HUMAN-CENTRED TECHNOLOGY SUMMER PROJECTS
2016-2017

HCT2016/1 A discipline-aware interface for multi-disciplinary collaborative learning
A/Prof Corinne Caillaud (Charles Perkins Centre), Dr Marie-Claude Gregoire (ANSTO), A/Prof Kalina Yacef (School of Information Technologies)

Background: This project is proposed in the context of a new unit of study that will put together students from different disciplines to solve research questions on metabolism using various state of the art ANSTO/University of Sydney imaging platform technologies. The multi-disciplinary nature of this unit brings excellent learning and collaborative opportunities but also a number of challenges, as students with various backgrounds and expertise need to communicate and work effectively as a team, each bringing their own expertise and viewpoint. For instance Glucose metabolism can be explored at different scales (from cell to living organisms) in both animal models and humans. The challenge is to provide student teams with a global understanding of both the physiological problem and the technical solutions to explore it. This project aims at building a learning environment that will support problem solving within a multi-disciplinary approach.

Project: Create the foundations of a system that will manage the learning exercises and the different viewpoints relevant to the disciplines involved (eg: physiology, cell biology, molecular biology, biophysics, chemistry, pharmacology, imaging, statistics) and adapt its interface and content to the discipline of each student. During this summer scholarship, the scope will be limited to 2-3 disciplines and 2-3 technical tools.

HCT2016/2 Analysing the Immune Response through Dynamic, Dimensionality-Reducing, Time-Series Clustering
A/Prof. Irena Koprinska (School of Information Technologies), A/Prof Uwe Roehm (School of Information Technologies), Dr Mark Read (Charles Perkins Centre), Prof Nick King (Charles Perkins Centre), Thomas Ashhurst (Charles Perkins Centre)

Cutting edge technological advances in mass cytometry have enabled unprecedented detailed analyses of immune cells. This technology can rapidly measure around 40 parameters on each cell in a population of millions. However, computational analyses to make sense of the resultant high-dimensional data sets are lacking.

This project will explore how machine learning can help advance this field of immunological analysis. Specifically, we will explore how dimensionality-reducing clustering algorithms can be applied in a way that explore cluster evolution over time. The techniques developed will show in fine detail how an immune response progresses, how sub-populations develop and evolve into one another, and how these sub-populations correlate with specific phases of disease.

This project will have access to a West Nile Virus (WNV) dataset to aid in development. WNV is a mosquito-borne disease that causes inflammation in the brain; it is lethal for some, and others never develop symptoms, yet the early immune response decisions underlying this disparity are unknown. The techniques developed here represent a key-enabling technology for mass cytometry, and are applicable to a wide variety of diseases beyond WNV; other data sets can be made available for this project if needed.
**HCT2016/3 Automated detection of vehicle control in VR simulations**

Dr Sabina Kleitman (School of Psychology), Prof Judy Kay (School of Information Technologies), Dr Simon Jackson (School of Psychology), Dr Fabio Ramos (School of Information Technologies)

The CODES Research Lab is currently piloting a VR driving simulation to test people's ability to adapt under changing conditions. Among other goals, this simulation is being used in research attempting to automate the real-time detection and communication of changes in drivers’ performance levels. Video recordings and raw data streams of driver inputs (e.g., steering wheel angle, accelerator and brake level) will be collected for multiple drivers during pilot testing. The successful candidate will be responsible for working with this data to automate the detection of occasions in which the driver has lost control of the vehicle. This will involve considerable data wrangling, manual video tagging, data mining and the implementation of supervised and unsupervised machine learning algorithms. Experience using R (particularly for machine learning) is desirable.

**HCT2016/4 Campus Flora for Cultural Competence**

Dr Rosanne Quinnell (School of Life and Environmental Sciences), Prof Alan Fekete (School of Information Technologies)

Campus Flora is a suite of apps (web, iOS, android) designed and developed by students and staff at the University of Sydney. The existing trails in the App are aligned to the biology curriculum and used in the undergraduate Biology to engage users with the living botanical world on our campuses and to improve ‘botanical literacy’. Interesting, the broader campus community also uses the apps and there are requests to include trails that can be used for 1) ‘walking meetings’ to improve workplace health, 2) ‘cultural competence’ with the inclusion of ethnobotanical narratives and indigenous language, 3) outreach for visitors to the University. There is a lot of interest outside of this University from those who would like to adopt and adapt the CampusFLora system.

**Development of Trails:** At the moment we offer ‘trails’ as a simple filter. Ideally we would like to offer trails as walking paths and to include some information about the trail. Some restructuring of the RubyOnRails database would be required in order to select individual trees with species and to capture the ‘trail information’ (Priority 1).

**Broader Adoptions:** Being able to offer an easily downloadable database ‘framework’ to schools in the local area would allow students and staff at those locations to develop their own content for their own context. With this in mind, we would like to offer the webApp as a downloadable system so local schools, TAFEs, Botanic Gardens can offer their own Campus Floras (Priority 2). Some finessing of the system to allow upload of observations captured in, say, iNaturalist would be idea (Priority 3).

**Data updates of mApps:** Once a solution for trails is offered in the WebApp, the mApps will need to modified to offer trails as path ways(Priority 4). Currently the Ruby-On-Rails database does not communicate with the mobile apps to ensure content is up to date. Every so often trees are removed and others are planted so an ‘endpoint’ solution is required (Priority 5).

**HCT2016/5 Data Mining and Interfaces for i-Engage**

A/Prof Kalina Yacef (School of Information Technologies), A/Prof Corinne Caillaud (Charles Perkins Centre), Prof Margaret Allman-Farinelli (Charles Perkins Centre), Dr Olivier Galy (University of New Caledonia)

Background:
Non-communicable diseases (NCD), including cardiovascular diseases and type 2 diabetes, are a major cause of deaths (75%) in the Pacific Islands countries. The i-Engage project aims at reducing the incidence of NCDs through increased physical activity and healthier food
choices. i-Engage is a multicomponent intervention, supported by an online education platform, providing high school students with engaging learning activities, sensing devices and a team challenge to improve their health literacy with regards to physical activity and food choices, and engage them in goal setting and self-monitoring. The main research project partners are the University of Sydney and University of New Caledonia in collaboration with two NSW industry partners.

Project A: i-Engage will be deployed over a 6 week pilot study in semester 2, 2016. This project will consist in mining the data that collected from the multiple sources (e-learning platform, sensing bracelets and relevant anthropomorphic data) to extract patterns that can help improving and personalising the technology.

Project B: This project will consist in creating a set of intuitive interfaces for various end-users (such as program directors, public health researchers, school directors, parents and children) ranging from simply monitoring progress to visualising cohorts’ results and elaborating some mining and statistical queries.

HCT2016/6 Software to develop tailored decision aids for patient health issues
Dr Carissa Bonner (Sydney School of Public Health), Prof Kirsten McCaffery (Sydney School of Public Health), Prof Lyndal Trevena (Sydney School of Public Health), Dr Na Liu (School of Information Technologies)

Rationale: This project is part of a Centre of Research Excellence (CRE) at the School of Public Health, which will develop new systems to help doctors discuss up-to-date health research with their patients so they can make an informed decision together. Part of this project involves creating and testing decision aids, which present evidence-based information about the health issue, the risks and benefits of different management options (e.g. medication or changing diet), and activities to support decision making. They may use a variety of different textual, numerical, graphical, audio and visual formats to convey this information to patients with different levels of health literacy.

Aim: To develop software that will allow our research group to create and test different decision aid formats, based on a patient’s individual health risk calculation and their health literacy level.

Basic requirements: All content will be provided by the CRE. The software will involve 4 functional stages, that may be within a standalone program or developed as add-ons to existing functions within existing survey software (e.g. survey monkey, qualtrics):

1. Survey: questions about relevant patient characteristics (risk factors + health literacy)
2. Add-on: Generate individual risk results for several health risk calculators depending on available data (e.g. breast cancer, CVD, diabetes – algorithms will be provided)
3. Add-on: Generate different risk result formats using various text, number, and graph-based formats (e.g. risk level, percentage risk, icon array)
4. Add-on: Option to read out results to patients using an avatar
5. Add-on: Generate printable decision aid booklet based on a template where the researchers can insert explanatory text about the health issue/options, images, and selected risk result formats from stages 2 and 3
6. Survey set up: researchers able to set up basic survey questions and select which risk formats to show to selected/randomised groups of participants, create URL link to invite participants to complete a survey
7. Survey participation: participants complete risk calculator questions (stage 1), see selected risk result/format/decision aid/avatar explaining results (stages 2-5), answer further questions (stage 6)
8. Data collection: researchers download participant data in a secure password-protected table that can be downloaded as an Excel file by STEP.

Optional additional requirements:
We are also interested in testing other audio-visual and interactive formats for conveying health information.

| HCT2016/7 Using Internet measurement and cyber policy to detect network interference  
| Dr Ralph Holz (School of Information Technologies), Dr Frank Smith (Centre for International Security Studies) |

The Internet is no longer an open network. A multitude of options now exist for governments and other organisations to filter the free flow of information online. While there are benign uses for filters (e.g. preventing industrial espionage), this technology is dual-use and can therefore have harmful or undesirable effects as well. These range from accidentally blocked information and purposeful censorship to malicious violations of net neutrality and incursions into personal privacy.

This research project will examine the use of Internet filtering technology in certain areas, most likely South East Asia. In short, the official policies of several countries will be compared with their observed practices for network interference. Analysis will draw on empirical data collected through the Open Observatory of Network Interference (Tor) and possibly Citizen Lab, as well as original policy research. This cross national comparison will be supervised by members of the Human Centred Technology cluster with technical and political expertise, providing student researchers with a unique combination of multidisciplinary mentorship.

Two HCT Summer Scholarships are offered in this project:

a. We are looking for one outstanding candidate with a strong background in computer networks and quantitative data analysis. The ideal candidate is a multidisciplinary team player who understands the links between computer and social sciences.

b. We are looking for another outstanding candidate with a strong background in national security policy and/or Internet governance. The ideal candidate is a team player with a keen interest in information technology and a willingness to work with computer scientists.

| HCT2016/8 Visualising the High Dimensional Temporal Development of the Immune Response  
| A/Prof Irena Koprinska (School of Information Technologies), A/Prof Uwe Roehm (School of Information Technologies), Dr Mark Read (Charles Perkins Centre), Prof Nick King (Charles Perkins Centre)  
| Thomas Ashhurst (Charles Perkins Centre) |

Cutting edge technological advances in mass cytometry have enabled unprecedented detailed analyses of immune cells. This technology can rapidly measure around 40 parameters on each cell in a population of millions. However, computational analyses to make sense of the resultant high-dimensional data sets are lacking.

This project will explore dynamic visualisation techniques that intuitively summarise the development and evolution of the immune response, as characterised through high dimensional temporal data. This is important in gaining insight into how particular cellular populations correlate with specific phases of disease.

This project will have access to a West Nile Virus (WNV) dataset to aid in development. WNV is a mosquito-borne disease that causes inflammation in the brain; it is lethal for some, and
others never develop symptoms, yet the early immune response decisions underlying this disparity are unknown. The techniques developed here represent a key-enabling technology for mass cytometry, and are applicable to a wide variety of diseases beyond WNV; other data sets can be made available for this project if needed.

There is a rapidly growing trend for people to use digital technologies and e-learning platforms to acquire new skills, healthy behaviours, or knowledge. For example, to increase physical activity people track their movements with wearable technology, or directly engage with virtual reality exergames; likewise, to acquire new knowledge and skills within or outside of formal degree programs, people are turning to e-learning platforms to learn independently in their own time. In all of these cases, users of these technologies are in control of how much time they spend on any given task or activity, and the task sequence. However, recent findings suggest that having this control is only beneficial for people if they are actively reflecting upon their own experience allowing them to make optimal decisions about how to spend their time. While some seem predisposed to engage in this reflection, many are not, and even those who do often misestimate their progress. A common problem across these domains is that it’s not clear how to best present people with feedback about their performance and how their performance relates to their goals. The purpose of this project is to design a dashboard which presents feedback to users of fitness and educational technologies about their progress in order to foster successful strategies for goal-achievement.

Personality questionnaires backed by psychology theories have long been used to classify people into broad psychological groups. For example, the Big Five model of personality assigns a score to a person for the following five personality traits: openness, conscientiousness, extraversion, agreeableness and neuroticism. This project will explore the feasibility of determine a person's personality type without the need for a dedicated questionnaire, relying on physiological and behavioural indicators instead. The subject will be presented with a stimuli (e.g. a game, photo, music, video clip or a simple task to do) and different types of signals will be measured, e.g. behavioural signals such as gaze duration, psychological signals such as pupil dilation and brain activity, and IT-interaction signals such as mouse clicks. The goals will be to investigate if it is possible to build a classifier that is able to predict accurately the personality type, using the information from these signals.

The project will involve experiment design, data collection and analysis using machine learning techniques. It is a collaboration between the School of IT, CSIRO Data61 and the School of Psychology.

Required skills: good programming skills and background knowledge in machine learning (e.g. completed COMP3308/3608).