School of Mathematics, Statistics and Applied Mathematics Research Day
5th May 2011

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1 Introduction

Welcome to the annual Research Day of the School of Mathematics, Statistics and Applied Mathematics. Research in the School covers a broad range of areas in pure and applied mathematics, statistics, biostatistics and bioinformatics. There are close to 30 PhD students in the School, spread across all these areas. Among the funded research activities in the School are the De Brún Centre for Computational Algebra and the Galway wing of the BIO-SI centre for bioinformatics and biostatistics, both supported by SFI under the Mathematics Initiative. The latter is a collaboration with the School of Mathematics and Statistics in the University of Limerick. There are several other collaborative activities with UL in mathematical modelling and in statistics. Currently, members of the School are engaged in the formation of a new interdisciplinary research activity focussing on the mathematical modelling and analysis of complexity.

The De Brún Centre has, once again, had a busy and productive year, with well attended international workshops featuring courses by world experts. The annual Groups in Galway conference, now in its 33rd year, continues to attract leading researchers and has established Galway as an acknowledged centre of excellence in algebra.

Forthcoming activities in statistics, biostatistics and bioinformatics include CASI 2011, the 31st Conference on Applied Statistics in Ireland, to be held in NUI Galway, and the 2nd International BIO-SO Workshop on Statistical Modelling.

The work of the School continues to attract funding in a difficult environment. A Marie Curie Fellowship has been awarded to a foreign researcher who intends to work with Professor Graham Ellis. In the latest round of IRCSET PhD fellowships, three awards have been made to the School, putting it in first place among all the schools of mathematical science in the country.

The School continues to develop its research activities into new areas, including computational algebra, geometry and topology, group theory and design theory, numerical analysis, quantum computing and computer algebra, biostatistics and bioinformatics, mathematical physics, mathematical modelling and biomechanics. The lectures given today give a sample of some of this and the poster session showcases some of the work being done by our research students.

Ray Ryan
Head of School

2 Presentations

Epitope discovery with probabilistic models

Cathal Seoighe
School of Mathematics, Statistics and Applied Mathematics

I will provide an overview of research projects underway in my group, followed by a more detailed presentation of research involving the inference of immune epitopes from evolutionary models of DNA sequences. The human adaptive immune system consists of a cellular component, involving cells that kill infected or defective cells and a humoral component, consisting of antibodies that target circulating pathogenic agents (e.g. viruses or bacteria). The identification of non-self proteins within cells or in circulation involves the binding of immune proteins to specific parts of the pathogen proteins, called epitopes. In the case of the cellular immune response these epitopes are short linear stretches of about 9-12 amino acids. Antibodies, by contrast, usually bind to epitopes on the surface of the folded protein, which are not linear at the sequence level. Pathogens can evade host immune responses by mutating the sequence of epitopes, constrained by the need to preserve protein function. In response the host adaptive immune response can mount fresh responses against the changed epitope or alternative sites. This sets up a host-pathogen arms race that results in characteristic patterns of sequence evolution within and around immune epitopes. Our research in this area involves the use of evolutionary models, specifically phylogenetic models of codon sequence evolution and phylogenetic hidden Markov models to predict immune epitopes, given DNA sequences from viruses isolated from multiple individuals and information about the immune genotype or neutralization efficiency of the infected individuals.

From Linked Data to Networked Knowledge - The Digital Enterprise Research Institute

Stefan Decker
DERI, NUI Galway

Acoustics of soft solids

Michel Destrade
School of Mathematics, Statistics and Applied Mathematics

Rubbers and biological soft tissues undergo large isochoric motions in service, and can thus be modelled as nonlinear, incompressible elastic solids. It is easy to enforce incompressibility in the finite (exact) theory of nonlinear elasticity, but not so simple in the weakly nonlinear formulation, where the stress is expanded in successive powers of the strain. In linear and second-order elasticity, incompressibility means that Poissons ratio is 1/2. Here we show how third- and fourth-order elastic constants behave in the incompressible limit. For applications, we turn to the propagation of elastic waves in soft incompressible solids, a topic of crucial importance in medical imaging (joint work with Ray Ogden, University of Aberdeen).

Algebraic, geometric and combinatorial rigidity for mapping class groups

Javier Aramayona
School of Mathematics, Statistics and Applied Mathematics

We will give an overview of recent progress on a number of rigidity problems about mapping class groups and related objects.

Impact and Friction Problems in Engineering

Joanna Mason
School of Mathematics, Statistics and Applied Mathematics

Nonsmooth systems can exhibit extraordinarily complicated and chaotic dynamics, which are often manifested as undesirable behaviour, such as noise, vibration, and wear. In this talk an overview of techniques used to gain an understanding of the rich dynamics found in a model of gear rattle will be presented. The challenges faced in applying similar techniques to three other real engineering problems with nonsmoothness - magnetic bearings, the great bell of Cologne Cathedral, and cam-follower devices - will also be discussed.

Quantum Random Walks

Michael McGettrick
School of Mathematics, Statistics and Applied Mathematics

I will present ongoing work in Quantum Computing (also known as Quantum Information). This is an interdisciplinary research area involving Physics, Mathematics and

Computer Science (not necessarily in that order!) In particular I will talk about results pertaining to (a) memory effects in Quantum Random Walks, (b) simulating a 2-dimensional walk with an alternating 1-dimensional walk, and (c) concepts of fairness in lazy Quantum Random Walks.

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3 Poster Session

Probing the Epigenomics of Inflammation-Associated Carcinogenesis in the Gastrointestinal Tract

Alan Barnicle,
Supervisors: Cathal Seoighe, Aaron Golden, Laurence Egan

Chronic inflammation of any gastrointestinal organ increases the risk of the development of carcinoma in the affected organ. Little is known about how chronic inflammation induces the neoplastic transformation of intestinal epithelial cells. Previous work in Prof. Egans lab has revealed that the DNA methyltransferase 1 DNMT1 is overexpressed in inflammatory bowel disease (IBD)-associated colon cancers, and in cell lines his group have shown that inflammation-induced DNMT1 overexpression is associated with CpG methylation, gene silencing and enhanced tumorigenesis. Together with the Egan group we are interested in determining if inflammation-induced DNA methylation and the downstream consequence of tumour-suppressor gene silencing is an important pathogenic mechanism in inflammation-associated colon carcinogenesis. We want to assess how the epigenetics of long term IBD contributes towards neoplasia, and in particular the role methylation plays in the silencing of key tumour-suppressor genes in the pre-neoplastic colon. In addition to the discovery of biological insights of disease pathogenesis, this project offers the possibility of novel DNA methylation-based biomarker discovery. The planned work involves using a combination of ChIP-based and high throughput epigenomic technologies to assess differential and absolute CpG DNA methylation in pre-neoplastic colon biopsies of IBD patients attending Galway University Hospital. A large number of samples have already been obtained from carefully phenotyped IBD patients and well-matched controls. Additional samples from this project are now being obtained in Galway and from Prof. Egans collaborators at University Hospital Galway, and processed at the Translational Research Facility. Laser capture micro-dissection will be utilized to separate epithelial from lamina propria DNA in some studies. A period of time will be spent at the Centre for Epigenomics, Albert Einstein College of Medicine, NY implementing HELP-based methylation assays and gaining valuable insights into integrative epigenomics techniques, in collaboration with our colleague

Prof. John M. Greally, the Centre Director. Using this approach, we propose to synthesize this genomic and epigenomic information into an integrative model for methylation induced IBD-associated neoplasia. This work would provide an important contribution to the understanding of inflammation-associated carcinogenesis, and provide potentially valuable biomarkers for the diagnosis of this condition.

Modelling the "Edge Snapping" evolution of an asymmetric network of oscillators and investigating the emergent graph's topology

Richard Burke
Supervisor: Dr. Petri Piiroinen

We aim to build robust mathematical models of asymmetric dynamical networks of both integrators and oscillators. We are drawing heavily on a technique called "Edge Snapping" to create networks that evolve to a static steady state. We hope to analyse the emergent topologies via different graph theory metrics, to understand the influence of key parameters and initial conditions on the evolutions and finally, we want to undertake a rigorous investigation of the stability of the dynamical systems.

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A Mathematical Model of CENP-A Incorporation in Human Centromeres

Kevin Doherty
Supervisors: Dr. Martin Meere, Dr. Petri Piiroinen

DNA is found in cells wrapped around nucleosomes comprised of eight histones, which is further packaged in a number of steps to form chromosomes. A region of the chromosome called the centromere is needed for kinetochore formation and subsequent spindle microtubule attachment, thereby allowing two copies of the DNA to be faithfully seperated into two daughter cells during mitosis. A large network of proteins are involved in different stages of this complex process. In order to understand this routine we start by concerning ourselves with the incorporation of a histone H3 variant named Centromere Protein A (CENP-A) into the centromeric nucleosomes. This protein has been shown to be required for kinetochore formation and accurate chromosome segregation [1]. We developed a mathematical model of CENP-A incorporation and maintenance based on existing knowledge of the proteins and mechanisms involved, which we analysed using a dynamical systems approach.

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Title

Cara, Dooley, John, Hinde

Often in Survival Analysis, an event can occur which prevents the event of interest occurring, for example, we may be interested in death caused by cardiac issues but the patient may die from other causes meaning that the event of interest is never seen. This often means the data for the patient who had the died from other causes is treated as censored but as these events are rarely independent this introduces bias in to the analysis. The two (or more) events can be treated as *competing risks*. By incorporating the competing risks into the analysis, the bias can be removed. The ideas are illustrated with an example where patients have received heart transplants and following this die from rejection of the transplanted organ or die from other causes.

[1] Hein Putter, Marta Fiocco, and Ronald B. Geskus (2007) Tutorial in Biostatistics: Competing Risks and Multi-State Models. Statistics in Medicine, 26, 2389-2340.

[2] Liesbeth C. de Wreede, Marta Fiocco, Hein Putter (2011). mstate: An R Package for the Analysis of Competing Risks and Multi-State Models.

Journal of Statistical Software, 38(7), 1-30. URL http://www.jstatsoft.org/v38/i07/.

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DNA Methylation Patterns in Ulcerative Colitis

Paul Geeleher
Supervisors: Aaron Golden, Cathal Seoighe

DNA Methlylation is a modification of DNA, which in adult somatic tissues typically involves the addition of a methly group to the number 5 position of the cytosine pyrimidine ring, this generally occurs in the context of a CpG site and has the effect of reducing gene expression. DNA methylation patters vary between different tissue types and have a substantial role to play in the phenotypic diversity observed among cell types; methylation patterns have also been shown to be altered in many cancer types[1]. In this preliminary study, using a small number of Agilent Human CpG Island microarrays, we assay the DNA methylation patterns of individuals suffering from uclerative colitis, a disease of which long standing sufferers have been shown to be at increased risk of colon cancer[2].

[1] Rudolf Jaenisch and Adrian Bird. Epigenetic regulation of gene expression: how the genome integrates intrinsic and environmental signals. Nat Genet, 33 Suppl:245254, Mar 2003.

[2] J. A. Eaden, K. R. Abrams, and J. F. Mayberry. The risk of colorectal cancer in ulcerative colitis: a meta-analysis. Gut, 48(4):526535, Apr 2001.

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Higher Genus Aspects of Vertex Operator Algebras

Thomas Gilroy
Supervisor: Dr. Michael Tuite

This year I have been developing my understanding of Vertex Operator Algebras and their genus 1 correlation functions, and recently my understanding of Riemann surfaces with the intention being to study correlation functions, their convergence, automorphic properties and recursion at genus 2 and higher. The approach to studying correlation functions at genus 2 and higher is to build genus 2 correlation functions from genus 1 functions and sewing procedures on tori.

[1] Victor G. Kac, *Vertex Algebras for Beginners*, 2nd Ed., University Lecture Series 10, AMS (1998)

[2] Geoffrey Mason and Michael P.Tuite, *vertex Operators and Modular Forms*, "A Window Into Zeta and Modular Physics", MSRI Pulications 57 (2010)

[3] H.M. Farkas and I. Kra, *Riemann Surfaces*, Springer-Verlag (New York, 1980).

Supported by IRCSET

Vertex Operator Algebra

Dinh Van Hoang
Supervisor: Michael P. Tuite

Let V be a Vertex Operator Algebra of strong CFT-type. We define the Casimir vector and correlation functions in the case V_2, V_3. By expanding the correlation function in various domains we get trace formulas and we also examine the simplicity of the algebras V_2, V_3.

[1] Mason, Geoffrey and Tuite,Michael *Vertex Operators and Modular Forms*, "A Window Into Zeta and Modular Physics", MSRI Publications Volume 57 (2010).

[2] Tuite, Michael, The Virasoro Algebra and Some Exceptional Lie and Finite Groups. SIGMA **3** 2007

[3] Li, H., Invariant Symmetric Bilinear Forms on Vertex Operator Algenras. Journal of Pure and Applied Algebra **96** 1994.

Supported by Science Foundation of Ireland

Stability of $(1,n)$-Orbits within a Discontinuity-geometry Framework

Neil Humphries
Supervisor: Petri Piiroinen

Discontinuity Geometry is a geometric framework for the analysis and representation of periodically-forced impact oscillators that represents the dynamics of the system by a 2-manifold - the Discontinuity Surface V_c - embedded in a 3-dimentional representation space [1]. Although a geometric method within this framework for determining the existence of $(1,n)$-orbits (and also whether there will be a saddle-node manifested in the neighbourhood of a grazing bifurcation) was previously reported [2], this method did not address the issue of the stability of orbits. In this poster we describe a method for assessing the stability of a $(1,n)$-orbit in terms of the components of the normal vector to V_c and its time derivative, both evaluated at the point of impact of the orbit.

[1] Chillingworth D.R.G., Discontinuity geometry for an impact oscillator, *Dynamical Systems*, pp 389-420, **4**, 2002.

[2] Humphries N., Piiroinen P.T., A discontinuity geometry view of the relationship between saddle-node and grazing bifurcations, Accepted for publication by *Physica D*.

Supported by I.R.C.S.E.T.

Virasoro Correlation Functions for Vertex Operator Algebras

Donny Hurley
Supervisor: Dr Michael Tuite

We are interested in n-point Correlation functions for these types of Vertex Operator Algebras on Riemann surfaces of genus zero and one. These functions are not manifestly symmetric, however, it can be shown that they are symmetric for $z_1,\ldots,z_n$ and described using graphical representations with weights attached to the edges in the graph.

For a function over a sphere (genus zero), the n-point function can be defined as an inner product $\langle \mathbf{1}, Y(\omega,z_1)\ldots Y(\omega,z_n)\mathbf{1}\rangle$, a rational function in $z_1,\ldots,z_n$. Using a recursive reduction formula the n-point function can be expressed as a sum of all oriented graphs with n vertices and each vertex has exactly 2 edges. It is also possible to describe the n-point function using a β extension of the permanent.

For a function over a torus (genus one), the n-point function $G_n(z_1,\ldots,z_n)$ can be calculated using Zhu's Reduction Formula. In this case there are terms involving the Eisenstein series E_2, modular functions $P_2(z_i-z_j)$ and q-derivative terms. Again we will express this as the sum of all oriented graphs with n vertices where each vertex has 0, 1 or 2 edges and appropriate weights are chosen.

Finally, using the n-point function over a torus we can solve a particular degeneration limit at genus 2.

On estimating mean survival life time with right censored data

Alberto Alvarez-Iglesias
Supervisors: John Newell and John Hinde

Different methods have been proposed in the literature for estimating the mean survival time. In the presence of censoring, the sample mean fails to give good estimates of the population mean. The reason is that censored observations are incomplete and any given estimate of this measure have to take into account this incomplete information. It seems, however, that existing methods are not able to deal with situations in which the right tail of the underlying distribution is unknown due to the fact that some of the patients are still alive at the end of the study. In this work, estimates of the mean survival time are calculated using a combination of existing methods and extreme value theory.

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Supported by IRCSET

Quantifying the Impact of PRPF8 Mutations on Splicing

Paul K. Korir
Supervisor: Prof. Cathal Seoighe

Retinitis pigmentosa (RP) is the name given to a group of genetically inheritable diseases that are characterised by gradual impairment of vision eventually leading to incurable blindness. Individuals with the disease typically experience poor darkness adaptation (*nyctalopia*) followed by gradual reduction in peripheral vision (tunnel vision) and, by about age 60, permanent loss of vision. Several mutations have been associated with the disease some of which occur in components of the splicing machinery. Among these, non-synonymous mutations in the pre-mRNA processing factor 8 (*PRPF8* also referred to as *PRP8*) are classified as part of autosomal dominant RP (ARDP). PRPF8 is a component of the major spliceosome and has been demonstrated to play an important role in splicing [2, 3]. We undertake a study of four individuals with PRPF8 mutations and sibling controls to quantify the effect of splicing on mature transcripts sequenced using RNA-seq and assayed with exon arrays.

References

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Linear and Affine Spaces of Matrices with Special Properties

James McTigue
Supervisor: Rachel Quinlan

The rank of a matrix is a concept of fundamental importance in linear algebra, and in any mathematical area where one has occasion to consider linear functions, or matrix encoding of data.

Despite the generally haphazard behaviour of rank with respect to matrix addition in the space $M_{m\times n}(\mathbb{F})$ ($m \times n$ matrices with entries in a field $\mathbb{F}$), one can inquire into the existence of $\mathbb{F}$-subspaces of $M_{m\times n}(\mathbb{F})$ in which rank does behave in a controlled manner. This may mean that within the subspace all non-zero elements have the same rank, or that the non-zero ranks occurring in the subspace have a particular upper or lower bound. Investigations of such properties can involve:

[1] Construction of large subspaces having the property - such objects are elusive and cannot normally be found by inspection;

[2] Determination of (bounds on) the maximum possible dimension of a subspace having the property;

[3] Construction and classification of those subspaces in which this maximum is attained.

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Problems with Reversed Items in Multidimensional Variables

Nur Fatihah, Mat Yusoff, John, Hinde

This study relates to an investigation of differential response to reversed items in multidimensional instruments in the "Big Five" personality trait scales. Data was collected at the University Malaysia Sarawak, Malaysia, where 899 students from the second year and above were randomly selected as respondents. A questionnaire was administered that included aspects of personality, academic achievement and background. Dealing with real social science or psychometric data requires care with issues of the reliability of the measurements. Here, Principal Component Analysis (PCA) was conducted to detect structure in the relationships between variables, items and individuals using biplots to display the data. We expected that all the statements which measure the same dimension would project in the same direction in the biplot, once the score of negative statements was reversed to agree with positive statements. While this expectation was almost true for the variables with no negative statements, for the variables with positive and negative statements, the biplot showed contradictory patterns. These findings provide an insight into the existence of an inconsistency of responses, which leads to reliability and validity issues. In order to study this problem, further analysis was performed in various groups according to gender, faculties, response and so on. Our aim from these analyses was to identify the group of respondents who gave inconsistent responses that caused reliability problems.

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Modelling Glucose Homeostasis in the Body

Liam O'Callaghan, Petri Piiroinen

In humans, glucose is of great importance to the proper functioning of the body. Glucose is a simple sugar and is the preeminent substance produced from carbohydrate digestion. It is heavily involved in the supply of cellular energy which is used for growth and division. Accordingly, the regulation of blood glucose concentration, or *glycemic regulation*, is important.

In particular, the interaction between glucose and the hormone *insulin* is the focus of the work presented here. Insulin is a *peptide hormone* produced in the β*-cells* of the pancreas. Its primary function is to serve to reduce blood glucose concentration. The relationship between the two is that they share *negative feedback*. It is the nature of this negative feedback system which is investigated for the purpose of modelling.

[1] R.N. Bergman, Y.Z Ider, C.R. Bowden, and C. Cobelli. Quantative estimation of insulin sensitivity. *American Journal of Physiology - Gastrointestinal and Liver Physiology*, 236 (6):667, 1979.

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Supported by Science Foundation Ireland

Title

Padraig Ó Catháin
Supervisor: Dane Flannery

A *Hadamard matrix* of order $4n$ is a matrix with entries in $\{\pm 1\}$ which satisfies $HH^\top = 4nI_{4n}$. A Hadamard matrix of order $4n$ determines both a 2-$(4n-1, 2n-1, n-1)$ design and a 3-$(4n, 2n, n-1)$, called Hadamard 2- and 3-designs respectively. An old paper of Ito considers actions of non-affine doubly transitive groups on Hadamard 3-designs, and concludes that such a group must be $PSL_2(q)$, M_{12} or $Sp_6(2)$. By consideration of the Hadamard 2-designs, we have shown that each group has a doubly transitive action on a unique equivalence class of Hadamard matrices.

We say that $D \subseteq G$ is a *difference set* of G if every non-identity element of G has a fixed number, λ, of distinct representations $d_i d_j^{-1}$ where $d_i, d_j \in D$. A difference set corresponds naturally to a regular subgroup of the automorphism group of a 2-design. We say that D is a *Hadamard difference set* if $|G| = 4n-1$, $|D| = 2n-1$ and $\lambda = n-1$. A difference set is *skew* if $G = \{1_G\} \cup D \cup D^{(-1)}$, where $D^{(-1)} = \left\{d^{-1} \mid d \in D\right\}$. A skew difference set is necessarily Hadamard. Classical examples are given by the Paley difference sets, and for many years it was conjectured that there are no others. Other examples have been found in groups of order q^3 over the past 5 years or so. We describe a new family of skew-Hadamard difference sets. This provides new examples at infinitely many new orders.

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Abelian normal subgroups of nilpotent linear groups

Tobias Rossmann
Supervisors: Dane Flannery, Alla Detinko

We investigate the structure of finitely generated nilpotent linear groups that admit homogeneous maximal abelian normal subgroups. We obtain a classification result in terms of the abstract extension structure of such a group and certain field-theoretic objects.

This work is supported by the Research Frontiers Programme of Science Foundation Ireland, grant 08/RFP/MTH1331.

Numerical Solution of a Model for Glucose and Insulin Levels in Critically Ill Patients

Anh Thai Nhan
Supervisor: Niall Madden

We investigate the numerical solution of a recently developed mathematical model of glucose and insulin levels in critically ill patients. In particular, our main aim is to select numerical solution techniques that allow the model to be incorporated into a Dynamic Bayesian Network. The classical numerical methods seem too expensive in terms of computational cost for this problem. To overcome this, we present an adaptive nonuniform time-stepping technique that can be combined with the explicit Euler method. We briefly describe some analysis that motivates the method, and present the results of numerical experiments that demonstrate its efficiency.

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[3] L. O'Callaghan, *Models of Glycemic Regulation*, M.Sc. thesis (in preparation; supervisor: P.T. Piiroinen), School of Mathematics, Statistics and Applied Mathematics, NUI Galway, 2011.

Supported by the Science Foundation Ireland under Grant No. 08/RFP/CMS1254.

Mathematical Modelling of Drug Delivery

Tuoi VO Thi Ngoc
Supervisor: Martin Meere

The growth of hydrogel technologies has advanced numerous biomedical applications including controlled drug delivery. Hydrogel-based systems have been used to control release rate of several growth factors through affinity binding; such as heparin-binding growth factors release from fibrin hydrogel. A mathematical model for the controlled release of heparin-binding growth factors from heparin-based delivery system is described. In addition, a reduced system has been developed to model the evolution of free drug, bound drug and binding sites in a biological tissue. Some solutions are presented and parameter regimes for optimal release behaviour are identified.

[1] modelling

[2] controlled release

[3] diffusion

Supported by the Mathematics Applications Consortium for Science and Industry (MACSI) and Science Foundation Ireland (SFI)(06/MI/005)

Bioassay model with natural mortality and random effect in the dose levels

Mariana R. Urbano
Supervisors: John Hinde and Clarice G.B. Demtrio

In fitting dose-response models to entomological data it is often necessary to take account of natural mortality and/or overdispersion. The standard approach to handle natural mortality is to use Abbott's formula (Abbott, 1925), which allows for a constant underlying mortality rate. Standard overdispersion models include beta-binomial models, logistic-normal, and discrete mixtures. We extended the standard model (Morgan, 1992), and included a random effect in the dose levels. We consider the application of this model to data from an experiment on the use of a virus (*PhopGV*) for the biological control of worm larvae (*Phthorimaea operculella*) in potatoes, and implemented this procedure in software R. Using the model with random effects in the doses, we obtained a better fit than that provided by the standard model.

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R (2011) Development Core Team, R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria, ISBN: 3-900051-07-0. URL `http://www.R-project.org`.

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Using Node resampling in Classification and Regression Trees as an alternative to Random Forest approaches

Deirdre Wall
Supervisors: Alberto Alvarez, John Hinde, John Newell

CART (Classification and Regression Trees) construct models which are obtained by recursively partitioning the data and fitting a simple prediction model to each partition [1]. Classification Trees are designed for response variables that take a finite number of unordered values, with prediction error measured in terms of misclassification costs. Regression trees involve response variables that take continuous or ordered discrete values, with prediction error typically measured by the square difference between the observed and predicted values.

Random Forests, an extension to CART, are an ensemble method involving resampling of the data [2]. In addition to constructing each tree using a different bootstrap sample of the data, random forests change the way the tree is constructed. Instead of using the best split from all the variables, each node is split using the best split from a small subset of variables randomly chosen at that node. The advantage in Random Forests is a reduction in prediction error however no information relating to the underlying structure in the covariate space is available.

In this poster we will investigate the performance of resampling data at the node level as an alternative approach to Random Forests. Node resampling results in a single tree, thereby retaining structure, while retaining the robustness of Random Forests.

A practical example involving marine science data will be given in order compare the performance of the node resampling and forest approaches.

[1] Wei-Yin Loh: Classification and Regression Trees

[2] Breiman, L.: Random Forests, (2001)

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4 Abstracts of Recent PhD Theses

On the quiver presentation of the descent algebra of type A or B

Bishop, Marcus
Supervisor: Dr. G. Pfeiffer

The descent algebra of a finite Coxeter group is an algebraic structure, encoding many of the group's combinatorial and geometric properties. This thesis introduces a new combinatorial language that facilitates the description and investigation of the import examples of descent algebras associated to the symmetric groups.

[1] L. Solomon, A Mackey formula in the group ring of a Coxeter group. *J. Algebra* **41** (1976), 255–268.

[2] G. Pfeiffer, A quiver presentation of Solomon's descent algebra. *Adv. Math.* **220** (2009) 1428–1465.

The Semi-Inverse Method in solid mechanics:theoretical underpinnings and novel applications.

De Pascalis, Riccardo
Supervisors: Profs G. Saccomandi and M. Destrade

Recently, the biomechanics of soft tissues has become an important topic of research in several engineering, biomedical and mathematical fields. Soft tissues are biological materials that can undergo important deformations (both within physiological and pathological fields) and they clearly display a nonlinear mechanical behaviour. In this case the analysis of the deformations by computational methods (e.g. finite elements) can be complex. The geometrical nonlinearity of the model under investigation makes it very difficult to grasp the true physics of the problem and often the intuition of the engineer can do very little if it is not guided by careful and exact mathematical analysis. To this end the possibility of obtaining easy exact solutions for the field equations is an important and privileged tool, helping us to gain a better understanding of several biomechanics phenomena.The semi-inverse method is one of few known methods available to obtain exact solutions in the mathematical theory of Continuum Mechanics. The semi-inverse method has been used in a systematic way during the whole history of Continuum Mechanics, but unfortunately this use has always

happened essentially in a heuristic way, completely disconnected from a general method.Essentially, the purpose of the semi-inverse method consists in formulating a priori a special ansatz for the unknown fields in a certain theory and in reducing the general balance equations to a simplified subset of equations (for example passing from a system of partial differential equations to an ordinary differential system).This Thesis was developed in six chapters to study several points of view of this method and other connected methodologies. The first chapters are essentially introductory while the others collect the results of research obtained during the length of the PhD [1,2,3].

[1] De Pascalis, R., Destrade, M., Saccomandi, G., The stress field in a pulled cork and some subtle points in the semi-inverse method of nonlinear elasticity, Proceedings of The Royal Society of London. Series A. Mathematical, Physical and Engineering Sciences, 463: 29452959 (2007).

[2] De Pascalis, R., Rajagopal, K. R., Saccomandi, G., Remarks on the use and misuse of the semi-inverse method in the nonlinear theory of elasticity, Quarterly Journal of Mechanics and Applied Mathematics, 62: 451464 (2009).

[3] De Pascalis, R., Destrade, M., Goriely, A., Nonlinear correction to the Euler buckling formula for compressed cylinders with guided-guided end conditions, Journal of Elasticity, 102: 191–200 (2011).

Virasoro Correlation Functions for Vertex Operator Algebras

Hurley, Donny
Supervisor: Dr. Michael Tuite

This thesis considers Virasoro correlation functions in the theory of Vertex Operator Algebras on Riemann surfaces of genus zero and one, and considers the degeneration limit to one torus of a general genus two partition function. Virasoro correlation functions on Riemann surfaces of genus zero and one are necessarily symmetric but the Zhu reduction formula does not present them in a manifestly symmetric way. We show that these correlation functions can be expressed as the symmetric sum of weights of particular graphs at each genus. Furthermore, we can express the correlation functions at genus zero and one in terms of derangements and permutations respectively. We discuss modular forms and elliptic functions, which naturally arise at genus one, including a general formula for the modular derivative of Eisenstein series and a particular non-linear differential equation obeyed by Weierstrass functions. We also consider the 1-point function for a Virasoro descendent of the vacuum on a genus one Riemann surface. Using this result we solve the problem of the degeneration limit for the partition function of a general Vertex Operator Algebra on a genus two Riemann surface formed by sewing two tori in the limit where one of the tori pinches down to a Riemann sphere.

Moduli Spaces of Planar Realizations of Weighted Graphs

McLaughlin, Jonathan
Supervisor: Dr. James Cruickshank

In this thesis known results regarding the realizability of a weighted graph (G,l) and the connectedness of the associated moduli space $M(G,l)$ are extended from the case where G is a cycle to the case where G is a two-terminal series-parallel graph. The moduli spaces of the weighted graphs (K^4,k) and $(K_{3,3},l)$ are analyzed and realizability and connectedness results are given. A brief introduction to the analysis of the smooth structure of the moduli space of weighted two-terminal series-parallel graph concludes the thesis.

[1] *Series Parallel Linkages.* James Cruickshank, Jonathan McLaughlin. Publicacions Matemàtiques. In press.

Computing the Table of Marks of a Finite Group

Naughton, Liam
Supervisor: Dr. G. Pfeiffer

The table of marks of a finite group is a compact description of its subgroup lattice by a square matrix of numbers. This thesis introduces a new method for the computation of the table of marks of a finite group from that of a normal subgroup of prime index.

[1] W. Burnside, *Theory of groups of finite order*. Dover Publications Inc., New York, 1955, 2nd ed.

[2] G. Pfeiffer, The subgroups of M_{24}, or how to compute the table of marks of a finite group. *Experiment. Math.*, **6** (1997), 247–270.

Features and purposes of mathematical proofs in the view of novice students: observations from proof validation and evaluation performances

Pfeiffer, Kirsten
Supervisor: Dr. Rachel Quinlan

This thesis describes a comprehensive exploratory study of the approaches taken by novice students to the validation and evaluation of mathematical proofs. A theoretical framework based on sociocultural learning theories was considered suitable as a basis to develop a new terminology and schema for observations and interpretations of proof validations and evaluations. In this theoretical framework learning is seen as accessing and participating in the practice of an expert community. The theoretical considerations of this thesis build on Hemmi's conception of proofs as artifacts in the community of practice. Philosophical theories about the evaluation of artifacts are specialized to the case of mathematical proof. A result of these considerations is a schema that extends Hemmi's model of proofs as artifacts, and provides both a theoretical basis and an analytic tool for consideration of the practice of proof evaluation and for interpretation of specific instances of proof evaluation. The study is based on a series of tests and interviews with first year honours mathematics students at the National University of Ireland, Galway. The students were asked to evaluate and criticize numerous proposed (correct and incorrect) proofs of mathematical statements. The participants' written comments and the interview discussions on different and partly incorrect proofs give insights into their criteria for valuing a mathematical proof, their habits when performing proof validations and evaluations and their knowledge about features and purposes of mathematical proofs. This thesis describes the theoretical framework as well as the design, observations and findings of the written and oral exercises. It also includes a discussion about advantages and shortcomings of the schema that has been developed and used for the interpretation of evaluations of mathematical proofs and a discussion about possibilities for further research.

[1] Hemmi, K. (2006). *Approaching Proof in a Community of Mathematical Practice*. Doktoral Thesis. Stockholm University.

[2] Lave, J. and Wenger, E. (1991). *Situated Learning: Legitimate peripheral participation*. Cambridge University Press, Cambridge.

[3] Selden, A. and Selden, J. (2003). *Validations of proofs written as texts: Can undergraduates tell whether an argument proves a theorem?*. *Journal for Research in Mathematics Education*, 34 (1), 4–36.

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5 Research Activity from 1 Jan 2010 to 31 Dec 2010

Permanent and Contract Staff

Aramayona, Javier

Current Research Interests

Publications

Most significant publications

[1] Simplicial embeddings between pants graphs. Geometriae Dedicata, 144 (2010), vol. 1, 115–128.

Research Activities

1 preprint (Homomorphisms between mapping class groups, with J. Souto, 69 pages); 1 paper accepted in Michigan Math. Journal; 1 paper in preparation.
Co-organiser of Groups in Galway 2010; coorganiser of summer programme 'Geometry and dynamics of character varieties' (Singapore, July-August 2011), including one summer school and two conferences, both satellites of the ICM. co-organiser of the the William Rowan Hamilton Geometry and Topology Workshop (Dublin, September 2010); co-organiser of Groups in Galway 2010.
Several research visits/talks, including: Glasgow, Brown (1 week), Michigan (1 week)
Invite for plenary talk at the British Topology meeting 2011 (Edinburgh, September 2011)
4 papers refereed.

Browne, Patrick

My name is Patrick Browne. I am a researcher and contract lecturer at the NUI Galway school of mathematics, statistics and applied mathematics. My primary degree is in mathematical physics and my PhD is in mathematics. My doctoral thesis was concerned with Abelian ideals in the Borel subalgebra of a complex simple Lie algebra (for more information see *http://arxiv.org/abs/math/0210463*).

Current Research Interests

Currently I am working on extending the results from my doctoral thesis to the isotropy representation of a symmetric space. I am also investigating constructions of *Einstein solvmanifolds*. A Riemannian manifold is called a *solvmanifold* if it admits a transitive solvable group of isometries, and *Einstein* if the Ricci tensor is proportional to the metric.

Burns, John

Current Research Interests

My current areas of research are Algebra (Lie algebras, Lie groups, Weyl groups) and Differential Geometry (Homogeneous manifolds, Symmetric spaces and Einstein manifolds). The exponents of a Lie group arise naturally in the study of Casimir invariants and Dynkin indices of Lie algebra representations. Recently (with R. Suter at the ETH in Zurich) we have given a complete solution to a question of D.Panushev on the power sums of these exponents in:// Power Sums of Coxeter Exponents, arXiv:1101.5082v1 // In the area of geometry (together with Dr. Patrick Browne) we have found new examples of homogeneous Einstein manifolds with solvable fundamental group and a paper on thses results is in preparation.

Publications

Most significant publications

[1] Burns, John M.; Clancy, Michael J. Recurrence relations and Dynkin diagrams. Math. Proc. R. Ir. Acad. 110A (2010), no. 1, 1319.

Research Activities

Refereeing: 1 paper, Reviewing: 2 papers, Conferences and workshops: The Irish geometry conference, Groups in Galway, 4th De Brun workshop. Thesis Examination: 1 Ph.d thesis

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Cruickshank, James

Current Research Interests

I have two main interests at the moment.

- Topology: I am interested in the topology of spaces of realisation of elementary geometric objects such as graphs or polyhedra.

- Linear algebra: I am also working on some problems related to linear spaces of nilpotent matrices (not algebras). This is a joint project with Rachel Quinlan and James McTigue.

Publications

Series Parallel Linkages, James Cruickshank and Jonathan McLaughlin, In press, Publicacions Matemàtiques

Research Activities

Research visits:

- Mathematical Sciences Research Institute, Berkeley. February 2010.
- Stockholm University, April 2010.

Conferences: Hewlett Packard Innovations in Education Summit, Palo Alto, CA, February 2010.

Invited talks: Stockholm University, April 2010.

External posts: Licentiate examiner, Stockholm University, April 2010.

Destrade, Michel

Current Research Interests

Stability of soft solids; Acousto-elasticity with application to soft tissues; Mechanical modelling of Human Skin.

Publications

Numbers of publications appearing in calendar year 2010: 9

Four significant publications

[1] M. DESTRADE, J.G. MURPHY, R.W. OGDEN. On deforming a sector of a circular cylindrical tube into an intact tube: Existence, uniqueness, and stability, International Journal of Engineering Science, Special Issue in Honour of K.R. Rajagopal [invited contribution], 48 (2010) 1212-1224.

[2] M. DESTRADE, R.W. OGDEN. On the third- and fourth-order constants of incompressible isotropic elasticity, Journal of the Acoustical Society of America, 128 (2010) 3334-3343.

[3] M. DESTRADE, M.D. GILCHRIST, R.W. OGDEN. Third- and fourth-order elasticity of biological soft tissues, Journal of the Acoustical Society of America, 127 (2010) 2103-2106.

[4] M. DESTRADE, M.D. GILCHRIST, J.A. MOTHERWAY, J.G. MURPHY. Bimodular rubber buckles early in bending, Mechanics of Materials, 42 (2010) 469-476.

Research Activities

Research grants: Marie Curie Intra-European Fellowship (PI), SFI Walton Award for R.W. Ogden (co-I), NUI and Ile-de-France Mobility Grants for A. Ni Annaidh (co-I), 2 Postgraduate IRCSET Fellowships (co-I), NUIG start-up grant, NUIG Millenium Fund for travel; Numbers of graduate students: 3; Journal submissions: 9; Conferences: 4; Visits: 3; Invited talks: 6; Research visits: 3; Papers refereed: 15; Editorships: Quarterly Journal of Mechanics and Applied Mathematics, International Journal of Applied Mechanics, International Journal of Non-Linear Mechanics; Special Issues: International Journal of Engineering Science, IMA Journal of Applied Mathematics; Memberships: Acoustical Society of America, Society for Industrial and Applied Mathematics, International Society for the Interaction of Mechanics and Mathematics; External posts: Adjunct Professor of Mechanical Engineering, University College Dublin; Directeur de Recherche, Institut d'Alembert, CNRS, Paris, France (on leave).

Ellis, Graham

Current Research Interests

My research interests lie in *homotopical algebra*, particularly nonabelian algebra related to low-dimensional integral homotopy types of spaces. Much of my recent research activity has focused on developing practical algorithms for computing algebraic homotopy invariants of spaces. The algorithms are being implemented as part of an officially refereed, and ever growing, *Homological Algebra Package (HAP)* for the computer algebra system GAP. The algorithms were initially aimed at spaces arising theoretically as classifying spaces of algebraic objects such as groups, Lie algebras and crossed modules. Recently my focus has broadened to include spaces mod-

elling real-life data from medical images, bioinformatics and dynamical systems.

Publications

5 publications appeared in 2010

Most significant publications

[1] A colimit of classifying spaces (with R. Mikhailov). Adv. Math. 223 (2010), no. 6, 2097–2113.

[2] The $K(\pi,1)$ conjecture for a class of Artin groups (with E. Sköldberg). Comment. Math. Helv. 85 (2010), no. 2, 409–415.

[3] Homology of some Artin and twisted Artin groups (with M. Clancy). Journal of K-Theory 6 (2010), 171–196.

Research Activities

- I supervised two PhD students and one postdoctoral researcher.
- I was on the editorial boards of three journals: Homology, Homotopy and Applications; Journal of homotopy and related structures; Applicable Algebra in Engineering, Communications and Computing.
- I was an external examiner for a PhD at Grenoble and an internal examiner for two PhDs at Galway.
- I refereed a number of papers.
- I Delivered a course of four lectures on *computational cohomology* at the Summer School on Algorithmic Mathematics, Freie Universität Berlin. .
- I gave a plenary lecture to the Mathematics Algorithms and Proofs conference, Universidad de la Rioja.

Flannery, Dane

Current Research Interests

Computing with matrix groups over infinite fields (joint with Alla Detinko). Our goal is to continue the establishment of a new area of computational group theory: computing with matrix groups over infinite fields. We are developing special techniques for the efficient handling of linear groups over infinite fields by computer, and are using those techniques to answer a number of vital computational questions. Output of the project includes software that enables practical computing in this class of groups.

Algebraic Design Theory. Solution of a wide range of problems whose theme is the application of algebra in design theory. These concern (for example) the automorphism group of a design and its regular subgroups, the composition of smaller designs to make larger designs with useful properties, and the connection between designs with regular group actions and solutions of norm equations.

Publications

Most significant publications

[1] (with Warwick de Launey), *Algebraic Design Theory*, Mathematical Surveys and Monographs, vol. 175, American Mathematical Society, Providence, RI, xii + 310pp.

[2] (with A. LeBel and K. J. Horadam), *Group algebra series and coboundary modules*, Journal of Pure and Applied Algebra, 214, no. 7, 1291-1300.

[3] (with K. J. Horadam), Guest editorial for the special issue on design theory, Cryptography and Communications: Discrete Structures, Boolean Functions and Sequences, 2, no. 2, 127-128.

Research Activities

One Research Frontiers Programme grant (08/RFP/MTH1331), one Mathematics Initiative 2007 grant (07/MI/007; with G. Ellis and G. Pfeiffer), three PhD students (one co-supervised with Alla Detinko), two journal submissions, one co-editorship, co-organization of the Fifth de Brun Workshop, co-organization of the Third Workshop on Cocyclic and Hadamard Matrices and Their Applications, two refereeings, two Mathematical Reviews, one research visit (Queen Mary, University of London).

Golden, Aaron

Research Interests

Computational Biology and Bioinformatics

Hayes, Michael

Hinde, John

Current Research Interests

Statistical modelling, particularly generalized linear models and random effects models; statistical computing and statistical software; likelihood theory and inference; applications of statistics in biological, medical and social sciences.

Publications

Publications appearing in calender year 2010: 3

Most significant recent publications

[1] Aitkin, M.A., Francis, B.F., Hinde, J.P. and Darnell, R (2009) *Statistical Modelling in R*. Oxford University Press, Oxford, 576pp.

[2] Hinde, J.P. (2010) Entries on Logistic and Logistic-normal distribution in *International Encyclopedia of Statistical Science*, Miodrag Lovric (Editor), Springer.

[3] Jansakul, N and Hinde, John P. (2009) Score tests for extra-zero models in zero-inflated negative binomial models. *Communications in Statistics - Simulation and Computation*, **38**, 92-108.

Research Activities

Current research grants:

SFI Research Frontiers Programme - Random Effect Mixture Models for Multicategory Data (Euro 175,324)

SFI Mathematics Initiative - Bio-statistics and Informatics (BIO-SI) with Prof. Mackenzie, University of Limerick (Euro 500,000)

Graduate students: 4; Postdoctoral Researchers: 2.

Journal submissions: 2 accepted, 1 under review

Conferences: Co-organised 1; attended 5.

Visit to ESALQ/USP Piracicaba, Brasil, December

Invited talks:

Teaching Styles Revisited - 30 Years of Modelling — Murray Aitkin 70th Birthday Meeting, RSS, London, February

Random Effects in Cumulative Mortality Models - STMDA, Crete, June.

Mixture Extensions of Linear Models — Linstat, Tomar, Portugal, July.

Editorships: Statistics and Computing (Associate); Computational Statistics and Data Analysis (Associate); Statistical Modelling (Advisory Board)

President of the British and Irish Region of the International Biometric Society (2010-2012); Council Member, International Biometric Society.

Holian, Emma

My research explores methods of clustering individuals into homogeneous groups according to the value of their observed responses, in particular in longitudinal applications.

Hurley, Ted

Research Areas

Generally: *Algebra*. In particular: *Combinatorial Group Theory, Computer Algebra, Group Rings* and applications thereof in *the Communications/Information* areas.

Jennings, Kevin

My research interests are in difference sets with classical parameters. These are finite sets D with k elements taken from a finite group G with v elements. Each nonidentity element of the group can be expressed the same number of times as a difference $a-b$ where $a,b \in D$. These objects are often realised as the image of a hyperplane in a finite field under an identification of scalars. The central problems include finding new constructions, showing that new instances are inequivalent to known constructions and ruling out various parameter families. Basic working techniques are linear algebra over finite fields and some combinatoric arguments.

Krnjajić, Milovan

Current Research Interests

Bayesian model specification, Bayesian non-parametric modelling, Inverse problems.

Publications

[1] Submitted one paper (currently under revision).

Research Activities

Served as a reviewer for several journals (JASA, JRSS/B, CSDA, etc.).

Madden, Niall

Current Research Interests

My primary interest is the design and mathematical analysis of numerical schemes for certain families of differential equations. Often these schemes lead to very large systems of linear equations that must be solved efficiently. This has led to a recent interest in the area of computation linear algebra. In addition to the analysis of numerical methods, I am interested in their application to applied problems. This includes work with Naresh Chadha and Michael Hartnett on finite difference schemes for advection-dominated process, and with Michael Madden, Petri Piiroinen and a group of research students on adaptive time stepping for glucose-insulin models.

Publications

[1] Torsten Linß and Niall Madden. Analysis of an alternating direction method applied to singularly perturbed reaction-diffusion problems. *Int. J. Numer. Anal. Model.*, 7(3):507–519, 2010.

Research Activities

I am the PI on one current research grant (SFI RFP/CMS/1205), and co-PI on another (SFI RFP/CMS/1254). I am supervising one research MSc student, Nhan Anh Thai. During 2010 I submitted 3 papers for publication:

- with K.K. Mondal, *Improved mathematical and numerical modelling of dispersion of a solute from a continuous source*, to appear in Lect. Notes Comp. Sci (2011).
- with N.M. Chadha, *A two-weight scheme for a time-dependent advection-diffusion problem*, to appear in Lect. Notes Comp. Sci (2011).
- with C. Enright and M. Madden, *Clinical Time Series Data Analysis Using Models from Medical Texts*, to appear in Proc. AIME 2011.

I presented at international conferences in Zaragoza and Minneapolis. I visited the Institute for Mathematics and its Applications at the University of Minnesota from October to December to participate in the thematic year on "Simulating Our Complex World". I refereed papers for the journals: Applied Mathematics and Computation, Computational and Applied Mathematics, Numerical Methods for Partial Differential Equations, Lecture Notes in Computational Science and Engineering, and Numerical Algorithms.

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. A central question which has held my attention and that of collaborators for some time concerns the order that naturally arises amongst the (homeomorphism classes of) subspaces of the real line.If A and B are subspaces of $\mathbb{R}$ and $[A]$ and $[B]$ are the respective homeomorphism classes, we say that $[A] \leq [B]$ if and only if A embeds into B. This order lacks antisymmetry but nonetheless the ensuing order-theoretic structure of $\mathscr{P}(\mathbb{R})$ has the potential to represent partially-ordered sets of cardinality at most $2^{\mathfrak{c}}$. But which ones? This question has engaged the attention of several eminent international collaborators with all of whom successful research exchange positions have been awarded. My research platform has recently (since 2008) expanded to include a new research direction within Mathematics Education. My particular interest is in facilitating development in and aptitude for advanced mathematical thinking.

Publications

Two publications appearing in 2010.

Research Activities

I maintain active links with 'local'like-minded researchers via the Galway Topology Colloquia series, founded at NUI Galway in 1997 and running annually between centres of research at Oxford, Birmingham, Belfast and Galway. A key focus for the establishment of this event was to foster a productive enabling environment for postgraduate students in the area. Since 2009, Ircset-funded postgraduate Mr. Jorge Bruno has joined me at NUI Galway and contributes significantly to our forum as he pursues his PhD. I was external examiner for a PhD thesis from the University of Birmingham and refereed articles for the journals *Quaestiones Mathematicae*and *Questions and Answers in General Topology*. During a research visit to Auckland in April 2010, I participated in the NZIMA *Envisioning the future* meeting. Other 2010 invitations/presentations include the University of Limerick (April); St. Patrick's College, Drumcondra (May); NUI Galway CELT's 8th Annual Symposium (Pecha Kucha, June) and the 13th Galway Topology Colloquium (University of Birmingham, July). In July 2010, I accepted an invitation to join a cross-border funded research initiative on mathematics teacher education led by Stranmillis College, QUB and St. Patrick's College, Drumcondra. I was also appointed external reviewer for an independent joint (NUI Maynooth - St. Patrick's College) mathematics education project. I was a member of a Creativity Group (Jan. - June 2010) and a Higher Education Research Group led by CELT, of an intervarsity mathematics education reading group and of three graduate research committees (since 2009). I also undertook research towards the award of a Masters degree in Academic Practice.

Mc Gettrick, Michael

Current Research Interests

My current research interests are mainly in the area of Quantum Computation (an interdisciplinary research area involving mathematics, physics and computer science). In particular, I work mostly on studying properties of Quantum Random Walks (QRW) (which have been proven useful as a methodology for designing Quantum algorithms - such as the Grover search algorithm - that outperform Classical algorithms). My work is concerned with rigorous proof of properties of QRWs (e.g. amymptotics, localization,...), qualitative aspects, simulations, and sometimes consideration of necessary physical resources for their implementation.

Within Quantum Computation I also have a strong interest in Quantum Game Theory. Other interests are in Computer Algebra, Tropical Mathematics and using mathematics and computational techniques to analyze and compose music.

Publications

1 publication in 2010 Most significant publications

[1] "One dimensional Quantum Walks with memory", M. Mc Gettrick **Quantum Information and Computation** Vol. 10 (5-6), pp. 509-524 (2010)

Research Activities

I participated in two conferences in 2010: In January I gave an invited talk at the "North-South Quantum Information Winter School 2010" at NUI, Maynooth. In April I participated in the "Fifth Conference on the Theory of Quantum Computation, Communication and Cryptography" at the University of Leeds. The meeting in Maynooth led to the establishment of a collaboration with C. Di Franco and Th. Busch (both at UCC), which led to the submission of a joint paper to Physics Review Letters in October 2010. Two further articles have been submitted in 2010, one of which is still under consideration. An application was made with ERCIM (European Research Consortium for Informatics and Mathematics) for a postdoc position for Jarek Miszczak (Polish Academy of Sciences) to work with me in Galway. Unfortunately this was not successful. Fortunately though it has led to ongoing work (with Miszczak and Michael Batty at the University of Durham) on Quantum Walks with memory on the cycle Z_n. Miszczak visited in the fall of 2010 to give a seminar and to progress the research and C.Röver) contributed to the discussions.

Two research (masters) students started to work under my supervision in 2010 (Aine Ni Dhonnacha and David Dolphin), and both have made progress in their respective areas (an online simulator of quantum walks on the cycle - see http://walk.to/quantum - and phenomenological results for lazy Quantum Random Walks using qutrits, respectively). 2 papers were refereed in the area of Quantum Random Walks. Two further applications were made in December 2010 to employ postdoctoral researchers under the IRCSET scheme. An Invention Disclosure Form

(IDF) has been filed with the Technology Transfer Office of the University in late 2010.

Meere, Martin

Current Research Interests

I have an interest in drug release modelling, and in particular modelling drug release from thermoresponsive polymers. This project also involves modelling the effect of specific and non-specific binding on drug behaviour in vivo. I am also assisting on a project to mathematically model the epigenetic inheritance of centromeres. These projects are being carried out in collaboration with colleagues in the School and in some of the Research Centres of the University. Finally, I have an interest in modelling atomic diffusion in crystals.

Publications

One paper
M.G. Meere & J.R. King, Diffusion in a strained cubic crystal, Journal of Engineering Mathematics, Volume 69, p.1 - 23, Number 1, DOI 10.1007/s10665-010-9361-4 (Published online: 2 February 2010)

Research Activities

Current Grants: MACSI and SFI research grant for a PhD student (06/MI/005)
Current Graduate Student: I currently supervise two PhD students, one of whom is co-supervised by Petri Piiroinen
Completed MSc projects: Kevin Doherty completed his MSc by research on the modelling of anaerobic digestion
Papers submitted: (1) Vo Thi Ngoc Tuoi, Rongbing Yang, Yury Rochev & Martin Meere, A mathematical model for drug delivery, ECMI 2010 conference proceedings, accepted
(2) Rongbing Yang, Vo Thi Ngoc Tuoi, Alexander Gorelov, Fawaz Aldabbagh, William Carroll, Martin Meere & Yury Rochev, A mathematical model for pulsatile release: controlled release of rhodamine B from UV-crosslinked thermoresponsive thin films, submitted
Talks presented: Vo Thi Ngoc Tuoi & Martin Meere, Some mathematical models for drug delivery, the 16th European Conference on Mathematics for Industry July 26-30, 2010 Wuppertal, Germany
Study Groups: Attended the European Study Group with Industry 2010 at the University of Limerick 27th June - 2nd July 2010, and helped author the report 'Spin-coated substrates for cell growth'

Newell, John

Current Research Interests

Research interests include biostatistics, statistical modelling, statistical computing, survival analysis and the application of statistics in Sports Science.

Nolan, Louise

Current Research Interests

Applying dynamical systems analysis to model the general relativistic collapse of cylindrically symmetric spacetimes filled with various matter fields. As we are interested in the details of gravitational collapse we can apply the self-similarity hypothesis and look for the existence of homothetic solutions to the field equations.

Using standard Darmois matching conditions to model the evolution of manifolds which have been 'glued' together and applying these results to cosmology.

O'Keeffe, David

Current Research Interests

My current research is concerned with the calculation of the cohomology groups and rings for various classes of associative algebras. In my PhD thesis, I calculated the cohomology algebra for the class of quadratic monomial algebras and presently I am hoping to extend these results to larger classes of algebras.

I am also interested in maths and education. I was chief organiser of Maths Week 2010 at NUI Galway. Primary and secondary school audiences, along with members from the general public were invited into the university to participate in a series of workshops and lectures in mathematics. Participating schools were also visited during this week where workshops were held. Currently I am working with

both Dr.Aisling McCluskey and Dr.Maura Clancy on a mathematical project which hopes to promote the understanding and usefulness of maths to students in the 12-14 age group.

Research Activities

Talk at NUI Maynooth April 2011: *Calculating the cohomology of an associative algebra*.

O'Regan, Donal

Current Research Interests

Differential Equations, Nonlinear Analysis and Fixed Point Theory.

Pfeiffer, Götz

Current Research Interests

I am working on problems in Computational Algebra. In particular, I am interested in finite groups, representation theory, computational group theory, algebraic combinatorics and the theory of formal languages and semigroups. I have participated in the development of the GAP system for computational group theory, and has contributed to several software packages for GAP. I am a member of the GAP council.

Piiroinen, Petri T

Current Research Interests

My main research interests are in the area of discontinuous dynamical systems with application to rigid-body mechanics, economics and biological systems. I have also recently started some projects that involves the analysis of evolving networks. An overarching aim of my research is to bridge the gap between mathematics, numerical analysis and engineering to make mathematical theories more applicable to non-theoreticians.

Research Activities

During 2010 I supervised or co-supervised 2 PhD students and 2 MSc students. I submitted 4 papers to international peer-reviewed journals (2 are now accepted), I attended 2 conferences and gave 4 academic seminars (UCC, UL, University of Manchester $\times$ 2). I am a guest editor for the Special Issue *Discontinuous Dynamical Systems: Theory and Numerical Methods* of the journal Mathematics and Computers in Simulation (MATCOM).

Quinlan, Rachel

Current Research Interests

My current research is primarily situated in the area of linear algebra and its interactions with combinatorics, field theory, group theory and representation theory. I am interested in the identification and classification of large subspaces of matrix algebras whose elements possess prescribed properties not normally preserved under addition. Examples of such properties include invertibility, upper or lower bounds on rank, and nilpotency. A classical theorem in this vein is Gerstenhaber's 1958 description of linear spaces of nilpotent matrices of maximum possible dimension. Some of my recent work involves an extension and reinterpretation of this theorem.

I also have research interests in mathematics education at university level.

Publications

Most significant publications

[1] R. Quinlan, "Guessing at our mental models" or "committed knowing acts" - what are our students doing?, Bull. Irish Math. Soc., No. 66, Winter 2010.

Research Activities

During 2010 I supervised the research of two PhD students, J. McTigue and K. Pfeiffer.
Journal submissions : one article submitted to *Linear Algebra and its Applications* (appeared in February 2011)
Conference presentation : *Minimum polynomials and spaces of matrices with special rank properties*, 16th Conference of the International Linear Algebra Scociety, Pisa,

June 2010.
Invited seminars/colloquia :

- University College Dublin Algebra Seminar, May 2010
- University of Alberta Algebra Seminar, September 2010
- University of Wisconsin–Madison, Combinatorics Seminar, November 2010
- University of Regina Mathematics Colloquium, November 2010

Mathematical Reviews : 3 reviews in 2010
Memberships : Irish Mathematical Society, American Mathematical Society, Mathematical Association of America, International Linear Algebra Society, British Society for Research into the Learning of Mathematics

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Röver, Claas

Current Research Interests

Group Theory

Publications

Nothing appeared in 2010.

Research Activities

Conference in Hanmer Springs, January 3-10, New Zealand
Visiting Eamonn O'Brien in Auckland, New Zealand, January-June
Two seminar talks in Auckland
Visiting Ben Martin in Christchurch, New Zealand, 2 weeks in June
Visiting Laurence Reeves in Melbourne, Australia, 2 weeks in March
Invited talk at Postgraduate Group Theory Conference in St Andrews, June 28-30, 2010
Refereed 2 papers
Submitted joint paper with Götz Pfeiffer and Matjaž Konvalinka
Visited Bejamin Klopsch in Royal Holloway, August 2010
Attended 4th de Brun Workshop in Galway, December 6-12

Ryan, Ray

Current Research Interests

Functional Analysis: multilinear, polynomial and holomorphic functions on Banach spaces. Tensor products of Banach spaces and Banach lattices. Regular polynomial and holomorphic functions on Riesz spaces and on Banach lattices.

Research Activities

Refereeing papers for journals, membership of editorial board of journal, hosting of visiting researcher, preparation of papers for submission to journal.

Seoighe, Cathal

Bioinformatics is interdisciplinary in nature and consequently I collaborate with several life sciences research groups on campus. A major focus of recent collaborations involves the analysis of data from ultradeep sequencing technologies. These technologies can be used to sequence genomes or for studying gene expression or the binding of proteins to DNA, which is critical for the control of gene expression.

Current Research Interests

The focus of my research is on modeling molecular biological data, including epigenetic data, gene expression, alternative mRNA splicing and molecular evolution, in particular the evolution of viruses such as HIV-1.

Publications

Five journal articles appeared in 2010.

Most significant publications

[1] Heritability in the efficiency of nonsense-mediated mRNA decay in humans. Seoighe C, Gehring C. PLoS One. 2010 21;5(7):e11657.

[2] A flexible R package for nonnegative matrix factorization. Gaujoux R, Seoighe C. BMC Bioinformatics. 2010 2;11:367.

[3] Epitope discovery with phylogenetic hidden Markov models. Lacerda M, Scheffler K, Seoighe C. Mol Biol Evol. 2010 27(5):1212-20.

[4] Genome-wide analysis of the structure of the South African Coloured Population in the Western Cape. de Wit E, Delport W, Rugamika CE, Meintjes A, Mller M, van Helden PD, Seoighe C, Hoal EG. Hum Genet. 2010 128(2):145-53

Research Activities

My research group consisted of four PhD students in 2010. Research is currently supported by SFI (Stokes Programme) and IRCSET, through a graduate education programme in collaboration with UCD. Several research collaborations across NUIG were established or developed in 2010. Academic community service included memberships of editorial boards of Bioinformatics, PLoS One and Trends in Evolutionary Biology and refereeing for a wide range of journals (e.g. PLoS Computational Biology, Molecular Biology and Evolution, Genome Research) and granting agencies (Wellcome Trust and Swiss Science Foundation).

Sheahan, Jerome

Current Research Interests

Sequences of various kinds, including iid and dependent sequences. Random Processes with violations of standard assumptions.

Sköldberg, Emil

Current Research Interests

Group Theory, Computational Group Theory and Formal Languages and Automata.

Tuite, Michael

Current Research Interests

Vertex operator algebras (VOAs), conformal field theory, Riemann surfaces, elliptic and modular functions in number theory, Lie algebras, combinatorics. I am particularly interested in computing partition and correlation functions on higher genus Riemann surfaces for various VOAs. I am also interested in exceptional VOAs and their relationship to Virasoro constraints.

Publications

4 publications appeared in calender year 2010.

Most significant publications

[1] Mason, Geoffrey and Tuite, Michael P., *Free bosonic vertex operator algebras on genus two Riemann surfaces I*, Comm. Math. Phys. **300**, 673–713 (2010).

[2] Lepowsky, Jim, McKay, John and Tuite, Michael P. (editors), Moonshine: the first quarter century and beyond, London Math. Soc. Lecture Note Series **372** (CUP, Cambridge 2010).

[3] Mason, Geoffrey and Tuite, Michael P., *Vertex operators and modular forms* in 'A window into zeta and modular physics', Math.Sci.Res.Inst.Publ. **57**, 183–278 (CUP, Cambridge 2010).

Research Activities

- I currently hold two SFI RFP grants and an IRCSET Embark Studentship.
- I supervised one postdoc and three PhD students in 2010.
- I have four papers in press, and refereed 2 papers.
- I gave seminars/conference talks at DIAS, Glasgow University, NUI Galway, Queen's University Belfast and Kyoto University.

Ward, James

Current Research Interests

Research interests in Subnormal Subgroups, Noncommutative Rings and the History of Mathematics. One

of the main organizers of the joint meeting of the 61st British Mathematical Colloquium and the Irish Mathematical Society was hosted by NUI Galway in April 2009.

Visitors

Demétrio, Clarice, ESALQ/USP, Piracicaba, Brazil

Dates of visit: 02 to 15/05/2010

Research Interests

The purpose of this visit was to continue collaborative work with Professor John Hinde, specifically the writing of a book *Overdispersion: models and estimation*. The purpose of this book is to provide an overview of methods for handling overdispersion in generalized linear models, show the links between different approaches, and provide extended models for structured random effects.

During the visit Prof Demétrio presented a seminar on *An Extended Random-effects Approach to Modeling Repeated, Overdispersed Count Data*. Plans were also made for a one-year visit of a postgraduate student from ESALQ to NUIG under the joint supervision of Professors Demétrio and Hinde.

Feldman, Arnold

Dates of visit: 15 July, 2010 - 15 August, 2011

Current Research Interests

I have been working with Rex Dark since 1999 on problems in finite soluble group theory. I have also worked with students at my home institution, Franklin and Marshall College, in Lancaster, Pennsylvania, USA, reading papers by Ted Hurley. This past July, I was the external examiner for one of Ted's Ph.D. students. This is my third sabbatical at NUIG – I also spent academic years 1999-2000 and 2004-2005 here.

Mondal, Kajal Kumar

Dates of visit: July 2009–July 2010.

Research Interests

I work on the mathematical modelling of advection-diffusion processes, and the numerical solution of these models.

I was funded by the Government of India BOYSCAST Fellowship (SR/BY/M-03/2008) to work at NUI Galway for one year in a joint project between Mathematics and Civil Engineering.

Recent publication:

[1] Niall Madden and Kajal Kumar Mondal, *Improved mathematical and numerical modelling of dispersion of a solute from a continuous source*, BAIL 2010 - Boundary and Interior Layers, Computational and Asymptotic Methods, Lecture Notes in Computational Science and Engineering, Vol. 81, 2011 (to appear).

Klopsch, Benjamin

Dates of visit: March 4-11, 2011

Research Interests

Bejamin and Claas are working on representation growth for fractal branch

groups. We have recursive formulae for the representation growth of the

Gupta-Sidki 3-group and lower bounds that improve results of Passman

and Temple.

Now we are trying to generalise this to other Gupta-Sidki groups.

Postdoctoral Researchers

Chadha, Naresh

Current Research Interests

Designing and analyzing numerical methods for time dependent singularly perturbed differential equations. Models for studying solute transport in a water body usually lead to solving a time-dependent advection-diffusion problem in one, two, or three dimensions depending onto the practical requirements. Many popular computer models for the two- and three-dimensional cases employ certain time-splitting methods, e.g., alternating direction implicit (ADI) method and operator splitting method, where the problem is solved in only one coordinate direction over a fraction of a time-step. See, for example, the two-dimensional finite difference model DIVAST [1] which employs ADI to solve a variant of the Navier-Stokes equations for calculating velocity fields, and then the time-dependent advection-diffusion equation for the solute transport problem, using a space-staggered uniform grid.

It is well known that in a case where the solute transport problem is advection dominated, the standard central difference scheme on a uniform mesh may yield spurious oscillations in the computed solution. One may get rid of these spurious oscillations by using upwind operator for the advection term, however the accuracy of the computed solution would be compromised. In a region of strong tide-induced currents the problem may alternate from diffusion dominated to advection dominated throughout a tidal cycle, see, e.g., [2]. This leads naturally to the following questions:

1. How to design a finite difference scheme which offers better stability, yet produce a sufficiently accurate computed solution on a uniform mesh, and which can be easily extended to higher dimensional problems?
2. Is it possible to devise an optimal time-stepping for the scheme which yields a sufficiently accurate solution?

Within the framework of a two weight scheme, we attempt to answer to these questions which leads to design novel algorithms for optimal time stepping for a time-dependent advection-diffusion problem.

Publications

N. M. Chadha and N. Madden. *A two-weight scheme for a time-dependent advection-diffusion problem.* Proc. BAIL 2010 - Boundary and Interior Layers, Lecture Notes in Computational Science and Engineering, Vol. 81., 2011. (to appear in print).

Research Activities

Received the *Royal Irish Academy Postdoctoral Mobility Grant* 2010-Ireland to visit RICAM, Austria.

Presentations:

- Adaptive mesh construction for a class of singularly perturbed differential equations. Johann Radon Institute for Computational and Applied Mathematics (RICAM), Linz, Austria, April-2010.

- An optimal time-stepping for a time-dependent convection-diffusion problem. (with N. Madden) *International Conference BAIL 2010 Boundary and Interior Layers - Computational & Asymptotic Methods*, Zaragoza, Spain, July 2010.

Three papers refereed for Applied Mathematics and Computation.

Coffey, Norma

Current Research Interests

My current area of research involves applying standard functional data analysis techniques to time-course gene expression data and clustering time-course gene expression data using the linear mixed effects model. I am presently working on clustering SNP data using finite mixtures of orthogonal regression lines. I have also been involved in some consultancy projects with the Clinical Research Facility.

Research Activities

I presented my work at several conferences in 2010 including

- an oral presentation titled Analyzing time-course microarray data using functional data analysis - a review at the International Conference on Statistical Modelling and Data Analysis, Chania, Crete, 7-11th June 2010 and
- an oral presentation titled Analyzing time-course microarray data using functional data analysis at the International Biometric Conference, Florianopolis, Brazil, 6-10th December 2010.

I had one paper accepted for publication in 2010 titled

- Coffey, N., Donoghue, O., Harrison, A.J. and Hayes, K. Common functional principal components analysis - a new approach to analysing human movement data.*H*uman Movement Science.

which is to appear in Human Movement Science in 2011, and a second paper titled

- Coffey, N., Hinde, J. Analyzing time-course microarray data using functional data analysis - a review.

submitted to Bioinformatics, which has since been accepted for publication in Statistical Applications in Genetics and Molecular Biology to apper in 2011.

I also attended a number of short courses during the year as shown below:

- Irish Statistical Association short course on mixed modelling and convergence in Dublin, Ireland on 4-5th March 2010;
- short course titled Bayesian hierarchical modelling at NUI Galway on the 1st June 2010;
- short course titled Competing risks and multi-state models: concepts, methods and software at the International Biometric Conference, Florianopolis, Brazil on the 5th December 2010.

Mason, Joanna

Current Research Interests

My current research is motivated by three real engineering problems with nonsmoothness: magnetic bearings, the great bell of Cologne Cathedral, and cam-follower devices. Nonsmooth systems can exhibit extraordinarily complicated and chaotic dynamics, which are often manifested as undesirable behaviour, such as noise, vibration, and wear. The objective of my work is to develop numerical and analytical techniques to study these example impact and friction problems.

Research Activities

I joined the school of Mathematics, Statistics and Applied Mathematics in December 2010. I currently hold an IRCSET postdoctoral fellowship (December 2010-2012). J.F. Mason and P.T. Piiroinen. Interactions between global and grazing bifurcations in an impacting system. Submitted to *Chaos* in September 2010. Now published in Chaos, Volume 21 (2011).

J.F. Mason and P.T. Piiroinen. Internal and external basin-boundary metamorphoses in an impacting system (submitted 2010). J.F. Mason, P.T. Piiroinen and N. Humphries. Classical analysis and discontinuity geometry of an impact oscillator with two discontinuity surfaces. Presented at The 8th AIMS Conference on Dynamical

Systems, Differential Equations and Applications, Dresden, Germany, May 2010.

J.F. Mason and P.T. Piiroinen. Interactions between global and grazing bifurcations in an impacting system. Poster presentation at The 8th AIMS Conference on Dynamical Systems, Differential Equations and Applications, Dresden, Germany, May 2010.

J.F Mason and P.T. Piiroinen. Impact and Friction Problems in Engineering. Poster presentation at Globe Forum, Dublin, November 2010.

Organising committee member of: Women in Mathematics Day Ireland, University of Limerick, April 2010; MACSI Mathematical Modelling summer school, University of Limerick, June 2010; 75th European Study Group with Industry, University of Limerick, June 2010.

Zuevsky, Alexander

Vertex algebras

In joint research with M. P. Tuite (Department of Mathematical Physics, National University of Ireland, Galway), and G. Mason (Department of Mathematics, University of California Santa Cruz), we are developing a procedure for the construction of all n-point correlation functions for general orbifold super vertex operator algebras (VOA)/conformal field theories on Riemann surfaces of genus one and higher based on properties of corresponding vertex operator algebras. A constructive definition of n-point correlation functions for free chiral fermionic conformal filed theories on genus two Riemann surfaces sawn from two genus one surfaces is introduced. In the fermionic case, instead of ordinary differentials we use half-order differentials (Szegő kernel) defined on two Riemann surfaces. Then implementing the sewing procedure, we prove properties and find formulae for the Szegő kernel on the sewed genus $g_1 + g_2$ Riemann surface as a function of the Szegő kernels on initial Riemann surfaces of genuses g_1 and g_2. We have found a straightforward approach in which we have managed to obtain the genus two partition function for free fermion vertex operator algebra formula expressed as a square root of the determinant of an infinite matrix constructed from matrices with Szegő kernel elements corresponding to two original Riemann surfaces. Exact expression for the genus two generating function for all n-point functions for free fermionic vertex operator algebra is constructed as a determinant incorporating genus two partition function and a matrix containing specific genus two Szegő kernels. A generalization of the genus two partition function versions of the classical Triple Jacobi Identity is found.

Publications

Most significant publications

[1] Tuite M. P., Zuevsky A. Genus Two Partition and Correlation Functions for Fermionic Vertex Operator Superalgebras I. To appear in Commun. Math. Phys. 2011, arXiv:1007.5203v1

[2] Tuite M. P., Zuevsky A. The Szegö kernel on a sewn Riemann surface. To appear in Commun. Math. Phys., 2011, arXiv:1002.4114v1

[3] Zuevsky A. $U_q(\widehat{\mathscr{G}})$ Heisenberg families. Journal of Nonlinear Mathematical Physics. 2010

[4] Zuevsky A. Hardy spaces on compact Riemann surfaces with boundary II. Journal of Mathematical Sciences, 2010; arXiv:0911.3908 [math.AG]

Research Activities

Current research grant:

Supported by a Science Foundation Ireland Frontiers of Research Grant, and

by Max–Planck Institut für Mathematik, Bonn

Research visit:

Max–Planck Institut für Mathematik, Bonn

Invited talks:

Institut Fourier, Université Grenoble I, France ,Kings College London, UK ,University College London, UK. Invited talk ,Queen Mary, University of London, UK ,Freie Universitat Bozen, Italy. ,University of Liverpool, UK ,University of Glasgow, UK ,University of Metz, France ,University of Caen, France ,University of Nantes, France ,LAPTH, Annecy, France

Memberships:

International Association of Mathematical Physics

Postgraduate Researchers

Name	Degree	Supervisor(s)
Gilroy, Thomas	PhD	Michael Tuite
Hoang, Dinh Van	PhD	Michael Tuite
Hurley, Donny	PhD	Michael Tuite
Alvazer, Alberto	PhD	John Newell, John Hinde
Bruno, Jorge	PhD	Aisling McCluskey
Doherty, Kevin	PhD	Martin Meere, Petri Piiroinen
Dooley, Cara	PhD	John Hinde
Geeleher, Paul	PhD	John Hinde, Aaron Golden
Hegarty, Fintan	PhD	Graham Ellis
Humphries, Neil	PhD	Petri Piiroinen
Hurley, Barry	PhD	Dane Flannery
Lacerda, Miguel	PhD	Cathal Seoighe
Nguyen, Trung Thong	PhD	Cathal Seoighe
Nhan, Anh Thai	MSc	Niall Madden
O'Callaghan, Liam	MSs	Petri Piiroinen
Ó Catháin, Padraig	PhD	Dane Flannery
Pfeiffer, Kirsten	PhD	Rachel Quinlan
Vo Thi Ngoc Tuoi	PhD	John Hinde
Wall, Deirdre	PhD	John Newell
Korir, Paul	PhD	Cathal Seoighe
McTigue, James	PhD	Rachel Quinlan
Le Van Luyen	PhD	Graham Ellis
Burke, Richard	MSc	Petri Piiroinen
Barnicle, Alan	PhD	Cathal Seoighe, Aaaron Golden
Nur Fatihah Mat Yusoff	PhD	John Hinde
Nazaré Barreira, Sofia	PhD	Cathal Seoighe
Ragassi Urbano, Mariana	PhD	John Hinde
Fatima, Attia	PhD	Cathal Seoighe, Aaron Golden

Seminars

[1] Edwin O'Shea, NUI, Galway. **Algebraic methods in discrete optimization** 14/1/2010

[2] Thomas Waters, NUI, Galway. **Chaotic geodesics on a certain class of surfaces** 21/1/2010

[3] Niall Horgan, Virginia. **Nonlinear elasticity theory: a rich source of interesting mathematical problems** 28/1/2010

[4] David Quinn, NUI, Galway. **Three Problems in Algebraic Combinatorics** 1/2/2010

[5] Volkmar Welker, Marburg. **Random to Random Shuffles and Commuting Families of Matrices** 1/1/2010

[6] Michael Mc Gettrick, NUI, Galway. **Quantum Random Walks with Memory** 4/2/2010

[7] Ruth Charney, Boston. **Right-angled Artin groups and their Automorphisms** 11/2/2010

[8] Thomas Unger, UCD. **The Procesi-Schacher conjecture and Hilbert's 17th problem for algebras with involution** 18/2/2010

[9] John Cosgrave, St. Pats, Drumcondra. **Gauss-Jacobi advances** 25/2/2010

[10] Sebastian Franz, University of Limerick. **The Capriciousness of Numerical Methods for Singular Perturbations** 4/3/2010

[11] Eimear Byrne, UCD. **The Linear Programming Bound for Codes Over Rings** 11/3/2010

[12] Des MacHale, UCC. **Some of my favourite mathematics puzzles** 22/3/2010

[13] Ken Duffy, Maynooth. **The Cyton Model: a stochastic analysis of the adaptive immune response** 6/5/2010

[14] Clarice Demetrio, Sao Paulo. **An Extended Random-effects Approach to Modeling Repeated, Overdispersed Count Data** 13/5/2010

[15] David Chillingworth, Southhampton. **Gravitational lensing and Galois Theory** 14/5/2010

[16] Thomas Banchoff, Brown University. **Visualizing the Fourth Dimension: From Flatland to Hypergraphics** 18/5/2010

[17] John Butcher, Auckland. **A beginner's guide to numerical ODEs** 20/5/2010

[18] Alexander Ivanov, Imperial College, London. **Majorana Theory** 20/5/2010

[19] George Havas, Queensland. **On Coxeter's families of group presentations** 27/5/2010

[20] Jessica O'Shaughnessy, NUI, Galway. **Convolutional Codes from Group Rings** 22/7/2010

[21] Graham Ellis, NUI, Galway. **Applied statistics for biologists, physicists and group theorists** 9/9/2010

[22] Claas Röver, NUI, Galway. **Representation Growth of Branch Groups** 16/9/2010

[23] Arny Feldman, Franklin and Marshall College. **Generalizations of t-groups** 23/9/2010

[24] Zsolt Balogh, Nyiregyhaza (Hungary). **Group identities and involutions in group algebras** 30/9/2010

[25] Michael Tuite, NUI, Galway. **Combinatorics of strings on Riemann surfaces** 7/10/2010

[26] Simon Wilson, TCD. **Source separation for multi-spectral images, with application to the cosmic microwave background** 13/10/2010

[27] Brendan Guilfoyle, IT, Tralee. **A new representation of the Euclidean group** 21/10/2010

[28] Jaroslaw Miszczak, Polish Academy of Sciences. **Product numerical range in quantum information theory** 28/10/2010

[29] Brett Houlding, TCD. **Nonparametric Predictive Utility Inference** 3/11/2010

[30] Javier Aramayona, NUI, Galway. **Homomorphisms between mapping class groups** 11/11/2010

[31] Eoin O Colgain, Korea Institute for Advanced Study. **What higher-dimensional supergravity may tell us about the real world** 18/11/2010

[32] Frederic Dias, UCD. **Freak Waves** 25/11/2010

[33] Emil Sköldberg, NUI, Galway. **Resolutions with multiplicative structures** 2/12/2010

[34] Louise Nolan, NUI, Galway. **Cylindrically symmetric gravitational collapse - a dynamical systems approach** 16/12/2010

Conferences and Workshops

- Groups in Galway 2010 (Organiser(s): **Javier Aramayona, Götz Pfeiffer, Rachel Quinlan**), 28-29 May 2010.
- Irish Applied Mathematics Teachers Association (IAMTA) Conference and AGM (Organiser(s): Brendan Doheny, **Kevin Jennings**), 13 November, 2010.
- Fourth De Brún Workshop: Group Actions (Organiser(s): **Javier Aramayona, Graham Ellis**), 6-12 December, 2010.
