2019 AUT Mathematical Sciences Symposium

Auckland University of Technology
Auckland, New Zealand

21st – 22nd November 2019

Published by:
Mathematical Sciences Research Group
School of Engineering, Computer and Mathematical Sciences
Auckland University of Technology
http://www.aut.ac.nz/study-at-aut/study-areas/computer-mathematical-sciences/research-groups/mathematical-sciences-research-group

Contents

Welcome to the 2019 AUT Mathematical Sciences Symposium

On behalf of the Mathematical Sciences Research Group within the School of Engineering, Computer and Mathematical Sciences at Auckland University of Technology, I have much pleasure in welcoming you to the 2019 AUT Mathematical Sciences Symposium.

This is the sixth such Symposium and it is a continuation of our efforts to develop and promote the research being undertaken within the Department of Mathematical Sciences. I am delighted to welcome a number of invited speakers to the symposium with the aim of exploring collaborative opportunities and potential new areas of research that can be established with our research active staff.

The concept of this Symposium was a joint effort of Professor Emeritus Jeffrey Hunter and me, starting in 2014. We both appreciate the assistance of staff of the Department, in particular Dr Sarah Marshall, Dr Victor Miranda, Dr Nuttanan Wichitaksorn, Dr Wenjun Zhang and others, who have each been involved in a variety of activities to ensure the continued success of this series.

As New Zealand's newest university we have recently had the opportunity to employ a number of new academic staff, all of whom have been developing research profiles. We are currently continuing to appoint additional staff to assist with our expanding Analytics program and developments in Engineering and Data Science. We are putting in place a number of opportunities that will support and assist our academic staff to extend and enhance their activities, with this meeting being one such effort.

Our growing postgraduate programme in the Mathematical Sciences at Honours, Masters and Doctoral levels has been enhanced with our Master of Analytics (MAnalytics) degree, now in its fifth year. The success of this programme, with close on sixty students at various stages of completion of the degree, is leading to increased project supervision demands on our staff as well as leading to growing links with business and industry. We have an established arrangement with the SAS Institute that sees students in our MAnalytics degree gaining SAS Certification on graduation.

The Mathematical Sciences Research Group focuses on two main areas – Analytics and Applied Mathematics. We are very much focused on "research lead teaching" and we have developed a small number of research clusters within these areas to strengthen and support those academic staff working in these areas. Ideally we would like to foster collaborative activities and we thank those of you who have joined us at this meeting and we hope that we can facilitate some future joint research efforts.

We have kept the focus narrow so as to make the meeting meaningful and rewarding for those who participate. I hope that you enjoy your time with us and that you find the exercise a useful adjunct to the mathematical and statistical scene within New Zealand.

On behalf of the Mathematical Sciences Research Group

Jiling Cao
Professor of Mathematics

Chair of the 2019 AUT Mathematical Sciences Symposium

AUT CITY CAMPUS

55 Wellesley Street East, Auckland 1010

SCHOOLS

Art & Design – Level 3, WE building
Business & Economics – Level 1, WF building
Creative Technologies – Level 11, WG building
Communication Studies – Level 12, WG building
Engineering, Computer & Mathematical Sciences – Level 3, WZ building
Hospitality & Tourism – Level 3, WH building
Language & Culture – Level 8, WT building
Law – Level 6, WY building
Science – Level 5, WS building
Social Sciences & Public Policy – Level 14, WT building
Te Ara Poutama – Level 3, WB building

STUDENT HUB

Level 2, WA building

Phone: 0800 AUT AUT (0800 288 288)
Web: www.aut.ac.nz/studenthub

SERVICES AND FACILITIES

AUT International Centre – Ground Floor, WY building
AUTSA (Auckland University of Technology Student Association) – Level 2, WC building
Early Childhood Centre – Level 2, WA building via Gate 2
Estates Service Centre, Security – Corner St Paul & Wakefield St, WO building
Learning Lab – Level 3, WA building
Library – Level 4, WA building
PinkLime (print services) – Level 3, WA building
Student Counselling & Mental Health – WB204, WB building
Student Medical Centre – WB219, WB building
ubiq (formerly University Bookshop) – WC122, WC building

- Student Hub
- Student lounge & study space
- Cafés
- Library
- Early Childhood Centre
- Gym
- Conference facility
- Intercampus shuttle bus stop
- Breast feeding and baby change room
- Mobility parks

Symposium Information

Location

The AUT Mathematical Sciences Symposium will be held in **WF Building**, corner of Wakefield Street and Mayoral Drive, Auckland Central, rooms WF710 and WF711.

Registration

Registration will take place on level 7 of the WF building.

Presentations

Invited talks will be 40 minutes with 5 minutes for questions and contributed talks will be 20 minutes with 5 minutes for questions. There is a 5 minute break after each invited talk to allow delegates to move between rooms.

Refreshments

Morning tea and afternoon tea will be served on level 7 of the WF Building. There are a large number of choices for lunch within a short walking distance of the campus.

Dinner

The symposium dinner will begin at 6:30pm on Thursday 21st November 2019. The venue for the dinner is Four Seasons, WH Building, corner of Mayoral Drive and Wellesley Street East, Auckland.

The cost of dinner will be covered by Mathematical Sciences Research Group (MSRG) for participants who are presenting at the symposium. Partners are welcome to attend the dinner, however unfortunately the cost of their meals will not be covered by MSRG. If you need to pay for your or your partner's dinner, please discuss this with a member of the organising committee when you register.

Further Queries

If you have any queries please do not hesitate to contact a member of the organising committee: Jiling Cao, Sarah Marshall, Victor Miranda, Nuttanan Wichitaksorn and Wenjun Zhang.

Symposium Schedule

	Thursday 21st November	
8:45- 9:00	**Registration** WF Level 7	
9:00 - 9:10	**Welcome** WF710	
9:15-10:00	**Boris Choy** WF710	
10:05-10:30	**Melanie Moylan** WF710	**Jiling Cao** WF711
10:30-11:00	Morning Tea	
11:00-11:45	**Andreas Kempa-Liehr** WF710	
11:50-12:15	**Nate Wichitaksorn** WF710	**Gray Manicom** WF711
12:15-13:30	Lunch	
13:30-14:15	**Fabien Montiel** WF710	
14:20-14:45	**Rewat Khanthaporn** WF710	**Jose Da Fonseca** WF711
14:50-15:15	**Sarah Marshall** WF710	**Hyuck Chung** WF711
15:15-15:45	Afternoon Tea	
15:45-16:10	**Patricio Maturana-Russel** WF710	**Wenjun Zhang** WF711
16:15-16:40	**Oliver Stevenson** WF710	**Shu Su** WF711
16:45-17:30	**Simona Fabrizi** WF710	

	Friday 22nd November	
9:00-9:45	**Thomas Yee** WF710	
9:50-10:15	**Murray Jorgensen** WF710	**Graeme Wake** WF711
10:20-10:45	**Victor Miranda** WF710	**Michael Lockyer** WF711
10:45-11:05	Morning Tea	
11:05-11:30	**Azam Asanjarani** WF710	**Robin Hankin** WF711
11:35-12:00	**Robin Aldridge-Sutton** WF710	**Jason Chen** WF711
12:05-12:50	**Rachel Fewster** WF710	
12:50-13:00	**Farewell**	

18:30	**Dinner** Four Seasons Restaurant, AUT WH Building, corner of Mayoral Drive and Wellesley Street East

List of Authors and Titles

New methods for estimating population size based on close-kin genetics and extensions

Robin Aldridge-Sutton, Emma Carroll, Rachel Fewster
Department of Statistics, University of Auckland
rald898@aucklanduni.ac.nz

Close-kin genetics is an emerging approach to estimating population size and demographics, based on family relationships elicited from samples of genotyped animals. The field is still in its infancy but is generating considerable interest, partly due to recent advances in genomics providing high-resolution genotype datasets. Some flagship studies have already been completed, including estimates of population demographics for white sharks in Australia and New Zealand. We are interested in estimating the size and demographics of the New Zealand southern right whale population (Tohorā), which is now recovering from a dramatic decline after an estimated 35,000 whales were slaughtered during 19th century whaling. We describe new R code for simulating populations under more realistic scenarios, in respect of breeding behaviour, abundance trajectories, and genetic inheritance. We present a Shiny interface for investigating relevant characteristics of the simulated populations. We then present new ideas for extending close-kin genetics to a wider methodology for estimating population abundance and demographics. Instead of requiring the analyst to predetermine kinship between each pair of animals, and delete any pairs over which there is doubt, the new method is based on a pseudo-likelihood which incorporates multiple levels of kinship together with kinship uncertainty. The pseudo-likelihood is based on a saddlepoint approximation to the probability density function of a measure of kinship strength between each pair of DNA samples. We present preliminary estimation results based on our simulated right whale population to show the method produces usefully precise information on abundance, survival and growth rates.

Alternative Markovian Arrival Processes for Bursty Traffic

Azam Asanjarani, Yoni Nazarathy, Sophie Hautphenne
Department of Statistics, University of Auckland
azam.asanjarani@auckland.ac.nz

We revisit the popular Markov Modulated Poisson Process (MMPP) and introduce an alternative that we call Markovian Transition Counting Process (MTCP). The latter is simply a point process counting the number of transitions of a finite continuous time Markov chain. For a given MTCP one can establish an MMPP with the same first and second moments of counts. In this paper, we show the other direction by establishing a duality in terms of first and second moments of counts between MTCPs and a rich class of MMPPs which we refer to as slow-MMPPs (modulation is slower than the events). Such a duality confirms the applicability of MTCP as an alternative to MMPP which is superior when it comes to moment matching and finding the important measures of the inter-event process. We illustrate our analytic results with numerical illustrations.

Rough stochastic elasticity of variance and option pricing

Jiling Cao, Jeong-Hoon Kim, See-woo Kim, Wenjun Zhang
Department of Mathematical Sciences , Auckland University of Technology
jiling.cao@aut.ac.nz

This study is concerned with the elasticity of variance for risky assets. We show that the elasticity of variance for S&P500 exhibits short-range correlations. By using asymptotic and martingale methods, we obtain a semi-analytical expression for the option price in the two-scale regime where the constant elasticity of variance is perturbed by a smooth and bounded function of a rapid fractional Ornstein-Uhlenbeck process with Hurst exponent within (0, 1/2). The associated implied volatility is presented and discussed. As a result, the scope of Markov stochastic elasticity of variance model is extended to a non-Markov case.

Optimal Consumption, Portfolio Choices and Information Trading with Recursive Utility

Jason Chen, Edwin Ruan, Wenjun Zhang
Department of Mathematical Sciences, Auckland University of Technology
xingjiang.chen@aut.ac.nz

We study a consumption-portfolio allocation and information trading problem in continuous time when stock returns are unobservable, and the investors have to learn about it by using the stock price and the information products they purchase. We derive optimal consumption, portfolio polices and information trading strategies in a semi-closed-form. Our quantitative analysis shows that ignoring the information trading opportunities leads to significant economic losses for investors, particularly in a high-uncertainty case.

On some developments of the multivariate Student-t distribution

Boris Choy
Discipline of Business Analytics, University of Sydney Business School
boris.choy@sydney.edu.au

The Student-t distribution is the second most popular continuous and symmetric distribution after the Guassian distribution. It is a well-known robust distribution for its flexible heavy-tailedness. This talk revisits the characteristics of the multivariate t-distribution. Some of the properties improve the modelling ability for robustness and some make the model implementation of the t-distribution as easy as the Gaussian distribution using Bayesian computational methods. We also propose a new non-elliptical multivariate t-distribution which allows for additional flexibility on its marginal t-distributions. Illustrative examples are given.

Bending motion of inhomogeneous floating plate

Hyuck Chung
Department of Mathematical Sciences, Auckland University of Technology
hchung@aut.ac.nz

I present an analytical method of computing the bending wave field across an area of irregular mass and rigidity in an elastic floating plate of infinite extent. The fully coupled system between the plate and the water makes this problem more difficult than decoupled ones such as spring-loaded plate or shallow-water problems. We show a method using a Green's function of the floating plate. Scattered flexural waves by a finite of irregular features are computed.

A simple microstructure model based on the Cox-BESQ process with application to optimal execution policy

Jose Da Fonseca, Yannick Malevergne
Department of Finance, Auckland University of Technology
jose.dafonseca@aut.ac.nz

We develop a microstructure model whose order flow is driven by a Cox-BESQ process. We derive important analytical properties of the Cox-BESQ process in order to explicit the stock price dynamics at different time scales, provide different parameter estimators and solve the optimal execution problem. We implement the model using a large data set of stock index and bond futures. Our results show that the Cox-BESQ process provides an alternative framework to the Hawkes process to build a microstructure model that is very flexible.

Unanimous Jury Voting with an Ambiguous Likelihood

Simona Fabrizi, Steffen Lippert, Addison Pan, Matthew Ryan
Department of Economics, University of Auckland
s.fabrizi@auckland.ac.nz

We study collective decision-making in a voting game under the unanimity rule, with an ambiguous likelihood and ambiguity-averse voters who are MaxMin Expected Utility maximizers. We characterize the symmetric voting equilibria of this game, demonstrating that ambiguity helps reduce Type I errors: under ambiguity, voters are less likely to vote strategically against their information. Information aggregation improves as a result, and may even be restored to a fully informative equilibrium. We report evidence from a laboratory experiment supporting these predictions.

How to count what you cannot see: some new directions in estimating numbers of animals, people, and things

Rachel Fewster
Department of Statistics, University of Auckland
r.fewster@auckland.ac.nz

Estimating the size of a population of animals or people is a topic with numerous applications in biodiversity monitoring, epidemiology, and social sciences. Capture-recapture methods are based on multiple attempts to 'capture' or observe individuals, and are among the most popular methods for estimating population size. However, it is not always possible to ensure that each animal or human will be individually recognisable when seen on different occasions. For example, animals might be identified by a combination of methods such as photos and DNA samples, which cannot be matched to each other; or humans might be distinguished by various different ID tags such as name or national health number in different official lists. As a result, capture-recapture samples often involve data that are informative - but not definitive - about identity. I will describe some new approaches to dealing with uncertain identity when estimating population size. Previous approaches largely use simulation-based methods such as MCMC, which repeatedly sample from the possible combinations of matched identities. However, these methods are very slow in large data-sets. Instead, I will focus on fast methods that enable inference without requiring any matching of unknown identities. The first approach is a likelihood approximation based on the saddlepoint method, while the second is a new framework we have dubbed 'cluster capture-recapture'. In each case, we consider directly the relationship between the population parameters and the observable data, rather than attempting to reconstruct the hidden intermediate layer of true matchings.

Draw monsters and collusion in chess: generalized Bradley Terry

Robin Hankin
Department of Mathematical Sciences, Auckland University of Technology
robin.hankin@aut.ac.nz

In inference problems where the dataset comprises Bernoulli outcomes of paired comparisons, the Bradley-Terry model offers a simple and easily interpreted framework. However, it does not deal easily with chess because of the existence of draws, and the white player advantage. Here I present a new generalization of Bradley-Terry in which a chess game is regarded as a three-way competition between the two players and an entity that wins if the game is drawn. Bradley- Terry is then further generalized to account for the white player advantage by positing a second entity whose strength is added to that of the white player. These techniques afford insight into players' strengths, response to playing black or white, and risk-aversion as manifested by probability of drawing.

Mixture Model Clustering in R

Murray Jorgensen
Department of Mathematical Sciences, Auckland University of Technology
majmurr@gmail.com

The CRAN Task View "Cluster Analysis and Finite Mixture Models" lists 113 packages in this category. My purpose here is not to review those of the these 113 which can be described can be described as Mixture Model Clustering but to talk about my experience in implementing the Multimix model family in R.Multimix was developed by Lyn Hunt and myself in the late 90s, and Lyn Hunt wrote Fortran programs implementing it. In this talk I will describe the model family and the R user interface.I will give an outline of the structure of the R code and some of the unusual (to me) features I employed. I will illustrate all this by clustering a real data set.

Balancing Small Samples and Big Data - On the Transition from Time Series Feature Engineering to the Engineering of Time Series

Andreas W. Kempa-Liehr
Department of Engineering Science, University of Auckland
a.kempa-liehr@auckland.ac.nz

Promising fields of application for machine learning are the Internet of Things (IoT) and Industry 4.0 environments. In these fields, machine learning models anticipate future device states by combining knowledge about device attributes with historic sensor time series. They permit the classification of devices into risk classes with respect to a specific defect. This presentation discusses the distributed and parallel time series feature extraction algorithm FRESH, which allows for balancing small samples (e.g. predictive maintenance) with big data volumes from sensor time series and enterprise data on the basis of scalable hypothesis tests.A popular implementation of FRESH is given by the Python library tsfresh, which extracts more than 790 time series features by default. This automation of time series feature extraction allows to shift the focus from the engineering of time series features to the engineering of time series. This use case of automated time series feature extraction is discussed for event sequences, simultaneously measured signals, and time series with high sampling rates.

GARCH-Mixture Innovation with Efficient Bayesian MCMC Algorithm in Application to Real-World Stock Returns

Rewat Khanthaporn, Nate Wichitaksorn
Department of Mathematical Sciences, Auckland University of Technology
raysuge044@hotmail.com

Volatility clustering and fat-long-tails and asymmetric distribution are crucial characteristics of the time series in the financial market. The generalised autoregressive conditional heteroscedasticity (GARCH) model in Bollerslev (1986) is one of the most important conditional volatility models because it can capture the first one characteristic. In this talk, the proposed model is initially based on GARCH-Mixture-Bayesian-MCMC approach to fulfil both crucial characteristics. According to the GARCH-Mixture-Bayesian approach, the innovation of the GARCH model is the mixture of normal and generalised Pareto distributions. An efficient Bayesian Markov chain Monte Carlo (Bayesian MCMC) method is the griddy Gibbs algorithm. The proposed model significantly outperforms the standard GARCH model with robustness result through simulation analysis. Moreover, this talk will demonstrate that the efficient Bayesian MCMC results in a better statistical performance in parameter estimation through the benchmark of standard maximum likelihood estimator. Also, empirical analysis with global stock indices around the world indicates that the inferred density and the global stock index returns density is the same distribution through the two-sample Kolmogorov-Smirnov test. Besides, in this talk, some potential further research to capture another crucial financial time series characteristic and its application to portfolio risk management will be discussed.

Lorenz return maps and inverse limits

Michael Lockyer, Stefanie Hittmeyer
Department of Mathematical Sciences, Auckland University of Technology
michael.lockyer@aut.ac.nz

The Lorenz system is a 3 dimensional nonlinear system of differential equations. They were first studied by Edward Lorenz in the 1960s as a model of atmospheric convection, and it was soon realised that at the 'classical' parameter values the system exhibits properties that are today called 'chaotic'. Since its introduction, the system has been extensively studied, at a range of parameter values.One of the features of the Lorenz system is the 'return map' of the attractor: this is a one dimensional discrete map that encodes much of the information about the dynamics of the system. It has been recognised that for a range of parameter values, one variant of the return map looses its one dimensional nature. It can, however, be described as a one dimensional set valued map. We aim to use the newly introduced techniques of set valued inverse limits to describe the system at these, and other, parameter values.In this talk I will introduce the problem, discuss what has been found this far, and where we hope to take the project.

Modelling task switching with noisy heteroclinic networks

Gray Manicom
Department of Mathematics, University of Auckland
gman522@aucklanduni.ac.nz

We all know that multitasking is inefficient. This is related to the implicit time cost for task switching, called the switch cost. Psychologists are interested in this phenomena and how it varies from person to person. My research project involves trying to understanding the phenomena of task switching by modelling it using a dynamical object called a noisy heteroclinic network. Heteroclinic networks are special solutions of dynamical systems in which trajectories cycle between various states, such as saddle type equilibrium solutions or periodic orbits. These heteroclinic networks are structurally stable in cases where the underlying system of ODEs has symmetries, and thus there existing invariant subspaces which contain the connecting heteroclinic orbits. The deterministic behaviour of these systems is, in some cases, well-understood. However, with the addition of noise to the system its behaviour can change significantly. The noisy system may exhibit dynamics such as switching between the network's sub-cycles, a change in the residence times of trajectories near the aforementioned states, and lift off. Lift off occurs when a noisy trajectory no longer lies within the invariant plane containing the heteroclinic connection, causing the system to manifest non-Markovian dynamics. It is the presence of memory in these systems that makes them suitable tools to model task-switching, since an individual's performance at a task depends on whether they have switched from another task or not. We aim to construct a noisy heteroclinic network in such a way that the system (with memory) produces dynamics akin to task-switching dynamics.

Computation of the Mean Value Function of an Alternating Geometric Process

Sarah Marshall, Richard Arnold, Yu Hayakawa, Stefanka Chukova
Department of Mathematical Sciences, Auckland University of Technology
sarah.marshall@aut.ac.nz

An alternating geometric process can be used to model consecutive operational and repair times of a system. In this study we are interested in a system that is ageing, and thus we use a decreasing geometric process to model the consecutive operational times and an increasing geometric process to model the consecutive repair times. In this type of system, the expected number of failures and the expected number of repairs by a given time, are often of interest. In this talk we will introduce the alternating geometric process (AGP) and present new results for the computation of the mean value function of two counting processes related to the AGP, namely the number of failures and the number of repairs up to a given time. We illustrate our results for a variety of parameter values and discuss their relevance to warranty cost analysis.

Spectral density estimation using P-spline priors

Patricio Maturana-Russel, Renate Meyer
Department of Statistics, University of Auckland
p.russel@auckland.ac.nz

Useful information about a stationary time series is encoded in its spectral density function. We propose a Bayesian approach to estimate it based on a mixture of P-spline distributions. Our proposal is motivated by the B-spline Dirichlet process prior in combination with the Whittle's likelihood and aims at reducing the high computational complexity of its posterior computations. The strength of the B-spline Dirichlet process prior over the Bernstein-Dirichlet process prior lies in its ability to estimate spectral densities with sharp peaks and abrupt changes due to the flexibility of B-splines with variable number and location of knots. Here, we suggest to use P-splines that combine a B-spline basis with a discrete penalty on the basis coefficients. We demonstrate in a simulation study and two real case studies that this approach retains the flexibility of the B-splines, achieves the same ability to accurately estimate peaks due to a new data-driven knot allocation scheme but significantly reduces the computational costs.

Vector generalized linear models and two parameter link functions, with applications to quantile and negative binomial regression

Victor Miranda, Thomas Yee
Department of Mathematical Sciences, Auckland University of Technology
victor.miranda@aut.ac.nz

Vector generalized linear models (VGLMs) are extensions of GLMs and accommodate multiple linear predictors which individually involve a link function applied to a parameter. While VGLMs have shown to offer advantages for different data types, we loosen the restriction of one-parameter linear predictors by developing the two-parameter case. For instance, estimating the negative binomial distribution with its canonical link (called the NB-C2-2 model) had previously been unsatisfactory in the VGAM R package but has now been implemented correctly. In this talk we present details of the new methodology. The key is to use total derivatives when deriving the score vector and the working weight matrices, quantities which are essential requirements for the iteratively reweighted least squares/Fisher scoring algorithm. In addition to a correctly implemented NB-C2-2 model, we also develop direct quantile regression based on the normal distribution. By 'direct' it is meant that at least two specified quantiles are modelled by new link functions which enable the covariates to be more directly related with the quantiles. Coupled with a parallelism constraint, the quantile-crossing problem is overcome.

Modelling the coupled ocean waves/sea ice system while making sense of the data: what's the challenge?

Fabien Montiel
Department of Mathematics and Statistics, University of Otago
fmontiel@maths.otago.ac.nz

Observations of ocean waves breaking up sea ice floes in the ice-covered Southern Ocean date back to the early 20th century and Sir Ernest Shackelton's famous Endurance expedition. Recent evidence now suggests that this very process could be a key driver of sea ice extent and morphology, and therefore impact the global climate system. Describing, let alone modelling, the range of physical processes governing the coupled ocean waves/sea ice system is not an easy task, mainly due to the difficulty of collecting data in such a harsh environment. This is therefore the perfect playing field for applied mathematicians to propose highly idealised models, ranging from sea ice as a homogeneous viscoelastic material to more sophisticated models of wave scattering by large arrays of perfectly circular floes. Due to its relevance to the climate system as well as to the shipping industry, theoretical research on ocean waves/sea ice linkages has been burgeoning in recent years and has attracted much funding worldwide. This talk is an attempt to reflect on these recent developments (including my own work), which in some cases are driven by the need to incorporate some kind of representation of the system in large scale forecasting models as opposed to trying to understand the underlying physics. I will further discuss results from recent field work data that seem to challenge our current modelling approaches.

Predicting Motor Vehicle Collisions rates of Sleepy Drivers with an A Priori Algorithm

Melanie Moylan, Mark Griffin, Romola Bucks
Department of Biostatistics and Epidemiology, Auckland University of Technology
melanie.moylan@aut.ac.nz

Introduction: Studies have shown that Obstructive Sleep Apnoea increases the risk of a motor vehicle collision (MVC) by 2- to 7-fold. The aim of this research was to identify if screening algorithm could predict the risk of MVCs.

Methods: 940 truck drivers were sent a combination of previously validated sleep questionnaires, plus an additional partner questionnaire. Questionnaires were scored and analysed using an a priori algorithm into 4 categories (initial diagnosis): Negative, equivocal, probable and positive for OSA. A final diagnosis was confirmed on polysomnography.

Results : 39.5% returned questionnaires. Regression analysis was conducted using a zero-inflated Poisson model. Participants who were initially diagnosed as positive were 6.1 (95% CI 2.7-13.9), probable 5.3 (95% CI 2.6-10.9) and equivocal 3.5 (95% CI 1.6-7.6) times more likely to have an MVC compared to a 'negative' driver.

Conclusion: This study supports previous research in confirming that OSA dramatically increases the risk of a MVC. Given the economic advantages, this tool may prove invaluable in reducing MVCs in truck drivers.

Batting and bowling with Bayes: modelling the career trajectories of professional cricket players

Oliver Stevenson, Brendon Brewer
Department of Statistics, University of Auckland
o.stevenson@auckland.ac.nz

In the sport of cricket, player ability is traditionally measured using batting and bowling averages. However, these averages fail to measure both short-term changes in ability that occur during a match, and long-term changes that occur between matches, due to the likes of recent form, age and experience. We derive and fit a Bayesian parametric model that employs a Gaussian process to measure and predict how the abilities of cricket players vary and fluctuate over the course of entire playing careers. The general findings suggest players do not begin their careers playing to the best of their ability. Rather, it takes players a number of matches to 'find their feet' at the international level. The results allow us to better quantify and predict player ability, compared with both traditional cricket statistics – such as batting and bowling averages – and more complex models, such as the official International Cricket Council ratings. In a practical sense, the model may have significant implications in the likes of player comparison and team selection policy, as coaches and selectors will have a more direct means of understanding the risks and real life impacts of selecting one player over another.

Specification Analysis of VXX Option Pricing Models under Levy Processes

Shu Su
Department of Mathematical Sciences, Auckland University of Technology
shu.su@aut.ac.nz

This paper examines specification issues of VXX option pricing models under the Levy process by using the VXX index and VXX options data from 2010 to 2017. The option pricing models are derived from the underlying log return process via inverse Fourier transform. We classify the underlying return process based on the drift specification, volatility specification, and jump structure. Our estimation results indicate that a good model for capturing the dynamics of log VXX return should consider stochastic volatility process which can generate positive volatility skew, stochastic drift process which can describe mean-reverting property, and infinite-activity jump component which can demonstrate asymmetry in the upward jump and downward jump.

Decision Support Modelling in Public Policy-making for NZ: A Personal View

Graeme Wake, Martin Manning, Bridget Robson
School of Natural and Computational Sciences, Massey University Auckland
g.c.wake@massey.ac.nz

In the absence of "accessible" better options New Zealand's primary-industry and environment sectors rely heavily on defective mathematical and statistical tools. These are far from "best practice" internationally and could lead to poor decision-making, particularly for water quality initiatives. A policy approach that seeks to allocate the rights and responsibilities for nitrate leaching has led some local and national organisation to use a methodology that is clearly wrong and has not been independently peer-reviewed. Issues that this decision support tool is being used to address, require instead a complex systems evolutionary model that addresses limits in data, accumulates errors in a statistically robust way, and to be scientifically sound.This short presentation gives recent instances in NZ of the use of a decision support tool called "Overseer" which is backed by strong commercial interests and has been in use (fortunately just in NZ) for nearly thirty years. Its basis and technical details are unclear and

have not been scrutinised by professional mathematicians or statisticians. However, some elementary mathematical errors are clear. Our experience and reviews of similar work in other countries suggest NZ's environmental management is at risk, because of inappropriate reliance on this tool. We join the Parliamentary Commissioner for the Environment in calling for a first principles review of this tool, and the development of more suitable alternatives. This work was co-authored by Graeme Wake (FRSNZ, Industrial and Biological Mathematician, Massey University), Martin Manning (New Zealand Climate Change Research Institute, VUW, joint Nobel-Peace Prize winner 2007), and Bridget Robson (Environmental Consultant, eLand, Bay of Plenty)

Analyzing Stock Returns through Mixture of Normal and Generalized Pareto Distributions

Nate Wichitaksorn, Rewat Khanthaporn
Department of Mathematical Sciences, Auckland University of Technology
nuttanan.wichitaksorn@aut.ac.nz

In this talk, I will present a couple of models with errors following the mixture of normal and generalized Pareto distributions. The advantage of this mixture is to allow us in analyzing the tail behaviors at the desired quantiles. For illustration, a simulation study with a linear regression model and a generalized autoregressive conditional heteroskedasticity (GARCH), and an empirical study with real data on stock returns will be shown.

Vector Generalized Linear and Additive Models: An Overview and Some Recent Work

Thomas Yee
Department of Statistics, University of Auckland
t.yee@auckland.ac.nz

Much of this presentation will be a survey of the vector generalized linear and additive model (VGLM/VGAM) framework, including minor associated classes such as Reduced-Rank VGLMs. Loosely, VGLMs extend ordinary GLMs to outside the exponential family and to multivariate and multiple responses. They are a very general implementation of the Fisher scoring/iteratively reweighted least squares algorithm that encompasses a very wide range of models and data types. Software in the form of the VGAM R package will illustrate the main ideas. Time remaining, some current work will be sketched, such as the Hauck-Donner effect in Wald tests (detection, tipping points, parameter space partitioning) and two families of generally-altered, -inflated, and -truncated distributions.

Pricing VIX Derivatives with Infinite-Activity Jumps

Wenjun Zhang, Jiling Cao, Xinfeng Ruan, Shu Su
Department of Mathematical Sciences, Auckland University of Technology
wzhang@aut.ac.nz

In this paper, we investigate a two-factor VIX model with infinite-activity jumps, which is a more realistic way to reduce errors in pricing VIX derivatives. Our two-factor model features central tendency, stochastic volatility and infinite-activity pure jump Levy processes which include the variance gamma (VG) and the normal inverse Gaussian (NIG) processes as special cases. We find empirical evidence that the model with infinite-activity jumps is superior to the models with finite-activity jumps, particularly in pricing VIX options. As a result, infinite-activity jumps should not be ignored in pricing VIX derivatives.

Index of Authors