NUI Galway
OÉ Gaillimh

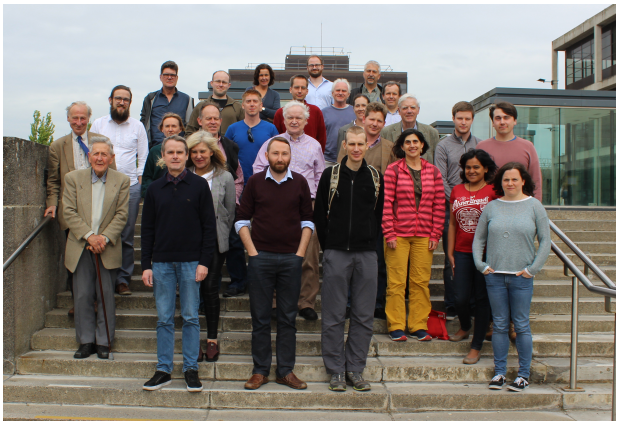
School of Mathematics, Statistics and Applied Mathematics

Tenth Annual Research Day

10 April 2019

Programme

	Talks take place in the **Tyndall Lecture Theatre** Coffee, lunch, posters and reception take place in the **Orbsen Building Atrium**
9:20–9:30	Welcome by **Rachel Quinlan**, Head of School
9:30–9:40	Opening by **Walter Gear**, Executive Dean of the Colleges of Science and Engineering & Informatics.
9:45–10:15	**Ronan Egan (NUI Galway)** *Connecting coding theory and design theory*
10:15–10:45	**Cathal Seoighe (NUI Galway)** *Selection shapes stop codon use in mammals*
10:45–11:30	**Coffee** (Orbsen Building Atrium)
11:30–12:00	**Angela Carnevale (NUI Galway)** *Counting matrices*
12:00–12:30	**Mark Howard (NUI Galway)** *Quantum Information and Quantum Computation*
12:30–14:00	**Lunch and Poster Session**
14:00–14:45	**Norma Bargary (University of Limerick)** *Statistical modelling of lattice data with applications in flow cytometry*
14:45–15:45	**Research blitz (Organizer: Roberto Galizia)** Michel Destrade: *The Mechanics of A Twisted Brain* • John Hinde: *Bivariate Residual Plotting* • Niall Madden: *Computational Geophysics* • Rachel Quinlan: *The minimum rank problem for graphs* • Tobias Rossmann: *Board games* • Nina Snigireva: *The Lure of Semiattractors* • Giuseppe Zurlo: *Non-Euclidean Winding*
15:45–17:00	**Poster session** (Orbsen Building Atrium)
16:00–17:00	**Reception & poster prizes** (Orbsen Building Atrium)



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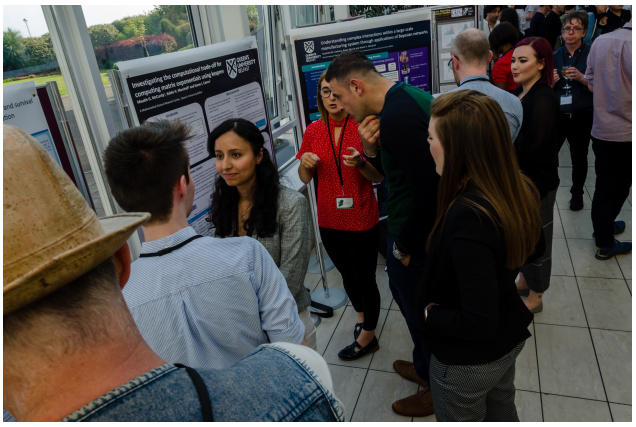

1 Introduction

Welcome to the 10th annual Research Day of the School of Mathematics, Statistics and Applied Mathematics. This year's Research Day celebrates the achievements and contributions of our research community during 2018 and looks forward to exciting developments ahead. Today's programme of talks and poster exhibition highlights the quality, the breadth, and the international significance of the research activities in all of our disciplinary clusters: the Biostatistics/Bioinformatics Cluster, the Stokes Cluster for Applied Mathematics, and the de Brún Centre for Mathematics. Many thanks to the organizers of this year's Research Day: Ronan, Roberto, Mary, Niall, Andrew and Michael T.

The year 2018 was an eventful one for the School of Maths, seeing several exciting developments and some major changes. For example

- We welcomed six new colleagues to the School, joining us from recent positions in Germany, Croatia, the United Kingdom, New Zealand and Ireland: Angela Carnevale, Ronan Egan, Mark Howard, Davood Roshan, Tobias Rossmann and Andrew Simpkin.

- We celebrated the elevation of John Hinde, Ray Ryan and Jerome Sheahan to the highest ranks of academia. The contributions of our emeritus colleagues to the research life of our School are very plentiful and very valuable.

- A particularly welcome development in 2018 has been the expansion of our full-time research staff numbers to six, across all the disciplines in the School, with external funding from the Marie Skłodowksa-Curie Fellowship Scheme, Science Foundation Ireland, the Irish Research Council and the SFI-Royal Society University Research Fellowships.

- With a budget totalling 13M, the SFI Centre for Research Training in Genomics Data Science will welcome its first cohort of PhD students in September this year. The Centre will be hosted in the School of Maths at NUI Galway, with four institutional partners in Dublin and Cork. Congratulations to Cathal and the Bioinformatics group on the excellent work that they have already completed and on the success of the proposal. The development is hugely significant for Genomics research and for PhD Education in Galway.

- It has been another good year for our PhD programmes: Daher Al-Baydli, Daron Anderson, Lida Fallah, Amirhossein Jalali, Paul Greaney, Hieu Ha Van, Robert Mangan, Shirin Moghaddam, and Ngoc Nguyen have all completed their PhD degrees in our School since the 2018 Research Day. We congratulate all of our PhD graduates and wish them every success. Welcome to the students who have commenced their PhD studies with us in the same period: Malak Almutairi, Sultan Alzahrani, Declan Bennett, James Blackwell, Beatrice Charamba, Siobhán Cleary, Pearce Harney-Nolan, Kelvin Killeen, Noor Khehrah and Andrew Peters. We also recognize the research achievements of our undergraduate students, 80 of whom completed final year projects with us in 2018/19.

- We hosted three academic conferences: the 41st annual Groups in Galway meeting in May, the 38th annual Conference on Applied Statistics in Ireland in May 2018, and the unique Ray Days conference in functional analysis in July. Conference hosting plans for 2019 include Groups in Galway in a few weeks, the annual meeting of the Irish Mathematical Society in September, and a special conference to launch the SFI Centre for Research Training in Genomics Data Science, also in September.

We completed the IRRP process in 2018, and agreed an action plan with the University Management Team, in response to the reviewers' findings and to our own self-assessment. The external reviewers reported "excellent, world class research being carried out throughout the School of Mathematics, Statistics and Applied Mathematics. In each research group there is evidence of a strong and vibrant research culture leading to the publication of top-quality papers in the leading journals of each research group".

Our "strong and vibrant research culture" was created and is maintained by our entire community of students, colleagues and collaborators. It is evident in our day to day activities and especially at events such as the Research Day. Best wishes to everyone for an enjoyable and stimulating day today and a productive and fulfilling research experience in the coming months - let's talk to each other about our interests, build on our recent successes and look forward to our future efforts.

Rachel Quinlan.

2 Abstracts of talks

Norma Bargary (University of Limerick): *Statistical modelling of lattice data with applications in flow cytometry.*

Abstract: Flow cytometry is a technology that simultaneously measures and analyses physical and chemical properties of cells as they flow in a fluid stream through a beam of laser light. The technology has become a state-of-the-art device in microbiology, dairy science and in medical diagnostics. A key step when analysing flow cytometry data is gating. Gating involves the identification of homogeneous cell populations within these complex datasets. The objectives of gating are equivalent to those of cluster analysis in statistics. It is currently performed using expert opinion or naïve clustering algorithms rather than employing a specialised statistical framework. The data from flow cytometry lies on a structured lattice grid, a key property that is ignored by current clustering approaches. This research develops statistical methods for the analysis and clustering of lattice data for automated gating.

Cathal Seoighe (NUI Galway): *Selection shapes stop codon use in mammals*

Abstract: Gene sequences are translated (indirectly) into proteins by means of the three-letter genetic code defined on the four-letter nucleotide alphabet (A, C, G, T). Recent research has suggested that the sequences that specify the point at which the translation of a gene into a protein terminates may have some unanticipated functions. Triplets of nucleotides are called codons and the three triplets that specify the end of translation are known as the stop codons. Because they all function to terminate translation, mutations between the stop codons should have little functional effect. To explore the extent to which stop codons may have functions other than terminating translation, we developed a novel form of the continuous-time Markov models used to describe the evolution of gene sequences. Fitting a mixture model based on this to data from over $14,000$ gene families, we estimate that over half of the stop codons evolve in a constrained manner, consistent with functions in addition to their role in specifying the end of translation. Genes with constrained stop codons share a set of characteristics that provide hints as to what these functions may be. Our results provide strong evidence that selection, rather than mutation patterns, is responsible for the large differences in stop codon frequencies in mammals.

Angela Carnevale (NUI Galway): *Counting matrices*

Abstract: How many matrices of a given shape have a given rank? We will see in this talk that answers to such questions involve a blend of algebra, combinatorics, and geometry.

Mark Howard (NUI Galway): *Quantum Information and Quantum Computation*

Abstract: I will provide a biased selection of some of the problems in this field, and highlight some of the mathematical tools involved in their study.

Ronan Egan (NUI Galway): *Connecting coding theory and design theory*

Abstract: In this talk I will introduce the basic concepts of coding theory, which underpin modern digital communications. Linear codes over finite fields, which are effectively vector spaces, are particularly useful as encoding and decoding is efficient. The goal in coding theory is often to produce codes with strong error-correcting properties, which depends on the minimum Hamming distance between distinct codewords. I will discuss some extra mathematical properties a linear code may have, such as self-orthogonality, and how using tools from design theory and algebraic techniques we can construct linear codes with these features.

3 Abstracts of Posters

Minimally primitive graphs

Malak Almutairi
Supervisor: Rachel Quinlan

A directed graph Γ is *primitive* if there exists a positive integer k with the property that for every pair of (not necessarily distinct) vertices u and v, there is a directed walk of length exactly k from u to v in Γ. The least k for which this occurs is referred to as the *exponent* of Γ.

These definitions have an interpretation in terms of matrices. The graph Γ is primitive of exponent k if and only if the adjacency matrix A of Γ has the property that A^k has positive entries and that k is minimal with this property. Since this statement also applies to any non-negative matrix with the same pattern of zero entries as A, it motivates a definition of primitivity and exponent for non-negative matrices.

We say that Γ is minimally primitive if the deletion of any arc from Γ results in an imprimitive digraph. We say that Γ is exponent-critical if Γ is primitive but the deletion of any arc from Γ results either in a primitive graph of higher exponent or in an imprimitive graph. The broad goal of this PhD project (which commenced in January 2019) is to develop a theory of minially primitive and/or exponent-critical graphs analagous to existing theories of minimally strongly connected and/or diameter-critical graphs.

Groupoids and Computational Topology

Nisreen Alokbi
Supervisor: Prof Graham Ellis

It is well recognised that the fundamental groupoid of a topological space has an important role to play in the basic theory of algebraic topology concerning fundamental groups and covering spaces. It also plays a role in the area of geometric group theory. The aim of this work is to develop computational aspects of groupoids and their use in computational algebra.

In applied topology the basic idea is to investigate experimental data by associating cellular spaces to the data and then computing and studying and interpreting homotopical invariants of the associated spaces. To date most research in applied topology deals with the most easily computed invariants of a space, namely its homology and cohomology. However, there has been some work on computing fundamental groups. Due to the large size of data sets in applied topology, efficiency of the algorithms is of paramount importance.

This work contains illustrations of new algorithms such as:

- the computation of a finite presentation of the fundamental group of a finite regular CW-complex based on the groupoid version of the van-Kampen theorem. This allows for parallel computation of low-dimensional cup products,
- the fundamental groupoid (and group) of simplicial complexes arising, via Mapper, from gait analysis data,
- the fundamental groupoid (and group) of simplicial complexes arising from time-series data.

References

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A numerical method for fourth-order real and complex-valued singularly perturbed

Faiza Alssaedi
Supervisor: Dr Niall Madden

We are interested in the numerical solution of singularly perturbed, fourth-order, real and complex-valued reaction diffusion equations. Our model differential equation is

$$-\varepsilon u^{(4)}(x) + a u''(x) - b u(x) = f(x) \qquad (1a)$$

on $\Omega := (0,1)$, subject to the boundary conditions

$$u(0) = u''(0) = 0, \qquad u(1) = u''(1) = 0. \qquad (1b)$$

Here ε is a positive, real-valued parameter. We assume $0 < \varepsilon \leq 1$, but typically have that $\varepsilon \ll 1$. The coefficient functions a, b and right-hand side function f are real or complex-valued.

References

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New Results on Ask and Conjugacy Class Zeta Functions of Lie Algebras and Groups

Sultan Alzahrani
Supervisor: Tobias Rossmann

My research is a continuation of [4]. I obtained a new theorem on average sizes of kernels and conjugacy class zeta functions. I also computed some examples of conjugacy class zeta functions of groups. Let $\mathfrak{g} \subseteq \mathfrak{gl}_d(\mathbb{Z}_p)$ be a Lie subalgebra where $\mathbb{Z}_p$ is the ring of p-adic integers:

$$\mathbb{Z}_p = \varprojlim_n \mathbb{Z}/p^n\mathbb{Z} := \Bigg\{ (a_n) \in \prod_{n=0}^{\infty} \mathbb{Z}/p^n\mathbb{Z} : a_{n+1} \equiv a_n \pmod{p^n}, \forall n \in \mathbb{N} \Bigg\}.$$

Let $\mathsf{Z}^{\mathsf{ask}}_{\mathfrak{g}}(T)$ and $\mathsf{Z}^{\mathsf{cc}}_{G}(T)$ denote the ask and conjugacy class zeta functions of $\mathfrak{g}$ and G as defined in [4] and [2], respectively.

Theorem. *Suppose that $\mathfrak{g}$ is an isolated submodule of $\mathfrak{gl}_d(\mathbb{Z}_p)$ and $G^m = \exp(p^m\mathfrak{g})$ is the group associated with $p^m\mathfrak{g}$ where $m > \frac{1}{p-1}$ and $r = \operatorname{rank}\mathfrak{g}$. Then:*

(i) $\mathsf{Z}^{\mathsf{ask}}_{\mathrm{ad}_{p^m\mathfrak{g}}}(T) = 1 + T + \cdots + T^m + p^r T^{m+1} + \cdots + p^{r(m-1)} T^{2m-1} + p^{rm} T^{2m} \mathsf{Z}^{\mathsf{ask}}_{\mathrm{ad}_{\mathfrak{g}}}(T)$.

(ii) $\mathsf{Z}^{\mathsf{cc}}_{G^m}(T) = \mathsf{Z}^{\mathsf{ask}}_{\mathrm{ad}_{p^m\mathfrak{g}}}(T)$.

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Sub-clinical prediction of antibody mediated rejection (AMR) in kidney transplant patients using gene expression profiles

Mariel Barbachan e Silva
Supervisor: Pilib Ó Broin

Antibody-mediated rejection (AMR) is one of the primary mechanisms of graft loss following organ transplantation [1]. A key concern with AMR is that clinical diagnosis typically occurs only after the patient has presented with physiological symptoms, by which stage damage to the graft may already be too great for it to be maintained. The diagnosis of AMR is also complicated by the fact that differing interpretations of histological data can result in contradictory diagnosis [2, 3].

High-throughput gene expression profiling of graft biopsies can provide evidence of AMR before a clinical phenotype manifests [4, 5]. Halloran et al.[6]

have previously used linear discriminant analysis to predict AMR status in kidney transplant patients using microarray data. In this work, we test three alternative approaches for prediction of AMR status. We used a subset of the data deposited by Halloran et al. at GEO (GSE36059) which includes 65 patients with AMR and 77 non-rejecting controls. We applied the following approaches from the Python scikit-learn package: i) Support Vector Machines (SVM), ii) Logistic Regression (LR) and iii) Random Forest (RF). The data were divided into a training set, and a test set corresponding to 75 and 25 percent of the total data respectively. Predictive accuracy for the algorithms was as follows: 0.68 (SVM), 0.80 (LR), and 0.67 (RF); while the predictive accuracy of model proposed by Halloran et al. was 0.81. As any individual predictive model may suffer from high variance, current work is focused on model averaging/ensemble learning approaches, as well as ways to integrate both clinical and molecular data for dynamic patient risk stratification.

Supported by the College of Science, National University of Ireland Galway

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Functional limits of agreement in method comparison studies

Kishor Das
Supervisor: John Newell

In method comparison studies, reproducibility of measurements of a method and agreement of measurements between two methods have been well studied in non-functional data settings [1, 2]. The complexity arises when the measurements are functional in nature with multiple replicates which are collected over different sessions. This poster proposes a novel statistical approach to address such questions in the functional data context.

References

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Genetic variation in human mutation rates, spectra and sources of inherent bias

Declan Bennett
Supervisor: Prof. Cathal Seoighe

Somatic mutations occur in non-clonal cells at relatively low population frequencies. The low frequency of occurance makes true mutations difficult to seperate from technical errors that arise in short-read sequencing data. Typically, somatic mutations are called using sufficient sequencing depth and two separate sources of cells from an individual such as, tumour tissue and non-cancerous tissue, to give a set of high-confidence mutations. Over the last number of years it has become apparent that most sources of true mutations and technical errors arise in a context-dependent manner allowing us to estimate the proportion of mutations that arise from distinct biological mutational processes. The aim of this project is to use a probabilistic approach to disentangle true biological mutations from sequencing artefacts in single-sampled individuals using low-depth sequencing data. We will leverage the fact that technical artefacts arise in a systematic manner. Matrix factorisation techniques can be used to estimate the contribution of each source of mutation in our data, allowing us to asign probabilities to each mutation arising from each source using an iterative EM algorithm. Using the above method, a somatic mutational rate can be assigned to each individual allowing the genetic architecture underpinning the somatic mutation rate to be uncovered. This work will open large population-scale datasets to the study of how somatic mutational processes and rates in healthy tissue shape the ætiology of cancer and ageing.

This work is supported by Irish Research Council Postgraduate Scholarship, *GOIPG/2018/1291*

Modelling the relationship between glucose and QTc in type-1 diabetes patients

Beatrice Charamba
Supervisor: Dr. Andrew Simpkin & Prof. John Newell

Type-1 diabetes patients sometimes die whilst sleeping, with no sign of what may be the cause of death. Studies done have linked the death to heart arrythmia which may be triggered by nocturnal hypoglycaemia (blood glucose $<$ 4mmol/L). QTc (corrected QT interval) prolongation (QTc $>$ 440 milliseconds) is a risk factor for cardiac arrhythmia. This study aims at determining if there is a relationship between QTc and blood glucose using functional data analysis. Of the studies done, none has applied intensive longitudinal data analysis to determine that relationship. This poster presents data collection and study design, functional regression models fitted and the results obtained from modelling. It also, includes discussion and conclusion as well as acknowledgements.

Supported by Insight Center for Data Analytics

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Inference of somatic mutations from low-depth cancer sequencing data

Siobhán Cleary
Supervisor: Cathal Seoighe

Somatic mutations are the basis for the development of cancer, with defects in DNA repair playing a role in the risk of multiple cancer types [1]. The number of cell divisions of the self-renewing cells that maintain different tissues strongly correlates with relative cancer risk in different tissues, suggesting that somatic mutation load is a key risk factor across cancer types [2]. Inference of the rate of somatic mutation from high throughput sequencing data is challenging because sequencing errors and DNA damage can be mistaken for somatic mutations.

Current bioinformatic work-flows involve multiple steps to process the data prior to the identification of somatic mutations. Each step has the potential to incorporate errors which are not accounted for and get propagated through each subsequent step of the work-flow. Existing methods require high sequencing depth in order to provide enough evidence to distinguish true somatic variants from sequencing errors and other artefacts, such as PCR errors and DNA degradation. The high costs associated with generating enough coverage to confidently call somatic mutations limits the use of whole exome sequencing (WES) in a clinical setting.

The main objective of our study is to implement probabilistic modelling techniques in order to account for the uncertainty at each step, using low depth sequencing data. Our models will improve upon existing methods to give more power to estimate sample-wide rates and patterns of mutations by accurately distinguishing between variants that arise due to error from those that are true somatic mutations.

In this poster, we outline the standard bioinformatic work-flow used to call somatic mutations and to identify mutational signatures from WES data. We will discuss each step from processing raw sequencing data right through to inferring somatic mutations and highlight the points at which our models will aim to account for the uncertainty generated through data processing.

Supported by Science Foundation Ireland

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Charge-controlled soft dielectric plates

Hannah Conroy Broderick
Supervisor: Michel Destrade

Dielectric materials are smart materials that deform elastically in the presence of an electric field. They have potential applications in devices such as artificial muscles and soft robotics, where there is demand for materials that can undergo repeated large deformations.

We investigate the case of a soft dielectric plate deformed by the coupled effects of a mechanical prestress applied on its lateral faces and an electric field applied through its thickness under charge-controlled actuation, where the electric field is created by spraying charges on the major faces of the plate. Although in practice this mode of actuation is harder to achieve than a voltage-driven deformation, here we find that it turns out to be much more stable in theory. We show that the geometric instability associated with the formation of small-amplitude wrinkles on the faces of the plate that arises under voltage control does not occur in this case. Further, using Finite Element simulations, we find that the actuation is limited by a breakdown due to inhomogeneous fields developing close to the clamps of the plate.

Supported by the Irish Research Council (Project GOIPG/2016/712).

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The contribution of BCL11B related biology to Schizophrenia and Cognition

Laura Fahey

Supervisors: Dr Derek Morris and Dr Pilib Ó Broin

Schizophrenia (SCZ) is a common but severely debilitating adult-onset mental illness characterized by hallucinations, delusions, and a lack of desire to accomplish goals or form social relationships. Cognitive deficits (affecting memory, IQ or attention) are also a core feature of schizophrenia. However these deficits are not effectively targeted by current treatments, primarily owing to a lack of understanding of the shared biology of schizophrenia and cognition. Our hypothesis is that variation in genes with immune function contribute to both SCZ and the associated cognitive deficits. We focus on BCL11B, a transcription factor involved in regulating the differentiation and development of cells in both the central nervous system (CNS) and the immune system. Both BCL11B and its interacting partner SATB2 are risk genes for schizophrenia. To test our hypothesis, we first integrated existing RNA-seq and ChIP-seq data on BCL11B to identify its direct targets in immune cells and brain cells and define functionally related gene sets. We tested for enrichment of common variants in these gene-sets with MAGMA gene-set analysis (GSA) using summary statistics from genome wide association studies (GWASs) on both SCZ and cognition. Enrichment of rare variation in our gene-sets was tested with denovolyzeR using data pooled from multiple studies identifying genes containing de novo mutations through exome sequencing of SCZ probands and their parents. Our results suggest that genes functionally related to BCL11B are enriched for de novo mutations but not common SNPs. These data support the involvement of BCL11B-related biology in the etiology of SCZ.

Regions of Reduced Dynamics in Dynamical Networks

Roberto Galizia

Supervisor: Petri T Piiroinen

We investigate the stability of equilibrium points in dynamical networks [1] of N coupled identical agents. The dynamics of each agent is given by two distinct component: a vector field that models the uncoupled dynamics and a communication protocol that describes how the agents interact with one another. The connection structures are given by the topology of undirected graphs [2], and the vector fields are given by saddle-node, transcritical and supercritical pitchfork bifurcation normal forms [3]. This leads to N-dimensional dynamical systems that depend on two parameters.

The main objective of the research is to determine the bifurcation structure of N-agents networks for each of the considered vector fields. To do this, we initially study three cases of two coupled agents [4], corresponding to the three different vector fields. For each type we have closed solutions for the equilibrium points and Jacobians and thus have analytical bifurcation diagrams. For higher-dimensional networks the complexity of the problem increases rapidly due to large number of equilibrium points and the lack of closed solutions. This forces us to use numerical continuation [5] to explore the parameter space.

From numerical experiments we conjecture the existence of a particular subset of the parameter space in which the bifurcation structure of the N-agents system is topologically equivalent to one of the corresponding 1-dimensional normal form. We define this subset as the Region of Reduced Dynamics.

Furthermore, considering the case of agents with supercritical pitchfork structure leads us to the study of multi-stable networks. Among the many possible stable equilibrium points, we are interested in the two synchronous stable equilibrium points for which networks are synchronized. We define a global transition as a controlled trajectory that brings the network from one synchronous stable equilibrium point to the other. We finally show how such a transition can be realised by defining a set of control inputs acting on some of the agents.

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Modelling bioabsorbable polymers

Aoife Hill
Supervisors: William Ronan, Michel Destrade

Bioabsorbable polymers can offer powerful alternatives to various clinical applications, providing a temporary device that slowly degrades as healing takes place. Mathematical modelling of these materials can provide important insight for device design, a task complicated by the many underlying complex degradation mechanisms that bioabsorbable polymers exhibit.

In the poster, we present a kinetic scission model that captures changes in the polymer properties as degradation takes place, motivated by Wang et al. and Shirazi et al. [1, 2]. Biocompatible polyesters experience degradation due to a hydrolytic reaction when placed in an aqueous medium. Water hydrolyses ester bonds throughout polymer chains, causing chains to split. Acidic degradation products can build-up in the material and accelerate the hydrolytic degradation, i.e., autocatalysis. Assuming a closed system, the degradation mechanism is modelled as follows:

$$\frac{dC_e}{dt} = -(k_h C_e + k_a C_e C_a^{0.5}), \tag{2}$$

$$\frac{dC_a}{dt} = k_h C_e + k_a C_e C_a^{0.5}, \tag{3}$$

where C_e is the concentration of ester bonds, C_a is the concentration of acidic degradation products, and k_h and k_a are the reaction rates of simple hydrolysis and autocatalysis, respectively. A representative polymer chain distribution is generated and scissions are performed on chains at random, with the number of scissions to be performed in a time step calculated using (3). This provides predictions for the evolution of the molecular weight distribution of bioabsorbable polymers as a function of degradation time. An entropy-spring theory [3] is also implemented in the model to provide insight into the evolution of Young's modulus of the system. Finally, we calibrate the model using experimental data for in vitro degradation of a poly(lactide-co-glycolide) film [4].

Supported by the Irish Research Council, GOIPG/2018/2697.

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Adapted *a posteriori* meshes for Burgers' equation

Róisín Hill

Supervisor: Niall Madden

We consider the numerical solution, by finite element methods, to differential equations whose solutions exhibit layer-type phenomena. Our model problem is Burgers' equation, formulated as

$$u_t = \varepsilon u_{xx} - \left(\frac{u^2}{2}\right)_x, \quad \text{for } x \in (0,1),\ t > 0, \tag{4a}$$

subject to the boundary conditions,

$$u(0,t) = u(1,t) = 0, \tag{4b}$$

and the initial condition,

$$u(x,0) = \sin(2\pi x) + \frac{1}{2}\sin(\pi x). \tag{4c}$$

When the positive real parameter ε is small, the solution is initially smooth, but a shock, manifested as an interior layer, develops over time. Accurate numerical resolution of the shock requires a mesh that is fitted to the layer. Since the width and location of this shock varies over time, we are motivated to develop algorithms that automatically generate *adapted* meshes, based on *a posteriori* information, which evolve over time to concentrate the mesh points in the shock region. That is, at each time-step, mesh points are relocated to better represent the evolving solution. The main challenges in achieving this are

(i) estimating errors in a computed solution,

(ii) using those error estimates to drive a (non-linear) mesh adaption algorithm, and

(iii) solving the non-linear adaptivity problem.

In this poster we will describe the use of a "*moving mesh partial differential equation" (MMPDE)* method [1] for generating the adapted meshes. As the name suggests, this method is based on solving a PDE (in this case, a non-linear parabolic problem) in order to compute the new mesh point locations. Our solver is implemented in FEniCS, an open-source platform for solving partial differential equations [2]. That is, we use FEniCS to solve both Burger's equation and the MMPDE.

The success of the approach depends on a sensible choice of the MMPDE (among other user-tunable aspects of the algorithm).

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The fundamental long exact sequence in arithmetic group cohomology

Kelvin Killeen

Supervisor: Graham Ellis

This project is concerned with a certain long exact sequence that arises in the theory of arithmetic group cohomology. So-called the *'fundamental sequence'* by Harder [1], it plays an integral role in the understanding of automorphic forms in number theory. The main objectives of this project are to develop an understanding of the wealth of theory at play here, then to ultimately implement this sequence on a computer via the GAP computer algebra system.

In this poster, the basic setup for this scenario will be described, with the discrete group in question being $SL_2(\mathbb{Z})$. This group will act on the Poincaré disk model of the hyperbolic plane, allowing for a nice visual component. As well as this, a synopsis of the tasks that have been completed to date will be given. This includes a few GAP algorithms concerning the universal cover of an arbitrary CW-complex.

Supported by the Irish Research Council GOIPG/2018/2152

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Modelling glucose phosphorylation by hexokinase I

Vinh Q. Mai
Supervisor: Dr. Martin Meere

Phosphorylation of glucose is the initial step of glycolysis and is catalysed by hexokinase using ATP as a phosphoryl donor. The product of this process, glucose-6-phosphate, is key in producing energy and synthesising many vital constituents for cells. Four isozymes of hexokinase, named hexokinase I, II, III, and IV, are naturally present in mammalian tissue and only hexokinase IV isozyme is not inhibited by its product. Furthermore, inorganic phosphate P_i antagonises the inhibition of hexokinase I by glucose-6-phosphate at low concentration levels only and inhibits hexokinase I at high concentration levels. A complete kinetic mechanism for hexokinase I remains to be in the debate due to inconsistent experimental evidence. In the present work, we have proposed a theoretical kinetic mechanism to be the basis of developing our mathematical model that describes the phosphorylation of glucose by hexokinase I within a system of hexokinase I, glucose, ATP, and P_i. The model results present a quite good consistency with experimental studies. Hence, it is seemly rational to believe that our kinetic mechanism is probably applicable for hexokinase I.

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Alternating Signed Bipartite Graph Colourings

Cian O'Brien
Supervisors: Rachel Quinlan and Kevin Jennings

This poster develops a theme of Brualdi et al [1] by investigating a class of bipartite graphs that arise from *alternating sign matrices*. To an alternating sign matrix, we may associate an *alternating signed bipartite graph*, which has a vertex for each row and column of the matrix. Vertex r_i is connected to vertex c_j by a blue edge if there is a 1 in the (i, j) position of the matrix, and by a red edge if there is a -1.

In this poster, we present results on when a given graph G admits an edge colouring c such that the coloured graph G^c is an alternating signed bipartite graph.

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Bacterial Contamination Removal & Ploidy Inference using NGS data

Andrew Peters
Supervisor: Prof. Cathal Seoighe

Major issues in bioinformatics NGS (Next Generation Sequencing) analysis include presence of contaminated sequences and inference of ploidy levels, i.e., haploid (one set of chromosomes) or diploid (two sets of chromosomes) etc., in unknown ploidy samples. Removal of contaminated sequence data is of paramount importance to draw key conclusions from cleaned NGS data. Inferring ploidy is important, as some species adopt different ploidy levels throughout their life cycle and hence ploidy level inference would grant an insight into the sample's life cycle. Seaweeds are key organisms to address these issues, owing to the presence of seaweed-associated bacteria and their complex life cycle. Using 115 seaweed data samples from Dr. Ronan Sulpice's lab, pipelines were built to remove contamination and evaluate the ploidy levels for each individual seaweed sample.

Covering groups of elementary abelian groups

Dana Saleh
Supervisor: Rachel Quinlan

The theme of this poster is the classification up to isomorphism of covering groups of elementary abelian p-groups. For a prime p and postive integer n, the elementary abelian group of order p^n is the direct product of n copies of C_p. A *covering group* of C_p^n is a group G with the following properties

- $G/G' \sim C_p^n$;
- G' is elementary abelian of order $p^{\binom{n}{2}}$;
- $G' = Z(G)$.

If G is a covering group of C_p^n, then G has a generating set $\{x_1, \ldots, x_n\}$, and G' and the set of commutators of the form $[x_i, x_j]_{i<j}$ generates G' as an elementary abelian group. In particular the pth power of each x_i is uniquely expressible as a product of such commutators, and we may construct a covering group by choosing the pth power of each x_i as an elemenet of $\langle [x_i, x_j] \rangle_{i<j}$. It is challenging to decide when different choices of the pth power map on a generating set determine isomorphic groups.

If p is odd, then the pth power map on G is a group homomorphism and may be interpreted as a linear transformation of $\mathbb{F}_p$ vector spaces, which has a rank between 0 and n. There are $n-1$ isomorphism types of covering groups of C_p^n for odd p.

We propose an analogue of the concept of rank for 2-groups, with respect to which the isomorphism types of rank 1 covering groups of C_2^n correspond to isomorphism types of graphs of order n. The poster reports on investigation of the corresponding question for rank 2.

Tightness of Surface Graphs

Qays Shakir
Supervisor: Dr James Cruickshank

For integers $k \geq l$, a graph is (k,l)-sparse if any subset X of the vertex set V spans no more than $k|X| - l$ edges. It is (k,l)-tight if it has $k|V| - l$ edges in total. Sparsity and tightness of graphs have been subject much research. For example (k,k)-tight graphs are exactly those that can be decomposed into edge-disjoint spanning trees by a well-known theorem of Nash-Williams and Tuttle. In geometric rigidity theory, Laman has shown that $(2,3)$-tight graphs are precisely those for give rise to rigid generic bar and joint frameworks in the plane. In geometric graph theory, certain families of tight graphs arise as contact graphs associated to configurations of geometric objects.

In this project, we study inductive constructions for graphs that are embedded in surfaces without edge crossings. In particular, for $(2,2)$-tight graphs on a torus we exhibit a complete inductive construction theorem for such graphs. We also give a geometric application of this result to representations of graphs as contact graphs of configurations of circular arcs.

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Boundary Noise in Chua's Circuit

Eoghan J. Staunton
Supervisor: Petri T. Piiroinen

In a smooth dynamical system the characteristics of a given reference trajectory can be determined, to lowest order, by examining the linearised system about the reference trajectory. This form of analysis cannot be directly used in nonsmooth systems as the vector field is not everywhere differentiable, or the flow function is not continuous [1]. In this poster we introduce a method for the linearisation of discontinuous systems with stochastically varying boundaries, and show how the method can be used to estimate the dynamics of such systems [2].

In particular, we focus on the analysis of a discontinuous variant of the *Chua circuit*. The Chua circuit is a nonlinear electronic circuit that was created with the aim of being the simplest autonomous circuit capable of generating chaos. It was the first physical system for which the presence of chaos was shown experimentally, numerically and mathematically [3]. Here we apply noise to the discontinuity boundaries generated by the piecewise-linear nature of the voltage-current response of *Chua's diode*. We find that our method allows us to analyse the effects of boundary noise on periodic attractors close to bifurcation points. In particular, we show that we can use the method to accurately predict the noise amplitude required to destroy periodic attractors.

Eoghan Staunton is supported by an Irish Research Council Postgraduate Scholarship, Award Number GOIPG/2015/3500.

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Hochschild homology rings of the square-free monomial complete intersections

Nghia Tran
Supervisors: Dr. Emil Sköldberg, Dr. Alexander Rahm

In [1] Holm provided a description in terms of generators and relations of the Hochschild cohomology ring of the k-algebra $k[x]/\langle f\rangle$, where f is a monic element of the polynomial ring $k[x]$ in a single variable. This work of Holm inspired the authors in [3] to give a concrete approach in computing the structure of the Hochschild cohomology ring of square-free monomial complete intersections with n variables. Of particular interest to us is the ring structure of the Hochschild homology version of these algebras. In this poster, we will present our early findings on determining the ring structure of the Hochschild homology of square-free monomial complete intersections $k[x_1, x_2, \ldots, x_n]/\langle x_1 x_2 \cdots x_n\rangle$ in terms of generators and relations. Also, we exhibit computations on a small example to illustrate our conjectures on multiplicative structure of the Hochschild homology.

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Genus g Zhu Recursion for Vertex Operator Algebras

Michael Welby
Supervisor: Michael Tuite

This poster presents a recursive relation for n-point correlation differentials for a vertex operator algebra on a genus g surface, constructed using the Schottky formalism for self-sewing the Riemann sphere. We expand on ideas in complex geometry of Bers [2], combining them with the recursive identity to obtain a number of identities for universal objects on a Riemann surface of arbitrary genus.

Supported by an Irish Research Council scholarship

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4 Abstracts of PhD Theses

Computation of cohomology operations for finite groups

Daher Waly Freh Al Baydi
Supervisor: Prof. Graham Ellis

The main result of this dissertation is the computation of all Steenrod squares on the Mod 2 cohomology of all groups of order dividing 32 and on all but 58 groups of order 64; partial information on Steenrod squares is obtained for all but two groups of order 64. For groups of order 32 this thesis completes the partial results due to Rusin [R], Thanh Tung Vo [T] and Guillot [G]. The thesis also demonstrates how the underlying techniques can be used to compute the Stiefel-Whitney class of certain real representations. Other contributions of the dissertation are a range of algorithms, implemented in the GAP system for computational algebra, aimed at various homological calculations in the cohomology of finite p-groups.

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Non-Cut Points in Hausdorff Continua

Daron Anderson
Supervisor: Dr Aisling McCluskey

This thesis concerns the nature and extent of non-cut points in Hausdorff continua. The line of research began in 1923 when Moore [1] proved the original non-cut point theorem which states every metric continuum has two or more non-cut points. The result was adapted in 1968 by Whyburn [2] to the non-metric case through natural replacements for sequences, chains of closed sets and inductive argument.

Recent research [3, 4] takes an approach perpendicular to Whyburn. Rather than dropping the metric assumption, authors Leonel, Bobok, Pyrih and Vejnar are interested in more refined types of non-cut points in metric continua. In this thesis, we attempt to complete the other half of the picture by investigating special types of non-cut points in Hausdorff continua.

Our investigation is quickly confronted with facts about metric continua that do not generalise at all to the Hausdorff case. Chief among these is the existence of indecomposable continua with exactly one composant, henceforth called Bellamy continua. These creatures are a peculiarity of the non-metric realm. They quickly become the second theme of the thesis.

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Aspects of Modelling and Application of Survival-type Data

Lida Fallah
Supervisor: Prof John Hinde

Survival analysis is collection of methods for analyzing data where the outcome of interest is the time to an event and some of the observations are censored.

Survival data can arise naturally from studies on, machines' time to break down (also known as reliability) to agricultural experiments on how some environmental conditions affect flowering, to medical cohort studies following-up cancer patients' survival and their reaction to treatments, etc.

In industrial applications there are obvious benefits of progressive censoring (briefly speaking, removing live individuals progressively over time according to a censoring plan) in machine testing where effort, resource, and cost can be saved by early censoring. Furthermore, in agricultural applications, such as the serious threat of certain pests to sugar cane during the planting season or the maturation phase of the cane, biological control assays are used to study the survival of pests under exposure to pesticides. In addition, in recent decades, detecting the associations between patients gene expression profiles and phenotypic data is of increasing interest to aid in improving diagnosis and prognosis of patients and in facilitating treatment discoveries.

To appreciate different aspects of survival data and its applications, this thesis puts together different methods for modelling such data and deals with the unique difficulties that each type of data brings to bear on data analysis.

Translational Statistics and Dynamic Nomograms

Amirhossein Jalali
Supervisor: Prof. John Newell

Translational Medicine, within biomedical and public health research domains, is defined as the convergence of basic and clinical research with the aim to transfer knowledge on the benefits and risks of therapies. The concept of Translational Statistics is proposed to facilitate the integration of biostatistics within clinical research to enhance communication of statistical research findings in an accurate and accessible manner to diverse audiences (e.g. policy makers, patients and the media). The use of appropriate visualisation is central to all areas of statistical research. Providing meaningful graphical representations of data is necessary to identify features about the population from which the data were sampled and may throw up an unsuspected view of the data such as a pattern or unusual observations. Informative graphical representations of statistical models play an important translational role. Static nomograms have been used to visualise statistical models. In this study, we propose the use of dynamic nomograms as a visualisation and translational tool to further aid the communication of the results of a statistical analysis to a non-statistical audience. A visualisation tool for time-to-event data is presented which contains a collection of useful graphical summaries, in particular, the Mean Residual Life function. It includes the classical survival summaries as well as the dynamic prediction for survival function and the mean residual life function as the two attractive alternatives. In theory, most regression-type models presented in the literature could have an accompanying web address to direct the reader to the corresponding dynamic nomogram allowing them to 'interact' with the model to gain insight into the effect of each explanatory variable on the primary response.

Thinning Instabilities in Biological and Electroactive Membranes

Paul Greaney
Supervisors: Martin Meere, Giuseppe Zurlo

This thesis addresses several problems in the mathematical modelling of biological and electroactive membranes. We begin with a review of the necessary scientific background of biological and electroactive membranes in Chapter 1. In Chapter 2, we introduce the mathematical framework required for modelling such membranes, consisting of an overview of differential geometry and nonlinear elasticity. Following this, in Chapter 3 we give a full derivation of the shape equations of a lipid membrane whose energy density depends on the mean and Gaussian curvatures, the stretch of the membrane mid-surface, and the gradient of this stretch. While the first three of these quantities has received much attention previously in the literature, the inclusion of the stretch gradient dependence is a recent development in this area and

allows for more sophisticated mathematical modelling of membranes. We also show how these equations can be specialised to a specific geometry to obtain a set of ordinary differential equations, and thus how they can be used to predict the behaviour of membranes, and possibly to calibrate experimental results with the theory. In Chapter 4, we turn our focus to the modelling of dielectric membranes, and develop a new mathematical model describing wrinkling and dielectric breakdown in thin dielectric elastomer devices. We compare our theory with experimental results reported in the literature, and find a good match between theory and experiment. Chapter 5 presents some suggestions on how the theory developed for dielectric membranes might be extended to the case of biological membranes, in particular, to the modelling of pore formation in lipid bilayers interacting with peptide proteins.

Entry Pattern Matrices

Hieu Ha Van
Supervisor: Dr Rachel Quinlan

An entry pattern matrix (EPM for short) is a rectangular matrix in which each entry is an indeterminate. The same indeterminate may appear in multiple positions, but different indeterminates are independent. For a field $\mathbb{F}$, an $\mathbb{F}$-completion of an EPM is the matrix that results from assigning a specific value from $\mathbb{F}$ to each indeterminate that appears as an entry of the matrix. In this thesis, we are concerned with the set of $\mathbb{F}$-completions of an entry pattern matrix which can be considered as a vector space whose dimension is equal to the number of distinct indeterminates appearing in the entry pattern matrix.

Chapter 1 presents some background to the content of Chapters 3, 4, and 5. We discuss linear subspaces of square matrices in which every nonzero element is either nonsingular, and in which every element is nilpotent. In particular, we consider bounds on the dimensions of such spaces.

In Chapter 2 we will introduce the concept of an entry pattern matrix and discuss some general properties.

In Chapter 3 we will consider the maximum rank of a completion of a given entry pattern matrix over a field $\mathbb{F}$. We will show that this number can depend on the field under consideration, and focus on cases where it does. We will define the generic rank and the maximal completion rank of an entry pattern matrix and introduce the concept "EPM-rank-tight" field and prove that every finite field of characteristic less than 17, except $\mathbb{F}_2$, is EPM-rank-tight.

In Chapter 4 we will introduce the concept of an $\mathbb{F}$-almost-nonsingular EPM as an EPM whose completions are all nonsingular provided that their entries are not all equal. We present constructions for entry pattern matrices that are almost-nonsingular over the real, the rational fields and over finite fields, and obtain lower bounds for their numbers of indeterminates.

In Chapter 5 we will give bounds for the number of indeterminates in $n \times n$ nilpotent entry pattern matrices over fields of positive characteristic. We also give the classification of such entry pattern matrices attaining the bounds.

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Waves, wrinkles and creases in deformed soft solids

Robert Mangan
Supervisor: Michel Destrade

This article-based thesis comprises a collection of four articles, each of which constitutes a chapter written and formatted in pre-print manuscript form. The general aim underlying these articles is to model the large deformations of soft solids including soft biological tissues, with particular interest in wrinkle and crease formation, and in wave propagation. These wrinkles and creases occur frequently in nature, often as a result of an instability of a finite deformation. Waves can be used to characterise the mechanical properties of a soft solid, including biological soft tissues. These soft tissues may undergo large deformations in service or in testing, so we study the propagation of waves in a soft solid subject to an underlying finite deformation.

Bayesian Imputation of Right Censored Data in Time-to-Event Studies

Shirin Moghaddam
Supervisor: Prof John Hinde & Prof John Newell

In time-to-event studies subjects are followed until the event of interest has happened. Subjects who do not experience the event are referred to as censored. Due to censoring, methods of plotting individual survival time, such as density plots, are invalid. The graphical displays of time-to-event data usually take the form of a Kaplan-Meier survival plot. However, using a Kaplan-Meier survival plot might not be the most informative way to present the data to answer the typical questions of interest. The median survival is often used as a summary of the survival experience of a patients' population and it is easily read off the Kaplan-Meier plot. It is unlikely however that the median is a relevant summary at the patient level and a density plot of the data is perhaps more informative for communication than a single summary statistic. A fundamental idea in this thesis is to consider censored data as a form of missing, incomplete, data and use approaches from the missing data literature to handle this issue. In particular, we will use the idea of imputing the censored observations, based on the other information in the dataset and some form of assumed model. By imputing values for the censored observations and combining the original complete and imputed incomplete data, it is possible to plot the density of the full data to complement the information given by Kaplan-Meier plots. In this thesis, we consider using parametric Bayesian and non-parametric Bayesian methods to impute right censored survival data to achieve this aim. The imputation of censored observations not only allows more interpretable graphics to be produced for a wider general audience (physicians and patients), but it opens up the possibility of the use of standard formal methods of analysis for continuous responses.

Edge-minimal graphs of exponent 2

Olga O'Mahony
Supervisor: Rachel Quinlan

A simple undirected finite graph G has the me_2-property if every pair of distinct vertices of G is connected by a path of length 2, but this property does not survive the deletion of an edge. If u and v are adjacent vertices in an me_2-graph G, then either u is the unique common neighbour in G of v and another vertex w, or v is the unique common neighbour in G of u and another vertex w . If both of these properties hold for every pair of adjacent vertices in G, then we say that G has the *strong-me_2-property.* The me_2- and strong-me_2-properties can be viewed as relaxations of the friendship property, and this thesis investigates graphs with the me_2- and strong-me_2-properties. The relationship between these properties is discussed, and particular classes of graphs with these properties are described. We also discuss the behaviour of the me_2- and strong-me_2-properties under certain graph products.

It is shown that every graph of order n is an induced subgraph of an me_2-graph of order at most $3n+2$. The problem of which graphs can be embedded as induced subgraphs of strong-me_2-graphs is considered, and a construction for complete graphs is presented. The problem of embedding a given graph as an induced subgraph of an me_2-graph or

strong-me_2-graph with no edges amongst the additional vertices is studied in detail for trees. Not all graphs can be embedded in this manner. This thesis initiates a study of edge-minimal graphs of exponent 2 and poses some open problems on this subject.

In conclusion, this thesis demonstrated several novel high-throughput approaches and strategies for immunological repertoire analysis. It also addressed some important biological questions relating to the allelic diversity of immune receptor genes by exploiting public biological resources, which could potentially inform subsequent studies.

Novel Insights into Allele-specific Expression and Translation in Human Lymphoblastoid Cell Lines through Integrative Analysis of Transcriptomic and Ribosome Profiling Data

Ngoc Nguyen
Supervisor: Prof. Cathal Seoighe

The rate of mRNA translation makes an important contribution to determining protein abundance in cells and genetic variants that affect the rate at which a protein is synthesized may give rise to human genetic diseases and phenotypes. Cis-acting regulatory elements affecting translation can be revealed from the imbalances in translation rates between the two alternative alleles of a gene in a heterozygous diploid individual. The work presented in this thesis represents the first attempt to infer allelic differences in the rate of protein translation, referred to as allele-specific translation (AST), and develops a mixture model to estimate the prevalence of AST in human lymphoblastoid cell lines (LCLs), using an integrative analysis of transcriptomic and ribosome profiling sequencing data. We applied the pipeline to identify AST in data from both the HeLa and 63 LCLs and found that AST is widespread (a median of 31% of genes are affected), with broader and stronger effect sizes than are found for allele-specific expression across human LCLs. Variants associated with AST are enriched in the $5'$ leaders of mRNAs, suggesting that translational control is mostly regulated at the initiation step. We found several cancer- and disease-associated genes that exhibit strong AST signals in HeLa (e.g. *NQO1*) and multiple LCL samples (e.g. *RPLP2* and *SREBF2*) and validated one candidate causal AST variant experimentally (in the *NQO1* gene). The dysregulation of expression of these genes is observed in several cancers as well as other diseases and complex phenotypes, indicating the potential for clinically relevant impacts of genetic variants in these genes. Further investigation of the phenotypic effects of these genetic variations during pathophysiological development of the diseases might help to uncover the mechanisms underlying the etiology of these diseases. Thus, our method contributes to better understanding of human translational biology.

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5 Staff Profiles

Balbi, Valentina

Current Research Interests

My research project aimed at improving our understanding of the mathematics and the mechanics of living soft tissues (e.g. the skin, the brain, internal organs etc.) by combining theoretical, numerical and experimental approaches. In particular, I conducted a series of mechanical tests on brains in order to determine the properties of the tissue under large deformations. Other research topics I am interested in are the mechanics of growth and morphogenesis and viscoelasticity.

Recent Publications

[1] Balbi V, Shearer T, Parnell WJ. A modified formulation of quasi-linear viscoelasticity for transversely isotropic materials under finite deformation. Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences. 2018;474(2217):20180231.

[2] Balbi V, Destrade M, Goriely A. The mechanics of human brain organoids. arXiv preprint arXiv:181101893. 2018;.

[3] Balbi V, Trotta A, Destrade M, Ní Annaidh A. Poynting effect of brain matter in torsion. arXiv preprint arXiv:181100832. 2018;.

Research Activities

My research was funded by the European Commission (Marie Curie individual fellowship from March 2017 to February 2019). During my fellowship I supervised one undergraduate student (O Donnell, Cillian), edited a special issue for the International Journal of Nonlinear Mechanics, written an article for RTE Brainstorm and participated in several outreach activities (FameLab Galway 2018, Middle School Lectures in Torino). I presented my work at several conferences, among those the 10^{th} European Solid Mechanics Conference in Bologna and the mini-workshop at the Oberwolfach Research Institute for Mathematics, and I organised a mini-symposium at the British Applied Mathematics Colloquium in St Andrews, UK. I am a member of the National Group of Mathematical Physics (GNFM), INdAM since 2018 and I served as a reviewer for several applied mathematics and mechanics journals.

Burns, John

Current Research Interests

My current research interests are Algebra (Lie algebras, Lie groups, Weyl groups) and Differential Geometry (Homogeneous manifolds, Symmetric spaces). One current research project involves graded Lie Algebras and their application to the geometry of homogeneous submanifolds of noncompact symmetric spaces. These spaces are interesting as they contain a large class of Einstein manifolds.

Recent Publications

[1] Burns, John M.; Makrooni, Mohammad A. Parabolic subroot systems and their applications. *Glasgow Math. J.* , 2019. doi:10.1017/S0017089519000156.

[2] Burns, John M.; Makrooni, Mohammad A. Compact homogeneous spaces with positive Euler characteristic and their 'strange formulae'. *Q. J. Math.* , 66(2):507–516, 2015.

Research Activities

- Invited talks: British and Irish Geometry Meeting,Q.U.B. June 2018, "Graded Lie Algebras-their representations and applications. "
- Refereeing: 1 paper.
- Conferences and workshops: Groups in Galway, May 2018.
- Journal Submissions: 2.

Carnevale, Angela

Current Research Interests

My research is primarily in the fields of algebraic, analytic, and enumerative combinatorics. My work is often motivated by enumerative questions, mostly in algebra and geometry, that require the development and application of combinatorial tools. The main research directions that I am presently pursuing include matrix enumeration and permutation statistics, and enumeration of ideals of rings under base extension.

Research outputs

[1] F. Brenti and A. Carnevale. Odd length in Weyl groups. *Algebraic Comb.* (2019), to appear.

[2] A. Carnevale, S. Shechter and C. Voll. Enumerating traceless matrices over compact discrete evaluation rings. *Israel J. Math.* 227 (2018), 957–986.

[3] F. Brenti and A. Carnevale. Proof of a conjecture of Klopsch-Voll on Weyl groups of type *A*. *Trans. Amer. Math. Soc.* 369 (2017), 7531–7547.

Research Activities

- Papers submitted:
  - Odd length in Weyl groups (with F. Brenti)
  - Partial Word and Equality Problem and Banach densities (with M. Cavaleri).
- Awarded an Irish Research Council Postdoctoral Fellowship (2018–2020).
- Refereed papers for various journals.
- Junior Research Fellow at the Erwin Schrödinger Institute in Vienna (August to November 2018).
- Invited speaker of the *Geometry and Analysis on Groups Research Seminar* at the University of Vienna. Talk: "Enumerating traceless matrices".
- Invited participant (3–20 December 2018) of the Trimester Program *Logic and Algorithms in Group Theory* at the Hausdorff Research Institute for Mathematics in Bonn.
- Invited speaker at the symposium *Geometric Group Theory at Infinity*, December 2018, Bielefeld University. Talk: "Partial Word and Equality Problems".

Cruickshank, James

Current Research Interests

Current research interests include

- Geometric rigidity theory: This is the mathematical rigidity theory of structures such as bar and joint frameworks, panel and hinge structures and many other variations. Collaborators: Qays Shakir (NUIG), Derek Kitson (Lancaster), Steve Power (Lancaster), Bill Jackson (Queen Mary), Tony Nixon (Lancaster)
- Problems in topological graph theory arising from representations of graphs as contact graphs for various classes of geometric objects. Collaborators: Qays Shakir (NUIG)
- Multilinear algebra over local rings: generalizations of classical results on classification of various types of mutilinear forms over fields to local rings. Also we have considered the presentations and representations of the the unitary groups arising from these forms. Collaborators: Rachel Quinlan (NUIG), Fernando Szechtman (Regina), Luis Gutierrez (Santiago, Chile)
- Percolation and games on random geometric graphs. This is a collaborative project along with colleagues in Discipline of Information Technology. We are interested in studying the spread/evolution of behaviour in networks modelled on random geometric graphs, in particular on random hyperbolic graphs. Collaborators: Christine Marshall (NUIG), Colm O'Riordan (NUIG).

Recent Publications

[1] J. Cruickshank, D. Kitson and S. C. Power The rigidity of a partially triangulated torus. *Proceedings of the London Mathematical Society*, (0). https://www.doi.org/10.1112/plms.12215.

[2] J. Cruickshank and F. Szechtman. Generators and relations for the unitary group of a skew hermitian form over a local ring. *Linear Algebra Appl.*, 552:1–28, 2018.

[3] James Cruickshank, Bill Jackson, Hakan Guler, and Anthony Nixon. Rigidity of Linearly Constrained Frameworks. *Int. Math. Res. Notices*, 08 2018. https://doi.org/10.1093/imrn/rny170

Research Activities

- Current postgrad students: Qays Shakir (PhD), Christine Marshall (PhD, cosupervised with Dr Colm O'Riordan)
- Papers appearing in 2018: 5 journal papers and 1 conference paper.
- Conferences: Invited speaker at "Rigidity and Flexibility of Geometric Structures", Erwin Schrödinger Institute, Vienna, Septmber 2018. Contributed talk at "Bond-node structures: rigidity, combinatorics and chemistry", Lancaster, June 2018.
- 2 papers refereed.
- Editorial board of the Bulletin of the IMS.

Destrade, Michel

Current Research Interests

In 2018, I worked on the modelling of dielectric elastomers, on growth and residual stresses for soft tissues, on wrinkles and creases in soft solids, and on computer simulations of brain neurons,

Recent Publications

[1] T. Sigaeva, R. Mangan, L. Vergori, M. Destrade and L. Sudak. Wrinkles and creases in the bending, unbending and eversion of soft sectors. *Proc. Roy. Soc. A*, 474, 20170827, 2018.

[2] Y. Su, H. Conroy Broderick, W. Chen, and M. Destrade. Wrinkles in soft dielectric plates. *J. Mech. Phys. Solids*, 119, 298–318, 2018.

[3] I. Cinelli, M. Destrade, M. Duffy, P. McHugh. Electro-mechanical response of a 3D nerve bundle model to mechanical loads leading to axonal injury. *Int. J. Num. Methods Biomed. Eng.*, 34, e2942, 2018.

Research Activities

- *Current research grants*: 4 IRC postgraduate scholarships; Visiting PhD grant from China Research Council, 1 Marie Curie Postdoctoral Fellowship; IRC postdoctoral Fellowship; Flaherty Research Scholarship; Visiting Grant from Zheijiang university; President's Award for Research Excellence.
- *Graduate students:* 7, James Blackwell (four years, 2018-2022), Robert Mangan (three years, 2015-2018), Hannah Conroy Broderick (four years, 2016-2020), Ilaria Cinelli (three years, 2016-2019), Aoife Hill (three years, 2018-2021), Yangkun Du (two years, 2018-2020), Michele Righi (nine months, 2018-2019);
- *Journal papers:* 8;
- *Research Fellows*: 2 (Dr Valentina Balbi, Dr Yipin Su);
- *Conferences/Seminars:* 10 (DCU, UCD, Hangzhou, Nanjing, Ningbo, Xi'an, Shanghai, Milan, Oxford, Paris);
- *Graduate Courses:* 2 (Brescia, Hangzhou);
- *Outreach talks:* 10+;
- *Research Visits:* 4 (Hangzhou, Xi'an, Milan, UCD);

- *Research Visitors:* Ray Ogden FRS (University of Glasgow); John Hutchinson (Harvard University); Souhayl Sadik (Max Planck Institute for Mathematics in the Sciences); Taisiya Sigaeva (University of Calgary); Giuseppe Saccomandi and Luigi Vergori (University of Perugia); Harold Berjamin (Ecole Centrale de Marseille).
- *Papers refereed:* 6;
- *International Grant referee:* 2 (BBSRC, EPSRC, United Kingdom);
- *PhD External Examiner:* 1 (Milan);
- *Editorial Board Member:* Proceedings of the Royal Society A, Quarterly Journal of Mechanics and Applied Mathematics, International Journal of Applied Mechanics, International Journal of Non-Linear Mechanics, Journal of the Acoustical Society of America, SIAM Journal of Applied Mathematics;
- *External positions:* Reviews Editor (Proceedings of the Royal Society A); Contributing Editor (International Journal of Non-Linear Mechanics); Adjunct Professor of Mechanical Engineering (University College Dublin); Adjunct Professor of Mechanical Engineering (Zhejiang University); Directeur de Recherche, Institut d'Alembert, CNRS, Paris, France (on leave); International Brain Mechanics and Trauma Lab (Oxford); Biomechanics Research Centre (NUI Galway).
- *Consultancy work:* 1 (expert technical report for INSPEC International Ltd, United Kingdom).

Egan, Ronan

Current Research Interests

My main research interests can be divided into two categories, Design Theory and Coding Theory, but more broadly my interests are in Discrete Mathematics, Algebra and Combinatorics. My current project focuses on the intricate links between combinatorial structures such as block designs and Hadamard matrices, and linear codes over finite fields. Algebraic and combinatorial techniques are used to construct and analyse relevant combinatorial structures: matrices obeying a combinatorial constraint equivalent to desirable properties of corresponding codes. These structures are used to computationally generate linear codes with good error-correction capabilities. Similar techniques are used to solve difficult existence and classification problems in design theory and related fields.

Recent Publications

[1] Ronan Egan. Phased unitary Golay pairs, Butson Hadamard matrices and a conjecture of Ito's. *Des. Codes Cryptogr.*, 87, 1, 67–74, 2019.

[2] Dean Crnković, Ronan Egan, Andrea Švob. Constructing self-orthogonal and Hermitian self-orthogonal codes via weighing matrices and orbit matrices. *Finite Fields Appl.*, 55, 64–77, 2019.

[3] Ronan Egan, Padriag Ó Catháin, Eric Swartz. Spectra of Hadamard matrices. *Australas. J. Combin.*, 73(3), 501–512, 2019.

Research Activities

- I started an IRC Postdoctoral Fellowship in October 2018.
- Until the end of June 2018 I was a postdoc at University of Rijeka, Croatia.
- I published two papers in 2018 not listed above and I'm currently awaiting reports on three journal submissions from 2018.
- I spoke at Combinatorics 2018 in Arco, Italy, in June, and at Groups in Galway in May.
- I spent two weeks in April of 2018 in USA, visiting with Padraig Ó Catháin at Worcestor Polytechnic Institute in Massachusetts, where I spoke at the Department of Mathematical Sciences Colloquium, and visiting with Eric Swartz at College of William and Mary in Virginia, where I spoke at the Groups Analysis and Geometry Seminar.
- I refereed various journal articles in 2018.

- Associate member of the Institute of Combinatorics and its Applications.

Ellis, Graham

Current Research Interests

I am interested in algebraic topology, particularly in algorithmic aspects and in aspects that relate to low dimensional topology and group theory.

Recent Publications

[1] Ellis, Graham, *An invitation to computational homotopy*, Oxford University Press, 683pp, in press and to appear September 2019.

[2] Ellis, Graham and Fragnaud, Cédric, Computing with knot quandles, J. Knot Theory Ramifications, 27, 2018, 14, 18pp,

[3] Alokbi, Nisreen and Ellis, Graham, Distributed computation of low-dimensional cup products, Homology, Homotopy and Applications, 20, 2018, 2, 41–59,

Research Activities

- Daher Freh completed a PhD in 2018. Nisreen Alokbi submits her PhD in 2019. Kelvin Kileen started a PhD in 2018.
- Co-organized a conference with Philippe Elbaz-Vincent and others at the Centre International de Recontres Mathématiques, Luminy on "Cohomology of Arithmetic Groups, Lattices and Number Theory: Geometric and Computational Viewpoint", 25-29 March, 2019.
- Editorial Board Member for:
  - Homology, Homotopy and Applications (HHA)
  - Journal of Homotopy and Related Structures (JHRS)
  - Applicable Algebra in Engineering, Communication and Computing (AAECC)
  - Tbilisi Mathematical Journal (TMJ)

Dane Flannery

Current Research Interests

Computing with linear groups, algebraic design theory.

Recent Publications

[1] *Linear groups and computation*, Expositiones Mathematicae (with A. S. Detinko). `https://doi.org/10.1016/j.exmath.2018.07.002`

[2] *Algorithms for experimenting with Zariski dense subgroups*, Experimental Mathematics (with A. S. Detinko and A. Hulpke). `https://doi.org/10.1080/10586458.2018.1466217`

[3] *On quasi-orthogonal cocycles*, Journal of Combinatorial Designs 26, 401–411, 2018 (with J. A. Armario).

Research Activities

- Research in Pairs, MFO Oberwolfach, June 2018.
- Research visits to Dr Alla Detinko (St Andrews), Prof. Eamonn O'Brien (Auckland), Prof. V. Shpilrain (CUNY).
- Participant in the Trimester Programme 'Logic and Algorithms in Group Theory', Hausdorff Research Institute for Mathematics, November/December 2018.

Golden, Aaron

Current Research Interests

In **Astronomy** I am interested in exploring the magnetic activity of flares stars and substellar objects, with a particular focus on understanding the conditions that give rise to auroral emission in several nearby cool T dwarfs. I am also interested in the detection and characterisation of extrasolar coronal mass ejections, and their likely impact on habitability.
In **Earth Observation** I am working on cloud based methodologies to process NASA, EU/ESA and commercial remote sensing data to monitor

Irish groundwater, assess Irish lake and coastal water quality and quantify kelp biomass around the Irish Atlantic coast.
Finally in **Radiobiology** I continue to collaborate with colleagues in the Department of Medical Physics & Bioengineering in Galway University Hospital on the optimisation of radiotherapeutic models and in the area of radiomics.

Publications

Two manuscripts currently under review.

Research Activities

Telescope Time Awarded (following peer review)

(Proposal Code/Date, Proposal Title, Configuration, Time Awarded)

South African Astronomical Observatory, Sutherland, South Africa
Golden-2018-01-74-inch-147, *'High Time Resolution Monitoring of Flares on Proxima Centauri'*, SHOC/1.9m telescope, 7 nights
Golden-2018-09-74-inch-208, *'High Time Resolution Monitoring of Flares on Proxima Centauri'*, SHOC/1.9m telescope, 7 nights

Low-Frequency Array (LOFAR), Netherlands
LC9_040, *'A search for aurora on nearby flare stars using LOFAR'*, 4.2 hours
LC10_018, *'A search for aurora on nearby flare stars using LOFAR'*, 8.4 hours

e-MERLIN (Multi-Element Radio Linked Interferometer Network), Jodrell Bank, U.K.
CY6006, *'Joint e-MERLIN/LOFAR Observations of CN Leo'*, 12 hours
CY7002, *'Joint e-MERLIN/LOFAR Observations of EQ Peg'*, 12 hours

Liverpool Telescope, Roque de los Muchachos Observatory, Canary Islands, Spain
PQ18B02, *'Simultaneous LT, LOFAR and e-MERLIN Observations of the flare binary EQ Peg'*, 7 hours

The Neil Gehrels Swift Observatory, NASA
10361, *'Monitoring of CN Leo in X-ray/UV'*, 9000 seconds (5 orbits)
11283, *'Monitoring of EQ Peg in X-ray/UV'*, 11283 seconds (7 orbits)

Vatican Advanced Technology Telescope, Mount Graham, Arizona, USA
04/05/18-11/05/18, *'Photometric monitoring of brown dwarfs'*, 8 nights
11/10/18-21/11/18, *'Photometric monitoring of brown dwarfs'*, 11 nights

Research Grants Awarded

Environmental Protection Agency, *'GRACE Monitoring of Groundwater over Ireland'*/2018-W-DS-33, PI, € 88K
Environmental Protection Agency, *'The Diversity and Resilience of kelp ecosystems in Ireland'*/2018-W-MS-35, Co-I, € 250K
Royal Astronomical Society Education & Outreach Small Grants Scheme, *'Connacht Schools Planetary Radio Telescope Network'*, PI, $ 3K
Europlanet Horizon2020 Outreach Funding Scheme 2018, *'Connacht Schools Planetary Radio Telescope Network'*/654208, PI, € 7.5K

Conference Publications

Golden, A., Campbell, P., De Hora, P., Grogan, S., Hession, A., Mulvey, P., O'Gorman, S., Ó hÉanaigh, M., Spellacy, N., Stephens, J., Toner, J., *'Connacht Schools Planetary Radio Telescope Network'*, European Planetary Science Congress 2018, id.EPSC2018-1004, 2018
Dulaimi, S., Boyle, R.P., Fitzgerald, K., **Golden, A.**, & Butler, R.F., *'Untangling the light-curves of the brown dwarf binary J0746+20'*, Cambridge Workshops of Cool Stars, Stellar Systems and the Sun, July 29 - Aug 3 2018, Cambridge, USA

External Service

NASA Postdoctoral Fellowship Program, (Expert Reviewer in: Astrophysics, Solar System Sciences, Astrobiology, Technology)
European Commission Marie Sklodowska-Curie Individual Fellowships (MSCA-IF) 2017 call (Expert Reviewer: Physics Panel)
Time Allocation Committee, Giant Meterwave Radio Telescope, Tata Institute for Fundamental Research, Pune, India
Ad-hoc Reviewer, Bioinformatics (Oxford University Press), Monthly Notices of the Royal Astronomical Society (Oxford University Press)

Meetings Attended

10th Annual Radiogenomics Consortium Meeting, held at the Manchester Cancer Research Centre, Manchester, UK, 16/07/2018.
European Planetary Science Congress 2018, 16/09/2018-21/09/2018, TU Berlin, Berlin, Germany
Geoscience 2018 - Meeting the Challenges, Geological Survey of Ireland, 08/11/2018, Hibernia Conference Centre, Dublin Castle.
Irish LOFAR Consortium Meeting, 18/12/2018, Dunsink Observatory, Dublin.

Graduate Supervision

Salam Dulaimi, Ph.D. Candidate, *High Speed Optical Photometry of Brown Dwarfs*, School of Physics (co-supervised with Dr. Ray Butler)
Hien Thi Thu Trinh, Ph.D. Candidate, *Chromatin organisation of divergent eukaryotes*, School of Natural Sciences (co-supervised with Dr. Andrew Flaus)

Hinde, John

Current Research Interests

Statistical modelling, particularly generalized linear models, under- and over-dispersion, random effects, and mixture models; statistical computing and statistical software; applications of statistics in biological, medical and social sciences.

Research outputs

Number of publications appearing in calender year 2017: Journal papers: 5; Software 2.
Recent publications.

Recent Publications

[1] Martial Luyts, Geert Molenberghs, Geert Verbeke, Koen Matthijs, Eduardo E Ribeiro Jr, Clarice GB Demétrio and John Hinde. A Weibull-count approach for handling under- and overdispersed longitudinal/clustered data structures. *Statistical Modelling*, doi.org/10.1177/1471082X18789992, 2018.

[2] Cóilín Minto, John Hinde and Rui Coelho. Including unsexed individuals in sex-specific growth models. *Canadian Journal of Fisheries and Aquatic Sciences*, 75(2), 282–292, 2018.

[3] Rafael A. Moral, John Hinde, Clarice G. B. Demétrio, Carolina Reigada and Wesley A. C. Godoy. Models for Jointly Estimating Abundances of Two Unmarked Site-Associated Species Subject to Imperfect Detection. *Journal of Agricultural, Biological and Environmental Statistics*, 23(1), 20–38, 2018.

Research Activities

- Journal submissions: 9; accepted 4; under review 3; under revision 2
- Conferences: Invited Speaker: 2
- Seminar talks: 1
- Conference Organisation: Member of Scientific Programme Committee COMPSTAT 2018, Iasi, Romania; RBras 2018, Curitiba, Brazil; International Workshop on Statistical Modelling 2019, Guimarães, Portugal.
- Editorships: Statistics and Computing (Associate); Computational Statistics and Data Analysis (Associate Editor); Statistical Modelling (Advisory Board); Referee for numerous journals.
  Guest co-Editor 4th special issue on Advances in Mixture Models. *Computational Statistics and Data Analysis.*
- External Examining: Statistics Extern School of Maths UCD; Certificate/Diploma in Statistics, Trinity College, Dublin; Statistics Extern, Technological University Dublin; PhD exams: Durham, UK; Barcelona, Spain.
- Professional Societies: Chair of Nominating Committee, International Biometric Society (IBS); Conducted operational review of International Biometric Office, IBS.

Holian, Emma

Current Research Interests

Mixture modelling to cluster longitudinal data profiles and to model the group features via generalized linear mixed models and penalized smoothing models, leading to the formulation of the Regression Cluster Model (RCM). Analysis into capability

of the RCM to handle missing data within profiles or profiles measured at variable time-points. Extension of the RCM to longitudinal profiles measured on discrete or categorical scales. P-Splines and mixed effects model clustering with an extension to multivariate applications.

Prognostic models in Breast Cancer in particular variable selection methods in survival models for data with various missingness mechanisms.

Statistical applications in microarray analysis and Next-Generation Sequencing (NGS).

Statistical challenges in environmental impact studies, in particular a recent focus on groundwater, sets some interesting features in left-censored values.

Research outputs

[1] "Arsenic in Groundwater in South West Ireland: Occurrence, Controls, and Hydrochemistry" McGrory, E,Holian, E,Alvarez-Iglesias, A,Bargary, N,McGillicuddy, EJ,Henry, T,Daly, E,Morrison, L (2018) Frontiers in Environmental Science, 6.

[2] "Quantifying Tip60 (Kat5) stratifies breast cancer." McGuire, A,Casey, MC,Shalaby, A,Kalinina, O,Curran, C,Webber, M,Callagy, G,Holian, E,Bourke, E,Kerin, MJ,Brown, JAL (2019) Scientific Reports, 9.

[3] "Clustering longitudinal profiles using P-splines and mixed effects models applied to time-course gene expression data." Coffey, N., J. Hinde, and E. Holian. Computational Statistics & Data Analysis 71 (2014): 14-29.

Research Activities

- Supervision: Ph.D student Olga Kalinina, Prognostic models in Breast Cancer, variable selection methods in survival models for data with various missingness mechanisms.
- Memberships: Irish Statistical Association. The International Biometric Society.
- Affiliations: Staff member Biostatistics Unit. HRB Clinical Research Facility, Galway, (CRFG). Collaborations: INSIGHT NUIGalway.
- Outreach activities with participation in Social Entrepreneurs Ireland Academy Bootcamp 2018.

Howard, Mark

Current Research Interests

I'm primarily interested in quantum information theory, specifically:

- Stabilizer formalism (generalization to d-level systems, quantum error-correcting codes, Gottesman-Knill theorem)
- Clifford group and classical simulability of restricted quantum circuits
- Discrete Wigner functions (negative quasiprobabilities, relationship with G-K theorem)
- Magic state distillation and Quantum Fault-tolerance more generally
- Mutually unbiased bases, SIC-POVMs, foundations of quantum theory
- Nonlocality & Contextuality

Recent Publications

[1] M. Howard, J. Wallman, V. Veitch, and J. Emerson, Contextuality supplies the "magic" for quantum computation. *Nature*, 510, 351 (2014).

[2] S. Bravyi, D. Browne, P. Calpin, E. Campbell, D. Gosset and M. Howard, Simulation of quantum circuits by low-rank stabilizer decompositions. arXiv:1808.00128 [quant-ph] (2018).

[3] M. Howard, and E. T. Campbell, Application of a resource theory for magic states to fault-tolerant quantum computing *Physical review letters* 118 9 090501 (2017).

Research Activities

- Current research grants:
  - Royal Society-SFI University Research Fellowship (2019-2023)
  - Royal Society Research Enhancement Award (2019-2021)
  - IRC Ulysses Scheme (2019)
- Conference Attended:
  - QIP 2019 in Boulder, Colarado, where Ref[2] above was presented.
- Research Visitor:
  - Michael Beverland (Microsoft Quantum) [March 2019]

Hurley, Ted

Current Research Interests

Coding Theory including quantum coding, Information Theory, Group Rings and Representations.

Recent Publications

[1] Hurley T., Hurley D., "Coding theory: the unit-derived methodology", Intl. J. of Information and Coding Theory (IJICOT), Vol. 5, no. 1, pp. 55-80, 2018.

[2] Hurley T., "Representations of group rings and groups", Intl. J. Group Theory, Vol. 7, no.2, pp 31-44, 2018.

[3] Hurley T., Hurley D., Hurley B., "Quantum error-correcting codes: the unit design strategy", Intl. J. of Information and Coding Theory, Vol.5, no.2, pp 169-182, 2018.

[4] Hurley, T., "Solving underdetermined systems with error-correcting codes", Intl. J. of Information and Coding Theory, Vol 4, No.4, 2017.

Research Activities

- The following research papers have been submitted but have appeared on arXiv as noted.

[1] Hurley T., Hurley D., Hurley B., "Entanglement-assisted quantum error-correcting codes from units", pp. 5, 2018. arXiv:1806.10875, 2018.

[2] Ted Hurley, "Linear complementary dual, maximum distance separable codes", arXiv 1901.04241, pp. 10, 2019.

[3] Hurley T., Hurley D., "Maximum distance separable codes to order", arXiv 1902.06624, pp. 12, 2019.

- Invited speaker for two international conferences.
- Referee for Discrete Maths, AMS, J. Group Theory, J. Mathematical Chemistry.
- Reviewer (3 papers) for Mathematical Reviews.

Makrooni, Mohammad Adib

Current Research Interests

Since November 2018, as a postdoctoral researcher in Prof. Cathal Seoighe's research group, I have been working on a SFI project which aims to develop models and tools to infer somatic mutation rates from high-throughput sequence data.

Recent Publications

[1] JOHN M. BURNS and MOHAMMAD A. MAKROONI. Parabolic Subroot Systems and Their Applications *Glasgow Mathematical Journal*, accepted for publication in 13 March 2019.

Research Activities

- Burns, John M. and Makrooni, Mohammad A. "Coxeter Exponents and Orthogonal Complements of Highest Roots". (Submitted to Communications in Algebra, May 2018).

- Makrooni, Mohammad, A. (November 2018). Invited speaker. "Topological Data Analysis" In Insight Center for Data Analytics. Galway, Ireland.

Madden, Niall

Current Research Interests

I am interested in the development and analysis of algorithms for computing approximate solutions to partial differential equations, particularly those whose solutions feature boundary or interior layers. Specifically, I study (mainly) finite element schemes that *resolve* these layer features, and are "fast", such as sparse grid methods, multigrid-based solvers, and adaptive methods. These studies can be *theoretical*, and focus on a rigorous mathematical analysis, or *applied*, where implementation for highly non-trivial problems is the goal.

Recent Publications

[1] Thái Anh Nhan, Scott MacLachlan, and Niall Madden. Boundary layer preconditioners for finite-element discretizations of singularly perturbed reaction-diffusion problems. *Numer. Algorithms*, 79(1):281–310, 2018.

[2] Stephen Russell and Niall Madden. An introduction to the analysis and implementation of sparse grid finite element methods. *Comput. Methods Appl. Math.*, 17(2):299–322, 2017.

[3] James Adler, Scott MacLachlan, and Niall Madden. A first-order system Petrov-Galerkin discretization for a reaction-diffusion problem on a fitted mesh. *IMA J. Numer. Anal.*, 36(3):1281–1309, 2016.

Research Activities

- I am currently supervising two PhD students: Faiza Alssaedi, and Róisín Hill (IRC Scholar). Faiza and I are working on analysis of finite difference methods for complex-valued problems. Róisín and I are working on adaptive methods.
- Submitted two manuscripts to international peer-reviewed journals.
- I was on sabbatical leave from January to June, 2018.
  In January, I spent a week at the Beijing Computational Science Research Center, working with Martin Stynes and Stephen Russell.
  From February to June, I was a Visiting Professor at the Memorial University of Newfoundland.
- In May, I participated in "Adaptive Numerical Methods for Partial Differential Equations with Applications", a five-day workshop at the Banff International Research Station.
- During 2018, I refereed manuscripts for Calcolo, the Journal of Applied Mathematics and Computation, Mathematics and Computers in Simulation, the Journal of Computational and Applied Mathematics, the Journal of Computational Physics, and Numerical Methods for Partial Differential Equations.
- I continue to serve as an associate editor of Numerical Algorithms (Springer).

McCluskey, Aisling

Current Research Interests

My research interests draw from my background in analytic topology and in undergraduate mathematics education. Currently I am working on problems within discrete dynamical systems in addition to characterisations deriving from power sets that encapsulate fundamental notions of 'betweenness'. I am also interested in developing undergraduate mathematical thinking in the context of mathematical analysis and in the context of initial teacher education.

Recent Publications

[1] Aisling McCluskey and Brian McMaster.

Undergraduate Analysis - a working textbook

Oxford University Press, 2018.

[2] Paul Bankston, Aisling McCluskey, and Richard Smith.

Semicontinuity of betweenness functions. *Topology and its Applications*, 246:22–47, 2018.

Research Activities

- Completion of PhD programme in November 2018: Daron Anderson
- Presentation at the 20th Galway Topology Colloquium, University of Birmingham, UK.

Mc Gettrick, Michael

Current Research Interests

I am mainly interested in the asymptotic properties of probability distributions produced by quantum walks on graphs, and in the convergence properties of iterated quantum games. These are "building blocks" for quantum algorithms. A secondary interest initiated in 2018 is in the mathematics of transport, more specifically in mathematical models for calculating the utility of urban tram/metro networks in cities of different "shapes" and population densities.

Research outputs

Two publications submitted in 2018.

Research Activities

- Conferences participated in:
  - Highlights of Algorithms, *Vrije Universiteit Amsterdam*, June 4-6, 2018. `2018.highlightsofalgorithms.org`
  - The Second Information Universe Conference *University of Groningen*, July 3-6, 2018. `www.informationuniverse.rug.nl`
  - International Conference on Quantum Computing *École Normale Supérieure, Paris*, November 26-30, 2018. `icoqc.sciencesconf.org`
- Member of the Irish Mathematical Society and the American Mathematical Society
- Member of the (UK) EPSRC (Engineering and Physical Sciences Research Council) Peer Review College, for whom I carried out two research grant evaluations in 2018.
- Mentor for the successful Royal Society / Science Foundation Ireland application of Mark Howard to join us at NUI Galway.
- Active participant in the online forums *Mathematics* (4 badges) and *MathOverflow* (1 badge) on `stackexchange.com`
- External Expert for the evaluation of three EU COST (**CO**operation in **S**cience and **T**echnology) proposals.

Meere, Martin

Current Research Interests

Modelling enzymatic processes; modelling diffusion in strained crystals; modelling drug delivery applications.

Research outputs

Three peer reviewed publications in 2018.

[1] Vinh Q. Mai, Tuoi T. Vo & Martin Meere, Modelling hyaluronan degradation by streptococcus pneumoniae hyaluronate lyase, *Mathematical Biosciences*, 303, pp. 126-138, 2018.

[2] Michael Vynnycky, Sean McKee, Martin Meere, Christopher McCormick & Sean McGinty, Asymptotic analysis of drug dissolution in two layers having widely differing diffusion coefficients, *IMA Journal of Applied Mathematics*, `https://doi:10.1093/imamat/hxz002`, 2018.

[3] Paul Greaney, Martin Meere & Giuseppe Zurlo, The out-of-plane behaviour of dielectric membranes: Description of wrinkling and pull-in instabilities, *Journal of the Mechanics and Physics of Solids*, `https://doi.org/10.1016/j.jmps.2018.09.006`, 2018.

Research Activities

I have one PhD student, co-supervised by Dr Tuoi Vo. I co-supervised one PhD student who graduated this year (Dr Paul Greaney, principal supervisor: Dr Giuseppe Zurlo). I gave two invited talks (ECMI 2018, Budapest; MEDDS 2018, Glasgow). One week research trip to Nottingham University in August 2018.

Newell, John

Current Research Interests

My primary areas of research in Biostatistics and Data Science are in the theory and application of statistical methods in clinical trials and population health interventions and in the development of novel analytic approaches in Sports and Exercise Science. My research interests include statistical modelling, statistical computing, design and analysis of cluster randomised trials, smoothing techniques, derivative estimation, survival analysis, tree based classification problems and sports analytics.

Research outputs

6 publications appeared in calendar year 2018
Most significant recent publications

[1] Ferguson, J,Alvarez-Iglesias, A,Newell, J,Hinde, J,O'Donnell, M. (2018), Estimating average attributable fractions with confidence intervals for cohort and case-control studies. Statistical Methods In Medical Research, 27 :1141-1152.

[2] Hayes P, Casey M, Glynn LG, Molloy GJ, Durand H, O'Brien E, Dolan E, Newell J, Murphy AW. (2018) Prevalence of treatment-resistant hypertension after considering pseudo-resistance and morbidity: a cross-sectional study in Irish primary care'. British Journal Of General Practice, 68 (671):394-400.

[3] Molloy GJ, Noone C, Caldwell D, Welton NJ, Newell J (2018) Network meta-analysis in health psychology and behavioural medicine: a primer. Health Psychology Review.

[4] Hayes P, Kielty H, Casey M, Glynn LG, Molloy GJ, Durand H, Newell J, Murphy AW (2018) 'Prognosis of patients with apparent treatment-resistant hypertension-a feasibility study'. Pilot and Feasibility Studies, 43.

Research Activities

- Current research grants: PI (1, Insight), Co-PI (2, CURAM, Psychology), Co-Applicant (3, Medicine, General Practice).
- Graduate students: Davood Roshan, Kishor Das, Jaynal Abedin (Insight), Lara Coyne (Insight), Diarmuid Daniels (Insight).
- Journal submissions: 9
- Conference: Co-organised 31st Conference on Applied Statistics in Ireland (CASI), Galway May 2018.
- Workshop: Data Science as a Gateway to Statistics. Prof. Mine Çetinkaya-Rundel, Department of Statistical Science, Duke University.
- Invited talks: 4 (XXVII Isokinetic Medical Group Conference, USA Swimming, IBM Watson Health, PPI Ignite NUIG).
- Memberships: International Society for Clinical Biostatistics, Irish Statistical Association, Statistical Modelling Society.
- Adjunct post: Adjunct Senior Research Fellow in the Department of Mathematics and Statistics, University of Canterbury, Christchurch, New Zealand.
- External Examiner: UCC MSC Data Science and Analytics.

Ó Broin, Pilib

Current Research Interests

My research interests lie in clinical/translational bioinformatics (focusing on cancer genomics, immunology, and neuroscience) and computational biology (in particular, the development and application of machine learning methods to genomic

data). Examples of current projects include: i) the identification of variants associated with recurrence risk following chemo-radiation in head and neck squamous cell carcinoma (HNSCC), ii) the integration of molecular profiling and clinical data for dynamic risk stratification in kidney transplant patients, and iii) the use of imaging and population data for the association of genetic variants with schizophrenia and bipolar disorder.

Research outputs

[1] Thomas J Ow, Cory D Fulcher, Carlos Thomas, Pilib Ó Broin, Andrea Lpez, Denis E Reyna, Richard V Smith, Catherine Sarta, Michael B Prystowsky, Nicolas F Schlecht, Bradley A Schiff, Gregory Rosenblatt, Thomas J Belbin, Thomas M Harris, Geoffrey C Childs, Nicole Kawachi, Chandan Guha, Evripidis Gavathiotis. Optimal targeting of BCL-family proteins in head and neck squamous cell carcinoma requires inhibition of both BCL-xL and MCL-1. *Oncotarget* 10(4):494-510 (2019)

[2] Michelle Lubetzky, Nicole Hayde, Pilib Ó Broin, Maria Ajaimy, Yi Bao, Omar Mohammed, Daniel Schwartz, James Pullman, Enver Akalin. Molecular signatures and clinical outcomes of transplant glomerulopathy stratified by microvascular inflammation and donorspecific antibody. *Clinical Transplantation* e13469 (2018)

[3] Pilib Ó Broin, Michael V Beckert, Tomohisa Takahashi, Takeshi Izumi, Kenny Ye, Gina Kang, Patricia Pouso, Mackenzie Topolski, Jose L Pena, Noboru Hiroi. Computational analysis of neonatal mouse ultrasonic vocalization. *Curr Prot. Mouse Biology.* 8(2),e46 (2018)

Research Activities

- In 2018, my group consisted of: 3 x PhD students - Mariel Barbachan e Silva (CoS fellowship), Laura Fahey (IRC fellowship, co-supervised with Dr. Derek Morris, Biochemistry), and Barbara Martinelli (Brazilian Government fellowship, co-supervised with Prof. Cathal Seoighe, Maths), 5 x Biomedical/Computational Genomics MSc students, and 2 x Research interns.
- Conference presentations: 3
- Funded by: SFI (Opportunistic Fund), EC (MCSA RISE), HRB (NCI Summer Curriculum)
- Reviewer for: Evolutionary Bioinformatics and BMC Systems Biology
- Research visit: 6-week secondment to ProtoQSAR in Valencia, Spain in April 2018 to work on models and pipelines for the prediction of chemical compound toxicity.
- Memberships: European Association for Cancer Research (EACR), International Society for Computational Biology (ISCB), Irish Society for Human Genetics (ISHG), European Society for Human Genetics (ESHG)

O'Regan, Donal

Current Research Interests

Ordinary differential equations; difference and functional equations.

Books

(with Agarwal, R. & Flaut, C.) *An introduction to real analysis*, CRC Press, 2018.

Recent papers

Over 60 publications in 2018.

Pfeiffer, Götz

Current Research Interests

I'm interested in computational aspects of abstract algebra. This concerns in particular the development and implementation of efficient algorithms for the study of finite groups, finite-dimensional algebras and their representation theory. Ongoing collaborations deal with the geometry and combinatorics of complex reflection groups, and with the structure of the double Burnside ring of a finite group.

Recent Publications

[1] Götz Pfeiffer and Hery Randriamaro. The Varchenko Determinant of a Coxeter Arrangement. *J. Group Theory* **21** (2018), 651–665.

[2] Brendan Masterson and Götz Pfeiffer. On the Table of Marks of a Direct Product of Finite Groups. *J. Algebra* **499** (2018), 610–644.

[3] Ivan Marin and Götz Pfeiffer. The BMR Freeness Conjecture for the 2-Reflection Groups. *Math. Comp.* **86** (2017), no. 306, 2005–2023.

Research Activities

- Current Research Grants: IRC Postdoctoral Fellowship.
- Sabbatical Leave: July to December 2018.
- Research Visits: Ruhr-University Bochum, Germany; University of Arizona, US; Mathematisches Forschungsinstitut Oberwolfach, Germany.
- Invited Talks: *Bisets and the Double Burnside Algebra of a Finite Group* (May 2018, Groups in Galway, NUI Galway, Ireland); *A Matrix Model of the Double Burnside Algebra* (June 2018, Groupes d'Artin et Algèbres de Hecke, Universitè de Picardie Jules Verne, Amiens, France); *Bisets and the Double Burnside Algebra of a Finite Group* (July 2018, Computational Lie Theory, University of Stuttgart, Germany); *Symmetries in Music* (October 2018, MathSoc, NUI Galway, Ireland); *Bisets and the Double Burnside Algebra of a Finite Group* (November 2018, Algebra Seminar, University of Arizona, Tucson, US); *Burnside Algebras of a Finite Groups* (December 2018, IMS Invited Lecture, University College Cork, Ireland);
- Papers refereed: 10.
- Research Fellows: 1.
- External PhD Examination: 1 (Amiens).
- Editorial Board Member: Journal of Symbolic Computation; Mathematical Proceedings of the Royal Irish Academy.
- Member: Irish Mathematical Society; American Mathematical Society.

Pfeiffer, Kirsten

Current Research Interests

My research interests are concerned with educational interventions to enhance students' creative reasoning skills and ultimately the learning of mathematical argumentation and proof. I'm interested in task design in the teaching of mathematics at university level, in particular in students' practice of proof evaluation exercises and possible learning effects of these. I'm also interested in the role of mathematics support centres from a sociocultural point of view.

Publications

Most significant recent publications

[1] Mac an Bhaird, C., Nolan B., O'Shea A., Pfeiffer K. (2017) 'A Study of Creative Reasoning Opportunities in Assessments in Undergraduate Calculus Courses' in *Research in Mathematics Education Special Issue "What can summative assessment in mathematics education tell us?"*.

[2] Buchbinder, O., Cooper, J., Stylianides, G., Pfeiffer, K. (2018) ERME Column. *EMS Newsletter March 2018)*, `http://www.ems-ph.org/journals/newsletter/pdf/2018-003-107.pdf`

Research Activities

- Conference presention at the CETL-MSOR 2018 *Evidencing Excellence in the Mathematical Sciences* in Glasgow.
- Reviewer for 'Educational Studies in Mathematics' and 'Journal for Research in Mathematics Education'.
- Vice chair of the Irish Mathematics Learning Support Network (IMLSN).

Piiroinen, Petri T

Current Research Interests

My research interests span the area of piecewise-smooth dynamical systems, evolving networks, population dynamics, economic dynamics, sports dynamics, decision making and biological systems. An overarching aim of my research is to bridge the gap between mathematics and numerical analysis, on one hand, and applied sciences, on the other, and to make mathematical methodologies more applicable to non-theoreticians.

Publications

Publications in 2018:

1. Donohue, J.G. and Piiroinen, P.T., *A technique for analysis of density dependence in population models*, Theoretical Ecology 11(4), pp. 465-477, December 2018. (DOI: 10.1007/s12080-018-0380-5)

2. Staunton, E. and Piiroinen, P.T., *Noise and multistability in the square root map*, Physica D: Nonlinear Phenomena 380-381, pp. 31–44, October 2018. (DOI: 10.1016/j.physd.2018.06.002)

3. Burke, R. and Piiroinen, P.T., *Reduced-order approximation of consensus dynamics in networks with a hybrid adaptive communication protocol*, Nonlinear Analysis: Hybrid Systems 27, pp. 298–306, February 2018. (DOI: 10.1016/j.nahs.2017.09.005)

Research Activities

During 2018 I supervised 4 PhD students (Richard Burke, Eoghan Staunton, Roberto Galizia and Pearce Harney-Nolan) and 2 visiting MSc students (Davide de Palo and Gianmario Varchetta) from Naples. I gave academic seminars at University of Naples Federico II, Italy and Chalmers University of Technology, Sweden and a talk at the conference NOLTA 2018 in Tarragona, Spain. I co-edited a special issue on *Theory and applications of non-smooth dynamical systems* in the European Journal of Applied Mathematics. From September 2018 I have been on sabbatical and I have made research visits to University of Naples Federico II, Italy and Madurai Kamaraj University, India.

Quinlan, Rachel

Current Research Interests

I am interested in linear algebra and matrix theory, particularly from an algebraic or combinatorial viewpoint. I like to study the interactions of linear algebra with field theory, graph theory and the representation theory of finite groups. Together with my current and recent PhD students and other collaborators, I am involved in the following ongoing projects:

- Matrix spaces defined by entry patterns, with Hieu Ha Van;
- Identifying graphs related to alternating sign matrices, with Cian O'Brien and Kevin Jennings;
- Classifying low rank covering groups of elementary abelian groups, with Dana Saleh;
- Minimally primitive graphs, with Malak Almutairi and Olga O'Mahony
- Non-nilpotent matrix spaces, with Fernando Szechtman and Anatolii Tushev.

Recent Publications

[1] Cruickshank, James; Quinlan, Rachel; Szechtman, Fernando. Hermitian and skew hermitian forms over local rings. Linear Algebra Appl. 551 (2018), 147–161.

[2] O'Mahony, Olga; Quinlan, Rachel. Edge-minimal graphs of exponent 2. Linear Algebra Appl. 542 (2018), 66–83.

[3] Ha Van, Hieu; Quinlan, Rachel. On the maximum rank of completions of entry pattern matrices. Linear Algebra Appl. 525 (2017), 1–19.

Research Activities

- Current PhD students: Cian O'Brien, Dana Saleh, Malak Almutairi.
- Conference and seminar presentations in 2018: Prairie Discrete Mathematics Workshop, University of Regina Colloquium, NUI Galway School of Maths seminar.

- Recent PhD students: Olga O'Mahony (graduated 2018), Hieu Ha Van (completed PhD 2019).
- Referee for Linear Algebra and its Applications, Electronic Journal of Graph Theory and its Applications.
- Coordinator of School Linear Algebra seminar, Semester 1 2018-19.
- Two journal submissions currently under review.

Roshan, Davood

Current Research Interests

My primary research interests is in the longitudinal analysis of clinical biomarkers. In particular, I am interested in developing individualised and dynamic reference ranges for clinical biomarkers that are recorded longitudinally over time. My research domain includes but not limited to medicine, sport, engineering, finance and etc. I have also interest in survival analysis, reliability analysis, data visualisations and data science.

Publications

[1] Roisin Gardiner, Davood Roshan, Ann Brennan, Denise Connolly, Susan Murray, Donal Reddan, Trends in the Treatment of Chronic Kidney Disease Associated Anaemia in a Cohort of Haemodialysis Patients. The Irish experience. Irish Journal of Medical Science (IJMS).

[2] Roshan, D., Ferguson, J., Sullivan, F., & Newell, J. Dynamic reference ranges for blood biomarkers: An application in prostate cancer. CASI 2018, 93.

[3] Roshan, D., Ferguson, J., Sullivan, F., & Newell, J. New Methods for Generating Dynamic Reference Ranges for Blood Biomarkers With Applications in Prostate Cancer. Proceedings of the 33rd International Workshop on Statistical Modelling. 2018.

Research Activities

[1] Executive member of Young Irish Statistical Association.

[2] Memberships: Young-ISA, Irish Statistical Association, International Society for Clinical Biostatistics, International Biometric Society, Statistical Modelling Society.

Rossmann, Tobias

Current Research Interests

Most of my research interests are in the areas of asymptotic and computational algebra. Currently, I primarily focus on the study of a class of zeta functions introduced in [1]. This involves techniques from algebra, algebraic geometry, and combinatorics. Apart from their intrinsic appeal, these zeta functions have applications in the study of orbit, conjugacy class, and representation growth of groups.

Research outputs

[1] *The average size of the kernel of a matrix and orbits of linear groups.* Proc. Lond. Math. Soc. (3) 117 (2018), no. 3, 574–616.

[2] *Computing local zeta functions of groups algebras, and modules.*

Trans. Amer. Math. Soc. 370 (2018), no. 7, 4841–4879.

[3] *Enumerating submodules invariant under an endomorphism.*

Math. Ann. 368 (2017), 391–417.

Research Activities

- Paper submitted:

  The average size of the kernel of a matrix and orbits of linear groups, II: duality. arXiv:1807.01101, 33 pages

- Invited participant (1–20 December 2018) of the Trimester Program *Logic and Algorithms in Group Theory* at the Hausdorff Research Institute for Mathematics in Bonn.

  Talk: "Zeta functions of groups: theory and computation".

- Invited talk "Growth of submodules invariant under an endomorphism" at the symposium *Geometric Group Theory at Infinity* in Bielefeld (17–19 December 2018).

- Invited minicourse on "Orbits, kernels, and growth of class numbers" at the workshop *Zeta functions of groups and dynamical systems* in Düsseldorf (17–20 September 2018).

- Invited talk "Growth in Nilpotent Groups" at the conference *Groups and Geometry 2018* in Auckland (23–26 January 2018).

- Referee for specialised journals in algebra.

- PhD student: Sultan Alzahrani (since 2018).

Ryan, Ray

Current Research Interests

Functional Analysis: Tensor Products of Banach Spaces; Polynomials and Holomorphic Mappings on Banach Spaces and Riesz Spaces.

Books

"Introduction to Tensor Products of Banach Spaces", Springer Verlag Monographs in Mathematics.

Recent papers

(with C. Boyd & N. Snigireva) *Radius of analyticity of analytic functions on Banach spaces*,J. Math. Anal. Appl. (2018),463, No. 1,40–49.

Research Activities

Orthogonally Additive Polynomials on $C(K)$, "Complex approximation and bounded holomorphic functions", Levico Terme, Trento, October 2018 (joint work with C. Boyd & N. Snigireva).

Seoighe, Cathal

Current Research Interests

Research interests include molecular evolution, genomics and epigenetics; in particular, variation in germline and somatic mutation rates, development and application of models and computational methods to analyze molecular sequence evolution and gene expression data and the analysis of genomic data in order to generate insights into the links between genomic and phenotypic variation.

Recent Publications

[1] F. Cathomas, D. Azzinnari, G. Bergamini, H. Sigrist, M. Buerge, V. Hoop, B. Wicki, L. Goetze, S. Soares, D. Kukelova, E. Seifritz, S. Goebbels, K. A. Nave, M. S. Ghandour, C. Seoighe, T. Hildebrandt, G. Leparc, H. Klein, E. Stupka, B. Hengerer, and C. R. Pryce. Oligodendrocyte gene expression is reduced by and influences effects of chronic social stress in mice. *Genes Brain Behav.*, 18(1):e12475, 01 2019.

[2] P. Geeleher, A. Nath, F. Wang, Z. Zhang, A. N. Barbeira, J. Fessler, R. L. Grossman, C. Seoighe, and R. Stephanie Huang. Cancer expression quantitative trait loci (eQTLs) can be determined from heterogeneous tumor gene expression data by modeling variation in tumor purity. *Genome Biol.*, 19(1):130, 09 2018.

[3] C. Seoighe, N. J. Tosh, and J. M. Greally. DNA methylation haplotypes as cancer markers. *Nat. Genet.*, 50(8):1062–1063, Aug 2018.

[4] N. Tosh, J. Ferguson, and C. Seoighe. History by the numbers? *Proc. Natl. Acad. Sci. U.S.A.*, 115(26):E5840, 06 2018.

Research Activities

My research group currently includes five PhD students and one postdoctoral researcher. In 2018 I received an SFI Investigator award to develop and apply models and methods to study variation in rates and patterns of mutations. My research is currently also supported by the European Commission (Marie Sklodowska Curie programme), IRC and Science Without Borders (Brazil). I am the principal investigator of the SFI Centre for

Research training in Genomics Data Science (a multi-institutional PhD training centre, awarded in March 2019, that will train 100 PhD students in genomics data science over the coming years). Academic community service includes membership of the editorial board of Briefings in Bioinformatics and Annual Reviews in Biomedical Data Science, review of grants for a number of international funding agencies, as well as refereeing for a range of journals. Reviewing assignments in the past year have included *Nature Communications* and *Science*.

Simpkin, Andrew

Current Research Interests

My research focusses on longitudinal data analysis, functional data analysis, genomics and data science. In particular I'm interested in modelling high-throughput data such as those arising from sensor technologies. I work on many interdisciplinary projects across medicine, engineering, biology, sociology and sports science. I'm interested in applied statistics and data science, developing methods and tools to work with people in a wide variety of disciplines.

Research outputs

I have had nine journal articles published in the last year, with the most significant being

Recent Publications

[1] Andrew Murray, Alec Buttfield, Andrew J Simpkin, John Sproule, Anthony P Turner. Variability of within-step acceleration and daily wellness monitoring in Collegiate American Football. *Journal of Science and Medicine in Sport*, 22(4):488–493, 2019.

[2] Erin C Dunn, Thomas W Soare, Yiwen Zhu, Andrew J Simpkin, Matthew J Suderman, Torsten Klengel, Andrew DAC Smith, Kerry Ressler, Caroline L Relton. Sensitive periods for the effect of childhood adversity on DNA methylation: Results from a prospective, longitudinal study. *Biological Psychiatry*, 2019.

[3] James R Staley, Matthew Suderman, Andrew J Simpkin, Tom R Gaunt, Jon Heron, Caroline L Relton, Kate Tilling. Longitudinal analysis strategies for modelling epigenetic trajectories. *International Journal of Epidemiology*, 47(2), 516–525, 2018.

[4] Andrew J Simpkin, Maria Durban, Debbie A Lawlor, Corrie MacDonald-Wallis, Margaret T May, Chris Metcalfe, Kate Tilling Derivative estimation for longitudinal data analysis: Examining features of blood pressure measured repeatedly during pregnancy. *Statistics in Medicine*, 37(19):2836–2854, 2018.

Research Activities

- Current research grants:
  - Simpkin AJ, Wijns W, Newell J (co-PIs). Modelling continuous longitudinal glucose and heart rate data. CURAM. August 2018 to July 2022; €100,000
  - Dunn, E (PI), Simpkin AJ, Suderman, M, Relton CR. (co-investigators). Childhood adversity, DNA methylation, and risk for depression: A longitudinal study of sensitive periods in development. National Institute for Health. 1 July 2017 to 30 June 2022; $1,662,633
- Graduate students: Beatrice Charamba, *Modelling continuous longitudinal glucose and heart rate data.*
- Conference presentations:
  - Derivative estimation: an application to blood pressure change during pregnancy, CASI 2019, Galway, Ireland
  - Predicting Training Load in Elite Sport, useR 2019, Brisbane, Australia
- Invited talks: Derivative Estimation for Longitudinal Data Analysis; Frontiers in Functional Data Analysis workshop, UCD, Ireland
- External posts: Honorary Research Fellow, Bristol Medical School, UK
- Membership: Irish Statistical Association, International Biometrics Society, European College of Sports Science

- Workshops organised: Introduction to R for Developers; Inaugural Data Science Institute Developer's Forum, Galway

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Sheahan, Jerome

Current Research Interests

Asymptotics

Research Outputs

4 publications in 2018.

Sköldberg, Emil

Current Research Interests

My research interests mostly lie in commutative algebra, in particular the study of combinatorial objects such as monomial and binomial ideals and their quotient rings. Most of my work involve (co)homological methods.

Recent Publications

[1] Emil Sköldberg. Algebraic Morse theory and homological perturbation theory. *Algebra Discrete Math.*, 26(1):124–129, 2018.

[2] Nghia T. H. Tran and Emil Sköldberg. The hochschild cohomology of square-free monomial complete intersections. *Communications in Algebra*, 0(0):1–16, 2019.

Research Activities

- Current PhD student: *Nghia Thi Hieu Tran*

Snigireva, Nina

Current Research Interests

Invariant measures for non-hyperbolic iterated function systems (IFS). Mobius IFS. Polynomials and holomorphic functions on Banach lattices.

Recent papers

[1] (with C. Boyd and R. Ryan) *Radius of analyticity of analytic functions on Banach spaces*, J. Math. Anal. Appl. (2018),463, No. 1,40–49.

[2] (with C. Boyd) *On the Analyticity of Fredholm Determinant*, to appear in Monatshefte für Mathematik

[3] (with K. Lesniak and F. Strobin) *Weakly contractive iterated function systems and beyond*, to appear in Journal of Difference Equations and Applications

Research Activities

- (with C. Boyd and R. Ryan) *Geometry of Spaces of Orthogonally Additive Polynomials on $C(K)$*, submitted paper, 34 pages, online link: arXiv:1807.02713.
- Organised conference *Topics in Functional Analysis*, July 9-11, 2018
- Made research visit to K. Lesniak at Nicolaus Copernicus University, Torun, Poland, 24th July-1st August 2018
- Refereed papers and reviewed for Math Sci Net.

Su, Yipin

Current Research Interests

I am currently an Irish Research Council Postdoctoral Fellow working with Professor Michel Destrade at School of Mathematics, Statistics and Applied Mathematics, NUI Galway in Solid Mechanics. My research interests are mostly in the field of electroelasticity. Basically I try to model, describe and predict the mechanical behaviour of soft electroelastic solids.

Recent Publications

[1] YP Su, WQ Chen, and M Destrade. Tuning the pull-in instability of soft dielectric elastomers through loading protocols. *Int. J. Non-Lin. Mech.*, 113:62–66, 2019.

[2] YP Su, B Wu, WQ Chen, and M Destrade. Finite bending and pattern evolution of the associated instability for a dielectric elastomer slab. *Int. J. Solids Struct.*, 158:191–209, 2019.

[3] YP Su, HC Broderick, WQ Chen, M Destrade. Wrinkles in soft dielectric plates. *J. Mech. Phys. Solids*, 119:298–318, 2018.

Research Activities

- Academic visit to Professor Gal Shmuel at Technion, Israel, Jul - Sep, 2018.
- Academic visit to Professor Pasquale Ciarletta at PoliMi, Italy, Jul - Sep, 2019.
- YP Su, B Wu, WQ Chen, M Destrade. Pattern evolution in bending dielectric-elastomeric bilayers. Journal of the Mechanics and Physics of Solids (under review). [invited contribution to Special Issue in Honour of Davide Bigoni].

Tuite, Michael

Current Research Interests

Vertex operator algebras (VOAs). Mainly working on VOAs on general genus Riemann surfaces with Tom Gilroy (IT Tallaght) and my PhD student Mike Welby. This work relies on developing the explicit relationship between the geometry of Riemann surfaces and VOAs and relies on a new extension of classical ideas of Bers concerning holomorphic differentials on a Riemann surface. I'm also part of a research programme "Vertex operator superalgebras, Jacobi functions and Mathieu moonshine" sponsored by the American Institute of Mathematics at San Jose involved with Geoff Mason (UC Santa Cruz), Matt Krauel (Sacramento) and Gail Yamskulna (Illinois State). This is directed at understanding a number of puzzling results that appeared in the last ten years relating the Mathieu group to the elliptic genus of a K3 surface in Super VOAs [1].

Recent Publications

[1] G. Mason, M.P. Tuite and G. Yamskulna. $N = 2$ and $N = 4$ Subalgebras of Super Vertex Operator Algebras. *J. Phys. A: Math. Theor.* **51** 064001 (2018).

Research Activities

- One IRC funded PhD student, Michael Welby;
- 2 journal submissions;
- Invited talk: University of Zagreb, Croatia, May 2018;
- Research visit to the American Institute of Mathematics at San Jose, June 2018;
- Co-organizer of international conference on "Vertex operator algebras, number theory and related topics" at Sacramento State University, California June 2018;
- 3 papers refereed.

Yang, Haixuan

Current Research Interests

My focus is in Bioinformatics & Statistical Modelling, especially of network data such as protein-protein interactions, co-expression, and functional similarity. A bio-molecular network can be viewed as a collection of nodes, representing the bio-molecules, connected by links, representing relations between the bio-molecules. I am working on inferring valuable information from bio-molecular networks.

Recent Publications

[1] Mohan Timilsina, Haixuan Yang, and Dietrich Rebholz-Schuhmann. A 2-Layered Graph Based Diffusion Approach for Altmetric Analysis *2018 IEEE/ACM International Conference on Advances in Social Networks Analysis and Mining (ASONAM).*

[2] Haixuan Yang and Cathal Seoighe. Impact of the Choice of Normalization Method on Molecular Cancer Class Discovery Using Nonnegative Matrix Factorizatio. *PLOS ONE*, 2016.

Research Activities

- With Mohan Timilsina, Ratnesh Sahay and Dietrich Rebholz-Schuhmann, submitted a paper to *BMC Bioinformatics*.
- With Mohan Timilsina, Declan Patrick Mc Kernan, Dietrich Rebholz-Schumann, and Mathieu d'Aquin, submitted a paper to *Bioinformatics*.
- With Mohan Timilsina, and Mathieu d'Aquin, submitted a paper to *SIGIR conference*.

Zurlo, Giuseppe

Current Research Interests

I am interested at the mechanical behavior of soft matter. More in detail, I work in the field on nonlinear elasticity and continuum mechanics, with a special focus on the modelling of unusual behavior of soft solids. In recent years, I have worked on the problem of growth, with special emphasis to surface accretion, describing for example the growth of bones, plants, but also 3D printing. My goal is to develop a general framework to describe the occurrence of inelastic effects taking place during accretion, leading for example to the accumulation of internal stresses, that can lead to instabilities and, eventually, to fracture. Other current research interests are electro-elasticity and the dynamical behavior of prestressed elastic bodies, like for example human arteries.

Recent Publications

[1] Truskinovsky L., Zurlo G., Nonlinear elasticity of incompatible surface growth *Phys. Rev. E*, submitted (2019).

[2] Zurlo G., Destrade M., Lu T., Fine tuning the electro-mechanical response of dielectric elastomers *Appl.Phys. Lett.*, 113, 162902 (2018).

[3] Greaney P., Meere M., Zurlo G., The out-of-plane behaviour of dielectric membranes: Description of wrinkling and pull-in instabilities *J.Mech.Phys.Solids*, 122, 84–87 (2018).

Research Activities

- Supervisor (together with M.Meere) of Paul Greaney, graduated Feb 2019.
- Sabbatical leave in Paris, ESPCI-ParisTech (Jan–Jun 2018).
- Research visit to the Einstein Institute of Mathematics, Jerusalem, Israel, May 2018.
- Guest-Editor of the Special Issue "Constitutive Modelling in Biomechanics", on the Int.J.Non-Lin.Mech., 2018.
- 8 invited talks in 2018 (Napoli, Grenoble, Jerusalem, Paris, St.Andrews, Copenaghen, Brescia, Milan).
- Organisation of a BAMC mini-symposium, St. Andrews.

Visitors

Sigaeva, Taisiya (University of Calgary)
Visiting: Michel Destrade

Dates of visit: 01 March 2018 – 27 March 2018
Research Activity

Finish an article with Robert Mangan on creases and wrinkles in soft solids (published), start a new one on modelling of arteries (under revision); give a talk at PG Modelling seminar.

Saccomandi, Giuseppe (University of Perugia)
Visiting: Michel Destrade

Dates of visit: 14 May 2018 – 18 May 2018
Research Activity

Work on a chapter for the *Encyclopedia of Continuum Mechanics* (published); Edit a theme issue of *Philosophical Transactions* (published).

Ogden, Ray (University of Glasgow)
Visiting: Michel Destrade

Dates of visit: 05 June 2018 – 08 June 2018
Research Activity

Give a talk at Joint Seminar with School of Engineering; External examiner for Robert Mangan's PhD.

Hutchinson, John (Harvard University)
Visiting: Michel Destrade

Dates of visit: 11 June 2018 – 13 June 2018
Research Activity

Give a talk at Joint Seminar with School of Engineering.

Sadik, Souhayl (Max Planck Institute for Mathematics in the Sciences, Leipzig)
Visiting: Michel Destrade

Dates of visit: 09 September 2018 – 14 September 2018
Research Activity

Give a talk at the School's Seminar; write a Marie Curie proposal.

Berjamin, Harold (Ecole Centrale de Marseille)
Visiting: Michel Destrade

Dates of visit: 26 September 2018 – 28 September 2018
Research Activity

Write an IRC grant; give a talk at PG Modelling seminar.

Linß, Torsten (FernUniversität in Hagen)
Visiting: Niall Madden

Dates of visit: 30 October – 1 November 2018
Research Activity

Discussions on numerical methods for singularly perturbed problems.

Ogden, Ray (University of Glasgow)
Visiting: Michel Destrade

Dates of visit: 26 November 2018 – 01 December 2018
Research Activity

Work on dielectrics with Hannah Conroy Broderick and Michele Righi (paper now under review).

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6 Research Students

The research students in the School of Mathematics, Statistics and Applied Mathematics, or co-supervised by staff in the School, as of April 2019, are listed below.

Jaynal Abedin
Nisreen Alokbi
Malak Almutairi
Faiza Alssaeidi
Sultan Alzahrani
Daron Anderson
Mariel Barbachan e Silva
Declan Bennett
James Blackwell
Issac Burke
Richard Burke
Beatrice Charamba
Siobhan Cleary
Hannah Conroy Broderick
Lara Coyne
Kishor Das
Diarmuid Daniels
Laura Fahey
Roberto Galizia
Pearce Harney-Nolan
Aoife Hill
Róisín Hill
Noor Khehrah
Kelvin Killeen
Quang Mai
Barbara Martinelli
Cian O'Brien
Andrew Peters
Dana Saleh
Qays Shakir
Eoghan Staunton
Nghia Tran Thi Hieu
Michael Welby

Several of research students have received commendations for their contributions at workshops and conferences over the past 12 months, including

Roberto Galizia: Best lecture at the Irish Mathematical Student Association Conference, UCC, March 2018.

Qays Shakir: third prize in the poster competition at the Young Researchers in Mathematics (YRM 2018), Southampton, July 2018.

Hannah Conroy Broderick: Poster prize at the Women in Mathematics Day, UCD, August 2018.

Eoghan Staunton: the NOLTA Society Best Student Paper Prize, at the International Symposium on Nonlinear Theory and Its Applications, Tarragona, Spain, September 2018.

Róisín Hill: Best presentation prize at the Fifth Irish SIAM Student Chapter Conference, University of Limerick, January 2019.

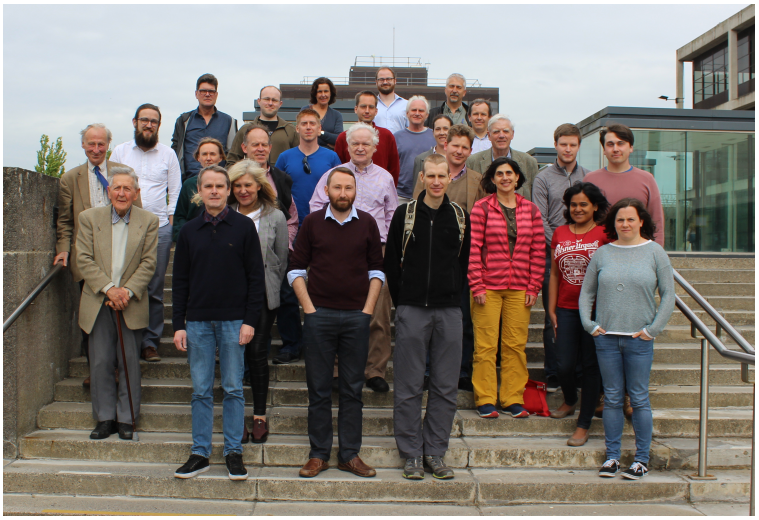
Aoife Hill: Royal Academy of Medicine in Ireland Section of Bioengineering award for 2nd place in Cardiovascular Track Oral Presentation at the Bioengineering in Ireland, Limerick, January 2019.

Eoghan Staunton, International Symposium on Nonlinear Theory and Its Applications, Tarragona.

Róisín Hill, Irish SIAM Student Chapter Conference, Limerick.

7 Conferences and Workshops in 2018

- **Groups in Galway 2018 (41st annual meeting)**
  Dates: 18 and 19 May, 2018
  Speakers: Rob Craigen (Manitoba), Ronan Egan (Rijeka), Bettina Eick (Braunschweig), Daniel Horsley (Monash), Eoin Long (Oxford), Maura Paterson (Birbeck), GÃűtz Pfeiffer (Galway), John Sheekey (UCD), Ann Trenk (Wellesley).
  Organisers: Dane Flannery, Kevin Jennings, Tobias Rossmann
  Funders: Irish Mathematical Society and NUI Galway.

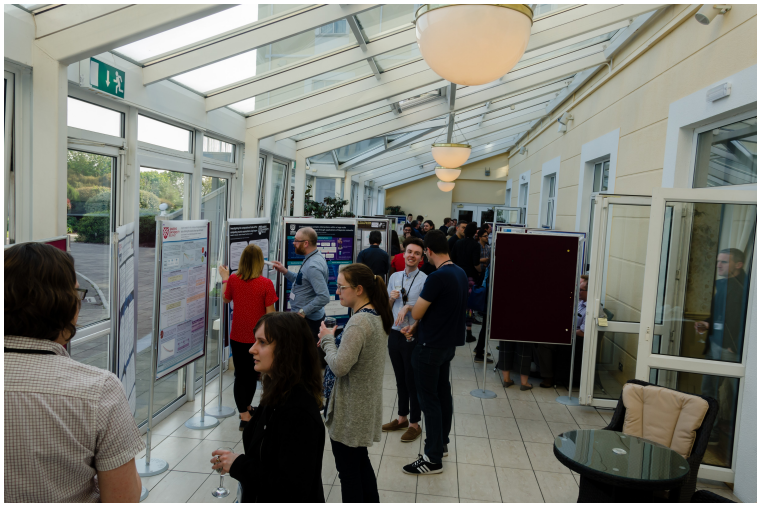


Some of the participants of the 41st Groups in Galway

- **Topics in Functional Analysis 2018 ("*RayDays*")**
  Dates: 9–11 July, 2018
  Invited Speakers: R. Aron (Kent, USA), S. Dineen (UCD), P. Galindo (Valencia), P. Kirwan (Waterford IT), M. Lindström (Åbo Akademi, Finland), L. Moraes (UF Rio de Janeiro), B. Turett (Rochester, Michigan), D. Werner (FU Berlin), I. Zalduendo (Buenos Aires)
  Contributed Talks: A. Brown (UCD), Y. S. Choi (Postech, Korea), C. Gilmore (Manchester), T. Honda (Senshu University, Japan)A. Kaminska (Memphis), S. K. Kim (Chungbuk, Korea), H.J. Li (Dongguk Univeristy, Korea), P. Rueda (Valencia), M. Venkova (DIT)
  Organisers: Chris Boyd (UCD), Michael Mackey (UCD), Rachel Quinlan, Nina Snigireva
  Funders: Irish Mathematical Society and NUI Galway.

Some of the participants of "RayDays", July 2018

- **38th Conference on Applied Statistics in Ireland**
  Dates: 16–18 May, 2018 **Speakers:** Paul Rosenbaum (University of Pennsylvania), Maria Durbán Reguera (Carlos III University), Carl Scarrott (University of Canterbury), Garrett Grolemund (R Studio), Cóilín Minto (Galway-Mayo Institute of Technology, Galway), Trevor Bailey (University of Exeter).
  Organisers: John Newell, Neil O'Leary, Maeve McGillycuddy, John Ferguson, Carl Scarrott, Lida Fallah, Alberto Alvarez-Iglesias, Jaynal Abedin, Kishor Das, Andrew Simpkin, Cara Dooley, Davood Roshan, John Hinde.
  Sponsors: SFI, Insight, CURAM, ZURICH, Axis Consulting, Statsols, CRC Press, Central Bank of Ireland.



Poster session at CASI, May 2018

8 Seminars in 2018

Weekly Seminars

- School Seminar
- Bioinformatics seminar series/journal club
- Linear Algebra Seminar
- Statistics Reading Group
- Postgraduate Modelling and Applied Mathematics Research Group Talks

School Seminars

[1] Nina Snigireva, NUIG. *Invariant measures for non-hyperbolic Iterated Function Systems*, 11/1/2018. (Contact: Michael Mc Gettrick)

[2] Yipin Su, NUIG. *Analysis of Waves and Instabilities in Soft Electroactive Structures*, 18/1/2018. (Contact: Michel Destrade)

[3] Michel Destrade, NUIG. *Elastic waves in soft tissues: Theory, Simulations, Experiments, Validation*, 8/2/2018. (Contact: Michael Mc Gettrick)

[4] Kevin Doherty, University of Exeter, UK. *The Parameter Optimisation Problem for Computational Biology Models: A Case Study*, 15/2/2018. (Contact: Martin Meere)

[5] Michael Tuite, NUIG. *Vertex operator algebras on Riemann surfaces with some applications*, 22/2/2018. (Contact: Michael Mc Gettrick)

[6] Mark Howard, University of Sheffield, UK. *The Cost of Tolerating Faults in a Quantum Circuit*, 27/3/2018. (Contact: Michael Mc Gettrick)

[7] Bill Jackson, Queen Mary University of London, UK. *Rigidity of linearly-constrained frameworks*, 19/4/2018. (Contact: Jim Cruickshank)

[8] Anthony Brown, UCD. *Non-homogeneous tensor products and norms of projections between spaces of polynomials*, 26/4/2018. (Contact: Ray Ryan)

[9] Emil Skoldberg, NUIG. *Type theory and the univalent foundations*, 10/5/2018. (Contact: Michael Mc Gettrick)

[10] Luigi Vergori, Università degli Studi di Perugia, Italy. *Influence of the extrinsic curvature on the equilibrium of nematic films*, 17/5/2018. (Contact: Michel Destrade)

[11] Yibin Fu, Keele University, UK. *Evaluation of the Gent, Gent-Gent, and Ogden material models using inflation of a plane membrane*, 24/5/2018. (Contact: Michael Tuite)

[12] Michael Mackey, UCD. *How to park a small car*, 31/5/2018. (Contact: Nina Snigireva)

[13] Ray Ogden, University of Glasgow, UK. *Nonlinearly elastic biomechanical modelling of soft biological tissues*, 7/6/2018. (Contact: Michel Destrade)

[14] John Hutchinson, Harvard University, US. *Shell BucklingâĂŤthe old and the new*, 12/6/2018. (Contact: Michel Destrade)

[15] Mine Cetinkaya-Rundel, Duke University, US. *Data science as a gateway to statistics*, 20/6/2018. (Contact: John Newell)

[16] Tobias Rossmann, NUIG. *Growth in groups*, 21/6/2018. (Contact: Michael Mc Gettrick)

[17] John McCarthy, Washington University in Saint Louis, US. *Matrix Monotone functions of several variables*, 26/6/2018. (Contact: Ray Ryan)

[18] Nial Friel & Norma Bargary, UCD & UL, 15/8/2018. (Contact: John Newell)

[19] Souhayl Sadik, Max Planck Institute for Mathematics in the Sciences, in Leipzig, Germany. *A Geometric Theory of Nonlinear Morphoelastic Shells*, 13/9/2018. (Contact: Michel Destrade)

[20] Kirk Soodhalter, TCD. *Augmented Arnoldi-Tikhonov Methods for Ill-posed Problems*, 20/9/2018. (Contact: Niall Madden)

[21] Andrew Simpkin, NUIG. *Derivative estimation for longitudinal data analysis: examining features of blood pressure measured re-*

peatedly during pregnancy, 27/9/2018. (Contact: Michael McGettrick)

[22] Giuseppe Zurlo, NUIG. *My sabbatical leave in France and its (Riemannian) frustration*, 4/10/2018. (Contact: Michael McGettrick)

[23] Paul Hurley, IBM Research Zurich / Western Sydney University. *Bluebild: A new imaging paradigm for radio astronomy interferometry and other applications*, 9/10/2018. (Contact: Aaron Golden)

[24] Geert Molenberghs, Universiteit Hasselt, Belgium. *Hierarchical models with normal and conjugate random effects*, 11/10/2018. (Contact: John Hinde)

[25] Pedro Tamaroff, TCD. *Minimal model of monomial algebras*, 18/10/2018. (Contact: Emil Skoldberg)

[26] Dessislava Kochloukova, University of Campinas, Brazil. *Title Weak commutativity and isoperimetric functions*, 24/10/2018. (Contact: Graham Ellis)

[27] Milo Orlich, Aalto University, Finland. *Relations between algebraic and combinatorial invariants*, 25/10/2018. (Contact: Emil Skoldberg)

[28] Xiangyun Meng, Beijing Computational Science Research Center, China. *Convergence analysis of the Adini element on a Shishkin mesh for a singularly perturbed fourth-order problem in two dimensions*, 1/11/2018. (Contact: Niall Madden)

[29] Miriam Backens, University of Oxford, US. *Classifying the computational complexity of counting problems using knowledge from quantum computing*, 8/11/2018. (Contact: Michael Mc Gettrick)

[30] Rachel Quinlan, NUIG. *Nilpotency in matrix spaces*, 15/11/2018. (Contact: Michael McGettrick)

[31] Paul Bankston, University of Milwaukee, US. *Postcards from the edge (of a continuum)*, 22/11/2018. (Contact: Aisling McCluskey)

[32] Jessica Mar, University of Queensland, Austalia. *One of these cells is not like the other âĂŞ how variability of gene expression highlights regulatory control*, 11/12/2018. (Contact: Aaron Golden)

Postgraduate Modelling and Applied Mathematics Research Group Talks Seminars

[1] 26/01/18 Roberto Galizia: *Analysis of Multistable Networks*
Hannah Conroy-Broderick: *Instabilities in Soft Dielectric Plates*

[2] 02/02/18 Qays Shakir: *Building Sparse Graphs by Inductive Operations*
Christine Marshall: *Identifying Influential Nodes to Inhibit Bootstrap Percolation on Hyperbolic Networks*

[3] 09/02/18 Cian O'Brien: *A Characterisation of Clique Graphs*
Michael Welby: *Genus Two Zhu Theory for Fermionic VOSAs II*

[4] 16/02/18 Daher Al Baydli: *Computation Steenrod Square of finite groups*

[5] 23/02/18 Róisín Hill: *Mesh generation using a balanced norm for singularly perturbed reaction-diffusion problems*
Faiza Alssaedi: *Numerical solution of a complex-valued singularly perturbed differential equation*

[6] 09/03/18 Taisiya Sigaeva (University of Calgary): *Soft materials: experiments, theory and applications*

[7] 16/03/18 Aoife Hill: *Modelling the evolving ductility of biodegradable polymers*
Davide Di Palo: *Supercritical Pitchfork Bifurcation Networks: Global Control*

[8] 23/03/18 Vinh Mai: *Hyaluronan Biosynthesis*
Hieu Ha Van: *Existence of nonsingular Entry pattern matrices*

[9] 13/04/18 Eoghan Staunton: *An Introduction to Noisy Saltation*

Roberto Galizia: *Stick-slip dynamics of slider blocks under discontinuous forcing*

[10] 20/04/18 Michael Welby: *Genus g Zhu Recursion for Vertex Operator Algebras*
Hannah Conroy Broderick: *Wrinkles in Soft Dielectric Plates*

[11] 08/06/18 Eoghan Staunton: *Noise and Multistability in the Square Root Map*
Paul Greaney: *Inhomogeneous Thinning and Breakdown of Thin Dielectric Elastomers*
Faiza Alssaedi: *Parameter robust methods for second-order complex-valued reaction-diffusion equations*
Roberto Galizia: *Phase Transitions of Multistable Networks via Switching Control*
Vinh Mai: *Modelling hyaluronan degradation by Streptococcus pneumoniae hyaluronate lyase*

[12] 28/09/18 Harold Berjamin (Aix-Marseille Université): *Internal-variable modeling of solids with slow dynamics*

[13] 05/10/18 Cian O'Brien: *ASBG-Colourings of Trees*
Faiza Alssaedi: *4th order real-valued singularly perturbed problems*

[14] 12/10/18 Qays Shakir: *On Some Kinds of Contact Graphs*
Róisín Hill: *Adapted a posteriori meshes*

[15] 19/10/18 Roberto Galizia: *Coupling normal forms via linear connection*
Aoife Hill: *Biodegradable polymers: Towards an updated model*

[16] 26/10/18 Vinh Mai: *Glucose Phosphorylation*
Hieu Ha Van: *Nonsingular Entry Pattern Matrices*

[17] 02/11/18 Hannah Conroy Broderick: *Stability of charge-controlled dielectric plates*
Eoghan Staunton: *Dealing with Discontinuity Boundaries*

[18] 16/11/18 Daher Al Baydli (Wasit University): *Fuzzy Mathematics*

[19] 23/11/18 James Blackwell: *Finding brain tumors with ultrasound*
Faiza Alssaedi: *A positive definite system of real-valued singularly perturbed problems*

[20] 30/11/18 Gianmario Varchetta: *Control of a model of competition between two animal species*
Pearce Harney-Nolan: *Preventing Sports Injuries Through Motion Capture*

[21] 11/12/18 Gianmario Varchetta, Pearce Harney-Nolan, Roberto Galizia, Eoghan Staunton, Richard Burke and Petri Piiroinen: *Christmas Blitz*

9 SIAM Student Chapter

The NUI Galway Student Chapter of SIAM, the Society for Industrial and Applied Mathematics, aims to bring together students and researchers from across campus to generate interest in applied mathematics, share ideas, and develop leadership skills. Members range from pure and applied mathematics to information technology, physics and engineering.

The current officers and Committee (2018/2019) are

President: Hannah Conroy Broderick

Vice President: Roberto Galizia

Secretary: Cian O'Brien

Treasurer: Aoife Hill

Faculty Advisor: Niall Madden

Committee Members: Faiza Alssaedi, Nisreen Alokbi, Róisín Hill, Vinh Mai, Christine Marshall, Qays Shakir, Eoghan Staunton, Michael Welby.

In 2018, the chapter organised the following events.

03/03/2018: Seminar on soft materials: experiments, theory and applications by Dr Taisiya Sigaeva (University of Calgary).

08/06/2018: A conference preparation day gave members a chance to practice talks for upcoming conferences and to receive feedback in a friendly environment. The day also gave the speakers a chance to share their research with a wide audience from NUI Galway.

18/06–19/06/2018: Eight chapter members attended the SIAM UKIE National Student Chapter Conference 2018 at the University of Bath, contributing seven talks and one poster.

22/06/2018: Annual General Meeting.

09/07–13/07/2018: Chapter President (2017/2018) Eoghan Staunton represented the chapter at the SIAM Annual Meeting (AN18) in Portland, and presented his work on noise in the square root map.

15/11/2018: *Careers in Mathematical Sciences Evening* for Undergraduate Students. Mathematics graduates gave short talks on their experiences of finding employment, establishing careers, and developing networks. Companies represented included Medtronic, Dairymaster, BrainWaveBank, and Valeo. Carol Keenan from the Career Development Centre briefed us on where previous graduates are working/studying and outline the careers services and supports available to students.

19/01/2019: Five chapter members attended, and gave contributed talks, at the fifth Irish SIAM Student Chapter Conference, at the University of Limerick. Chapter member Róisín Hill won the best presentation prize at the conference.

Members of the NUIG SIAM Chapter attending the UK and Ireland Annual Meeting

Members of the NUIG SIAM Chapter attending the 5th Irish SIAM Student Conference, Limerick