NUI Galway
OÉ Gaillimh

School of Mathematics, Statistics and Applied Mathematics

Ninth Annual Research Day

3 May 2018

Programme

	Lectures take place in **NCBES Seminar Room, 214, Orbsen Building** Coffee, lunch, posters and reception take place in the **Orbsen Building Atrium**
9:15–9:30	**Prof Götz Pfeiffer** Welcome by the Head of School
9:30–9:45	**Prof Ciarán Ó hÓgartaigh** Opening by President of NUI Galway
9:45–10:30	**Prof Cathal Walsh (University of Limerick)** **Title:** *Bayesian evidence synthesis - dealing with imperfect studies* **Abstract:** Randomised controlled trials (RCTs) and meta-analyses of these are seen as the gold standard in evidence when considering the efficacy of new drugs. However, it is increasingly the case that drugs are receiving licences without this standard of evidence. In order to consider which drugs the Irish State pays for it is necessary to use all available evidence including single armed and observational studies. In this talk I explore the challenges and problems involved and discuss how well (and in what circumstances) solutions to these can be found.
10:30–11:00	**Coffee** (Orbsen Building Atrium)
11:00–11:30	**Dr Nina Snigireva (NUI Galway)** **Title:** *Odd vs even* **Abstract:** We begin with a review of n-homogeneous polynomials on Banach lattices. Then we will explore how the properties of these polynomials differ depending on whether they are of odd or even degree. This is joint work with C. Boyd and R. Ryan.
11:30–12:00	**Dr Tobias Rossmann (NUI Galway)** **Title:** *Orbits and kernels* **Abstract:** What is the average size of the kernel of a matrix? We will see that this question leads to curious arithmetic and geometric problems which are closely related to natural group-theoretic counting problems.

(continued overleaf)

12:00–12:30	**Dr Valentina Balbi (NUI Galway)** **Title:** *The mechanics of soft tissues* **Abstract:** Biological soft tissues are particularly common in nature. For instance, many organs in the human body such as the skin, the brain, the gastrointestinal system are made of soft tissues. A tremendous effort has recently focused on understanding their mechanical properties in view of helping medical doctors, surgeons and biomedical engineers to improve episodes of care for patients. In the first part of the talk I will present the mathematical framework for modelling the mechanics of soft tissues. I will then illustrate an example where this framework can be used to model the biological processes of growth and morphogenesis in the gastrointestinal system.
12:30–14:00	**Lunch and Poster Session**
14:00–14:45	**Prof Dirk Werner (Freie Universität Berlin)** **Title:** *The hitchhiker's guide to tensors, polynomials, and everything* **Abstract:** The talk is meant to be an introduction to some research areas in which Ray Ryan has been active and will discuss a few of his contributions.
14:45–15:30	**Research blitz (Organizer: Hannah Conroy-Broderick)** Short research talks by: • Ray Ryan *The power of positive thinking* • Yipin Su *Voltage-induced self-bending and the associated instability of an elastomer-dielectric soft unimorph* • Kirsten Pfeiffer *SUMS from a sociocultural point of view* • Faiza Alssaedi *Numerical solution of a complex-valued singularly perturbed differential equation* • Aaron Golden *Irish lakes from space - studying water quality from low Earth orbit* • Graham Ellis *Four graphs* • Isaac Burke *The maximum likelihood degree of toric varieties*
15:30–17:00	**Poster session** (Orbsen Building Atrium)
16:00–17:00	**Reception & poster prizes** (Orbsen Building Atrium)

1 Introduction

The research activity in the School is driven by our three research clusters:

- **The De Brún Centre for Mathematics** supports mathematical research across a spectrum of areas, including Algebra, Analysis, Geometry, Topology and Mathematics Education.
- **The Biostatistics/Bioinformatics Cluster** covers the areas of Biostatistics and Bioinformatics and is engaged in collaborative work with researchers in Genomics and other areas, and with clinicians, through the Clinical Research Facility (CRF).
- **The Stokes Applied Mathematics Cluster** applies advanced mathematical skills to the modelling of computational, physical and biological phenomena, with the aim of fostering interdisciplinary research across the NUI Galway campus and beyond.

Some highlights from the year:

- We were delighted to welcome two new postdoctoral research fellows: Valentina Balbi and Yipin Su (both working with Michel Destrade).
- We have been very fortunate in continuing to attract high quality PhD students and 2017 was no exception, with five new research students joining us. At the same time, five students successfully defended their theses, leaving our overall research student population at a healthy 28.
- We welcomed John Newell (Statistics), Nina Snigireva (Mathematics) and Tobias Rossmann (Mathematics) as new members to the School.
- We were again placed second in Ireland in the QS Subject Rankings.
- We completed the Institutional Review of Research Performance (IRRP).
- The School hosted a total of six conferences and workshops:
  - 14th Annual Workshop on Numerical Methods for Problems with Layer Phenomena (06-07 Apr 2017)
  - 6th annual UK and Ireland SIAM National Student Chapter Conference. Section of SIAM (26 May 2017)
  - Groups in Galway 2017 (18-20 May 2017). This renowned conference has been running annually since 1978.
  - Workshop on Computational Deconvolution (25 May 2017).
  - 4th Annual Stokes Modelling Workshop. (06-09 Jun 2017).
  - 4th Irish SIAM Student Conference (01 Dec 2017).
- Members of the School published over 500 papers in the four years from 2014 to 2017.

Götz Pfeiffer,
Head of School

2 Poster Session

Fundamental Groupoids and Applications

Nisreen Alokbi
Supervisor: Graham Ellis

The fundamental group algorithm in [1] involves the construction of an admissible discrete vector field on large CW-spaces X, and this construction can consume significant memory and time for X. So we explain how the van Kampen theorem for fundamental groupoids yields a distributed version of the fundamental group algorithm of [1], and hence a distributed method for computing

$$\cup : H^1(X,\mathbb{Z}) \times H^1(X,\mathbb{Z}) \to H^2(X,\mathbb{Z})$$

The algorithm is illustrated in two applied topological settings:

- 3-dimensional digital images;
- topological data analysis of a finite sample of points from a metric space.

[1] P. Brendel, P. D lotko, G. Ellis, M. Juda, and M. Mrozek. Computing fundamental groups from point clouds. Appl. Algebra Engrg. Comm. Comput., 26(1-2):27–48, 2015.

[2] R. Brown. Groupoids and van Kampen's theorem. Proc. London Math. Soc. (3), 17:385–401, 1967.

[3] R. Brown and A.R. Salleh. A van Kampen theorem for unions of nonconnected spaces. Arch. Math. (Basel), 42(1):85–88, 1984.

Numerical solution of a complex-valued singularly perturbed differential equation

Faiza Alssaedi
Supervisor: Niall Madden

We are interested in the numerical solution of a singularly perturbed, second-order, complex-valued reaction diffusion equation. Our model differential equation is: find $u \in C^2[0,1]$ such that

$$Lu := -\varepsilon^2 u'' + bu = f \qquad \text{on} \qquad \Omega := (0,1), \quad \text{(1a)}$$

subject to the boundary conditions

$$u(0) = u_0, \qquad u(1) = u_1. \qquad \text{(1b)}$$

Here ε is a positive, real-valued parameter. We assume $0 < \varepsilon \leq 1$, but typically have that $\varepsilon \ll 1$. The coefficient function b and right-hand side function f are complex valued functions on the real interval Ω. That is, $b : \Omega \to \mathbb{C}$, and $f : \Omega \to \mathbb{C}$. Furthermore, we assume that $b, f \in C^4(0,1) \cup C[0,1]$.

We compute numerical solutions to (2) using standard finite difference methods, but on specialised fitted meshes: the well-known piecewise uniform *Shishkin* mesh, and the more complicated *Bakhvalov* mesh.

The numerical analysis of such method usually relies on Maximum Principles, but these do not hold, in a direct way, for the complex-valued problem (2).

Since we can't use standard ideas, we will take a special approach by rewriting (2) as a coupled system of real-valued problems, and establish that the coefficient matrix for this system is positive definite. From that we conduct the analysis using ideas due to Bakhvalov. We also present numerical results that demonstrate that our theoretical error estimates are sharp.

[1] N.S. Bakhvalov. On the optimization of the methods for solving boundary value problems in the presence of a boundary layer. *Zhurnal Vychislitel'noi Matematiki i Matematicheskoi Fiziki* **9** 841–859 (1969).

[2] R. Bruce Kellogg, Torsten Linss, and Martin Stynes. A finite difference method on layer-adapted meshes for an elliptic reaction-diffusion system in two dimensions. *Math. Comp.* **77** 2085–2096 (2008).

[3] J. J. H. Miller, E. O'Riordan, and G. I. Shishkin. *Fitted numerical methods for singular perturbation problems.* World Scientific Publishing Co. Pte. Ltd., Hackensack, NJ, revised edition, 2012.

Indecomposable Continuum with a Non-Weak-Cutpoint

Daron Anderson
Supervisors: Aisling McCluskey and Paul Bankston

This poster presents the construction of an indecomposable continuum with exactly one non-weak-cutpoint. Indecomposable metric continua have uncountably many composants. Thus our example is necessarily non-metric. The construction is an adaptation of Bellamy [1]. We start with an ω_1-chain of

indecomposable metric continua and retractions. The inverse limit is an indecomposable continuum with exactly two composants. Our example is formed by identifying a point in each composant.

[1] David Bellamy. Indecomposable Continua with One and Two Composants. *Fundamenta Mathematicae* 101(2):129–134, 1978.

[2] Daron Anderson. Indecomposable Continuum with a Non-Weak-Cutpoint. *To Appear.* 2018.

Research supported by the Irish Research Council Postgraduate Scholarship Scheme grant number GOIPG/2015/2744.

Wrinkles in soft dielectric plates

Hannah Conroy Broderick
Supervisor: Michel Destrade

Dielectric materials are smart materials that deform elastically in the presence of an electric field. Large actuation can be achieved by soft dielectrics, using the snap-through behaviour of the material. Soft dielectrics 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 show that a smooth giant voltage actuation of soft dielectric plates is not easily obtained in practice. In principle one can exploit, through pre-deformation, the snap-through behaviour of the loading curve to deliver a large stretch prior to electric breakdown. However, we demonstrate that even in this favourable scenario, the soft dielectric is likely to first encounter the plate wrinkling phenomenon, as modelled by the onset of small-amplitude sinusoidal perturbations on its faces.

[1] Y. Su, H. Conroy Broderick, W. Chen, M. Destrade, *Wrinkles in soft dielectric plates*, arXiv:1804.03204v1

Supported by a Government of Ireland Postgraduate Scholarship from the Irish Research Council

---

Injury prediction in elite sports: State of play

Kishor Das
Supervisor: John Newell

Sports injuries have a direct impact on player physiology, psychology and performance. In addition to that it has financial implication for the professional sport leagues such as Major League Baseball, NFL, NBA, and English Premier League. To alleviate this issue, studies relating to injury prediction in sports tend to follow four different analytical approaches: risk factor identification, prediction modelling, prevention using intervention, and identification of a single injury risk factor. However, most of the studies lack sufficient statistical power, causing unreliable prediction. Building registry to ensure enough number of events or devising proxy continuous variable could solve the issue. If prior information can be elicited from a relevant panel of experts Bayesian Networks could give more insight about the factors responsible for injuries and the causal pathway to injury occurrence.

[1] G.S. Collins and J.B. Reitsma, 2015.

[2] L. Parry and B. Drust, 2006.

[3] E.W. Steyerberg, 2008.

Control of Global Phase Transitions in Multistable Networks

Davide Di Palo
Supervisor: Petri Piiroinen

In this poster we develop a control method for a complex network of bistable and nonlinear agents with the aim to drive all states from one equilibrium point to another. The dynamics of each agent is given by a vector field of the pitchfork bifurcation normal form. At the same time, another aim is to minimize a cost function that can be given by, for instance, the number of used controllers or the total control energy. The poster shows how the structure of the network is set up, what a bistable system is and how we have modelled the system. We introduce two different control algorithms and described their behaviours through simulations and analytical proofs. Finally, in the "future work" section, the possible future improvements of the algorithm are listed, like the possibility to choose a better strategy to select the nodes that we want to control directly and the design of a cost function that give us some constraints to satisfy.

[1] P. De Lellis, M. di Bernardo, and G. Russo, On QUAD, Lipschitz, and Contracting Vector Fields for Consensus and Synchronization, IEEE Trans. Circuit Syst. I Reg. Papers, vol. 58,no. 3,pp. 576–583, March 2011.

[2] Steven H. Strogatz, Nonlinear dynamics and chaos: with applications to physics, biology, chemistry, and engineering.Hachette UK, 2014.

Variation in immune genes contributes to schizophrenia and cognitive deficits

Laura Fahey
Supervisors: Pilib Ó Broin and Derek Morris

BCL11B is associated with schizophrenia and is an important transcription factor regulating the differentiation and development of cells in both the central nervous system (CNS) and the immune system. Its interacting partner SATB2 is also a schizophrenia risk gene indicating that other genes interacting with or are regulated by BCL11B are making a contribution to schizophrenia. Cognitive deficits are core element of schizophrenia. My hypothesis is that variation in genes with immune function contribute to schizophrenia and associated cognitive deficits. I performed a literature search to construct sets of genes that are functionally related to BCL11B i.e. genes whose products have being shown to physically interact with BCL11B or genes that are transcription targets of BCL11B. I plan to use summary statistics from genome wide association studies (GWASs) on schizophrenia and cognition to investigate if genes associated with these phenotypes are enriched for genes in my BCL11B gene-set. I will measure the SNP-heritability for each gene-set i.e proportion of phenotypic variance explained by SNPs in each gene-set. Such gene-set analysis (GSA) enables detection of the effects of multiple weaker associations which would be missed by traditional GWAS methods that test for the association of individual SNPs or genes with phenotype. I will also use polygenic risk score (PRS) profiling to quantify the contribution that each gene-set is making to the genetic overlap between schizophrenia and cognition. I will use tools such as PRCise-2, which performs gene-set-based PRS analysis. I will also use machine learning analysis methods, which are gaining increased popularity in this field due to the high-dimentionality of SNP data. As well as using published summary statistics, I will be using genetic data from the UK Biobank which contains 500,000 samples. Data on this large number of samples will provide the statistical power required to detect genetic variation in such a complex disorder. I am currently in the process of carrying out sample and variant quality control on these data.

[1] Whitton, L. et al, Cognitive analysis of schizophrenia risk genes that function as epigenetic regulators of gene expression, Am. J. Med. Genet. B Neuropsychiatr. Genet. **171** 1170–1179 (2016).

[2] Koo, C.L., Liew, M.J., Mohamad, M.S., Salleh, M. and Hakim, A., A review for detecting gene-gene interactions using machine learning methods in genetic epidemiology, Biomed Res Int. **2013** 2013:43237.

[3] Ganna, A. et al, Ultra-rare disruptive and damaging mutations influence educational attainment in the general population, Nat Neurosci. **19** 1563–1565 (2016).

Computation of the Steenrod Square for finite 2-groups

Daher Al Baydli
Supervisors: Graham Ellis, Emil Sköldberg and Alexander Rahm

The main goal of this project is to develop algorithms and software that can be used by mathematicians who wish to investigate the standard cohomology operations (cup-i products, Bockstein operation, Steenrod squares, Stiefel-Whitney classes of a real representation) in the cohomology of groups. In particular, we use the Homological Algebra Programming package (HAP) to implement our method for calculating Steenrod squares on finite 2-groups

[1] Graham Ellis.HAP - Homological Algebra Programming, Version 1.11.3, 2015.

[2] R.E. Mosher and M.C. Tangora. Cohomology Operations and Applications in Homotopy Theory. Harper and Row, Publishers, New York, 1968.

[3] Brown, Kenneth S. Cohomology of Groups. Graduate Texts in Mathematics, Springer, 1994.

Structural stability of networks with bistable nodes

Roberto Galizia
Supervisor: Petri Piiroinen

In this research we analyse the dynamic behaviour of multistable networks, i.e. networks with coexisting attractors. We show that by connecting bistable nodes we can construct multistable networks with any

topology. In the networks we let the dynamics of each node be given by the normal form of the supercritical pitchfork bifurcation and the nodes are then linearly coupled. For a simple two-node network we analytically show the complex bifurcation structure that emerge and describe how the dynamics change as parameters are varied. When more than two nodes are considered, the high dimension and the lack of closed solutions prevent us to find similar analytic results. Instead, numerical methods are used to extend the analysis to higher dimensions. Finally, simulations of different networks are shown to highlight a variety of behaviours.

[1] H. Dankovic and F. Schilder. Recipes for continuation, volume 11. SIAM, 2013.

[2] M. Newman. Networks: an introduction. Oxford university press, 2010.

[3] Y. Kim. Effects of symmetry on bifurcations in coupled pitchfork systems. Journal of Korean Physical Society. 2009.

Inhomogeneous Thinning and Breakdown of Thin Dielectric Elastomers

Paul Greaney
Supervisors: Giuseppe Zurlo and Martin Meere

Thin dielectric elastomers with compliant electrodes have diverse applications in areas such as energy harvesting and microfluidics. The application of a voltage across the thickness direction of an incompressible dielectric elastomer results in an in-plane expansion, which can be large enough to produce areal strains of 500%. When the voltage applied is increased to a critical threshold, the elastomer thins *catastrophically* in localised regions, ultimately leading to the formation of holes and cracks. Modelling the electric breakdown associated with this catastrophic thinning phenomenon is a major challenge associated with the practical implementation of dielectric elastomers. We present some recent work which extends a theoretical model for catastrophic thinning in homogeneous systems [1] to the case of inhomogenously deformed systems. We compare our results with recent experimental findings on out-of-plane inhomogeneous deformations of dielectric elastomer actuators [2] and find a good match between theory and experiment.

[1] G. Zurlo et al. Catastrophic Thinning of Dielectric Elastomers. Phys. Rev. Lett., **118**. 078001 (2017).

[2] C. Zhang et al. Electromechanical deformation of conical dielectric elastomer actuator with hydrogel electrodes. J. Appl. Phys., **119**, 094108 (2016).

Supported by the College of Science, NUI Galway.

On the Nonsingularity of Entry Pattern Matrices

Ha Van Hieu
Supervisor: Rachel Quinlan

An entry pattern matrix (EPM for short) A is a matrix in which all entries are indeterminates. For a field $\mathbb{F}$, an $\mathbb{F}$-completion of A results from assigning a value from $\mathbb{F}$ to each indeterminate entry. We says that a square EPM is **$\mathbb{F}$-nonsingular** if all of its nontrivial completion are nonsingular. This poster was intended to construct nonsingular EPMs over the real numbers field $\mathbb{R}$ and some finite fields.

[1] Huang, Zejun and Zhan, Xingzhi, "Nonsymmetric normal entry patterns with the maximum number of distinct indeterminates", Linear Algebra and its Applications, volume 485, 359–371, 2015.

[2] Hieu Ha Van and Rachel Quinlan, "On the maximal rank of completions of entry pattern matrices", Linear Algebra and its Applications,2017.

[3] Adams, J. Frank, Peter D. Lax, and Ralph S. Phillips. "On matrices whose real linear combinations are nonsingular." Selected Papers Volume II (2005): 562-566.

Balanced norms and mesh generation for singularly perturbed reaction diffusion problems

Róisín Hill
Supervisor: Niall Madden

We consider the numerical solution of singularly perturbed differential equations by finite element methods, implemented in FEniCS, a open-source platform for solving partial differential equations (https://fenicsproject.org/). The simplest model problem is the one dimensional linear reaction-diffusion problem:

$$-\varepsilon^2 u''(x) + b(x)u(x) = f(x) \quad \text{on } \Omega = (0,1), \quad (2a)$$

with the boundary conditions

$$u(0) = u(1) = 0. \tag{2b}$$

It is *singularly perturbed* in the sense that the positive real parameter ε may be arbitrarily small, but, if we formally set $\varepsilon = 0$, it is ill-posed. When ε is small, the solution may exhibit boundary layers (and, perhaps, also interior layers, depending on the smoothness of b and f).

The numerical solution of (2), and its generalisations to higher-dimensional problems, and to the closely related convection-diffusion problem, presents numerous mathematical and computational challenges, particularly as $\varepsilon \to 0$. The development of algorithms that compute *robust* solutions of (2) is the subject of intense mathematical investigation [3].

Finite element methods are usually analysed with respect to the energy norm, which, arguably, underweights the layer terms in the solution when $\varepsilon \ll 1$ [2]. In addition, much of the research published over the past 20 years focuses on the solution of these problems on fitted meshes, which are constructed based on detailed *a priori* knowledge on the location and asymptotic properties of layers. This is somewhat artificial since, for many problems (particularly nonlinear ones) the location or width of layers may be unknown.

This motivates us to develop algorithms that iteratively generate *adaptive* meshes, based on *a posteriori* information. This leads to three problems that must be addressed:

(i) how to estimate errors in computed solutions;

(ii) how to quantify that error locally, to provide information to drive the mesh adaption;

(iii) how to solve the non-linear adaptivity problem.

In this presentation, we will describe approaches for each of these when computing numerical solutions of (2), and its generalisations, by FEMs in FEniCS. Taking inspiration from [1], for (i), we construct a hierarchical error estimator, based on comparing solutions computed in polynomials spaces of different degree. For (iii), we use a de Boor-type equidistribution algorithm. The key novelty in this presentation is how we address (ii). We will compare results obtained by equidistributing two different monitor functions: one based on the usual energy norm, and one on a special "*balanced*" norm [2]. We compare their ability to resolve the boundary layers of (2) and therefore, the appropriateness of the resulting mesh.

Our results show that the energy norm is too "weak" to adequately resolve the boundary layers, but that the balanced norm approach can achieve this.

[1] W. Huang and W. Sun. Variational mesh adaptation II: error estimates and monitor functions. *Journal of Computational Physics*, 184(2):619–648, 2003.

[2] R. Lin and M. Stynes. A balanced finite element method for singularly perturbed reaction-diffusion problems. *SIAM J. Numer. Anal.*, 50(5):2729–2743, 2012.

[3] T. Linß. *Layer-adapted meshes for reaction-convection-diffusion problems*, volume 1985 of *Lecture Notes in Mathematics*. Springer-Verlag, Berlin, 2010.

Supported by the Irish Research Council.

Evaluation of Trends in Post-Mastactomy Breast Reconstruction: Irish Population

Olga Kalinina
Supervisors: Emma Holian and John Newell

Introduction. Breast reconstruction is an important part of the multidisciplinary breast cancer management for patients undergoing mastactomy (removal of the whole breast). The practice of post-mastectomy breast reconstruction has developed gradually in the past decade as a result increasing mastectomy rates and variety of techniques to reconstruct the breast. The aim of the current study was to assess the trends in rates and types of breast reconstruction with respect to clinicopathalogical features and treatment therapies.

Data. Data was reviewed from a prospectively maintained database at Galway University Hospital, a tertiary breast cancer referral centre between 2009 and 2014. The first outcome of interest studied, post-mastectomy breast reconstruction include women diagnosed with ductal carcinoma in situ and invasive breast cancer who had mastectomy with or without breast reconstruction. The second outcome of interest is implant vs autologous tissue breast reconstruction offered as an immediate procedure.

Methods. The association of each outcome and prognostic factors are assessed using binary regression. Also backward variable selection and penalized regression technique are used to choose the most parsimonious model. A common issue with those approaches, discussed in literature, is their instability. To address this issue Tarr, Mueller and Welsh(2015) proposed graphical model stability and variable selection procedure for linear and generalized linear

models. These will be demonstrated using the breast reconstruction data.

Conclusion. Breast reconstruction post-mastectomy has become the standard of care in the surgical treatment of breast cancer. Recent trends show a transition favouring implant-based approaches. As the science of breast reconstruction progresses, surgical strategies for post-mastectomy breast reconstruction will continue to evolve.

[1] Albornoz, C.R., Bach, P.B., Mehrara, B.J., Disa, J.J., Pusic, A.L., McCarthy, C.M, et al., A paradigm shift in US Breast reconstruction: increasing implant rates. Plastic and reconstructive surgery, *J Breast 2015*, **131(1)**, 15–23 (2013).

[2] Murray, K., Heritier, S. and Mueller, S., Graphical Tools for Model Selection in Generalized Linear Models. *Stat Med 2013*, **32(25)**, 4438–4451] (2013).

[3] Tarr,Mueller and Welsh, mplot: Graphical Model Stability and Model Selection Procedures , R package version 0.7.9 (2015).

Acoustic Wave Elastography of Arteries: Theory, Simulations, Experiments, Validation

Robert Mangan
Supervisor: Michel Destrade

In vivo measurement of the mechanical properties of thin-walled soft tissues and in situ mechanical characterization of thin-walled artificial soft biomaterials in service are of great challenge and difficult to address via commonly used testing methods. Here we investigate the properties of guided waves in immersed pre-stressed plates and tubes, and show that they can address this challenge in a non-destructive manner. To this end, we carry out (i) a theoretical analysis based on incremental wave motion in finite deformation theory (ii) finite element simulations and we validate these results with (iii) experiments on cryogel phantoms immersed in water.

[1] Couade et al., Quantitative assessment of arterial wall biomechanical properties using shear wave imaging, Ultrasound. Med. Biol. 36.10 (2010): 1662–1676.

[2] Li et al, Guided waves in pre-stressed hyperelastic plates and tubes: Application to the ultrasound elastography of thin-walled soft materials, J. Mech. Phys. Solids 102 (2017): 67–79.

MHap: Maximum likelihood inference of methylation haplotypes

Barbara Zambiasi Martinelli
Supervisors: Cathal Seoighe and Pilib Ó Broin

The methylation status of adjacent CpG dinucleotides in the genome is correlated and groups of CpGs are frequently more informative about the functional status of their genomic locus than individual CpGs. Analysis of the methylation status of multiple sites on the same DNA molecule (methylation haplotypes) can, therefore, provide a better understanding of the diversity and functional implications of DNA methylation between cell types or across individuals. Recently, methylation haplotypes in circulating cell-free DNA have been proposed as a means of determining cancer status and identifying the affected tissue. We developed MHap, an Expectation-Maximization (EM)-based algorithm to obtain maximum likelihood estimates of methylation haplotype frequencies from short-read sequencing data as well as methylation haplotype entropy. In addition, we show that the inferred methylation haplotype frequencies provide improved estimates of methylation fractions at individual sites from low-coverage sequencing data. MHap is freely available at https://github.com/bzmartinelli/MHap

[1] Do CB, Batzoglou S. What is the expectation maximization algorithm?. Nature biotechnology. 2008 Aug;26(8):897.

[2] Teschendorff AE, Relton CL. Statistical and integrative system-level analysis of DNA methylation data. Nature Reviews Genetics. 2018 Mar;19(3):129.

[3] Xie H, Wang M, De Andrade A, Bonaldo MD, Galat V, Arndt K, Rajaram V, Goldman S, Tomita T, Soares MB. Genome-wide quantitative assessment of variation in DNA methylation patterns. Nucleic acids research. 2011 Jan 27;39(10):4099-108.

Supported by the Brazilian National Council for Scientific and Technological Development (CNPq), grant GDE207374/2014-7 and by Science Foundation Ireland (grant16/IA/4612).

Generalised Clique Graphs

Cian O'Brien
Supervisors: Rachel Quinlan and Kevin Jennings

In a graph G, a *clique* is a complete subgraph. A *maximal clique* is a clique that is not contained in another clique. The *clique graph* of a graph G is defined as a graph H with a vertex that corresponds to each maximal clique in G. Two vertices of H are connected if their corresponding cliques in G have any vertices in common.

An extension of this concept arose very naturally out of our research into alternating signed matrices. We define a *generalised clique graph (GCG)* H of a graph G to be a graph with each vertex corresponding to some clique in G, with the same notion of adjacency as above. The cliques of G represented in H need not be maximal or distinct, but every edge in G must be contained in some clique that is represented in H.

In this poster, we will present some related questions and results about GCGs, with a focus on identifying which graphs may arise as GCGs of a given graph G.

[1] R.C.Hamelink. A Partial Characterization of Clique Graphs, Journal of Combinatorial Theory, 1968.

[2] F.S. Roberts, J.H. Spencer. A Characterization of Clique Graphs, Journal of Combinatorial Theory, Series B, 1971.

Supported by Hardiman Research Scholarship

Tightness of Surface Graphs

Qays Shakir
Supervisor: 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.

[1] Md. Alam and et. al, Contact graphs of circular arcs, Algorithms and data structures, Lecture Notes in Comput. Sci., vol. 9214, Springer, Cham, 2015, 1–13.

[2] G. Laman, On graphs and rigidity of plane skeletal structures, J. Engrg. Math. 4, 1970, 331–340.

[3] B. Mohar and C. Thomassen, Graphs on surfaces, Johns Hopkins Studies in the Mathematical Sciences, Johns Hopkins University Press, Baltimore, MD, 2001.

A Noisy Saltation Matrix

Eoghan J. Staunton
Supervisor: Petri T. Piiroinen

In a smooth dynamical system the characteristics of a given reference trajectory with starting point $\mathbf{x}_0^{\text{ref}}$ can be determined, to lowest order, by examining the linearised system about the reference trajectory. In other words, we can approximate the deviations of trajectories with starting points $\mathbf{x}_0 \approx \mathbf{x}_0^{\text{ref}}$ after a given time t by multiplying the *fundamental solution matrix* of the reference trajectory by their initial deviation.

This analysis method cannot be used in nonsmooth systems as it stands since the vector field $\mathbf{f}$ is not everywhere differentiable, or the flow function $\phi(\mathbf{x}_0^{\text{ref}}, t)$ is not continuous. To account for this we derive the *zero-time discontinuity mapping* $\mathbf{D}$ associated with the discontinuity boundary, i.e. we find the map $\mathbf{D}$ such that when time $t = T$ is greater than the length of time it takes the trajectory starting at $\mathbf{x}_0$ to cross the boundary

$$\phi(\mathbf{x}_0, T) = \phi_2(\mathbf{D}(\phi_1(\mathbf{x}_0, t_{\text{ref}})), T - t_{\text{ref}}), \qquad (3)$$

where $\phi_{1,2}$ are the flows corresponding to the vector fields $\mathbf{f}_{1,2}$ on either side of the discontinuity boundary $\mathcal{D}$ and t_{ref} is the time of flight from $\mathbf{x}_0^{\text{ref}}$ to the boundary. The derivative $\mathbf{D}_{\mathbf{x}}$ of the mapping $\mathcal{D}$ is known as the *saltation matrix* and its properties can tell us how the crossing of the discontinuity boundary

affects the deviations of trajectories from a reference trajectory.

Here we derive a saltation matrix for a system in which the position of the discontinuity boundary varies randomly in time according to some stationary stochastic process. We then present a simple example of a ball bouncing on an oscillating floor whose motion has a random component.

[1] M. di Bernardo, C. Budd, A.R. Champneys, and P. Kowalczyk, *Piecewise-smooth dynamical systems: theory and applications*, vol. 163, Springer, 2008.

[2] H. Dankowicz and P.T. Piiroinen, *Exploiting discontinuities for stabilization of recurrent motions*, Dynamical Systems, vol. 17, no. 4, pp. 317-342, 2002.

[3] J.J. Barroso, M.V. Carneiro, and E. E. N. Macau, *Bouncing ball problem: Stability of the periodic modes* Phys. Rev. E **79**, 026206, 2009.

Supported by an Irish Research Council Government of Ireland Postgraduate Scholarship

---

In the shadows of a hypergraph: looking for the asscociated primes of powers of squarefree monomial ideals

Nghia Tran
Supervisors: Alexander Rahm and Emil Sköldberg

Let H be a hypergraph and $J(H)$ be the cover ideal of H, which is the intersection of the primes corresponding to the edges of H. The aim of this project is to study the associated primes of powers of the ideal $J(H)$. We introduce the *shadows* of a hypergraph and examine how these shadows preserve information about the associated primes of the powers of $J(H)$. This is joint work with E. Bela and G. Favacchio in a project started during the PRAGMATIC 2017 Research School "Powers of ideals and ideals of powers" held in Catania, Italy.

[1] C.A. Francisco, H.T. Hà, A. Van Tuyl, Colorings of hypergraphs, perfect graphs, and associated primes of powers of monomial ideals. Journal of Algebra. 2011 Apr 1; 331(1): 224–242. `arXiv:0908.1505`

[2] T. Kaiser, M. Stehlík, R. Škrekovski, Replication in critical graphs and persistence of monomial ideals. *J. Combin. Theory Ser. A* **123** (2014), 239–251.

[3] Erin Bela, Giuseppe Favacchio, N—, In the shadows of a hypergraph: looking for asscociated primes of powers of squarefree monomial ideals, (preprint, 2018+).

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

Mechanism of hyaluronan synthesis

Vinh Q. Mai
Supervisors: Tuoi Vo and Martin Meere

Hyaluronan is a high-molecular-weight polysaccharide composed of repeating N-Acetylglucosamine and N-Glucuronic acid disaccharide units. It is naturally present in most vertebrate tissues and is involved in many physiological processes, such as cancer metastasis and cell migration. It is accepted that the biological functions of a hyaluronan chain are dependent upon the length of the chain. The massive molecular weight hyaluronan in naked mole rats may play a vital role in their remarkable resistance to aging and cancer. There are three hyaluronan synthases responsible for synthesising hyaluronan in certain cells. Investigators have proposed a kinetic mechanism of hyaluronan synthesis by these hyaluronan synthases and a pendulum model for their extrusion through the plasma membrane. We proposed to develop a mathematical model describing the cellular synthesis of hyaluronan. Amongst the questions the model will help address are to define what factors that determine chain length in synthesis and how sensitive the model is to these factors.

[1] Eva A. Turley, David K. Wood, and James B. McCarthy. Carcinoma cell hyaluronan as a "portable" cancerized prometastatic microenvironment. Cancer Research, 76(9); 2507-12, 2016.

[2] Xiao Tian, Jorge Azpurua, Christopher Hine, Amita Vaidya, Max Myakishev-Rempel, Julia Ablaeva, Zhiyong Mao, Eviatar Nevo, Vera Gorbunova and Andrei Seluanov. High-molecular-mass hyaluronan mediates the cancer resistance of the naked mole rat. Nature 499, 346-349, 2013.

[3] Paul H. Weigel. Hyaluronan synthase: The mechanism of initiation at the reducing end and a pendulum model for polysaccharide translocation to the cell exterior. International Journal of Cell Biology, volume 15, 2015.

Genus g Zhu Recursion for Vertex Operator Algebras

Michael Welby
Supervisor: Michael Tuite

This poster presents work recently done on genus g Zhu recursion, which relates n-point functions to $(n-1)$-point functions. Much work has been done on genus zero, one and two, and this project extends the result to higher genera using a sewing scheme which attaches handles to the Riemann sphere.

[1] McIntyre, A. and Takhtajan, L.A.: Holomorphic Factorization of Determinants of Laplacians on Riemann Surfaces and a Higher Genus Generalization of Kronecker's First Limit Formula, Geom.Funct.Anal. **16**, 1291–1323 (2006).

[2] Tuite, M.P. and Zuevsky, A.: The Bosonic Vertex Operator Algebra on a Genus g Riemann Surface, RIMS Kokyuroko **1756**, 81–93 (2011).

[3] Zhu, Y.: Modular invariance of characters of vertex operator algebras. J.Amer.Math.Soc. **9**, 237–302 (1996).

Supported by a Government of Ireland Postgraduate Scholarship (awarded by the Irish Research Council).

3 Abstracts of PhD Theses

Aspects of Modeling and Application of Survival-type Data

Lida Fallah
Supervisor: 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 modeling such data and deals with the unique difficulties that each type of data brings to bear on data analysis.

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

Shirin Moghaddam
Supervisors: John Hinde and 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.

Investigation of T cell receptor and Immunoglobulin repertoire through next generation sequencing data

Yaxuan Yu
Supervisors: Cathal Seoighe and Rhodri Ceredig

The diversity of the immunological repertoire has long been a subject of research focus, providing important insights into the adaptive immune system. Rapid developments in next generation sequencing technologies have revolutionized the way immunological repertoires are analyzed, providing unprecedented high-resolution data. Nonetheless, these high-throughput approaches also present unique computational challenges that must be addressed through the development of accurate and efficient bioinformatics pipelines. In this thesis, we demonstrated a complete bioinformatics workflow for processing and analysis of high-throughput sequences from immune receptors, and applied these tools to explore research questions relating to the diversity of immune receptor genes in human populations.

An aspect of the immunological repertoire that is frequently of immediate interest to immunologists is the distribution of different immune receptor clonotypes among individuals, as knowledge of this could lead to a better understanding of the dynamics of the immune system in different conditions. We first implemented a bioinformatics pipeline to analyze next generation sequencing data from T cell receptors and immunoglobulins. This pipeline featured an ultra-fast and accurate fast-tag-searching algorithm for VDJ alignments, which outperformed all the other similar

pipelines on benchmarking. In addition to that, this pipeline included two novel functional components. The first function was polymorphism analysis, which reports putative novel SNPs found in the input sequences. The second novel function was the ability to construct lineage mutation trees to describe the affinity maturation process of immunoglobulins.

No matter how sophisticated the alignment algorithms are, accurate gene alignment always requires the right reference database. Unfortunately, the IMGT database, which is the most widely used reference database in immunological repertoire analysis pipelines, has been shown to be incomplete and to contain numerous errors. Thus, the second task undertaken in this PhD thesis was to create a more comprehensive reference database for T cell receptors and immunoglobulin genes by exploiting the large volume of publicly available human genome resequencing data generated in recent years. Based on the variant calling information retrieved from the 1000 Genomes Project and the current human reference genomes, we were able to infer a set of putative alleles of immune receptor genes. Lym1k, our database of these inferred alleles, provided a more comprehensive collection of immune receptor alleles found in global human populations, as evidenced by a significantly improved alignment performance on real datasets compared to IMGT.

The immune receptor loci are among the most dynamic regions of the human genome, with a high rate of structural variation, as well as high allelic diversity. Previous analyses of the allelic diversity of immune receptor genes in global human populations were constrained by the limited size of human genome resequencing data. We focused on addressing three research questions relating to the allelic diversity of immune receptor genes in our last research chapter. Firstly, it has been shown by many studies that African populations have greater overall allelic richness than other human populations, we thus compared the allelic diversity between African and Non-African populations for immune receptor genes. Not surprisingly, the immune receptor alleles in African populations were more diversified compared to Non-African populations. As the immune receptor genes with the same gene type are located adjacent to each other on the chromosome, we secondly investigated if genomic location was associated with allelic diversity, potentially reflecting differences in the frequency of receptor gene use between genes located towards the proximal or distal ends of the arrays of genes of a given type. However, we did not find an effect of position on allelic diversity. Lastly, we hypothesized that immune receptor genes that are more frequently selected during rearrangement are under higher diversifying selection pressure, and this would lead to a higher allelic diversity. Surprisingly, the correlation was absent from most of the gene types except for weak positive correlations in TCRA genes.

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.

4 Permanent & Contract Staff

Burns, John

Current Research Interests

My current research interests are Algebra (Lie algebras, Lie groups, Weyl groups) and Differential Geometry (Homogeneous manifolds, Symmetric spaces). Research in these areas is ongoing with various authors:

Adib Makrooni and I are studying relations between root theoretic data, such as the Coxeter number and the exponents, of parabolic sub-root systems and those of the parent root systems. Applications include formulae for the defect of projective varieties.

Patrick Browne and I are working on 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.

Publications

Two papers under review. Most significant recent publications

[1] Burns, John M. and Makrooni, Mohammad A. Compact homogeneous spaces with positive Euler characteristic and their 'strange formulae'. Q. J. Math. **66** (2015), no. 2, 507–516.

Research Activities

- Reviewing: 1 paper.
- Conferences and workshops: Irish Geometry Conference, May 2017 (Maynooth) . Groups in Galway, May 2017.
  Symplectic geometry conference, INI, Cambridge, August 2017.
  Modern moduli theory conference, University of Oxford, September 2017.

Cruickshank, James

Current Research Interests

I have two main areas of activity at the moment.

- Multilinear algebra over local rings. Together with Fernando Szechtman (University of Regina) and Rachel Quinlan (NUIG) we have investigated the structure of various types of sesquilinear forms over local rings. We are also interested in the groups associated to these forms.
- Geometric rigidity. I am interested in the combinatorial and geometric problems arising from the rigidity of bar and joint frameworks and various other similar structures. I am currently collaborating with Qays Shakir (NUIG), Derek Kitson and Steve Power (Lancaster) on a project involving rigidity theory and topological graph theory. Also, I have recently done some work with Bill Jackson (QMUL) on linearly constrained frameworks.

Publications

0 publications appeared in 2017

Most significant recent publications:

[1] J. Cruickshank, F Szechtman. Generators and relations for the unitary group of a skew hermitian form over a local ring. *To appear in Linear Algebra and its Applications.* Available at https://arxiv.org/abs/1710.11574

[2] J. Cruickshank, F Szechtman. Unitary groups and ramified extensions. *To appear in Communications in Algebra.* Available at https://arxiv.org/abs/1611.00824

[3] J. Cruickshank, R. Quinlan, F Szechtman. Hermitian and skew hermitian forms over local rings. *To appear in Linear Algebra and its Applications.* Available at https://arxiv.org/abs/1705.01562

[4] J Cruickshank, D Kitson, S. C. Power. The generic rigidity of triangulated spheres with blocks and holes. *Discrete Comput. Geom.* 51 (2014), no. 3, 702-721

Research Activities

- Research visits to University of Regina (May 2017) and Lancaster University (Feb. 2017 and June 2017)
- 2 papers refereed
- Editorial board of the IMS
- External examiner for CIT
- 2 current PhD students
- Conference presentation at Lancaster Workshop on Bond-Node Structures (June 2017)

Destrade, Michel

Current Research Interests

I apply the principles of Continuum Mechanics to the modelling of soft matter, including soft silicones, gels, and biological tissues such as the human skin and brain matter. I am mainly working in problems and applications of elastic wave propagation, elastic stability, and experimental and computational solid mechanics. I recently started looking at the modelling of residual stress and of growth, and the interaction of these phenomena in tissues. I also looked at post-buckling creases using finite element simulations. Finally, I am working on modelling electroactive polymers, which are used for artificial muscles, soft robotics and energy harvesters, for the moment concentrating on their stability.

Publications

Number of publications appearing in calendar year 2017: six Most significant recent publications

[1] G.-Y. Li, Q. He, R. Mangan, G. Xu, C. Mo, J. Luo, M. Destrade, Y. Cao. Guided waves in pre-stressed hyperelastic plates and tubes: Application to the ultrasound elastography of thin-walled soft materials. *Journal of the Mechanics and Physics of Solids*, **102** (2017) 67-79.

[2] M. Carfagna, M. Destrade, A.L. Gower, A. Grillo. Oblique wrinkles. *Philosophical Transactions A*, **375** (2017) 20160158.

[3] M. Destrade, G. Saccomandi, I. Sgura. Methodical fitting for mathematical models of rubber-like materials. *Proceedings of the Royal Society A*, **473** (2017) 20160811.

[4] G. Zurlo, M. Destrade, D. DeTommasi, G. Puglisi. Catastrophic thinning of dielectric elastomers. *Physical Review Letters*, **118** (2017) 078001.

Research Activities

- *Research grants:* 2 IRC postgraduate scholarships; 1 Marie Curie Postdoctoral Fellowship; 1 IRC postdoctoral fellowship; 1 Flaherty Research Scholarship; 1 Enterprise Ireland Coordinator support grants; 1 SoftMech EPSRC visiting grant; 1 Visiting Grant from Zheijiang university.
- *Graduate students:* 3 (Robert Mangan, Hannah Broderick-Conroy, Ilaria Cinelli);
- *Journal submissions:* 7;
- *Research Fellows*: 2 (Valentina Balbi, Yipin Su);
- *Conferences/Seminars:* 6 (Brescia, Hangzhou, Shanghai, Castro-Urdiales, Cortona, Lyon);
- *Outreach talks:* 10;
- *Research Visits:* 6 (Madrid, Hangzhou, Ecole Polytechnique, Glasgow, Perugia, UCD);
- *Research Visitors:* Alain Goriely, Oxford University, 05-06 April (brain mechanics); KR Rajagopal, Texas A&M University, 26-28 October (visco-elasticity), Stephan Rudykh, Technion (electro-elasticity);
- *Papers refereed:* 11;
- *Professorial Promotion Internal Examiner:* 1;
- *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).

Ellis, Graham

Current Research Interests

My current research interests lie in computational algebraic topology and its applications to group cohomology and to data science.

Publications

Most significant recent publications

[1] Bayer-Fluckiger, Eva; Elbaz-Vincent, Philippe; Ellis, Graham; Mini-Workshop: Computations in the Cohomology of Arithmetic Groups. Oberwolfach Rep. 13 (October 2016), no. 4, 2941–2973. Published 2017.

Research Activities

[1] Supervised two PhD students (one in cohomology of groups and one in data science).

[2] Served on the jury for the PhD exam of Thomas Camus at Grenoble. Thesis title: Méthodes algorithmiques pour les réseaux algébriques

[3] Served on the editorial boards of

- Homology, Homotopy and Applications (HHA)
- Journal of Homotopy and Related Structures (JHRS)
- Applicable Algebra in Engineering, Communication and Computing (AAECC)
- Tbilisi Mathematical Journal (TMJ)

[4] Served on the GAP Council for GAP computational algebra software.

Flannery, Dane

Current Research Interests

Linear group theory, particularly its computational aspects; algebraic design theory.

Publications

Most significant recent publications

[1] Zariski density and computing in arithmetic groups, Mathematics of Computation. Published electronically August 2017 (with A. S. Detinko and A. Hulpke).

[2] Automorphisms of generalized Sylvester Hadamard matrices, Discrete Mathematics 340, no. 3, 516–523, 2017 (with R. Egan).

[3] On quasi-orthogonal cocycles, Journal of Combinatorial Designs, 1–11, 2017 (with J. A. Armario).

[4] GAP functionality for Zariski dense groups, Oberwolfach Preprint OWP 2017-22 (with A. S. Detinko and A. Hulpke).

Research Activities

- Department of Mathematics, University of Auckland, 6–20 May 2017.
- Research in Pairs, Mathematisches Forschungsinstitut Oberwolfach, 4–24 June 2017.
- Research in Groups, International Centre for Mathematical Sciences, UK, 16 July–5 August 2017.
- Mathematics Institute, University of Warwick, 21–24 August 2017.
- Reviewer, Engineering and Physical Sciences Research Council, UK.
- Two Mathematical Reviews, five papers refereed.

Golden, Aaron

Current Research Interests

- Developing predictive models of ground truth conditions using low earth orbit remote sensing data.
- Characterising the rotational and kinetic properties of Jupiter family comets and active asteroids.
- Exploring the prevalance and role of flaring activity & magnetospheric aurora at the substellar boundary.
- The functional genomics of radiobiology

Publications

Most significant recent publications

[1] Demaerel, W, Hestand, MS, Vergaelen, E, Swillen, A, López-Sánchez, M, Pérez-Jurado, LA, McDonald-McGinn, DM, Zackai, E, Emanuel, BS, Morrow, BE, Breckpot, J, Devriendt, K, Vermeesch, JR, Antshel, K, Arango, C, Armando, M, Bassett, A, Bearden, C, Boot, E, Bravo-Sanchez, M, Breetvelt, E, Busa, T, Butcher, N, Campbell, L, Carmel, M, Chow,

E, Crowley, TB, Cubells, J, Cutler, D, Demaerel, W, Digilio, MC, Duijff, S, Eliez, S, Emanuel, B, Epstein, M, Evers, R, Fernandez Garcia-Moya, L, Fiksinski, A, Fraguas, D, Fremont, W, Fritsch, R, Garcia-Minaur, S, Golden, A, Gothelf, D, Guo, T, Gur, R, Gur, R, Heine-Suner, D, Hestand, M, Hooper, S, Kates, W, Kushan, L, Laorden-Nieto, A, Maeder, J, Marino, B, Marshall, C, McCabe, K, McDonald-McGinn, D, Michaelovosky, E, Morrow, B, Moss, E, Mulle, J, Murphy, D, Murphy, K, Murphy, C, Niarchou, M, Ornstein, C, Owen, M, Philip, N, Repetto, G, Schneider, M, Shashi, V, Simon, T, Swillen, A, Tassone, F, Unolt, M, van Amelsvoort, T, van den Bree, M, Van Duin, E, Vergaelen, E, Vermeesch, J, Vicari, S, Vingerhoets, C, Vorstman, J, Warren, S, Weinberger, R, Weisman, O, Weizman, A, Zackai, E, Zhang, Z, Zwick, M *Nested Inversion Polymorphisms Predispose Chromosome 22q11.2 to Meiotic Rearrangements.* **American Journal of Human Genetics**, 101, 4:616–622 (2017).

[2] Barnicle, A, Seoighe, C, Greally, JM, Golden, A, Egan, LJ, *Inflammation-associated DNA methylation patterns in epithelium of ulcerative colitis.* **Epigenetics**, 12, 8:591–606 (2017).

[3] Pollack, RM, Barzilai, N, Anghel, V, Kulkarni, AS, Golden, A, Ó Broin, P, Sinclair, DA, Bonkowski, MS, Coleville, AJ, Powell, D, Kim, S, Moaddel, R, Stein, D, Zhang, K, Hawkins, M, Crandall, JP, *Resveratrol Improves Vascular Function and Mitochondrial Number but Not Glucose Metabolism in Older Adults.* **Journal of Gerontology A Biol. Sci. Med. Sci.**, 72, 12:1703–1709 (2017).

Research Activities

[1] **Research Grants**
• 2017-W-MS-30: 'Remote Sensing of Irish Surface Waters', Environmental Protection Agency, 2017-2020, €249k

[2] **External Appointments**
• Research Associate/Visiting Astronomer, Armagh Observatory & Planetarium, Co. Armagh, U.K. *(July 2017–July 2020)*
• Member, European Science Consortium for NASA's LUVOIR space observatory *(June 2017–)*

[3] **Astronomical Observing Campaigns Completed**
• Coordinated radio observations of Venus with the Japanese Space Agency's 'Akatsuki' orbiter *(Program Code LG002: 'LWA Monitoring of Planetary Electrostatic Discharges')*
• Serendipitous Observations of Short Period Comets by NASA's K2 Observatory *(Program Codes GO12033 & GO13033)*
• Galway Ultrafast Photometer/Vatican Advanced Technology Telescope observations of the active asteroid 60558 Echeclus.*(Dec. 2017)*
• NASA Swift Observatory Target of Opportunity observations of comets' 90P/Gehrels & 228P/LINEAR *(07/01/17 & 18/01/17)*
• Optical spectroscopic observations of brown dwarfs using the South African Large Telescope *(Program Code 2017-1-SCI-003 'H_α observations of a nearby T dwarf' Oct. 2017)*

[4] **Telescope Time Awarded**
• Program Code LC9_040, 'A search for aurora on nearby flare stars using LOFAR' *(LOFAR: The LOw-Frequency ARray, ASTRON, Netherlands, 30/10/17)*
• Program Code CY6006, 'Joint e-MERLIN/LOFAR Observations of the Flare Star CN Leonis' *(e-MERLIN/VLBI National Facility, Jodrell Bank, University of Manchester, U.K., 22/12/2017)*

[5] **International Expert Review Service**
• Proposal Reviewer, NASA Postdoctoral Program *(Apr, Nov 2017)*
• Planetary Panel Review Member, NASA Postdoctoral Program *(Aug 2017)*

[6] **Journal Review Service**
• *Ad hoc* reviewer for Bioinformatics (OUP) *(June 2017)*

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.

Publications

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

Most significant recent publications

[1] Rafael de Andrade Moral, John Hinde, and Clarice Garcia Borges Demétrio (2017) Half-Normal Plots and Overdispersion in R: the hnp Package. *Journal of Statistical Software*, **81**.

[2] Wagner H. Bonat, Bent Jørgensen, Célestin C. Kokonendji, John Hinde and Clarice G. B. Demétrio. (2018) Extended Poisson-Tweedie: properties and regression models for count data. *Statistical Modelling*, **18**, 24–49.

[3] Rafael A. Moral, John Hinde, Clarice G.B. Demétrio, Carolina Reigada and Wesley A.C. Godoy. (2018) Models for jointly estimating abundance of unmarked predator and prey populations subject to imperfect detection. *Journal of Agricultural, Biological and Environmental Statistics*, **23**(1), 20–38.

[4] John Ferguson, Alberto Alvarez-Iglesias, John Newell, John Hinde and Martin O'Donnell (2017). Joint incorporation of randomized and observational evidence in estimating treatment effects. Accepted for *Statistical Methods in Medical Research*.

Research Activities

- Graduate students: 3.
- Journal submissions: 10; accepted 5; under review 2; under revision 3
- 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.
- External Examining: Statistics Extern School of Maths UCD; Certificate/Diploma in Statistics, Trinity College, Dublin; PhD Kent, UK; PhD Bilbao, Spain.

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. Applications in microarray analysis.

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

Publications

[1] McGrory, E., Holian, E., Alvarez-Iglesias, A., McGillicuddy, E., Bargary, N. and Morrison,L., Arsenic in groundwater in south west Ireland: occurrence, controls and hydrogeochemistry, Preparing for submission.

[2] Casey, M.C., Holian, E., McGuire, A., Kalinina, O., Shalaby, A., Curran, C., Webber, M. , Callagy, G., Bourke, E., Brown, J., and Kerin, M.. Quantifying Argonaute 2 expression in breast cancer." Preparing for submission Scientific Reports.

[3] McGuire, A., Casey, M.C., Shalaby, A., Kalinina, O., Curran, C., Webber, M., Callagy, G., Holian, E., Bourke, E., Kerin, M.J. and Brown, J.A. Quantifying Tip60 (Kat5) stratifies breast cancer. Preparing for submission Scientific Reports.

[4] McGuire, A., Kalinina, O., Holian, E., Curran, C., Malone, C.A., McLaughlin, R., Lowery, A., Brown, J.A.L. and Kerin, M.J. Differential impact of hormone receptor status on survival and recurrence for HER2 receptor-positive breast cancers treated with Trastuzumab.' (2017) Breast Cancer Research And Treatment, 164 :221–229

[5] Clancy, C., Khan, S., Glynn, C.L., Holian, E., Dockery, P., Lalor, P., Brown, J.A., Joyce, M.R., Kerin, M.J. and Dwyer, R.M. Screening of exosomal microRNAs from colorectal cancer cells. (2017), Cancer Biomarkers, 17 (4):427–435

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.
- Awards : Athena Swan Midcareer Lecturer Research Capacity Building Grant August 2017, €5000.

Madden, Niall

Current Research Interests

I am interested in the development and analysis of algorithms for computing approximate solutions to partial differential equations – particularly two and three-dimensional problems whose solutions feature boundary or interior layers. Within this area, I work is in two main branches: *discretizations* which is the process of reducing these problems to finite-dimensional ones, expressed as linear system of equations, and *solvers*, which are algorithms to solving these systems.

Publications

Recent publications.

[1] Stephen Russell and Niall Madden. An Introduction to the Analysis and Implementation of Sparse Grid Finite Element Methods. *Computational Methods in Applied Mathematics*, 17(2), pp. 299-322. 2017.

[2] José Luis Gracia, Niall Madden, and Thái Anh Nhan. Applying a patched mesh method to efficiently solve a singularly perturbed reaction-diffusion problem. In Hans Georg Bock, Hoang Xuan Phu, Rolf Rannacher, and Johannes P. Schlöder, editors, *Modeling, Simulation and Optimization of Complex Processes HPSC 2015*, pages 41–53, Cham, 2017. Springer.

[3] Thái Anh Nhan, Scott MacLachlan, and Niall Madden. Boundary layer preconditioners for finite-element discretizations of singularly perturbed reaction-diffusion problems. *Numerical Algorithms*, Nov 2017.

Research Activities

- Currently supervising two PhD students: Faiza Alssaedi, and Róisín Hill, who was awarded a Irish Research Council scholarship in 2017.
- Submitted three manuscripts to international peer-reviewed journals.
- In April I was the main organiser of the *14th Annual Workshop on Numerical Methods for Problems with Layer Phenomena*, held here at NUI Galway.
- In June I was one of the main organisers of the *2017 Stokes Modelling Workshop* at NUI Galway, which was funded by *MI-NET*, the Mathematics for Industry Network COST Action.
- In June I presented at the *27th Biennial Numerical Analysis Conference* Strathclyde, 27-30 June 2017. I also co-organised a minisymposium on *Advances in the robust solution of singularly perturbed differential equations*, with with Natalia Kopteva (Limerick) and Torsten Linß (Hagen).
- In September, I presented at the *3rd Irish Linear Algebra and Matrix Theory Meeting*, Maynooth University.
- In December, I delivered a one-week course on *Theory and Computation of Singularly Perturbed Differential Equations*, at the Department of Mathematics, IIT (BHU), Varanasi, funded by the Global Initiative for Academic Networks (GIAN).
- During 2017, I refereed manuscripts for Applied Numerical Mathematics, the Journal of Computational and Applied Mathematics, Computational Mathematics, the Journal of Applied Mathematics and Computing, the International Journal of Numerical Analysis and Modelling, Mathematical Communications, Numerical Methods for Partial Differential Equations, and Numerical Algorithms.
- I continue to serve as an associate editor of Numerical Algorithms (Springer).
- I was the faculty advisor to the NUI Galway Student Chapter of the Society for Industrial and Applied Mathematics during 2017. In May, we hosted the 2017 “National” Student Chapter

Conference for the UK and Ireland section of SIAM. In December, we held the *4th annual Irish SIAM Student Chapter Conference*.

McCluskey, Aisling

Current Research Interests

My research interests reside primarily within analytic topology, with a particular fascination in how order theoretic structures mesh with topology. Other ongoing research concerns continua theory in the context of both a natural associated order (a notion of "betweenness"), and of discrete dynamical systems. I also maintain a keen interest in research in undergraduate mathematics education. Specifically, I am interested in the development of and facility with proof and proving in abstract analysis-based mathematical subjects typically taken in mathematics-major degree programmes.

Publications

Most significant recent publications

[1] Bruno, J., McCluskey, A., Szeptycki, Betweenness in a Categorical Setting, Results in Mathematics 72 Issue 1-2 (2017), 649–664.

[2] S. Greenwood and A. McCluskey, "Continuous functions on Hausdorff continua", Topology Appl. 212 (2016), 142–165.

[3] A. McCluskey and B. McMaster, "Undergraduate topology: a working textbook", Oxford University Press, 2014.

Research Activities

- Publications: 1 published; 2 in process
- Graduate students: Daron Anderson PhD; summer intern: Kelvin Killeen 3BMS
- Conferences: 51st Spring Topology and Dynamical Systems conference, New Jersey City University
- Peer reviewer of two professors for the National Research Foundation in South Africa
- External examiner (PhD) at University of Birmingham
- Invited talk at UCD
- Member of Scientific Committee for the 2019 Summer Conference on Topology and its Applications in Johannesburg
- Referee for Topology and its Applications.

Mc Gettrick, Michael

Current Research Interests

I work at the intersection of (theoretical) computer science, (theoretical) physics and mathematics, more specifically on quantum information. I am interested in constructing quantum algorithms using quantum walks and quantum games. Other areas of interest include algorithmic composition (in music), discrete event dynamical systems and computer algebra.

Research Activities

- I am a member of the Irish Mathematical Society (IMS), the American Mathematical Society (AMS) and the (UK) EPSRC (Engineering and Physical Sciences Research Council) Peer Review College. For the EPSRC I carried out two reviews of research grant proposals in 2017.
- From June 14-16 2017, I participated in TQC2017 (Conference on Theory of Quantum Computation, Communication and Cryptography) at Université Pierre et Marie Curie (Paris).

Meere, Martin

Current Research Interests

Modelling polymer degradation; modelling membrane mechanics and cellular uptake; modelling diffusion in strained crystals; modelling drug delivery applications.

Publications

Two peer reviewed publications in 2017; one journal paper and one conference proceedings.

[1] Tuoi Vo, Sarah Morgan, Christopher McCormick, Sean McGinty, Sean McKee & Martin Meere. Modelling drug release from polymer-free coronary stents with microporous surfaces, International Journal of Pharmaceutics, doi.org/10.1016/j.ijpharm.2017.12.007, 2017

[2] Martin Meere, Sean McGinty & Giuseppe Pontrelli. Mathematically modelling the dissolution of solid dispersions. Proceedings Of Equadiff 2017, 341–348. K. Mikula, D. Sevcovic and J. Urban, Eds. Published by Slovak University of Technology, ISBN:978-80-227-4757-8.

Research Activities

I have two PhD students, one co-supervised by Dr Giuseppe Zurlo, and another co-supervised by Dr Tuoi Vo (University of Limerick). I gave one invited talk (Bratislava, Equadiff 2017). I visited the Consiglio Nazionale delle Ricerche, Rome, for a week in May 2017. I visited the University of Glasgow for a week in June 2017.

Newell, John

Current Research Interests

My primary areas of research in Biostatistics are in the theory and application of statistical methods in clinical trials of health service 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 and derivative estimation, survival analysis, tree based classification problems and sports analytics.

Publications

4 publications appeared in calendar year 2017

Most significant recent publications

[1] Coote, S, Uszynski, M, Herring, MP, Hayes, S, Scarrott, C, Newell, J, Gallagher, S, Larkin, A,Motl, RW (2017) Effect of exercising at minimum recommendations of the multiple sclerosis exercise guideline combined with structured education or attention control education - secondary results of the step it up randomised controlled trial. BMC Neurology, 17.

[2] McGrath, ER, Espie, CA, Power, A, Murphy, AW, Newell, J, Kelly, C, Duffy, N, Gunning, P,Gibson, I, Bostock, S, O'Donnell, MJ (2017) Sleep to Lower Elevated Blood Pressure: A Randomized Controlled Trial (SLEPT). American Journal Of Hypertension, 30 :319-327.

[3] Durand H, Hayes P, Morrissey EC, Newell J, Casey M, Murphy AW, Molloy GJ. (2017) Medication Adherence among Patients with Apparent Treatment-Resistant Hypertension: Systematic Review and Meta-Analysis. Journal Of Hypertension, 35 (12):2346-2357.

[4] Hayes, S, Uszynski, MK, Motl, RW, Gallagher, S, Larkin, A, Newell, J, Scarrott, C, Coote, S (2017) Randomised controlled pilot trial of an exercise plus behaviour change intervention in people with multiple sclerosis: the Step it Up study. BMJ Open, 7.

Research Activities

- Current research grants: PI (1), Co-PI (1), Collaborator (4), Co-Applicant (3).
- Number of graduate students: 5
- Journal submissions: 4
- Conferences: 2
- Invited talks: 2
- Memberships: Irish Statistical Association
- External posts: Adjunct Senior Research Fellow in the Department of Mathematics and Statistics, University of Canterbury, Christchurch, New Zealand.

Ó Broin, Pilib

Current Research Interests

My research interests can be classified into two broad areas - clinical bioinformatics (focusing on cancer genomics, immunology, and neuroscience) and computational biology (in particular, the development and application of statistical machine learning methods for biomarker discovery and modelling of regulatory genomic data). Specific projects include:

- Identification of variants associated with recurrence risk following chemo-radiation in head and neck squamous cell carcinoma
- The use miRNAs as biomarkers of breast cancer subtype
- Integration of molecular profiling and clinical data for dynamic risk stratification in kidney transplant patients

- Population genomics for the association of non-coding variants with cognitive deficits in schizophrenia.

Publications

Most significant recent publications

[1] 'Resveratrol Improves Vascular Function and Mitochondrial Number but Not Glucose Metabolism in Older Adults', Rena M Pollack, Nir Barzilai, Valentin Anghel, Ameya S Kulkarni, Aaron Golden, Pilib Ó Broin, David A Sinclair, Michael S Bonkowski, Alexander J Coleville, Danielle Powell, Sharon Kim, Ruin Moaddel, Daniel Stein, Kehao Zhang, Meredith Hawkins, Jill P Crandall, Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences, 72(12): 1703-1709.

[2] 'A Molecular Approach to Chronic Rejection: Antibody or T-Cell Mediated?', L Kamal, P Ó Broin, M Lubetzky, Y Bao, E Akalin, American Journal of Transplantation 17, 345-345.

[3] 'Molecular Significance of Peritubular Capillaritis in Early Transplant Kidney Biopsies of Donor-Specific Antibody Negative Patients', M Ajaimy, P Ó Broin, Y Bao, E Akalin, American Journal of Transplantation 17, 532-532.

[4] 'Clinical and Molecular Significance of Microvascular Inflammation Negative Transplant Glomerulopathy', M Lubetzky, N Hayde, P Ó Broin, Y Bao, E Akalin, American Journal of Transplantation 17, 532-532

Research Activities

Journal Submissions: 4
Conference Presentations: 6
Graduate Students: 6 (3 PhD, 3 MSc)
Professional Memberships: ISCB, EACR
Funding: SFI, HRB, MCSA

O'Regan, Donal

Current Research Interests

Nonlinear functional analysis (theory, methods and applications).

Publications

Most significant recent publications

[1] Agarwal, R., Hristova, S., Kopanov, P. and O'Regan, D., Impulsive differential equations with Gamma distributed moments of impulses and p-moment exponential stability, Act.Math.Sc. **37** 985–997 (2017).

[2] Nowakowski, A. and O'Regan, D., Periodic Navier solutions for the plate equation with non-monotone nonlinearities: The multidimensional case, Proc.Edin.Math.Soc. **60** 203–230 (2017).

[3] De la Sen, M., O'Regan, D. and Saadati, R., Characterization of modular spaces, J.Comp.Anal.App. **22** 558–572 (2017).

[4] Agarwal, R.P., Asma, Lupulescu, V. and O'Regan, D., L_p-solutions for a class of fractional integral equations, J.Int.Eqn.App. **29** 251–270 (2017).

Research Activities

38 publications in 2017.

Pfeiffer, Götz

Current Research Interests

Computational algebra, representations of finite groups and associative algebras, combinatorics and geometry of finite Coxeter groups, Burnside rings and double Burnside rings of finite groups.

Publications

Most significant recent publications

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

[2] (with Alice C. Niemeyer and Cheryl E. Praeger) On the Complexity of Multiplication in the Iwahori–Hecke Algebra of the Symmetric Group. *J. Symb. Comp.* **80** (2017), 817–832.

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

[4] (with Marcus Bishop, J. Matthew Douglass and Gerhard Röhrle) Computations for Coxeter arrangements and Solomon's descent algebra III: Groups of rank seven and eight. *J. Algebra* **423** (2015), 1213–1232.

Research Activities

I attended the *Groups St Andrews 2017* conference at the University of Birmingham, August 5 – 13, 2017, and presented a talk *Bisets, Double Burnside Rings, and the Subgroups of a Direct Product.* I presented an invited talk *On the Double Burnside Ring of a Finite Group* at the ALSPAG conference, Queens University Belfast, August 30 – September 2, 2017.

In November 2017, I visited Leibniz Fellow H. Randriamaro at Mathematisches Forschungsinstitut Oberwolfach. Subsequently, we submitted one research paper, which is now appearing in *Journal of Group Theory.*

I wrote 6 reviews for the Mathematical Reviews and I refereed 8 research papers.

I am on the Editorial Board of the *Mathematical Proceedings of the Royal Irish Academy.*

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

- Co-organiser of the Thematic Working Group *Argumentation and Proof* at at CERME 10 (10th Congress of European Research in Mathematics Education), 1 – 5 February 2017.
- Supervision of a master student's project on learning styles in teaching and learning of mathematics at university level.
- Speaker at the 11th Annual Irish Workshop on Mathematics Learning Support.
- 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 main research interests are in the area of discontinuous dynamical systems with application to rigid-body mechanics, evolving networks, population dynamics, economics, psychology and biological systems. An overarching aim of my research is to bridge the gap between mathematics and numerical analysis, on one hand, and biology, engineering and social sciences, on the other, and to make mathematical theories more applicable to non-theoreticians.

Publications

Most significant recent publications

1. Erazo, C., Homer M., Piiroinen, P.T. and di Bernardo M., *Dynamic cell mapping algorithm for computing basins of attraction in planar Filippov systems*, International Journal of Bifurcation and Chaos 27(12):1730041, 16 pages, November 2017.
(DOI: 10.1142/S0218127417300415)

2. Zgonnikov, A., Aleni, A., Piiroinen, P.T., O'Hora, D. and di Bernardo, M., *Decision landscapes: Visualising mouse-tracking data*, Royal Society Open Science 4:170482, November 2017.
(DOI: 10.1098/rsos.170482)

3. Burns, S. and Piiroinen, P.T., *Numerical location of Painlevé paradox-associated jam and lift-off in a double pendulum mechanism*, Journal of Computational and Nonlinear Dynamics 12(6), 8 pages, November 2017. (DOI: 10.1115/1.4037033)

4. Donohue, J.G. and Piiroinen, P.T., *Protective parenting may have population-level consequences*, Ecological Complexity 31, pp. 72–77, 2017. (DOI: 10.1016/j.ecocom.2017.04.006)

Research Activities

During 2017 I supervised 1 Postdoc, 3 PhD students and 1 visiting MSc student from Naples. The MSc student has since graduated.

Quinlan, Rachel

Current Research Interests

Linear algebra and its interactions with combinatorics, field theory and the representation theory of finite groups. Current projects involve minimally primitive and exponent-critical graphs, and dimension bounds for nilpotent and non-nilpotent matrix spaces.

Publications

Most significant recent publications

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

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

[3] Kirsten Pfeiffer and Rachel Quinlan. *Proof-evaluation as a step towards proof authorship* in: Beyond Lecture: Resources and Pedagogical Techniques for Enhancing the Teaching of Proof-Writing Across the Curriculum, Mathematical Association of America (2016). (book chapter)

[4] James McTigue and Rachel Quinlan. *Partial matrices of constant rank.* Linear Algebra Appl. 446 (2014), 177–191.

Research Activities

Currently supervising the PhD research of Ha Van Hieu, Cian O'Brien (jointly with K. Jennings) and Dana Saleh (part time).
Conference presentations 2017: 26th British Combinatorial Colloquium (Strathclyde), 21st Conference of the International Linear Algebra Society (Iowa), 3rd Irish Linear Algebra and Matrix Theory Meeting (Maynooth).
Co-organised minisymposium on Linear Algebra Education at the 2017 Conference of the International Linear Algebra Society.
Several refereeing and reviewing contributions.

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 new type of zeta function which is related to rank distributions in spaces of matrices. These zeta functions exhibit a number of intriguing algebraic, arithmetic, and combinatorial features. Apart from their intrinsic appeal, they have applications in the study of orbit, conjugacy class, and representation growth of groups.

Publications

Most significant recent publications

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

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

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

Math. Ann. 368 (2017), 391–417.

[3] *Topological representation zeta functions of unipotent groups.*

J. Algebra 448 (2016), 210–237.

[4] *Computing topological zeta functions of groups, algebras, and modules, I.*

Proc. Lond. Math. Soc. (3) 110 (2015), 1099–1134.

Research Activities

- Feodor Lynen Postdoctoral Fellow (funded by the Alexander von Humboldt Foundation) throughout 2017.
- Invited speaker at the *Fourth International Workshop on Zeta Functions in Algebra and Geometry*, 29 May – 2 June 2017, Bielefeld.
- Paper submitted:

  The average size of the kernel of a matrix and orbits of linear groups.

  arXiv:1704.02668, 50 pages (as of April 2018).
- Referee for specialised journals in algebra and number theory.
- Obtained habilitation and *venia legendi* in mathematics from Bielefeld University (June 2017).

Ryan, Ray

Current Research Interests

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

PhD Students:

Padraig Kirwan: "Complexification of Multilinear and Polynomial Mappings on Normed Spaces" (1997)
Bogdan Grecu: "Geometrical Properties of Spaces of Homogeneous Polynomials" (2001)
John Loane: "Polynomials on Riesz Spaces" (2008)

Books:

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

Publications

[1] Cruickshank, J., Loane, J. & Ryan, R.A., *Positive polynomials on Riesz spaces*, Positivity 21 (2017), no. 3, 885–895.

[2] Abobaker, H., & Ryan, R.A., *Modular metric spaces*, Irish Math. Soc. Bulletin 80 (Winter 2017), 35–44.

[3] Boyd, C. & Ryan, R.A., *The norm of the product of polynomials in infinite dimensions*, Proc. Edinb. Math. Soc. (2) 49 (2006), 17–28.

[4] Grecu, B. & Ryan, R.A., *Polynomials on Banach spaces with unconditional bases*, Proc. Amer. Math. Soc. 133 (2005), no. 4, 1083–1091.

[5] Aron, R. M.; Boyd, C.; Ryan, R. A.; Zalduendo, I. *Zeros of polynomials on Banach spaces: the real story*, Positivity 7 (2003), no. 4, 285–295.

[6] Boyd, C.; Ryan, R. A. *Geometric theory of spaces of integral polynomials and symmetric tensor products*, J. Funct. Anal. 179 (2001), no. 1, 18–42.

Research Activities

- **Conference Talks** *The Radius of Analyticity for Real Analytic Functions*, Conference on Non-Linear Functional Analysis, Valencia, October 2017.

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.

Publications

4 journal articles appeared in 2017.

Most significant recent publications

[1] Yu, Y., Ceredig, R. and Seoighe, C., A Database of Human Immune Receptor Alleles Recovered from Population Sequencing Data, J. Immunol. 2017 Mar 1;198(5):2202–2210.

[2] Seoighe, C. and Scally, A., Inference of Candidate Germline Mutator Loci in Humans from Genome-Wide Haplotype Data, PLoS Genet. 2017 Jan 17;13(1):e1006549.

[3] Barnicle, A., Seoighe, C., Greally, J.M., Golden, A. and Egan, L.J., Inflammation-associated DNA methylation patterns in epithelium of ulcerative colitis. Epigenetics. 2017 Aug;12(8):591–606.

Research Activities

My research group consisted of three PhD students in 2017. Current research grants are from the EU (Marie Sklodowska Curie), IRC, Science Without Borders (Brazil), and SFI (PI Award, granted in 2018). Academic community service included membership of the editorial board of Briefings in Bioinformatics, review of grants for a number of international funding agencies, as well as refereeing for a wide range of journals.

Sheahan, Jerome

Current Research Interests

Asymptotics

Publications

5 publications in 2017.

Sköldberg, Emil

Current Research Interests

I am interested in combinatorial commutative algebra, in particular homological properties of monomial and binomial ideals.

Publications

Most significant recent publications

[1] M. Badiane, I. Burke, and E. Sköldberg, *The universal Gröbner basis of a binomial edge ideal*, Electron. J. Combin. **24** (2017).

Research Activities

I supervised Ms. Nghia Tran, working on Hochschild cohomology, and co-supervised Mr. Daher Al-Baydli, working on the cohomology of groups. In April/May 2017, I hosted Dr. Veronica Crispin from Uppsala University, for collaboration on resolutions of monomial ideals whose lcm-lattice is shellable. From September to December, I visited Prof. Alexander Engström's group at Aalto University in Helsinki, Finland.

Snigireva, Nina

Current Research Interests

Invariant measures for non-hyperbolic iterated function systems (IFS). Mobius IFS. Properties of orthogonally additive polynomials on Banach lattices.

Publications

Most significant recent publications

[1] C. Boyd, R. A. Ryan, N. Snigireva *Radius of Analyticity of Analytic Functions on Banach Spaces*, Journal Of Mathematical Analysis And Applications, volume 463, 40–49, (2018).

[2] C. Boyd and N. Snigireva *On the Analyticity of the Fredholm Determinant*, preprint

[3] K. Lensiak and N. Snigireva *Mobius Iterated Function Systems via Lasota-Myjak theory*, preprint

Research Activities

- Research visit to K. Lesniak at Nicolaus Copernicus University, Torun, Poland, 3rd August-16th August, 2017.
- Invited seminar talk at University College Cork, May 2017.
- Refereed 2 research papers.

Tuite, Michael

Current Research Interests

Vertex operator algebras (VOAs), Riemann surfaces, elliptic, Jacobi and modular functions in number theory and combinatorics. With Tom Gilroy, we have recently discovered the geometric meaning of genus two Zhu reduction theory for VOAs. This has been applied to obtain a modular invariant partial differential equation describing all genus two partition functions for the (2,5) minimal model VOA and exceptional VOAs related to the Deligne exceptional Lie algebras. A general genus version of Zhu reduction has also been developed using the Schottky parametrization of a Riemann surface with my PhD student Mike Welby. I have also been working on superconformal algebras with Matt Krauel, Geoff Mason and Gail Yamskulna where we have constructed a new generalized elliptic genus moonshine for the smallest Matheiu simple group M_{11}.

Publications

Most significant recent publications

[1] M.P. Tuite, Vertex algebras according to Isaac Newton, J. Phys. A: Math. Theor. **50** 413001 (2017).

[2] M.P. Tuite and Hoang Dinh Van, On exceptional vertex operator (super) algebras, 'Developments and Retrospectives in Lie Theory', DEVM **38** 351–384 (Springer Verlag) (2014).

Research Activities

- Invited talks at Quantum Foundations Meeting UCD, University of Rome and Cardiff University.
- First annual week long meeting of a 3 year research project entitled "Vertex operator superalgebras, Jacobi functions and Mathieu moonshine" funded by the American Institute of Mathematics, San Jose California with Matt Krauel, Geoff Mason and Gail Yamskulna
- 1 PhD student with IRC funding
- 3 journal submissions, 4 papers in preparation.
- Research visit from Professor Christopher Marks, California State University Chico, CA July 2017.

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.

Publications

Most significant recent publications

[1] H Yang and C Seoighe. Impact of the Choice of Normalization Method on Molecular Cancer Class Discovery Using Non-negative Matrix Factorization. PLOS ONE, 2016.

[2] Y Jiang *et al.* An expanded evaluation of protein function prediction methods shows an improvement in accuracy. Genome biology, 2016.

[3] Radivojac, Predrag *et al.* A large-scale evaluation of computational protein function prediction. Nature Methods 10 (3), 2013.

[4] Pierre C. Havugimana *et al.* A census of human soluble protein complexes. Cell 150 (5), 1068-1081, 2012.

Research Activities

- With T Mateo, A Romero and A Paccanaro. Submitted CAFA-Pi protein function prediction competition.
- Mohan Timilsina, Haixuan Yang and Dietrich Rebholz Schuhmann. Submitted to *Briefings in Bioinformatics*.
- Reviewed papers for the journals *Complexity* and *Scientific Report*.

Zurlo, Giuseppe

Current Research Interests

I am currently interested at surface instability phenomena in thin films, related to the role of elasticity towards capillarity, electrostatics, surface swelling and growth. In the special case of electroelasticity, I have recently started a fruitful collaboration with my colleague Michel Destrade of my same School, together with a group of researchers in Xi'an Jiaotong University, Xi'an in China. I am also interested at the mechanics of surface growth, with special emphasis on the modelling of additive layered manufacturing or "3D printing", a project in collaboration with Lev Truskinovsky, based in Paris, and with Raz Kupferman, from the Hebrew University in Jerusalem. Finally I have interests in the modelling of biological membranes, with special emphasis to the process of endocytosis; this is a PhD thesis that I am currently supervising, together with my colleague Martin Meere of my same School.

Publications

Most significant recent publications

[1] 1. Zurlo G., Destrade M., DeTommasi D., Puglisi G., Catastrophic Thinning of Dielectric Elastomers, Physical Review Letters 118, 078001 (2017)

[2] 2. Zurlo G., Truskinovsky L., Printing Non-Euclidean Solids, Physical Review Letters 119, 048001 (2017).

[3] 3. Zurlo G., Truskinovsky L., Inelastic surface growth, Mechanics Research Communications, in press.

Research Activities

I am currently supervising 1 PhD student. During 2017 I have given invited talks in: University of Manchester (10/Feb), Universita di Firenze (16/3), University of Pittsburgh-USA (6/May), Universita di Brescia (29/May), Castro-Urdiales Spain (28/Jun), MFO Oberwolfach (16/Jul), University of Okinawa-JP (20/Sep), Universita di Roma Sapienza-IT (22/Nov), University of Oxford-UK (30/Nov). I have peer-reviewed 6 papers. Since October 2017, together with Michel Destrade and Valentina Balbi, I am editing a Special Issue on the International Journal of Nonlinear Mechanics.

Postdoctoral Researchers

Balbi,Valentina

Current Research Interests

My current Marie Curie project aims 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 am conducting 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.

Publications

[1] Mathematical Modeling of Morphogenesis in Living Materials. V Balbi, P Ciarletta (2016) in: Mathematical Models and Methods for Living Systems. Switzerland: Springer International Publishing.

[2] A modified formulation of quasi-linear viscoelasticity for transversely isotropic materials under finite deformation. V Balbi, T Shearer, WJ Parnell. arXiv preprint arXiv:1804.06897 (submitted to Proc Roy Soc A).

Research Activities

My postdoctoral fellowship is funded by the European Commission under the H2020 programme (Marie Curie Individual Fellowship). Under this fellowship I participated in several international conferences such as the INdAM Meeting on Mathematical Physics of Living Systems, Italy and the International Workshop on Modelling of Nonlinear Continua, Spain. In occasion of the annaul British Applied Mathematics Colloquium, I have organised a mini-symposium on "Constitutive modelling in biomechanics" and I am guest editor for a special issue on the same theme for the International Journal of Non-linear Mechanics. I visited the School of Engineering in UCD, the School of Mathematics at the University of Manchester and the Mathematical Institute at Oxford University for research collaborations. I am a member of the Gruppo Nazionale per la Fisica Matematica in the Solid Mechanics group (INdAM).

Su, Yipin

Current Research Interests

Modelling of Soft Solids, Elastic Waves, Instabilities and patterns of Deformed Soft Matter, Nonlinear Electro-magneto-elasticity, Piezoelectricity, Nonlinear Biomechanics.

Publications

[1] Wu, B., Su, Y., Liu, D., Chen, W., Zhang, C. On propagation of axisymmetric waves in pressurized functionally graded elastomeric hollow cylinders. Journal of Sound and Vibration, 2018, 421, 17-47.

[2] Zhou, W., Chen, W., Shen, X., Su, Y., Pan, E. On surface waves in a finitely deformed coated half-space. International Journal of Solids and Structures, 2017, 128, 50-66.

[3] Su, Y. P., Wang, H. M., Zhang, C. L., Chen, W. Q. Propagation of non-axisymmetric waves in an infinite soft electroactive hollow cylinder under uniform biasing fields. International Journal of Solids and Structures, 2016, 81: 262-273.

[4] Su, Y. P., Zhou, W. J., Chen, W. Q., Li£ · , C. F. On buckling of a soft incompressible electroactive hollow cylinder. International Journal of Solids and Structures, 2016, 97: 400-416.

Research Activities

- Waves in Soft Electroactive Cylindrical Shells Subject to Elastic and Electric Biasing Fields. Conference: ICAST 2012: 23rd International Conference on Adaptive Structures Technologies, 10-13 October 2012, Nanjing, China.
- Propagation of non-axisymmetric waves in an infinite soft electroactive hollow cylinder under inhomogeneous biasing fields - the State Space Formulism. Conference: CCTAM 2015: The Chinese Congress of Theoretical and Applied Mechanics, 15-18 August 2015, Shanghai, China.
- Propagation of non-axisymmetric waves in a soft electroactive hollow cylinder under uniform biasing fields. Symposium: Advances in Mechanics, 3-4 December 2015, Dublin, Ireland.
- On buckling of a soft incompressible electroactive hollow cylinder. Mini-Symposium (MS11) "Instabilities and Bifurcations in Solids, Structures and Soft Materials" in 2016 EMI International Conference - Engineering Mechanics Institute Conference of ASCE. 25-27 October 2016, Metz, France

---

Visitors

Goriely, Alain (Oxford University)
Visiting: Michel Destrade

Dates of visit: 5/4/2017 – 6/4/2017

Research Activity

Discussions on brain mechanics.

Rajagopal, K.R. (Texas A&M University)
Visiting: Michel Destrade

Dates of visit: 26/10/2017 – 28/10/2017

Research Activity

Discussions on visco-elasticity.

Rudykh, Stephan (Technion)
Visiting: Michel Destrade

Dates of visit: 26/10/2017 – 28/10/2017

Research Activity

Discussions on electro-elasticity.

Dobrine, Natasha (University of Denver)
Visiting: Aisling McCluskey

Dates of visit: 6/12/2017 –18/12/2017

Research Activity

Working towards a proof of an independence result

Miszczak, Jarek (Polish Academy of Sciences)
Visiting: Michael McGettrick

Dates of visit: 9/11/2015 to 13/11/2015

Research Interests

Research on quantum walks and quantum evolutionary game theory.

Scarrott, Carl (University of Canterbury, NZ)
Visiting: John Newell

Dates of visit: Feb 2017 –Mar 2017

Research Activity

Collaborative research with John Newell, John Hinde and Albert Alvarez (two publications submitted)

Boyd, Chris (UCD)
Visiting: Ray Ryan and Nina Snigereva

Dates of visit: Weekly Saturday Visits

Research Activity

Research on polynomials on Banach lattices.

Marks, Christopher (California State University Chico)
Visiting: Michael Tuite

Dates of visit: 12/7/2017 – 15/7/20172017

Research Activity

Discussions on vertex operator algebras.

Postgraduate Students

Daher Al-Baydli	daher.mathematics@gmail.com
Nisreen Alokbi	nisreen.alokbi@gmail.com
Faiza Alssaedi	f.alssaedi1@nuigalway.ie
Daron Anderson	d.anderson2@nuigalway.ie
Mariel Barbachan e Silva	m.barbachanesilva2@nuigalway.ie
Issac Burke	i.burke1@nuigalway.ie
Richard Burke	richardburke8@gmail.com
Hannah Conroy Broderick	hconroybroderick@gmail.com
Kishor Das	k.das2@nuigalway.ie
Laura Fahey	l.fahey5@nuigalway.ie
Lida Fallah	lida_fallah@yahoo.com
Roberto Galizia	r.galizia1@nuigalway.ie
Paul Greaney	p.greaney3@nuigalway.ie
Ha Van Hieu	hieuhavan88@gmail.com
Róisín Hill	r.hill2@nuigalway.ie
Olga Kalinina	o.kalinina1@nuigalway.ie
Quang Mai	vinh.maiquang83@gmail.com
Robert Mangan	rmangan10@gmail.com
Barbara Martinelli	martinelli.bz@gmail.com
Brendan Masterson	b.masterson1@nuigalway.ie
Shirin Moghaddam	sh.moghaddam@alumni.ut.ac.ir
Ngoc Thanh Nguyen	thanhngochp@gmail.com
Cian O'Brien	c.obrien40@nuigalway.ie
Davood Roshan	d.roshansangchin1@nuigalway.ie
Qays Shakir	q.shakir2@nuigalway.ie
Eoghan Staunton	e.staunton2@nuigalway.ie
Nghia Tran Thi Hieu	hieunghiatoan1a@gmail.com
Michael Welby	m.welby5@nuigalway.ie
Yaxuan Yu	yuyaxuan0@gmail.com

Conferences and Workshops

- **14th Annual Workshop on Numerical Methods for Problems with Layer Phenomena**
  Dates: 6–7 April 2017
  Funders: Irish Mathematical Society, School of Mathematics, Statistics and Applied Mathematics.
  Speakers: Abdelhamid Ainouz Boumediene), Simon Becher (Dresden), Sebastian Franz (Dresden), José Luis Gracia (Zaragoza), Alan Hegarty (UL), Natalia Kopteva (UL), Torsten Linß (Hagen), Dmitry Lukyanenko (Lomonosov MSU), Nikolay Nefedov (Lomonosov MSU), Eugene O'Riordan (DCU), Stephen Russell (Beijing), Martin Stynes (Beijing), Catherine Timoney (UL), Vladimir Volkov (Moscow), Chad Westphal (Wabash), Christos Xenophtonos (Cyprus).
  Organisers: Niall Madden (main organiser), Faiza Alssaedi, Natalia Kopteva, and Qays Shakir.

- **6th annual UK and Ireland SIAM National Student Chapter Conference**
  Dates: 26 May, 2017
  Funders: Science Foundation Ireland, SIAM, Irish Mathematical Society, and the School of Mathematics, Statistics and Applied Mathematics, NUI Galway.
  Speakers: Leá Deleris (IBM Research) and Patrick Farrell (Oxford University)
  Organisers: the NUI Galway SIAM Student Chapter

- **4th Annual Stokes Modelling Workshop**
  Dates: 6–9 June 2017.
  Funders: MI-NET (the Mathematics for Industry Network COST Action)
  Invited Mentors: John Donohue (Limerick), Atur Gower (Manchester), Luca Manzari (Stockholm), Doireann O'Kiely (Oxford), Thi Ngoc Tuoi Vo (Limerick)
  Organisers: Niall Madden (main organisers), Michel Destrade, Roberto Galizia, Paul Greaney, Martin Meere, Robert Mangan, Petri Piiroinen, Eoghan Staunton, Michael Welby, Giuseppe Zurlo

- **4th Irish SIAM Student Conference**
  Date: 1 December 2017.
  Funders: SIAM, the School of Mathematics, Statistics and Applied Mathematics.
  Speakers: Dr Nicole Beisiegle (UCD), Catherine Enright (Valeo Vision Systems)
  Organisers: NUI Galway SIAM Student Chapter

- **40th Groups in Galway**
  Date: 18–20 May 2017.
  Funders: Science Foundation Ireland, NUI Galway, The Irish Mathematical Society
  Speakers: Karel Dekimpe (Kortrijk), Arnold Feldman (Franklin & Marshall), Lukasz Grabowski (Lancaster), Derek Holt (Warwick), Conchita MartÃŋnez-Pérez (Zaragoza), Martin Newell (NUI Galway), Damian Osajda (Wroclaw), Péter Pálfy (Alfréd Rényi Institute, Budapest), Colva Roney-Dougal (St. Andrews), Juan Souto (Rennes), Eric Swenson (Brigham Young), Markus Szymik (Trondheim)
  Organisers: Dieter Degrijse and Claas Röver.

- **Workshop on Computational Deconvolution**
  Date: 25 May 2017
  Funders: Science Foundation Ireland
  Invited speakers: Renaud Gaujoux (Technion), Ruth Luthi-Carter (University of Leicester), Alberto Capurro (University of Leicester), Andrew Simpkin (NUIG), Barbara Martinelli (NUIG)
  Organizers: Cathal Seoighe, Barbara Martinelli

Seminars

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] Matt Holden, University of St. Andrews. 12/1/2017. (Contact: Tim Downing)

[2] Chris Boyd, University College Dublin. *Measuring Invertibility*, 26/1/2017. (Contact: Ray Ryan)

[3] Imre Leader, Cambridge University. *Partition Regular Equations*, 16/2/2017. (Contact: Aisling McCluskey)

[4] David Firth, University of Warwick. *Football leagues: A better mid-season ranking than the points tally?*, 9/3/2017. (Contact: John Hinde)

[5] Thomas Keane, European Bioinformatics Institute (EMBL-EBI). *Using reference-free compressed data structures to analyse*, 16/3/2017. (Contact: Cathal Seoighe)

[6] Laura Ciobanu, Heriot-Watt University. *Conjugacy growth in groups*, 23/3/2017. (Contact: Dieter Degrijse)

[7] Sarah Mitchell, University of Limerick. *Numerical, perturbation and approximate solutions to Stefan problems*, 30/3/2017. (Contact: Niall Madden)

[8] Giuseppe Di Molfetta, Aix-Marseille Université. *Quantum Walks Gravity Simulation*, 27/4/2017. (Contact: Michael Mc Gettrick)

[9] Caitríona Ní Shé, Dublin City University. *Technology enhanced Resources for Mathematics Education (TeRMEd)*, 2/5/2017. (Contact: Kirsten Pfeiffer)

[10] John Ferguson, HRB - Clinical Research Facility, Galway. *Estimating Average Attributable Fractions*, 4/5/2017. (Contact: John Hinde)

[11] Davide Barilari, Université Paris Diderot. *From thermodynamics to image reconstruction: an invitation to sub-Riemannian geometry*, 11/5/2017. (Contact: Giuseppe Zurlo)

[12] Piotr Gawron, Polish Academy of Sciences. *Quantum hidden Markov models based on transition operation matrices*, 18/02/2017. (Contact: Michael Mc Gettrick)

[13] Cora Stack, Institute of Technology, Tallaght. *Eggert's conjecture and a structure theorem*, 25/5/2017. (Contact: Götz Pfeiffer)

[14] Nesibe Manav, Gazi University, Turkey. *An Introduction to Approximation Theory*, 10/8/2017. (Contact: Ray Ryan)

[15] Vedran Dunjko, Max Planck Institute, Germany. *Machine learning and Quantum Information Processing: more than the sum of parts*, 14/9/2017. (Contact: Michael Mc Gettrick)

[16] José M. Gutiérrez, Universidad de la Rioja, Spain. *Newton's method: from Kantorovich theory to dynamical systems*, 28/9/2017. (Contact: Graham Ellis)

[17] Rafael Moral, University of São Paulo, Brazil. *Mixed and Marginal Models for Analysing Light Interception Data*, 5/10/2017. (Contact: John Hinde)

[18] Kelly Cline, Carroll College, Helena, Montana. *Teaching Undergraduate Mathematics with Clickers and Classroom Voting*, 12/10/2017. (Contact: Kevin Jennings)

[19] Colm Mulcahy, Spelman College, Atlanta, Georgia. *Pioneering Women in Irish Maths*, 13/10/2017. (Contact: Rachel Quinlan)

[20] Andrew Fowler, University of Limerick / Oxford University. *Liesegang rings*, 26/10/2017. (Contact: Michael Tuite)

[21] K.R. Rajagopal, Texas A&M University. *The mechanics and mathematics of bodies described by implicit constitutive equations: Specific Applications*, 27/10/2017. (Contact: Michel Destrade)

[22] Louis Theran, University of St. Andrews. *Unlabelled rigidity problems*, 9/11/2017. (Contact: James Cruickshank)

[23] Aisling Connolly, École normale supérieure, Paris. *Surpassing the 'All or Nothing' Paradigm in Cryptography*, 23/11/2017. (Contact: Kevin Jennings)

[24] Pooya Farshim, École normale supérieure, Paris. *Crypto for Strength*, 24/11/2017. (Contact: Kevin Jennings)

[25] Krzysztof Leśniak, Nicolaus Copernicus University, Toruń, Poland. *Non-hyperbolic iterated function systems*, 6/12/2017. (Contact: Nina Snigireva)

[26] Natasha Dobrinen, University of Denver. *Big Ramsey degrees for the universal, homogeneous triangle-free graph*, 7/12/2017. (Contact: Aisling McCluskey)

[27] Jim Cruickshank, National University of Ireland Galway. *Sparse topological graphs*, 14/12/2017. (Contact: Michael Mc Gettrick)

[28] Cliff Gilmore, University of Helsinki. *Minimal growth of frequently hypercyclic harmonic functions*, 19/12/2017. (Contact: Ray Ryan)

Postgraduate Modelling and Applied Mathematics Research Group Talks Seminars

[1] 13/01/17 Qays Shakir: *Continuous Rigidity and Infinitesimal Rigidity; When They Agree?*
Arkady Zgonnikov: *Intermittent motor control: The case for intrinsically stochastic control activation*

[2] 20/01/17 Arkady Zgonnikov: *Modeling noise-driven control activation in intermittent balance control*
Vinh Mai: *Enzymatic degradation of Hyaluronic acid*

[3] 27/01/17 Roberto Galizia: *Convex optimization: an introduction*
Hannah Conroy Broderick: *Modelling Electroelastic Materials*

[4] 10/02/17 Michael Welby: *Genus Two n-point Functions for VOAs I*
Daher Al-Baydli: *Computations Induced homology and cohomology homomorphism*

[5] 03/02/17 Cian O'Brien: *An Introduction to Alternating Sign Matrices*

[6] 17/02/17 Richard Burke: *3d flocking*
Faiza Alssaedi: *Maximum Principles in Differential Equations*

[7] 24/02/17 Paul Greaney: *Membranes and Thinning*
Eoghan Staunton: *Error Distributions in the Square Root Map with Additive Noise*

[8] 03/03/17 Ha Van Hieu: *The Distribution of rank of Completions of Entry Pattern Matrices*
Robert Mangan: *Wrinkles in the opening angle method*

[9] 10/03/17 Hannah Conroy Broderick: *Equibiaxial Deformations in Dielectric Elastomers*

[10] 24/03/17 Qays Shakir: *Degrees of Freedom in Rigidity Theory*
Roberto Galizia- *LQR control of complex networks*

[11] 31/03/17 Michael Welby: *Genus Two n-point Functions for VOAs II*
Cian O'Brien- *Alternating Signed Bipartite Graphs*

[12] 07/04/17 Richard Burke: *Conference Preparation Talk*

[13] 29/09/17 Eoghan Staunton: *Noise, Deviation Distributions and Multistability in the Square Root Map*
Roberto Galizia- *Dynamics of multistable networks*

[14] 06/10/17 Robert Mangan: *Wrinkles and Creases in Bending and Unbending of a Cylindrical Sector*
Paul Greaney: *A Stretch-Gradient Model for Membrane Thickness Variations*

[15] 13/10/17 Christine Marshall: *Targeting influential nodes for recovery in bootstrap percolation on hyperbolic networks*
Hannah Conroy-Broderick: *Instabilities in Dielectric Elastomers*

[16] 20/10/17 Cian O'Brien: *Alternating Sign Matrices and Their Corresponding Bipartite Graphs*
Qays Shakir: *Self-Stress in Rigidity Theory*

[17] 27/10/17 Róisín Hill: *Discontinuous Galerkin Methods and FEniCS*
Michael Welby: *Genus Two Zhu Theory for Fermionic VOSAs I*

[18] 03/11/17 Aoife Hill: *Biodegradable Polymers: An Introduction*
Hieu Ha Van: *Counting the number of entry pattern matrices*

[19] 10/11/17 Faiza Alssaedi: *Parameter robust methods for second-order complex-valued reaction-diffusion equations*
Daher Al Baydli: *Naturality and Bockstein homomorphism*

[20] 17/11/17 Eoghan Staunton: *Steady-State Deviation Distributions in the Square Root Map*
Vinh Mai: *A scheme for Hyaluronan catabolism*

[21] 24/11/17 Nadim Atiya (Ulster University): *Dynamics of Decision Confidence and Change-of-Mind in a Distributed Neural Circuit Model*