

AMSI
VACATION
RESEARCH
SCHOLARSHIPS

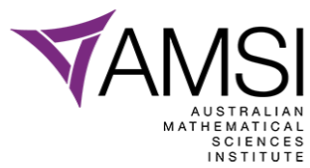
2018-2019



*Dive into Research
this Summer*

EVENT REPORT

Thank you to the following **AMSI Vacation Research Scholarships 2018-2019** sponsors:



AMSI Vacation Research Scholarships 2018-2019

Undertaken at AMSI Member Universities
December 2018 to February 2019

Foreword	4
Program Manager's Report	5
Research Reports	7
AMSIConnect	13
Guest Speakers	14
Best Presentations	15
Participation Breakdown	16
Feedback Analysis	18
Media Release	19
Featured Project	20
Student Case Studies	21
Media Coverage	21

FOREWORD

AMSI Vacation Research Scholarships (VRS) provide undergraduate students from around Australia with the opportunity to spend six weeks at the frontline of their chosen area of mathematical sciences, developing essential research and communication skills. As one of five premier flagship events hosted each year around Australia, VRS forms part of the Securing Australia's Mathematical Workforce: 2016-2020 agreement between AMSI and the Department of Education and Training.

“The Vacation Research Scholarship gives some of the nation's top students in mathematics and statistics the chance to experience the thrill of advancing knowledge. These students are the future research workforce, thought leaders who will help transform technology and how we engage with and live in the world. They seize the chance to break new ground and benefit so much from the experience. AMSIConnect allows them to communicate their excitement to peers, thus developing networks that will deliver much for Australia.”

Professor Tim Brown
AMSI Director

The Scholars experience life as researchers while they work closely with a supervisor to complete a project over six weeks. Concluding their summer of research, they present their findings at two-day residential student conference AMSIConnect in Melbourne. As an additional exercise they write blog posts relating to the mathematical sciences, giving them experience in scientific writing for broader audiences.

The AMSI Vacation Research Scholarships 2018-2019 program was jointly funded by the Australian Mathematical Sciences Institute and the Australian Government's Department of Education and Training.

PROGRAM MANAGER'S REPORT

Chloe Pearse

Australian Mathematical Sciences Institute



AMSI's Vacation Research Scholarship program has been run successfully since 2003/04. The program inspires undergraduates across Australia to commence a research career by funding second- and third-year students to complete a six-week mathematical sciences research project over their summer break. The scholarships are awarded on a competitive basis, with applicants required to identify a clear research component including outcomes for their project. The Vacation Research Scholarship experience is directly linked to research careers through the project supervision provided by research academics at each student's home university. For some students, their Vacation Research Scholarship project also delivers their first academic publication. The 2018/19 program intake was the largest cohort to date. From 91 applications, 71 students were awarded AMSI Vacation Research Scholarships and 68 completed their research projects.

At the end of summer, the Scholars come together in Melbourne to present their research projects and conclusions to their peers and supervisors at AMSIConnect. This provides the Scholars with a valuable professional-development experience in communication and networking skills, and a unique opportunity to meet like-minded students in a mathematical conference setting. A major highlight of the AMSIConnect program is the opportunity for Scholars and Supervisors to network. AMSIConnect 2019 was hosted by AMSI at The University of Melbourne's International House and was a rewarding experience for the students and their academic mentors. The conference commenced on 6 February, with an ice-breaker dodgeball tournament and welcome dinner. Scholars were allocated to random teams and following a series of games, the two best-performing teams playing off in a high-standard final. The tournament was well-received with Scholars showing their competitive streak and exhibiting excellent team-work skills.

AMSI's new Director Professor Tim Brown opened the formal program with a warm welcome to Scholars and Supervisors from across Australia. The careers talks highlighted evolving career and graduate study opportunities for students. Dr Laura Karantgis spoke about her career progression and passed on some tips for students taken from her time as a PhD student at La Trobe University. Professor Steven Siems from Monash University spoke of the importance of flexibility and taking on new challenges to create a successful and fulfilling career in the mathematical sciences. Following the guest speakers, each of our 68 Scholars delivered a high-quality presentation about their research project—prompting new questions and discussion. As well as formally engaging in research talks, the Scholars had plenty of time for networking during dinner and break times. The final session given by Professor Tim Brown gave the Scholars a unique opportunity to discuss future study and career opportunities in a group setting followed by the awards for the best research presentations.

Special thanks to our academic panel—Professor Brian Davey from La Trobe University and Professor Geoff Prince from AMSI—for their assistance.



RESEARCH REPORTS

Seventy-one students from 21 AMSI Member universities were awarded a 2018/19 AMSI Vacation Research Scholarship. Sixty-eight Scholars completed research with a supervisor for their chosen project (external circumstances forced three Scholars to withdraw from the program). Each student prepared a research report and blog post, presenting their research and findings at AMSIConnect in February 2019. Student profiles, research reports and blog posts can be viewed on the AMSI Vacation Research Scholarship website at vrs.amsi.org.au or by clicking on the student names below.

AMSI would like to express its appreciation to all Vacation Research Scholarship supervisors who gave their time and expertise to the Scholars and their projects. Their contribution is integral to the success of the program.

UNIVERSITY	STUDENT	SUPERVISOR(S)	PROJECT TITLE
Australian National University	Alexander Cox	Michael Norrish	Equivalence of Natural Deduction and Sequent Calculus in HOL4
	Douglas Coulter	Laurence Field	Brownian Motion and Harmonic Functions
	James Martini	Stephen Roberts	Utilising Sparse Grids for Airfoil Simulations & Uncertainty Quantification
Deakin University	Rudra Kumar	Sophie McKenzie and Shaun Bangay	Evaluating an AR Experience to Determine Play Strategies
La Trobe University	Emily Groves	Yuri Nikolayevsky and Grant Cairns	Drawings of the Complete Graphs K5 and K6, and the Complete Bipartite Graph K3,3
	Jade Bujeya	Toen Castle and Christopher Lenard	Chemically Feasible Configurations of Topologically Tangled Cubes
	Kevin Newman	Natalie Karavarsamis and Hien Nguyen	Is Anybody Home? Modelling Frog Occupancy at the La Trobe Wildlife Sanctuary
	Phillip Newbold	Natalie Karavarsamis	An R Package for Occupancy Model-Parameter Estimation Using the Two-Stage Approach

Macquarie University	Andy Tang	Georgy Sofronov	Analysis of Chances of Winning in a Poker Game: Combinatorial Probability and the Law of Large Numbers
	Hugh Entwistle	Georgy Sofronov	Convergence in the Central Limit Theorem
	Shay Tobin	Frank Valckenborgh	The Geometric and Probabilistic Structure of Classical Physical Theories
Monash University	Chang Yu Wang	Todd Oliynyk	Gravitational Waves: A Mathematical Analysis
	Eliza Jones	Anja Slim	Dynamics of Compound Droplets
	Kshitija Vaidya	Santiago Barrera Acevedo	Cocyclic Hadamard Matrices
	Kyria Wawryk	Leo Brewin	Precession of the Perihelia in a Schwarzschild Spacetime
	Siksha Sivaramakrishnan	Julie Clutterbuck	Symmetrisations and Other Rearrangement Inequalities
Murdoch University	Michelle Gardiner	Gerd Schroeder-Turk and Bruce Gardiner	Disordered Analogues of Triply-Periodic Minimal Surfaces
Queensland University of Technology	Christyn Wood	Elliot Carr	Calculating Thermal Diffusivity from Laser-Flash Experiments
	Kanupriya Agarwal	Michael Bode	How to Measure a Halo
	Ryan Watson	Elliot Carr	Extracting Insight into Advection-Dispersion Processes Through Moment Analysis
	Solene Hegarty-Cremer	Pascal Buenzli	A Grid-Based Particle Method for Solving Hyperbolic Curvature Flows
	Jamie Owen	Belinda Spratt	Including Patient Preference in Outpatient Appointment Scheduling
RMIT University	Genevieve Batten	Stephen Davis	Mathematical Modelling of the Long-Term Dynamics of Cyprinid Herpes Virus 3

	Guo Feng Anders Yeo	Vural Aksakalli	Single Document Key Phrase Extraction and Clustering
	Daniel Glasson	Graham Clarke	Cayley Graphs of Finite Semigroups
	Daniel Molent	Andrew Eberhard	Experiments with Trust Regions and the BFGS Method in Non-Smooth Optimisation
	Shidan Liu	Laleh Tafakori	Predicting Behaviour of Financial Systems based on a Multivariate GARCH Perspective and Dynamical Network
The University of Adelaide	Alexander Lai De Oliveira	Finnur Lárusson	Schemes and Their Functors of Points
	John Davey	Lewis Mitchell	Do the Rich get Richer on Reddit?
	Scott Carnie-Bronca	Giang Nguyen	A Markov-Chain-Based Investigation into Renewable Energy Storage in South Australia
	William Abbott	Giang Nguyen	Modelling Wind Farm Power Output Using Hidden Markov Models and Its Implications for South Australian Wind Farms
	James McCusker	Thomas Leistner	Quaternions and Octonions
The University of Melbourne	Adrian Hendrawan Putra	Marcy Robertson	A Topological Study of the Grothendieck-Teichmüller Group
	Amir Farid Kaveh	James McCaw and Pengxing Cao	The TIV Model: Robustness with Respect to Parameter Variation
	Jonathon Liu	Nick Beaton and Thomas Wong	Generating Function Approach to a Directed-Walk Model for Polymer Propagation
	Leo Li	Nick Beaton and Thomas Wong	The Transfer Matrix Approach to Polymer-Modelling Dyck Paths
	Somya Mehra	Jennifer Flegg and James McCaw	Developing a Within-Host Model for <i>Plasmodium Vivax</i> in an Endemic Setting

	Stephen Zhang	Barry Hughes	A Continuum-Limit Approach to a Persistent Exclusion Process
	Alex Savvinos	John Sader	Dynamics of Small-Scale Devices in Gas
	Tim Kay	John Sader and Jesse Collis	Hydrodynamic Particle Trapping in Microvortices
The University of New England	Daniel Sykes	Gerd Schmalz	Rigid Spheres and CR Structures in General Relativity
	Mitchell Harris	Thomas Kalinowski	Convex Hulls of Graphs of Bilinear Functions
The University of New South Wales	Ian Powell	Maarit Laaksonen and Jake Olivier	Estimating Population-Attributable Fractions in the Presence of Competing Risks
	Rumi Salazar	Michael Cowling	The Shape of a Drum
The University of Newcastle	Alastair Anderberg	Dave Robertson	Random Walks on Derived Graphs
	Chloe Wilkins	Bishnu Lamichhane	Earthquake Modelling with Differential Equations
	Peter Groenhout	George Willis and Colin Reed	Simple Groups of Infinite Matrices
	Max Carter	George Willis and Stephan Tornier	Free Products of Graphs
	William Roland-Batty	Jeffrey Hogan	Fourier Optics, Hermite Functions and Prolates
The University of Queensland	Gavrilo Šipka	Valentin Buciumas	Fusion Categories from Representations of Quantum sl_2 at Roots of Unity
	Jackson Ryder	Diane Donovan	Adoption of Agricultural Technologies in African Countries
	Jacquie Omnet	Chris van der Heide	Nonuniqueness in Geometric Partial Differential Equations
	Rohin Berichon	Ramiro Lafuente	Closed Geodesics on Euclidean Homogeneous Spaces

The University of Sydney	John Su	Emi Tanaka	Visual Inference for Linear Mixed Models
	Michael Zhao	Stephan Tillmann	Trisecting Hyperbolic 4-Manifolds
	Nicholas Fazio	Peter Kim	Modelling of Sexual Conflict Within Primates
	William Trad	Daniel Hauer	Powers of Maximal Monotone Operators on Hilbert Spaces
	Timothy Lapuz	Milena Radnovic	Modelling of Infectious Diseases
The University of Western Australia	James Evans	John Bamberg	Generalised Polygons and Their Symmetries
The University of South Australia	Maria Kapsis	Amie Albrecht and Peter Pudney	Optimal Partitioning of Photovoltaic Modules on a Curved Solar Collector
	Thomas Miller	Peter Pudney and Pung Zhou	Optimal Cruise Control with Dual Electric Motors
University of Technology Sydney	Daniel Condon	Adel Rahmani	Performance of Artificial Neural Networks on Small Structured Datasets
	Thomas Goodwin	Anthony Dooley	Mathematical Model of Neuron Flows and Structures in the Brain
University of Wollongong	Ngoc Lan Chi (Emma) Nguyen	Xiaoping Lu	A Laplace Transform Approach to Pricing Convertible Bonds
	Theresa O'Brien	Mark Nelson and Tristram Alexander	A Giggle a Minute: Agent-Based Simulation of Laughter Propagation in an Audience
	Vivien Yeung	Mark Nelson and Xiaoping Lu	Baking Cake: A Mathematical Model
	James Lawless	Ben Whale and Adam Rennie	Why the Increasing Surface-Area Law for Black Holes is an Open Problem
Western Sydney University	Sajit Gurubacharya	Laurence Park	Detection of Australian Racism in Social Networks



“My favourite part was experiencing what research is like. I enjoyed studying a specific concept in detail and making new discoveries was extremely rewarding. This project and AMSIConnect, in particular, showed me the path I want to take with my career and education clearly; it had always been unclear to me.”

Daniel Molent

RMIT University

AMSIConnect

AMSIConnect 2019 allowed the Scholars to present their research in a conference setting—a first for most of them. It provided an opportunity to network, explore future career pathways and engage in debate and conversation. Social activities such as dodgeball and meals provided enjoyment and opportunities to make new friends.



Dodgeball Icebreaker

On Wednesday 6 February 2019, the AMSI Research & Higher Education team welcomed arriving Scholars to AMSIConnect at The University of Melbourne’s International House, and got the ball rolling with the annual VRS Dodgeball tournament. Everyone participated in friendly round-robin matches that brought out their team-working skills and competitive energy.

Networking & Social Events

As well as exploring unfamiliar areas of research, Scholars were encouraged to network, collaborate and socialise with other like-minded individuals during AMSIConnect. To facilitate this, the program included a number of formal and informal networking opportunities such as a welcome pizza dinner, second-night BBQ and catered break times.

GUEST SPEAKERS

Life as a PhD Student

Dr Laura Karantgis (La Trobe University)

Laura Karantgis was recently awarded a PhD in applied mathematics for her research on landslides in collaboration with CSIRO's Data61. As a former Vacation Research Scholar herself, she spoke about the path she has taken to capitalise on her opportunities and develop her research interests.



Life as a Researcher

Professor Steven Siems (Monash University)

Steven Siems is an atmospheric scientist who studied and worked in America and England before moving to Australia. He drew on his background to give the Scholars an idea of the unexpected places that a degree in the mathematical sciences could take them.



Careers in Maths

Professor Tim Brown (AMSI)

AMSI Director Tim Brown closed this year's AMSIConnect on Friday with careers advice for the Scholars. Tim shared his views on the current employment landscape for mathematical sciences graduates, the skills that they would need to develop and the ever-increasing opportunities in STEM.

Research Presentations

Over Thursday and Friday, Scholars delivered twenty-minute presentations conveying their research and findings in a professional and engaging manner. Presentations were held in parallel sessions and Scholars were encouraged to carefully select and attend other presentations, to learn from others and improve their own skills and knowledge in the mathematical sciences. Three Scholars were voted by their peers to have given the best presentations.

BEST PRESENTATIONS

Alexander Lai De Oliveira (The University of Adelaide), **Kyria Wawryk** (Monash University) and **Theresa O'Brien** (University of Wollongong) won the Best Presentation awards for their research talks in the peer-voted competition. Alexander spoke on “Schemes and Their Functors of Points”, while Kyria covered the “Precession of the Perihelia in a Schwarzschild Spacetime”, and Theresa’s topic was “A Giggle a Minute: Agent-Based Modelling of Laughter Propagation in an Audience”.



L-R: AMSI Director Professor Tim Brown, Theresa O'Brien, Kyria Wawryk and Alexander Lai De Oliveira.

PARTICIPATION BREAKDOWN

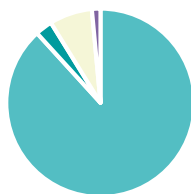


UNIVERSITY

Australian National University	3
Deakin University	1
La Trobe University	4
Macquarie University	3
Monash University	5
Murdoch University	1
QUT	5
RMIT University	5
The University of Adelaide	5
The University of Melbourne	8
The University of New England	2
UNSW	2
The University of Newcastle	5
The University of Queensland	4
The University of Sydney	5
The University of Western Australia	1
University of South Australia	2
University of Technology Sydney	2
University of Wollongong	4
Western Sydney University	1
TOTAL	68

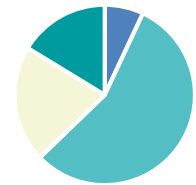
RESIDENCY STATUS

Australian Citizen	60	88%
Permanent Resident	2	3%
Student Visa	5	7%
New Zealand Citizen	1	2%



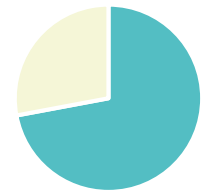
STATE/TERRITORY

ACT	3	5%
NSW	24	35%
QLD	9	13%
SA	7	10%
VIC	23	34%
WA	2	3%



GENDER

Female	19	28%
Male	49	72%



ATSI STATUS

Yes	1	1%
No	67	99%





*“It was great meeting people who had the same interests as me.
Talking to people about what they love gave me ideas for my future.”*

Christyn Wood

Queensland University of Technology

FEEDBACK ANALYSIS

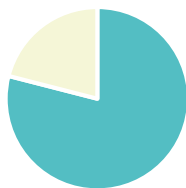
Sixty-two per cent of Vacation Research Scholars completed the online survey to provide their feedback and comments on the program and AMSIConnect.

There was unanimous satisfaction with the quality of the program, with 100 per cent of responses agreeing or strongly agreeing that the VRS experience was positive and rewarding.

In rating their overall VRS and AMSIConnect experience on a scale of 1 to 10 (1 being poor and 10 excellent), the respondents' average rating was 9.

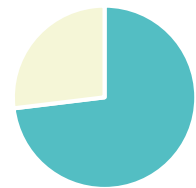
UNDERTAKING A RESEARCH PROJECT WAS POSITIVE AND REWARDING

Strongly Agree	79%
Agree	21%
Neutral	0%
Disagree	0%
Strongly Disagree	0%

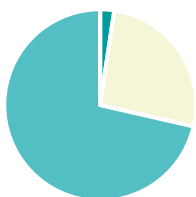


PRESENTING MY RESEARCH AT AMSIConnect WAS POSITIVE AND REWARDING

Strongly Agree	57%
Agree	43%
Neutral	0%
Disagree	0%
Strongly Disagree	0%

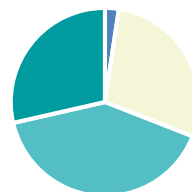


I FOUND THIS RESEARCH PROJECT A GOOD OPPORTUNITY TO EXPLORE MY CHOSEN AREA OF MATHEMATICS



Strongly Agree	71%
Agree	26%
Neutral	2%
Disagree	0%
Strongly Disagree	0%

I MADE USEFUL CONTACTS AND NETWORKS AT AMSIConnect



Strongly Agree	29%
Agree	40%
Neutral	29%
Disagree	2%
Strongly Disagree	0%

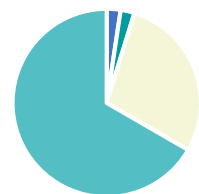
VRS HAS STRENGTHENED MY RESOLVE TO CONTINUE ONTO A MASTERS/HONOURS COURSE

Strongly Agree	50%
Agree	33%
Neutral	17%
Disagree	0%
Strongly Disagree	0%



AMSIConnect WAS WELL-ORGANISED

Strongly Agree	67%
Agree	29%
Neutral	2%
Disagree	0%
Strongly Disagree	0%



MEDIA RELEASE

Summer of Research: Aussie Students Dive into AMSI Scholarships

6 February 2019

Making history as the biggest intake since the program commenced, 68 mathematics and statistics students from 20 Australian universities took a dive into research as part of the 2018/19 Australian Mathematical Sciences Institute (AMSI) Vacation Research Scholarship (VRS) program.

It is the 15th year that AMSI has offered the now-\$3000 scholarship placements, which are funded by the Australian Government under the Institute's Securing Australia's Mathematical Workforce project. This year's intake brings the total students through the program to 700.

The latest round received over 91 applications, with successful recipients commencing projects in December 2018. Each has spent six weeks learning how to make high-impact mathematical discovery alongside some of Australia's leading researchers.

AMSI Director Professor Tim Brown said there had been increased interest in the scholarships due to growing awareness of the opportunities across the spectrum of fundamental to applied research, as well as the need to complement specialist knowledge with soft skills.

"The VRS program is fast becoming a must for students to build skills and knowledge through practical research application in a real-life setting," says Professor Brown.

Projects span all areas of the mathematical sciences from commercial optimisation problems to making money using game theory and applications in genetics and medical research.

The students are currently in Melbourne to mark the end of their projects by presenting their research at the AMSIConnect Conference. Prizes are up for grabs for top presentations with students also treated to a range of information talks and access to advice on career pathways.

"These students are the future research workforce, thought leaders who will help transform technology and how we engage with and live in the world. This program is about giving them the skills to apply their expertise where it is needed most," said Professor Brown.

AMSIConnect runs from 6 – 8 February with presentation winners to be announced during the event.

For more on AMSI VRS: vrs.amsi.org.au

For Full Project List: vrs.amsi.org.au/current-projects/

FEATURED PROJECT

Outpatient Scheduling in Public Hospitals

Scholar: Jamie Owen (Bachelor of Mathematics, Queensland University of Technology)

Supervisor: Dr Belinda Spratt (Lecturer in Operations Research, Queensland University of Technology)

Large public hospitals frequently serve as a regional hub for a variety of outpatient services. Despite improved access to healthcare for many rural communities, patients are still often redirected to capital city hospitals with access to a greater range of specialists and equipment better suited to their needs. Given the cost and impact of long-distance travel, this often leads to the challenge of scheduling appointments within multiple outpatient clinics for a single trip. While many patient care pathways are well-defined, appointment lengths are variable and it is difficult to plan for unexpected ad-hoc services requested to assist in diagnosis and treatment. This project investigated the multi-appointment outpatient scheduling problem in large public hospitals. Jamie worked to create a mixed integer programming model to minimise the total time patients are required to spend at a hospital.

Jamie:

“My project is on helping to improve outpatient appointments by including patients’ preferences in the decision-making process. By doing this, patients will get appointment times they want more than are [currently] available. This means that no-shows could be reduced, decreasing everyone’s waiting time. My VRS experience has been valuable in allowing me to experience completing a non-curricular project at a high level, and it has reaffirmed my desire to complete an honours year. I plan to continue with the project into my honours year, broadening the scope of the model and using advanced solving techniques to help solve it.”

Belinda:

“The efficiency of healthcare systems is an important area of research that benefits the wider community. Jamie’s work on outpatient appointment scheduling can be used to improve the accessibility of healthcare by balancing patient preference with queue fairness. This project has been an excellent opportunity for Jamie to get a feel for research before commencing his honours degree in mathematics.”

For more on Jamie and his research project: vrs.amsi.org.au/student-profile-jamie-owen/

STUDENT CASE STUDIES



RENEWABLE ENERGY STORAGE

“My project, investigating a renewable energy grid for South Australia, is important for the community as energy storage is vital for maintaining an all-renewable grid due to the high variability in production.”

Scott Carnie-Bronca, The University of Adelaide

[Read more](#)



SPREADING THE GIGGLES: THE MATHS OF LAUGHTER

“This research helps us understand contagious social behaviour... The VRS experience has been a fantastic space for me to use my broad interdisciplinary background in social science as well as maths and stats.”

Theresa O'Brien, University of Wollongong

[Read more](#)



OUTPATIENT SCHEDULING IN PUBLIC HOSPITALS

“My project is on helping to improve outpatient appointments by including patients' preferences in the decision-making process... This means that no-shows could be reduced, decreasing everyone's waiting time.”

Jamie Owen, Queensland University of Technology

[Read more](#)

MEDIA COVERAGE

“AMSI scholarship helps UOW student research the ‘Maths of Laughter’”

Illawarra Mercury, 8 February 2019

[Read more](#)

“Maths whiz full of energy ideas”

Adelaide Advertiser, 13 February 2019

[Read more](#)

AMSI
VACATION
RESEARCH
SCHOLARSHIPS

2018-2019



*Dive into
Research
this Summer*

APPLY FOR A PAID, SIX-WEEK
VACATION RESEARCH SCHOLARSHIP
IN THE MATHEMATICAL SCIENCES

V R S . A M S I . O R G . A U



Australian Mathematical Sciences Institute

Research and Higher Education
Building 161 C/- The University of Melbourne
VIC 3010 Australia

events@amsi.org.au
www.amsi.org.au

