2021 UQ Winter Research Scholarship Program

Research Projects
offered by the
School of Mathematics and Physics (SMP)

How to apply:

The UQ Winter Research Program is offered by the School of Mathematics and Physics (SMP) and UQ Student Employability Centre during the winter vacation period (late June to late July). Here is the list of available SMP projects for students undertaking mathematics, statistics and physics. It is open to undergraduate (including Honours) and masters by coursework students.

(1) Browse the list of projects.

(2) Contact the supervisor in the area of your interest, or the contact person listed, to discuss your interest and eligibility to undertake their research project. Gain the research project supervisor's tentative approval, and include this with your full UQ Winter Research Program application.

(3) Applications open on **Monday 22nd March** and close by **11.59pm, Sunday 18th April 2021**.

IMPORTANT NOTE TO APPLICANTS:

- Check your eligibility for the program.
- Read the Conditions of Participation before applying.
- Late applications will not be accepted.

UQ Winter Research Project Description

Project title: SMP-WRP-01-21	**Exotic Einstein Geometries on Spheres**
Project duration:	4 weeks
Description:	The round sphere has the highly desirable property that it is Einstein, meaning its curvature is constant everywhere. The aim of this project is to investigate exotic Einstein spheres, which are Einstein spaces that are topologically identical to the round sphere, but behave very differently from the geometric point of view. In this project, the student will gain a comprehensive understanding of why there are no exotic Einstein spheres if the sphere has dimension three or less. The student will then use symmetry methods to explore the interesting examples of exotic Einstein spheres that have been constructed in higher dimensions.
Expected outcomes and deliverables:	The student will gain an appreciation for the significance of several important open questions in geometry and topology, as well as a hands-on experience in solving algebraic equations, ODEs and PDEs. Essential research skills will be improved through the writing of a short report at the conclusion of the project.
Suitable for:	This project would be suitable for a mathematics student in their 3rd or 4th year of study who has taken several courses in mathematical analysis. It will be important for the student to have an understanding of basic concepts in topology, functional analysis and differential geometry before starting the project
Primary Supervisor:	Dr Timothy Buttsworth
Further info:	If you are interested in participating, or would like more information about the required background for this project, please send an email to t.buttsworth@uq.edu.au

UQ Winter Research Project Description

Project title: SMP-WRP-02-21	**Applied PDEs**
Project duration:	4-5 weeks
Description:	Typically, projects are available in the mathematical/computational modelling and simulation of cell biology. Areas of particular interest are cellular morphogenesis, intra-cellular transport, (collective) cell migration and mechanical aspects of Neurobiology. This project – depending on interest – might involve 3D agent based simulations and 3D visualization in Julia
Expected outcomes and deliverables:	Experience in using PDEs as modelling tools and in manipulating PDEs both algebraically and numerically.
Suitable for:	Talent and interest in Applied Mathematics and PDEs, curiosity and self-motivation. Starting from 3rd year
Primary Supervisor:	Dr Dietmar Oelz
Further info:	Please contact Dr Dietmar Oelz by email (d.oelz@uq.edu.au)

UQ Winter Research Project Description

Project title: SMP-WRP-03-21	**Modelling and simulation in cell biology**
Project duration:	4-5 weeks
Description:	Typically projects are available in the mathematical/computational modelling and simulation of cell biology. Areas of particular interest are cellular morphogenesis, intra-cellular transport, (collective) cell migration and mechanical aspects of Neurobiology. This project – depending on interest – might involve 3D agent based simulations and 3D visualization in Julia
Expected outcomes and deliverables:	Experience in mathematical modelling and simulation
Suitable for:	Students with interest in and intuition for applications, programming skills, curiosity and self-motivation. Starting from 3rd year
Primary Supervisor:	Dr Dietmar Oelz
Further info:	Please contact Dr Dietmar Oelz by email (d.oelz@uq.edu.au)

UQ Winter Research Project Description

Project title: SMP-WRP-04-21	**Modelling and simulation of the L-arginine – NO (nitric oxide) pathway**
Project duration:	4-5 weeks
Description:	Modelling and ssimulation of the L-arginine – NO (nitric oxide) pathway. This might involve 3D agent based simulations (in Julia, visualisation using Makie) of intracellular L-arginine kinetics
Expected outcomes and deliverables:	Experience in modelling and simulation techniques. Quantitative understanding of the effect of CAT (amino-acid transporters) on NO synthesis.
Suitable for:	This project is open to students with a background in physics, chemistry, or Talent and interest in Applied Mathematics and simulation, curiosity and self-motivation. Starting from 3rd year
Primary Supervisor:	Dr Dietmar Oelz
Further info:	Please contact Dr Dietmar Oelz by email (d.oelz@uq.edu.au)

UQ Winter Research Project Description

Project title: SMP-WRP-05-21	**Graphical user interface design for visual stimuli**
Project duration:	4-5 weeks
Description:	We aim to understand the computational principles by which stimuli in the world are represented by patterns of neural activity, and how these representations emerge during development. To do this we are recording the activity of thousands of neurons simultaneously, at single-cell resolution, in the brain of the larval zebrafish, and also recording zebrafish behaviour. While recording neural activity, we present visual stimuli to the fish by playing movies of artificially generated spots and shapes designed to mimic prey and other environmental cues that the fish might encounter in its natural environment. We are seeking a skilled software engineer, computer scientist or programmer to develop a new user-friendly graphical user interface for fast and flexible generation of a wide range of these artificial visual stimuli using Python.
Expected outcomes and deliverables:	You will be embedded in an interdisciplinary team of neuroscientists, engineers, mathematicians and physicists. While in the lab you will gain exposure to cutting edge experimental neuroscience and state-of-the-art computational analysis techniques from machine learning, applied mathematics and statistical physics. Project aims: • Develop an extensible modular package for the generation of movies of artificial visual stimuli in Python. • Develop a graphical user interface for users to specify the design of the stimuli (i.e. shape, size, position, speed, direction etc.) and various optical corrections. Project deliverables are source code and comprehensive package documentation.
Suitable for:	• Strong skills in coding in Python and demonstrated experience in GUI design are essential. • Experince with version control (GitHub) and creation of software documentation is required. • A background in mathematics and experience with standard Python scientific packages such as numpy and scipy are also highly desirable. • Previous knowledge of neuroscience is not essential.
Primary Supervisor:	Professor Geoff Goodhill
Further info:	Please contact Professor Goodhill (g.goodhill@uq.edu.au) prior to submitting an application. Further background can be obtained from the following article: goodhill.org/pub/avitan20.pdf