PhD Topics

Supervisor: Małgorzata O'Reilly

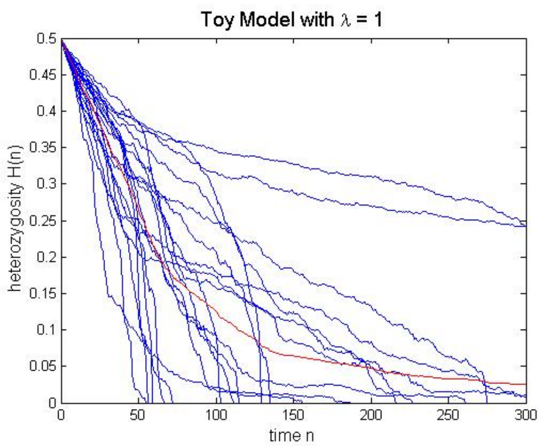
Stochastic Models for the Conservation of Endangered Species.

(currently available)

Co-supervisors:
Dr Sophie Hautphenne, Melbourne University
A/Prof. Barbara Holland

Summary: In populations of endangered species, management strategies referred to as *genetic rescue* have been advocated in order to help avoid extinction. An example of considerable concern in the Australian context is the conservation management of Tasmanian Devils suffering from the *Devil Facial Tumour Disease* (DFTD), which puts them in danger of extinction. An important factor in this context is the ability to assess the impact of conservation efforts. Conservation strategies have been used with the hope of increasing the genetic diversity of the wild population, but this remains a challenging problem.

An essential objective of conservation strategies is to increase the genetic diversity of a wild population, with the hope of increasing its chances of survival in the long term. This project will focus on developing stochastic simulation and theoretical models for the numerical assessment of conservation strategies, which will assist in these efforts. The techniques will be applied to the problem of conservation of the Tasmanian Devil population, suffering from the DFTD. This work will involve a collaboration with biologists, and communication with groups whose role is to maintain the *Insurance Population* gathering animals from areas where there had not been evidence of DFTD.



Stochastic Modeling of Patient Flow in Hospitals

(Ms Erin Trainer, PhD candidate, 2016-now)
Co-supervisor: Dr Mark Fackrell, Melbourne University

Summary: Modern hospital is a highly complex and unpredictable system, which cannot be managed efficiently using intuitive methods. Instead, we require sophisticated tools in the form of efficient algorithms developed using appropriate mathematical modeling. Compelling clinical evidence indicates that when mathematical modeling is used in hospitals, significant savings can be made that have a positive outcome to the patients. The aim of this project is to develop modelling tools for the analysis of the patient flow and optimal bed allocation algorithm for the patients in the Emergency Department to the wards.

Time Series Analysis: Growth Season Onset Dealy Problem

(Mr Axiom Dowling, PhD candidate, 2016-now)
Co-supervisors:
Kumudini Dharmadasa, Brian Salmon (Engineering)

Summary: MODIS is a scientific instrument launched into Earth orbit by NASA in 1999 on board the Terra Satellite, and in 2002 on board the Aqua Satellite. A full set of images at the various wavelengths of the entire Earth is downloaded to NASA base stations every 8 days, and is then available at no charge to anybody with Internet access. The Earth is divided into a large number of pixels. The data recorded for a given pixel can be represented as a time series $Y(t)$ of signals at times t.

This has opened the door to monitoring the environment on a global scale in a far more comprehensive and effective way than has ever been possible in the past. However, this data contains significant levels of noise and data impairments of a stochastic nature, which is impossible to mitigate without the use of analytical tools. Consequently, the task of developing appropriate methods for the analysis of MODIS satellite data has been a focus of international research in the recent years.

Stochastic models for the satellite data analysis is a crucial component of the methodology being developed for detecting changes in the environment, or predicting the risk of future scenarios. Models are used to simulate the real-life data, and are an important part of change detection algorithms in which the parameters are fitted to the models from the analysis of the data, and then various metrics are used to detect any deviations of the new inputs from these parameters.

The aim of this project is to develop methodology for tackling growth season onset delay problem.

Markovian-modulated stochastic models and their applications

(Ms Aviva Samuelson, PhD candidate, 2015-now)
Co-supervisor: Prof Nigel Bean, The University of Adelaide

Summary: Markovian-modulated models are a class of models with a two-dimensional state-space consisting of a phase and a level. The phase variable is often used to describe the state of some physical environment that we want to model. Simple two-phase examples are on/off mode of a switch in a telecommunications buffer, peak/off-peak period in a telephone network, or wet/dry season in reservoir modeling. The model assumes that the transitions between phases occur according to some underlying continuous-time Markov Chain. Furthermore, the rate of increase of the fluid level at time t depends on the phase at time t, and so the Markov Chain is the process that drives the fluid level at time t. The aim of the project is to develop novel models and methods in the area. Research will involve theoretical analysis using appropriate applied probability theory, development of numerical algorithms, and coding in MATLAB.

Mathematical Models for Microsatellite Evolution

(Mr Tristan Stark, PhD candidate, 2014-now)
Co-supervisor: A.Prof Barbara Holland

Summary: Microsatellites are found in vastly greater density than that which would be implied by random allocation of nucleotides. They are found throughout the genome, in coding and non-coding regions and in organisms composed of cells of any structure. Many microsatellites are thought to evolve neutrally, experiencing no selective pressure, and polymerase chain reaction techniques lead to a high availability of microsatellite data by allowing for the production of many copies of DNA sequences. This, together with high levels of polymorphism resulting from frequent mutation, leads to microsatellites being highly favoured as genetic markers (sequences of DNA occurring at a known locus, used to identify an individual or species). Hence, microsatellites are of interest in a wide array of population genetics and evolutionary inference applications. In order to make inferences using microsatellite data, a biologically realistic model for the time evolution of microsatellites is required, however theoretical models have largely failed to explain observed allele frequency distributions. The aim of this project is to build appropriate mathematical models for more accurate and relevant way of representing the evolution of microsatellites.

Statistical Algorithms for Land/Forest Cover Change Detection Using Remote Sensing Data

(Mr Asim Anees, PhD candidate, 2012-now)
Co-supervisor: Dr Jagannath Aryal (School of Geography and Environmental Studies)

Summary: Monitoring the environment and the use of natural resources is a crucial issue, which corresponds to the protection of the environment, and also has a direct effect on carbon emissions. The ocean and the forests are two major carbon dioxide sinks, and so if some changes in those environments occur, we need to know about them. Deforestation and loss of plankton in the ocean both increase carbon emissions. Monitoring these environments by observation using human eye is not a feasible solution, as the amount of data is beyond the human ability to analyse it. An example of application is illegal logging, which uses selective logging strategy, and is impossible to detect from the large data set without the use of tools.

Around the year 2000 the MODIS satellites have been installed by NASA, and since then it has been possible to obtain data of large-scale global dynamics including changes in Earth's cloud cover, radiation budget and processes occurring in the oceans, on land, and in the lower atmosphere for the first time. This has opened the door to monitoring the environment in a far more effective way. The collected data however, contains a lot of noise of stochastic nature, which is impossible to read without appropriate analytical tools. Consequently, we need to develop stochastic models for the analysis of this data so that we can monitor the various environments.