THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

The University of Sydney Faculty of Engineering is offering up to 90 Summer Research Scholarships to provide valuable research experience relevant to students interested in a career in research at a university or in industry.

Eligibility

The Summer Research Program is open to students who are enrolled in a relevant undergraduate or postgraduate coursework degree at the University of Sydney or another Australian University.

Undergraduate candidates are required to have a WAM of 75 or above and have already completed at least 72 credit points at the time of application and have current enrolment that will allow the completion of 96 credit points prior to the commencement of the Scholarship.

Candidates must have the background knowledge, skills and experience required for their nominated research projects.

Benefits

Receive a scholarship of $5,000 for a 10-week project or $4,000 for an 8-week project. Projects are 10 weeks unless stated.

How to Apply

Submit the Summer Research Program application form by 11.30pm on 20 October 2019.

More information

For more information email: engineering.scholarships@sydney.edu.au

Selection Criteria

Candidates will be selected on the basis of:

- Academic excellence
- Broader relevant achievements such as previous industry or research experience
- Match of background and skills to the projects nominated by the student

Candidates will be ranked according to their academic transcript, a 2-page curriculum vitae, a 150-word personal statement, and their preference of research projects (as indicated on the application form). Students will be advised of the outcome of their application after the closing date once all applications have been ranked.

Available Scholarships

Use the buttons below to navigate to projects provided by each School.

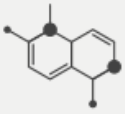
Aeronautical, Mechanical and Mechatronic Engineering Projects

Biomedical Engineering Projects

Civil Engineering Projects

Computer Science Projects

Electrical and Information Engineering Projects



Westmead/Engineering Joint Projects

Aeronautical, Mechanical and Mechatronic (AMME) Projects

Back to home page

Biomedical Engineering (BME) Projects

BME2019-1 User interface for real-time and custom processing of electroencephalogram signal

BME2019-2 Comprehensive characterisation of tuberculosis using a multi-modal deep learning framework

BME2019-3 Microfluidic analysis for biomechanical thrombosis: A future point-of-care diagnostics for clotting problems

BME2019-4 Head & neck cancer detection from PET-CT images)

BME2019-5 MR image analysis for quantification of autism spectrum disorders

BME2019-6 Vision processing software validation and extension

BME2019-7 Motion capture analysis and prosthetic ankle design for elite rowers with lower limb amputation

BME2019-8 Fabrication of hermetic electronics capsule for the Bionic Eye laser welding platform development and brazing process validation

BME2019-9 Role of Mechano-stress in cancer survival and progression

BME2019-10 Next-Generation Reconfigurable Magnetic Materials

BME2019-11 4D printing of bio-inspired ceramics and bio ceramics

BME2019-12 Optical-Magnetic Bifunctional Nanoparticles for Biomedical Applications

BME2019-13 Advanced Bionics – Programmable Frequency Synthesiser

Back to home page

Civil Engineering (CIVL) Projects

- CIV2019-1 Service life prediction of composite structures with machine learning
- CIV2019-2 3D printing of fibre reinforced polymer (FRP) composites
- CIV2019-3 Improving the mechanical performance of 3D printed aluminium alloys
- CIV2019-4 Structural health monitoring with new technology
- CIV2019-5 Understanding and Reducing Disaster Mortality from Typhoons
- CIV2019-6 Stakeholder Engagement through Social Networks
- CIV2019-7 Identifying the Characteristics of Ride-sourcing Contractors (e.g. Uber drivers)
- CIV2019-8 Graphic user interface for flow and contaminant transport software
- CIV2019-9 Forecasting the Electricity Market
- CIV2019-10 Lens-less Particle Image Velocimetry (L-PIV)
- CIV2019/11 Infrastructure access in growing cities
- CIV2019/12 Parsimonious traffic models for motorway congestion control
- CIV2019/13 Prediction of cracking propagation and failure in concrete structures
- CIV2019/14 Response of a partially saturated soil column to dynamic loading

Back to home page

Computer Science (CS) Projects

CS2019-1 Red Belly Blockchain for IoT

CS2019-2 Mobile blockchain scanner

CS2019-3 Predicting physical activity behaviours in children

CS2019-4 Maintaining perfect matchings under dynamic inputs

CS2019-5 Interactive database access in Jupyter Notebooks

CS2019-6 Data mining of dietary patterns

CS2019-7 Predicting hospital admissions

CS2019-8 Using Rewriting Systems to Implement and Reason about Interrupt Programs from Probabilistic Perspective

CS2019-9 Byzantine-robust Federated Learning

CS2019-10 Paraphrase Detection in User Generated Text

CS2019-11 Sports Video Analysis

CS2019-12 AI-guided financial data pattern recognition

CS2019-13 Rearranging Mobile Deep Neural Network (DNN) Inference during Service Outage

CS2019-14 Supporting Consumer Decision Using Online Reviews

CS2019-15 Medical Computer Vision for Three-Dimensional Neuron Reconstruction

CS2019-16 Fingerprinting Tor Web Traffic Using Deep Learning

CS2019-17 Healthcare Monitoring Using Wearable Activity Sensors

CS2019-18 Exploring translation and rotation invariance in Deep Learning with Steerable Filters

CS2019-19 Community Search over Large Graphs

CS2019-20 Verifying probabilistic models

CS2019-21 Does that treatment work

CS2019-22 Scalable Visual Analytics of Big Complex Data

CS2019-23 Deep learning-based visualization development for PET-CT biomedical images

CS2019-24 A social & incentive oriented mobile intervention for improved lifestyle behaviour outcome among overweight and obese patients

CS2019-25 Novel Logic Evaluation Strategies

CS2019-26 Ethereum Virtual Machine

CS2019-27 Data Analysis and Visualisation of Australia's National Health

CS2019-28 Process Modelling of a selected Cancer Care Pathway

CS2019-29 Predicting risks and safety of nanomaterials using machine learning

CS2019-30 Development of mobile app eGuardian Angel

CS2019-31 Process-Oriented Data Science for Health Imaging Services at BMDH

Back to home page

Electrical and Information Engineering (EIE) Projects

Back to home page

Westmead/Engineering (WHA) Joint Projects

Back to home page

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/1 Nanomechanics and nanoplasticity of individual twin boundaries of high-entropy alloy

Supervisor:	Dr. Xianghai An
Eligibility Criteria:	High achievement in a relevant undergraduate engineering degree (a WAM of 80 or above). This summer project has the option to be combined with an honours project.
Project Description:	High-entropy alloys (HEAs), which generally consist of multiple principle elements in equi-atomic or near equi-atomic proportions, have aroused significant research interest due to their fascinating properties that are not available in conventional alloys with one major element and minor additions of other alloying elements. HEAs have promising potential for a wide range of industry applications. It is well known that twin boundaries (TBs), which are a special kind of grain boundaries, affects remarkably the mechanical properties of materials by impeding dislocation movement and increasing dislocation density. However, our knowledge of the precise role of individual twin boundary in the hardening behaviour is still limited. This project aims to investigate the nanoscale plasticity in twin boundary regions with respect to crystalline orientations, moreover, to study the influence of orientation difference across the TBs on these behaviours. A CoCrFeNi HEA will be used as a model material in this project. The characterization of the local plasticity will be quantified by micro/nano-indentation tests combined with advance microscopy techniques.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/2 Deformation kinetics of the additively manufactured hierarchical 304L steel

Supervisor:	Dr. Xianghai An
Eligibility Criteria:	High achievement in a relevant undergraduate engineering degree (a WAM of 75 or above). This summer project has the option to be combined with an honours project.
Project Description:	Additive manufacturing (AM), also known as 3D printing, is revolutionizing manufacturing processes to build 3D parts by progressively adding thin layers of materials guided by digital models. The AM exhibited powerful advantages of net-shape manufacturing capability and design freedom. The near-fully dense 304L stainless steel can be additively manufactured successfully and exhibit a hierarchical structure, including melt pools, columnar grains, sub-micron cellular structures, and dislocations. As-built samples exhibit an outstanding combination of high strength and excellent ductility compared to those fabricated by conventional methods. However, due to the novel hierarchal structures, the deformation kinetics of the materials is necessarily to be explored. In this project, the deformation behaviour of as-built samples will be investigated by recourse to a series of specially designed mechanical tests. The results can not only resolve highly unsatisfactory state in understanding the structure–property relationship, but also enhance our ability of providing accurate prediction of mechanical behaviours on the basis of microstructures that further equips us powerful capability of structural materials design for superior mechanical properties.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: AMME2019/3 Machine Learning Methods in Mining Systems

Supervisor:	Dr. Robin Vujanic
Eligibility Criteria:	Some familiarity with basic machine learning models (PCA, logistic regression, tree-based models, as well as coding in Python are of advantage.
Project Description:	In this project the student will investigate large amounts of diverse data and assess how it could be used to make predictions about different processes in the mining supply chain. Specific prediction tasks suitable for a summer internship are available on in-pit operations, railway transportation as well as port processes. This will be an excellent opportunity to get your hands dirty working with Big Data, learning about Machine Learning algorithms, feature design and data pipelines, in a project that has the potential of significant practical impact.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/4 Advanced Optimization Techniques for Mining Operations

Supervisors: Dr. Robin Vujanic and Dr. Abdul Qadir

Eligibility Criteria: Some familiarity with mathematical optimization techniques (linear programming, mixed-integer optimization) and coding in Python are an advantage.

Project Description: Mining production and transportation systems are complex entities. In this thesis the student will investigate the use of advanced optimization techniques that can handle sources of stochasticity in the decision making process (weather, equipment outages, uncertainties about the quality of the material dug up, natural variability of tasks' processing times, ...) as well as address the combinatorial nature of certain production tasks.

This will be an excellent opportunity for a student to get to learn about a complex industrial production network by making sense of large amounts of real-world data, setting up appropriate ETL pipelines and use them within advanced mathematical optimization models to provide answers to practical problems. All the techniques covered are widely applicable to other engineering disciplines.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/5 Avoiding thermal damage caused by laser ablation

Supervisor: Julie Cairney

Eligibility Criteria: The suitable candidate for this role will have some knowledge of thermodynamics.

Project Description: Laser ablation is now used as a method for preparing samples for analysis by atom probe tomography and transmission electron microscopy. Both of these materials characterisation tools require the preparation of samples with dimension of less than 200 nm. Therefore, preparation needs to be free of damage at the nanometer scale. In an initial study conducted at the University of Sydney, we have observed damage caused by laser beam interaction with an aluminium alloy to be on the order of microns. The observed damage is caused by thermal interaction between the laser beam and the material. It is therefore proposed that the damaged region would be reduced if the material was more stable at higher temperatures. In order to prove this theory, it is necessary to repeat the current experiment on a material such as Kanthal APM, a stainless steel known to maintain its crystal structure and resist oxidation at temperatures greater than 1200 °C. Pending the results from this first material it is proposed that a variety of materials with different thermal transition temperatures be selected and exposed to the laser beam to ascertain the temperatures reached during laser ablation. With this knowledge it would be possible to identify a range of materials suitable for preparation using laser ablation. The preparation and analysis of these samples will require the use of the laser ablation tool, mechanical polishing tools and the use of scanning electron microscopy to assess for damage.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/6 Burst Photography for Better Underwater Imaging

Supervisors:	Dr. Donald G. Dansereau and Associate Professor Oscar Pizarro
Eligibility Criteria:	Image processing in Matlab, Python or C++. Knowledge of computer vision and machine vision cameras would be beneficial
Project Description:	Working with researchers in the Australian Centre for Field Robotics' Marine Robotics and Robotic Imaging groups, this project will develop techniques for improving underwater imaging performance in challenging conditions. It will combine the advanced imaging capabilities of modern underwater robots with state-of-the-art low-light imaging algorithms like those found on modern mobile phones. There are opportunities to deliver clearer imagery in dark conditions or through murky water, and to customise computer vision algorithms like feature detection to directly improve robotic navigation and mapping, while working with underwater cameras and robots in a test tank or in the field.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/7 An Underwater Imaging Test Tank Facility

Supervisors:	Dr. Donald G. Dansereau and Associate Professor Oscar Pizarro
Eligibility Criteria:	Skills depending on focus: Lighting and imaging, pumps, filtration and water chemistry
Project Description:	This project will investigate techniques for testing underwater cameras in a laboratory environment by developing a state-of-the-art underwater test tank facility. A key requirement when developing new imaging hardware is being able to measure performance in a repeatable, quantifiable way while realistically replicating challenging real-world conditions. Using existing 5m3 tank facility within the Australian Centre for Field Robotics' Marine Robotics and Robotic Imaging groups, this work will establish techniques for simulating a range of underwater imaging conditions including low light, murky water, sea snow, and strong interference from veiling sunlight. There will be an opportunity to focus on lighting and imaging, or on introducing/removing compounds from the water to emulate scattering and sea snow.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/8 Open-Source Light Field Camera

Supervisor:	Dr. Donald G. Dansereau
Eligibility Criteria:	Essential skills: Solidworks, laser cutting, 3D printing. Knowledge of optics would be beneficial
Project Description:	This project builds on existing prototypes developed in the Robotic Imaging group at the Australian Centre for Field Robotics to deliver an open-source easily-fabricated light field camera. These cameras capture a rich representation of light in four dimensions, encoding light rays in terms of position and direction. The ability to see light in this rich space can let robots work better in low light, around refractive and shiny objects, and in challenging weather including rain and snow. This project will deliver an open-source, easily fabricated light field camera, allowing researchers around the world to customize and deploy their own light field cameras specialised to robotics applications.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/9 Generalised Time of Flight Camera for Interactive Robotic Vision

Supervisor:	Dr Donald G. Danesreau
Eligibility Criteria:	Essential skills: Electronics. Image processing in Matlab, Python or C++. Knowledge of PCB design, analog RF signals, and optics would be beneficial.
Project Description:	Time of flight cameras like the Microsoft Kinect use high-speed signal processing to measure the time it takes light to travel through a scene. Recent work has shown how these devices can be adapted to other problems like detecting object boundaries, measuring velocity, or imaging through murky water. In this project you will develop new hardware and signal processing algorithms to allow robots to adaptively deploy these techniques using a modified time of flight camera. This will allow robots to see better across a broad range of conditions using adaptive imaging strategies. Working with researchers and technical staff in the Australian Centre for Field Robotics, you will construct custom electronics hardware to add new capabilities to an existing proof-of-concept camera. You will also develop the software needed to drive this new device, ultimately demonstrating enhanced imaging capabilities in a range of challenging imaging scenarios.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/10 Scalable Bottom Following Float for Seafloor Imaging (multiple sub-projects)

Supervisor:	Associate Professor Oscar Pizarro
Eligibility Criteria:	Essential background: Mechatronics, Mechanical, or EECS. Python or Matlab and prior experience with ROS would be beneficial. Desirable: Controls, Electronics or Mechanical design. Scope of the project to be tailored to your background and interests.
Project Description:	Collecting high-quality georeferenced imagery from the seafloor is a task often performed by large, complex robots that require expensive support vessels and highly-trained personnel. This project will investigate the use of multiple, simple, low-cost, minimally instrumented and actuated platforms designed to drift under the effect of currents while acquiring images of the bottom at a constant altitude. Such an approach has the potential to scale to hundreds or thousands of platforms operating around the world, transforming how we observe the seafloor. This project presents multiple interesting challenges in vision-based altitude estimation and control, terrain-aided localisation, platform design and fabrication, and planning in the presence of currents. Working with researchers and technical staff in the Australian Centre for Field Robotics, you will have the opportunity to tackle one or more of these areas.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/11 Visual motion estimation and serving for underwater robots

Supervisors:	Dr. Donald G. Dansereau and Associate Professor Oscar Pizarro
Eligibility Criteria:	Essential skills: Image processing in Matlab, Python or C++. Knowledge of computer vision and machine vision cameras and prior experience with ROS would be beneficial.
Project Description:	Working with researchers in the Australian Centre for Field Robotics' Marine Robotics and Robotic Imaging groups, this project will develop techniques that allow underwater robots to position themselves using visual data and additional sensor streams. This capability is critical for robotic intervention and manipulation tasks, as well as for docking to service modules (for recharging and data transfer at depth) which enables persistent, long-duration deployments for environmental monitoring and infrastructure inspection and maintenance. You will have an opportunity to work with researchers and technical staff in the Australian Centre for Field Robotic and implement proof-of-concept demonstrations with underwater cameras and robots in a test tank or in the field.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/12 Drone-on-demand 3D printing of drones

Supervisor:	Dr. Dries Verstraete
Eligibility Criteria:	Australian citizenship / Aeronautical, mechanical or mechatronics students with a WAM of 75 or above / practical (RC and 3D printing) experience is a plus.
Project Description:	Rapidly-advancing additive manufacturing technologies are leading a shift from mass production of identical drones to provision of one-off, bespoke systems. We are developing a turn-key design, optimisation and manufacturing framework for mission-tailored fixed-wing drones. In this project you will assist with the automation of the manufacturing environment for drone-on-demand. You will help develop the automated CAD framework and its interface with the 3D printing manufacturing environment.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/13 Combustion on catalysts for the after-treatment of exhausts

Supervisor:	Professor Assaad Masri
Eligibility Criteria:	Achieved honours
Project Description:	The project aims at developing an improved understanding of surface-chemistry reactions of hydrocarbon fuels on catalysts such a platinum (or other metals). The objective is to develop chemical kinetic mechanisms that can accurately describe these reactions to aid in the optimised development of exhaust treatment devices for the reduction of pollutants. The project involves the use of an existing set-up to measure the concentration of gases exiting a catalytic reactor under controlled conditions.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: AMME2019/14 The suppression of fires with a chemical agent

Supervisor:	Professor Assaad Masri
Eligibility Criteria:	Achieved Honours.
Project Description:	The project aims at developing a chemically suppressing agent that can be used with water to enhance its fire-fighting capability. The research will study the dynamics of delivering water sprays into a fire and then the water will be mixed with various agents (such a metal salts) to check the possible improvement of fire suppression. A controlled experiment with buoyant flames will be established and various imaging diagnostics will be employed to monitor the dynamics of the flame as it is subjected to the spray.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/15 Natural Language Processing for Advanced State Inference and Prediction

Supervisors:	Dr. Konstantin Seiler, Dr. Mehala Balamurali and Dr. Andrew Hill
Eligibility Criteria:	Programming experience, preferably Python. Knowledge in natural language processing, machine learning and/or SQL are an advantage.
Project Description:	Directing operations in mining requires good knowledge of the operational state and performance of equipment to allow efficient task scheduling. Data from a variety of sources, such as onboard sensors and electronic dispatching systems, is collected and stored in central databases for use throughout the operation in real-time and for historic analysis. This information is often incomplete and lacks context when analysed in isolation. Operators frequently communicate important information verbally via on-site radio. This project aims at augmenting the recorded system state with information extracted from on-site radio streams. This will be an excellent opportunity to gain hands-on experience with natural language processing in conjunction with state of the art speech recognition systems such as AWS Transcribe and combine it with other data mining techniques.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: AMME2019/16 Determine bedding angle in mine geology via matching signals in downhole measurements

Supervisors:	Dr. Arman Melkumyan, Dr. Katherine Silversides and Dr. John Zigman
Eligibility Criteria:	Knowledge of Matlab/Python to load data, conduct matrix/vector and linear algebra operations and numerical optimisation.
Project Description:	This project is based in the Rio Tinto Centre for Mine Automation and will focus on investigating methods of identifying features in 1D signal data in drill holes and matching these features between nearby holes. Up to two students will be accepted. One focus is on the exploration data, using downhole chemical or natural gamma data to determine both the vertical shift and the apparent stretching or compression between holes. The second focus is on measure while drilling (MWD) data. This involves matching short signals between holes in close proximity. This data has a much higher noise to signal ratio and less distinctive signals. The identified MWD features will be used to calculate the angle of bedding surfaces.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/17 Computational Design for Additive Biomanufacturing (3D Printing)

Supervisors:	Professor Qing Li
Eligibility Criteria:	Postgraduate and Undergraduate students in biomedical and mechanical engineering
Project Description:	Each year an estimated millions of patients suffer from bone fracture, while hundreds of thousands of patients have conditions where large segments of bone are destroyed or must be removed. As such new clinical treatment schemes are necessary to augment the body's natural healing process. As a fast emerging interdisciplinary technology, biofabrication and tissue engineering provide alternative therapeutic strategies for repair of damaged tissue and organs (Groll et al 2016, Moroni et al 2018), which shows enormous potential to generate host-grown tissue in sufficient quantity and quality. A milestone in the load-bearing tissue (e.g. bone/cartilage) engineering has been the development of 3D scaffolding construct that guides cells to generate desirable functional tissue under appropriate mechanical and biological conditions (Li and Mai 2017). The success of tissue regeneration lies heavily on the architecture design of the scaffold and its bio-reaction with the seeding cells (Entezari et al 2019). Permeability has been recognised as one critical criterion for scaffold design in ensuring cell migration and nutrient delivery (Chen et al 2011). This summer intern project will be conducted in ARC Centre for Innovative BioEngineering through collaboration with local and global industry partners. It will aim to (1) characterise the effective stiffness and permeability of different scaffold architecture; (2) develop finite element based homogenisation technique for tissue scaffold/constructs; (3) optimise structural design for additive biomanufacturing. The student is expected to closely work with the PhD students and Research Fellows in the ARC Center by using image-based finite element method (FEM) and design optimisation techniques for biomanufacturing of targeted tissue scaffolds/constructs. The novel computational design results will be prototyped through additive manufacturing facilities in the ARC Center for validation.
References:	Chen et al (2011) Microstructure design of biodegradable scaffold and its effect on tissue regeneration, Biomaterials 32: 5003-5014. Entezari et al (2019) Architectural design of 3d printed scaffolds controls the volume and functionality of newly formed bone. Advanced Healthcare Materials 8 (1), 1801353. Groll et al (2016) Bio-fabrication: Reappraising the definition in an evolving field. Bio-fabrication 8, 013001. Moroni et al (2018) Bio-fabrication: a guide to technology and terminology. Trends in Biotechnology 36 (4), 384-402. Li, Mai (2017) Biomaterials for Implants and Scaffolds. Springer-Verlag GmbH Germany

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/18 Chracterising spatial fibre distribution in composite laminates

Supervisor:	Professor Liyong Tong
Eligibility Criteria:	A WAM of 80 or above
Project Description:	Fibre reinforced composite materials are finding wide applications in aerospace and space industries due to their high specific stiffness and strength. Fibre volume fraction is one key parameter to characterize various mechanical properties without actually considering the role of fibre spatial distribution. This ignorance limits our understanding of widely scattered failure strengths and thus hinders our attempt of achieving highest performance of such composite materials. This project aims at looking at this issue by studying the spatial distribution features of fibres in cross section. The project involves development of a Matlab code for (a) digitizing spatial fibre distribution by using cross sectional images via image processing and visualization; (b) developing a method and algorithm for characterizing and capturing relevant spatial fibre distribution in composite laminates and estimating relevant mechanical properties.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/19 Microstructure of a CrCoNi alloy experienced dynamic deformation at cryogenic temperature

Supervisor:	Professor Xiaozhou Liao, Mr. Peng Gao
Eligibility Criteria:	A WAM of 80 or above
Project Description:	A CrCoNi medium-entropy alloy presents outstanding strength–toughness properties at cryogenic temperatures. Unlike most other metallic materials, the strength and ductility of the CrCoNi alloy increases simultaneously with reducing temperature, making it an outstanding candidate for cryogenic structural applications in areas including space exploration, superconducting devices, nuclear reactors, and storage of cryogens. The key structural reason to this remarkable phenomenon is the significant deformation twinning of the material at low temperature. It is well-known that both high strain rate and low temperature promote deformation twinning. Therefore, it is possible that the alloy would also present superior mechanical properties at high strain rates. However, little has been done to explore the high strain-rate deformation behaviour of the alloy. We are now investigating the mechanical behaviour of a CrCoNi ally under high strain rates using split Hopkinson pressure bar and have obtained some exciting results. This project aims to investigate the structural evolution of a CrCoNi medium entropy alloy subjected to high strain-rate deformation at cryogenic temperatures. Scanning electron microscopy and transmission electron microscopy will be the major research tools for the structural characterisation.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

AMME2019/20 Computation of High Speed Flows

Supervisor:	A/Prof Ben Thornber
Eligibility Criteria:	HWAM>75
Project Description:	The computation of high speed flows holds many challenges, and in our research group we are pushing forward the state-of-the-art in governing models, numerical methods and understanding of physics. This summer research project will work on either the development of new methods for high speed (high Mach number) reacting flows, or examining time integration methods to dramatically speed up our lower speed compressible flow computations.
Duration and Amount:	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/1 User interface for real-time and custom processing of electroencephalogram signal

Supervisor:	Dr Omid Kavehei
Eligibility Criteria:	Python programming
Project Description:	In order to enable real-time non-invasive biomarker detection and identification on electroencephalogram (EEG) signal, it is necessary to be able to effectively and efficiently process EEG signals. With an existing EEG headset and Python API (application programming interface), this project is expected to produce a python based user interface for real-time extraction and processing of EEG signals to support a range of deep learning models developed by our team on the data in real-time.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/2 Comprehensive characterisation of tuberculosis using a multi-modal deep learning framework

Supervisors:	Dr. Andre Kyme (AMME/Biomedical Engineering), Dr. Will Rae (FHS) and Dr. Luping Zhou (EIE)
Eligibility Criteria:	This project will suit students with a strong interest in and/or experience using deep learning methods and strong programming skills.
Project Description:	The chest X-ray is one of the most common and cost-effective medical imaging examinations performed for suspected tuberculosis (TB). However, clinical diagnosis of TB from a chest X-ray is extremely challenging, even for expert radiologists, because of the highly varied manifestation of the disease which is often further complicated by co-existing disease (e.g. HIV-AIDS). The aim of this research is to develop deep learning models which leverage information from chest X-ray images along with medical reports, audio cough signals, blood test results and other disparate data sources to classify, localise and characterise TB. This will be used to augment and assist the human observer in reliably screening suspected TB cases. Beginning with a rich dataset from our collaborators in South Africa, the aim is to build and test accurate deep learning models for increasingly complex diagnostic tasks and TB sub-populations. These data are unique in having longitudinal information, plentiful lab test results and reliable ground truth. A successful outcome would lead to significant improvements in clinical care in South Africa and other developing countries where TB continues to pose a major health threat to the population. The outcomes would also be highly relevant to Australian and other populations relying on chest X-ray imaging for disease screening. The project brings together the field of artificial intelligence methods with real-world health applications. Students with a strong interest in and/or experience using deep learning methods and medical imaging will find this project highly stimulating and rewarding.
Value and Duration:	$4000 for an 8 week project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/3 Microfluidic analysis for biomechanical thrombosis: A future point-of-care diagnostics for clotting problems

Supervisor:	Dr. Arnold Lining Ju
Eligibility Criteria:	This is a multidisciplinary project between haematology, microfluidics, biorheology and imaging aims to develop a prototype microfluidic device that can detect exaggerated blood clot formation. Students who have taken undergraduate courses and obtained in fluid mechanics, cell biology, AutoCAD engineering designs with average marks higher than 85 will be eligible. Otherwise, students who are very interested in cardiovascular diseases and point of care microfluidic devices are also welcome to send enquiry to arnold.ju@sydney.edu.au with CV.
Project Description:	Excessive clotting (thrombosis) leads to the cardiovascular diseases such as heart attack and stroke— the No.1 world-wide killer, killing one Australian every 12 minutes. It has long been recognized that platelets play a central role in thrombosis and are unique in their ability to form stable adhesive interactions under conditions of rapid blood flow. We have recently discovered a new 'biomechanical' prothrombotic mechanism that highlights the remarkable platelet sensitivity to the shear stress gradients of blood flow disturbance. Importantly, we found that the current anti-thrombotic drugs have limited effect against this biomechanical thrombosis. Notably, at the Charles Perkins Centre, we have developed humanized biomechanical thrombosis models – novel microfluidic devices that recapitulate shear stress gradients, capable of inducing platelet aggregation. In this project, we will use these devices to profile the clotting phenotypes for individual human donors including yourself if you are interested. Our long-term goal is focussed on developing a clinically useful, rapid and high throughput profiling microdevice for disorders in haemostasis and thrombosis.
References:	Ju, L. et al. An integrin alphallbbeta3 intermediate affinity state mediates biomechanical platelet aggregation. Nature Materials 18, 760-769, doi:10.1038/s41563-019-0323-6 (2019).
Value and Duration:	$4000 for an 8 week project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME 2019/4 Head & neck cancer detection from PET-CT images

Supervisor:	Dr. Ashnil Kumar
Eligibility Criteria:	Third year or higher students preferred; the project could have growth to a thesis project. Students will require programming skills (Python or C++ is ideal, MATLAB can also work). Knowledge of computer vision, prior experience with AI or ML toolboxes, knowledge of anatomy, biology, and physiology, will be beneficial.
Project Description:	In this project, functional information from PET images will be merged with anatomical information from CT images to enable the detection of cancer at different locations in the head and neck. We will utilise modern machine learning (ML) and artificial intelligence (AI) techniques to process and analyse the imaging data to enhance and support clinical decision-making, e.g. improved cancer diagnosis and staging. The computer algorithm developed during the project will be evaluated with publicly available clinical data. **Value and Duration:** $4000 for an 8 week project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/5 MR image analysis for quantification of autism spectrum disorders

Supervisor:	Dr. Ashnil Kumar
Eligibility Criteria:	Third year or higher students preferred; the project could have growth to a thesis project. Students will require programming skills (Python or C++ is ideal, MATLAB can also work). Knowledge of computer vision, prior experience with AI or ML toolboxes, knowledge of anatomy, biology, and physiology, will be beneficial.
Project Description:	In this project, functional and anatomical information from brain magnetic resonance images will be used to quantify characteristics that can be used to assess and quantify autism spectrum disorders. We will utilise modern machine learning (ML) and artificial intelligence (AI) techniques to identify biomarkers that are predictive for the disorder. The computer algorithm developed during the project will be evaluated with publicly available clinical data.
Value and Duration:	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/6 Vision processing software validation and extension

Supervisor:	Greg Watkins
Eligibility Criteria:	Strong programming skills in Java or C++. Knowledge of, and ideally experience with, version control software such as git or bitbucket. Familiarity with android development is an advantage.
Project Description:	A visual prosthesis consists of implanted electronics and an external vision processor which translates an image into electrical stimulation for nerves in the eye. While the hardware provides a critical foundation for the restoration of a sense of vision, it is likely that the vision processing software will significantly affect the extent to which recipient is able to "see". The objectives of the project are to a) build, test and archive existing vision processing software on an android platform and b) research and propose enhancements to the software. If possible, the enhancements should be implemented.
Value and Duration	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/7 Motion capture analysis and prosthetic ankle design for elite rowers with lower limb amputation

Supervisor:	Lucy Armitage (UNSW), Lauren Kark (UNSW)
Eligibility Criteria:	Background in biomedical engineering, mechatronic or mechanical engineering. Ability to travel to Randwick (Prince of Wales Hospital) for testing. Experience using basic programming in Matlab an advantage. Experience using or willingness to learn CAD and rapid fabrication techniques such as 3D printing and laser cutting. Ability to communicate clearly with participants in a lab environment
Project Description:	Elite rowers with amputation have limited access to custom built prosthetic ankles. This means they often compete using prostheses that have not been designed for rowing at all. There is a need for a prosthetic ankle that allows the user improved range of motion and control for rowing specific movements. The first step in the process of developing a prosthetic ankle for rowing is to assess how current prostheses perform. This project will seek to perform a motion capture analysis on 3 elite rowers with transtibial amputation and three elite rowers without a disability. You will have the opportunity to develop assessment methods in a motion capture laboratory, collect and analyse data, and then use this information to assist in the design of a rowing specific prosthetic ankle.
Value and Duration:	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/8 Fabrication of hermetic electronics capsule for the Bionic Eye: laser welding platform development and brazing process validation

Supervisor:	Professor Gregg J. Suaning
Eligibility Criteria:	Good practical skills, experience with mechanical design and prototype manufacturing. Interest in high precision processes and awareness of the high-quality requirements for medical implants manufacturing.
Project Description:	Electrical stimulation of the retina of blind people has been successfully used to restore a sense of vision. This project focuses on the processes used to hermetically encapsulate the electronics responsible for the delivery of the stimuli, to protect them from the fluid of the body during long term implantation. One of core tasks will be to develop and build an automated stage for the positioning of the implant during welding laser operation. Validation of the brazing process used to fuse ceramics with Titanium will also guarantee safe implant operation for the entire lifetime of the patient.
Value and Duration:	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/9 Role of Mechano-stress in cancer survival and progression

Supervisor:	Dr. Yogambha Ramaswamy
Eligibility Criteria:	The project will suit students from biomedical engineering, with a strong interest in cell biology, biomaterial fabrication and characterisation and imaging.
Project Description:	Cancer cells have the ability to reprogram their energy metabolism in order to survive the often-harsh conditions of the tumour microenvironment. This microenvironment of the tumour contributes greatly to the response of tumour cells. In recent years it has been shown that the physical environment (mechanical cues) of the cancer cells can be an important determinant of the cell behaviour. Mechanics can affect intracellular signalling events, influencing carcinogenesis, cancer progression and the tumour response to therapy. This project is focused on using a hydrogel system to understand the cancer cell progression in response to changes in the tumour microenvironment through the mechanical cues. The specific aims of this project will be to: 1) Fabricate the hydrogels with various mechanical cues 2) Investigate the response of cancer cells encapsulated in the hydrogels with various mechanical cues
Value and Duration:	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/10 Next-Generation Reconfigurable Magnetic Materials

Supervisors:	Dr. Gurvinder Singh, Dr. Yogambha Ramaswamy and Professor Hala Zreiqat
Eligibility Criteria:	Knowledge or experience in instrumentation, AutoCAD, COMSOL.
Project Description:	Magnetic materials are rigid or solid in nature. The potential of these solid magnetic materials can be not realized for biomedical devices requiring the flexible materials of low rigidity. Such applications require softness in the magnetic materials so that it can be stretched or deformed. The current situation thus demands urgent development of a novel fabrication technique enabling the design of 2D and 3D reconfigurable magnetic materials from nanoscale building blocks in high throughput. The current project aims to build a manufacturing technology platform that will allow the development of reconfigurable magnetic materials in different 2D and 3D architectures inspired by nature. The project will also explore the use of external magnetic field to further manipulate the design of magnetic materials.
Value and Duration:	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/11 4D printing of bio-inspired ceramics and bio ceramics

Supervisors:	Mohammad Mirkhalaf, and Professor Hala Zreiqat
Eligibility Criteria:	We would be happy to have you on board if you are an emerging enthusiastic scientist who (i) is a careful experimenter, (ii) is keen to develop new materials and methods, (iii) is keen to understand the physics and chemistry behind a phenomenon, and (iv) preferably have a good background in mechanics. The successful candidate will learn a lot about advanced manufacturing techniques (e. g. 3d/4d printing), architectured materials, ceramics and bioceramics, and mechanics of materials.
Project Description:	While 3D printing can be used for free-form fabrication of ceramics, development of thin ceramic layers with complex shapes is still a major challenge due to the inherent resolution of 3D printers; but it is this very thinness that minimises defect size and therefore maximises strength and toughness. Nature has evolved powerful strategies to make complex shapes with smooth surfaces at different length scales. Materials such as plant stems, pinecones, and wheat awns undergo complex shape reconfigurations that are essential for their functions. Inspired by these materials, we will develop novel classes of 4D printing procedures for ceramics.
Value and Duration:	$4000 for an 8 week project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/12 Optical-Magnetic Bifunctional Nanoparticles for Biomedical Applications

Supervisors:	Dr. Gurvinder Singh, Pooria Lesani, and Professor Hala Zreiqat
Eligibility Criteria:	Knowledge or experience in nanomaterials synthesis
Project Description:	Magnetic nanoparticles have advanced the treatment of cancerous through remote controlled target drug delivery, magnetic hyperthermia localized therapy, and simultaneous diagnosis through MRI and therapy. However, most applications are limited by the use of expensive MRI technology which is not accessible to research laboratories. Carbon quantum dots (CQDs) has emerged as novel fluorescent probe for in vitro and in vivo live imaging because of their unique properties such as photostability, biocompatibility and ability to image deep in tissue. The project aims to establish a novel synthetic strategy to integrate CQDs into magnetic nanoparticles, thus developing optical-magnetic nanomaterials. Such bifunctional nanoparticles will accelerate the development of a single platform providing diagnosis and therapeutic functions.
Value and Duration:	$4000 for an 8 week project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

BME2019/13 Advanced Bionics – Programmable Frequency Synthesiser

Supervisors:	Greg Watkins
Eligibility Criteria:	Electronic design skills in the specified frequency range including PCB design using Eagle or similar. Experience with microcontrollers would be helpful but support in this area can be provided.
Project Description:	Advanced Bionics is a level 5 course in the School of Biomedical Engineering which investigates the principles and technology of implantable bionic devices such as cochlear implants. A key aspect of such devices is transcutaneous power transfer using inductive coupling in the RF frequency range. The objective of this project is to design and build a low part-count, micro-controller programmable, frequency source operating at frequencies in the range 1-6Mhz.
Value and Duration:	$4000 for an 8 week project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/1 Service life prediction of composite structures with machine learning

Supervisor:	Dr Ali Hadigheh
Eligibility Criteria:	Basic knowledge about nano-composite materials and programming.
Project Description:	Structures are subject to gradual and progressive deterioration over time, and are likewise prone to damage due to accident, misuse or extreme natural events. Durability is the resistance of a structure to deterioration. Good durability reduces significantly the need for repair and the cost of maintenance during the life of a structure. The on-going requirement for more structurally sound structures has driven the development and introduction of advanced composite materials into the civil engineering construction industry. Techniques for strengthening existing structures now include strengthening with fibre reinforced polymer (FRP) composite applications. This research investigates the potentials for using machine learning for service life prediction of FRP-strengthened infrastructures.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/2 3D printing of fibre reinforced polymer (FRP) composites

Supervisor:	Dr Ali Hadigheh
Eligibility Criteria:	Basic knowledge about nano-composite materials.
Project Description:	3D printing of fibre reinforced polymer (FRP) composites will enable manufacturing and rapid prototyping of different structural sections in construction. This research investigates potential of 3D printing using short fibres for manufacturing of structural elements.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/3 Improving the mechanical performance of 3D printed aluminium alloys

Supervisor:	Gwénaëlle Proust and Julie Cairney
Eligibility Criteria:	No specific requirements
Project Description:	Advanced manufacturing technologies, such as metal additive manufacturing, are providing opportunities to develop new materials and new design for a large range of industries. The technology is still recent and improving the mechanical performance of the manufactured products is paramount to the success of additive manufacturing. During this project, the student will be asked to perform different post-treatments (for example heat treatments) on an aluminium alloy fabricated by selective laser melting and to monitor the change in microstructure and mechanical properties. The goal of this project is to design a post-treatment protocol to optimize the strength of the material. The student will learn about metallurgy, metallography, microscopy and mechanical testing during the project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/4 Structural health monitoring with new technology

Supervisor:	Daniel Dias-da-Costa
Eligibility Criteria:	No specific requirements
Project Description:	This project will develop high-end technology for monitoring the behaviour and safety of structures. In particular, image processing techniques using high-definition imagery will be proposed for tracking fracture propagation and prevent structural failure in real-scale structures. Monitoring will be coupled with advanced predictive analytical/numerical models to assess the residual life-span for damaged bridges or buildings. Small-scale tests will also be carried out for validation. Different case studies can be targeted based on the background and interests of the student.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/5 Understanding and Reducing Disaster Mortality from Typhoons

Supervisor:	Dr Aaron Opdyke
Eligibility Criteria:	Familiarity with or willingness to learn GIS software.
Project Description:	The United Nations Sendai Framework for Disaster Risk Reduction, adopted in 2015, has targeted substantially reducing global disaster mortality by 2030. Between 2000 and 2016 disasters in the Philippines caused over 23,000 deaths and affected roughly 125 million people. This research seeks to understand causes of mortality from typhoons, one of the most regular natural hazards impacting Filipino communities. The project will analyse records from the Philippine National Disaster Risk Reduction and Management Council and hazard models to develop a framework for causes of typhoon mortality, including contributing geographic and demographic factors.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/6 Stakeholder Engagement through Social Networks

Supervisor:	Dr Ken Chung
Eligibility Criteria:	Data analytics skills - e.g. coding with MatLab or R, proficient with Excel, and statistical analysis.
Project Description:	Currently in Australia, there is huge wastage in public infrastructure projects in terms of public dollars through poor project governance, decisions and communication. In this research, you will be assisting with the development of stakeholder engagement models in the context of projects (e.g. Sydney Light Rail, WestConnex).

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/7 Identifying the Characteristics of Ride-sourcing Contractors (e.g. Uber drivers)

Supervisor:	Dr. Mohsen Ramezani
Eligibility Criteria:	Computer programming (preferably Matlab and/or Python), Familiarity (or strong willingness to learn) traffic modelling, Data analysis; CIVL2700-Transport Engineering, and preferably CIVL3704-Transport Informatics
Project Description:	Ride-sourcing systems (e.g. Uber, Didi) provide a disruptive mobility service that acts as a two-sided market, enabling self-scheduling contractors (drivers) to be matched with travel requests of passengers. A feature of ride-sourcing services that distinguishes them from traditional taxi services is the characteristics of drivers who provide the supply side of the market. This project tries to identify the behaviour of ride-sourcing drivers such as the number of market entry and duration of working shifts based on field data.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CIV2019/8 Graphic User Interface for Flow and Contaminant Transport Software

Supervisor:	Prof Abbas El-Zein
Eligibility Criteria:	Strong computer programming background and interest, preferably computer engineering major.
Project Description:	The current graphic interface of an advanced finite-element software for modelling water flow and contaminant migration suffers from significant limitations. The aim of the project is to explore several possible strategies for a new interface (including choice of programming language), then implement one of them, by conducting the developments and testing the new interface.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CIV2019/9 Forecasting the Electricity Market

Supervisors:	Pierre Rognon
Eligibility Criteria:	Strong motivation to learn and develop data science tools for analysis the energy market.
Project Description:	Project description (approx. 100 words): Australia is experiencing an unprecedented energy transition, which sees a rapid development of solar and wind electricity generation. The intermittency of these sources may be resolved by energy storage systems such as batteries. Currently, the AEMO regulates the electricity dispatch price nation-wide to match production and demand at any time. This leads to a fluctuating price for electricity that is updated every 5 minutes, and fluctuates from -$1000/MWh to +$14000/MWh. The questions for using battery storage effectively is: when to buy and when to sell electricity. This question may only be answered based on some forecast of the market price. In this project, you will develop a mathematical and numerical tool to generate such a forecast. You will access historical data from the AEMO, and analyse it using relevant statistical tools (possibly including AI).
Duration:	10 weeks (preferred)

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CIV2019/10 Lens-less Particle Image Velocimetry (L-PIV)

Supervisors:	Dr Kapil Chauhan and Dr Yixiang Gan
Eligibility Criteria:	Advanced programming skills in either Matlab, Python, R or C/C++ An understanding of basic geometric projection. Some familiarity with imaging technology and fluid flow.
Project Description:	Micro-fluidic flows typically concern with movement of fluid within geometric constraints of sub-millimetre scale with applications in engineering, chemistry, biotechnology and many other areas. In a novel approach to determine displacement (and thereby velocity) of particles in micro-fluidic flows, multiple monochromatic light sources are utilised to create a composite image on a single CCD/CMOS sensor without lens. The CCD/CMOS sensor is sparsely illuminated due to the Bayer filter with different coloured light incident from different angles. The aim of the project is to develop a reconstruction algorithm that will determine three-dimensional location of a particle(s) in the flow field. The study is to undertake parametric simulation and assess the accuracy of determining particle locations and displacements.
Duration:	10 weeks

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CIV2019/11 Infrastructure access in growing cities

Supervisor:	Emily Moylan
Eligibility Criteria:	Experience with or willingness to learn GIS and Python
Project Description:	Project description (approx. 100 words): Accessibility is a framework for quantifying the ease of accessing activities and opportunities through the transport network. Often, it is applied to residents accessing jobs and aggregated to large geographies. However, emerging datasets, such as satellite imagery, allow us to broaden this approach looking at disaggregate measures for trip origins and destinations as well as diverse types of activities. One application of interest is measuring the spatial and social inequality in access to social infrastructure such as schools and hospitals. The analysis will support infrastructure investment recommendations for a more sustainable and equitable Sydney.
Duration:	10 weeks

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CIV2019/12 Parsimonious traffic models for motorway congestion control

Supervisor:	Dr. Mohsen Ramezani
Eligibility Criteria:	Computer programming (preferably Python), Familiarity (or strong willingness to learn) traffic modelling and software (Aimsun), CIVL2700-Transport Engineering, and preferably CIVL3704-Transport Informatics
Project Description:	Ramp metering control is a common operation measure in motorways to regulate flows from on-ramps and manage congestion on the main carriageway. Early works attempted to alleviate local traffic problems using local ramp metering. It has been identified that local ramp metering approaches are not always efficient to ameliorate global traffic conditions of the overall traffic network. This project seeks potentials in use of parsimonious macroscopic traffic models for ramp metering. Among them, the Macroscopic Fundamental Diagram (MFD) offers an efficient tool for expressing aggregated dynamics of traffic networks. Although a unimodal and low-scatter MFD was observed in a homogeneous region of a city, existence of a well-defined MFD in general cases specifically in motorway networks is still an open question, which requires more research on the benefits of MFD for traffic control applications on motorways.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CIV2019/13 Prediction of cracking propagation and failure in concrete structures

Supervisor:	Associate Professor Daniel Dias-da-Costa
Eligibility Criteria:	No specific requirements
Project Description:	There are several computational techniques that are now available for predicting the crack propagation in structures. However, these are yet to gain traction in commercial software. This project will develop finite element methods that are robust and can be easily implemented, possibly based on XFEM or in elements with embedded discontinuities, for handling the large-scale modelling of structures. The focus will be given to the development of the technique and its validation. There are several pathways possible for this research depending on the research interests and background of the applicant.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CIV2019/14 Response of a partially saturated soil column to dynamic loading

Supervisor:	David Airey, Javad Ghorbani
Eligibility Criteria:	Knowledge of soil mechanics would be helpful.
Project Description:	Pavements for roads and railways are generally constructed on partially saturated soils. Their stability depends to varying extents on the pore water suctions in the partially saturated soil. We have been developing unique soil models that can properly account for the soil suctions and their evolution due to dynamic traffic loading. In this project a series of tests will be performed to provide data for validation of the numerical models. The tests will involve applying a dynamic load to the surface of a soil column and monitoring its response. Data analysis and comparison with model predictions will follow the experiments.
Duration:	10 weeks

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/1 Red Belly Blockchain for IoT

Supervisor:	Vincent Gramoli
Eligibility Criteria:	Excellent programming skills, knowledge of debian-based linux would be helpful
Project Description:	The Concurrent Systems Research Group at the University of Sydney has recently designed, proved correct and implemented a scalable blockchain, called the Red Belly Blockchain in collaboration with CSIRO Data61. This blockchain is particularly well suited to run on all types of devices as (i) it does not large storage capability to download the blockchain in order to be secure and (ii) it does not need powerful CPU to solve computationally hard crypto puzzle. Although the Red Belly Blockchain has been evaluated on up to 1000 virtual machines spread over 4 continents, it remains unclear how it would perform on small devices that are used in Internet of Things. The goal of this project is to script the deployment of the Red Belly Blockchain on 40 Raspberry Pis to test its performance. The project will involve using an existing benchmark that issues transactions to the blockchain and report the throughput (as the number of transactions treated per second) and latency (the average time needed to commit a transaction).
Related Reading:	Crain, Natoli, Gramoli. Evaluating the Red Belly Blockchain (Links to an external site.).

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/2 Mobile blockchain scanner

Supervisors:	Vincent Gramoli
Eligibility Criteria:	Excellent programming skills, basic knowledge of the Dart programming language would be helpful.
Project Description:	The project consists in extending a mobile application into an application that scans an item address and record its position and the current time in the Red Belly Blockchain. The current version simply scans a QR-code-based payee address and sends her/him money by writing in the Red Belly Blockchain. The mobile app currently allows the user to enter a location that will be stored along with the transactions, the mobile app should be changed to support the automatic populating of the location based on the GPS sensor of the phone. An optional feature of the app would be, given an item ID (scanned or entered manually) to fetch the content of the existing database to indicate where it is located and when it was last seen.
Related Reading:	https://protect-au.mimecast.com/s/r_D2CxnMRvtVkPxklvH-ul?domain=hades.it.usyd.edu.au

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/3 Predicting physical activity behaviours in children

Supervisors:	Kalina Yacef and Corinne Caillaud (Health Sciences and Charles Perkins Centre)
Eligibility Criteria:	Background in Artificial Intelligence/Machine learning/Data Science essential. Good oral and written communication skills (note the inter-disciplinary nature of the project). No prior knowledge is expected in Health sciences (but a genuine interest is welcome).
Project Description:	This project will first make use of clustering techniques to extract PA behaviour clusters from Geneactiv activity tracker data, and then explore the use of machine learning techniques to create a model that can be used by researchers to predict likelihood of certain physical activity (PA) behaviours in school children based on a range of data such as lifestyle factors, socio-demographic data, body-mass index, fitness levels. The project will use a comprehensive dataset from over 1000 children various regions in the Pacific. This summer project fits within a larger project aiming at reducing alarming obesity rates in the Pacific region and is a collaboration with the Charles Perkins Centre and the University of New Caledonia.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/4 Maintaining perfect matchings under dynamic inputs

Supervisors:	William Umboh
Eligibility Criteria:	Ability to reason about algorithms mathematically at the level of COMP3027 (or equivalent)
Project Description:	Bipartite matchings have important applications such as job scheduling and content delivery. In these applications, the two sides of the bipartite graph model servers and clients and an edge between a client and a server model which servers can serve each client. A critical aspect of these applications is that clients arrive over time and each client needs to be matched immediately on arrival to a free server without any knowledge about future clients. We are also allowed to re-match previous clients, but re-matchings can be expensive: in the context of job scheduling, re-matching a client to a different server requires interrupting its job. Thus, we would like to minimise the number of re-matchings. The aim of this project is to develop and analyse algorithms for the dynamic matching problem with few re-matchings.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/5 Interactive database access in Jupyter

Supervisors:	Dr Uwe Roehm
Eligibility Criteria:	Programming skills in Python and SQL.
Project Description:	Human-centred data analysis requires interactive user interfaces that allow to interact with data visualisations in a natural way as many users are nowadays used to touch-based mobile devices. On the other hand, analysing large data sets, such as stored in an SQL database, takes time; the typical analytical SQL query runs much longer than 500ms which is considered the maximum to still be called an interactive response time. To bridge this gap, we have implemented a research prototype called ProgressiveDB which splits an analytical SQL query into a series of smaller queries on an underlying database, and then produces a continuous stream of approximate query results to the client with guaranteed interactive response times. This allows the users to interact with a visualisation while the underlying query is still executing. So far, our prototype is written in Java and works as a stand-alone program. In this SSP project, we would like to integrate this with a common user interface for Data Scientists - Jupyter Notebook - so that some data visualisation cells in a notebook can make use of the progressive query execution of ProgressiveDB in the background. The idea is to extend an existing Jupyter kernel extension for databases, so that we can demonstrate the capabilities of ProgressiveDB with interactive data analysis via a Jupyter notebook on-top of a multi-GB data set about the on-time performance of airlines.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/6 Data mining of dietary patterns

Supervisors:	Prof Judy Kay
Eligibility Criteria:	No specific requirements
Project Description:	This project will apply data mining techniques to analyse nutrition data about young adults, in order to understand their eating habits and prevent obesity. We have collected data about the type of foods, their frequency and where they are eaten (at home or away from home). Clustering can be used to find groups of participants with similar consumption, e.g. high processed meat and low vegetable consumption, and the characteristics of each cluster can be analysed (e.g. do not exercise, skip breakfast). Classification methods can also be used to predict the type of diet (healthy or unhealthy) based on the frequency and contribution of foods eaten away from home, health, social and environmental variables. This project is a collaboration with researchers from the Charles Perkins Centre and the Cancer Council.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/7 Predicting hospital admissions

Supervisors:	Irena Koprinska and Michael Dinh (RPA Hospital)
Eligibility Criteria:	No specific requirements
Project Description:	The goal of this project is to predict if a patient will get admitted to hospital based on the patient's characteristics and symptoms when presented at the Emergency Department. The project will explore the application of machine learning techniques to create an accurate prediction rule that can be used by triage nurses to improve the patient flow in emergency departments. The project will use a large dataset from several hospitals in NSW.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/8 Using Rewriting Systems to Implement and Reason about Interrupt Programs from Probabilistic Perspective

Supervisors:	Dr Xi Wu
Eligibility Criteria:	Strong skills in mathematics and functional programming, basic knowledge of operating systems
Project Description:	With the rapid development of the computer industry, multitudinous operating systems spring up in the past forty years, such as Windows, Unix, Solaris, Linux, Mac OS X, etc. An operating system (OS), as a particular software running on computers, not only manages the computer hardware, but also provides the common platform for efficient execution of various application software. In recent years, many researchers have paid much attention to verifying the operating systems. However, most OS verification involves interrupt and interrupt behaviours are extremely difficult to verify and reason about in the development of operating system due to their randomicity and nondeterminism. The objective of this project is to implement interrupt programs based on a probabilistic formal model using rewriting systems, with a focus on reasoning about properties of interrupt programs.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/9 Byzantine-robust Federated Learning

Supervisors:	Dr Nguyen Tran
Eligibility Criteria:	Machine Learning Programming (Python with Pytorch or Tensorflow)
Project Description:	Federated Learning (FL) is a fast-developing distributed machine learning technique with participation of massive user devices. While FL has benefits of data privacy and the abundance of user-generated data, some users may behave abnormally (e.g., Byzantine failures) with potential adversarial behaviour. This project aims to develop a distributed learning algorithm that are against such abnormal behaviour.
Related Reading:	Rakesh Agrawal and Ramakrishnan Srikant. 2000. Privacy-preserving Data Mining. *SIGMOD Rec.* 29, 2 (May 2000), 439–450. Peva Blanchard, El Mahdi El Mhamdi, Rachid Guerraoui, and Julien Stainer. 2017. Byzantine-Tolerant Machine Learning. *arXiv preprint arXiv:1703.02757* (2017). Jiashi Feng, Huan Xu, and Shie Mannor. 2014. Distributed Robust Learning. *arXiv preprint arXiv:1409.5937* (2014). Michael I Jordan, Jason D Lee, and Yun Yang. 2016. Communication-Efficient Distributed Statistical Inference. *arXiv preprint arXiv:1605.07689* (2016).

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/10 Paraphrase Detection in User Generated Text

Supervisors:	Ying Zhou
Eligibility Criteria:	Proficiency in Python; familiarity with Tensorflow; and some general knowledge on machine learning and on NLP
Project Description:	Paraphrasing detection can be used or integrated in many NLP tasks such as text summarization and plagiarism detection. The GLUE benchmark includes two paraphrasing datasets MRPC and STS-B, both drawn from online news sources. Models trained on those datasets, such as BERT based models, perform reasonably well on similar datasets containing well-structured sentences. However, they cannot not handle user generated text such as tweets, reviews or opinions. Such data contains text with large variety of styles and vocabularies. This project has two aims: First, construct an annotated dataset set from user generated text; Second, develop and evaluate a few paraphrasing detecting models that can tackle the unique features of user generated text.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/11 Sports Video Analysis

Supervisors:	Dr Zhiyong Wang
Eligibility Criteria:	Third-year or higher UG students, or PG students with skills on image processing and machine learning
Project Description:	Sports videos provide rich information of individual players and team coordination. This project aims to investigate advanced video analysis techniques for better understanding sports games and individual players and for bring better watching experiences to viewers. The outcomes of this project could help track individual player, categorize their actions, analyse their performance, and identify sports highlights.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/12 AI-guided financial data pattern recognition

Supervisors:	Dr. Matloob Khushi
Eligibility Criteria:	Machine/Deep Learning
Project Description:	Financial markets including stocks and forex constantly fluctuate. Apart from individual company performances, various external factors such as human psychology of the masses, local and international news contribute to the dynamics of the markets. Forecasting the level of the impact of these factors on financial markets is a dream of many decision makers. Development of an artificial intelligent (AI) agent based on market movement wave theory can make this dream a reality. The wave theory describes the repetitive patterns and impact of human psychology on financial markets. However, the manual analysis of these patterns is very laborious and subjective. We have shown previously that AI can successfully unveil the hidden patterns in the financial data. AI implementation to financial data helps to identify social mood of the masses and thus the movement in financial markets. Therefore, in this project, we anticipate implementing and improving some of our previously developed machine/deep learning pattern recognition strategies.
Related Reading:	Meng, T.L., Khushi, M (2019). Reinforcement Learning in Financial Markets. Data 4 (3). DOI:10.3390/data4030110

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/13 Rearranging Mobile Deep Neural Network (DNN) Inference during Service Outage

Supervisors: Dr Wei Bao

Eligibility Criteria: Eligibility criteria and skill requirement: The applicant should have knowledge of cutting-edge machine-learning platforms (e.g., TensorFlow). One research paper is expected to be written to submit to a high-quality conference/journal. Applicants are expected to enrol a follow-up honour-year project, 18cp master capstone project, MPhil or PhD degree.

Project Description: In this project, we aim to establish and implement a new framework supporting smooth Deep Neural Network (DNN) inference schemes during service outage.

In recent years, the rapid development of edge computing enables us to process a wide variety of intelligent applications by DNN inference at the edge, such as real-time video analytics. However, edge computing could suffer from service outage caused by the fluctuated wireless connection (e.g., handovers) or congested computing resource. Therefore, DNN Inference jobs must be rearranged to avoid severe performance deterioration.

We aim to develop a framework that improves system performance during service outage. Our design will be based on two recently developed schemes. (1) Early Exit of DNNs: we can exit DNNs at earlier layers without consuming much computing resource, by sacrificing an acceptable level of accuracy. (2) Dynamic DNN Partition: the first part of DNN is run at the device and the rest is run at the edge, and the partition is dynamically adjusted by the availability of computing resource and channel status. Our preliminary results [1] [2] (the research outcome of Summer Scholarship in 2018) show that using Early Exit or Dynamic DNN Partition individually will be beneficial. We will expand to jointly deploy the two schemes to achieve higher performance gain and we will build a fully functioning system.

This summer project is also aligned with the collaborative project with our industry partner, Link Group Pty Ltd. Link Group is a technology start-up that provides enterprise-grade smart Internet-of-Things (IoT) solutions for small business. Link Group plans to employ mobile deep-learning technologies in their new products to realise a variety of new services. The designed solution of this summer project will be tested in their real-world system.

[1] Zizhao Wang, Wei Bao, Dong Yuan, Liming Ge, Nguyen H. Tran, Albert Y. Zomaya, "SEE: Scheduling early exit for mobile DNN inference during service outage," accepted by ACM International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems (MSWiM), Miami, FL, 2019.

[2] Weiyu Ju, Dong Yuan, Wei Bao, Liming Ge, and Bing Bing Zhou, "DeepSave: Saving DNN inference during handovers on the edge", accepted by ACM/IEEE Symposium on Edge Computing (SEC), Washington, DC, 2019.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/14 Supporting Consumer Decision Using Online Reviews

Supervisors:	Kevin Kuan
Eligibility Criteria:	Basic understanding on Python and R programming for data analysis.
Project Description:	Consumers are increasingly relying on online reviews in their decision. This project aims to understand how consumers use online reviews in their decision and explore novel ways in which online review data can be used to support consumer decision. Students will be involved in analysing a large amount of semi-structured data consisting of both number and text.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/15 Medical Computer Vision for Three-Dimensional Neuron Reconstruction

Supervisor:	Associate Professor Weidong (Tom) Cai
Eligibility Criteria:	An academic background in biomedical image computing, computer vision, and machine learning; strong programming skills in C/C++, Python
Project Description:	Three-dimensional neuron reconstruction is one of the major domains in computational neuroscience, a frontier research area intersected with signal processing, computer vision, artificial intelligence and learning theory, applied mathematics, fundamental neuroscience and quantum physics. The 3D morphology of a neuron determines its connectivity, integration of synaptic inputs and cellular firing properties, and also changes dynamically with its activity and the state of the organism. Analysing the three-dimensional shape of neurons in an unbiased way is critical to understanding how neurons function and developing applications to model neural circuitry. Such analysis can be enabled by reconstructing tree models from microscopic image stacks by manual tracing. However, such manual process is tedious and hard to scale. This project aims to develop novel computer vision approaches for automatic three-dimensional reconstruction of neuron models from noisy microscopic image stacks. Such computational methods would enable faster and more accurate neuron models to further accumulate the knowledge of neuron functionalities and neural network connectome.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/16 Fingerprinting Tor Web Traffic Using Deep Learning

Supervisors:	Dr. Suranga Seneviratne
Eligibility Criteria:	Background in networking/familiarity with web technologies, Deep learning, and Wireshark/Tensorflow/Keras is required.
Project Description:	Tor is a commonly used anonymity network; mainly by internet users who need some extra privacy. Recent work highlighted that even one uses the Tor network, traffic signatures can be built and which websites the Tor users are browsing can be easily determined. This project has two components. First you will create a data collection framework to collect and process network traffic when using a Tor browser. Then you will evaluate the state-of-the-art deep learning models and evaluate the longevity of those models. i.e. once you train a model, how long it is going to work given website content are changing frequently.
Related Reading:	https://arxiv.org/pdf/1708.06376 (Links to an external site.) https://arxiv.org/pdf/1801.02265

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/17 Healthcare Monitoring Using Wearable Activity Sensors

Supervisors:	Dr Anusha Withana
Eligibility Criteria:	Excellent skills in programming, skills in embedded systems, machine learning, knowledge in design and fabrication, and human computer interaction are added benefits.
Project Description:	Preventive measures for many health risks depend on the continuous measurement of physiological activities. For instance, cardiovascular diseases are the leading contributor of death and acquired disability. Risk pools are often identified but researchers lack accessible sensing technologies to monitor them over long periods of time. In this project we aim to develop affordable technologies to monitor cardiovascular activities. Particularly, we are interested in creating technologies that blend with users' body, cloths and accessories that allow us to collect long-term data. This project not only involve data collection and analysis, but also computational design and fabrication of attractive and fashionable wearable sensors.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/18 Exploring translation and rotation invariance in Deep Learning with Steerable Filters

Supervisor:	Dr Vera Chung
Eligibility Criteria:	Python or Mathlab programming skill, Deep Learning knowledge
Project Description:	Deep learning-based solutions learn a function that maps from a particular input type to a particular output type. For instance, an image classification model is trained to map from an input image to the predicted class whereas an object detection model is trained to map from an input image to the predicted bounding boxes that surround the objects. In the training phrase, the model is fed with batches of inputs for it to perform the mapping. The output of the model is then compared to the ground truth labels that provide supervision for the model to learn the correct mapping. Models trained with such method requires the availability of large amounts of raw data and their corresponding labels. Therefore, extensive capital and human resources have to be devoted to collect the input data as well as to obtain the corresponding labels manually. When data is not available in large volume, deep learning-based techniques tend to fail to generalise well from only a few samples. This problem may arise on particular classes, i.e. class imbalance problem, or on the dataset as a whole, low data volume problem. Recently, Steerable Filter CNNs (SFCNNs) is proposed to achieve joint equivariance under translations and rotations by design. Such a method is experimentally verified to achieve state-of-the-art performance on the rotated MNIST benchmark and on the ISBI 2012 2D EM segmentation challenge. This project aims to investigate the extend which the steerable filter is able to mitigate the above mentioned two problems of deep learning.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/19 Community Search over Large Graphs

Supervisors:	Dr. Lijun Chang
Eligibility Criteria:	Good programming skills in C/C++
Project Description:	Graph data are prevalent in the big data era, where interconnected data are naturally modelled as graphs, such as social networks, communication networks, collaboration networks, and biological networks. Community search is a fundamental problem in graph analysis. Given a large graph G (e.g., with millions of vertices) and a set of query vertices, community search is to find one or top-k subgraphs of G such that each subgraph contains all query vertices and also is dense (e.g., with high minimum degree or high average degree). In this project, we will implement and evaluate our newly proposed algorithm for efficient community search over large graphs.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/20 Verifying probabilistic models

Supervisor:	Sasha Rubin
Eligibility Criteria:	Strong background in discrete mathematics and/or formal languages and logic.
Project Description:	Probabilistic models are used to describe randomised protocols. Verifying the correctness of such protocols can be done by devising algorithms for computing the probability that a given model satisfies a given formal specification (this is called model-checking [1], a technique for which the proponents won two Turing awards). Interestingly, classic specifications talk about infinite runs of the model [2,3]. However, in certain applications in Artificial Intelligence and Business Process Management it is more appropriate to consider specifications that talk about *finite* runs. The aim of this project is to devise algorithms for model-checking properties of finite-runs of probabilistic models. The focus on finite runs has the major advantage that one can often rely on classic undergraduate-level constructions to devise the algorithms [4].
Related Reading:	[1] Edmund M. Clarke, Thomas A. Henzinger, Helmut Veith, Roderick Bloem: Handbook of Model Checking. Springer 2018, ISBN 978-3-319-10574-1 [2] Costas Courcoubetis and Mihalis Yannakakis: The complexity of probabilistic verification. J. ACM, 42(4):857–907, 1995. [3] Doron Bustan, Sasha Rubin, Moshe Y. Vardi: Verifying omega-Regular Properties of Markov Chains. CAV 2004: 189-201 [4] Giuseppe De Giacomo, Moshe Y. Vardi: Synthesis for LTL and LDL on Finite Traces. IJCAI 2015: 1558-1564

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/21 Does that treatment work?

Supervisors:	Dr Josiah Poon & A/Prof Simon Poon
Eligibility Criteria:	Good programming and data analytics skill; knowledge in data mining & machine learning is desirable.
Project Description:	Multiple Sclerosis (MS) is a common chronic neurological disease that is found among young adults in the age range of 20 to 40 and. Its effect among women is three times more than men. MS not only has a devastating and profound effect on the quality of life, and the worst is that it is no cure. Hence, anything to improve the condition is a welcome. We have our collaborators who have carried out an integrative treatment to a recruited group of patients. The aim is to carry out an analysis and creative visualisation to inform the clinicians the best clinical approach and decision.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/22 Scalable Visual Analytics of Big Complex Data

Supervisor:	Prof. Seok-Hee Hong
Eligibility Criteria:	Programming (Java, C++, JavaScript, Python), Data Structure, Algorithm, Cloud computing, Data Mining, Machine Learning
Project Description:	Technological advances such as sensors have increased data volumes in the last few years, and now we are experiencing a "data deluge" in which data is produced much faster than it can be used by humans. Further, these huge and complex data sets have grown in importance due to factors such as international terrorism, the success of genomics, increasingly complex software systems, and widespread fraud on stock markets. We aim to develop new scalable algorithms for effective visualization and interaction methods for analysts to find patterns in big complex data sets, especially social networks, telephone call networks, biological networks, stock buy-sell networks, and transport networks. These new visualization and interaction algorithms are in high demand by industry.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/23 Deep learning-based visualization development for PET-CT biomedical images

Supervisors:	A/Prof Jinman Kim and Prof David Feng
Eligibility Criteria:	A candidate is expected to have strong skills in software development particularly with C++, with optional experience in deep learning.
Project Description:	We have developed and implemented a PET-CT image visualization viewer at our partner site at the Molecular Department at Royal Prince Alfred (RPA) hospital. The next stage for the viewer is to integrate deep learning-based automated image analysis algorithms for decision support. This includes automatic registration and visualization of serial imaging datasets, multi-modality image enhancement, and GPU-based 3D visualization. The candidate will work in a team to develop and implement these algorithms.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/24 A social and incentive oriented mobile intervention for improved lifestyle behaviour outcome among overweight and obese patients

Supervisors:	A./Prof Jinman Kim
Eligibility Criteria:	We are looking for a candidate who is capable of acting as an intermediary in this multi-disciplinary research study and who has a sufficient understanding and knowledge of IT and software. The candidate needs to be self-disciplined, have good communication skills and be willing to learn new things.
Project Description:	Obesity in Australia has been labeled as an epidemic, with rates becoming alarmingly high especially in regions surrounding Sydney. Despite the simplistic nature behind the treatment method, it is often difficult to achieve successful outcomes due to the required changes in personal lifestyle behaviour and dietary habits. As part of our collaboration with the Nepean Metabolic Health Service at the Nepean Hospital, we aim to study the effect of incorporating a social + incentive driven mobile application as part of the care curriculum for overweight and obese patients, with particular focus on measuring the changes in lifestyle and behaviour outcome. The design and development of the mobile app has already been completed. We have also received ethics approval to commence the study. The chosen candidate for this project is expected to work in a hospital setting, help with the recruitment of patients, assist in the completion of the trial, and analyse the data collected at the end of the trial.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/25 Novel Logic Evaluation Strategies

Supervisors:	A/Prof Bernhard Scholz
Eligibility Criteria:	A third or fourth year undergraduate or postgraduate student who has basic knowledge in logic, good C++ skills, a good understanding of data-structures.
Project Description:	Logic evaluation has two classical strategies: a top-down strategy (from the goal to the facts) and a bottom-up strategy (from the facts to the goal). These two classical logic evaluation strategies have been widely used in logic engines. However, they are limiting for applications. For example, some applications require continuous re-computation for a stream of changing input facts. Such Applications occur in integrated development environments that perform semantic checks for programs on the fly. Other applications may compute large data-sets although only a small fragment of the computation is required for the goal. This summer scholarship will focus on the implementation of new evaluation strategies for non-classical logic applications. We will investigate new algorithms and new data-structures for this purpose.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: CS2019/26 Ethereum Virtual Machine

Supervisor:	A/Prof Bernhard Scholz
Eligibility Criteria:	A third or fourth year undergraduate or postgraduate student who has some RUST knowledge and a basic knowledge of block chain and smart contracts
Project Description:	Smart contracts are programs that are executed on the block chain. A virtual machine executes the bytecode which interacts with the blockchain. Recent measurements have shown that the performance of smart contracts deteriorates over time. New execution models for the virtual machine are of paramount importance to overcome these performance bottlenecks. If not solved, the blockchain will die a complexity-death. This project will go deep into the building blocks of the EVM. The task will be the exploration and the implementation of new execution models for the EVM.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CS2019/27 Data Analysis and Visualisation of Australia's National Health

Supervisors:	Associate Professor Simon Poon (primary contact), Dr Boris Choi (Business Analytics)
Eligibility Criteria:	Skills in Network Analysis, Statistics/machine learning/data mining, strong interest/background in Public Health Informatics
Project Description:	This project aims to explore interesting health patterns from the longitudinal National Health Surveys (NHS) released by the Australian Bureau of Statistics (ABS). There is total of eight releases (1977-78, 1983, 1989-90, 1995, 2001, 2004-05, 2007-08 and 2011-13). This survey provides information about: · The health status of the population, including long term medical conditions experienced and recent injuries; · Health–related aspects of people's lifestyle, such as smoking, exercise and alcohol consumption; · Use of health services such as consultations with doctors and dentists, visits to hospital and other actions people have recently taken for their health; and · Demographic and socio–economic characteristics. · Student may require to communicate with Australian Bureau of Statistics (ABS) for further data collection.
Value and Duration	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CS2019/28 Process Modelling of a selected Cancer Care Pathway

Supervisors:	Associate Professor Simon Poon, Associate Professor Lynleigh Evans (Westmead Crown Princess Mary Cancer)
Eligibility Criteria:	Skills in Simulation modelling, strong interest in Process modelling. Communication skills are critical for data gathering from interviews, focus groups and observations.
Project Description:	Process modelling is a promising technique used to give insight into complex and flexible healthcare processes. It can map the patient journey at a local level and audit it against explicit standards of good clinical practice, which will enable us to intervene at the individual and system level to improve care. The aim of this project is to preform cancer pathway analysis using existing clinical patient records, by applying concepts of process modelling and visualisation and comparing the performance metrics against the standard pathway laid out by hospital guidelines. A systematic review to be conducted to see how process modelling has been used in the related cancer domain. Appropriate datasets for a chosen cancer stream will be identified. A process model to be constructed based on patient records stored in cancer clinical management system ARIA at Westmead Hospital. Process Modelling techniques will be applied to the clinical data to analyse performance and conformance of the selected cancer pathway metrics to a given guideline metrics. These techniques were evaluated with stakeholders to ascertain its impact on user experience.
Value and Duration	$4000 for an 8 week project

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CS2019/29 Predicting risks and safety of nanomaterials using machine learning

Supervisors: A/Prof Irena Korpinska (School of Computer Science) and A/Prof Wojtek Chrzanowski (Sydney Nano Institute and School of Pharmacy)

Eligibility Criteria: Interest in machine learning and data science. Some prior machine learning skills (e.g. completed COMP3308/3608 or COMP5318) would be an advantage.

Project Description: Nanomaterials are integral to many products used daily, including food, cosmetics and batteries. Human and environmental exposure to nanomaterials is therefore inevitable. The steep increases in the use of nanomaterials have not been matched by progress in understanding their environmental, health and safety implications. These are critically needed both to protect health and the sustainability and benefits of nanomaterials.

This project aims to develop new predictive models for safety of nanomaterials using experimental data. It will examine multiple toxicity characteristics, considering humans as well as the broader environment, to enable the development of reliable machine learning-based predictive models for safety and toxicity.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CS2019/30 Development of mobile app: eGuardian Angel

Supervisors:	Associate Professor Simon Poon (primary contact), Professor Julie Redfern (Westmead Applied Research Centre)
Eligibility Criteria:	Mobile app design and development, user evaluation methodology; understanding/interest in social determinants of health. Communication skill is critical for user requirements gathering & evaluation
Project Description:	The Guardian Angel concept proposes the idea that a large, decentralised social support network can more effectively motivate individual in a connected community to collectively improve a population's health and lifestyle habits than a traditional centralised system of a few localized hubs, e.g., health care professionals (e.g. clinicians), monitoring a large number of spokes (e.g. patients). The Guardian Angel idea is to organise patients, so that each individual has a guardian angel (or more than 1 guardians) from among the other patients (defined as children) and is assigned to be a guardian angel for someone else. The angel has the ability to engage with the other person's activities and then encourage and motivate the person to continue on a positive trajectory (to accomplish health goal). Every person tries to motivate someone and is motivated by someone else so that the health and lifestyle of the whole community improves. This summer project is a part of larger project, consisting two sub-parts: • Mobile application development: This part of the project would involve developing a mobile application prototype to enable the Guardian Angel Network. One aspect is to identify functionalities to encourage and motivate, and the other aspect is about user interface design • Evaluation: This part of the project would involve designing and implementing a suitable clinical trial to test and evaluation the usability & usefulness of the mobile Guardian Angel application
Value and Duration	$4000 for an 8 week project with a possible extension to 10 weeks subject to funding availability

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

CS2019/31 Process-Oriented Data Science for Health: Imaging Services at BMDH

Supervisors:	Associate Professor Simon Poon, Associate Professor Noel (Westmead Hospital), Associate Professor James Nol (Blacktown & Mount Druitt Hospital Medical Imaging Services)
Eligibility Criteria:	Simulation modelling, strong interesting in Process modelling, communication skill is critical for data gathering from interviews, focus groups and observations.
Project Description:	The aim of this project is to use patient records and clinical management system data to improve clinical care by optimising patient flow and clinical service delivery at Blacktown-Mt Druitt Hospital (BMDH). By combining traditional process analysis and data-centric analysis to improve healthcare deliveries, we propose the development of a process management tool that will enable a more transparent and insightful understanding of the patient's journey within the BMDH. Using process-oriented data science techniques, the ultimate goal is to utilise clinical management system data in various forms to extract knowledge and insights related to clinical care. Event data extracted from the hospital clinical information will also play a critical source of information for analysing and improving processes at BMDH Imaging services. Using the imaging service as an exemplar, we aim to apply process-oriented data analytics on routine electronic health record data for optimising and transforming patient care in imaging services.
Value and Duration	$4000 for an 8 week project with a possible extension to 10 weeks subject to funding availability

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: EIE2019/1 High Performance Sensors for Medical Devices

Supervisor:	Professor Xiaoke Yi
Eligibility Criteria:	Open to third or fourth year undergraduate or postgraduate students.
Project Description:	There is an increasing demand for non-invasive monitoring and early-detection of the diseases. Novel use of sensors to diagnose childhood disease offers significant advantages, such as immunity to electromagnetic interference, contact-free, high-resolution and improved stability. This project covers three research scopes (1) sensor design (2) prototype testing, evaluation and adjustment (3) prototype optimization, which includes minimizing the power of the light source while maximizing sensing efficiency, accuracy and sensitivity.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: EIE2019/2 Photonic sensing technologies for various applications

Supervisors: Professor Xiaoke Yi and Dr Liwei Li

Eligibility Criteria: Open to third or fourth year undergraduate or postgraduate students.

Project Description:

The state-of-the-art sensing technology is rapidly growing and will play a critical role in the near future. For instance, smart phones, which play a significant role in our daily life, have a fingerprint identity sensor that makes it easy for us to access the device, and they also use an ambient brightness sensor to adjust the display brightness, etc.

The project is to deliver the superior, multi-functional photonic sensing platforms that arise with cutting-edge solutions to address the important challenges across a diverse range of applications in various fields, particularly in Internet of Things, Big Data, clean energy networks, smart grids, high-capacity telecommunication networks, bio-medical, medicine, defence, and aerospace. The project targets (i) ultra-sensitive sensing (ii) highly-selective sensing and (iii) extreme-range sensing. The amazing advances in waveguide-based topology, nano-fabrication, lab-on-chip co-integration technologies, and innovative signal processing and nano-sensing capabilities will be carried out during the project.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: EIE2019/3 Preventing Security and Privacy Attacks in IoT Communication Systems

Supervisors:	Dr. Phee Yeoh and Prof. Branka Vucetic
Eligibility Criteria:	Matlab/C programming skills
Project Description:	The security and privacy of wireless data transmissions are major challenges in large-scale distributed Internet-of-things (IoT) systems. This project will design and evaluate novel lightweight algorithms to prevent attacks in the physical and networking layers. We will also consider the use of advanced theoretical models using machine learning and distributed blockchains to improve the reliability and latency of IoT communication systems.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: EIE2019/4 Wireless AI

Supervisor:	Professor Yonghui Li
Eligibility Criteria:	No specific requirements
Project Description:	This project aims to introduce cognition, intelligence, automation, and agility for future wireless communication system design with the cutting-edge artificial intelligence techniques. We will develop new tools and frameworks to design intelligent communication architectures, protocols, and operations.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: EIE2019/5 Tele-robotics

Supervisor: Professor Yonghui Li

Eligibility Criteria: No specific requirements

Project Description:

Remote robot control has a wide range of applications including warehouse management, e-commerce, telesurgery, factory automation, process automation, smart grid, tactile Internet and intelligent transport systems. In this project we have two interesting topics:

Ultra-reliable high-performance remote robot control by developing cutting-edge joint communication-control theories and algorithms. This topic involves both advanced wireless communication and networked control techniques.

Reliable robot grasping by developing advanced computer vision and grasp-planning algorithms. This is a challenging topic due to uncertainty about object properties such as object shape, pose, material properties and mass. The topic involves deep learning, computer vision, and off-the-shelf robot control techniques.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: EIE2019/6 Tactile Internet

Supervisor:	Professor Yonghui Li
Eligibility Criteria:	No specific requirements
Project Description:	Tactile Internet will enable the sensation of touching (formally as tactile or haptics) to be transmitted over the Internet, instead of just audio and visual information in the current Internet. Typical applications include human-machine collaborations in industry automation, tele-surgery in healthcare, virtual reality (VR) and augmented reality in remote education and gaming industry. The student will utilize both vision and tactile to do robotic grasping research and development for industry automation by using reinforcement learning.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

WHA2019/1 Computer-aided dentistry using deep learning

Supervisors:	Eduardo Delamare (Charles Perkins Centre), Dr. Ashnil Kumar (Computer Science), Dr. Audrey Wang (Westmead Initiative)
Eligibility Criteria:	A 3rd year (or higher) engineering or computer science student Required skills: Programming (Python or C++ is ideal) Desirable skills: Computer vision; prior experience with AI or ML toolboxes; knowledge of anatomy, biology, and physiology, user interface development.
Project Description:	Population oral health interventions that target the detection of caries in lower socio-economic populations and early detection of caries via school program-based dental screening assist in preventing long term effects. The most common clinical assessment for oral health screening includes identifies decayed, missing, and filled teeth (DMFT). Digital x-ray imaging is part of this screening practice with bitewing radiographs being the first line of imaging techniques used for children. The detected DMFT are usually noted by the dentist via manual entry in electronic or paper medical records. The aim is to create a machine learning pipeline for DMFT screening in children according to their bitewing radiographs. The pipeline is to be built by modifying the current techniques used for screening adult teeth radiographs. The outcomes will include software that comprises image pre-processing, quality assessment, with image analysis and classification, which is to be achieved either by combining feature extraction and machine learning or via deep learning in an end-to-end fashion. The use case for this software is in automated screening of patients in remote health centres as a means of referring at-risk patients to specialist dental care.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

Project: WHA2019/2 A radiomics tool for patient outcomes prediction

Supervisors:	Dr. Eric Hau (Westmead Clinical School), Dr. Harriet Gee (Westmead Hospital), Dr Ashnil Kumar(Computer Science)
Eligibility Criteria:	A 3rd year (or higher) engineering or computer science student Required skills: programming (Python or C++ is ideal) Desirable skills: computer vision; prior experience with AI or ML toolboxes; knowledge of anatomy, biology, and physiology, user interface development.
Project Description:	In this project, a tool for CT images will be developed based on our recent research to enable clinicians to analyse cancer patient image data. We will utilise modern machine learning (ML) and artificial intelligence (AI) techniques to process and analyse a variety of imaging data to enhance and support clinical decision-making. The goal will be to develop and evaluate computational algorithms that can analyse medical image data to automatically determine important clinical characteristics. We envision that these algorithms may form the basis of computer aided diagnosis software.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

WHA2019-3 Pressure injury prevention strategies

Supervisors: David Pryce (Western Sydney Local Health District), Dr. Ashnil Kumar (Computer Science), Dr. Audrey Wang (Westmead Initiative), Mark Read (Computer Science)

Eligibility Criteria: A 3rd year (or higher) engineering, computer science or economics student with a strong background in computer science/financial modelling
Required skills: programming (Python or C++ is ideal)
Desirable skills: computer programming; prior experience with AI or ML toolboxes; knowledge of medical terminology, statistics.

Project Description: Pressure injuries have severe consequences on a patient's quality of life and their health outcomes. Despite the variety of pressure injury related biomedical interventions including specialist wound care nurses and interventions, hospital acquired pressure injuries often results in increased length of stay with increased healthcare resource utilisation and prolonged or poor recovery outcomes post hospitalisation.

- The most common clinical assessment for at risk patients for hospital acquired pressure injuries are the Waterlow assessment tool. The current rate of completion of all necessary assessment tools remain less than 60% (unpublished audit data).
- The proposed project focus on a retrospective analysis of prospective data entry of those who had acquired hospital pressure injuries. This first study will use a data-driven approach to identify candidate risk stratification factors for intervention based on a combination of electronic medical records, business analytics data and tools for hospital healthcare related expenditure. These include building on current audit comprehensive care cycles for pressure injuries and identifying candidate factors including resource factors such as staffing expertise and levels of sickness absence and co-morbidities related to those who acquired have multifactorial components.
- The aim is to create a machine learning pipeline on hospital related data based on initial algorithm models built using computational statistics on pressure injury audit data

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

WHA2019/4 Understanding the immune response to disease through temporal cluster tracking

Supervisors:	Suat Dervish (Westmead Initiative for Medical Research), Mark Read (Computer Science), Irena Koprinska (Computer Science), Thomas Ashhurst (Charles Perkins Centre), Givanna Haryono (School of Computer Science)
Eligibility Criteria:	• Good programming skills • Interest in machine learning. Some prior machine learning skills would be an advantage • A willingness to learn about the immune system (prior knowledge is NOT a requirement).
Project Description:	To develop effective disease interventions, we must understand how our immune system works and fails. This project aims to develop machine learning analytical tools for cytometry, which measures 50 different characteristics in each of millions of immune cells. You will develop an extension of the popular clustering algorithm FlowSOM, to perform temporal cluster tracking. The tracking includes how the clusters split and merge over time, and when new clusters emerge. One possible approach is based on nearest neighbour techniques. The extension enables a truly dynamic analysis of how immune cells mature and move around the body, essential for understanding disease.

THE UNIVERSITY OF SYDNEY

Faculty of Engineering:

2019/2020 Summer Research Projects

WHA2019/5 Quantifying fluctuating skin oxygen levels during sleep

Supervisors:	A/Professor Terry Amis, Mr Christopher Lambeth, A/Professor Kristina Kairaitis
Eligibility Criteria:	This would suit a student with experience in signal processing and data acquisition.
Project Description:	We have recently adapted a diffusion-based, transcutaneous, partial pressure of oxygen (TcPO2) method for continuous recording of skin oxygen levels during sleep. We have collected preliminary data in melanoma patients that suggests a potential link between fluctuating skin oxygen levels during sleep and melanoma site, and data in healthy subjects under control conditions. The aim of this project is to develop signal processing methods for quantifying fluctuating skin oxygen levels and measure contribution of physiological states (sleep stage, heart rate, skin temperature) to skin oxygen levels. This measurement will be used in future studies to look at links between skin oxygen and melanoma site.