Charles Sturt University

AI and Cyber Futures Institute

CSIRO Next Generation Graduates Program (NGGP)
AgriTwins: Bridging Cyber-secure Emerging Technologies and Data-centric Twin Tech for Resilient Agriculture of the Future

HDR and Honours
Scholarship Prospectus

Charles Sturt University

Charles Sturt is Australia's leading regional university, has a proud history of partnering with industry and businesses to benefit our students and the local community. We have a social responsibility to use its expertise to support and deliver outcomes that foster prosperous and resilient regional communities. Our goal is to influence and contribute to the economic, social, and environmental sustainability and well-being of our regional, national, and global spheres.

Charles Sturt is a world-class, research-driven university for the study and practice of rural health, cyber, food and water security, and regional well-being. Our history of innovation and educational empowerment reaches back as far as 1895 with the establishment of the Bathurst Experimental Farm. That was the first step in connecting people, communities and industry to make a real difference, Professionally, Socially, economically.

Our vision as Australia's leading regional university, is to advance the careers of our students, inspire research excellence and drive regional outcomes with global impact.

We seek to empower the leaders of tomorrow through innovative education and applied research, and we have a strong commitment to learning from and working with Australia's First Nations Peoples.

It's why we are committed to the transformative University Strategy 2030. It's our commitment to our communities. To our partners. To our students. To our regions. A long-term strategy deepens our relationships, enabling us to build a stronger tomorrow together.

At Charles Sturt, our locations are our strength. Our university is spread across several prime sites in Australia: Bathurst, Canberra, Wagga Wagga, Orange, Albury-Wodonga, Port Macquarie, and Sydney. These campuses boast tight-knit, secure environments where everything you need - from classrooms, workshops, and cafes to gyms and the essential library - is conveniently located within easy walking distance.

Joining Charles Sturt means becoming part of a vibrant student body. With students hailing from all corners of Australia and 113 other countries - a quarter of our student population is international – you will not only gain knowledge but also form lasting friendships with peers from diverse backgrounds.

AI and Cyber Futures Institute

Charles Sturt University's AI and Cyber Futures Institute (AICF), a cutting-edge research institute of excellence in data science, artificial intelligence, and cyber security, is poised to showcase the power of AI developed in unconventional environments, ensuring its benefits are tailored not only for metropolitan populations but also for the broader society, positioning Australia on the global map. While most data science and AI advancements typically emerge from bustling urban centres, there is a notable disparity when it comes to their applicability in regional communities. Given that 3.4 billion individuals live in rural settings (as highlighted by the United Nations), it's vital that we create technologies that are both effective and relevant for these populations. At AICF, we are diving deep into how data from non-urban settings, along with the tools and practices based on this data, can be optimized for widespread societal benefit. Our approach focuses on inclusivity, diversity, and sustainability, directing our efforts towards creating transparent AI systems, ensuring ethical AI applications, and fostering collaboration between urban and regional settings. In essence, AICF aims to chart new territories in regional futures by pushing boundaries in AI, data science, and cyber security, always with an unwavering commitment to research excellence.

Our aim is to develop a centre of excellence in regional NSW. We'll do this by:

- building trustworthy data-driven systems and embedding transparent reporting practices in all AI-related research
- promoting inclusive interoperable AI design relevant not only to cities, but also to rural areas
- maintaining ethical integrity of AI-driven designs, which should not exploit rural populations for the benefit of urban systems
- encouraging respectful co-creation between regions and cities.

About the AgriTwins

At AICF, we aim to create secure, sustainable, responsible, and inclusive technologies that maximize human potential and wellbeing in agriculture. By bridging cyber-secure emerging technologies with data-centric innovations, we aim to build a resilient agricultural and environmental future.

Central to this effort is our AgriTwins program, a transformative approach that integrates advanced digital and quantum twin technologies with cybersecurity. This program addresses escalating agricultural challenges, such as sustainability, efficiency optimization, and resource management, providing real-time insights and data-driven precision to support resilience and adaptability.

Through AgriTwins, we leverage digital twin methodologies to monitor and model agricultural operations, enabling precision farming, greenhouse emission control, and proactive agronomy. By merging these insights with robust cybersecurity, we ensure that our technologies not only enhance productivity but also safeguard agricultural data and systems against present and future threats. Our goal is to actively shape the future of agriculture, creating a sector that remains adaptable and resilient to evolving challenges while fostering a sustainable and secure digital ecosystem.

The Next Generation Graduates Program is a cohort-based, industry driven, multi-disciplinary graduate training program that aims to equip students with entrepreneurial thinking and skill sets that are key to boost breakthrough innovation in the exciting fields of AI and other emerging technologies. The program will train students to be prepared for the problem-based environments they will face upon entering their respective fields. They will engage with a distinguished national cohort of peers from diverse disciplines and locations, fostering a rich and dynamic learning experience.

As part of the CSIRO Next Generation Graduates Programs, the AgriTwins represents a transformative approach to addressing the myriad challenges faced by the agricultural sector today. By seamlessly integrating advanced cybersecurity measures with emergent data-centric twin technologies, we aim to tackle sustainability concerns, optimise efficiency, and ensure resilience in our agricultural practices.

This program leverages cutting-edge digital twin and quantum twin methodologies, offering real-time operational data insights, precision farming capabilities, advanced greenhouse emission management, and

proactive agronomy solutions. Our vision is not merely to adapt to the digital era but to proactively shape the future of agriculture, making it resilient against both current and unforeseen challenges. By harnessing the strengths of these emerging technologies, the AgriTwins Program seeks to create a robust, cyber-secure foundation that addresses immediate agricultural hurdles while paving the way for a sustainable, future-ready agricultural landscape.

Projects within the program covers topics from crop simulation, food processing, livestock health to soil health, carbon emission, sustainability report etc. Student on each project will work closely with supporting industry, university academics from digital technology and agriculture to conduct research activities.

Scholarships

The AgriTwins program offers scholarships for PhD, Masters and Honours students to conduct research under the supervision of university and industry experts.

Eligibility

To be eligible for a scholarship, applicants must be domestic students as per the Higher Education Support Act at the time of award. Students must meet minimum requirements for Charles Sturt University. Students need to consider entry into a PhD/Master's program into Session 1 of 2025.

Domestic students include:

Australian citizens

Australian permanent residents

a person entitled to stay in Australia, or to enter and stay in Australia, without any limitation as to time

a New Zealand citizen.

Requirements by NextGen AgriTwins program (CSIRO requirements)

Students must enrol through the supervising University.

Students will be required to undertake industry placements with an approved industry partner(s) of the program.

Students must register and complete the coursework component of the Next Generation Graduates Program within the **first 18 months** of receipt of a scholarship.

Students who receive a scholarship are expected to undertake their training in Australia and endeavour to remain in Australia for two years following completion of their degree.

Coursework

The coursework component of the Next Generation Graduates Program is designed to introduce future graduates to the key concepts that will be useful during their candidature and aims to cover a breadth of concepts and domains by developing knowledge and practical skills.

The purpose of NGGP Coursework is to build collaborative, interdisciplinary, industry-focused cohorts of individuals who are aware of where they sit within the ecosystem of technology development. It will provide students with unique opportunities to engage with a broad range of topics, themes, and research domains.

By exploring diverse topics including deep learning, computer vision, ethics, decision making under uncertainty, innovation, and entrepreneurship, this course stands out for its holistic approach to problem-solving with technology. To find out more about the modules, see appendix 1.

Scholarships are available for students at Honours and all postgraduate levels across Australian universities. Master of Philosophy (MPhil) and Doctor of Philosophy (PhD) scholarship holders must enrol in a full-time degree.

Table 1 Scholarship in a glance

DEGREE TYPE	PHD	MASTER OF PHILOSOPHY	MASTERS (RTP QUALIFIED PROGRAM)[1]	HONOURS & COURSEWORK MASTERS[2]
RESEARCH DURATION	3.5 years	2 years	1 year	1 year
INDUSTRY PLACEMENT	6 months	3 months	20 days	6 days
COURSEWORK DURATION	11 weeks	11 weeks	4 weeks	4 weeks
STIPEND RATE (P.A.)	$42,483	$42,483	$30,000	$10,000
TRAINING (P.A.)	$15,000	$10,000	$5,000	$5,000
TRAVEL (TOTAL)	$5,000	$5,000	N/A	N/A
THESIS ALLOWANCE (TOTAL)	$840	$420	N/A	N/A
COST OF LIVING PAYMENT	$5,000	$2,000	N/A	N/A
ADDITIONAL SUPPORT ALLOWANCE[7]	Assessed on case-by-case basis	Assessed on case-by-case basis	Assessed on case-by-case basis	Assessed on case-by-case basis

How to apply?

AICF will run a two-stage EOI process which will be advertised on the Charles Sturt University scholarships page and through national media.

The first stage will require applicants to complete an online form and submit, along with a professional CV. Enquiries send to aicf@csu.edu.au with headline of 'AgriTwins student enquiries + project number'.

Candidates will then be shortlisted and top applicants will be contacted in early January. Supervisors and candidates will be invited to complete the Charles Sturt admissions process.

Closing date for EOI is **4th January 2025**. Position open until been filled.

Key Details

Commencement:

Students must commence by acceptance of offer on the scholarship by 28th March 2025.

Study load:

Only full-time applicants will be accepted for shortlisting.

Stipend:

As in table 1 above.

Tuition Fees:

Fee exemption for the duration of research at full-time study.

Selection:

A weighting system will be established to rank candidates. Shortlisting will take place by an expert committee of research active academics and maybe industry representatives as well.

Project Pitches

Project 1

PhD project: Development of A Digital Twin of a Rice Handling and Processing Facility

Description:

This project aims to create a comprehensive digital twin of a rice handling and processing facility to enhance operational efficiency, optimise resource utilisation, and improve product quality and sustainability. By leveraging historical data from the facility, the project will develop machine learning algorithms to build a digital twin, enabling detailed analysis, visualisation, and monitoring of rice processing steps.

Objectives:

1. Develop a digital twin for the efficient handling and initial processing of incoming rice grain.
2. Create and validate models for optimal storage conditions and effective drying to maintain grain quality.
3. Optimise rice processing operations, including husk removal, grading, sorting, and storage.
4. Implement effective management strategies for by-products and waste materials.
5. Facilitate the production of value-added retail products from processed rice.

This approach will ensure precise control and improvement across the entire rice processing workflow, contributing to overall sustainability and product excellence.

Deliverables:

1. A comprehensive digital twin model of the rice handling facility, accurately representing its processes from grain receival to secondary processing of retail products. The model will integrate real-time data feeds to maintain simulation accuracy and responsiveness.
2. A simulation platform of advanced simulation software capable of modelling complex operations and scenarios in real-time.
3. Development of algorithms and models for predicting and optimising grain handling, processing, and waste management.
4. Design and implementation of an intuitive user interface for facility operators to interact with the digital twin which has visualisation tools to monitor and analyse operational performance, quality metrics, and resource utilisation.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of digital twins and IoT will be desirable, and the application will be in agriculture.

Project 2

PhD Project: Using Data Science and Digital Twin technology on Development of An Integrated Geospatial Rice Production Decision Support System

Description:

Plant simulation models such as APSIM have been developed for simulating plant growth in recent years. However, decision-making support specifically for rice production remains a significant gap. This project will leverage emerging technologies, particularly machine learning and digital twins, along with geographic information systems (GIS), remote sensing, and data analytics, to provide comprehensive decision-making support for rice farmers, policymakers, and other stakeholders. By integrating geospatial data, grain yield, and quality metrics with advanced analytics, the system will enable predictive models that link GIS data and sensing data to forecast rice growth, grain quality, and inform decisions on water and fertilisation management.

Objectives:

1. Collecting historical geographic information, rice paddy data, crop management records, phenology records, and measurements of grain yield and quality parameters.

2. Developing algorithms for water management (e.g., timing of draining) and assessing the impact of fertilisation protocols on rice production parameters such as Head Rice Yield (HRY), grain protein content, and chalkiness.

3. Training data sets for model development to enhance decision-making and predictive capabilities.

4. Developing a digital twin system for easy visualisation and utilisation by stakeholders.

This project will thus bridge the gap in decision-making for rice production, facilitating more informed and effective management practices.

Deliverables:

1. Data warehouse for this research project’s requirements.

2. Advanced algorithms for data analytics to improve irrigation management and fertiliser protocols.

3. Developed and trained models for rice production decision making support system.

4. A digital twin space developed for rice production that can be practically used by stakeholders.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of digital twins, remote sensing and IoT will be desirable as well as agronomy knowledge, and the application will be in rice production.

Application: This project is supervised by University of Sydney and Charles Sturt University combined, to apply please submit your application to University of Sydney.

Project 3

PhD Project: Vineyard 3D Simulation Modelling for Vineyard Optimisation

Description:

The aim of this project is to leverage advanced 3D simulation technology to enhance the management and productivity of our vineyard. By constructing a comprehensive virtual model that encompasses the vineyard's topography, soil properties, plant variety, and environmental conditions, we will be able to simulate various management scenarios and evaluate their impacts. This model will enable functions to predict the outcomes of different irrigation schedules, nutrient applications, and pest control measures on vine growth, fruit yield, and overall vineyard health.

Objectives:

1. The primary objective is to use these predictive insights to optimise resource utilisation, minimise waste, and promote sustainable practices, thereby increasing profitability.

2. Through this project, we seek to deepen our understanding of the complex interactions within the vineyard ecosystem, enabling us to make data-driven decisions, mitigate risks, and adapt to changing environmental conditions.

3. Ultimately, this innovative approach aims to ensure the long-term viability and success of the vineyard, positioning us at the forefront of agricultural technology and sustainable farming practices.

Deliverables:

1. Comprehensive 3D Vineyard Model: A detailed virtual model of the vineyard, including topography, soil properties, tree species, and environmental conditions.

2. Simulation Scenario Reports: Detailed reports on the outcomes of various simulated management scenarios, including irrigation schedules, nutrient applications, and pest control measures.

3. Resource Optimisation Plan: A strategic plan outlining optimised resource utilisation practices based on simulation results to enhance productivity and sustainability.

4. Disease and Pest Management Strategy: A targeted intervention strategy for managing diseases and pests, developed from predictive simulation data.

5. Environmental Adaptation Framework: A framework for adapting vineyard management practices to changing environmental conditions, ensuring long-term viability and resilience.

Preferred candidate (skill set):

The preferred candidate should have programming and data science skills. Knowledge of digital twins and IoT will be desirable, and the application will be in viticulture. Candidate with knowledge of grapevine phenology is strongly encouraged to apply.

Application: This project is supervised by University of New South Wales and Charles Sturt University combined, to apply please submit your application to University of New South Wales.

Project 4

PhD Project: Development of Wine Industry Digital Twin for Improved Sustainability Measurement, Reporting and Verification

Description:

This project aims to create a digital twin harbouring data on (one of the focus points from Sustainable Winegrowing Australia program, such as environmental impact, social responsibility, economic viability, certifications and stakeholder engagement. https://www.wineaustralia.com/sustainability/sustainable-winegrowing-australia Sustainability Action Plan) to monitor and improve sustainability for Australian wine industry in a (TBC) region. The digital twin will enable tools for evaluating water value, adaptation to climate change, clean environment, land care and biodiversity credit, zero waster target.

Objectives:

1. To develop a digital twin model for sustainability analysis.
2. To improve measurement and reporting accuracy.
3. To enhance decision-making in vineyard management.

Deliverables:

1. An operational digital twin model for the wine industry.
2. Improved sustainability practices.
3. Enhanced accuracy in sustainability reporting.

Preferred candidate (skill set):

The preferred candidate should have programming and data science abilities, with experience in sensor technologies or IoT being highly desirable. A background in agricultural /viticulture/environmental science will be desirable. Familiarity with digital twin modelling, remote sensing, and cloud computing is valued, as is a commitment to learning and advancing in these areas. The successful candidate will have the ability to work with large datasets, applying data-driven insights to tackle real-world agricultural challenges. Problem-solving skills are essential, along with a collaborative spirit to bridge the gap between agricultural needs and innovative digital solutions for a sustainable future.

Project 5

PhD Project: Implementation of Digital Twin Technology for Environmental Monitoring and Sustainable Land Use Management in a Dairy Production Region

Description:

This project aims to apply digital twin technology to map and monitor land use in the dairy production region, focusing on greenhouse gas (GHG) monitoring and enhancing environmental sustainability. Utilising data from satellite imagery, drones, sensors, and weather stations, the digital/quantum twin will integrate land topography parameters, soil health data, and microclimate data to provide a dynamic and comprehensive representation of the region. This approach will enable better decision-making and environmental stewardship in dairy production, GHG monitoring, grazing management, enhancing both productivity and sustainability.

Objectives:

1. Develop a high-resolution digital twin of the dairy production region for land use classification.
2. Monitor and analyse land topography, resource utilisation, and environmental impacts.
3. Optimise land management practices to enhance sustainability and productivity.
4. Facilitate compliance with environmental regulations, to support stakeholder collaboration and informed decision-making.

Deliverables:

1. Comprehensive digital/quantum twin model of the dairy production region, incorporating detailed land use classifications.
2. Real-time environmental monitoring dashboard providing up-to-date insights into resource utilisation and environmental impacts.
3. Optimisation and decision support tools to aid in sustainable land management practices.
4. Regulatory compliance reports documenting adherence to environmental standards and facilitating regulatory interactions.
5. Training and engagement materials to educate stakeholders and promote active participation in sustainable dairy production practices.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of digital twins, IoT and GIS will be desirable, and the application will be in agricultural environment.

Application: This project is supervised by University of Queensland and Charles Sturt University combined, to apply please submit your application to University of Queensland.

Project 6

PhD Project: Towards A Digital Twin System for Integrated Dryland Crop Monitoring

Description:

Incorporating soil information, topographic information, farm management data and other crop data sources this project will refine crop monitoring capability by remote sensing, spatial pattern etc. Using GIS imagery data, meteorological data and ground truth data sets on crop phenology, disease pressure, this project is going to build a dashboard offering real-time crop monitoring function for stakeholders. With machine learning models to train data sets for identifying weather patterns, GIS imagery for fertiliser management decisions and disease prediction.

Objectives:

1. To integrate soil, topographic, farm management, and crop data for enhanced crop monitoring.
2. To develop machine learning models for weather pattern identification, fertilisation decisions, and disease prediction.
3. To build a real-time crop monitoring dashboard for stakeholders using GIS imagery, meteorological data, and ground truth datasets.

Deliverables:

1. A comprehensive data repository of well-organised dataset integrating special imagery, soil information, topographic data, farm management records, meteorological data, ground sensing data.
2. Towards building digital twin with maps and reports identifying spatial patterns and hotspots in crop health and productivity.
3. Trained models for weather pattern identification, disease prediction, and fertilisation for precision farming.
4. A user-friendly, interactive dashboard with real-time monitoring function that tested for prediction and supporting decision making.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of agriculture/agronomy/crop science, digital twins, IoT and GIS will be desirable, and the application will be in agriculture crop.

Project 7

Honours Student Project: Developing A Digital Model to Analyse Soil Moisture Retention Capacity for Optimal Probe Location

Description:

Soil water probes are essential tools for monitoring soil moisture retention in agricultural settings. However, variability in soil moisture caused by **soil heterogeneity**—including factors such as texture (sand, silt, and clay proportions), structure, organic matter content, and compaction—presents significant challenges. Current methods for determining probe placement often rely on landscape features and water runoff patterns, which may overlook other critical data layers.

This project adopts a **data-centric approach** to enhance decision-making by analysing multiple layers of information, including soil characteristics, land topography, and rainfall patterns. By integrating these data sources, we aim to develop a predictive model that identifies the optimal locations for placing soil moisture probes, improving monitoring accuracy and efficiency at the paddock level.

Objectives:

1. Data Identification and Collection: Compile and analyse relevant datasets required to build a digital model, including soil properties, environmental conditions, and topographical features.

2. Algorithm Development: Design algorithms to model the influence of soil and environmental factors on soil moisture retention capacity.

3. Predictive Model Creation: Develop and validate a digital model to recommend the most representative and effective locations for soil moisture probe placement within a paddock.

Deliverables:

1. Interactive Dashboard: A user-friendly platform for visualizing soil characteristics, environmental data, and moisture retention patterns.
2. Tested Predictive Model: An integrated tool combining soil and environmental data layers to predict crop development and guide probe placement.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of crop science, digital twins and IoT will be desirable, and the application will be in agriculture.

Project 8

Honours Student Project: Developing A Digital Model for Correlating Farm Condition and Machinery Performance

Description:

Machinery plays a crucial role for farm operation and management. Its performance determines the efficiency on utilising farm resources and ultimately crop development. With data centric technology, this project aims to integrate continuous machinery performance data and farmland, agronomic data for improved crop management.

Objectives:

1. To develop a dashboard for data visualisation of ongoing machinery performance such as engine performance, engine temperature wheel flip, fuel usage etc with concurrent GPS data.

2. To develop and test model on correlation between machinery performance and land spatial characters, crop growth conditions.

Deliverables:

1. A dashboard for data visualisation of machinery performance with concurrent GPS data.

2. A tested model on correlation between machinery performance and land spatial characters, crop growth conditions.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of machinery, digital twins and IoT will be desirable, and the application will be in agriculture.

Project 9

PhD Project: Using Data Science and Digital Twin technology on Developing Landscape Metrics for Animal Welfare in Extensive Grazing Systems

Description:

This project aims to develop quantitative landscape metrics and animal data into practical tools and knowledge that grazing producers can measure animal welfare outcomes in extensive grazing systems, using data science and digital twin modelling to enhance both welfare and business outcomes through landscape stewardship.

Objectives:

1. Analysing existing landscape and animal data to identify landscape factors with the greatest influence on animal welfare metrics like stress levels, movement, and reproduction rates etc.

2. Developing digital twin models of grazing lands that can simulate the impacts of landscape management changes on animal welfare and production outcomes.

3. Validating models through field data collection on animal responses to landscape features like shelter, water access, and vegetation quality.

4. Demonstrating use of models to grazing producers to guide landscape management decisions that optimise both animal welfare and economic productivity.

5. Disseminating research findings to industry and markets to help Australian producers meet emerging requirements for animal welfare credentials and sustainability.

Deliverables:

1. Identification of quantitative landscape metrics and thresholds that reliably indicate animal welfare in grazing systems. This will provide clear guidance for producers on landscape management best practices.

2. Development and validation of digital twin models that simulate relationships between landscape factors, management decisions, and animal welfare/production outcomes. These tools can help optimise landscape management.

3. Improved understanding and ability to measure animal welfare in the context of extensive grazing systems, addressing a major knowledge gap for industry.

4. Demonstration to producers of how landscape management optimisation can boost both animal welfare and economic returns through improved productivity.

5. Strengthened animal welfare credentials for Australian grazing industries, supporting access to export markets demanding high welfare standards and sustainability.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of animal science/veterinary, digital twins, GIS, remote sensing and IoT will be desirable, and the application will be in agriculture environment, particularly around livestock.

Project 10

PhD project: Integrated Australian Shorn Wool Production Forecasting System Using Digital Twin Technology

Description:

The Australian wool production forecasting traditionally relies on data from the Australian Bureau of Statistics (ABS), which conducts a comprehensive primary production survey every five years. This survey includes detailed information on livestock and crop numbers. However, the ABS has decided to discontinue this survey, leaving the wool industry without this crucial data. Despite this, there is consistent weekly data collected on livestock sales, slaughter numbers, and wool sales, including quality metrics. By analysing historical data from Australian Wool Production Forecasting Committee (AWPFC) (https://www.wool.com/market-intelligence/wool-production-forecasts/) along with climatic conditions, satellite imagery of pasture information, and current weekly data this project will develop an integrated Australian Shorn Wool Production Forecasting System focusing on the following objectives.

Objectives

1. Develop a digital platform to integrate climatic conditions and satellite imagery to assess pasture conditions historically such as maps showing pasture conditions over time on a local government area (LGA) basis.
2. Generate models leveraging historic data and real-time data such as weekly records of livestock sales, slaughter numbers, and wool sales, including quality metrics for accurate predictions of wool yield and quality.
3. To incorporate economic factors in the forecast system to analyse how market conditions (e.g., price changes) affect production decisions, to predict the influence of economic trends on wool production volumes and quality.
4. Integrate data on various stake holders such as buyers, processors and producers for valuable market insights to make informed decisions about livestock management and wool production.

Deliverables:

1. A data collection framework for collecting and integrating data from livestock sales, slaughter numbers, wool sales, climatic conditions, and satellite imagery of pastures.
2. A comprehensive analysis of historical livestock numbers, wool production, and quality metrics and correlation of historical data with climatic and pasture conditions.
3. Pasture condition mapping showing historical and current pasture conditions on an LGA basis using satellite imagery and climatic data.
4. Economic impact modelling that incorporates economic factors, such as market prices, to predict their influence on wool production and quality.
5. Forecasting algorithm development to forecast wool production volumes and quality based on collected data and identified correlations.
6. A user-friendly interface and reporting tools for stakeholders to access and interpret forecast data.
7. Validated and tested forecasting model to ensure accuracy and reliability.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of animal science, digital twins, GIS, remote sensing and IoT will be desirable, and the application will be in wool production.

Project 11

PhD project: Data-Centric Model of Remote Sensing on Soil Carbon

Description:

A system has been developed to estimate soil organic carbon using remote sensing, regionally based soils data, weather data, and climate data. While soil organic carbon measurements can vary significantly based on sample preparation and environmental conditions, making it difficult to achieve precise results with satellite data alone, the system has shown some intuitive accuracy, reflecting changes observed in the field, such as lower carbon levels during dry periods and higher levels during wet periods. To further develop the system, there is a need to focus on the local level of data required to improve accuracy and potentially making it predictive.

Objectives:

1. Use extensive soil testing data to compare the existing system's estimates with actual measurements for validating the accuracy of the remote sensing data.

2. Incorporate local data including soil and environmental data, farm management practices like grazing intensity and data on historical, current soil carbon levels for predicting the impact of different agricultural practices on soil carbon sequestration.

3. Develop predictive models that integrate the foregoing types of data to provide robust guidelines for farm management practices such as grazing intensity.

4. To influence and improve farming practices sustainably by continuous improvement.

Deliverables:

1. A data framework of extensive soil testing data on the existing system’s remote sensing data.

2. Comprehensive data analysis of conducted soil testing to provide a foundation for validating the accuracy of the remote sensing system.

3. An improved model that incorporates local soil and environmental data, resulting in more accurate soil carbon estimates. This model should address the variability caused by different sample preparations and environmental conditions.

4. A tool or software that links farm management practices to soil carbon levels, enabling farmers to predict the impact of different practices on soil carbon sequestration. This tool will provide actionable insights for sustainable farming practices.

5. A comprehensive report documenting the validation process, including what worked and what requires refinement. This report should include case studies and evidence-based recommendations for using the remote sensing system effectively.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of soil/environmental science, digital twins, GIS, remote sensing and IoT will be desirable, and the application will be in agriculture environment.

Project 12

PhD project: Using Data-Centric Tools to Develop a Comprehensive Digital Twin for Charles Sturt University's Commercial Farm

Description:

The Charles Sturt University Global Digital Farm spans a 1600-hectare full-scale, commercially operating mixed farm, providing an integrated environment for digital learning, innovation, and research. This project aims to develop a digital twin of the farm, accurately representing the physical landscape with detailed land use information, landscape capability, and the natural environment for crop and livestock production. Additionally, it will encompass greenhouse gas emissions, carbon reporting, and biodiversity dynamics.

The digital twin system will integrate historical data on soil characteristics, water retention, weather patterns, and farm management practices. This comprehensive dataset will enable the implementation of robust crop growth models, such as APSIM, linked with spatial data for localised farm paddocks. This integration will support informed decision-making to optimise land potential.

Furthermore, this system will facilitate teaching and research activities on the farm, showcasing modern farming practices in the digital era.

Objectives:

This project aims to

1. Establish a comprehensive data repository for the CSU Global Digital Farm, integrating all aspects of farm operations with various data layers, including GIS, topography, land use, soil characteristics, and real-time weather information.

2. Develop digital dashboards to visualise farm operations, landscapes, and real-time weather data using the integrated data.

3. Leverage detailed data from soil moisture probes and robotic sensors to create models that explore correlations between influencing factors and farming practices, thereby enhancing decision-making for continuous sustainability improvements.

4. Utilise the collected data to implement precise crop growth models, such as APSIM simulations, on a per-pixel basis to optimise crop management and improve yield predictions.

5. Identify the most suitable land areas for different purposes (such as crops, pasture, and biodiversity zones) to maximise efficiency and sustainability. Transition from exhaustive sampling to targeted, strategic sampling to more effectively understand land capability.

Deliverables:

1. Comprehensive Data Repository: A fully integrated database containing multiple data layers (GIS, topography, land use, soil characteristics, real-time weather data).

2. Documentation outlining the integration process and data sources.

3. Digital Dashboards: User-friendly, interactive digital dashboards for visualising farm operations, landscape features, and real-time weather data.

4. Training materials and user guides for farm managers to effectively use the dashboards.

5. Predictive Models Using Sensor Data: Predictive models that identify correlations between influencing factors and farming practices.

6. Reports and presentations on the findings and implications for sustainable farming practices.

7. Precise Crop Growth Models: Implementation of crop growth models like APSIM on a per-pixel basis.

8. Detailed simulation reports on crop growth patterns and yield predictions.

9. Recommendations for optimising crop management strategies based on simulation results.

10. Land Suitability Analysis and Capability Assessment Tool: Detailed maps and visualisations showing these suitable areas based on various criteria (soil characteristics, topography, climate data, etc.).

11. Development of a digital tool or software for assessing land capability using the new targeted sampling strategy.

Preferred candidate (skill set):

The preferred candidate should have strong programming and data science skills. Knowledge of agricultural/environmental science, digital twins, GIS, remote sensing and IoT will be desirable, and the application will be in agriculture environment.

Appendix 1

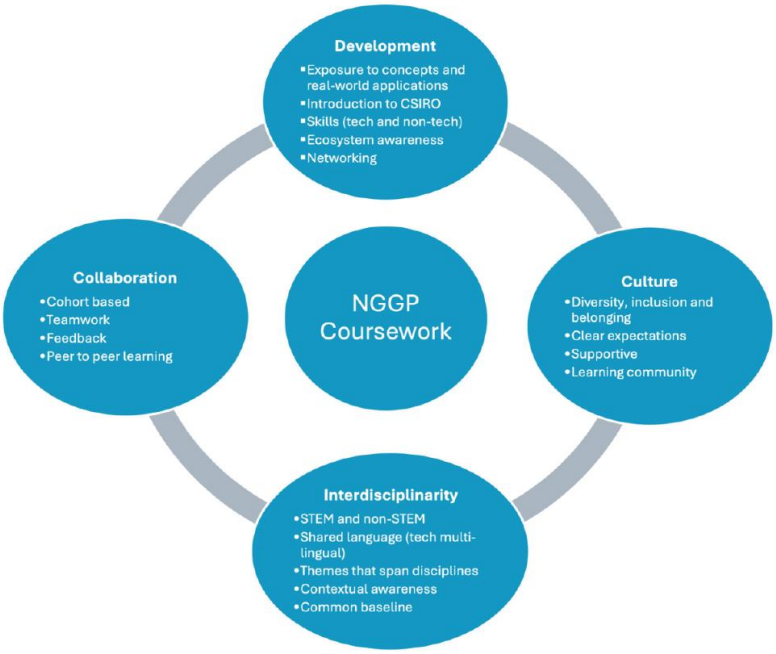
Next Generation Graduates Program (NGGP) Coursework Overview

November 2024

The Next Generation Graduates Program (NGGP) is a cohort-based, industry driven, multi-disciplinary graduate training program. PhDs, MPhils, Masters and Honours students will undertake coursework and in-depth training, providing them with a comprehensive understanding of problem-based environments in industry. They will explore trends in AI, Emerging Technology and Quantum, while cultivating entrepreneurial and innovative thinking required to thrive in a dynamic and fast-moving space.

Purpose

The purpose of NGGP Coursework is to build collaborative, interdisciplinary, industry-focused cohorts of individuals who are aware of where they sit within the ecosystem of technology development. It will provide students with unique opportunities to engage with a broad range of topics, themes, and research domains.



Based upon feedback and continuous improvement, the NGGP Coursework Overview may be updated from time to time.

Coursework Modules

While undertaking the following four modules, participants will complete an independent, in-depth project about their own research and industry context.

Data Centric Engineering

The development of AI and emerging technology systems in the real-world requires dealing directly with complex, heterogeneous, multimodal, and disorganised data. The implementation and deployment of these systems involves challenges which can only be tackled in a principled manner by following best practices from an engineering perspective – allowing efficient processing of large and incomplete datasets, deploying robust code, and scaling the processing capabilities in the cloud.

This unit integrates fundamentals from data science and engineering: It introduces basic data structures and data modelling, discusses techniques of data pre-processing, and analyses real-world datasets. Students will be exposed to a range of data intensive applications, and gain experience using practical tools, engage in collaboration activities and live workshops. From an engineering perspective, this unit covers the most significant data-engineering concepts and principles, such as DevOps, site reliability engineering and engineering design patterns.

Ethical Technology: Designing with Purpose

Emerging technologies and AI are already having an impact in the world around us, with governments and large corporations deploying systems which affect us directly. Developing and implementing AI-based solutions to real-world problems involves thinking out of the box, combining innovative ideas and tools while maintaining a user centred design and aligning with ethical frameworks.

This unit provides breadth of knowledge that will allow students to familiarise with moral dilemmas involved in socio technical systems – while keeping track of latest techniques, frameworks and building a viable roadmap for AI and emerging technology projects. Students will be guided by industry specialists and guest speakers to apply these concepts (with other fields of learning) in a series of live workshops. Student will discuss how their projects are aligned with AI ethical frameworks.

Foundations of Deep Tech

Artificial intelligence and emerging technologies are increasingly prevalent and changing the world we live in. The foundations of current AI innovations date back to the early 1900s: an understanding of this history and the theoretical foundation of AI is crucial to responsible practice in AI development. Familiarity with the scope of technology development in this space is also crucial to building interdisciplinary networks that drive innovation.

This unit provides a historical overview of the development of AI and its theoretical foundations, surveys the scope of application in society, and explores current trends and future directions. Students will explore themes around safety that span technologies, including cybersecurity, data privacy and ethics, before taking a deeper dive into the range of emerging technologies including developments in hardware, blockchain, IoT, robotics, augmented and virtual reality and immersive analytics.

Advanced AI/Emerging Technologies

Machine learning has gained traction as a powerful solution to complex problems using data. This unit covers both probabilistic machine learning, in which quantities of interest are represented as random variables, and deep learning, which uses neural networks to learn from large amounts of data. Probabilistic machine learning provides a framework for quantification of uncertainty – a crucial component for decision making in unstructured and stochastic environments, by developing a strong link between statistics and computer science.

This advanced unit covers the core aspects of probabilistic machine learning, including modelling, inference and decision making, providing an overall understanding of the general framework used in realistic scenarios.

The rise of neural networks as a flexible modelling tool, combined with powerful optimisation routines in high dimensional spaces, has resulted in an explosion of advanced computer vision and natural language processing, revolutionising many domain applications. Deep learning models are present throughout the internet and are responsible for search optimisation, recommender systems, image search and categorisation, language translation, and generative models among many others.

This unit covers the structural components of any computational system which uses deep learning, diving deeper into specific model structures that have recently proved very successful in specific applications, such as convolutional neural networks, recurrent neural networks, and transformers.

Throughout the module, students will engage in several collaboration activities and workshops to explore these ideas with their cohort and subject-matter specialists.

PhD and Master of Philosophy (MPhil) Students

PhD and MPhil students will complete up to 11 weeks of learning in total, with online content complemented by some in person opportunities to come together as cohort. The program design is 'flipped' in delivery, allowing students to watch guest lectures and complete activities asynchronously on the online Learning Management System, they then come together for facilitator-led synchronous sessions and workshops to further consolidate learning and to provide opportunities for peer-to-peer learning.

While some assessments (e.g. project tasks, quizzes and presentations) are included, completion of modules will not depend on graded assessment tasks, but on undertaking the learning with genuine engagement and participation. Students must complete the NGGP Coursework to the satisfaction of CSIRO.

Students will complete all four modules within **18 months** of commencement:

Begins February each year **5 weeks in total for 2 modules** **24 hours a week of learning content**	✚	**Begins April each year** **6 Weeks in total for 2 modules** **18 hours a week of learning content**
• Data Centric Engineering		• Foundations of Deep Tech
• Ethical Technology: Designing with Purpose		• Advanced AI/Emerging Tech

Masters and Honours Students

Masters and Honours students are required to complete two modules during their candidature:

Runs throughout the year from February to November **includes content from 2 *modified* modules** **On average up to 5 hours a month of learning content (asynchronous and live)**
*Data Centric Engineering
*Ethical Technology: Designing with Purpose

Masters and Honours Students will engage with components of the module content online and have opportunities to come together for live sessions. The delivery methodology for this cohort is tailored to meet the students' needs and is more industry focused and designed to enhance their professional development, and does not include assessment tasks. This prepares the students to transition into organisations where they can apply their skillsets with confidence.

Students must complete the NGGP Coursework to the satisfaction of CSIRO.

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