SUPERVISOR/S: Han Gan
PROJECT TITLE: Modelling how a virus could spread through Hamilton
FIELD: Mathematics & Statistics
DIVISION/SCHOOL: HECS - School of Computing and Mathematical Sciences
PROJECT LOCATION: Hamilton

PROJECT ABSTRACT:
Stochastic models are the typical starting point for modelling how a virus can spread through a population. One of the key advantages of a stochastic approach is that it becomes relatively straightforward to study how changes in various parameters such as connectivity of individuals, infectiousness of the virus and geographical information can affect the evolution of the spread of a virus. The stochastic approach is often seen as being necessary, particularly when modelling is based upon sparse or new and emerging data, see https://www.scoop.co.nz/stories/GE2004/S00132/modelling-covid-19-in-new-zealand-expert-reaction.htm for example. Often the starting point for modelling the spread of viruses is the classical SEIR model which models individuals as susceptible, exposed, infectious and recovered. Indeed, one of the early key COVID-19 modelling reports commissioned by the New Zealand Ministry of Health is based on this SEIR model: https://www.health.govt.nz/system/files/documents/publications/report_for_moh_-_covid-19_pandemic_nz_final.pdf, and the model has also been used and developed by Te Pūnaha Matatini: https://www.medrxiv.org/content/10.1101/2020.03.26.20044677v1. The canonical SEIR model is a relatively simple model, and has its limitations. We will seek to extend this model and modify the assumptions based upon real life population structure, and in particular rather than model infections in New Zealand as a whole, focus on a finer scale and study how infections could spread in the localised area of Hamilton.

In this project, the student would first gain a basic understanding of stochastic modelling, namely Markov chain theory, and then study some of the basic models for modelling epidemics, including the SEIR model. The student will then study relevant recent literature about the modelling of COVID-19 in New Zealand, and then decide upon a stochastic model that they wish to construct to model virus spread through the localised area of Hamilton. By using geographical and demography data, such as breaking Hamilton up into its respective suburbs, the student will build a model that can be used to study how the spread of a virus would depend upon various parameters. Questions of interest could include the expected number of infections, the time it takes for an outbreak to be eliminated and how differing levels of lockdown would affect these values.

STUDENT SKILLS:
• A strong understanding of undergraduate probability theory.
• Familiarity with at least one computer programming language.

PROJECT TASKS:
• Gain a foundation in the theory of stochastic processes, particularly Markov chains.
• Study some recent literature in modelling COVID-19 in New Zealand.
• Construct a stochastic model for how a virus could spread in Hamilton, incorporating geographic and demographic information.
• Create and write software code that will simulate the stochastic model.
• Via simulation, examine how modifying various inputs and parameters affect various aspects of an outbreak.
• Present the findings in a poster and short presentation.

I would like to mention that while this list of tasks may seem ambitious, I have a very capable student in mind for this project who is planning on continuing into honours and potentially a PhD. Some of these tasks could be skipped and further explored in
EXPECTED OUTCOMES:

- Student’s Research Poster (as per clause 6 of the Scholarship regulations)
- The student gains the ability to understand and study stochastic models.
- The student gains an understanding of the difficulties and open ended options one faces when trying to model real life applications, compared to the simplified scenarios in standard coursework.
- The student gains a taste of what research is like, by being given a myriad of options to design their model, and having to decide which approach is appropriate.
- The student gains experience in extracting useful information from a theoretical model by writing computer code and simulation.
- The student gains experience in presenting their work, both verbally in a presentation and written through a poster.