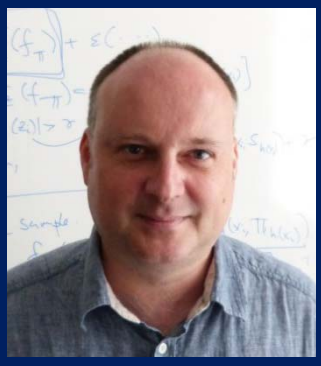
LSE Department of Mathematics

About the Department 2017



Thank you for your interest in our Department. This document provides some information about our research and teaching, our people, and what it is like to work in the Department.

The Department has grown rapidly in recent years, with new and exciting developments in research, and the introduction of new teaching programmes and modules.

The Department's research and teaching are shaped to a large extent by its position within LSE, a lively and stimulating place to work. We embrace the School's ethos of research-led teaching, and view research and teaching as complementary activities, each enhancing the other. Our aim is to be excellent both in teaching and research, in a way that reflects our location within a social sciences institution, engaging with other parts of LSE.

We offer a supportive and friendly environment in which to develop your career. We'll be happy to hear from you if you think you would like to join our team.

If you have any questions, or need more information, please consult our website or contact us on maths.info@lse.ac.uk

Professor Martin Anthony
Head of Department

Introduction

The LSE Department of Mathematics has been on a growth trajectory for a number of years now, since it was first established as a separate department in 1995. The Department of 35 members comprises: 10 Professors, 13 Associate Professors, 3 Assistant Professors, 2 Assistant Professorial lecturers, 1 LSE Fellow ,1 Centennial Professor, 1 Emeritus Professor and 5 professional services staff. It also has a team of (usually around 20) long-standing Guest Teachers, in addition to Graduate Teaching Assistants, Visiting Fellows, Visiting Senior Fellows and Visiting Professors.

Research

The Department's current research activity can, broadly speaking, be grouped into four areas (with corresponding staff indicated):

- Discrete Mathematics and Algorithms [Allen, Anthony, Batu, Biggs, Böttcher, Brightwell, van den Heuvel, Skokan, Swanepoel].
- Mathematical Game Theory and related areas [Dütting, Gossner, Lewis-Pye, Simon, von Stengel, Young].
- Financial and related Mathematics [Czichowsky, Danilova, Gapeev, Lokka, Ostaszewski, Ruf, Sasane, Veraart, Zervos].
- Operations Research [Lu, Papadaki, Sorkin, Végh, Zambelli].

These areas overlap, with some staff active in more than one area. For instance, some recent work in financial mathematics connects with mathematical game theory and addresses problems related to operations research. They are also approximate descriptors: for example, some work in discrete mathematics and algorithms, as well as in game theory, has strong links with operations research and theoretical computer science.

Our areas of research have evolved over time to be relevant to our particular position within an institution that specialises in the social sciences, and they link with work in other departments. For example, operations research has connections with Management; mathematical game theory has connections with Economics; and financial mathematics with Accounting, Finance and Statistics. Various areas of research in the Department (including discrete mathematics and algorithms) are likely to engage in research with several departments through initiatives such as the new inter-departmental research unit on Social and Economic Data Science.

Teaching

The Department is responsible for 3 Undergraduate (target 132 students p.a.) and 3 MSc programmes (target 95 students p.a.) All these programmes are in high demand and attract highly qualified students.

We have a thriving PhD programme which has grown in recent years. The PhD programme now includes taught courses delivered through the London Taught Course Centre for PhD Students in the Mathematical Sciences and the London Graduate School in Mathematical Finance; we contribute teaching to both. Additionally, PhD students are active participants in the Department's various seminar series and specialised reading groups.

We teach many students from other departments within the School and host a regular cohort of General Course (one-year visiting) students in the Department. The Department is also active in the University of London International Programmes, having introduced the successful BSc in Mathematics and Economics, delivered by flexible distance learning through UoLIP.

The Department of Mathematics plays a vital role in teaching at LSE. Even some of our specialist courses (by which we mean those taken by students on one of our own programmes) are taken in significant numbers by students on a range of programmes from other departments. We also provide 'service' courses for students not on our programmes.

Governance, organisation and decision-making

The Department has a Head and two Deputy Heads (one Teaching, one Research). The main committee in the Department is the Departmental Meeting which meets four times each year. Other committees are: Teaching Committee, Research Committee, Professors ' Committee (attended by all Full Professors) and EDI Committee.

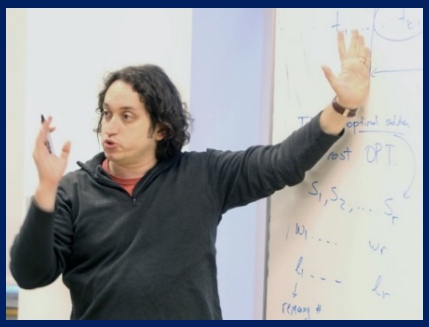
Important academic office-holders in the Department (other than the Head and Deputies) include: Chair of Teaching Committee (who need not be the Deputy Head Teaching), Departmental Tutors (one for 1st years and one for 2nd and 3rd years), MSc Programme Directors and Doctoral Programme Director.

Governance in the Department is open and transparent. Discussions relating to promotion and review are confidential items for the Professors' Committee, but all other matters are discussed in the Departmental Meetings, which all staff attend. All non-confidential meeting minutes are permanently available to staff on the intranet.

Our class teaching team also has its own meetings in the two teaching terms to discuss issues of particular relevance to them.

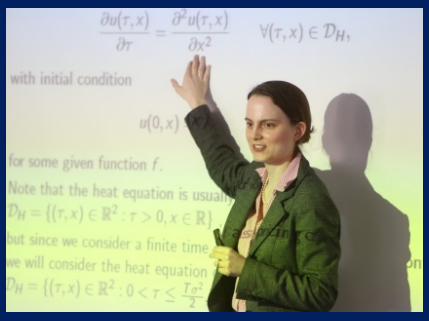
Academic Staff list 2017-18

Name	Rank	M/F	Country of PhD
Dr Peter Allen	Associate Professor	M	UK
Prof Martin Anthony	Professor	M	UK
Dr Tugkan Batu	Assistant Professor	M	USA
Dr Julia Böttcher	Associate Professor	F	Germany
Prof Graham Brightwell	Professor	M	UK
Dr Christoph Czichowsky	Associate Professor	M	Switzerland
Dr Albina Danilova	Associate Professor	F	USA
Dr Paul Dütting	Assistant Professor	M	Switzerland
Dr Pavel Gapeev	Associate Professor	M	Russia
Prof Olivier Gossner	Professor	M	France
Prof Jan van den Heuvel	Professor	M	Netherlands
Dr Ioannis Kouletsis	Assistant Professorial Lecturer	M	UK
Dr Andy Lewis-Pye	Associate Professor	M	UK
Dr Arne Lokka	Associate Professor	M	Norway
Dr Xue Lu	LSE Fellow	F	UK
Prof Adam Ostaszewski	Professor	M	UK
Dr Katerina Papadaki	Associate Professor	F	USA
Dr Johannes Ruf	Assistant Professor	M	USA
Prof Amol Sasane	Professor	M	Netherlands
Dr Robert Simon	Associate Professor	M	Germany
Dr Jozef Skokan	Professor	M	USA
Prof Gregory Sorkin	Professor	M	USA
Prof Bernhard von Stengel	Professor	M	Germany
Dr Konrad Swanepoel	Associate Professor	M	South Africa
Dr László Végh	Associate Professor	M	Hungary
Dr Luitgard Veraart	Associate Professor	F	UK
Dr James Ward	Assistant Professorial Lecturer	M	UK
Dr Giacomo Zambelli	Associate Professor	M	USA
Prof Peyton Young	Centennial Professor	M	USA
Prof Mihail Zervos	Professor	M	UK



Assistant Professor Tugkan Batu

Class teachers' meeting 2016



Associate Professor Luitgard Veraart

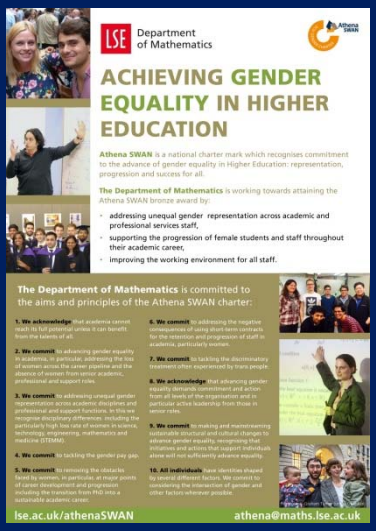
Culture survey 2016

"Meetings in my Department are completed in core hours (10am to 4pm) to enable those with caring responsibilities to attend"

100% of academic staff who responded chose "Mostly" or "Always"

Associate Professors Peter Allen and Julia Böttcher

Women in Mathematics Seminar October 2017



Athena SWAN publicity 2016

Culture survey 2016

"My department is a great place to work – for women"

100% of female responses agreed or strongly agreed

Academic staff: mentoring and review

Mentoring: The School encourages academic staff, in particular those in the early stages of their career (for whom it is required) to be assigned a senior colleague as a mentor, and to have regular meetings. The Department of Mathematics complies with this, but there is also broader, more informal networking and mentoring that takes place within and between the different research groups. The Department's formal arrangement is that every Assistant Professor has two mentors (one Associate and one Full Professor), while Associate Professors have one mentor assigned to them.

Peer observation of teaching: The Department has a system of peer observation of teaching for all teaching staff (including permanent faculty). The objectives are: to identify strengths and weaknesses, in order to help improve the quality of teaching and learning; to provide advice and support for less experienced teachers in the Department; to obtain extra information on the quality of teaching, which may be used when deciding on re-appointment of class teachers; and, for the observer, to take away possible ideas to improve their own teaching. New members of the Department are observed in their first term of teaching, and, additionally, during the next academic year. Thereafter, permanent faculty are observed at least once every three years.

Review: As is now standard LSE practice, there is an Academic Career Development Review (ACDR) meeting for all Assistant and Associate Professors.

Equity, diversity and inclusion (EDI)

The Department has a dedicated Equality Officer, whose role is to oversee all aspects of organisation regarding equity, diversity and inclusion. One of the specific duties of the role is to make sure that, as far as possible, departmental activities (seminars, meetings, social events) are scheduled during core hours, so that staff with caring responsibilities can participate fully. The Department also supports School-wide initiatives in this area, such as Unconscious Bias training for all staff. Actions towards improvements in equity, diversity and inclusion are documented in our EDI action plan, which is monitored by our EDI committee.

The Department has signed up to the London Mathematical Society Good Practice Scheme. Developed by the LMS Women in Mathematics Committee, this has the aim of supporting mathematics departments interested in embedding equal opportunities for women within their working practices. The Scheme provides specific support for departments, such as ours, working towards Athena Swan Award status. The Department is represented in the School's EDI advisors' network.

In general, LSE has excellent provisions for staff with caring roles, including generous parental and adoption leave, with additional research leave for staff following long-term absence from the School.

The Department has a Women In Mathematics seminar series. This is an academic, professional and personal development seminar series presented by leading female Mathematicians to offer support, encouragement and advice to staff and students.

LONDON MATHEMATICAL SOCIETY
GOOD PRACTICE SCHEME

Athena SWAN Member
EQUALITY CHARTER

Teaching and learning

Departmental Education Strategy

The Department's strategy in relation to learning and teaching is to improve students' learning and personal and professional development by:

- Developing and innovating in assessment, feedback and the curriculum (recognising, while staying true to understood and respected disciplinary norms, that there are many aspects of student ability that should be assessed).
- Making effective and appropriate changes to the management and organisation of teaching (in order to make best use of our abilities and facilities to help students learn).
- Building a supportive learning community (engendering a sense of cohesion, belonging and cohort identity in students on our degree programmes and a supportive learning environment for all students we teach).

An Action Plan to achieve our strategy is reviewed annual in meetings with the School's Pro Director (education) and progress is regularly communicated to the student members of the Department. We also hold termly Teaching Workshops on topics of particular interest to mathematicians.

Undergraduate programmes

The Department has three undergraduate programmes.

- BSc in Mathematics and Economics and BSc in Mathematics with Economics (97 new students each year, combined).
- BSc Financial Mathematics and Statistics (35 new students each year)

The Mathematics and Economics degree is approximately 50% mathematics and the Mathematics with Economics degree is approximately 75% mathematics. Both programmes receive the top rating on the School's programme health indicators. The Mathematics with Economics programme, introduced in 2010/11, has been significantly more popular than initially anticipated. The Financial Mathematics and Statistics degree, established with the Statistics Department, started in 2017.

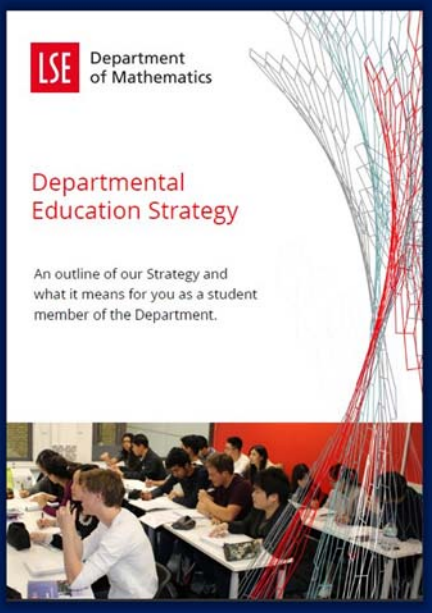
Our three-year undergraduate degree programmes provide courses in pure mathematics and mathematical methods to the national standard in these areas, complemented by courses mainly from the Departments of Economics, Finance and Statistics. These programmes enable students to learn logical argument, problem solving and mathematical modelling, appropriate to applications in social sciences. The learning of a logical framework also requires a facility with abstraction and rigorous formal developments, as well as an examination of the validity of assumptions and the validity of conclusions. As to applications, these primarily include economics, finance, operational research, and optionally some actuarial science. The teaching programme is designed so that the mathematics and the areas of its application both support each other, the latter providing a firm context for the former.

The Department, working with colleagues from the University of London International Programmes (UoLIP), also runs a BSc in Mathematics and Economics through distance and flexible learning. This programme closely mirrors the corresponding internal degree programme of the same name.

In 2015, together with the Department of Statistics, we launched a Maths & Stats Support Centre. This centre provides additional support to students through a drop-in clinic model.

Departmental Teaching Workshop summer 2017.

Maths Support Centre



Education Strategy student publicity

Undergraduate courses

MA100 Mathematical Methods
MA103 Introduction to Abstract Mathematics
MA107 Quantitative Methods
MA110 Basic Quantitative Methods
MA203 Real Analysis
MA207 Further Quantitative Methods
MA208 Optimisation Theory
MA209 Differential Equations
MA210 Discrete Mathematics
MA211 Algebra & Number Theory
MA212 Further Mathematical Methods
MA231 Operational Research Methods
MA300 Game Theory
MA301 Game Theory I
MA303 Chaos in Dynamical Systems (H)
MA305 Optimisation in Functions Spaces
MA310 Mathematics of Finance & Valuation
MA313 Probability for Finance
MA314 Algorithms in Java
MA315 Algebra and its Applications
MA316 Graph Theory
MA317 Complex Analysis
MA318 History of Mathematics
MA319 Partial Differential Equations
MA320 Mathematics of Networks
MA331 Practical Optimisation Modelling

MSc end of term party

PhD welcome event

Masters Level Courses

MA402 Game Theory
MA407 Algorithms & Computation
MA408 Discrete Mathematics & Graph Theory
MA409 Continuous-time Optimisation
MA410 Information, Communication & Cryptography
MA411 Probability & Measure
MA412 Functional Analysis & Applications
MA413 Games of Incomplete Information
MA414 Stochastic Analysis
MA415 Mathematics of the Black-Scholes Theory
MA416 Foundations of Interest Rate & Credit Risk Theory
MA417 Computational Methods in Finance
MA418 Preferences, Optimal Portfolio Choice & Equilibrium
MA419 Search Games
MA420 Quantifying Risk Modelling & Alternative Markets
MA421 Advanced Algorithms
MA422 Research Topics
MA423 Fundamentals of Operations Research
MA424 Modelling in Operations Research
MA425 Project in Operations Research and Analytics
MA426 Dissertation in Operations Research and Analytics
MA427 Mathematical Optimisation
MA428 Combinatorial Optimisation
MA429 Algorithmic Techniques for Data Mining
MA430 Efficient Algorithms for Hard Optimisation Problems
MA431 Advanced Topics in Operations Research and Applicable Maths
MA432 Programming in C++
MA498 Dissertation in Mathematics

MSc programmes

The Department is currently responsible for three MSc programmes, which score highly in the School's programme health indicators:

The **MSc in Applicable Mathematics** (12 months, full-time) draws together traditional and modern mathematical techniques in a variety of social science contexts. It is designed both for mathematics graduates who wish to make themselves more marketable by adding social science aspects to their knowledge and skills base, and for non-mathematics graduates with strong quantitative backgrounds who wish to add to and improve their understanding of the mathematics behind much of social science. Reflecting the increasing importance of computation, the programme has a compulsory algorithms and computer programming element. The MSc in Applicable Mathematics is probably one of the largest Mathematics MSc programmes in the country, other than programmes in financial mathematics.

The **MSc in Financial Mathematics** (10 months, full-time) combines the Department's strength in financial mathematics with that of LSE in finance and related areas. It develops students' understanding of the foundations of financial mathematics, and equips them with the knowledge of a range of mathematical and computational techniques that are required for quantitative positions in the financial sector. The programme starts with a compulsory pre-sessional course which introduces some key concepts and techniques. The programme provides high-level instruction in the mathematical theory underlying finance, and training in appropriate computational methods, including a compulsory computer programming element. Students take courses from the Departments of Finance and Statistics.

The **MSc in Operations Research & Analytics** (10 months, full-time, new from 2017-18) provides participants with the skills needed to apply mathematical methods to real-world analytics problems faced by companies, governments, and other institutions. With study in both practice and theory, students gain deep insight into analytics problems. They learn how to model a range of real-world problems using optimisation, simulation, and statistics, using specialist software taught with accompanying computer lab sessions. They learn to recognise the canonical underlying mathematical problems, and discover how to solve them with state-of-the-art methods. Students undertake a Project, working in a consultancy role in a host organisation, where they will turn a real problem faced by the organisation into a mathematical model whose solution provides tangible benefit. Alternatively, they may choose to write a Dissertation, supervised by a faculty member.

PhD programme

The Department has a steady influx of talented PhD students. Completion rates have been excellent. The Department (along with Statistics) is a founding member of the London Taught Courses Centre for PhD Students in the Mathematical Sciences (LTCC). This consortium provides a programme of courses for PhD students at various stages of their study. The scheme is a valuable opportunity for PhD students to have both advanced specialist teaching in their chosen field and to acquire insight into new developments across mathematics. The Department (again along with Statistics) was among the founding members of the London Graduate School in Mathematical Finance (LGSMF), a consortium of the mathematical finance groups in Birkbeck College, Brunel University, Cass Business School, Imperial College, King's College, LSE and University College London. Its main purpose has been to provide a programme of advanced courses in mathematical finance, primarily but not exclusively for first-year PhD students. In recent years, every PhD student in the Department has attended several courses in the LTCC and/or the LGSMF as part of their commitment to studying four taught courses in their first year. Other taught options come from Master's-level courses from Mathematics or related disciplines.

PhD students are active participants in the established departmental seminar series. There is also an informal weekly lunchtime seminar series, in which PhD students regularly present their work, followed by a networking lunch discussion. Additionally, there are Reading Groups in Discrete Mathematics and in Financial Mathematics. Doctoral students are encouraged (and financially supported) to attend and participate in conferences, workshops and other research meetings, both nationally and internationally.

Research

The Department of Mathematics was submitted jointly to REF 2014 with LSE's Department of Statistics: 84% of the research outputs of the two departments were classed as either world-leading or internationally excellent in terms of originality, significance and rigour.

The research work of the Department can, broadly speaking, be split into four (overlapping) areas.

Discrete Mathematics and Algorithms

The research areas covered by this group vary from pure mathematical ones (including extremal and structural properties of graphs and hypergraphs, random structures, probabilistic methods, and combinatorial geometry) to more applicable ones (including machine learning, sublinear algorithms for massive data sets, and algorithmic aspects of discrete mathematics in general). Increasing collaboration with operations research has encouraged the expansion of research in discrete algorithms as well as the development of new approaches to approximation, heuristic and randomised algorithms. The group plans to strengthen these connections further, together with growing connections with the mathematical game theory group. There is also be interest in working on 'big data' and 'analytics' as part of School-wide initiatives in these areas.

Established international collaborations include Emory University, Australian National University, Dartmouth College, Georgia Institute of Technology, Hungarian Academy of Sciences, IMPA Rio de Janiero, ENS Lyon, TU Hamburg-Harburg, Goethe-Universität Frankfurt, Liège, University of Melbourne, Adam Mickiewicz University Poznan, Charles University Prague, Rutgers, University of Sao Paulo, ETH Zürich.

Mathematical Game Theory

Game theory is a major tool and paradigm for economic theory. As a result, most game theory scholars now work in economics departments. Along with Paris and Jerusalem/Tel Aviv, LSE has one of the few mathematics departments with a concentration of game theorists. The mathematical aspects of game theory are the main focus of the group. Research topics include the economics and the strategic use of information, entropy methods, models of bounded rationality, games of incomplete information, stochastic games, and the computational and geometric structures of equilibria in games.

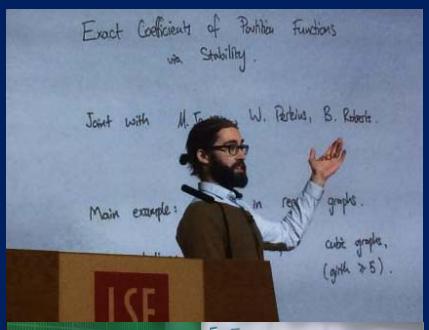
Central themes for future research include the understanding of strategic behaviour with bounded information, memory, and computational power; the diffusion of behaviour and information in networks of strategic agents; the existence of equilibria in stochastic and Bayesian games; the computational complexity of game-theoretic solution concepts.

Established international collaborations include Universities in Paris (École Polytechnique, Paris 6, Paris-Dauphine, Paris School of Economics), Pisa, ETH Zürich, Warsaw, Göttingen, Barcelona, Valencia, Tel Aviv, Jerusalem, Princeton, Stanford, Yale.

Financial and related Mathematics

This group has strong links with the Probability in Finance and Insurance group in the Department of Statistics. Taken together, they form one of the biggest concentrations of researchers in the area internationally. Within LSE, the group also has strong links with the Financial Markets Group. The research of the group covers a wide range of topics in mathematical finance and optimal control.

The group's ambition is to make theoretical advances that will be instrumental in the development of a mathematical finance theory that will enhance the stability of financial markets. Ground-breaking research activity in these directions will inevitably involve the development of genuinely new theory in the fields of stochastic processes and stochastic analysis.



Colloquia in Combinatorics 2017

Public lecture 2017

Research impact workshop 2017

Culture survey 2016

"My Department uses a diversity of people as visible role models (e.g. in staff inductions, as speakers in seminar programmes, at recruitment events)"

90% of academic staff agreed

Culture survey 2016

"My Department is a welcoming place to study as a Research Student"

100% of research students strongly agreed

Alumni reception and quiz 2017

General Course welcome breakfast 2016

Offer Holders' Day 2016

Undergraduate Christmas Party 2016

Established international collaborations include UC Berkeley, Columbia University, Humboldt University Berlin, Karlsruhe Institute of Technology, University of Duisburg-Essen, Universities in Paris (Evry Val d'Essonne, Paris Est, Sciences Po), Steklov Institute Moscow, University of Sydney, University of Vienna, ETH Zürich.

Operations Research

The operations research group has a wide range of interests, from the highly theoretical to the applied, many of which connect with those of other groups in the Department. Theoretical research areas include methods for solving linear and integer programs and network flows; polyhedral combinatorics; combinatorial optimization; network reliability; average-case analysis of algorithms for graph problems, formula satisfiability and constraint satisfaction problems; phase transitions in the same contexts; and exact algorithms for NP-complete problems. Applications, at levels from theoretical research motivated by practical problems to commercial development, include mobile network efficiency, car and truck fleet scheduling, search games and patrolling games, manufacturing optimisation, computer virus detection and recovery, and DNA sequencing. The operational research group is also keen to be involved in 'big data' and 'analytics' work.

Established international collaborations include Georgia Institute of Technology, Carnegie Mellon, MIT, Princeton, Rutgers, Waterloo, EPFL Lausanne, CWI Amsterdam, Eötvös University (Budapest), CORE Belgium, Padova, Uppsala, New South Wales, NICTA, Ohio State, Notre Dame, University of Cyprus.

Research seminars, workshops and public engagement

The Department hosts a number of series of seminars and workshops. Weekly during term-time, it has a Discrete Mathematics and Game Theory seminar, a Joint Risk and Stochastics and Financial Mathematics seminar, an Operations Research seminar, and an informal Friday lunchtime seminar. In addition to these seminars it co-hosts the bi-weekly London Mathematical Finance seminar with several other London-based universities.

In collaboration with QMUL, the Department runs a two-day Combinatorics Colloquium each year (with one day at LSE and one at QMUL), which has been financially supported by the London Mathematical Society and the British Combinatorial Committee. This has attracted some very high-profile speakers. In recent years, the Department has also organised a number of workshops in search games, in algorithmic game theory, and in infinite combinatorics. Recently, members of the Department organised the inaugural Heilbronn Institute/Alan Turing Institute workshop, on the topic of large-scale structures in random graphs.

We recently hosted public lectures by Nobel Prize-winning physicist Frank Wilczek, Professor June Barrow-Green, Professor Robin Wilson and Cathy O'Neil. We also coordinated recent EPSRC-supported Game Theory Workshops which attracted speakers including Alvin Roth, winner of the 2012 Nobel Prize in Economic Sciences. Andy Lewis-Pye (with colleagues) recently won the Infographics photograph award of the Royal Society's Picturing Science competition and Paul Dütting presented a poster at SET for Britain, at the Houses of Parliament.

The Department has set up a research blog, the goal of which is to inform an interested lay audience about our research activities. The Department engages with a widespread audience via its thriving Twitter account.