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MANCHESTER 1824
The University of Manchester

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Programme of events

Wed 19th and Thu 20th March

Alan Turing & Nancy Rothwell Buildings

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Website:
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Look out for

- **plenary speakers, including mathematician, author and science communicator Katie Steckles,**
- **Q&A panel with academics,**
- **student talks,**
- **networking opportunities.**

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Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Wednesday 19th March

11:00-11:20	**Registration & Welcome Talk**	*ATB Foyer and G205*
11:20-12:00	**Maja Drmač** Full-stack software engineer at Amex	*ATB G205*
12:00-13:00	**Student talks**	*ATB G205*

Zhaojie Cheng — From Rapid Memory Encoding to Equations

Tymofii Sagatyy — Exploring Combinatorial Game Theory through Tic-Tac-Toe

Jakub Šťavina — Games With Gaussian Integrals: Kelvin to Feynman

13:00-13:40	**Lunch break**	*ATB 1st Floor Bridge Area*
13:40-14:20	**Dr Saleh Zarepour** Senior lecturer in Philosophy	*ATB G205*
14:20-15:40	**Student talks**	*ATB G205*

Amy Armitage — On the validity of classical logic within physics

Arya Mosahab — The Use of HRV as a Predictor of Strokes

Aiden Thomas — The Use of Three-Dimensional Nullclines to Visualise Three-Variable Differential Equations

Veronika Lohmanova — Idealized ruler and collapsing compass: Euclidean geometry

15:40-16:00	**Afternoon break**	*ATB G205*
16:00-17:20	**Student talks**	*ATB G205*

Hoi Fung Cheng — Gödel's Incompleteness Theorems

Eun Hong Park — The Interplay between Algebra and Topology from a Galois-Theoretic perspective

Louis Bolton — Decisions, Decisions: Finding "The One" with the 37% Rule

Fawaz ATA Bouhamad — Mathematical Models for Sustainable Agriculture: Using Differential Equations to Optimize

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Thursday 20th March

10:50-11:00	**Registration**	*ATB Foyer*
11:00-12:00	**Student talks**	*ATB Frank Adams 1&2*
Dasha Barkova	Continuity and Its Application in Brouwer's Fixed-Point Theorem	
Rebecca Hutchinson	Securing a Vault: The Mathematics of Secret Sharing	
Peyman Ramezanpour	Undecidability and Limits of Computation in Geometry	
12:00-13:00	**Academic Panel**	*ATB Frank Adams 1&2*
13:00-13:40	**Lunch Break**	*ATB 1st Floor Bridge Area*
13:40-14:40	**Student Talks**	*ATB Frank Adams 1&2*
Azim Azimli	(Not So) Complex Numbers	
Ansar Adibay	Introduction to Supergeometry	
Rebecca Maver	Your Computer is a Girl: The History of Female Calculation	
14:40-15:00	**Break**	
15:00-15:40	**Student Talks**	
Na Wang	Computational Methods for Modelling Pipelines	
Jonty Male	From Babble to Babel: Formal Languages and Diagrams	
16:15-17:00	**Drinks Reception**	*Nancy Rothwell Foyer*
17:00-18:00	**Dr Katie Steckles** Mathematician, presenter and author **Prizes for Best Student Talks**	*Nancy Rothwell ThB*

Remember to book a ticket!

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Plenary Speaker: Maja Drmač

How certain is your machine learning model?

A mathematical perspective

Machine learning models make predictions all the time—from recommending movies to assisting in medical diagnoses. But how confident should we be in their answers, and how do we measure this confidence?

This talk introduces the fundamental, yet often overlooked, concept of uncertainty in machine learning. We will try to intuitively define the uncertainty, discuss the most well-known approaches to quantifying uncertainty and present the challenges these methods bring. Finally, through intuitive real-world examples, we will see why understanding uncertainty matters for safer and more reliable AI!

Maja completed her BSc in Mathematics at the University of Manchester in 2023, and recently graduated with an MSc in Computer Science from the University of Edinburgh. She has previously interned in a variety of developer and research roles in companies such as Google and DeepMind. She is now working as a full-stack software engineer at American Express.

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Plenary Speaker: Dr Saleh Zarepour

Two Medieval Arguments Against Infinities

Many medieval philosophers believe that no infinity can actually exist in the extramental world. They offered various arguments to justify their finitist view. In this talk, I briefly discuss (1) the origin of two such arguments, (2) how they became popular in three medieval traditions of Islamic, Jewish, and Christian philosophy, and (3) the relevance of these arguments to our contemporary conception of infinity.

Saleh is a senior lecturer in the Department of Philosophy at the University of Manchester. His research interests include philosophy of mathematics and logic as well as medieval Islamic philosophy and the philosophy of religion and language.

Plenary Speaker: Dr Katie Steckles

Maths' Greatest Unsolved Puzzles

Katie Steckles will talk to us about Math's Greatest Unsolved Puzzles. While mathematicians are undoubtedly brilliant, and their work is used in all kinds of amazing scientific and technological discoveries, there are still questions they can't answer. Every mathematical question is a puzzle to be solved, and while there'll be plenty of puzzles for you to chew on, we'll also discuss some of the questions that still leave mathematicians stumped - from simple-sounding number and shape problems to some truly mind-bending fundamental questions.

Katie Steckles is a mathematician based in Manchester, who gives talks and workshops and writes about mathematics. She finished her PhD in 2011, and since then has talked about maths at universities, schools events, festivals, on BBC radio and TV, in books and on the internet.

Please make sure you have registered for a ticket to Katie's talk.

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

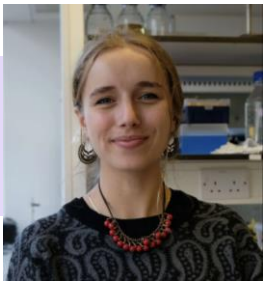
Ask questions and gain insight into life as an academic…

Marcus Tressl
Lecturer in Pure Mathematics

Ashleigh Hutchinson
Lecturer in Applied Mathematics

Nikesh Solanki
Lecturer in Mathematics (Teaching & Scholarship)

Christiana Charalambous
Lecturer in Statistics



Charlotte Taylor Barca
PhD in Applied Mathematics

Milo Edwardes
PhD in Pure Mathematics

Academic Panel

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Student Abstracts

Zhaojie Cheng BSc Mathematics and Physics (Second Year)

From Rapid Memory Encoding to Equations

This seminar will explore the fundamental mechanisms of rapid memory encoding, bridging the gap between biophysical processes and computational models of episodic memory formation. I will start by introducing one-shot learning how episodic memories can form after a single exposure to a novel stimulus. A key focus will be Behavioral Time Scale Plasticity (BTSP), a newly discovered form of synaptic plasticity in hippocampal circuits. BTSP enables rapid memory encoding by linking pre- and postsynaptic activity within behaviorally relevant time windows.

Then I will present how the biophysical model of BTSP can be simplified into a one-dimensional mapping, offering an intuitive description of how synaptic weights change following a single learning event. Afterward, I will discuss the role of memory storage in recurrent neural networks, demonstrating how spatial memories can be stored and retrieved in hippocampal-like networks as stable attractor states.

Finally, I will talk about the insights into BTSP could contribute to the development of therapeutic strategies for memory-related disorders, such as Alzheimer's disease, by identifying targets for enhancing memory formation and storage in impaired neural circuits.

Tymofii Sagatyy BSc Computer Science & Mathematics (First Year)

Exploring Combinatorial Game Theory through Tic-Tac-Toe

Game theory is a powerful mathematical tool for analyzing strategic interactions, which makes it a widely used concept - it is used in economics, artificial intelligence, decision-making, and so much more. In this presentation, I would like to introduce game theory using one of the most accessible and well-known models - a classic game of tic-tac-toe. This simple yet rich game works as a great entry point for exploring key concepts used in game theory, such as the minimax algorithm, alpha-beta pruning, and the strategy-stealing argument.

I will demonstrate how these methods lead to the conclusions about the outcomes of a perfect match and whether the results can be extended further by modifying the board size and winning conditions - introducing m,n,k-games. Finally, I will touch on multidimensional variants like 3D tic-tac-toe, showing how increasing complexity introduces deeper combinatorial challenges and links to results like the Hales-Jewett theorem.

By the end of the presentation, attendees will gain a general understanding of what game theory is about, insights into fundamental algorithmic techniques, and see how these ideas extend beyond tic-tac-toe into broader game-theoretic applications.

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Student Abstracts

Jakub Šťavina MMath&Phys Mathematics and Physics (Fourth Year)

Games With Gaussian Integrals: A brief journey from Lord Kelvin to Richard Feynman

William Thomson, better known as Lord Kelvin, once reportedly quipped that a true mathematician is one to whom it is as obvious as 2 + 2 = 4 that the integral of e^{-x^2} is $\sqrt{\pi}$. In this talk, we will become mathematicians by Thomson's definition: We will begin by evaluating this fundamental Gaussian integral before considering a series of progressively more complex (but more intriguing) integrals. As we venture beyond elementary calculus, our path will take us to multidimensional Gaussian integrals, which play a crucial role in probability theory, and onward into stochastic analysis. From there, we will cross into the realm of physics, where our newfound mathematical tools will allow us to explore functional integrals. These objects, essential to Feynman's path integral formulation of quantum field theory, lie somewhat outside of mathematics, in neighbourhood of probability theory and functional analysis, at the heart of fundamental physics. Through this journey, we will see how a seemingly simple integral unfolds into a deep and far-reaching mathematical structure, shaping our understanding of both abstract mathematics and physical reality.

Amy Armitage MMathPhys Mathematics and Physics (Second Year)

On the validity of classical logic within physics

Logical reasoning evolved from times long forgotten, acting as a crucial stepping stone in our ancestor's survival by distinguishing danger from not danger. In the modern world, we use this same reasoning by assigning set values to statements - true or false. These come along with some basic rules: a statement cannot be true and false simultaneously; if a statement is not true, it must be false, and so on.

This reasoning gave rise to the creation of classical logic; the default settings that mathematics operates under. This feels like the most natural way to do mathematics, with most mathematicians using classical proofs, which are typically simpler than constructive proofs that utilise intuitionistic logic.

In general, any logical system relies on a foundation of assumptions that we cannot prove to be true. When applied to physics, it introduces a level of uncertainty as to the validity of our theories, which are usually mathematical in nature. This brings up a crucial question: is classical logic limiting our understanding of the universe? Or more importantly, does the universe abide by any logical system at all?

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Student Abstracts

Arya Mohasab BSc Mathematics (First Year)

The Use of HRV as a Predictor of Strokes

Strokes are an immense public health problem as they are the second leading cause of death worldwide. While the annual mortality rate is approximately 5.5 million, up to 50% of stroke survivors are left chronically disabled. This study investigates the extent to which heart rate variability (HRV) can be a predictor of stroke incidence. It proposes a mathematical model and algorithm to calculate stroke risk using the SDNNI metric for HRV and to be implemented in smartwatches. The study also discusses the economic and ethical considerations of this innovation.

Aiden Thomas BSc Computer Science and Mathematics (First Year)

The Use of Three-Dimensional Nullclines to Visualise Three-Variable Differential Equations

Three-variable differential equations are fundamental in many scientific and engineering fields, including epidemiology, physics, and electrical engineering. While these equations can be solved analytically or numerically, interpreting their phase-space geometry remains a challenge.

This talk explores the use of 3D nullclines as a visualisation tool to investigate the dynamics of three-variable differential equations. By constructing nullcline structures—where at least one variable's derivative with respect to time is zero—we create a structured approach to analysing equilibrium points and phase space evolution. Phase spaces are three-dimensional diagrams that represent all the possible states of a system and how it evolves over time. This method offers an intuitive alternative to computationally expensive numerical simulations, providing a more efficient way to visualise system behaviour.

Using the SIR model as a case study, we will create a generalised phase space representation to examine the influence of different initial conditions on the system's evolution. The results from the case study demonstrate that this approach simplifies the interpretation of complex dynamical systems, enhancing both computational efficiency and the accuracy of system predictions. As a result, it serves as a valuable tool in fields such as epidemiology, physics, and electrical engineering.

Veronika Lohmanova BSc Computer Science and Mathematics (First Year)

Idealized ruler and collapsing compass: Euclidean geometry

In school, we learn to construct medians, bisectors, and perpendiculars using a ruler and compass. But what if we reverse the problem? Given just one angle, one height, and one bisector of a triangle — can we reconstruct the entire triangle? This simple question leads us to the method of geometric places. In this talk, I will introduce this method and guide you through developing the necessary tools to solve the problem, offering a fresh perspective on classical Euclidean geometry.

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Student Abstracts

Hoi Fung Cheng BSc Actuarial Science and Mathematics (First Year)

Gödel's Incompleteness Theorems

Intuitively, we may think that every mathematical statement, whether as simple as Pythagoras' theorem or as complex as Fermat's last theorem, can be proven to be true or false. However, Gödel's incompleteness theorems, published by Kurt Gödel in 1931, imply that our intuition is wrong, as the first theorem states that for all consistent formal systems containing arithmetic, there exist statements that are undecidable (i.e., cannot be proven to be true or false) within the system. Further, the second theorem states that the consistency of a consistent system cannot be proven within the system itself. In this talk, we will explore the two theorems and discuss some examples of undecidable statements that result from the theorems.

Eun Hong Park MSc Pure Mathematics

The Interplay between Algebra and Topology from a Galois-Theoretic perspective: Identifying Relations between the Galois Group and Covering Space Automorphism

Évariste Galois, widely regarded as one of history's brilliant mathematicians, made groundbreaking contributions to the solvability of polynomials. His work laid the foundation for Galois theory, a fundamental area of abstract algebra.

But did you know that Galois theory has intriguing connections to topology? Specifically, the Fundamental Theorem of Galois theory has a striking analogue in topology, known as the Galois Correspondence of Covering Spaces, which establishes a deep relationship between the Galois group of a field extension and the automorphism group of a covering space.

To build intuition, we will first examine an example: a field extension K over $\mathbb{Q}$ whose Galois group is isomorphic to the multiplicative group $\mathbb{Z}/n\mathbb{Z}$, alongside a covering space of a circle C whose automorphism group is also isomorphic to $\mathbb{Z}/n\mathbb{Z}$. This example provides insight into how Galois correspondence manifests in both algebra and topology. We will then extend this understanding by constructing the Galois Correspondence of Covering Spaces in a more general setting.

By drawing parallels between these structures, we gain deeper insight into how covering spaces can be understood through the framework of Galois Theory. This exploration offers a fresh perspective on the underlying structural similarities between these seemingly distinct mathematical fields.

Louis Boulton BSc Mathematics with Finance (Second Year)

Decisions, Decisions: Finding "The One" with the 37% Rule

Having trouble with being decisive, be it with what to watch, where to eat or even finding a partner? As the solution to the Secretary Problem, a classic problem in optimal stopping theory, the 37% rule uses statistical analysis to optimise decision making, and time spent. The rule is simple, evaluate the first 37% of your options without committing, then choose the next best one that comes along. With applications ranging from investment banking to rocket science, there are many ways that the 37% rule can help you in your day-to-day life.

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Student Abstracts

Dasha Barkova BSc Computer Science and Mathematics (First Year)

Continuity and Its Application in Brouwer's Fixed-Point Theorem

The concept of continuity in mathematical analysis is relatively intuitive: draw a curve without lifting your pen off the paper and it will be continuous. However, what happens if we abstract the notion of distance from this definition? At first glance, continuity might seem impossible to define without a metric. Yet, by shifting our perspective to topological spaces with the emphasis on 'closeness' rather than distance, we can develop a more general definition of continuity.

One consequence of continuity in topological spaces is Brouwer's Fixed-Point Theorem, proved by L. E. J. Brouwer in 1912. It states that any continuous function mapping a closed, bounded, and convex set onto itself must have at least one fixed point – a point that remains unchanged after the function is applied. This theorem is fundamental in proving the existence of solutions in mathematics, even when an exact solution is unknown. For example, there must always exist at least two antipodal points on Earth with identical temperature and pressure. This result demonstrates how topology extends our understanding of continuity through abstraction and provides powerful tools for solving problems across mathematics and beyond.

Rebecca Hutchinson BSc Computer Science and Mathematics (First Year)

Securing a Vault: The Mathematics of Secret Sharing

Some secrets are too critical to be entrusted to a single individual—such as the code to a bank vault. What if we could distribute the code among a group so that no individual possesses it entirely, yet the group, when combined, can reconstruct it? This is the foundation of secret sharing algorithms. However, as threats to cryptographic security evolve, several questions arise: How secure are these algorithms? Can they withstand the power of quantum computing? And are they efficient and practical for real-world implementation?

Peyman Ramezanpour BSc Computer Science and Mathematics (First Year)

Undecidability and Limits of Computation in Geometry

Given a set of geometric tiles and a few rules for attaching them together, is there a way to make sure whether we can cover the infinite plane or not ? The well-known "Tiling Problem" brings about many deep discussions about the nature and ability of computation and the extent to which computation, as we know it, can solve various mathematical problems that might arise in geometry (and elsewhere). In this talk, I will use examples from a variant of Wang's "Domino" problem in plane geometry as well as Turing's theory of computation, to deduce that the tiling problem goes beyond the scope of computation before briefly glimpsing into the generalisation of this proof in the extraordinary works of M.C. Escher and Roger Penrose. The real aim of this talk would be to scratch the surface of a deep connection between mathematical logic and geometry; something that anyone with a passion for beauty and puzzles can appreciate.

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Student Abstracts

Azim Azimli BSc Mathematics (First Year)

(Not So) Complex Numbers

Solving problems with complex numbers is easy. Understanding what complex numbers are - not so much. In my presentation I will look at a specific way to define complex field by defining addition and multiplication functions of an ordered set (a,b), and then we will understand how “i” fits in with these functions. We will then look at graphical interpretation of the complex field and see how to utilise them with mathematical concepts and problems. Finally, we will answer the big question of why we actually need complex numbers in real life.

Ansar Adibay BSc Mathematics and Physics (Third Year)

Introduction to Supergeometry

In this talk, we will review a historical development of a rather new topic in mathematical physics called supergeometry. In particular, we will speak about how this branch of mathematics arose from the idea of supersymmetry in theoretical physics. We will introduce basic concepts of supergeometry (super vector spaces, super algebras, superspaces, functions on superspaces, supermanifolds) and the corresponding motivation. Finally, we will make a remark how these tools are used in modern theoretical physics and how they are successfully implemented in a purely mathematical context.

Rebecca Maver MMath Mathematics (Third Year)

Your Computer is a Girl: The History of Female Calculation

Before the development of computers to organise data or solve tedious equations, mathematicians had another tool at their disposal - rooms full of young women. In recent years light has been shed on some specific examples of this phenomenon, from NASA to Bletchley Park, but these were not isolated incidents. In fact, women were the largest technical workforce throughout the mid-twentieth century. Despite this, little has been discussed about the impact of women on the tech industry and, crucially, how they were pushed out. This talk will grapple with the rise and decline of female computers as a workforce, explore what their ‘mundane’ groundwork actually entailed and look at some examples based in Manchester.

Na Wang BSc Computer Science and Mathematics (Third Year)

Computational Methods for Modelling Pipelines

Have you ever wondered how pipes transport clean water, gas and sewage to and from our homes? How to detect leakages in pipes deep underground? How pipes keep constant fluid flow despite traversing mountainous and uneven terrain? Most likely not. But pipelines are vital pieces of infrastructure for our modern lives. In this talk we will discuss the mathematics behind the planning and maintenance of fluid pipelines, applying linear algebra techniques and finite difference methods to physical systems.

Manchester Interdisciplinary Mathematics Undergraduate Conference 2025

Student Abstracts

Jonty Male BSc Mathematics (Third Year)

From Babble to Babel: Formal Languages and Diagrams

There are many ways to present information, typically due to biological and social limitations we use language. There are plenty of mathematical representations of linguistic systems, and the development of these is closely tied to the progression of computer science, programming, algebra, combinatorics and physics. The famed linguist Noam Chomsky developed a hierarchy of what are now called "formal languages" and proved that these are equivalent to models such as automata and Turing machines, best described using graphical diagrams. In this talk, we explore the development of these mathematical language models back to the root of their development, and explore how pictures, graphs and diagrams can be a well-defined method to convey mathematical reasoning further.

Fawaz A T A Bouhamad MSc Structural Engineering

Mathematical Models for Sustainable Agriculture: Using Differential Equations to Optimize Ecosystems and Resources

Mathematics plays a crucial role in understanding and sustaining agricultural ecosystems. How do species interactions, soil nutrients, and carbon storage change over time? Can mathematical models help predict and optimize these dynamics for a more resilient future? Using differential equations, we explore predator-prey relationships in pest control, nutrient transport in soil, and carbon sequestration in agricultural systems. By applying Lotka-Volterra models, advection-diffusion equations, and logistic growth functions, this talk demonstrates how mathematical modeling can drive sustainable solutions in agriculture and bio-resources engineering.

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