantisation, spectrum and unification of forces, conformal anomaly and extra dimensions, compactification on a circle and T-duality
- Introduction to conformal field theory: basic concepts and application to string theory

Number of students who completed the course:	23
Number of students who passed the course for credit:	3
Agreed the course was of a high standard:	92%

"For many students, myself included, AMSI Summer School is one of the first times they have interacted with mathematicians from outside of their home institution. Given that this is a 4-week long program, it is a great way to form long-lasting connections."

Forrest Koch, UNSW

PARTICIPANT BREAKDOWN

UNIVERSITY/INSTITUTION	
Australian National University	6
Flinders University	4
La Trobe University	6
Macquarie University	7
Monash University	22
Murdoch University	1
Queensland University of Technology	4
RMIT University	8
The University of Adelaide	28
The University of Melbourne	31
The University of New England	1
The University of New South Wales	18
The University of Newcastle	6
The University of Queensland	14
The University of Sydney	13
The University of Western Australia	4
University of South Australia	5
University of Tasmania	7
University of Technology, Sydney	3
University of Wollongong	2
Western Sydney University	1

191 attendees

from **21** universities

"No other time in your life will you be able to learn so much so quickly AND hang out with like-minded students!"

Joshua Bon, Queensland University of Technology

GENDER		
Female	44	23%
Male	142	74%
Other	2	1%
Prefer not to disclose	3	2%

RESIDENCY STATUS		
Australian Citizen	132	69%
Permanent Resident	8	4%
Student Visa	45	23%
Other	3	2%
Prefer not to disclose	3	2%

ABORIGINAL AND TORRES STRAIT ISLANDER		
No	185	97%
Yes	2	1%
Prefer not to disclose	4	2%

STATE/TERRITORY		
ACT	5	2.5%
NSW	47	25%
QLD	21	11%
SA	37	19%
TAS	7	4%
VIC	63	33%
WA	6	3%
International	5	2.5%

PARTICIPANT TYPE		
Undergraduate	18	9%
Honours	56	29%
Masters (by Coursework)	48	25%
Masters (by Research)	29	15%
PhD	32	17%
Early-Career Researcher	3	2%
Academic	3	2%
Other	2	1%

SCHOLARSHIPS

AMSI Scholarships provide financial support to students to assist them attend AMSI Flagship programs by covering the cost of their program fees.

In 2021, AMSI Summer School Scholarships were awarded to 53 students (including 11 women) from 15 AMSI Member universities.

- Junqi Huang, Australian National University
- Aidan Butler, Monash University
- Andrew Cook, Monash University
- Sami Elmasri, Monash University
- Yuqian Liang, Monash University
- Ellena Moskovsky, Monash University
- Richard Pinter, Monash University
- Jiahao Wu, Monash University
- Wafaa Mansoor, Murdoch University
- Joshua Bon, Queensland University of Technology
- Noa Levi, Queensland University of Technology
- Mung Suan Pau Duhlian, RMIT University
- Drew Holland, RMIT University
- Mahshid Sadeghpour, RMIT University
- William Allan, The University of Adelaide
- Abdul Hadi Asfarangga, The University of Adelaide
- Michael Fairbrother, The University of Adelaide
- Yuchen Jiang, The University of Adelaide
- Tyson Klingner, The University of Adelaide
- Wayne Maloney, The University of Adelaide
- Sean McGowan, The University of Adelaide
- Wills Nguyen, The University of Adelaide
- Luke O'Loughlin, The University of Adelaide
- Antonio Parrella, The University of Adelaide
- Christina Tait, The University of Adelaide
- Nan Wang, The University of Adelaide
- Joshua Watt, The University of Adelaide
- Christopher Swan, The University of Melbourne
- Alex Verhoijsen, The University of Melbourne
- Zachary Groth, The University of Newcastle
- João Vitor Pinto e Silva, The University of Newcastle
- Luke Davidson, The University of Queensland
- Christian Kennedy, The University of Queensland

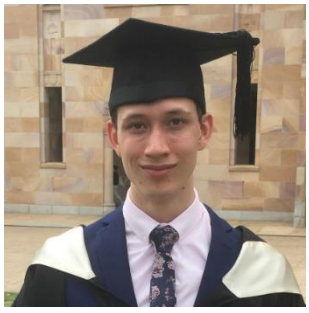
- Nizhum Rahman, The University of Queensland
- Joel Thomas, The University of Queensland
- Jack Thompson, The University of Queensland
- Thomas Malliaras Gavrielatos, The University of Sydney
- Theresa O'Brien, The University of Sydney
- Kai Turner, The University of Western Australia
- Kirsten Louw, The University of South Australia
- Jason Mackellar, The University of South Australia
- Thomas Miller, The University of South Australia
- Sandeep Santhosh Kumar, The University of South Australia
- Jiahao Diao, The University of Tasmania
- Albert Soewongsono, The University of Tasmania
- Joshua Stevenson, The University of Tasmania
- Dylan Maher, University of Wollongong
- Aditya Ganguly, UNSW
- Joshua Graham, UNSW
- Forrest Koch, UNSW
- Kevin Ho Fai Lam, UNSW
- Matt Pudig, UNSW
- Jiaxin Yu, UNSW

"The opportunity to network with peers (both in and not in our field) is extremely valuable. I feel that I had a very interesting cohort to network with in my course, and in fact we are still in touch and communicating about the content even after the event. I certainly value this network, which I would not have had access to had I not received the scholarship to attend Summer School."

Ellena Moskovsky, Monash University

"Without the AMSI Scholarships students with financial struggles will lose the opportunity to participate. Thus, the AMSI Scholarships are essential to engage low socio-economic students like myself."

Christian Kennedy, The University of Queensland



EVENT HIGHLIGHTS

Opening Ceremony

The 2021 Summer School was officially opened online by The University of Adelaide on Monday 11 January. The Chief Scientist of South Australia, Professor Caroline McMillan gave a fascinating keynote presentation on the importance of research and innovation and its contribution to major developments throughout history. Professor McMillan focused on statistical methods and data moving civilisation forward in the last 50-100 years and its impact on policy. AMSI Interim Director Professor Asha Rao, Acting Head of School, Associate Professor Gary Glonek and Event Director Associate Professor Thomas Leistner also welcomed students to the online program. Local state-based watch parties were hosted at the University of Adelaide, AMSI/University of Melbourne, Australian National University, University of Tasmania and University of Western Australia, allowing students to meet face-to-face and have a more social experience as they settled into the program. 115 students attended online and 53 students attended in the hubs.

Diversity in STEM Event

This online discussion panel brought together students and professionals with a wide range of mathematical backgrounds and life experiences. The panel discussed a myriad of topics including LGBTQI+ issues, mental health, industry mentors, advocates, role models and the advantages of embracing different perspectives in the workplace, including those from different genders and ethnicities. Attendees were invited to contribute to the discussion, ask questions from the panel and think more broadly about the ways they can participate and create a more inclusive community. State-based satellite events where students and presenters could meet in person and watch the live broadcast were hosted at the University of Adelaide and the University of Technology Sydney.

Thank you to our panellists:

- Stephanie Marinis, Masters student, La Trobe University
- Professor Louise Ryan, University of Technology Sydney
- Dr Giang Nguyen, University of Adelaide
- Professor Ben Burton, University of Queensland
- Assistant Professor Thomas Morrill, Trine University, USA

Careers Fair

The Careers Fair is always a highly anticipated event on the Summer School calendar. It is a rare chance for students to discover where their highly sought after mathematical credentials can lead them after university. In many instances, students are unaware of the depth and breadth of opportunities that are available to them, particularly in industry. In 2021, the event was conducted online, offering greater flexibility in the types of organisations that could participate in the event.

Hosted by incoming AMSI Director, Professor Tim Marchant, presentations about career pathways in mathematics were given by:

- The Australian Space Agency
- CSL
- Optiver
- Defence, Science and Technology Group
- Australian Signals Directorate
- CSIRO's Data 61

Presentations were followed by a stimulating Q&A session that discussed individual career pathways and the common myths and pitfalls of seeking a career in mathematics with panellists sharing their own personal experiences and providing advice from both an industry and academic standpoint.

Thank you to our panel members:

- Ben Kaufman, Trader, Optiver
- Dr Thomas Dyer, Maritime Operations Data Analyst, DST Group
- Dr Melanie Ayre, Research Consultant, CSIRO's Data 61
- Dr Milica Ng, Head of Research Data Science, CSL
- Dr Ramiro Lafuente, academic, The University of Queensland
- Dr Lewis Mitchell, academic, The University of Adelaide

The event was attended by over 100 students (in hubs and online) and feedback from both students and industry guests was positive.

"My perception was that I would be able to find a [research] career in academia only. The Careers Day program showed me that there are various opportunities in the industry and private sectors that meet my aspirations about my future career."

Mahshid Sadeghpour, RMIT

"One of my favourite things about mathematics is how versatile its applications are. The Careers Day was a great event to see this versatility showcased, and it got me excited for the possibility of working in industry one day."

Noa Levi, Queensland University of Technology

PUBLIC LECTURE

Distinguished Professor Kerrie Mengersen from the Queensland University of Technology presented the 2021 Summer School public lecture: *Deriving insights from new data sources*. This outreach event gives members of the public the opportunity to get a glimpse into the ways that mathematics surrounds us in our everyday lives. Using examples from environmental and wildlife conservation case studies, Professor Mengersen spoke about some of the advantages and challenges of dealing with and analysing data from new sources such as virtual reality, thermal imaging, satellites and crowdsourcing.

The lecture was well attended attracting 200 live viewers both online and at the state-based event hubs at The University of Adelaide, The University of Melbourne, University of Queensland, University of Technology Sydney and The University of Western Australia. A recording of the lecture was published on the AMSI YouTube channel (https://www.youtube.com/watch?v=hjQY1xDv0NA) in March which has had 174 views. The lecture was followed by an enthusiastic Q&A session from members of the audience wanting to know more about some of the concepts discussed in the presentation.

"AMSI Summer School is not only a chance to train yourself to adjust to the intense and fast-paced teaching styles, but, more importantly, a great place to meet like-minded people across Australia and learn about the mathematical community that you wouldn't normally hear about within regular degree structures."

Yuchen (Jency) Jiang, The University of Adelaide

"Going to the public lecture and then having supper afterwards was the best. The public lecture was a good base to start off conversations during supper."

Kirsten Louw, University of South Australia

FEEDBACK ANALYSIS

Fifty-five per cent of attendees completed the post-event feedback form commenting on their experiences at the 2021 Summer School. On the whole, the survey data suggests that this program continues to be integral to the mathematical sciences landscape in the higher education sector, giving students a platform to make valuable networks, broaden their knowledge and open up possibilities for future study and career paths in mathematics and statistics. In rating their overall experience where 1 signalled poor performance and 10 excellent, the average rating for the 2021 program was 8.2, which was in-step with results from the previous two years and an outstanding score given the event was adapted to a virtual format for the first time.

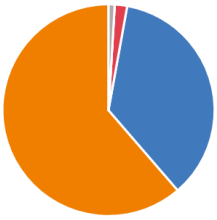
In 2021, 53 per cent of survey respondents cited "broadening their knowledge" as the major driver in participating in the Summer School. This ranked higher than "gaining credit towards their degree" (42 percent) which in past years has been the most popular motivator for students attending the program. An additional five per cent of students wished to learn from a specific lecturer.

For another year, the AMSI Summer School program demonstrated to participants the importance of mathematical sciences qualifications and their wide and varied application in industry. Fifty-four per cent of survey respondents noted that participating in the program strengthened their resolve to pursue a PhD in mathematics (28 per cent strongly agreed; 26 per cent agreed), while 59 per cent of students felt the Careers Day event provided good information and advice about careers and job opportunities (32 per cent strongly agreed; 27 per cent agreed).

Below is a further breakdown of thoughts and comments regarding the 2021 program.

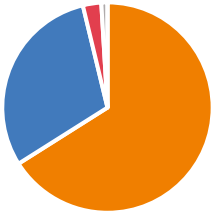
SUMMER SCHOOL WAS OF A HIGH STANDARD

Strongly Agree	61%
Agree	36%
Neutral	2%
Disagree	0%
Strongly Disagree	1%



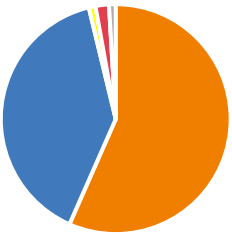
SUMMER SCHOOL WAS WELL-ORGANISED

Strongly Agree	66%
Agree	30%
Neutral	3%
Disagree	1%
Strongly Disagree	0%



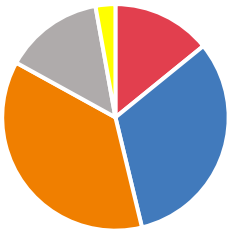
THE COURSES OFFERED PROVIDED A GOOD VARIETY OF SUBJECTS

Strongly Agree	57%
Agree	40%
Neutral	1%
Disagree	1%
Strongly Disagree	1%



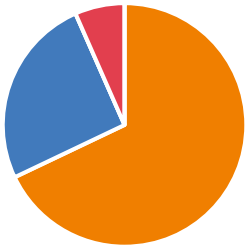
I MADE USEFUL CONTACTS AND NETWORKS AT SUMMER SCHOOL

Strongly Agree	14%
Agree	32%
Neutral	37%
Disagree	14%
Strongly Disagree	3%



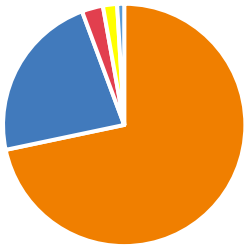
I WILL APPLY KNOWLEDGE GAINED FROM SUMMER SCHOOL TO MY CURRENT AND FUTURE STUDIES/ACTIVITIES

Strongly Agree	68%
Agree	25%
Neutral	0%
Disagree	7%
Strongly Disagree	0%



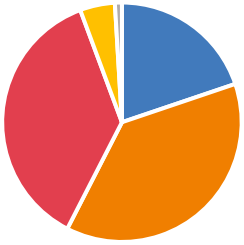
I WOULD RECOMMEND SUMMER SCHOOL TO OTHERS

Strongly Agree	72%
Agree	22%
Neutral	3%
Disagree	2%
Strongly Disagree	1%



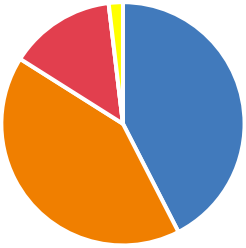
AS A RESULT OF THE CAREER RELATED CONTENT OF THIS SUMMER SCHOOL, I AM CLEARER ABOUT MY EMPLOYMENT OPTIONS

Strongly Agree	20%
Agree	38%
Neutral	37%
Disagree	4%
Strongly Disagree	1%



SUMMER SCHOOL HAS EXPOSED ME TO THE POSSIBILITIES THAT MATHEMATICS CAN BRING TO MY FUTURE CAREER

Strongly Agree	42%
Agree	42%
Neutral	14%
Disagree	0%
Strongly Disagree	2%



When asked about the main intention in their current career planning, 18 per cent of survey respondents said they were looking to apply their skills in a STEM related profession (not research or teaching), while five per cent aspire to teach at a tertiary and higher education level. Survey feedback points overwhelmingly at research being the ideal career choice for students with 56 per cent hoping to enter the academic sphere to conduct research within a higher education context. An additional 11 per cent noted they wished to conduct research in a research institute context (such as CSIRO) and eight per cent aim to be researchers within a STEM profession. A small percentage noted that they are still undecided about the direction of their career journey (2%).

"A big challenge facing mathematics is the misconception that the only career available for individuals with a degree in mathematics involves teaching. Programs like AMSI Summer School are important in debunking this misconception, since they inform people of the variety of career pathways that can be pursued with a mathematics degree. The experience has reinforced my decision to do Honours in mathematics."

Dylan Maher, University of Wollongong

COMMITTEES

AMSI wishes to acknowledge the generous donation of time and scientific advice by the following committees—without their contribution this event would not have been a success:

Program Committee

- Thomas Leistner (Event Director), The University of Adelaide
- Gary Glonek (Head of School, Mathematical Sciences), The University of Adelaide
- Tim Brown (Director), Australian Mathematical Sciences Institute
- Yuri Nikolayevsky (Summer School 2020 Director), La Trobe University
- Guoyin Li (Summer School 2019 Co-Director), UNSW
- Shane Keating (Summer School 2019 Co-Director), UNSW
- Simon Clarke (AMSI Summer School 2018 Director), Monash University
- Chloe Pearse (Program Manager, Research and Higher Education), Australian Mathematical Sciences Institute
- Galina Levitina, UNSW
- Giang Nguyen, The University of Adelaide
- Ivan Guo, Monash University
- Murray Elder, Monash University
- Bronwyn Hajek, University of South Australia
- Anna Muscara (Committee Secretary), Australian Mathematical Sciences Institute

Organising Committee

- Thomas Leistner (AMSI Summer School 2021 Director), The University of Adelaide
- Angela Coughlin, Australian Mathematical Sciences Institute
- Anna Muscara, Australian Mathematical Sciences Institute

"[Summer School] has made me more confident in the direction I am going. I truly feel more ready to jump into industry."

Drew Holland, RMIT

AMSI 21 SUMMER SCHOOL

IN THE MATHEMATICAL SCIENCES

VIRTUAL EVENT HOSTED BY THE UNIVERSITY OF ADELAIDE

11 JAN – 5 FEB 2021

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DR DAVID ROBERTS (UoA)

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DR ROSLYN HICKSON (CSIRO & JCU)

THE MATHEMATICAL ENGINEERING OF DEEP LEARNING
A/PROF YONI NAZARATHY (UQ)
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DR SARAT MOKA (UQ)

INTRODUCTION TO STRING THEORY
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