The Third Victorian Research Students' Meeting in Probability and Statistics

School of Mathematics and Statistics, The University of Melbourne

Wednesday, 02/10/2019

ACEMS
AUSTRALIAN RESEARCH COUNCIL CENTRE OF EXCELLENCE FOR
MATHEMATICAL AND STATISTICAL FRONTIERS

VRSMiPS

Welcome Address

Following La Trobe and Monash universities respectively, the School of Mathematics and Statistics at the University of Melbourne will host the third annual Victorian Research Students' meeting in Probability and Statistics.

The event is generously funded by the Australian Research Council Centre of Excellence for Mathematical and Statistical Frontiers (ACEMS). The meeting provides doctoral and master by research students from Victorian universities with an opportunity to present their research to their peers, as well as hearing from other students in an environment which facilitates collaboration.

We hope that you enjoy the programme and find opportunities to communicate your work with your peers.

Behrooz Niknami,
Jiesen Wang and
Tiffany Lo
Organising committee

Code of Conduct

The meeting's code of conduct fully reflects that of ACEMS. Participants are expected to follow these rules. For convenience, a copy of the information is presented below.

In the event that a breach of the code of conduct has been reported at an ACEMS event, and it is found by the organisers to require immediate action, the organisers are granted full discretion, with no prejudice to further judgement, to ask the accused to leave the event as soon as possible.

ACEMS Code of Conduct

Preamble

ACEMS expects professional and appropriate conduct from its members at all times. Professional and appropriate conduct involves scientific and ethical integrity, respectful behaviour towards others and equality of opportunity and treatment for everyone. Harassment, sexual or otherwise, is a form of misconduct that has no place in ACEMS. Members of ACEMS should actively work towards preventing misconduct in any form within our ACEMS community and the mathematical and statistical sciences.

What to do if you encounter misconduct

Any member of ACEMS who wishes to report or discuss an issue related to misconduct is encouraged to contact the ACEMS Equity and Diversity Committee or any member of the Executive Committee. You can find the contacts of all members on the ACEMS website's 'People' page.

Understanding Professional Ethics

ACEMS actively promotes professional integrity and accountability among its members. This includes ethical scientific conduct and statistical practice. Members are referred to the National Health and Medical Research

Council and the Australian Research Council Joint 'Australian Code for the Responsible Conduct of Research' for more details.

Understanding Harassment

ACEMS condemns, in the strongest terms possible, harassment towards anyone.

Harassment is a form of discrimination and is unlawful under both federal and all Australian state anti-discrimination laws.

Harassment is demeaning or threatening behaviour directed at an individual, or a group of people. This conduct may include, but is not limited to: epithets, slurs or negative stereotyping; threatening, intimidating or hostile acts; display or circulation of written or graphic material that disparages or shows hostility or aversion toward an individual or group; offensive verbal or written comments; disrespectful, dishonest or bullying comments on social media; sustained disruption of talks, or other events; or denigrating jokes.

Harassment also refers to bullying or coercion of a sexual nature. Sexual harassment can include offensive remarks about a person's gender, gender identity or sexual preference. Harassment may include unwelcome or inappropriate promises of rewards in exchange for sexual favours. The following are examples of behaviour that, when unwelcome and not stopped immediately upon request, may constitute sexual harassment: sexual flirtations, advances or propositions; unnecessary touching; verbal or written comments or physical actions of a sexual nature; sexually degrading words used to describe an individual; a display of sexually suggestive objects or pictures; or sexually explicit jokes. If at any time the object of these advances is perceived to be uncomfortable in a situation, then this may constitute sexual harassment.

It is important to be aware of discomfort or offence that words or actions may cause. A teasing comment or offhand remark that may be inoffensive to some may be perceived as harassment by others. Individuals should act to ensure that their words and actions communicate respect for others. Individuals are also encouraged to let others know when behaviour directed towards them is causing discomfort. Furthermore, individuals who witness inappropriate behaviour directed towards someone else, should also speak out. It is important to creating a culture of inclusion that inappropriate behaviour is called out by others.

It is also important to recognise the role of power in harassment. There is an inherent power imbalance between senior and junior members of the community, with the former often holding power over the career advancement of junior members. Individuals with lower rank or a subordinate

position may be reluctant to express their objections or discomfort regarding unwelcome behaviour. Individuals should be aware of how their actions may be interpreted by their juniors.

Harassment can have long-lasting negative effects. At ACEMS, all members have an obligation to promote an environment free of harassment and to call out harassment whenever they see it or hear about it.

Housekeeping

- Photographs will be taking during the event for promotional purposes and they may be reproduced electronically and physically. If you are uncomfortable with that please let us know prior to the start.

- The conference venue, Evan Williams Lecture Theatre in the Peter Hall building, is accessible via ramps as well as having a hearing aid loop.

- You can view the availability of religious facilities around the campus through the university website.

- You can find more information about the Parkville campus on the conference website.

- The venue is equipped with whiteboards and projectors, allowing for both whiteboard and projected presentations.

- If you are presenting, please see the organisers in the break before the session in which you present to prepare your presentation material.

- For more information please refer to the conference's website.

Schedule

Time	Title	Presenter
8:30 am	Registration	
8:50 am	Opening	
9 am	Plenary: Convergence of stochastic processes	Nguyen
10 am	Morning Tea	
10:30 am	Session 1	
10:30 am	The length of self-avoiding walks on the complete graph	Nasrawi
10:53 am	Confidence Intervals for Median Absolute Deviations	Arachchige
11:15 am	Double Auctions with Dynamic Supply and Demand	Niknami
11:38 am	Limit theorems for filtered long-range dependent random fields	Alodat
12 pm	Lunch	
1:30 pm	Session 2	
1:30 pm	Large Deviation Probabilities for Random Walks with Truncated Heavy-Tailed Jump Distributions	Chong
1:53 pm	Service capacity and consumer information in an $M/M/1$ feedback queue	Wang
2:15 pm	Non-central asymptotics for functionals of strong-weak dependent vector random fields	Omari
2:38 pm	Statistical models for the persistence of Hooded Plover in Mornington Peninsula developed using citizen science data	Wijewardhana
3 pm	Afternoon Tea	
3:30pm	Session 3	
3:30 pm	On the asymptotic behaviour of the number of renewals via translated Poisson	Liu
3:53 pm	On degree asymptotics of preferential attachments random graphs	Lo
4:15 pm	Loot Box Pricing and Design	Xing
4:38 pm	Interlude	
4:41 pm	Session 4	
4:41 pm	On some asymptotic properties of functionals of long-range dependent random fields	Donhauzer
5:04 pm	Approximate Bayesian Computation inference with Gaussian Process method	Li
5:26 pm	Queues with scheduled arrivals	Karunarathne

Plenary Speaker

Dr. Giang Nguyen

School of Mathematical Sciences, The University of Adelaide

Dr. Giang Nguyen is a Senior Lecturer in Applied Mathematics at the University of Adelaide. Her research interests include stochastic differential equations, Markov-modulated Brownian motions, stochastic fluid flows, matrix-analytic methods, branching processes, and the Hamiltonian cycle problem. She received a PhD from the University of South Australia in 2009, and completed her postdoctoral studies at the Universite libre de Bruxelles (2009-2012) and at the University of Adelaide (2012-2013). She was the inaugural Treasurer of the Australian Mathematical Society Women in Mathematics Special Interest Group (WIMSIG) (2013-2018), and is currently the Director of Gender Equity, Diversity and Inclusion of the Faculty of Engineering, Computer and Mathematical Sciences, the University of Adelaide. She is a 2019 South Australia Tall Poppy Winner.

Abstracts

Convergence of stochastic processes

Giang Nguyen   *The University of Adelaide*

`9am`

Limit theorems are useful as often one can use the approximating mathematical objects to gain insight about the limiting ones. In this talk, we consider stochastic fluid processes and Markov-modulated Brownian motion, and show that the former converge to the latter both weakly and strongly.

The length of self-avoiding walks on the complete graph

Abrahim Nasrawi   *Monash University*

`10:30:00 AM`

We study the variable-length ensemble of self-avoiding walks on the complete graph. We obtain the leading order asymptotics of the mean and variance of the walk length, as the number of vertices goes to infinity. Central limit theorems for the walk length are also established, in various regimes of fugacity. Particular attention is given to sequences of fugacities that converge to the critical point, and the effect of the rate of convergence of these fugacity sequences on the limiting walk length is studied in detail. Physically, this corresponds to studying the asymptotic walk length on a general class of pseudocritical points.

Confidence Intervals for Median Absolute Deviations

Chandima N.P.G. Arachchige   *La Trobe University*

10:52:30 AM

The median absolute deviation (MAD) is a very robust measure of scale that is simple to implement and easy to interpret. Motivated by this, we introduce interval estimators of the MAD to make reliable inferences for dispersion for a single population and ratios and differences of MADs to compare two populations. Our simulation results show that the coverage probabilities of the intervals are very close to the nominal coverage for a variety of distributions. We have used the partial influence functions to investigate the robustness properties of the difference and ratios of independent MADs.

Double Auctions with Dynamic Supply and Demand

Behrooz Niknami   *The University of Melbourne*

11:15:00 AM

Double auctions are systems used in many financial markets to facilitate the exchange of assets according to predetermined rules. As such, their structures play important roles in price formation and market health. There have been attempts to study simplified versions of these systems in the literature, where modest assumptions are made about the structure of the market. These facilitate the study of equilibrium behaviours for such systems. However, these conjectures are too restrictive for real life; but there have been attempts to generalise the above model in different manners.

We also aim to loosen the above assumptions, initially, to describe cases where the supply and demand functions are not constant. This will pave the way for a more general understanding of double auctions, which could promote future studies of the effects of regulation and trader behaviour on the market.

Limit theorems for filtered long-range dependent random fields

Tareq Alodat   *La Trobe University*

11:37:30 AM

We investigate general scaling settings and limit distributions of functionals of filtered random fields. The filters are defined by the convolution of non-random kernels with functions of Gaussian random fields. The case of long-range dependent fields and increasing observation windows is studied. The obtained limit random processes are non-Gaussian. Most known results on this topic give asymptotic processes that always exhibit non-negative auto-correlation structures and have the self-similar parameter $H \in (0.5, 1)$. In this work we also obtain convergence for the case $H \in (0, 0.5)$ and show how the Hurst parameter H can depend on the shape of the observation windows. Various examples are presented.

Large Deviation Probabilities for Random Walks with Truncated Heavy-Tailed Jump Distributions

Aaron Chong   *The University of Melbourne*

1:30:00 PM

The area of Large Deviations (LDs) is of great importance in both theoretical and applied Probability Theory. The focus in the area is on finding approximations to probabilities of events characterised by unusually large deviations of the trajectories of random process in question from their "typical behaviour". There are well-developed theories covering two main classes of random walks, the first being the classical Cramér case, when the jump distribution has a finite exponential moment, and the second being various types of "heavy-tailed" distributions; these have qualitatively different asymptotics for the LD probabilities.

My presentation will discuss my work on the situation in which the tail distribution has been created from a heavy-tailed law by censoring the distribution at a certain level, which results in a unique asymptotic depending on the level of deviation relative to the censoring level.

Service capacity and consumer information in an $M/M/1$ feedback queue

Jiesen Wang   *The University of Melbourne*

1:52:30 PM

We consider an $M/M/1$ feedback queue with linear waiting cost and fixed reward. At their arrival time, customers decide to join or to balk, and are served in order of arrival. After being served, each customer either departs the system and obtains the fixed reward with probability q, or immediately joins the end of the queue otherwise. For a revenue-maximizing server who can choose to increase its service capacity and conceal information on the actual queue length, is it desirable to do so? We also look at this problem from a sociological perspective. Is it socially optimal to encourage service capacity boost and information concealment? In this talk, we present our solution of the revenue and welfare optimization problem, and compare it with Naor's results of an $M/M/1$ queue to comprehend how the feedback mechanism plays a part.

Non-central asymptotics for functionals of strong-weak dependent vector random fields

Dareen Omari   *La Trobe University*

2:15:00 PM

In various applications researchers often encounter with cases involving dependent observations over time or space. Dependence properties of a random process are usually characterized by the asymptotic behaviour of its covariance function. The available literature, except a few publications, addresses limit theorems and reduction principles for functionals of weakly or strongly dependent random fields separately. For scalar-valued random fields it is sufficient as such fields can exhibit only one type of dependence. However, for vector random fields there are various cases with different dependence structures of components. Such scenarios are important when one aggregates spatial data with different properties. For example, brain images of different patients or GIS data from different regions. We consider functionals of vector random fields which have both strongly and weakly dependent components. The main results demonstrate that the asymptotic behaviour of such functionals is not necessarily determined by their Hermite ranks. As an application of the new reduction principle we provide some limit theorems for vector random fields. In particular, we show that it is possible to obtain non-Gaussian behaviour

for the first Minkowski functional of the Student random field built on different memory type components.

Statistical models for the persistence of Hooded Plover in Mornington Peninsula developed using citizen science data

Udani Wijewardhana   *Swinburne University*

2:37:30 PM

The BirdLife International assessed in 2015, that 13% of bird species are threatened with extinction and extinction of many bird species has become a theme too frequently occurring around the world. Determining whether a bird species has become extinct or extant has become a difficulty exercise due to survey efforts being too costly and sighting data limited. This is especially affecting threatened birds. However, because of citizen science data, the number of sightings has increased over the years (number of sightings in eBird database increased more than 20 million from 2012 to 2018).

The Hooded Plover is listed as a vulnerable bird species under IUCN red list assessment criteria. In this study we compared three different models to identify the effect of climate on extinction risk for the Hooded Plover in Mornington Peninsula in both temporal and spatial-temporal scales, which is a prerequisite for developing effective strategies to conserve them while identifying the factors effect for their persistence like climate change. In order to identify the climate change and citizen science effect for the persistence of Hooded Plover using citizen science data available from eBird which has a large amount of validated observational data for birds. The Hooded Plover is a non-migratory local bird in Australia, so we considered monthly data for our study. Initially probability of persistence models was used as a reference for determining the significant factors. It is useful to know if a forecast model provides better results than any reference model. Then, to identify the climate effect, we consider the mean monthly temperature, and total monthly rainfall in hurdle models. To control for the growth in citizen science data , we consider the human population on the Mornington Peninsula.

The citizen science count data often include excess zeros for rare species like Hooded Plover in specific areas or time periods. Therefore, we compared zero-inflated hurdle models and zero inflated models using Poisson and Negative Binomial distributions and discuss extensions of these models while using count data in temporal and spatial-temporal structures to deal with those excess zeros. In both the temporal and spatial-temporal models

the performance of the Negative Binomial distribution was superior while overcoming over-dispersion issue. Similar conclusions can be drawn from both temporal and spatial-temporal models. Temperature has a significant positive effect on the non-zero counts (i.e. higher counts of Hooded Plover are associated with higher temperature). Growth in citizen science effort, linked to population growth, explained the lower probability of a zero count.

This work shows that statistical models can be used to address the challenges associated with the use of citizen science data for monitoring the persistence of rare birds, while identifying factors affecting this persistence such as climate.

On the asymptotic behaviour of the number of renewals via translated Poisson

Qingwei Liu   *The University of Melbourne*

3:30:00 PM

In this note, we establish various error estimates for translated Poisson approximation to the number of renewals in terms of Kolmogorov distance, Wasserstein distance and total variation distance. The note complements the error estimates for normal approximation in Kolmogorov distance established in Englund (1980) and in Reinert & Yang (2018) and improves the bound for compound Poisson approximation in total variation given in Erhardsson (2004).

On degree asymptotics of preferential attachments random graphs

Tiffany Lo   *The University of Melbourne*

3:52:30 PM

Preferential attachment random graph models are useful models for studying real networks such as the world wide web and social networks. To construct these models, the basic idea is to sequentially add nodes to the graph, and the newly added node is connected to existing nodes where connection to nodes with higher degrees is more likely. In this talk, we discuss the martingale methods for studying the fixed degree sequence of this family of random graphs. We also discuss some of the limiting results, which were given in Peköz, Röllin and Ross (2017) and James (2015).

Loot Box Pricing and Design

Chenchen Xing   *The University of Melbourne*

4:15:00 PM

In the online video game industry, a significant portion of the revenue generated is from microtransactions, where a small amount of real-world currency is exchanged for virtual items to be used in the game. One popular way to conduct microtransactions is via a loot box, which is a random bundle of virtual items whose contents are not revealed until after purchase.

We review the paper 'Loot Box Pricing and Design' and compare asymptotic analysis of the optimal revenue generated from two loot box selling strategies.

On some asymptotic properties of functionals of long-range dependent random fields

Illia Donhauzer   *La Trobe University*

4:41:00 PM

The talk is about asymptotic properties of random fields possessing long-range dependence. We consider nonlinear integral functionals of the homogeneous isotropic Gaussian random field with long-range dependence. The limit of this functional is a random process represented by the Wiener-Ito integral. It is known that in the one-dimensional case, the limit has the property of stationary increments. However, it is unknown whether the limit process possesses this property in the multidimensional case. Our hypothesis is that in multidimensional case there is no a set of integration such that limit process has stationary increments. We consider increments of the limit process and suggest methods to show that they have different distributions.

Approximate Bayesian Computation inference with Gaussian Process method

Chengyu Li   *The University of Melbourne*

5:03:30 PM

Approximate Bayesian Computation (ABC) has been used over the last 20 years for model fitting when the likelihood function is intractable, but simulation is attainable. However, ABC has its limitations. Many problems can be solved by ABC theoretically, but it is unrealistic in practice due to computational burden. To this end, Gaussian Process (GP) can be used to model the discrepancy between the observed and simulated data as a function of the parameter, which dramatically decrease the number of simulations required. Currently there is a framework to do ABC inference with GP method, but the result is not accurate enough and fails to capture the correct posterior in some situation. In this talk, we will develop a new ABC method based on GP. We find that our method significantly improves the performance, considering the accuracy under the same computational time.

Queues with scheduled arrivals

Wathsala Karunarathne   *The University of Melbourne*

5:26:00 PM

In many queueing systems, competition for service has increased because of limited resources and increasing demand. A consequence is that, almost everywhere, queues are built. It is important to pay attention to the costs of server availability and customer waiting. We develop a scheduling model for a single server system with exponential service times and an infinite queue. Our objective is to derive scheduled customer arrival times which minimise the weighted sum of total customer waiting times and server availability time. We use the L-BFGS-B algorithm as our optimisation algorithm. The model improves the objective function value over an existing model and is computationally efficient.

Speakers

Aaron Chong, 11
Abrahim Nasrawi, 9

Behrooz Niknami, 10

Chandima Arachchige, 10
Chenchen Xing, 15
Chengyu Li, 16

Dareen Omari, 12

Giang Nguyen, 9

Illia Donhauzer, 15

Jiesen Wang, 12

Qingwei Liu, 14

Tareq Alodat, 11
Tiffany Lo, 14

Udani Wijewardhana, 13

Wathsala Karunarathne, 16

Participants

Aaron Chong	The University of Melbourne
Abrahim Nasrawi	Monash University
Achini Erandi Madduma Wellalage	The University Of Melbourne
Andres Jaramillo	RMIT
Antonios Meimaris	Monash University
Behrooz Niknami	The University of Melbourne
Chandima N.P.G. Arachchige	La Trobe University
Chenchen Xing	The University of Melbourne
Chengyu Li	The University of Melbourne
Che-Wei Hu	RMIT
Chuntao Chen	Monash University
Daniel Fryer	La Trobe University
Dareen Omari	La Trobe University
Darius Isaac	The University of Melbourne
Difang Huang	Monash University
Elisa Mena	RMIT
H Ruda	RMIT
Illia Donhauzer	La Trobe University
Jiabao Li	The University of Melbourne
Jiesen Wang	The University of Melbourne
Justin Munoz	RMIT
Kaustav Das	Monash University
Lakshmi Priya Madanapalli	RMIT
Leila Tavakoli	RMIT
Lishan Cui	RMIT
Lyuyuan Zhang	The University of Melbourne
Mac Kim	RMIT
Punya Alahakoon	The University of Melbourne
Qingwei Liu	The University of Melbourne
Qiong Yuan	The University of Melbourne
Rodger Benham	RMIT

Sam Rojas	The University of Melbourne
Samuel Holt	RMIT
Seyed Soheil Hosseini	Monash University
Tareq Alodat	La Trobe University
Tiffany Lo	The University of Melbourne
Tim Banova	The University of Melbourne
Udani Wijewardhana	Swinburne University
Vivek Katial	The University of Melbourne
Wathsala Karunarathne	The University of Melbourne
Ying Zhou	Monash University