British Young Mathematicians Colloquium

17th April 2019

University of Birmingham

Plenary Speakers

Pure Mathematics:

David Beltran
BCAM

Scott Harper
University of Bristol

Katherine Staden
University of Oxford

Applied Mathematics:

Gemma Cupples
University of Birmingham

John Pearson
University of Edinburgh

Oliver Sutton
University of Nottingham

Contact

Website: `http://web.mat.bham.ac.uk/BYMC/`

E-Mail: `bymc@contacts.bham.ac.uk`

Organising Committee

Gianmarco Brocchi, Alexander Brune (chair), Rory Duncan, Cara Neal, Jack Saunders, Karoline van Gemst

The organisers would like to thank The University of Birmingham and MAGIC for their financial support.

UNIVERSITY OF BIRMINGHAM

MAGIC

Schedule

Time	Watson A	Watson C	Strathcona 2	Strathcona 3
9:30–10:00	Registration			
10:00–10:50	Group generation through the generations (p. 1) **Scott Harper**	Locomotion at low Reynolds numbers (p. 2) **Gemma Cupples**		
10:50–11:15	Coffee Break			
11:15–11:40	Heat kernel expansion of the Dirac—Laplacian of multi-fractal Robertson–Walker metrics (p. 4) **Farzad Fathizadeh**	Mathematical modelling of human embryonic stem cell colony formation (p. 9) **Laura Wadkin**	Characterising number-theoretical objects using L-series (p. 4) **Harry Smit**	On the representation theory of automorphic Lie algebras (p. 7) **Drew Duffield**
11:45–12:10	Ricci flows in Milnor frames (p. 4) **Syafiq Johar**	Capturing the quasi-stationary distribution within a deterministic framework for stochastic SIS dynamics (p. 11) **Christopher Overton**	A generalisation of Dickson's commutative division algebras (p. 7) **Daniel Thompson**	Some results on generation and hierarchies of groups (p. 8) **Rudradip Biswas**
12:05–13:35	Lunch Break			
13:40–14:30	Graph decomposition (p. 1) **Katherine Staden**	PDE-constrained optimization for scientific processes: mathematical modelling and numerical methods (p. 2) **John Pearson**		
14:30–15:20	Regularity of maximal functions (p. 1) **David Beltran**	Polygonal meshes: a new frontier for finite element methods? (p. 3) **Oliver Sutton**		
15:20–15:45	Coffee Break			
15:45–16:10	On a class of anharmonic oscillators (p. 5) **Marianna Chatzakou**	Hyperparameter optimisation of the Multilayer Perceptron Classifier (p. 10) **Maja Gwozdz**	Partition regularity and multiplicatively syndetic sets (p. 8) **Jonathan Chapman**	Morita equivalence classes of blocks with defect group $(C_2)^5$ (p. 5) **Cesare Giulio Ardito**

16:15–16:40	A spine curve for almost sharp fronts of singular SQG (p. 6) **Calvin Khor**	Accounting for observation uncertainty due to unresolved scales in data assimilation (p. 10) **Zackary Bell**	Dirac's theorem for random regular graphs (p. 9) **Padraig Condon**	Jordan algebras vs axial algebras (p. 7) **Yunxi Shi**
16:45–17:10	Pseudo-differential operators on $SU(2)$ (p. 6) **Pablo Vinuesa**	Modifying the tropical version of Stickel's key exchange protocol (p. 10) **Any Muanalifah**	Resilience with respect to Hamiltonicity in random graphs (p. 8) **Alberto Espuny Díaz**	Idealisers in rings of differential operators (p. 6) **Ruth Reynolds**
17:15–17:40	Linear and cyclic antimetrics (p. 5) **Esteban Gomezllata Marmolejo**	The 3D Painlevé paradox (p. 9) **Noah Cheesman**	Dynamical models for random simplicial complexes (p. 7) **Tejas Iyer**	Cohomological conditions on module extensions (p. 5) **Matthew Westaway**

For directions to the lecture rooms, coffee breaks and lunch venue, please see page 12.

Plenary talks

Pure mathematics

Regularity of maximal functions

David Beltran, BCAM
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Maximal functions are classical objects in analysis related to a.e. convergence questions. In this talk, we will focus on some specific examples: the Hardy—Littlewood maximal function and the spherical maximal function. We will review some of its well known properties, such as boundedness on Lebesgue spaces, and discuss some recent results concerning the regularity properties of such operators.

Group generation through the generations

Scott Harper, University of Bristol
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There is a long and rich history of studying generating sets for groups, and this remains a topic of current research. The finite simple groups, the building blocks of all finite groups, have some particularly startling properties in the context of generation. In this talk I will tell (part of) the story of group generation from the earliest days of group theory to the present day, and I will discuss some recent work on a conjecture that seeks to characterise the finite groups that have a particularly strong generation property known as 3/2-generation.

Graph decomposition

Katherine Staden, University of Oxford
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When does a family $\mathcal{F}$ of graphs decompose a graph G? There has been a lot of recent progress in this area, and I will survey some of these results and the remaining open problems, focusing on the setting where the graphs in $\mathcal{F}$ are large. In particular, I will discuss a new result, joint with Peter Keevash, on the case where every graph in $\mathcal{F}$ is 2-regular and G is dense and quasirandom. A special case provides a new proof of the Oberwolfach problem.

Applied mathematics

Locomotion at low Reynolds numbers

Gemma Cupples, University of Birmingham

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Very low Reynolds number propulsion is a topic of enduring interest due to its importance in biological systems such as sperm migration in the female reproductive tract. I will talk about two different aspects of this topic, a theoretical investigation into propulsion in complex fluids and a software built to analyse sperm cell propulsion.

Motivated by the fibrous nature of cervical mucus we extend Taylor's classical model of small-amplitude zero-Reynolds-number propulsion of a 'swimming sheet' via the transversely isotropic fluid model of Ericksen. In the first section of this talk I will discuss the predictions of the model for both passive and active cases, noting that the energetic costs of swimming are significantly altered by all rheological parameters and the initial fibre angle.

In the second section of the talk I will introduce the work we have been doing on high-throughput computational image analysis of sperm, and the way in which the information we generate can be used in conjunction with mathematical modelling to better understand behaviour. I will discuss tracking and analysis of the flagellar waveform for a large number of cells in an automated fashion, as well as a simple representation of the flagellar waveform for analysis.

PDE-constrained optimization for scientific processes: mathematical modelling and numerical methods

John Pearson, University of Edinburgh

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Optimization problems subject to PDE constraints form a mathematical tool that can be applied to a huge range of scientific processes, including fluid flow control, medical imaging, option pricing, biological and chemical processes, and electromagnetic inverse problems, to name a few. These problems involve minimizing some function arising from a particular physical objective, while at the same time obeying a system of PDEs which describe the process. In this talk we derive mathematical models for practical applications, and devise numerical methods to tackle the very large matrix systems that result. To highlight the vast range of mechanisms which may be examined within a PDE-constrained optimization framework, we outline applications of this work in physics (fluid flow control), chemistry (reaction-diffusion equations modelling chemical processes), and biology (pattern formation and bacterial chemotaxis).

Polygonal meshes: a new frontier for finite element methods?

Oliver Sutton, University of Nottingham

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Finite element methods are a well known workhorse of applied mathematics, widely deployed to simulate natural and physical phenomena governed by systems of partial differential equations. Over the past few years, there has been growing interest in new families of methods which are designed to use computational meshes formed of general polygonal elements, rather than the square or triangular meshes used by conventional methods. This brings several key advantages, for instance by opening the door to a new generation of highly flexible adaptive methods, in which the polygonal mesh elements are locally coarsened or refined to focus resolution into regions where it is needed most, and the possibility of building meshes of complicated domains using just a small number of elements. This talk will discuss the design of these new methods, showing how they relate to conventional finite element methods, and demonstrate the extra flexibility they offer through examples.

Short talks

Pure mathematics

Morita equivalence classes of blocks with defect group $(C_2)^5$

Cesare Giulio Ardito, University of Manchester

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Donovan's conjecture predicts that given a p-group D there are only finitely many Morita equivalence classes of blocks of group algebras with defect group D. While the conjecture is still unknown for a generic p-group D, the conjecture has been proven in 2014 by Eaton, Kessar, Külshammer and Sambale when D is an elementary abelian 2-group, and in 2018 by Eaton and Livesey when D is any abelian 2-group. The proof, however, does not describe these equivalence classes explicitly. A classification up to Morita equivalence over a complete discrete valuation ring $\mathcal{O}$ has been done, among other examples, for D with rank 3 or less, and for $D = (C_2)^4$.
I have classified blocks of finite groups with defect group $D = (C_2)^5$ over an algebraically closed field k, and in this talk I will introduce the topic, give the relevant definitions and describe the process of classifying these blocks.

Some results on generation and hierarchies of groups

Rudradip Biswas, University of Manchester

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I will define a notion of generation for modules that is inspired from some notions of generations for triangulated categories which have been looked into by Rouquier. I will prove or mention a bunch of general results regarding generation of modules using my definition of generation, investigate when a module being generated in a finite number of steps by a class is equivalent to that module admitting finite resolutions by modules of that class, provide examples of classes that admit certain interesting properties regarding modules generated by them, and, if time permits, show how we can apply this notion of generation to derive certain properties of modules of groups that lie in Kropholler's hierarchy.

Partition regularity and multiplicatively syndetic sets

Jonathan Chapman, University of Manchester

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Partition regularity is one of the most studied topics in Ramsey theory. A system of equations is called partition regular if, given any partition of the positive integers into finitely many parts, there exists a solution to the system whose entries all belong to the same part of the partition. In 1933, Rado classified all partition regular systems of linear equations. More recent work has focused on the partition regularity of non-linear systems. In 2018, Chow, Lindqvist and Prendiville established an analogue of Rado's criterion for homogeneous polynomial equations in sufficiently many variables. Their arguments made use of a special family of sets known as multiplicatively syndetic sets, which are sets with "bounded multiplicative gaps".

In this talk, we will introduce multiplicatively syndetic sets and explore their connections with the partition regularity of dilation invariant systems. In particular, we show that a finite dilation invariant system of equations is partition regular if and only if it has a solution inside every multiplicatively syndetic set. A nice corollary of this fact is that, in any finite partition of the positive integers, one part of the partition contains solutions to all dilation invariant partition regular systems of equations.

On a class of Anharmonic oscillators

Marianna Chatzakou, Imperial College London

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We will present our work on a class of anharmonic oscillators within the framework of the Weyl–Hörmander calculus. The anharmonic oscillators arise from several applications in mathematical physics as natural extensions of the harmonic oscillator. A prototype is an operator on $\mathbb{R}^n$ of the form $(-\Delta)^l + |x|^{2k}$ for $k, l \geq 1$ integers. Here by associating a Hörmander metric g to a given anharmonic oscillator we investigate several properties of the anharmonic oscillators. We obtain spectral properties in terms of Schatten–von Neumann classes for their negative powers. We also study some examples of anharmonic oscillators arising from the analysis on Lie groups.

Dirac's theorem for random regular graphs

Padraig Condon, University of Birmingham

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This research is joint work with Alberto Espuny Díaz, António Girão, Daniela Kühn and Deryk Osthus.

The local resilience of a graph G with respect to a property P measures how much one has to change G locally in order to destroy P. We prove a resilience version of Dirac's theorem in the setting of random regular graphs. More precisely, we show that, whenever d is sufficiently large compared to $\varepsilon > 0$, a.a.s. the following holds: let G_0 be any subgraph of the random n-vertex d-regular graph $G_{n,d}$ with minimum degree at least $(1/2 + \varepsilon)d$. Then G_0 is Hamiltonian. This proves a conjecture of Ben-Shimon, Krivelevich and Sudakov. Our result is best possible: firstly, the condition that d is large cannot be omitted, and secondly, the minimum degree bound cannot be improved.

On the representation theory of automorphic Lie algebras

Drew Duffield, Loughborough University

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Automorphic Lie algebras are a class of infinite-dimensional Lie algebras that are closely related to a wide variety of algebraic structures that appear in integrable systems theory, mathematical physics and geometry. They can be viewed as a certain generalisation of the well-studied (twisted) loop algebras and current algebras, which have both generated an enormous body of research and spawned many exciting new developments in mathematics. Automorphic Lie algebras are constructed using three basic ingredients: a simple complex Lie algebra $\mathfrak{g}$, a commutative associative algebra A of meromorphic functions on the Riemann sphere (with poles restricted to a finite set of points), and a group G acting on both $\mathfrak{g}$ and A by automorphisms. Unfortunately, it can often be difficult to immediately gain an intuitive understanding of the algebraic structure behind an automorphic Lie algebra. For this, it is incredibly useful to look at the representation theory of the algebra. In this talk, the audience shall receive an introduction to these algebras followed by a discussion of some results concerning their structure that arise from representation theory.

Resilience with respect to Hamiltonicity in random graphs

Alberto Espuny Díaz, University of Birmingham
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This research is joint work with Padraig Condon, Jaehoon Kim, Daniela Kühn and Deryk Osthus.

The study of sufficient conditions for Hamiltonicity has provided many results, with Dirac's theorem being a well-known minimum-degree condition. Hamiltonicity is also one of the most studied properties in random graphs. Sudakov and Vu recently introduced the concept of *resilience*, which can be seen as an extension of the minimum degree conditions for Hamiltonicity to the setting of random graphs, and Lee and Sudakov proved a version of Dirac's theorem in this setting.

In this talk, I will present the concept of resilience, as well as the results of Lee and Sudakov, and discuss new results generalising the analog of Dirac's theorem to other degree sequences.

Heat kernel expansion of the Dirac–Laplacian of multifractal Robertson–Walker metrics

Farzad Fathizadeh, Swansea University
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This research is joint work with Yeorgia Kafkoulis and Matilde Marcolli.

I will talk about a recent work in which we find an explicit formula for each Seeley–deWitt coefficient in the full heat kernel expansion of the Dirac–Laplacian of a Robertson–Walker metric with a general cosmic expansion factor. We use the Feynman–Kac formula and combinatorics of Brownian bridge integrals heavily. The extension of the result to the inhomogeneous case, where the spatial part of the model has a fractal structure, will also be presented.

Linear and cyclic antimetrics

Esteban Gomezllata Marmolejo, University of Oxford
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The triangular inequality $m(a,b) \leq m(a,c) + m(c,b)$ characterizes the definition of a metric. Reversing this inequality leads instead to trivial spaces, where the distance between any two objects is zero.

However, if we require the inequality $n(a,b) \geq n(a,c) + n(c,b)$ to hold conditionally on a linear or cyclic order, we obtain non-trivial spaces. We call these maps "linear or cyclic antimetrics".

Furthermore, we show how the difference of a linear or cyclic antimetric and a pseudometric allows us to both construct new linear or cyclic orders, and obtain a linear or cyclic antimetric on this order.

Dynamical models for random simplicial complexes

Tejas Iyer, University of Birmingham
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This research is joint work with Nikolaos Fountoulakis, Cécile Mailler and Henning Sulzbach.

Models of scale free random graphs are ubiquitous in their application to network science. Recently, there has been a particular focus on the geometry of such networks. In this context, recently a number of authors have paid special attention to random evolving simplicial complexes as a suitable model. Motivated by this, we introduce a general model of random dynamical simplicial complexes and derive a formula for the asymptotic degree distribution. This asymptotic formula generalises results for a number of existing models, including the preferential attachment tree with fitnesses, random Apollonian networks and the weighted random recursive tree.

Ricci flows in Milnor frames

Syafiq Johar, University of Oxford

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We are going to discuss the Type I singularity on 4-dimensional manifolds foliated by homogeneous S^3 evolving under the Ricci flow. We review the study on rotationally symmetric manifolds done by Angenent, Isenberg, Knopf and Sesum. In their study, a global frame for the tangent bundle, called the Milnor frame, was used to set up the problem. This frame arises from the symmetries of the manifold, derived from the Lie group structure of S^3. Numerical simulations of the Ricci flow on these manifolds are done, providing some insight on their behaviour. Some analytic results will be proven for the manifolds $S^1 \times S^3$ and S^4 using maximum principles from parabolic PDE theory and some sufficiency conditions for a neckpinch singularity will be provided. Finally, we will pose a problem from general relativity with similar symmetries but endowed on a manifold with different topology, called the Taub metrics.

A spine curve for almost sharp fronts of singular SQG

Calvin Khor, University of Warwick

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In this talk, we will discuss a singular variant of the SQG equation, which is a PDE for the active scalar $\theta = \theta(x,t), x \in \mathbb{R}^2, t \geq 0$,

$$\begin{cases} 0 = \partial_t \theta + u \cdot \nabla \theta, \\ u = \nabla^{\perp} |\nabla|^{-1+\alpha} \theta, \end{cases} \quad \alpha \in (0,1).$$

Here, the Fourier multiplier $|\nabla| = (-\Delta)^{1/2}$ is the half-Laplacian on $\mathbb{R}^2$. For solutions that are locally constant outside a δ-neighbourhood ($\delta \ll 1$) of a curve that evolves in time, we describe a special curve called a spine supported in the neighbourhood whose evolution can be described with an error of the order of one power of δ better than a generic curve. This suggests that some structure may survive in the degenerate limit $\alpha \to 1$. This is a generalisation of the work of Fefferman, Luli, and Rodrigo.

Idealisers in rings of differential operators

Ruth Reynolds, University of Edinburgh

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Let I be a right ideal in a noncommutative ring R, the idealiser subring of I in R is the largest subring of R in which I becomes a two-sided ideal. These subrings often have interesting and pathological behaviour. In this talk we will describe some of their properties, in particular focusing on the case where R is a ring of differential operators.

Jordan algebras vs axial algebras

Yunxi Shi, University of Birmingham

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Jordan algebras are a class of non-associative algebras introduced by a German quantum physicist Pascual Jordan in 1933. The complete classification of Jordan algebras was achieved by Pascual Jordan, John von Neumann and Eugene Wigner in the finite dimensional case and by Efim Zelmanov in full generatlity. More recently the class of axial algebras was introduced motivated by applications in physics as well as in group theory. We introduce the basic concepts of both Jordan algebras and axial algebras and discuss the relationship between these two classes.

Characterising number-theoretical objects using L-series

Harry Smit, Utrecht University

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The L-series of various objects studied in number theory (e.g. number fields and elliptic curves) are complex functions that count certain invariants; in the case of number fields the L-series count the prime ideals by norm, in the case of elliptic curves the L-series count the number of points on the reductions of the curves modulo prime ideals. Two isomorphic objects always have the same L-series. In this talk we consider the inverse question: to what extent do the L-series determine the underlying object uniquely?

A generalisation of Dickson's commutative division algebras

Daniel Thompson, University of Nottingham

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Dickson's commutative semifields are an important class of finite division algebras first constructed in 1906. We generalise Dickson's construction of commutative division algebras by doubling both finite field extensions and central simple algebras and not restricting us to the classical setup where a cyclic field extension is taken. The latter case yields algebras which are no longer commutative nor associative. Conditions for when the algebras are division algebras are given that canonically generalise the classical ones known up to now. We investigate when we obtain non-isomorphic algebras and compute all the automorphisms, including the structure of the automorphism group in some cases.

Pseudo-differential operators on $SU(2)$

Pablo Vinuesa, University of Bath

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In this talk we will discuss some of the interests for studying pseudo-differential operators in the setting of the compact Lie group $SU(2)$. One of the main properties of this group is that it can be realised as the unit sphere in the space $\mathbb{C}^2$, which intuitively motivates us to study this topic. As a starting point, one can think of a pseudo-differential operator as a generalisation of a Fourier multiplier operator, which gives us a naive understanding of the roots of pseudo-differential theory. We will also discuss one of the most important elements in the analysis of these operators, which is to classify the corresponding symbols via the symbol classes S^m.

Cohomological conditions on module extensions

Matthew Westaway, University of Warwick
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This research is joint work with Dmitriy Rumynin.

Suppose one has a group G with a normal subgroup L, and a representation $\theta : L \to GL(V)$ for a finite-dimensional vector space V. A natural question in representation theory is whether this representation can be extended to a representation $\widetilde{\theta} : G \to GL(V)$. In this talk, I shall construct an object resembling an exact sequence which will provide cohomological conditions on existence and uniqueness of such an extension when V is G-stable. This approach shall provide insight into the Humphreys–Verma conjecture for algebraic groups in positive characteristic.

Applied mathematics

Accounting for observation uncertainty due to unresolved scales in data assimilation

Zackary Bell, University of Reading
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In numerical weather prediction, data assimilation is used to obtain initial conditions. Data assimilation is a state estimation method, combining observations with numerical models, taking account of their relative uncertainties. A good specification of uncertainty is key in producing accurate forecasts. This presentation will discuss the effects of assimilating observations into a numerical model with different spatio-temporal scales. In particular, the uncertainty and potential observation bias due to unresolved scales will be examined. We will discuss the Schmidt–Kalman filter that can compensate for error due to unresolved scales. Additionally, the novel use of a bias correction scheme in conjunction with the Schmidt–Kalman filter will be discussed. Through derivation of the true error covariance equation, the Schmidt–Kalman filter will be compared with other filters using a random walk model. Our results show the suitability of the Schmidt–Kalman filter for multi-scale filtering.

The 3D Painlevé paradox

Noah Cheesman, University of Bristol
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Every mathematician knows all too well that chalk can judder and squeal when pushed along a blackboard.

This phenomenon is linked to the Painlevé paradox, where no unique forward solutions exist to some rigid body problems with unilateral constraints and friction. This paradox has been a curiosity of mathematicians for over a century. But recently due to advances in mathematical techniques and the growth of robotics where the problem may prove important, there has been a surge in the study of the Painlevé paradox, both experimentally and theoretically.

In this contribution, we consider a stiff, slender rod, slipping along a rough surface. Results from developments in the 2D problem are generalised to the full 3D system. We show analytically how the planar case is singular, the introduction of the other spatial dimension complicates the dynamics and that, whilst in 2D no trajectories can enter the inconsistent region, in the 3D system, trajectories can enter the inconsistent region in finite time.

Hyperparameter optimisation of the Multilayer Perceptron Classifier

Maja Gwozdz, Ludwig Maximilian University of Munich

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In the talk I will discuss the challenges of hyperparameter optimisation of the Multilayer Perceptron Classifier (MLP) and compare the efficiency of several algorithms (random search, grid search, sequential search, among others). This machine-learning task is of great importance for a few reasons. First of all, it can radically reduce the time needed for finding satisfactory hyperparameters (or a closer range thereof) and, secondly, allow less experienced researchers to train an MLP fast and perform manual fine-tuning of the model in later stages. In the practical part of the talk I will introduce "MLP_Optimiser", a self-updating (scikit-learn-based) Python software implementing the most relevant theoretical foundations of hyperparameter optimisation. As a case study, I will present results obtained from the performance of the automatically-optimised MLP model trained on speech recognition data. In the final part I will draw conclusions from the experimental part and propose tentative ideas for further research.

Modifying the tropical version of Stickel's key exchange protocol

Any Muanalifah, University of Birmingham

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A tropical version of Stickel's key exchange protocol was suggested by Grigoriev and Sphilrain and successfully attacked by Kotov and Ushakov. We suggest some modifications of this scheme that do not use tropical matrix powers or polynomials and discuss some possibilities of attack on them.

Capturing the quasi-stationary distribution within a deterministic framework for stochastic SIS dynamics

Christopher Overton, University of Liverpool

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The stochastic SIS model represents an important class of epidemic dynamics, and is thought to accurately represent various processes, such as the spread of sexually transmitted diseases and computer viruses. A feature of this model is the existence of a single absorbing state, corresponding to the disease free state, to which the system will always converge for finite population sizes and disease transmission parameters. There has been a long history of deterministic representations of the SIS model. Relating these models to the stochastic dynamics frequently makes use of mean-field assumptions, which are derived from the infinite population limit. These models provide useful theoretical insight but do not feature the absorbing state, and therefore it is hard to link the insights back to the stochastic model. In this work we develop novel methods to account for the absorbing state of the stochastic SIS model within a deterministic framework. We do this by deriving a deterministic approximation to the quasi-stationary distribution (QSD) of the model; i.e. the long-term steady state behaviour conditional on not having reached the absorbing state. In particular, we build a system of population level equations, which when solved provide an accurate and efficient approximate to the QSD of the Markovian network-based epidemic model for a large range of networks and parameter sets.

Mathematical modelling of human embryonic stem cell colony formation

Laura Wadkin, University of Newcastle

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Human embryonic stem cells, hESCs, hold great promise for developments in regenerative medicine and are at the forefront of modern biological research due to their ability to differentiate into any type of human adult cell and their potential to self-renew indefinitely through repeated divisions. However, hESC behaviour is complex, poorly characterised and high rates of death and differentiation make them notoriously difficult to culture. As a mathematician in an interdisciplinary team at Newcastle University, I am working to optimise experiments by modelling the behaviour of hESC colonies using a combination of agent-based and stochastic techniques. Having already extracted important parameters of the kinematics of stem cells, I am now focussing on developing mathematical models of colony proliferation. A multi-population stochastic exponential model for the proliferation of hESCs captures our experimental observations and can be used as a predictive tool to achieve the best outcome for homogeneous clonal colony growth.

Maps & Directions

Conference

Talks will be held in lecture theatres A and C on the ground floor of the Watson building — R15 on the map on the next page — and lecture rooms 2 and 3 on the ground floor of the Strathcona building (R18).

Refreshments will be served in the Mason Lounge on the ground floor of the Arts building (R16) during coffee breaks.

Lunch will be in the Noble Room, on the 2nd floor of the Staff House (R24).

All buildings are located in the red zone of the full campus map which can also be downloaded at:

https://www.birmingham.ac.uk/Documents/university/edgbaston-campus-map.pdf

The annotated map on the next page can be downloaded at:

http://web.mat.bham.ac.uk/BYMC/19/images/annotated_campus_map_cropped.jpg

Accessibility

All lecture rooms as well as the coffee break venue are on the ground floor. There is a lift to the Noble Room. Please see the annotated campus map on the next page for accessible paths between the buildings.

Detailed accessibility information:

- Watson building: https://www.accessable.co.uk/venues/watson-building
- Strathcona building: https://www.accessable.co.uk/venues/strathcona
- Arts building: https://www.accessable.co.uk/venues/arts-building
- Mobility campus map with highlighted disabled parking: https://www.birmingham.ac.uk/Documents/university/edgbaston-campus-map-mobility.PDF

Please contact the organisers if you have any questions or requirements.

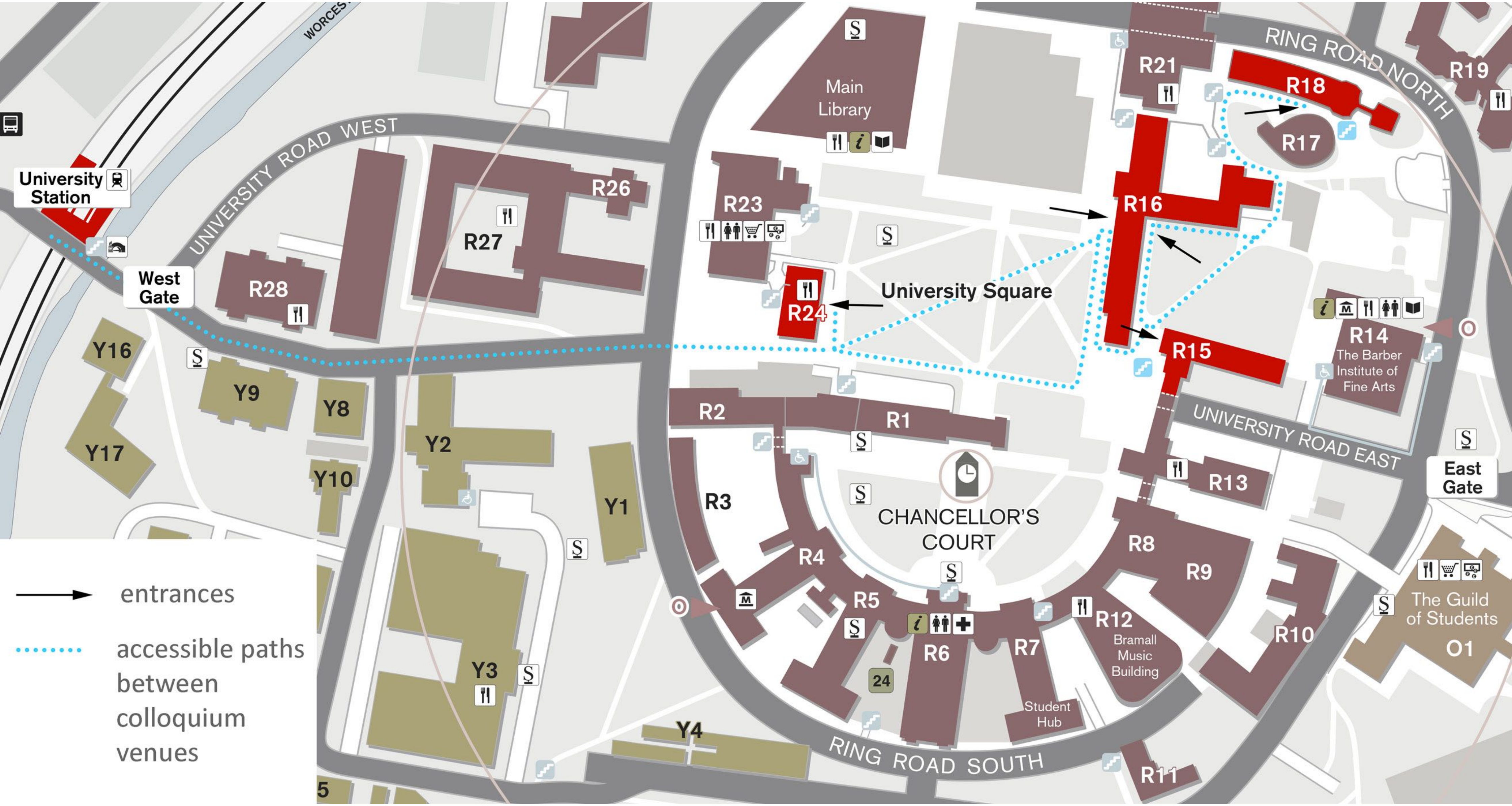
Conference Dinner

The conference dinner will be held at:

Café Rouge
172–176 Wharfside St
Mailbox
Birmingham B1 1RN

https://www.caferouge.com/bistro-brasserie/birmingham/mailbox/

The easiest way to get there from the University of Birmingham is to take the train from Birmingham University Rail Station (on the western end of campus, next to the canal, see campus map) to Birmingham New Street. Any train departing from platform 1 will call at New Street station. From there, it is a 10 minute walk to the Mailbox.



University Station
West Gate
UNIVERSITY ROAD WEST
WORCES
Main Library
RING ROAD NORTH
R21
R18
R17
R19
R16
R15
R14
The Barber Institute of Fine Arts
R26
R27
R28
R23
R24
University Square
UNIVERSITY ROAD EAST
East Gate
R2
R1
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
Bramall Music Building
R13
Student Hub
CHANCELLOR'S COURT
The Guild of Students
O1
24
Y1
Y2
Y3
Y4
Y8
Y9
Y10
Y16
Y17
5
RING ROAD SOUTH
entrances
accessible paths between colloquium venues