NZMASP 2020 Conference Programme and Abstracts

Zoom ID: 99621717767

26th - 27th November

26th November

Time	Activity
8:45	Introduction and explanation of schedule, use of Zoom, peer reviewing, etc.
9:00	**Session 1**
10:00	**Session 2**
11:00	**Session 3**
12:00	Lunch (we will keep zoom live here and allow break-out rooms as lunch tables)
13:00	Online games: scribble.io and kahoot.it
14:30	**Session 4**
15:30	**Session 5**
16:30	**Plenary talk - Mark Colyvan *'The Philosophy and Mathematics of Rational Decisions'.***
17:30	Dinner
18:30	Quiz night
21:30	Finish

27th November

Time	Activity
10:00	**Session 6**
11:00	**Plenary talk - Tanya Evans *'Mathematics education as a field of research: How to engage in research-informed evidence-based teaching and learning'***
12:00	Prize-giving and conclusion
12:30	Lunch

Session 1

9:00 - 10:00 **Chaired by Riley Knoedler**

Time	Speaker	Field	Topic
9:00	Nico Mokus	Applied Mathematics	*On using sparse matrices to solve scattering problems*
9:08	Mairaj Jafri	Mathematics Education	*Framework: Teaching and Learning of Mathematics Using Digital content Resources*
9:16	Em Rushworth	Statistics	*Compositional Data and Bayesian Analysis*
9:24	Pedro Henrique Barboza Rosesetto	Applied Mathematics	*Chaos in Plane Fronted Gravitational Waves*
9:32	Duttatrey Srivastava	Pure Mathematics	*Brauer Manin Obstruction on Hyperelliptic Curves*
9:40	Ravindra Bandara	Applied Mathematics	*Infinitely Many Multipulse Solitons of Different Types in a Waveguide with Quartic Dispersion*
		10 MINUTE BREAK	

Session 2

10:00 - 11:00 **Chaired by Hammed Olawale Fatoyinbo**

Time	Speaker	Field	Topic
10:00	Lina Berbesi	Applied Mathematics	*On Modelling Energy data with one-dimensional smoothers: Cubic Splines and two-dimensional smoothers: Markov Random Fields in a Generalized Additive Model – A case of Colombia*
10:08	Nianqi Petra Tang	Statistics	*Estimating Power Spectral Density Parameters of SGWB for LISA*
10:16	Henry Chen	Applied Mathematics	*An introduction to mathematical billiards and its applications*
10:24	Jordan Mitchell Barrett	Pure Mathematics	*The best proof of Cousin's lemma*
10:32	Riley Knoedler	Applied Mathematics	*Simulating nectarivorous avian foraging behaviour and pollen dispersal in New Zealand*
10:40	Jo Knox	Mathematics Education	*How can we tell if learners are seeing the general in the particular?: Discursive markers of generic example-use.*
		10 MINUTE BREAK	

Session 3

11:00 - 12:00 **Chaired by Nianqi Tang**

Time	Speaker	Field	Topic
11:00	Zehua Zang	Statistics	*Branching process with detection*
11:08	Sam Irvine	Applied Mathematics	*Modelling granular flow in silos*
11:16	Lukas Zobernig	Pure Mathematics	*Isogeny Graphs of Abelian Varieties*
11:24	Kaitlin Riegel	Mathematics Education	*Development of the Measure of Assessment Self-Efficacy (MASE)*
11:32	Valerie Jeong	Applied Mathematics	*A heteroclinic cycle as a controller in an evolutionary robotics task*
		10 MINUTE BREAK	

Session 4

14:30 - 15:30 **Chaired by Muhammad Zubair Moughal**

Time	Speaker	Field	Topic
14:30	Hammed Fatoyinbo	Applied Mathematics	*Stability Analysis of Traveling Wave Solutions in a Model of Coupled Pacemaker Cells*
14:38	Ray Khanthaporn	Statistics	*Asymmetric-GARCH-ICAPM-GG models with Mixture Innovation on Globe Stock Market during Coronavirus Pandemic*
14:46	Xi Li	Applied Mathematics	*Pricing of exotic option*
14:54	Erandi Nanayakkara	Statistics	*Lead Time Distribution in Periodic Lung Cancer Screening*
15:02	Gray Manicom	Applied Mathematics	*Modelling task-switching with a network*
15:10	Amber Bohanna	Pure Mathematics	*Three-way Submodularity of Connectivity Functions*
		10 MINUTE BREAK	

Session 5

15:30 - 16:30 **Chaired by Nelson Wong**

Time	Speaker	Field	Topic
15:30	Morgan Meertens	Applied Mathematics	*Folded homoclinic bifurcations*
15:38	Yujin Kim	Statistics	*Constrained Maximum Likelihood for Correlated Data*
15:46	Adi Jha	The History and/or Philosophy of Mathematics	*Metaphysics of Mathematical Patterns?*
15:54	DD Jena	Pure Mathematics	*A note on linear sets of minimum size*
16:02	Zubair Moughal	Applied Mathematics	*Generating Spiky solution that leads to New Galaxies*
		10 MINUTE BREAK	

Session 6

10:00 - 11:00, 27th November **Chaired by Em Rushworth**

Time	Speaker	Field	Topic
10:00	Lydia Turley	Applied Mathematics	*Modelling Evolution*
10:08	Yixuan Liu	Statistics	*Robust Bayesian Analysis of Multivariate Time Series*
10:16	Giorgia Vattiato	Applied Mathematics	*When personalities matter: including animal behaviour in models of population dynamics*
10:24	Rafael Lima	Pure Mathematics	*KMS states on groupoid C*-algebras*
10:32	Nelson Wong	Applied Mathematics	*Connections between saddle periodic orbits as organising centres of complicated dynamics*
10:40	Julie Mugford	Applied Mathematics	*Finding the signal of change in noisy ecological citizen science data*
		10 MINUTE BREAK	

Session 1 Abstracts

On using sparse matrices to solve scattering problems

Nicolas Mokus

Sea ice is a rapidly changing feature of the polar oceans. Its interaction with ocean waves is an active field of study, yet wave-induced breakup remains poorly understood and highly simplified in global climate models. I propose a linear water wave theory-based model to examine the sensitivity of this phenomenon to rheological parameters. This model technically relies on sparse matrix data structures to deal with the scattering of an incoming wave by an array of ice floes. I will discuss the advantage of this technique over iterative methods.

Framework: Teaching and Learning of Mathematics Using Digital content Resources

Mairaj Jafri

Little effort has been made to examine the current knowledge and skills of high school mathematics teachers for the use of Digital Content Resources (DCR). In contrast, a growing interest of international scholars is noticeable in the field of "Resources for Mathematics Teachers" which also includes digital content resources. Various theoretical, methodological and conceptual frameworks have emerged with this concern. This paper examined recent studies for the use of DCR in mathematics education and identified frameworks such as TPACK (technological pedagogical and content knowledge), PTK (pedagogical technological knowledge), Instrumental Genesis, and MDKT (mathematical digital knowledge for teaching) that can be used by national and international researchers as a lens to study the knowledge and skills of high school mathematics teachers for the use of DCR.

Compositional Data and Bayesian Analysis

Em Rushworth

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Chaos in Plane Fronted Gravitational Waves

Pedro Henrique Barboza Rosesetto

pp-waves are exact solutions for the full non-linear Einstein's Equations which represent idealized plane-fronted gravitational waves. In this talk I will discuss the motion of free particles in such spacetimes. Chaotic behavior for this system is already known in the literature. Additionally I will demonstrate that pp-waves also present the Wada property. This

contributes to the hypothesis that open dynamical systems with more than two exit options will normally exhibit Wada boundaries.

Brauer Manin Obstruction on Hyperelliptic Curves

Duttatrey Srivastava

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Infinitely Many Multipulse Solitons of Different Types in a Waveguide with Quartic Dispersion

Ravindra Bandara

Optical solitons are signals that do no change their shape as they are transmitted along a waveguide. Of particular interests are pure quartic solitons, which have been observed experimentally in [1] and exist through the balance between the quartic dispersion and the Kerr nonlinearity of the (photonic crystal) waveguide. Unlike conventional solitons, pure quartic solitons do not have quadratic dispersion. A natural question is whether new optical solitons with both quadratic and quartic dispersion exist. Most recently, Tam et al [2] tackled this problem by showing theoretically that such solitons do exist; namely, they used the generalized nonlinear Schrödinger equation (GNLSE) with fourth-order dispersion as a model to describe the transmission of a signal along the photonic crystal waveguide. We consider a stationary wave solution ansatz, where the optical pulse does not undergo a change in shape while propagating. This allows us to transform the governing partial differential equation (PDE) into a fourth-order nonlinear ordinary differential equation (ODE). We study the ODE to find bi-asymptotic trajectories, known as homoclinic solutions, which correspond to soliton solutions of the PDE. We take advantage of the mathematical properties of reversibility and existence of a Hamiltonian of the ODE to show that there are infinitely many symmetric homoclinic solutions in a certain parameter regime. Specifically, we employ numerical continuation techniques to compute a representative number of them. Moreover, we show the existence of infinitely many non-symmetric soliton solutions that arise in the ODE as connecting orbits between periodic orbits and equilibrium solutions.

1. Blanco-Redondo, A., De Sterke, C. M., Sipe, J. E., Krauss, T. F., Eggleton, B. J., & Husko, C. (2016). Pure-quartic solitons. Nature Communications, 7, 10427

2. Kevin K. K. Tam, Tristram J. Alexander, Andrea Blanco-Redondo, and C Martijn De Sterke. Generalized dispersion kerr solitons. Physical Review A, 101, 2020.

Session 2 Abstracts

On Modelling Energy data with one-dimensional smoothers: Cubic Splines and two-dimensional smoothers: Markov Random Fields in a Generalized Additive Model – A case of Colombia

Lina Berbesi

Previous literature shows that energy performs better under non-linear modelling approaches. The usual approaches are either nonparametric methodologies like Splines, Support Vector Machine (machine learning methodologies in general) or fully parametric methodologies as Generalized Linear Models (GLMs), a consistently found but overly simplified approach from GLMs is Linear Regression. From statistical point of view even when fully parametric methodologies are more desirable due to its high interpretability, they often perform poorly for not being able to capture the non-linear effects of the covariates over the response leading to higher errors, on the other hand, nonparametric methodologies like Machine learning have the lowest errors but tend to be looked down on because they are considered to be black box models that are highly flexible but outside of the user control for being fully automatic. This is where the Generalized Additive Models (GAMs) come into play as an appealing alternative due to their semi-parametric nature being an extension of Generalized Linear Models (GLMs) they can fit both linear and non-linear relationships through smoothing. Furthermore, the smoothing component allows them to account for the spatial varying effects of covariates over the response as would happen in a Geographically Weighted Regression (GWR). In this case instead of using a Kernel for modelling the spatially correlated covariates a two-dimensional discrete (Markov Random Fields) smoother is used. This dissertation shows how to use second Generation GAMs to model spatial-temporal energy data with one-dimensional smoothers: Cubic Splines and two-dimensional smoothers: Markov Random Fields using as case study data from Colombia.

Estimating Power Spectral Density Parameters of SGWB for LISA

Nianqi Petra Tang

Gravitational waves propagate through space and carry information about the history of our Universe, helping us understand the unknown part of the Universe. The Laser Interferometer Space Antenna (LISA) is a gravitational wave observatory in space, and is it used to detect the milihertz band of the GW signals. In my research I reconstruct the spectral density of the stochastic gravitational wave background of mock LISA signals, hoping to identify LISA's detection capability. In this talk I introduce LISA's unique setup, explain the method I use to construct the spectrum profile, present some of my results and explain the next step for my PhD.

An introduction to mathematical billiards and its applications

Henry Chen

Mathematical billiards is an area of study in dynamical systems, where we model billiards in an idealised environment. We stipulate that the billiard ball is a point mass that satisfies the law of reflection when interacting with the boundary. These simple constraints lead to surprisingly deep and complex dynamics. We introduce the analysis of billiards by the concept of unfolding by presenting the necessary and sufficient conditions in order for a trajectory to be periodic in the square. Applications of billiard theory to the Riemann hypothesis and pouring problems are discussed.

The best proof of Cousin's lemma

Jordan Mitchell Barrett

Kurzweil and Henstock's gauge integral generalises the usual Riemann and Lebesgue integrals, allowing a wider class of functions to be integrated. Cousin's lemma is a compactness principle that arises naturally when studying the gauge integral. Our aim is to find the "best" proof of Cousin's lemma, using the toolkit provided by reverse mathematics. We have done this for continuous functions; however, the problem remains open for functions of Baire class $n \geq 1$. Joint work with Downey and Greenberg.

Simulating nectarivorous avian foraging behaviour and pollen dispersal in New Zealand

Riley Knoedler

Native New Zealand plants that rely on bird visitation for successful pollination exhibit evidence of reproductive failure and inbreeding depression. It is an open question whether alien plant species overall negatively impact native plant neighbors by pulling birds away from them (on a local scale), or whether aliens can provide a net benefit to natives by attracting more birds to the area overall (on a regional scale). Gathering sufficient empirical data of pollen dispersal in the context of alien plants can be prohibitively time consuming. Additionally, the coupling of more detailed and biologically realistic, but computationally expensive, agent-based models with large scale dynamical systems models is an important technique in ecological modelling. In this talk, I will describe a spatially explicit, stochastic agent-based model of the nectar foraging behaviour of competing bird species under several proposed avian memory paradigms. I will discuss my investigation of pollination outcomes, in particular the dispersal kernel, which is the probability distribution function describing the distance pollen is dispersed from its parent plant, in a variety of landscape compositions and configurations. I will also examine challenges that emerge in using demographic parameters derived from the output of the agent-based model to parameterize the classic Lotka-Volterra competition model of population distribution.

How can we tell if learners are seeing the general in the particular?: Discursive markers of generic example-use.

Jo Knox

A 'generic example' (Mason & Pimm, 1984) or 'generic proof' is where a particular example is signalled within an argument as being representative of a whole class of objects, rather than the particular case itself. Generic proofs are considered to be particularly appropriate in the primary school context (e.g. Stylianides, 2007): (i) in contrast to empirical arguments, they are mathematically valid, and (ii) they have explanatory potential and offer accessibility for young learners over formal proofs. However, criteria for judging whether the author of an example-based argument is seeing the general and understands why it holds for all cases, or is seeing the particular in the example used, has been missing (Reid & Vallejo Vargas, 2018).

As part of my PhD research, I examined primary school students' verbal responses and their accompanying actions for indicators that suggested examples were being used generically rather than empirically. I analysed videos and transcripts from eights groups of 8- and 9-year-old students working in groups of four as they substantiated their endorsement of narratives about the sums of odds and evens. Using Sfard's (2008) commognitive framework, I developed four categories of example-use according to whether the example revealed numeric or generic realizations of odd and even and whether the substantiations were inductive or deductive. My findings show nuanced and multi-layered differences in example-use rather than a simple dichotomy of empiric or generic use of examples.

In this talk, I present these categories along with a range of subtle discursive markers that I claim implicitly point towards students' reasoning generically rather than empirically, and which provide criteria for researchers and educators in determining whether an example is being used generically.

Session 3 Abstracts

Branching process with detection

Zehua Zang

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Modelling granular flow in silos

Sam Irvine

Granular material, such as sand, soil, grain, and powders, is vital to many important industries, such as mining, agriculture, construction, and pharmaceuticals. Modelling granular material is an important but challenging endeavour. Modelling each particle individually can provide accurate simulations in small domains, however is computationally infeasible for many practical situations. Various continuum models have been created to predict the flow of granular materials; however, these models are underdeveloped and do not capture many of the different phenomena granular material exhibit in practice.

The relatively recent μ(I) model is a promising model, allowing an incompressible Navier-Stokes solver to provide a decent prediction for the dynamics of dense granular flow in various situations while not being computationally expensive. Many extensions for the μ(I) model have been developed, including extending the model to account for dilatancy, non-local effects, and segregation. This work focuses on accounting for these three factors to provide a powerful model capable of predicting granular material in various different geometries, while still being computationally tractable.

Silos provide an excellent testing ground for such a model, as they exhibit many different regimes of flow; some areas of the silo being stagnant with other areas being in near freefall. Various extensions of the μ(I) model are used to model the dynamics of both the ordinary single opening silo and the two-opening silo.

Isogeny Graphs of Abelian Varieties

Lukas Zobernig

We will explain briefly what we mean by isogeny graphs of abelian varieties and how their structure changes over different base fields and in different dimensions. We will then show some examples of graphs that we have computed.

Development of the Measure of Assessment Self-Efficacy (MASE)

Kaitlin Riegel

Self-efficacy is a significant construct in education due to its predictive relationship with achievement. Existing measures of assessment-related self-efficacy concentrate on students' beliefs about performing tasks but omit beliefs specific to assessment-taking. This research aimed to test the validity of the Measure of Assessment Self-Efficacy (MASE), designed to assess beliefs around assessment preparation and performance. This talk outlines the validation of the scale for a low-stakes and a high-stakes assessment. A confirmatory factor analysis of 10 items in Study 1 (N=301) suggested a two-factor model with latent factors 'emotional regulation' and 'comprehension and performance abilities'. Study 2 (N=356) of students in a second-year mathematics course confirmed this model. Potential uses of the MASE in educational research are discussed.

A heteroclinic cycle as a controller in an evolutionary robotics task

Valerie Jeong

In the field of evolutionary robotics, a control system of a robot is optimised using a genetic algorithm that is analogous to natural evolution. The controller can be described as a continuous dynamical structure, and we are particularly interested in the use of a heteroclinic cycle as a controller in evolutionary robotics. This idea is motivated by Rabinovich and the collaborators, suggesting that heteroclinic cycles can explain the "chunking"" phenomenon observed when the brain processes information.

In realistic settings, controllers are not free from perturbations and noise. However, the combined effect of perturbations and noise to a heteroclinic cycle is not well understood. In particular, it was observed that the residence time near a steady state increases for sufficiently small noise level, which is an unexpected phenomenon.

This talk is split into two parts. First, we present a plausible analytic explanation for the unexpected phenomenon with a stochastic model for a noisy trajectory near a heteroclinic cycle. In the second part, we present the use of a heteroclinic cycle in a restricted problem of a hexapod locomotion task, considering only a single leg. We evolve a set of parameters of a two-node heteroclinic cycle and demonstrate that the evolved robot shows a nearly periodic solution.

Session 4 Abstracts

Stability Analysis of Traveling Wave Solutions in a Model of Coupled Pacemaker Cells

Hammed Fatoyinbo

We prove the existence of travelling waves solutions in a model of electrically coupled pacemaker smooth muscle cells and numerically approximate the wave speed, c using the shooting method. We also investigate the spectrum of the linear operator $\mathcal{L}$ of the model linearised about a travelling wave and compute the essential spectrum of the linear operator $mathcalL$. In this talk, I will describe the spectral stability of associated travelling wave solutions and show how stable propagating solutions can lose stability as model parameters are varied.

Asymmetric-GARCH-ICAPM-GG models with Mixture Innovation on Globe Stock Market during Coronavirus Pandemic

Ray Khanthaporn

This talk will demonstrate univariate classical and asymmetric generalized autoregressive conditional heteroskedastic (GARCH) with innovation of mixture of Gaussian and main extremal behaviour describing distribution in extreme value theory, which is two-sided generalised Pareto, incorporate with intertemporal capital asset pricing model (ICAPM). Bayesian Markov Chain Monte Carlo (MCMC) approach and classical one-step maximum likelihood approach are used to be a model calibration. The experiments, using simulation and empirical data, will show the accuracy of parameters estimation through goodness of fit test both in-sample and out-of-sample among market turbulence due to COVID-19 pandemic.

Pricing of exotic option

Xi Li

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Lead Time Distribution in Periodic Lung Cancer Screening

Erandi Nanayakkara

Lead time plays an important role in early detection of lung cancer through periodic screening. It is the length of time between the age at transition into the clinical state and the age at screen detection, among individuals/participants in a screening program. To do a

parameter recovery for a multi-state statistical model for cancer screening, the development of lead time distribution with parallel to other inputs is a must. Therefore, this work discusses the probability distribution of lead time in periodic cancer screening examination. The distribution is a mixture of a point mass and a piecewise continuous distribution with three key parameters: sensitivity, the sojourn time and the transition probability. Here, we use Bayesian approach to make inferences for the unknown parameters when both screen detected and interval cases exist. Hamiltonian Markov Chain Monte Carlo (HMC) is used to generate posterior samples using non-informative priors (uniform priors). We simulated age-dependent screening data based on input parameter values with the following ranges $0 < b0 < 4, -0.1 < b1 < 0.1, 4 < \mu < 4.5, 0.01 < \alpha 2 < 0.05, 0.01 < \lambda < 0.5, 1.5 < \alpha < 4.0$ assuming that there are N = 500, 000 individuals in our study who are expected to be taking part in our periodic (annual) screening exams with initial age varying from 50 to 74 and having higher smoking frequency.

Keywords: lung cancer, lead time distribution, early detection, screening

Modelling task-switching with a network

Gray Manicom

Imagine listening to a NZMASP presentation over Zoom when you see an email notification pop up on your phone or laptop. It is discreet, but it is enough to grab your attention. You quickly read the text to see whether it is important, before returning your attention to the presentation. Notice that there is a short delay before you begin listening to the presentation again. This delay that occurs when you switch between tasks is called the switch cost, and psychologists have long been interested in the mechanism of task-switching.

In this talk I propose a SDE model for task-switching which uses a mixed excitable and heteroclinic network. Input (representing task stimulus) is added to the model to force transitions along the excitable connections, while the noise amplitude controls the time between transitions along the heteroclinic connections. Similar methods can be used to realize any directed graph as a network described by an SDE, and to control how much time is spent (on average) at each node of the network.

This talk will be so interesting that not even email notifications will be able to distract you.

Three-way Submodularity of Connectivity Functions

Amber Bohanna

This talk will introduce connectivity functions using concrete examples from graphs and matroids. After introducing connectivity functions I will discuss three-way submodularity, a stronger condition than submodularity.

Session 5 Abstracts

Folded homoclinic bifurcations

Morgan Meertens

Systems with multiple timescales frequently have the property that one or more variables in the system evolve on a much faster timescale than other variables. Solutions to models of multiple timescale systems may exhibit "bursting", which occurs when intervals of rapid spiking of the amplitude of one or more variables are interspersed with quiescent periods during which the amplitude changes slowly. There has been a great deal of interest over many years in the mathematical mechanisms underlying bursting, particularly the mechanisms that are associated with a change in the number of spikes in a bursting solution.

Recently, Deroches et al. showed numerically that the onset of bursting and spike-adding can be associated with a homoclinic bifurcation in a particular singular limit of a system related to the Plant model of neuron bursting; they named this singular homoclinic bifurcation a *folded homoclinic bifurcation*. A similar phenomenon has since been observed in numerical simulations of several other multiple timescale models. However, no systematic study of this phenomenon has been done and it is not yet known what dynamics is generically associated with a folded homoclinic bifurcation.

This talk will describe progress towards understanding the nature and origin of complex oscillations that arise from folded homoclinic bifurcations.

Constrained Maximum Likelihood for Correlated Data

Yujin Kim

Most statistical methods for the analysis of two-phase designs focus on settings where individual observations are independent. However, it is often the case those study participants are naturally correlated in practice. For instance, patients are treated by clinics and they are correlated within a clinic or observations can be correlated when study participants have repeated measures. In general, ignoring correlation among observations may underestimate the true variance that results into invalid inferences or conclusions. Therefore, it is important to consider the dependencies among the observations in estimating sampling variation.
To the best of our knowledge, not many research has been done for the analysis of data from two-phase designs applied where participants are naturally cluster-correlated. We seek to fill this gap by providing a framework for valid estimation and the inference that appropriately elucidate the correlated structure. In this work, we propose a variance correction for the case of two-phase designs and constrained maximum likelihood (CML) estimation in contexts where participants are naturally cluster-correlated.

Metaphysics of Mathematical Patterns?

Adi Jha

Unification arguments advanced in Philosophy of Science (PoS) discuss why we should believe in entities that formally unify phenomena based on scientific methodology. Parallelly, Unification arguments in Philosophy of Applied Mathematics (PoM) extend this ontological treatment to mathematical patterns and argues why we should believe in mathematical entities/patterns that not only explain a phenomena, but also analytically unify a larger set of the same phenomena. This talk maintains skepticism over the extension of such arguments flowing from PoS to PoM and briefly discusses why we should remain agnostic about metaphysics done through mathematical patterns when such patterns are generated via asymptotic reasoning and idealizations. The discussion is built within the context of the 'mapping' arguments (Pincock, 2004) and the 'inferential conception of applied mathematics' (Bueno & Colyvan, 2011).

Bueno, O., & Colyvan, M. (2011). An Inferential Conception of the Application of Mathematics. Noûs, 45(2), 345-374. http://www.jstor.org/stable/41330861

Pincock†, C. (2004). A Revealing Flaw in Colyvan's Indispensability Argument*. Philosophy of Science, 71(1), 61-79. doi:10.1086/381413

A note on linear sets of minimum size

DD Jena

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Generating Spiky solution that leads to New Galaxies

Zubair Moughal

The spikes in solutions generated so far are either early-time permanent spikes or transient spikes. We want to generate a solution with a late-time permanent spike. We achieve this by applying the Stephani transformation on Jacobs solution of Einstein's Field equation's. This late-time permanent spike explains the structure formation.

Session 6 Abstracts

Modelling Evolution

Lydia Turley

In this talk, we describe simple models for the evolution of continuous traits. We discuss how species' shared evolutionary histories lead to covariance under these models. Finally, we mention some of the challenges in computing likelihoods under these models.

Robust Bayesian Analysis of Multivariate Time Series

Yixuan Liu

There is a surge in the literature of nonparametric Bayesian inference on multivariate time series over the last decade, many approaches consider modelling the spectral density matrix using the Whittle likelihood which is an approximation of the true likelihood and commonly employed for Gaussian time series. Meier et al. (2019) proposes a nonparametric Whittle likelihood procedure along with a Bernstein polynomial prior weighted by a Hermitian positive definite Gamma process. However, it is known that nonparametric techniques are less efficient and powerful than parametric techniques when the latter specify the parameters which model the observations perfectly. Therefore, Kirch et al. (2019) suggests a nonparametric correction to the parametric likelihood in the univaraite case that takes the efficiency of parametric models and amends sensitivities through the nonparamtric correction. Along with this novel likelihood, the Bernstein polynomial prior equipped with a Dirichlet process wight is employed. In this short talk, I will give a quick introduction of how to extend the corrected Whittle likelihood procedure to the multivariate case.

When personalities matter: including animal behaviour in models of population dynamics

Giorgia Vattiato

Accurate models of population dynamics are key in making good choices for wildlife conservation. However, most of these models don't include individual behavioural heterogeneity ("personalities"), and if they do it's in the form of noise or of unrealistic binary personality traits (bold/shy, active/lazy, etc). I will present a few good ways of including animal personalities in a model, and show how much these personalities can influence the outputs of a population dynamics model.

KMS states on groupoid C*-algebras

Rafael Lima

Many important examples in the theory of C*-algebras can be described as groupoid C*-algebras. In this talk, we will introduce these concepts and see a theorem due to Neshveyev which gives a formula for the KMS states on groupoid C*-algebras. This theorem is an example of how topological properties of the groupoid help us understand C*-algebras in more detail.

Connections between saddle periodic orbits as organising centres of complicated dynamics

Nelson Wong

Recent theory states that connecting cycles between two saddle periodic orbits generate highly complicated dynamics when the periodic orbits have unstable manifolds of different dimensions. These heterodimensional cycles give rise to interesting nearby dynamics, including infinitely many periodic and/or homoclinic orbits. Furthermore, if a system has a codimension-one heterodimensional cycle, then every system in a sufficiently small C1-neighbourhood about the original system has two saddle periodic orbits that also form a heterodimensional cycle. In other words, the existence of a heterodimensional cycle is a C1-robust property. Since such cycles are primarily thought of abstractly, there are very few known examples arising out of applications. One system that is known to feature a heterodimensional cycle is a four-dimensional model of intracellular calcium oscillations. We employ Lin's method in conjunction with continuation techniques to compute heterodimensional cycles in this explicit calcium model. In this presentation, we show that both orientable and non-orientable cycles exist, and we discuss the nearby bifurcation structure in a parameter plane.

Finding the signal of change in noisy ecological citizen science data

Julie Mugford

Ecological citizen science projects, like iNaturalist NZ – a New Zealand based ecological citizen science project, have vast numbers of species observations at scales that are often not feasible for standard ecological data collection methods. As the demand for reports of biodiversity change over short time periods increases and expert resources struggle to meet the demand the information collected by citizen scientists is becoming vital. However, these citizen science projects are often curiosity driven and the users have a range of different behaviours for sharing observations that may result in bias and incomplete species data. For example, some users might treat them like Pokémon-Go and try catch them all by just sharing one photo of each species, and other users might only share photos of rare species. We use statistical methods to strip away the bias and noise of citizen science data to reveal the underlying species abundance trend. We focus on iNaturalist NZ data and use simulations of iNaturalist NZ users observing critters and sharing photos to investigate the reliability of the statistical methods.