WESTERN SYDNEY
UNIVERSITY

School of Computer, Data and Mathematical Sciences

Summer Scholarship Research Program 2020

Project Lists

Project 18: Statistical learning of chronic disease priorities in a Western Sydney Primary Health Network

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Project description

This project is part of a recently established research collaboration between WentWest Primary Health Network, the Translational Health Research Institute, and the Centre for Research in Mathematics and Data Science at WSU, entitled “Health analytics for the evaluation of chronic disease priorities”.

There is a high chronic disease burden in this catchment, and a need to ensure optimal allocation of resources and commissioning of most appropriate services to address the chronic disease burden. Using already obtained datasets from the Western Sydney University the goal is to assist in the exploration of related markers for chronic diseases to enable future early detection.

Large amounts of routinely collected data are currently used to inform the above. However, better integration of datasets will ensure more accurate assessment of disease burden and key health priorities, and inform evidence-based needs assessments to guide the commissioning of services.

Additionally, more innovative approaches are required to develop trajectories of risk in order to identify those individuals at risk of chronic illness outcomes for early intervention and treatment, and to disseminate this information to service providers in the population catchment.

Project Aims

Data science approaches, especially machine learning and statistical analysis, can be used to ensure that the PHN datasets are used to more clearly characterise disease burden in the population catchment, define and monitor service use trajectories, and identify service-level priorities.

- To help in the development of analytic approaches for risk stratification and predictive modelling of client trajectories for identified chronic disease outcomes (CVD risk factors, Type II diabetes, and mental health presentations)
- To help in developing analytic approaches and resources for individualised practice feedback relating to 'at risk' clients.

Project Methods

- A range of de-identified PHN data sources will be used to address the objectives of the research collaboration, including the PAT-CAT and PAT-BI primary care datasets, information on mental health referrals and presentations in the primary care setting, and includes information services such as psychologists, psychiatrists, community mental health.
- Developing software to efficiently analyse the health care data.
- Data exploration approaches will be applied to visualise the data and reveal the internal structure of the time series.
- Graph-based methods and predictive models will be investigated.

Opportunity for Skill Development

- Skills in data analysis, including visualisation, and statistical learning
- Interaction with a primary health network, building expertise for future as a data scientist
- Presentation skills of research analysis
- Writing skills

Students are required to have the following skills/meet the following pre-requisite(s) to apply

Best suited to a masters-level student from a numerate discipline such as data science. Excellent candidates from statistics, mathematics, computer science, or electrical engineer would also be welcome. Programming in python or R.

Project 19: Road Network Management with Autonomous Vehicles

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Second Supervisor

Project description

Over the last decade, research on autonomous vehicles (AVs) has made revolutionary progress, which brings us hope of safer, more convenient and efficient means of transportation. An autonomous vehicle system is an integration of many technologies, including computer vision, graphical processing, navigation, sensor technologies and so on. Most significantly, the recent advance of machine learning technologies enables a self-driving car to learn to drive in any complex road situations with millions of accumulated driving hours, which are way higher than any experienced human driver can reach. However, it becomes a new challenge for road network management once we allow autonomous vehicles to travel mixed with human driving vehicles. The primary goal of this project is to design and implement road network management protocols for autonomous vehicles as well as human driving vehicles. The research aims to implement a simulation system in Java based on an open source project – the Autonomous Intersection Management (AIM) created by the AI Laboratory in the Department of Computer Sciences at University of Texas at Austin (http://www.cs.utexas.edu/~aim/). The existing system can be used to create a scalable multi-agent framework for managing autonomous vehicles at intersections. However, the system can only simulate three fixed traffic management protocols – First-Come-First-Served (FCFS), Stop signs and Traffic signal. Only FCFS protocol allows multiple intersections. The task of the project is to extend the existing system so that it can simulate more traffic management protocols, such as Virtual Roundabout, Give-way, and other prioritized road use protocols. We will design and implement different protocols to compare their effectiveness and efficiency, and extend the system to allow simulations with multiple intersection.

Project Aims

The aims of this project are

- Download and understand the existing AIM system.
- Design and implement three new road management protocols - Virtual Roundabout, Give-way, and Prioritized Intersections.
- Extend the system so that it can simulate multiple intersections for each road management protocol.

Project Methods

The Autonomous Intersection Management (AIM) simulation system was implemented in Java using multi-agent system paradigm. It is open source thus the source code is available for research purpose. The system is very well written with stand-alone application and well-designed user interface. Three road management protocols have been implemented:

- **FCFS** - The AIM protocol with the First-Come, First-Served policy.
- **Stop** - Stop signs.
- **Alternate** - A traffic signal protocol with four phases. First, vehicles are only allowed to go straight through the intersection. Second, all vehicles stop before the intersection. Third, vehicles are only allowed to make a turn. Fourth, all vehicles stop before the intersection.

We will extend the system so that it can simulation more complicated road network (multiple intersections) and road management protocols. Since the source code is written in Java, it is recommended to further extend the system also in Java. However, it is also possible to use the current system's APIs as base and further extend it with other languages, such as Python.

Opportunity for Skill Development

The student who undertakes this project will have a chance to learn the frontier technologies of autonomous vehicles, intelligent robotics and multi-agent systems. The student can work with HDR students and get help from them to learn robot programming and run road network simulations. By conducting this project, the student can also develop their research skills for Higher Degree Research and programming/system development skills for industry jobs.

Students are required to have the following skills/meet the following pre-requisite(s) to apply

Students in year 2 or 3 of Bachelor of Computer Science, Bachelor of Computer Science (Advanced) and Bachelor of Information and Communication Technology (Advanced) with excellent programming skills are suitable for this project.

Project 20: Mitigating the physical degenerating effects of social isolation in older adults – the use of Virtual and Augmented Reality for dance training

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Second Supervisor

Project description

During social isolation older people in particular stayed at home and hence were subjected to neurophysiological deterioration; this includes loss of balance, strength, cardiovascular capacity and possible cognitive deterioration due to diminished social contact- Dance in a complex sensorimotor rhythmic activity with additional cognitive and social dimensions, all of which can simultaneously address a wide range of physiological and cognitive risks of falls and dementia. This project ask support from Software engineering student to develop a prototype of the Virtual/Augmented Reality of dance -based exercise program under the guidance of CIs.

Project Aims

Many older adults are facing declines in neuromotor fitness as a results of being home- bound in the “new normal “; this project offers a practical solution to a limited movement that is fun and enjoyable. Dance involve music and the virtual reality can create “social environment” with a “virtual teacher” to support the training as if “holding hand”. Within the Dance program we will include movements that challenge balance, orientation, gait speed and memory. At the second stage we would like to conduct formative evaluation with a group of older adults – however we need a prototype to begin with. We intend to ask for grant support such as idea grant from NHMRC.

Project Methods

The student would be developing the prototype in the Unity environment. Student’s task will be to interact with CIs and translate their requirements into 3D models and code. Conducting the study related to the effectiveness of this prototype is outside the scope of this project.

Opportunity for Skill Development

The student would learn how to develop a Virtual/Augmented Reality simulation in Unity and how to understand requirements of medical practitioners into a software prototype.

Students are required to have the following skills/meet the following pre-requisite(s) to apply

Good programming Skills and basic knowledge of Unity are essential. 3D modelling experience is a plus.