Manchester Interdisciplinary Mathematics Undergraduate Conference

Programme 2026

Wednesday 11th & Thursday 12th March

MIMUC
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LONDON MATHEMATICAL SOCIETY
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MIMUC 2026 Programme: Wednesday 11th March

10:00-10:30	**Registration & Welcome**	ATB G.205
10:30-11:00	**Student Talks**	ATB G.205
Veronika Lohmanova	The Game of Mind and Dice: Uncertainty Quantification	
Matt Dalgliesh	Twists, Turns, and Symmetry: the Rubik's Cube Group	
11:00-11:15	**Break**	ATB Atrium
11:15-12:00	**Student Talks**	ATB G.205
Siona Heritage	How Could Nature Compute Faster Than Silicon? Quantum Computing Through an Algorithmic Lens	
Harry Muncie	From 4 to 2: Maxwell’s Equations in Differential Forms	
Roman Galperin	The Banach–Tarski Paradox: How to clone Earth	
12:00-12:40	**Ayesha Irfan** Icebreaker and Intro to Maths Communication	ATB G.205
13:00-14:00	**Lunch**	ATB Kitchen
14:00-15:00	**Student talks**	ATB G.205
Daria Barkova	Finite Element Method: From Simple PDEs to Linear Systems	
Ashot Aslanyan	Quantum Mechanics in Pictures: How Abstract Mathematics Makes Physics Intuitive	
Swastik Bhattacharya	Learning Novel Types of Method and Theory for EEG-Based AI	
Man Claribelle Cheng	Voting Is Fundamentally Broken: Can Democracy Be Achieved?	
15:00-15:40	**Dr Charlotte Mégrourèche** Looping Mathematics: Is it Mathematics?	ATB G.205
15:45-17:00	**Student Talks**	ATB G.205
Hoi Fung Cheng	When Numbers Act on the Plane	
Tomos Smalldon	The Mathematics of Lego	
William Odumosu	Can Mathematics Make Music Sound “Good”? Tuning Systems as Optimisation Problems	
Louis Bolton	The Drunk Man & the Drunk Bird, How Dimensions Shape Random Walks	
Nurzhan Khassenov	On Fractals Arising in Plasma due to Turbulence	

MIMUC 2026 Programme: Thursday 12th March

10:00-10:15	**Registration & Welcome**	ATB Frank Adams
10:15-12:00	**Student Talks**	ATB Frank Adams
Leonie English	How Do We Build the Next Generation of Particle Accelerators?	
Giovanni Muratori	Modelling Bioheat Transport in the Lung: An Application to Bronchial Thermoplasty	
Isaac Stephens	Gauge Symmetries and the Higgs Boson	
Ecem Guvener	From Bits to Qubits: The Mathematics of Quantum Computation	
Joshua Alliet	Exposing the Future: A Mathematical Framework for Detecting Data Leakage in Medical Machine Learning	
Aneurin Quinn	Wiener Hopf Monte Carlo and their applications to Barrier options	
Myla Jeyagugan	The Randomness of Love	
12:00-13:00	**Academic Panel**	ATB Frank Adams
13:00-14:00	**Lunch**	ATB Kitchen & Bridge
14:00-14:40	**Prof Daniel Shiu** ML-KEM: The mathematics on which we are about to bet the Internet	ATB Frank Adams
14:45-16:30	**Student Talks**	ATB Frank Adams
Roxy Henderson	Representations and Characters of Finite Groups	
Sonia Balan	Emmy Noether's Ascending Chain of Abstraction	
Ammar Nagri	Neural Tangent Kernels: Modelling Neural Learning	
Daniel Jackson	Mario Kart Wii Time Trials: Geometric and Topological Analysis	
Sviatoslav Cherniak	The Arctic Game of Chicken. Merits and limitations of extensive form games in conflict studies.	
Rana Rustamli	Symmetry Forces Coincidence: An Introduction to the Borsuk–Ulam Theorem	
Harrison Reyland	The Mathematics of the Lazy Universe	
16:30-17:00	**Public Lecture Reception**	Schuster Building
17:00-18:15	**Rob Eastaway & Prize Ceremony** The Maths of Shakespeare's England	Rutherford Theatre, Schuster Building

Plenary Speaker: **Ayesha Irfan**

Welcome to MIMUC: Icebreaker and Intro to Maths Communication

This session serves as both an icebreaker and an introduction to the world of mathematics communication. We will cover some useful advice on explaining mathematics to different audiences and how to present complex ideas clearly.

Ayesha is a final year PhD student in Mathematics at the University of Bristol. She works on the intersection between Random Matrix Theory which emerged from Mathematical Physics and Number Theory. She is also a Data Scientist at Naimuri, a data intelligence company based in Manchester.

Plenary Speaker: **Dr Charlotte Mégrourèche**

Looping mathematics: Is this mathematics?

As a researcher in mathematics education, a question at the centre of my work is what gets to count as mathematics? In this presentation, I introduce a collaboration with a basket weaver who engages a distinctive form of mathematical practice through a weaving technique known as 'cycloid looping'. I present some of her pieces in which she explores numerical patterns, curvature and topological questions through material experimentation. I use these examples to open questions about what mathematics can be and who we recognise as doing it.

Charlotte Mégrourèche is a Research Associate on the Very Local Maths project. She comes from a background in mathematics teaching and conducts research in mathematics education. She is particularly drawn to questions of inclusion, and to the possibility of addressing them by reflecting on how mathematics is practiced, shared, and valued.

Plenary Speaker: Prof Daniel Shiu

ML-KEM: The mathematics on which we are about to bet the Internet

The Internet is about to make a big change as we try to deprecate our existing public key cryptography methods such as RSA and elliptic curves because they are vulnerable to attack by a moderately-sized quantum computer. In their place people are aiming to use a "module learning with errors" based approach called ML-KEM. In the talk I shall describe the mathematics behind ML-KEM and the computational problem that underpins it that we hope is hard to solve.

Daniel Shiu is Professor of Cryptography at the University of Manchester. Before academia, Daniel worked for GCHQ, the UK's intelligence, cyber and security agency for 20 years. He was the UK's Head of Cryptographic Design and Quantum Information Processing. Daniel also served as Head of the Heilbronn Institute for Mathematical Research (HIMR), which is a linchpin of the government's "Advanced Mathematics" strategy. Daniel also designs weekly puzzles for a national newspaper.

Academic Panel

Thursday 12th March 2026
Frank Adams 1&2, Alan Turing Building
12:00 Panel, 13:00 Networking lunch

Dr Nora Szakacs
(Lecturer in Pure Mathematics)

Prof Goran Peskir
(Professor in Probability)

Madalena Roque
(PhD student in Numerical Analysis)

Jasmine Hewitt
(PhD student in Pure Mathematics)

Dr Mark Muldoon
(Reader in Applied Mathematics)

Student Abstracts

Veronika Lohmanova The Game of Mind and Dice: Uncertainty Quantification
BSc (Hons) Computer Science & Mathematics (Second Year)

Congrats, you have trained your own "super-intelligent" model (perhaps even the next ChatGPT) that provides a prediction with high confidence. But even if the output probability for the chosen label is 100%, how reliable is such a prediction? Does the number "100%" mean anything in reality? And how can we work even if we disagree on the true label? Although this talk will start in a completely different direction, that is, Imprecise Probabilities, ultimately, we will reach an introduction to the field of Uncertainty Quantification in Machine Learning and Conformal Prediction in order to see how such a journey from ambiguous concepts to concrete implementation is needed for modern AI systems.

Matt Dalgliesh Twists, Turns, and Symmetry: the Rubik's Cube Group
MMath&Phys (Hons) Mathematics & Physics (Second Year)

This talk will explore group theory and its motivations using the example of a Rubik's cube. Invented in 1974 by a Hungarian architect to help his students understand 3D objects and motion, the Rubik's cube is the world's best-selling puzzle games and best-selling toy. Through the language of isomorphism, we'll show how the Rubik's cube can be represented as a group, defining its elements, and their order. We'll discuss symmetry, generators, and find out how just how large this group really is!

Siona Heritage How Could Nature Compute Faster Than Silicon? Quantum Computing Through an Algorithmic Lens
BSc (Hons) Computer Science & Mathematics with Industrial Experience (First Year)
Quantum computing promises to transform computation by harnessing the principles of quantum mechanics, superposition and entanglement, to perform tasks that are intractable for machines of the Silicon Age. In this talk, I will introduce the fundamental structure of quantum computation and illustrate how it departs from classical paradigms through the manipulation of qubits and carefully designed transformations. In order to contextualise potential usage, I will elaborate on some algorithms that rely on quantum mechanics' applied mathematics. Shor's algorithm efficiently factorises large integers by reducing the complexity of factoring from exponential to polynomial time, with profound implications for cryptography. [Cont. overleaf].

Siona Heritage How Could Nature Compute Faster Than Silicon? Quantum Computing Through an Algorithmic Lens

BSc (Hons) Computer Science & Mathematics with Industrial Experience (First Year)

...Grover's algorithm, meanwhile, provides a systematic way to accelerate search and optimisation problems wherever one must sift through large numbers of possibilities. These are made possible by techniques I will explore, such as the quantum Fourier transform and amplitude amplification. Core aspects of modern computation, from database queries and encryption to aspects of machine learning and logistics, could be changed fundamentally through this new technology. I will contextualise both the transformative potential and the current practical challenges of the field, and whether implementing the Quantum Age of computing is feasible.

Harry Muncie From 4 to 2: Maxwell's Equations in Differential Forms

MMath&Phys (Hons) Mathematics & Physics (Third Year)

James Clerk Maxwell originally formulated 20 equations in his 1865 paper, "A Dynamical Theory of the Electromagnetic Field." These equations were later refined and condensed by Oliver Heaviside into the four vector calculus equations we know today. In this talk, I will informally introduce the notion of differential forms and demonstrate their applications to physics, showing how we can rewrite those four equations into just two.

Roman Galperin The Banach–Tarski Paradox: How to clone Earth

BSc (Hons) Computer Science (First Year)

Imagine taking a solid ball, cutting it into a handful of pieces, and rearranging those pieces to create two balls identical to the original. No stretching. No adding material. No tricks. Just moving the pieces around.

This is not science fiction — it is a real mathematical theorem known as the Banach–Tarski paradox.

In this talk, I will explain how such a seemingly impossible result can be true in mathematics without breaking the laws of physics. The key lies in understanding what mathematicians mean by "cutting," what kinds of pieces are allowed, and how infinity plays a surprising role. Along the way, we'll explore how mathematics sometimes produces results that challenge our intuition — and why that doesn't mean mathematics is wrong, but rather that our intuitions about infinity and space can be incomplete.

Daria Barkova Finite Element Method: From PDEs to Linear Systems
BSc (Hons) Computer Science & Mathematics with Industrial Experience (Second Year)

Partial Differential Equations (PDEs) are fundamental for modelling a wide range of physical systems. Simple cases with regular geometries and boundary conditions, such as rectangular domains with Dirichlet boundaries, usually admit exact solutions. However, most real-world problems rarely satisfy these ideal conditions. For example, when modelling how a car deforms during a crash to predict safety performance, the resulting system is complex and generally cannot be solved exactly. Therefore, numerical methods are used instead to simplify the system and approximate solutions. One of the most powerful of these methods is the Finite Element Method (FEM), widely used across many engineering applications. The main idea behind FEM is to divide a complex domain into a finite number of small elements with simpler equations. After solving each element individually, the solutions are then assembled to simulate the behaviour of the entire system. In this talk, we will construct the FEM for Poisson's equation in one dimension to illustrate the main idea of the method and allude towards how it can be generalised to more complex systems.

Student Abstracts

Ashot Aslanyan Quantum Mechanics in Pictures: How Abstract Mathematics Makes Physics Intuitive
MMath&Phys (Hons) Mathematics & Physics (Second Year)

Category theory, originally developed in the mid-20th century for applications in algebraic topology, has since become a powerful unifying framework across many areas of mathematics. Remarkably, it also offers an highly intuitive perspective on quantum mechanics. In this talk, we introduce basic ideas of category theory as they apply to quantum mechanics and develop its diagrammatic (picture) calculus. We will see how this visual aproach can make deep physical and algebraic results suprisingly simple.

Swastik Bhattacharya Learning Novel Types of Method and Theory for EEG-Based AI
MSc Statistics

Understanding human decision-making through EEG signals remains a fundamental challenge due to the complex, high-dimensional nature of neural activity. In this study, we explore novel EEG-based AI theory and methods that integrate directional deep learning, geometrical modelling, and probabilistic inference to capture cognitive states during multi-class choices. A simulation environment was designed to consider multiple decision scenarios, enabling us to refine methods and discover patterns beyond traditional deep learning. Directional deep learning is particularly suited for identifying circular and angular patterns in EEG microstates, allowing more precise detection of hesitation, certainty, and choice-related brain activity. Using the DEAP dataset, which includes EEG recordings of 32 participants responding to music videos, along with binary arousal and valence labels, we performed directional analysis of brain waves and geometric modelling of mouse trajectories to infer cognitive states and choice probabilities. Our study demonstrates that combining simulation-based learning, geometrical analysis, probabilistic inference, and directional deep learning improves prediction and interpretability of cognitive states compared to conventional models. This approach provides new insights into brain behaviour dynamics and extensions for advanced AI applications in neuroscience and life sciences.

Man Claribelle Cheng Voting Is Fundamentally Broken: Can Democracy Be Achieved?
MMath&Phys (Hons) Mathematics & Physics (Second Year)

Can a ranked voting system ever be truly fair? We rely on votes to turn individual opinions into collective decisions, assuming that fair outcomes will follow. But can any system genuinely satisfy our basic definition of fairness? By modelling votes as ranked orderings and voting rules as mathematical functions, we can make "fairness" precise. Arrow's Impossibility Theorem delivers a striking conclusion: when there are three or more options, no voting system can satisfy a small set of natural and seemingly essential fairness conditions simultaneously. Through combinatorial reasoning and probabilistic paradoxes, we see how contradictions inevitably arise. Ultimately, this talk explores the structural limitations of voting systems and the deep mathematical challenges inherent in collective decision-making.

Hoi Fung Cheng When Numbers Act on the Plane
MMath (Hons) Mathematics (Second Year)

Consider multiplying a complex number z by i. On an Argand diagram, this corresponds to rotating z anticlockwise by 90°. This observation suggests that complex numbers can be viewed as transformations of the plane $\mathbb{R}^2$. In this talk, we first interpret complex numbers as linear transformations on $\mathbb{R}^2$ by constructing a matrix representation for each complex number. We then use this perspective to investigate the geometric effect of multiplying complex numbers. Finally, we extend this idea to similar number systems, such as the split-complex numbers and the dual numbers.

Tomos Smalldon The Mathematics of Lego
MPhys (Hons) Physics (Second Year)

Whilst Lego may initially seem to be a somewhat boring object mathematically, the ways that builders are able to break out of the system using the geometry of the pieces is anything but. In this talk I will be exploring the ways that unusual pieces are used in unexpected ways, and how so-called "illegal" techniques arise.

Student Abstracts

William Odumosu Can Mathematics Make Music Sound “Good”? Tuning Systems as Optimisation Problems
BSc (Hons) Mathematics (First Year)

Everyone agrees that twelve-tone equal temperament (12-TET), the tuning system behind every piano you have ever played, is the "best compromise." But best at what, exactly? Nobody seems to say. This talk takes that vague claim seriously and turns it into actual mathematics. Starting from the harmonic series and just intonation, I build an optimisation framework where tuning systems are evaluated against explicit loss functions (L1, L2, L∞) with musically motivated weightings that let you prioritise fifths, thirds, or full triads. I then compare 12-TET against alternatives like 19-TET, 31-TET, and quarter-comma meantone, and the results are surprisingly humbling for our favourite twelve notes: 12-TET is not universally optimal, and which system "wins" depends entirely on what you care about. The talk also explores how you can pull weights directly from a real piece of music, so the composer effectively gets to define the objective function. No prior music theory required, just a fondness for asking whether numbers can tell us what sounds beautiful.

Louis Bolton The Drunk Man & the Drunk Bird, How Dimensions Shape Random Walks
BSc (Hons) Mathematics with Finance (Third Year)

A well-known joke in probability says that "A drunk man always finds his way home, while a drunk bird gets lost forever". Behind the humour lies an interesting and important mathematical truth, the behaviour of a random walk depends almost entirely on the dimension and size of the space it moves through. In this talk, we aim to explore the world of Brownian motion that dictates the movements of the drunken man and bird, and see why two dimensions are just enough for the man to come back, while three dimensions make the bird disappear and leave forever. We'll understand what recurrence and transience really mean, look at simple ways to understand why two-dimensional random walks return almost surely. We will also add conditions to make the problem more realistic and see how it affects our results, such as the time it will take to find our way back and the amount of distance we can truly travel.

Nurzhan Khassenov On Fractals Arising in Plasma due to Turbulence
BSc (Hons) Mathematics & Physics (Second Year)

Controlled fusion reaction is promising infinite cheap energy for humanity. However, there are significant challenges in plasma physics and engineering have to be overcome before commercial energy production. One of these challenges is turbulence in plasma flowing in reactors, this effect can lead to loss of precious tritium necessary to run reaction. In this talk we will discuss physical origin of turbulence and show beautiful mathematical structures arising from non-linearities in plasma.

Leonie English How Do We Build the Next Generation of Particle Accelerators?
MPhys (Hons) Physics (Fourth Year)

Particle accelerators are important and versatile tools, with wide applications ranging from proton beam therapy in cancer treatment to searching for new physics entirely, through the Large Hadron Collider at CERN. An increasingly prominent issue is the scale of these accelerators. Current technology requires hundred-kilometre scale size and multi-billion-dollar radiofrequency (RF) cavities to be used for particle acceleration, with the next generation of colliders being estimated to cost billions of dollars due to size. Therefore, new methods of acceleration with smaller size scales are actively being pursued. One such method is laser-driven wakefield-acceleration (LWFA). In this talk I will present my year-long research into LWFA, focusing on the mathematical framework describing how particles can be accelerated to 99.9% of the speed of light by a laser propagating through plasma over only a few centimetres. The analysis is based on relativistic magnetohydrodynamics, which lies at the intersection of fluid mechanics, electromagnetism, and special relativity. This system of nonlinear partial differential equations describes the formation of plasma wakefields and provides the theoretical framework for analysing particle acceleration in LWFA.

Student Abstracts

Giovanni Muratori Modelling Bioheat Transport in the Lung: An Application to Bronchial Thermoplasty
MMath (Hons) Mathematics (Fourth Year)

Asthma is a chronic inflammatory disease of the airway, with severe cases accounting for 5-10% of all asthmatics, accompanied by more critical symptoms and a disproportionate escalated social cost. Bronchial thermoplasty aims to combat this by application of electrical current induced thermal energy to the airway wall interior, to reverse some of the airway remodelling characteristic of asthma. Although this has demonstrated benefits, including reduced exacerbations and hospitalisations, it is unclear how it has done so, with predicted and recorded temperatures insufficient in current bioheat models to cause the airway remodelling believed necessary for improvement. So, do existing models underpredict tissue temperature? We will assess some standard diffusion models for both the electric potential and heat in the tissue, observing how this changes for varying boundary conditions and parameters. We will then divide our tissue into a multi-layered continuum, as opposed to single layered, and see how differing material properties in these layers affects the potential and heat distributions. We will conclude by stepping beyond current multi-layered continuum models, using multiscale homogenisation to ask the more novel question: can features of the microstructure increase local temperature to nearer the appropriate anticipated levels?

Isaac Stephens Gauge Symmetries and the Higgs Boson
MPhys (Hons) Physics (Second Year)

The origin of the Standard Model of particle physics from a mathematical standpoint discussing how Noether's theorem leads to the discovery of the Higgs boson using mathematical symmetry and conservation. Further examples of how Noether's theorem is applied to quantum mechanics.

Ecem Guvener From Bits to Qubits: The Mathematics of Quantum Computation
BSc (Hons) Computer Science (First Year)
Classical computers store and process information using bits that take the values 0 or 1. Quantum computers, however, operate using quantum bits, or qubits, which can exist in superpositions of states. This seemingly simple difference leads to a fundamentally different mathematical model of computation. Some problems believed to be practically impossible for classical machines may become feasible on quantum computers. For example, factoring a 2048-bit number, a task that could take classical computers longer than the age of the universe, could theoretically be solved in hours using a sufficiently powerful quantum computer and Shor's algorithm. In this talk, we explore the mathematical framework behind quantum computing. Qubits are represented as vectors in complex vector spaces, and quantum operations correspond to unitary transformations acting on these states. This linear algebraic perspective allows quantum systems to exploit phenomena such as superposition, interference, and entanglement. By connecting ideas from quantum mechanics, linear algebra, and computer science, this talk provides an accessible introduction to the mathematics of quantum computation and explains why quantum computing represents a profound shift in our understanding of computation itself.

Joshua Alliet Exposing the Future: A Mathematical Framework for Detecting Data Leakage in Medical Machine Learning
BSc (Hons) Computer Science & Mathematics (Third Year)
Machine learning models predicting glioma survival often report highly inflated performance metrics due to 'data leakage', whereby features encoding future events are inadvertently included as predictors during training. We will explore a methodologically rigorous approach to diagnosing and quantifying this phenomenon. Using a dataset of 203 glioma patients, we developed a systematic four-step leakage detection pipeline combining statistical screening (correlation analysis) with clinical temporal reasoning. By mathematically examining how algorithms like XGBoost optimise loss functions, we illustrate how models opportunistically exploit these illegitimate temporal features. Applying our framework identified seven progression-related variables that constituted data leakage. Removing these features resulted in a 7.7% relative reduction in classification performance, with the AUC dropping from 0.730 to 0.674, which represents the true statistical cost of honest evaluation. [Cont. overleaf].

Student Abstracts

Joshua Alliet Exposing the Future: A Mathematical Framework for Detecting Data Leakage in Medical Machine Learning
BSc (Hons) Computer Science & Mathematics (Third Year)

...We further validated our clean models using Random Survival Forests, achieving a concordance index of 0.706. This presentation will touch on the mathematical mechanics of data leakage, showing that in interdisciplinary mathematical modelling, establishing a transparent methodology is far more scientifically valuable than merely optimising performance metrics.

Aneurin Quinn Wiener Hopf Monte Carlo and their applications to Barrier options
MMath (Hons) Mathematics (Fourth Year)

This presentation explores a new method for Monte Carlo simulation, the Wiener Hopf Method. We focus on generating paired samples of Brownian motion and its supremum, the highest point the process has reached so far in a given time interval. We investigate using simulation techniques to find the value of barrier options, a type of financial option which is dependent on knowing the path of Brownian motion and its supremum. In the traditional Monte Carlo Simulation, due to the nature of not being able to represent a truly continuous function using computers (we can make incredibly small intervals but never continuous), we often find that our simulation undervalues this financial option. The improved Wiener Hopf method is able to generate samples of the processes directly as pairs, escaping the limitation of computer software, and performs significantly better.

Myla Jeyagugan The Randomness of Love
MMath&Phys (Hons) Mathematics & Physics (Fourth Year)

Fate, destiny or just a stochastic process? In its most simplest form, the movement of humans is often modelled as a random walk. However, humans aren’t exclusively random, so maybe meeting our loved ones is more intentional than we realise. In this talk, we introduce the idea of modelling chance encounters as random walks and then developing this to a pedestrian model specifically the Social Force Model. We will look at the social forces that drive a person motion and how these models are used in urban planning and disaster management.

Roxy Henderson Representations and Characters of Finite Groups
MMath (Hons) Mathematics (Fourth Year)

Representation theory is a powerful, recent development in pure mathematics allowing us to study algebraic objects such as groups, rings and algebras all in the same framework. In essence, a representation of a group is just associating linear maps to the group elements to act on a vector space. We can then see some profound realisations of these groups as symmetries of certain shapes.

Sonia Bălan Emmy Noether's Ascending Chain of Abstraction
MMath (Hons) Mathematics (Third Year)

In 1915, Emmy Noether was brought to Göttingen to help rescue Einstein's theory of relativity. Simultaneously, she was forbidden from lecturing under her own name and worked unpaid despite the support of figures such as Hilbert and Klein. Her principal talent was her ability to strip structures of everything irrelevant, allowing her to survey mathematical objects at the level of their minimal axioms. This talk uses Noether's story to motivate this abstract spirit. I introduce rings and ideals as tools for understanding algebraic systems globally, and explain Noether's insight that several notions of "well-behavedness" are equivalent. One formulation requires that any ascending chain of nested ideals must eventually stop. Rings satisfying this principle are called Noetherian. The second part draws on my project, which asks how much of this finiteness survives beyond the commutative setting. I discuss some objects called 'skew polynomial rings', where commutativity is broken, and show how Noetherianity can persist. By passing to increasingly abstract versions of these rings, I arrive at a most general construction built directly from the axioms. I conclude with the story of Noether's life full of disruption, and what we still have to learn from it.

Ammar Nagri Neural Tangent Kernels: Modelling Neural Learning
BSc (Hons) Computer Science & Mathematics with Industrial Experience (First Year)

Neural networks are expensive and time-consuming to train, therefore is it possible to model the evolution of the network with much less computing power? Modern neural networks are over-parameterised and seen as a mysterious black box. However, when considering their width to be infinite, their training dynamics through gradient descent corresponds to previously defined kernel methods. [Cont. overleaf].

Student Abstracts

Ammar Nagri Neural Tangent Kernels: Modelling Neural Learning
BSc (Hons) Computer Science & Mathematics with Industrial Experience (First Year)
...Introduced in 2018, Jacot, Gabriel and Hongler defined a neural tangent kernel (NTK), providing a strong theoretical framework, formalising how neural networks can learn and generalise. In this talk, I will introduce NTKs and define the mathematics and intuition behind them. I will first define how neural networks can be modelled as a high-parameter function and then highlight how their learning dynamics linearise as their width increases. Then this linearisation leads to predictive generalisation results, connecting neural networks to Gaussian processes. Then, I shall introduce the applications of NTKs in practical machine learning and show a demonstration of their application on a sin(x) curve. This talk will highlight the intersection between functional analysis, differential equations and probability and their contribution to define a key concept for mathematical machine learning.

Daniel Jackson Mario Kart Wii Time Trials: Geometric and Topological Analysis
MMath&Phys (Hons) Mathematics & Physics (Third Year)
Mario Kart Wii is a racing game with an active time trial community, where hundreds of world records continue to be set each year. With each time trial being saved as a ghost file (.rkg) that records controller inputs frame by frame, we can model this as a multivariate discrete-time series representing trajectories in a high-dimensional input space and analyse input trends. This project investigates whether elite and intermediate players exhibit distinguishable geometric and topological structure in their input trajectories. By analysing curvature, smoothness, and delay embeddings, we can examine whether higher-level play occupies a structured, lower-dimensional region of input space. We further assess whether stylistic similarity between players can be identified independently of track or vehicle choice, and whether controller input alone contains sufficient information to characterise individual players.

Sviatoslav Cherniak The Arctic Game of Chicken. Merits and limitations of extensive form games in conflict studies.
BA Economics (Second Year)
The example of the Greenland crisis will be selected to highlight how a deeper understanding of path dependency and strategic inertia is needed for thinking holistically about modern conflict. Mixed strategies and extensive form games would be utilised to provide an example of a classic game theory application in modern IR studies as an example of applied math in humanities.

Rana Rustamli Symmetry Forces Coincidence: An Introduction to the Borsuk–Ulam Theorem
BSc (Hons) Computer Science & Mathematics (First Year)

At any given moment, are there two places on Earth with the exact same temperature and atmospheric pressure? Despite the apparent unpredictability of weather systems, topology provides a definitive answer: Yes. This striking conclusion follows from the Borsuk–Ulam Theorem, which states that for any continuous function from an n-dimensional sphere to n-dimensional space, there exist two antipodal points that share the same image. This talk explores how symmetry and continuity together impose unavoidable constraints on continuous maps. Beginning with the one-dimensional case and its connection to the Intermediate Value Theorem, we will build geometric intuition for why coincidence is forced in higher dimensions. By bridging the gap between abstract topological spaces and real-world planetary data, this presentation demonstrates that mathematical certainty can exist even within the most unpredictable physical systems. No matter how the wind blows, the Earth is always home to a pair of "climatic twins."

Harrison Reyland The Mathematics of the Lazy Universe
MPhys (Hons) Physics (Second Year)

Why does the universe work the way it does? Starting from the principle of least action, this presentation uses the method of calculus of variations to derive one of the most famous equations in physics, the Euler-Lagrange equation. This is then used to explore the motion of a double pendulum, demonstrating how easily chaotic behaviour can arise in nature.

MIMUC 2026 Public Lecture

Rob Eastaway

The Maths of Shakespeare's England

Rob Eastaway is a mathematician and author of books such as "Why Do Buses Come in Threes?", "What is a Googly?", and "Maths On The Back of an Envelope". Join him on Thursday 12th March at 5pm in the Rutherford Lecture Theatre of the Schuster Building where he'll be giving a talk on "The Maths of Shakespeare's England":

What do Shakespeare and Maths have in common? It turns out to be...a lot! In this engaging talk which connects history, maths and literature, Rob Eastaway reveals the surprising mathematical connections between Shakespeare and the world he lived in. Find out how Tudors multiplied, why dice games were a hazard for the unwary, and why Shakespeare really did make much ado about 'nothing'. With historical asides about calendars, optics, music and magic thrown in, this is a fascinating insight into a Renaissance world in which every subject was connected.

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Special thanks to Dr Mary Moschou, founder of MIMUC