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| **Topic** | **University supervisor/s** | **Project description** |
| Online digital mapping for better farm management | Professor Budiman Minasny | Digital agriculture draws decision to support on-farm management from a suite of soil and environmental data. Soil and many environmental data in Australia are currently available at a resolution of 100 m or coarser and not suitable for farm management and decision-making. This project will develop an online mapping tool which takes current field observations and maps and turns them into digital soil and climate maps at a fine resolution (30 m or finer) required for decision making. The methodology behind this tool is based on digital soil mapping technology developed in Sydney. The project will also develop efficient techniques to disaggregate coarser maps into fine resolution information. These maps will be combined with historical crop yield, weather data, crop management, and environment information to derive agronomic decisions for a farm meet its productivity and sustainability challenges. |
| Remote monitoring solutions for beef cattle welfare and productivity | Associate Professor Cameron Clark and Professor Sergio (Yani) Garcia | The focus of this project will be to develop and evaluate innovative methods to capture, analyse and optimise data derived from a range of technologies and sensors to optimise beef cattle health, welfare and efficiency in feedlot. Data sources may include a combination of animal, climate, farm and processing plant data and others. This multidisciplinary project interrelates diverse areas of research including livestock science, behaviour analysis, complex data acquisition and analysis, machine learning and optimisation using sophisticated modelling tools. The broad scope of the project, and its interdisciplinary nature, allows emphasis in specific area/s to be placed according to candidate's background and expertise. There is a clear need for advanced integration and utilisation of sensor-derived data to optimise monitoring, intervention and feeding management of individual beef cattle in feedlot. Technologies exist that allow animal behaviour and traits to be monitoring in real-time but these have not been integrated with other sources of information from the animal, the weather and the whole system. This project will be to develop and evaluate innovative methods to capture, analyse and optimise data derived from a range of technologies and sensors to optimise individual cow sorting at induction, health monitoring and pen feeding in feedlot.  A range of methodologies including controlled and feedlot studies, machine learning and advanced modelling is envisaged to be used.  |
| Yield forecasting for the sugar industry for improved fertiliser inputs | Associate Professor Thomas Bishop and Dr Patrick Filippi | The sugar industry relies on high fertiliser inputs to achieve yield targets however the high rainfall and proximity to coast make off-farm impacts of excessive fertiliser more serious than other industries. One approach to reduce this risk is to develop seasonal forecasts at a fine spatial resolution which are used to inform fertiliser inputs.The project will have 3 components -develop a data-driven approach using machine learning and geospatial data to forecast yield. The approach is based on aggregating yield observations over multiple blocks, farms and seasons to build the model. This will require some methodological development around the spatial support of the observations as the yield data in sugar cane is block averages (2-6 hectares) of varying shapes;-test the yield-forecasts with whole-block experiments where fertiliser rates are based on the seasonal yield forecasts-develop a methodology to analyse spatial experiments typical in Precision Agriculture. The statistical issues that need to be overcome relate to the fact that the response (yield) to each plot, strip has a large number of observations that are spatially correlated. While accounting for this we need to be able to map the treatment effect and its uncertainty spatially across the experimental area and perform hypothesis testing for each prediction. The methodology will be developed using linear mixed models with exploration of approximate and composite likelihood methods for handling the large dataset size.The proposed study area is the Bundaberg region with the USYD Supervisor has existing collaborations with extension to the other regions subject to data availability. |
| Near-real time prediction of C and N soil dynamics and plant nutrient update | Dr Federico Maggi and Professor Budiman Minasny | The recent implementation of climatic forecasts in near-real time mechanistic predictors of ecohydrological water fluxes into and from soil (Guglielmo et al, 2019) allows us to expand on soil biogeochemistry and plant nutrient uptake. The proposed project aims to develop and test assessment tools that make use of process-based mathematical models and use weather forecasts as the boundary to make short-term (up to 15 days), high time resolution predictions of carbon (C) and nitrogen (N) availability in soil and nutrient uptake by plants. We target managed crops, where an efficient use of fertilizers and irrigations is vital to maximize crop yield in water and nutrient stress conditions, and minimize costs. |
| Hyperspectral data management for crop trial analysis | Dr Phil Davies and Associate Professor David Gallacher | Use of hyperspectral data in crop trial analysis has progressed slowly despite potential benefits, particularly for plant breeding efficiency. A significant limiter has been the complexity of collecting and manipulating data, requiring skills not typically held by breeders and agronomists. This project will develop automated processes that capture hyperspectral field data via a drone-mounted sensor and process the data into a researcher-ready form. The project will then test the automated process(es) on pre-existing field trials, using existing research activities for ground-truthing.Field trials will be selected to represent variation in traits of value for plant breeders and agronomists. Hyperspectral data will be gathered from these trials and used to investigate both trait linked and spatiotemporal patterns within the trial. While sufficient field-trials are available at USyd Narrabri, CSIRO field trials could also be incorporated should traits of particular interest be identified. Examples include, but are not limited to:* Drought resistance of wheat and chickpea
* Crown rot of wheat
* Nitrogen dosage response

The student’s thesis will focus on hyperspectral data management for applied agronomic research. It will explore efficiencies in data management; e.g.; when and how to reduce data volumes, whether to use single exposures or orthomosaics, how workflows are affected by different spatiotemporal expression. The student will be expected to work with agronomists and breeders to understand their needs, but will not be expected to understand biological processes |
| Development of accurate and rapid diagnosis of rice diseases through AI machine learning using mobile application  | Associate Professor Rosanne Quinnell and Associate Professor Daniel Tan | Optimising rice productivity is one of the major determinants in achieving future food security as rice is a major staple food and currently feeds more than three billion people, most of whom are from developing countries where population growth is most rapid. Plants pathogens are one of the most significant causes of yield loss and quality reduction in rice production. The most common disease worldwide being a pathogenic fungus - *Magnathorpe oryzae* (rice blast), which causes necrotic lesions on the leaves and panicles of rice. Northwest Cambodia (NWC) is known as the “rice bowl of Cambodia” due to its rich soil fertility and high productivity; however, fungal rice blast is present in all of these lowland rice-growing regions. In NWC, the distinction between pathogenic organisms (bacterial, viral and fungal) is rarely known due to limited availability of accurate information on diseases, and that many farmers have had little or no formal education. Rice farmers simply refer to most, sometimes all of, plant diseases as “Kra” meaning “sick plant” in Khmer.Misidentification and misdiagnosis of plant diseases leads to incorrect management decisions resulting in money and time resources being wasted. To an untrained eye rice blast and bacterial blight have very common symptomology; however, the former is a fungal pathogen and the latter a bacterial disease. The management options require very different approaches; for example, the applications of either a fungicide or bactericide.This project aims to develop a mobile application (app) that incorporates evidence-based research findings collected in NWC. The main function will be to use machine learning to identify plant diseases based on the symptomology of rice plants and will act as a decision tool for smallholder rice farmers. This will be achieved by providing information and management options linked with each diagnosis which will be provided in Khmer (text and voice recordings) to ensure accessibility to farmers and to increase the likelihood of adoption of this technology |
| Image based site weed recognition | Dr Zhiyong Wang and Dr Michael Walsh | Advances in site-specific weed control requires accurate recognition of various weed species in site-specific crop fields. This project aims to establish a large scale dataset of weed images collected under various conditions (e.g., different sites and different crops) and to develop advanced machine learning techniques for this purpose. The outcomes of this project will benefit the development of new site-specific weed control strategies. |
| Machine Learning Approaches for Crop Health Monitoring and Yield Estimation | Dr Zhiyong Wang | Crop health monitoring and yield estimation are of great importance for precision agriculture, not only for harvest logistics planning, but also for operational decision making. The objective of the project is to develop advanced machine learning approaches for better monitoring crop health and growth and estimating crop yield, which will assist in decision making for growers and food supplier chains. The outcomes of this project will advance the current farming practice for more effective and sustainable agriculture. |