

Two one-day

# Colloquia in Combinatorics

08 and 09 May 2019

*If attending both days, please keep this programme for day two*



#CC2019 @QMULMaths @LSEMATHS

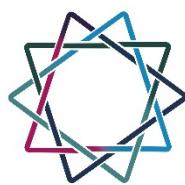
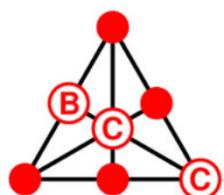
QMUL & LSE have hosted the Colloquia in Combinatorics for the past twelve years.

Thank you for joining us and supporting us through the years.

## SUPPORT

The organisers gratefully acknowledge support from:

- [The London Mathematical Society](#)
- [The British Combinatorial Committee](#)
- QMUL School of Mathematical Sciences
- LSE Department of Mathematics



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# INFORMATION

Those interested are welcome to attend for all or any part of the event; it is hoped that many people will be able to attend for both days.

Some funds are available to contribute to the **basic** travel expenses of **UK-based research students** who attend the meetings. We ask you to keep costs to a minimum, using public transport on **all** occasions and off-peak student travel tariffs wherever possible. Receipts for all journeys must be maintained as proof of travel. At this stage, we are unable to confirm the maximum amount available. Expense claim forms are available at the event from the event organisers. Please contact Enfale Farooq ([e.farooq@lse.ac.uk](mailto:e.farooq@lse.ac.uk)) for further information.

Event organisers: Julia Böttcher (LSE), David Ellis (QMUL), Jan van den Heuvel (LSE), Jozef Skokan (LSE) and Justin Ward (QMUL).

**WEDNESDAY 08 MAY 2019**

## Schedule

The first day of the Colloquia in Combinatorics will be held at Queen Mary, University of London, starting at 10.30am. Everyone interested is welcome to attend any part of the event. All the talks will be held in the Peston Lecture Theatre, Graduate Centre, Mile End Campus, QMUL. Refreshment breaks will be taken in the Graduate Centre Foyer.

Time	Speaker	Presentation title
10:00	<b>Coffee</b> (Graduate Centre Foyer)	
10:30	Péter Pál Pach	Polynomial Schur's theorem
11:20	Julia Wolf	Efficient regularity lemmas
12:05	<b>Lunch</b> (own arrangements – options on campus and nearby)	
13:40	Eoin Long	Sharp thresholds and expanded hypergraphs
14:30	Natasha Morrison	Invertibility of random symmetric matrices
15:15	<b>Afternoon tea break</b> (Graduate Centre Foyer)	
15:50	Keith Ball	Hadamard matrices and 1-factorization
16:40	Ola Svensson	Online matching with general arrivals
17:30	<b>Reception</b> (Senior Common Room, 1 <sup>st</sup> Floor, Queen's Building)	

10:30 Péter Pál Pach (BME Budapest)

### **Polynomial Schur's Theorem**

We consider the Ramsey problem for the equation  $x + y = p(z)$ , where  $p$  is a polynomial with integer coefficients. Under the assumption that  $p(1)p(2)$  is even we show that for any 2-colouring of  $\mathbb{N}$  the equation  $x+y = p(z)$  has infinitely many monochromatic solutions. Indeed, we show that the number of monochromatic solutions with  $x, y, z \in \{1, 2, \dots, n\}$  is at least  $n^{2/d^3 - o(1)}$ , where  $d = \deg p$ .

On the other hand, when  $p(1)p(2)$  is odd, that is, when  $p$  attains only odd values, then there might not be any monochromatic solution, e.g., this is the case when we colour the integers according to their parity. We give a characterization of all 2-colourings avoiding monochromatic solutions to  $x + y = p(z)$ .

This is a joint work with Hong Liu and Csaba Sándor.

11:20 Julia Wolf (Cambridge)

### **Efficient regularity lemmas**

Since Szemerédi's seminal work in the 70s, regularity lemmas have proven to be of fundamental importance in many areas of discrete mathematics. This talk will survey a flurry of recent work on exceptionally efficient regularity decompositions in both the graph and arithmetic setting, under additional assumptions such as model-theoretic stability and bounded VC-dimension.

13:40 Eoin Long (Oxford)

### **Sharp thresholds and expanded hypergraphs**

The sharp threshold phenomenon and its connection to the isoperimetric notion of influence of boolean functions has been an important theme in several areas of Mathematics. One fundamental question addressed by a conjecture of Kahn and Kalai is to characterise properties with coarse thresholds / functions of small influence. Results of Friedgut, Bourgain and Hatami say (roughly) that such properties / functions exhibit some kind of ‘junta-like’ behaviour, meaning that one can get a significant density increase by fixing the values of a small set of coordinates. However, all of these results only apply to the ‘dense setting’ that the initial density is bounded away from 0 and 1. We prove such results in the ‘sparse setting’ (i.e. any initial density) that establish a variant of the Kahn-Kalai Conjecture and a sharp form of Bourgain’s Theorem. Our main tool is a new hypercontractive inequality for quasirandom boolean functions.

Our results also have applications in Extremal Combinatorics (via the ‘junta method’), including proofs of two conjectures in a range of parameters that is within a constant factor of being optimal, namely the Huang-Loh-Sudakov Conjecture on cross matchings and the Füredi-Jiang-Seiver Conjecture on the Turán numbers of linear paths in hypergraphs.

This is joint work with Peter Keevash, Noam Lifshitz and Dor Minzer.

14:30 Natasha Morrison (IMPA Rio de Janeiro and Cambridge)

### **Invertibility of random symmetric matrices**

A well-known conjecture states that a random symmetric  $n \times n$  matrix with entries in  $\{-1, 1\}$  is singular with probability  $\Theta(n^2 2^{-n})$ . In this talk I will describe some recent work where we prove that the probability of this event is at most  $\exp(-\Omega(\sqrt{n}))$ . This improves the previous best known bound of  $\exp(-\Omega(n^{1/4} \sqrt{\log n}))$ , which was obtained by Ferber and Jain. Our main theorem is an inverse Littlewood-Offord theorem in  $\mathbb{Z}_p^n$ , which is inspired by the method of hypergraph containers.

This is joint work with Marcelo Campos, Letícia Mattos and Rob Morris.

15:50 Keith Ball (Warwick)

### **Hadamard matrices and 1-factorisation**

We shall describe a tantalising problem relating Hadamard matrices and 1-factorisations of the complete graph. We solve it for several well-known classes of Hadamard matrices.

This is partly joint work with O. Ortega and M. Prodromou.

16:40 Ola Svensson (EPFL Lausanne)

### **Online matching with general arrivals**

The online matching problem was introduced by Karp, Vazirani and Vazirani nearly three decades ago. In that seminal work, they studied this problem in bipartite graphs with vertices arriving only on one side, and presented optimal deterministic and randomized algorithms for this setting.

In comparison, more general arrival models, such as edge arrivals and general vertex arrivals, have proven more challenging and positive results are known only for various relaxations of the problem. In particular, even the basic question of whether randomization allows one to beat the trivially-optimal deterministic competitive ratio of  $1/2$  for either of these models was open.

We resolve this question for both these natural arrival models, and show the following.

- For edge arrivals, randomization does not help — no randomized algorithm is better than  $1/2$  competitive.
- For general vertex arrivals, randomization helps — there exists a randomized  $(1/2 + c)$ -competitive online matching algorithm.

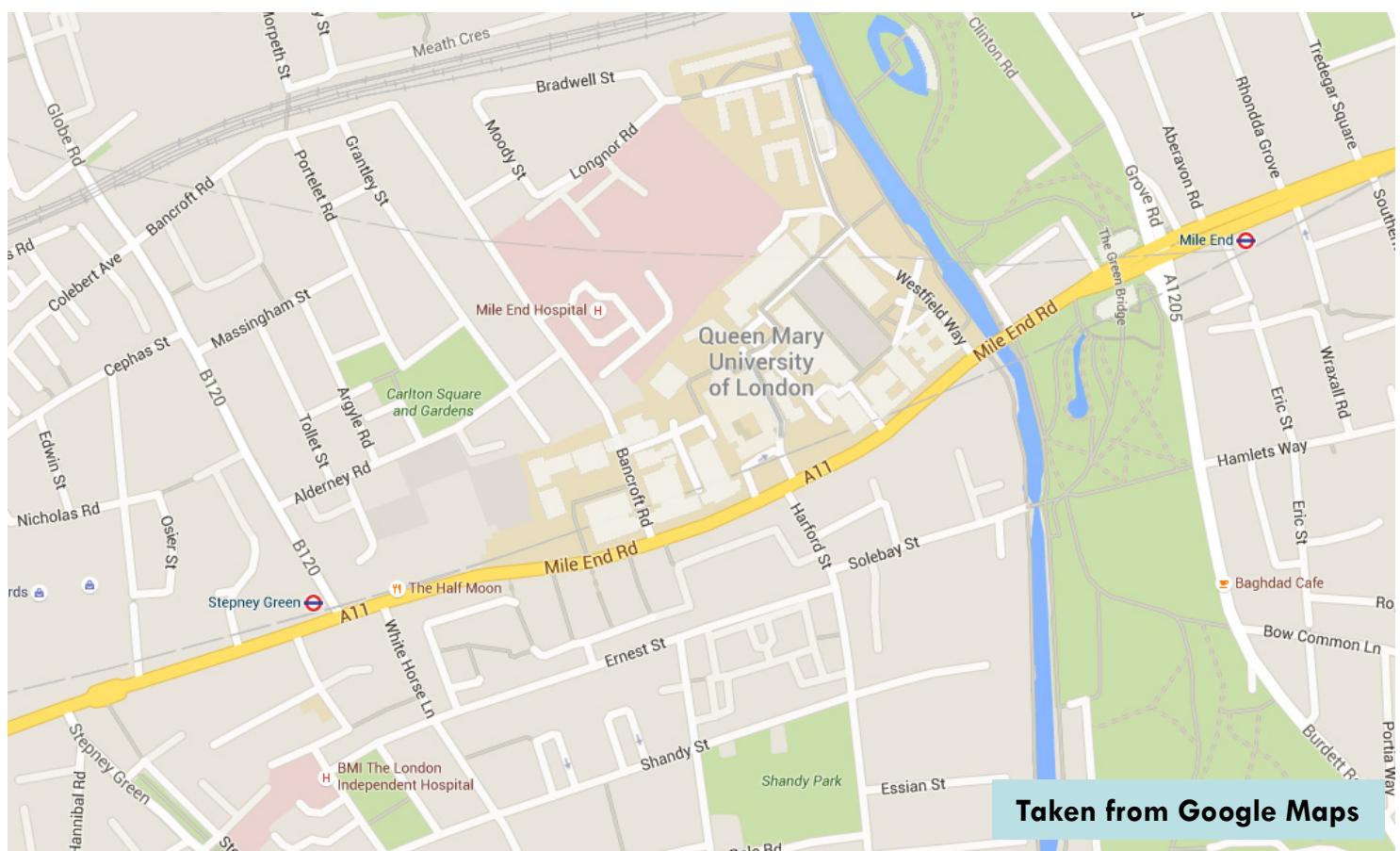
## PLACES TO EAT: in and around QMUL

### Close by:

- 90-degree Melt** – Vegetarian, molten-cheese-based menu – 235 Mile End Rd
- Costa** – standard café – 556 Mile End Rd
- Efes** – Turkish: kebabs, etc. – 230 Mile End Rd
- Greedy Cow** – burgers, salads & steaks – 2 Grove Rd
- Morgan Arms** – gastropub, possibly too far for lunch – 43 Morgan St
- Nandos** – Portuguese-style chicken chain – 552 Mile End Rd
- The Coffee Room** – best coffee in the 'hood – 6A Grove Rd
- The Half Moon** – Wetherspoon's, standard pub food – 213–223 Mile End Rd
- The Pizza Room** – pizzas – 2A Grove Rd
- Verdi's** – upscale Italian (by Mile End standards) – 237 Mile End Rd

### On campus:

- Cafe Grad/The Curve** – Starbucks coffee and sandwiches – Graduate Centre
- Drapers Bar & Kitchen** – basic student union-run operation – Godward Square
- Infusion** – shop with take-away sandwiches, etc. – Godward Square
- Mucci's** – pasta & pizza – Library Square
- SCR Bar** – freshly made sandwiches, limited hot food – Queen's Building



# Mile End Campus

Educational/Research	Residential	Facilities	Information
ArtsOne	Albert Stern Cottages	Advice and Counselling Service	Visitors who require further information or assistance should please go to the main reception in the Queens' Building.
ArtsTwo	Albert Stern House	Bookshop	The smoking of cigarettes or tobacco products are <b>only</b> permitted at designated smoking areas / shelters indicated on this map.
Arts Research Centre	Beaumont Court	Canalside	Electronic cigarettes permitted on outside spaces <b>only</b> .
Bancroft Building	Chapman House	Careers Centre	These premises are alarmed and monitored by CCTV; please call Security on +44 (0)20 7882 5000 for more information.
Bancroft Road	Chesney House	Clock Tower	
Teaching Rooms	Creed Court	CopyShop	
Peter Landin Building (Computer Science)	France House	The Curve	
Engineering Building	Feilden House	Disability and Dyslexia Service	
G.E. Fogg Building	Hatton House	Drapers' Bar and Kitchen	
G.O. Jones Building	Ifor Evans Place	Ground Café	
Geography	Lindop House	The Hive	
Graduate Centre	Lodge House	Housing Hub	
Informatics Teaching Laboratories	Lynden House	IT Services	
Joseph Priestley Building	Maurice Court	Mucci's	
Library	Maynard House	Occupational Health Service/ Student Health Service	
Law	Pooley House	Qmotion Health and Fitness Centre	
Lock-keeper's Cottage	Selincourt House	Sports Hall	
Occupational Health and Safety Directorate	Varey House	Santander Bank	
People's Palace/Great Hall		Security	<b>38/54</b>
Queens' Building		St Benet's Chaplaincy	<b>23</b>
Scape Building		Student Enquiry Centre	<b>19</b>
Temporary Building		Students' Union Hub	<b>34</b>
<b>Building construction site</b>		Union Shop	<b>9</b>
<b>Building closed for major refurbishment</b>		Village Shop	<b>52</b>
		Westfield Nursery	<b>11</b>





**THURSDAY 09 MAY 2019**

## Schedule

The second day of the Colloquia in Combinatorics will be held at The London School of Economics and Political Science, starting at 10.30am. Everyone interested is welcome to attend any part of the event. The talks will be held in the Sheikh Zayed Theatre, New Academic Building, LSE. Refreshment breaks will be taken in the Lower Ground Floor Atrium, New Academic Building, LSE; the reception will be held in the Shaw Library, 6th Floor, Old Building, LSE.

Time	Speaker	Presentation title
10:00	<b>Coffee</b> ( <i>Lower Ground Floor Atrium, New Academic Building</i> )	
10:00	<b>Poster presentation</b> until 17:30 ( <i>Lower Ground Floor Atrium, New Academic Building</i> )	
10:30	Dhruv Mubayi	Polynomial to exponential transition in Ramsey theory
11:20	Julia Komjathy	How to stop explosion by penalising transmission to hubs
12:10	<b>Lunch</b> ( <i>own arrangements – options on campus and nearby</i> )	
13:40	Sarah Penington	Branching Brownian motion with selection and a free boundary problem
14:30	Fatemeh Mohammadi	Generalized permutohedra from probabilistic graphical models
15:20	<b>Afternoon tea break</b> ( <i>Lower Ground Floor Atrium, New Academic Building</i> )	
15:50	Johannes Carmesin	Embedding simply connected 2-complexes in 3-space
16:40	Éva Tardos	<b>Biggs Lecture:</b> Online learning with partial information
17:45	<b>Reception</b> ( <i>Shaw Library, 6th Floor, Old Building</i> )	

10:30 Dhruv Mubayi (University of Illinois - Chicago)

### **Polynomial to exponential transition in Ramsey theory**

After a brief introduction to classical hypergraph Ramsey numbers, I will focus on the following problem. What is the minimum  $t$  such that there exist arbitrarily large  $k$ -uniform hypergraphs whose independence number is at most polylogarithmic in the number of vertices and every  $s$  vertices span at most  $t$  edges? Erdős and Hajnal conjectured (1972) that this minimum can be calculated precisely using a recursive formula and Erdős offered \$500 for a proof. For  $k = 3$ , this has been settled for many values of  $s$ , but it was not known for larger  $k$ .

Here we settle the conjecture for all  $k$  at least 4. Our method also answers a question of Bhat and Rödl about the maximum upper density of quasirandom hypergraphs.

This is joint work with Alexander Razborov.

11:20 Julia Komjathy (TU Eindhoven)

### **How to stop explosion by penalising transmission to hubs**

In this talk we study the spread of information in infinite inhomogeneous spatial random graphs. To model the spread of information in social networks, we take a spatial random graph that is scale free, that is, the degree of a vertex follows a power law with exponent  $\tau \in (2, 3)$ . One common approach to model the spread information is then to equip each edge with a random and iid transmission cost  $L$ , and study the cost of the least-cost path between vertices. In these graphs, it was observed earlier than it is possible to reach infinitely many vertices within finite cost, as long as the cumulative distribution function of  $L$  is not doubly-exponentially flat close to 0. This phenomenon is called explosion, and it seems off from reality for cases where individual contact is necessary, e.g., spreading of viruses, etc.

We introduce a penalty to transmit the information to hubs, and increase the cost of transmission through an edge with expected degrees  $W$  and  $Z$  by a factor that is a power of the product  $WZ$ . We find a threshold behaviour between explosion, depending on how steep the cumulative distribution function of  $L$  increases at 0: it should be at least polynomially steep, where the exponent depends on both the power-law exponent  $\tau$  and the penalty-exponent. This behaviour is arguably a better representation of information spreading processes in social networks than the case without penalizing factor.

This is joint work with John Lapinskas and Johannes Lengler.

13:40 Sarah Penington (Bath)

### **Branching Brownian motion with selection and a free boundary problem**

Consider a system of  $N$  particles moving according to Brownian motions and branching at rate one. Each time a particle branches, the particle in the system furthest from the origin is killed. It turns out that we can use results about a related partial differential equation known as a free boundary problem to control the long term behaviour of this particle system for large  $N$ .

This is joint work with Julien Berestycki, Eric Brunet and James Nolen.

14:30 Fatemeh Mohammadi (Bristol)

### **Generalized permutohedra from probabilistic graphical models**

Graphical models (Bayesian networks) based on directed acyclic graphs (DAGs) are used to model complex cause-and-effect systems. A graphical model is a family of joint probability distributions over the nodes of a graph which encodes conditional independence relations via the Markov properties. One of the fundamental problems in causality is to learn an unknown graph based on a set of observed conditional independence relations. In this talk, I will describe a greedy algorithm for DAG model selection that operates via edge walks on so-called DAG associahedra. For an undirected graph, the set of conditional independence relations are represented by a simple polytope known as the graph associahedron, which can be constructed as a Minkowski sum of standard simplices. For any regular Gaussian model, and its associated set of conditional independence relations we construct the analogous polytope DAG associahedron which can be defined using relative entropy. For DAGs we construct this polytope as a Minkowski sum of matroid polytopes corresponding to Bayes-ball paths in a graph.

This is joint work with Caroline Uhler, Charles Wang, and Josephine Yu.

15:50 Johannes Carmesin (Birmingham)

### **Embedding simply connected 2-complexes in 3-space**

A classical theorem of Kuratowski characterises graphs embeddable in the plane by two obstructions. More precisely, a graph is planar if and only if it does not contain the complete graph  $K_5$  or the complete bipartite graph  $K_{3,3}$  as a minor.

Can you characterise embeddability of 2-dimensional simplicial complexes in 3-space in a way analogous to Kuratowski's characterisation of graph planarity?

16:40 **The Norman Biggs Lecture**

Éva Tardos (Cornell)

**Online learning with partial information**

The goal of online learning is to help the learner find the best alternative while making decisions online. Applications include, for example, repeatedly selecting paths in networks for traffic routing. An important issue is what information is available to the learner. Two classical extremes are full information, where the learner receives the outcome of all options (learns the delays on all possible paths), while in the bandit framework, the learner only finds out only the outcome of her selected choice. In most applications the available feedback is somewhere between these two extremes. Online learning with graph based feedback is an elegant model of partial information introduced by Mannor and Shamir.

In this talk we'll develop a general framework for extending learning algorithms from full information to partial feedback where the learning error scales only with the best alternative and with the maximum independent set of the feedback graph.

Talk based on joint work with Thodoris Lykouris and Karthik Sridharan.



**THURSDAY 09 MAY 2019**

**Poster Presentation**

As part of the Colloquia in Combinatorics 2019, there is a poster session, allowing PhD students in Discrete Mathematics and related areas to present their work. The poster session runs from 10:00 to 17:30 and the best poster prize will be awarded during the wine reception (around 6pm). The jury for this prize is a subset of the speakers of the Colloquia.

The following posters will be presented:

Name	Institute	Title
Natalie Behague	QMUL	Semi-perfect 1-factorizations of the hypercube
Olie Clarke	Bristol	Semi-standard young tableaux and toric degenerations of flag varieties
Jan Corsten	LSE	Tiling edge-coloured graphs with few monochromatic tiles
Clément Dallard	Portsmouth	New results for colourful components problems
Attila Dankovics	LSE	Erdős-Rothschild problem for five and six colours
Alberto Espuny Díaz	Birmingham	Resilient degree sequences with respect to hamiltonicity in random graphs
Nóra Frankl	LSE	Almost monochromatic point sets in grids and the chromatic number of the plane
Mani Ghahremani	Portsmouth	On monotonicity of minimum cost inert node searching
Keat Hng	LSE	Minimum degree conditions for powers of cycles and paths
Joseph Hyde	Birmingham	A degree sequence Komlós theorem
Stan Kučera	LSE	Partial colourings and Hadwiger's conjecture
Gwen McKinley	MIT	Super-logarithmic cliques in dense inhomogeneous random graphs
Lewis Mead	QMUL	Random simplicial complexes
Akshat Mudgal	Bristol	Sums of linear transformations in higher dimensions
Yani Pehova	Warwick	On a Ramsey-Turán variant of the Hajnal-Szemerédi theorem
Xinyi Xu	LSE	On the partial correspondence colouring and the AGH conjecture

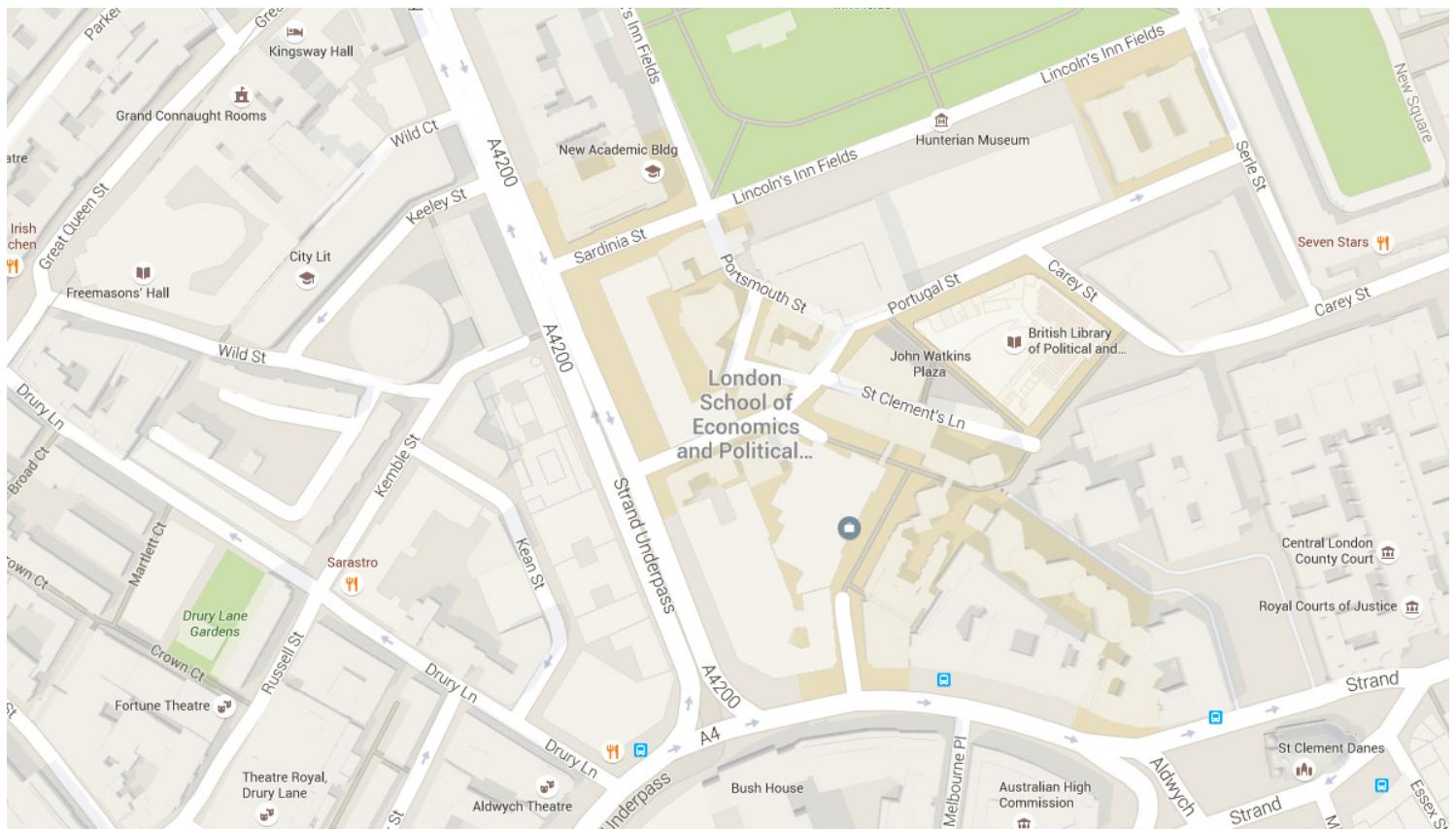
## PLACES TO EAT: in and around LSE

### Close by:

**All Bar One** – modern chain with full menu – 58 Kingsway  
**Belgo** – Belgian beer & food – 67 Kingsway  
**Bill's** – European chain with full menu – 42 Kingsway  
**Costa** – standard café – 9-11 Kingsway  
**EAT** – sandwich bar (chain) – 7-9 Kingsway  
**Paul** – bakery & café – 36-38 Kingsway  
**Pret a Manger** – standard café – 29 -33 Kingsway  
**Sainsburys** – supermarket – 129-133 Kingsway  
**Shakespeare's Head** – Wetherspoon's, standard pub food – 64-78 Kingsway  
**Starbucks** – standard café – 10 Kingsway  
**The Delaunay Counter** – casual café-deli – 55 Aldwych  
**Viet Eat** – Vietnamese – 48 Kingsway  
**Wasabi** – Japanese chain serving bento boxes, sushi & hot food – 19 Kingsway

### On campus:

**Café 54** – grab & go – New Academic Building  
**Fields Bar and Kitchen** – perfect for a relaxed lunch – Lincoln's Inn Fields  
**Fourth Floor Restaurant** – offers a wealth of eating options – Old Building  
**George IV Pub** – perfect for a pub lunch – Portugal Street  
**LSE Garrick** – cafe & restaurant – Columbia House  
**Plaza Café** – coffee and snacks – John Watkins Plaza  
**Shaw Café** – veggie/vegan café – New Academic Building



# LSE Accessibility Map



## Key

- LSE Building
- LSE Building Development
- Information
- No Access
- Gender Neutral accessible toilets
- Male only accessible toilets
- Cycle Hire Station
- Disabled Parking

**Access Guides to LSE Buildings**  
AccessAble have produced detailed access guides to the LSE campus and residences, and route maps between key locations. These access guides, and route maps, are now available [online](#).

**Disabled Access**  
After 6.30pm, please call Security Control on 020 7955 6200  
ensure that any disabled access doors are open. For access to 20 Kingsway, please call security staff on 020 7955 6200 up the portable ramp in the entrance foyer.

<b>PEA Peacock Theatre</b>	Portugal Street
	Wheelchair access, lifts
	Accessible Toilets:
	Ground floor
<b>PEL Petrick-Lawrence House</b>	Clement's Inn
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: 4, 6, 8, 10
<b>LCH Lincoln Chambers</b>	Portsmouth Street
	Wheelchair access, lifts
	Accessible Toilets:
<b>SLF 5 Lincoln's Inn Fields</b>	Aldwych
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: B, LG, G, 1, 2, 4
<b>CLM Clement House</b>	32 Lincoln's Inn Fields
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: B, 3, 4, 6
	Male Accessible Toilet:
	Floor 2
<b>COL Columbia House</b>	Lincoln's Inn Fields
	Wheelchair access, lifts
	Accessible Toilets:
	Ground floor
<b>CON Connaught House</b>	Aldwych
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: 1, 3, 5, 7
<b>COW Cowdray House</b>	Portugal Street
	Wheelchair access, lifts
<b>NAB New Academic Building</b>	Lincoln's Inn Fields
	Wheelchair access, lifts
	Accessible Toilets:
	All floors
<b>FAW Fawcett House (Access via PAN)</b>	Clement's Inn
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: G, 6, 10
	Male Accessible Toilet:
	Floor 3
<b>OLD Old Building</b>	Houghton Street
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: B, G, 1, 2, 4
<b>SHF Sheffield Street</b>	Sheffield Street
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: B, G, 1-5
<b>STC St Clements</b>	Clare Market
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: 1, 2, 4
	Male and Female Accessible Toilet:
	Floor 1
<b>PAN Parkhurst House</b>	Clement's Inn
	Wheelchair access, lifts
	Accessible Toilets:
	Floors: 1-11
<b>KGS King's Chambers</b>	Portugal Street
	Wheelchair access, lifts
<b>KSW 20 Kingsway</b>	Portugal Street
	Wheelchair access, lifts



Get the discussion going: when tweeting about the Colloquia, please use the hashtag **#CC2019**

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