THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

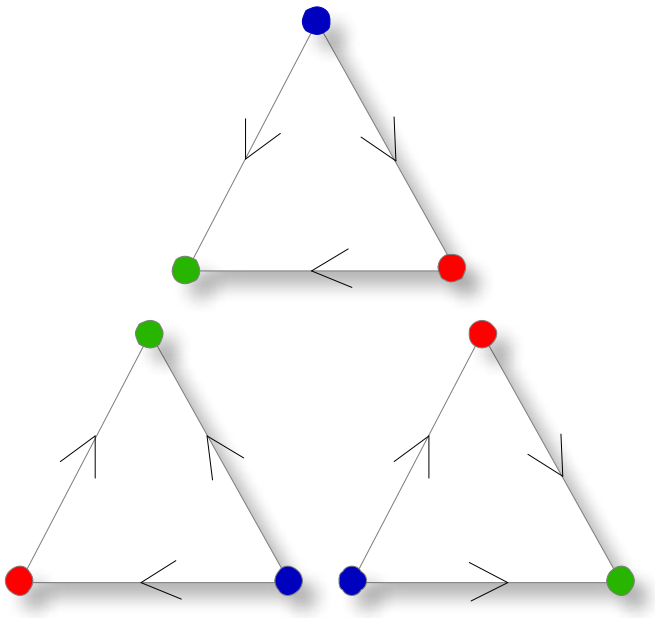
Queen Mary University of London

Queen Mary, University of London

The London School of Economics and Political Science

Two One-Day Colloquia in Combinatorics

11th and 12th May 2016



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

In 2016, QMUL & LSE are celebrating ten years of the Colloquia in Combinatorics.

Thank you for joining us for our tenth anniversary.

CONTENTS

INFORMATION

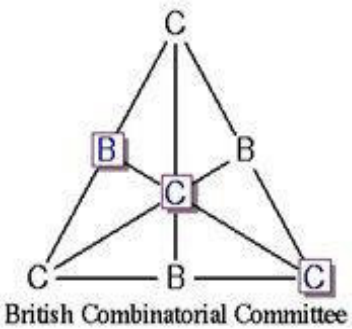
Those interested are welcome to attend for all or any part of the event; it is hoped that many people will be able to attend for both days.

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 Rebecca Lumb (r.c.lumb@lse.ac.uk) for further information.

Event organisers: Dr Julia Böttcher (LSE), Dr David Ellis (QMUL), Dr Robert Johnson (QMUL) and Dr Jozef Skokan (LSE).

SUPPORT

Support for this event from the London Mathematical Society (www.lms.ac.uk) and the British Combinatorial Committee (https://britishcombinatorial.wordpress.com/) is gratefully acknowledged.



LONDON MATHEMATICAL SOCIETY

Queen Mary
University of London

WEDNESDAY 11th MAY 2016

Schedule

The first day of the Colloquia in Combinatorics will be held at Queen Mary, University of London on Wednesday 11th May, starting at 10.30am. Everyone interested is welcome to attend any part of the event. All the talks will be held in the Fogg Lecture Theatre, G.E. Fogg Building, Mile End Campus, QMUL (please note this is a change to last year's venue – listed as 13 on page 6 map). Refreshment breaks will be taken in the Mathematical Sciences Building Foyer, Mile End, QMUL (4 on page 6 map); the reception will be held in the Senior Common Room, Queen's Building, Mile End, QMUL (19 on page 6 map).

Time	Speaker	Presentation title
10:00	**Coffee** *(Mathematical Science Building Foyer)*	
10:30	Béla Bollobás (Cambridge/ Memphis)	Problems and Results on Random Geometric Graphs
11:20	Karim Adiprasito (Jerusalem)	The Hodge-Riemann Relations in Combinatorics
12:10	**Lunch** *(own arrangements – options on campus and nearby)*	
13:30	Imre Leader (Cambridge)	Transitive Misere Games
14:20	Yufei Zhao (Oxford)	Quasirandom Cayley Graphs
15:10	**Afternoon tea break** *(Mathematical Science Building Foyer)*	
15:40	Andrew Granville (Montréal/UCL)	Smoothing Sieve Weights
16:30	David Conlon (Oxford)	Finite Reflection Groups and Graph Norms
17:30	**Reception** *(Senior Common Room, Queen's Building)*	

Problems and Results on Random Geometric Graphs

Béla Bollobás

Random geometric graphs have been around for almost as long as random graphs. In fact, it was E.N. Gilbert, the mathematician who introduced the binomial model $\mathcal{G}(n,p)$, who first proposed their study in 1961. A great many natural models of random geometric graphs have been studied, starting with the *Gilbert Disc Model* $\mathcal{D}(\mathbb{R}^n, r)$. The vertex set of a random graph $D_{n,r} \in \mathcal{D}(\mathbb{R}^n, r)$ is a Poisson process of density 1 in $\mathbb{R}^n$, and two vertices (points) are joined by an edge if their distance is at most r. For this model the basic task is to determine the values n and r such that a.s. the random graph $D_{n,r}$ has an infinite component, i.e. percolates.

In the lecture I shall consider problems concerning some of the basic models of random geometric graphs, and will present a number of results obtained jointly with Paul Balister, Amites Sarkar, Mark Walters and others.

The Hodge-Riemann Relations in Combinatorics

Karim Adiprasito

We discuss applications of Hodge theory, a part of algebraic geometry, to problems in combinatorics. We moreover discuss situations in which these deep algebraic theorems themselves can be shown combinatorially, extending our knowledge of cohomology of closed currents in toric varieties.

This is joint work with June Huh and Eric Katz.

Transitive Misère Games

Imre Leader

In the usual form of a combinatorial game, two players take turns to play moves in a set ('the board'), and certain subsets are designated as 'winning': the first person to occupy such a set wins the game. For these games, it is well known that (with correct play) the game cannot be a second-player win.

In the 'misère' form, the first person to occupy such a set loses the game. Here it would be natural to assume that the game cannot be a first-player win, at least if the game is transitive, meaning that all points of the board look the same. Our aim is to investigate this.

This is joint work with Robert Johnson and Mark Walters.

Quasirandom Cayley Graphs

Yufei Zhao

We prove that the properties of having small discrepancy and having small second eigenvalue are equivalent in Cayley graphs, extending a result of Kohayakawa, Rödl and Schacht, who treated the abelian case. The proof relies on a number of ingredients, including Grothendieck's inequality and non-abelian Fourier analysis. As a corollary, we also prove that a similar result holds in all vertex-transitive graphs.

Smoothing Sieve Weights

Andrew Granville

There are many analogies between the 'anatomies' of integers, of permutations and of polynomials in finite fields. The techniques used in the surprising recent proof by Maynard and Tao of bounded gaps between primes seemed very similar to what was already well-known and, we thought, understood. In this talk we report on investigations by Koukoulopoulos, Maynard and the speaker into the advantages of the weights used in that proof, and try to develop analogies in the combinatorics of permutations, and of polynomials in finite fields.

Finite Reflection Groups and Graph Norms

David Conlon

Given a graph H on vertex set $\{1, 2, \cdots, n\}$ and a function $f : [0,1]^2 \to \mathbb{R}$, define

$$\|f\|_H := \left| \int \prod_{ij \in E(H)} f(x_i, x_j) d\mu^{|V(H)|} \right|^{1/|E(H)|},$$

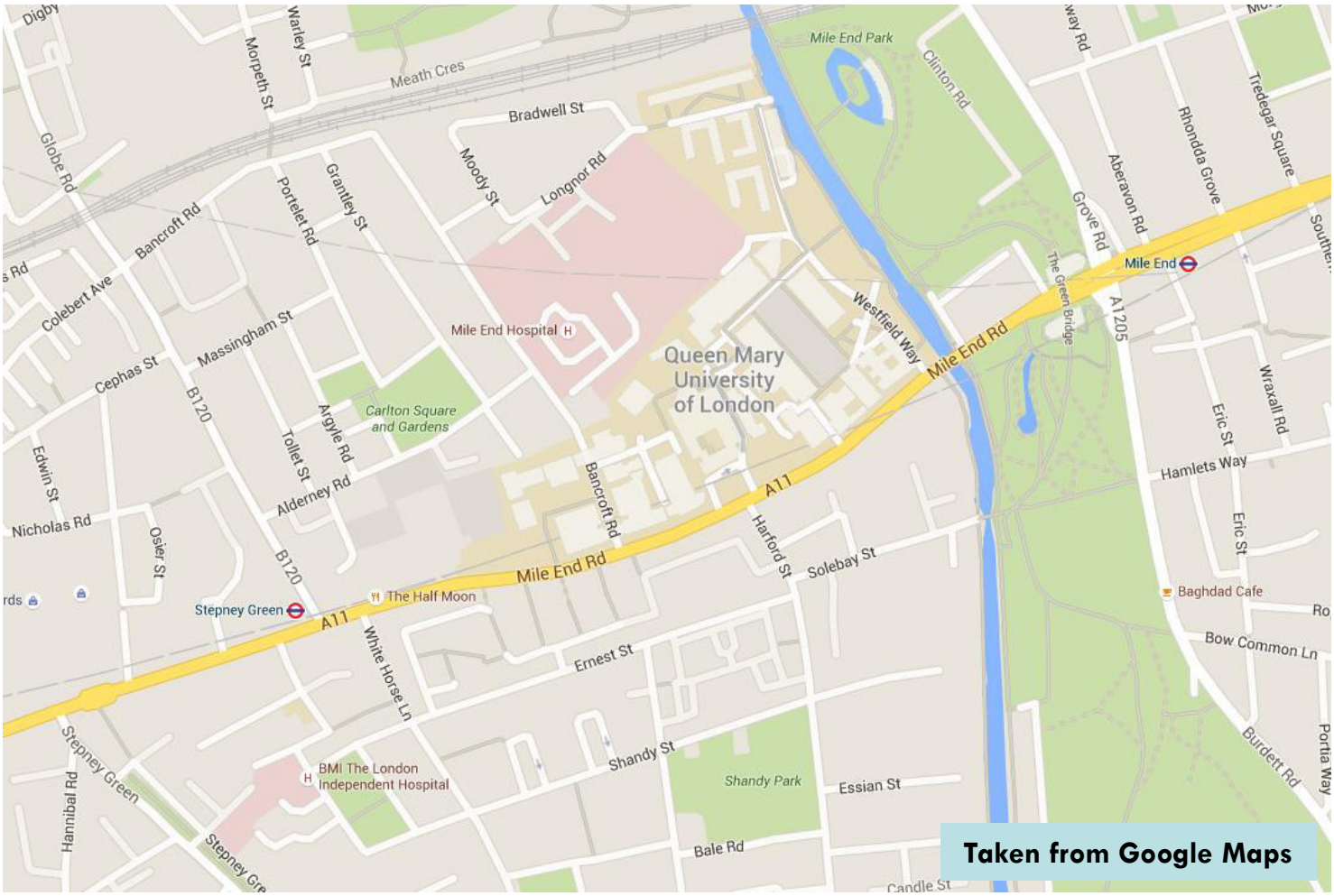
where μ is the Lebesgue measure on $[0,1]$. We say that H is *norming* if $\|\cdot\|_H$ is a semi-norm. We also define a similar notion $\|\cdot\|_{r(H)}$ by $\|f\|_{r(H)} := \||f|\|_H$, saying that H is *weakly norming* if $\|\cdot\|_{r(H)}$ is a norm.

Classical results show that weakly norming graphs are necessarily bipartite. In the other direction, Hatami showed that even cycles, complete bipartite graphs, and hypercubes are all weakly norming. Using results from the theory of finite reflection groups, we demonstrate that any graph which is edge-transitive under the action of a certain natural family of automorphisms is weakly norming. This result includes all previous examples of weakly norming graphs and adds many more. We also include several applications of our results. In particular, we define and compare a number of generalisations of Gowers' octahedral norms and we prove some new instances of Sidorenko's conjecture.

This is joint work with Joonkyung Lee.

PLACES TO EAT: in and around QMUL

Baghdad Café – Authentic Iraqi and Arabic food, Burdett Road
The Curve – international food to eat-in or take away, Westfield Way
Dirty Burger – burger joint, Mile End Road
Drapers Bar and Kitchen – wide range to suit all dietary requirements, Godward Square
Drunken Monkey – Asian fusion, Westfield Way
Greedy Cow – gastropub food, Grove Road
Half Moon Pub – Wetherspoons serving standard pub food, Mile End Road
Morgan Arms – Up-market pub food, Morgan Street
Mucci's – Italian trattoria, Library Square
Nandos – Portuguese Chicken, Mile End Road
The Orange Room – Lebanese, Burdett Road
Tayyabs – Indian, Fieldgate Street



Mile End Campus

Educational/Research

ArtsOne	37
ArtsTwo	35
Arts Research Centre	39
Bancroft Building	31
Bancroft Road Teaching Rooms	10
Computer Science	6
Engineering Building	15
G.E. Fogg Building	13
G.O. Jones Building	25
Geography	26
Informatics Teaching Laboratories	5
Joseph Priestley Building	41
Library	32
Law	36
Lock-keeper's Cottage Graduate Centre	42
Mathematical Sciences	4
Occupational Health and Safety Directorate	12
The People's Palace/Great Hall	16
Queens' Building	19
Temporary Building	61

Residential

Albert Stern Cottages	3
Albert Stern House	1
Beaumont Court	53
Chapman House	43
Chesney House	45
Creed Court	57
France House	55
Feilden House	46
Hatton House	40
Ifor Evans Place	2
Lindop House	21
Lodge House	50
Lynden House	59
Maurice Court	58
Maynard House	44
Pooley House	60
Selincourt House	51
Varey House	49

Facilities

Advice and Counselling Service	27
Housing Hub	48
Bookshop	22
Careers Centre	19
Clock Tower	20
CopyShop	56
The Curve	47
Disability and Dyslexia Service	31
Drapers' Bar and Kitchen	8
Canalside	63
Ground Café	33
The Hive	24
Infusion	9
IT Services	19
Mucci's	29
Occupational Health Service/ Student Health Service	28
Octagon	19a
Portering and Postal Services	17
Qmotion Health and Fitness Centre Sports Hall	7
Santander Bank	62
Security	38/54
St Benet's Chaplaincy	23
Students' Union Hub	34
Student Enquiry Centre	19
Village Shop	52
Westfield Nursery	11

Information

Visitors who require further information or assistance should please go to the main reception in the Queens' Building.

The smoking of cigarettes or tobacco products are **only** permitted at designated smoking areas / shelters indicated on this map.

Electronic cigarettes permitted on outside spaces **only**.

These premises are alarmed and monitored by CCTV; please call Security on +44 (0)20 7882 5000 for more information.

Key

- Library/bookshop
- Fitness centre
- Bar
- Coffee place
- Eatery
- Staff car park
- Bicycle parking
- Bicycle lockers
- Cash machine
- Smoking area / shelter

New Graduate Centre construction site 18

Engineering Building construction site 64

No access between Geography Square and Bancroft Road before 8am and after 6.30pm Mon–Fri. Closed weekends.

THURSDAY 12th MAY 2016

Schedule

The second day of the Colloquia in Combinatorics will be held at The London School of Economics and Political Science on Thursday 12th May, starting at 10.30am. Everyone interested is welcome to attend any part of the event. The talks will be held in Wolfson Theatre, New Academic Building, LSE (please note this is a change to last year's venue – listed as NAB on the LSE map on page 12). Refreshment breaks will be taken Lower Ground Floor Atrium, New Academic Building, LSE; the reception will be held on the 8th Floor, New Academic Building, LSE.

Time	Speaker	Presentation title
10:00	**Coffee and arrival** *(Lower Ground Floor Atrium, New Academic Building)*	
10:30	Daniela Kühn (Birmingham)	Packing Bounded Degree Graphs
11:20	Benny Sudakov (Zürich)	Equiangular Lines and Spherical Codes in Euclidean Spaces
12:10	**Lunch** *(own arrangements – options on campus and nearby)*	
13:30	Nati Linial (Jerusalem)	High-dimensional Permutations and Discrepancy
14:20	Monique Laurent (Amsterdam/ Tilburg)	Geometric Graph Realizations and Positive Semidefinite Matrix Completion
15:10	**Afternoon tea break** *(Lower Ground Floor Atrium, New Academic Building)*	
15:40	James Maynard (Oxford)	Primes with Missing Digits
16:30	Alan Frieze (Pittsburgh)	**Biggs Lecture:** Purchasing Under Uncertainty
17:30	**Reception** *(8th Floor, New Academic Building)*	

Packing Bounded Degree Graphs

Daniela Kühn

Questions on packings and decompositions have a long history, going back to the 19th century. For instance, the existence of Steiner triple systems (proved by Kirkman in 1847) corresponds to a decomposition of the edge set of the complete graph K_n on n vertices into triangles (if n satisfies the necessary divisibility conditions). There are several beautiful conjectures which have driven a large amount of research in this area. A prime example is the tree packing conjecture of Gyárfás and Lehel, which would guarantee a decomposition of a complete graph into a suitable given collection of trees. We develop a new method for constructing approximate decompositions of dense quasirandom graphs into bounded degree graphs. Our result can be viewed as an extension of the classical blow-up lemma of Komlós, Sárkőzy and Szemerédi to the setting of approximate decompositions. I will discuss this method and some of its applications.

This is joint work Jaehoon Kim, Deryk Osthus and Mykhaylo Tyomkyn.

Equiangular Lines and Spherical Codes in Euclidean Spaces

Benny Sudakov

A set of lines in $\mathbb{R}^d$ is called *equiangular* if the angles between any two of them are the same. The problem of estimating the size of the maximum family of equiangular lines has had a long history since being posed by van Lint and Seidel in 1966. A closely related notion is that of a *spherical code*, which is a collection C of unit vectors in $\mathbb{R}^d$ such that $x \cdot y \in L$ for any distinct x, y in C and some set of real numbers L. Spherical codes have been extensively studied since their introduction in the 1970's by Delsarte, Goethals and Seidel. Despite a lot of attention in the last forty years, there are still many open interesting questions about equiangular lines and spherical codes. In this talk we report recent progress on some of them.

This is joint work with I. Balla, F. Drexler and P. Keevash.

High-dimensional Permutations and Discrepancy

Nati Linial

This is part of our ongoing effort to develop what we call 'High-dimensional combinatorics'. We equate a permutation with its permutation matrix, namely an $n \times n$ array of zeros and ones in which every line (row or column) contains exactly one 1. In analogy, a two-dimensional permutation is an $n \times n \times n$ array of zeros and ones in which every line (row, column or shaft) contains exactly one 1. It is not hard to see that a two-dimensional permutation is synonymous with a Latin square. It should be clear what a d-dimensional permutation is, and those are still very partially understood. We have already made good progress on several aspects of

this field. We mostly start from a familiar phenomenon in the study of permutations and seek its high dimensional counterparts. Specifically we consider:

- The enumeration problem;
- Birkhoff von-Neumann theorem and d-stochastic arrays;
- Erdős-Szekeres theorem and monotone subsequences;
- Discrepancy phenomena;
- Problems related to communication complexity;
- Random generation.

These results were obtained in collaboration with my students and ex-students: Zur Luria, Michael Simkin and Adi Shraibman

Geometric Graph Realizations and Positive Semidefinite Matrix Completion

Monique Laurent

We consider some graph parameters related to the positive semidefinite matrix completion problem. In particular, we investigate the Gram dimension of a graph, which is defined as the smallest integer k such that, for every assignment of unit vectors to the nodes of the graph, there exists another assignment of unit vectors lying in the k-dimensional space and having the same inner products on the edges of the graph. We present complexity results and structural characterizations of the class of graphs with Gram dimension at most 4. We also discuss links to Euclidean graph realizations in distance geometry and to some Colin de Verdière type graph parameters.

Primes with Missing Digits

James Maynard

We show that there are infinitely many primes with no 7 in their decimal expansion. (And similarly with 7 replaced by any other digit.) This shows the existence of primes in a thin set of numbers, since only $O(X^{0.96})$ integers less than X have no 7 in their decimal expansion. The proof relies on decorrelating 'digit conditions' which say when the Fourier transform of numbers with restricted digits is large, from 'Diophantine conditions' which say when the Fourier transform of the primes is large.

'The Norman Biggs Lecture'

Purchasing Under Uncertainty

Alan Frieze

Suppose there is a collection $x_1, x_2, \ldots, x_N$ of independent uniform $[0,1]$ random variables, and a hypergraph F of target structures on the vertex set $\{1, \ldots, N\}$. We would like to buy a target structure at small cost, but we do not know all the costs x_i ahead of time. Instead, we inspect the random variables x_i one at a time, and after each inspection, choose to either keep the vertex i at cost x_i, or reject vertex i forever.

In this talk, we consider the case where $\{1, \ldots, N\}$ is the edge-set of some graph, and the target structures are the spanning trees of a graph, the paths between a fixed pair of vertices, perfect matchings, Hamilton cycles or the cliques of some fixed size.

This is joint work with Wesley Pegden.

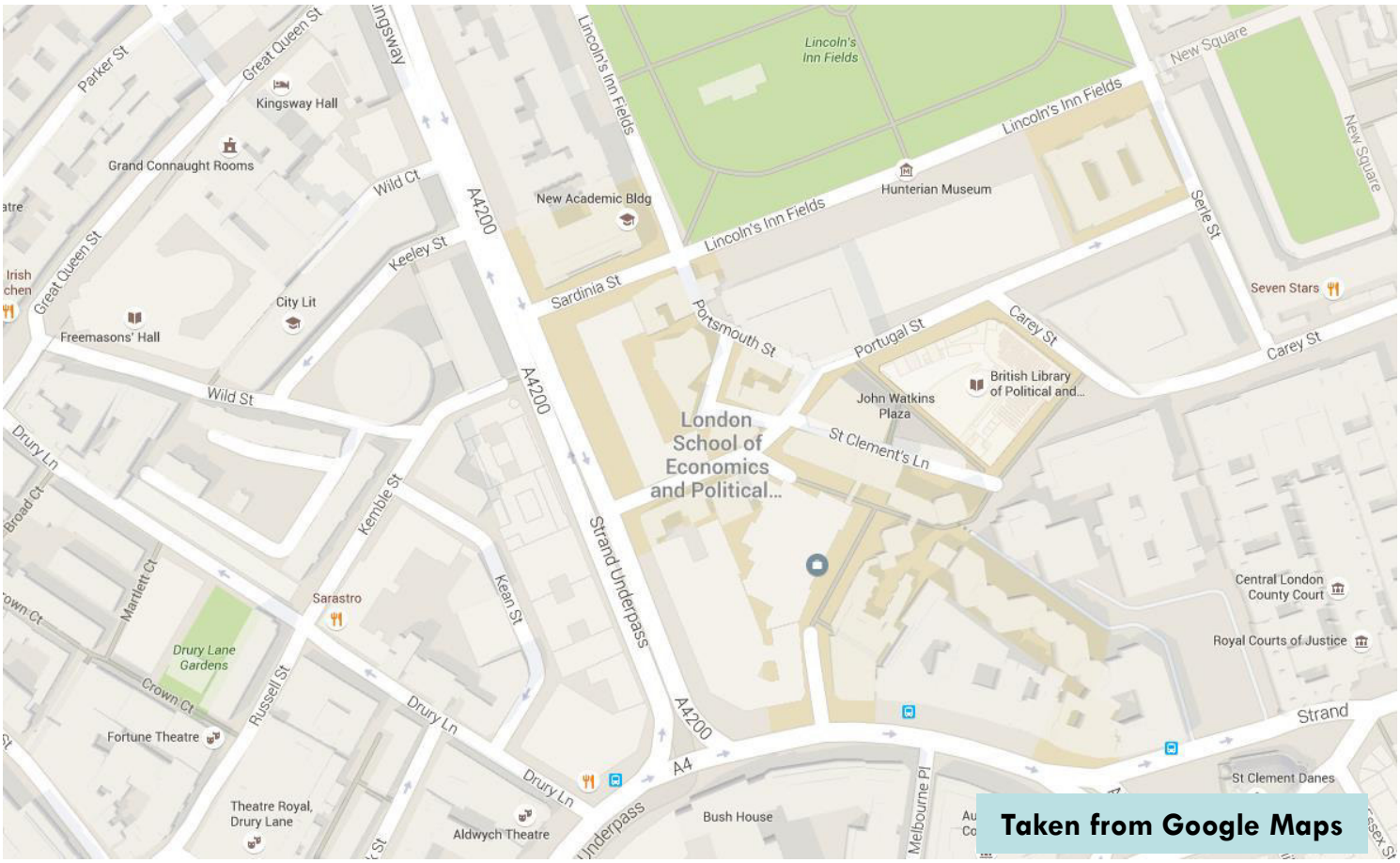
PLACES TO EAT: in and around LSE

Close by:

All Bar One – Kingsway
Belgo – Kingsway
Bill's – Kingsway
Café Amici – Kingsway
Café Nero – Kingsway
Costa – Kingsway
EAT – Kingsway
Paul – Kingsway
Pret a Manger – Kingsway
Sainsburys – Kingsway
Starbucks – Kingsway
Subway – Kingsway
The Delaunay Counter – Aldwych
Viet Eat – Kingsway
Wasabi – Kingsway

On campus:

The Bean Counter – 32 Lincoln's Inn Fields
Café 54 – New Academic Building
Daily Grind Coffee Shop – Tower One reception
Fields Bar and Kitchen – Lincoln's Inn Fields
Fourth Floor Café Bar – Old Building
Fourth Floor Restaurant – Old Building
George IV Pub – Portugal Street
LSE Garrick – Columbia House
Mezzanine Café – New Academic Building
Plaza Café – John Watkins Plaza
Three Tuns Bar – Saw Swee Hock Student Centre



Taken from Google Maps

Accessibility Map

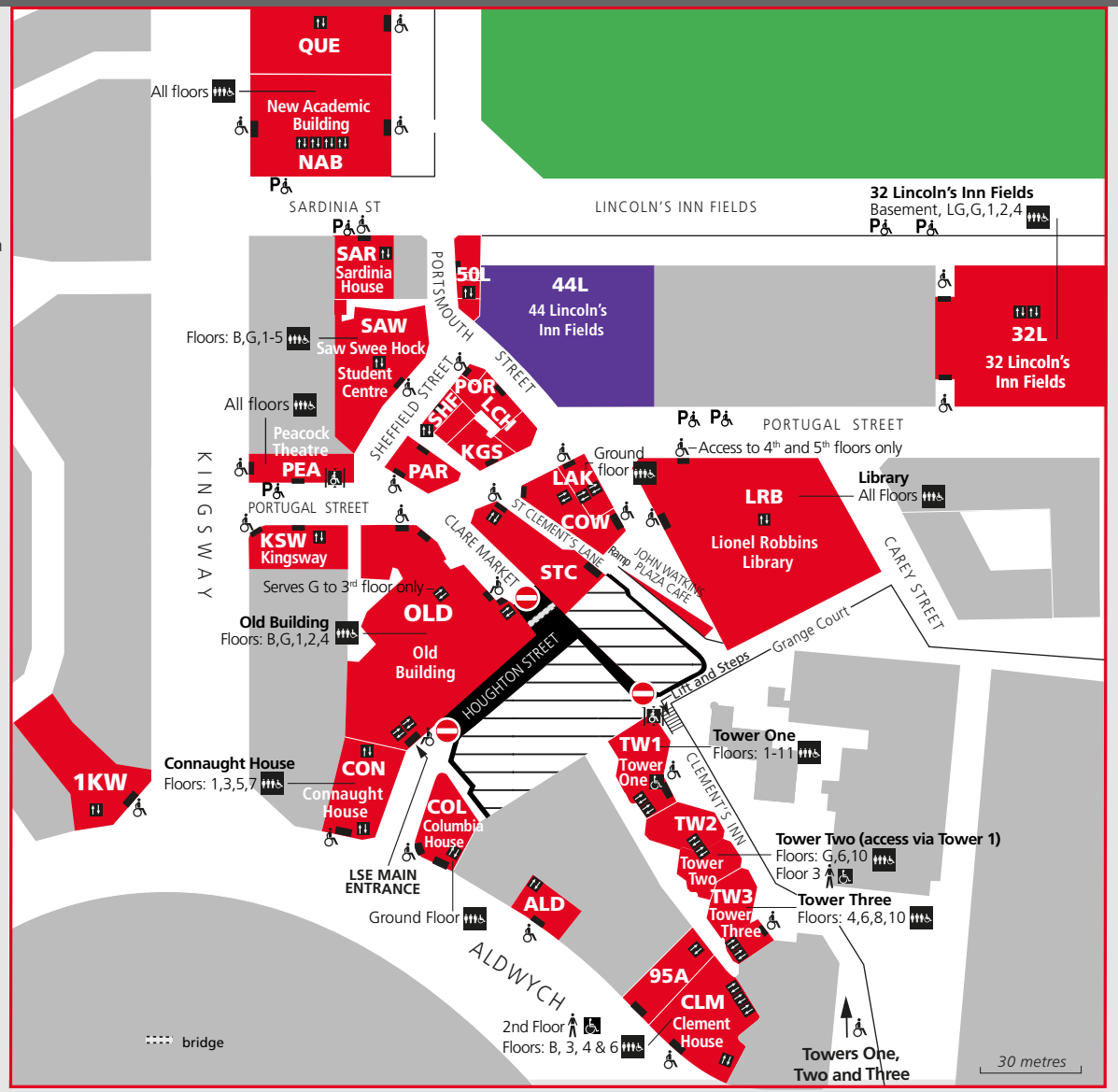
THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

- Disabled lift
- Lift
- Disabled parking (blue badge)
- Male accessible toilet
- Gender Neutral accessible toilets
- Disabled access
- Roads and Footpaths closed
- No entry
- Buildings under construction

Disabled access

After 6.30pm, please call Security Control on 020 7955 6200 to ensure that any disabled access doors are open.

Portable ramp for 20 Kingsway (**KSW** only) is located in entrance foyer. Please call **020 7955 6200** for Security staff to set up the ramp on request.



95A	**95 Aldwych** *Aldwych*
ALD	**Aldwych House** *Aldwych*
CLM	**Clement House** *Aldwych.*
COL	**Columbia House** *Aldwych*
CON	**Connaught House** *Aldwych*
COW	**Cowdray House** *Portugal Street*
KGS	**King's Chambers** *Portugal Street*
1KW	**1 Kingsway**
KSW	**20 Kingsway**
32L	**32 Lincoln's Inn Fields**
44L	**44 Lincoln's Inn Fields** (not occupied by LSE)
50L	**50 Lincoln's Inn Fields** *Portsmouth Street*
LCH	**Lincoln Chambers** *Portsmouth Street*
LAK	**Lakatos Building** *Portugal Street*
LRB	**Lionel Robbins Building, Library**
NAB	**New Academic Building** *Lincoln's Inn Fields*
OLD	**Old Building** *Houghton Street*
PAR	**Parish Hall** *Sheffield Street*
PEA	**Peacock Theatre** *Portugal Street*
POR	**1 Portsmouth Street**

QUE	**Queens House** *Lincoln's Inn Fields*
SAR	**Sardinia House** *Sardinia Street*
SAW	**Saw Swee Hock Student Centre** *Sheffield Street*
SHF	**Sheffield Street**

STC	**St Clement's** *Clare Market*
TW1	**Tower One** *Clement's Inn*
TW2	**Tower Two** *Clement's Inn*
TW3	**Tower Three** *Clement's Inn*

Student Services Centre
Ground floor, Old Building

Graham Wallas Room
OLD 5.25, Old Building

Hong Kong Theatre
Ground floor, Clement House

Old Theatre
Ground floor, Old Building

Shaw Library Sixth floor, Old Building

Sheikh Zayed Theatre
New Academic Building

Thai Theatre New Academic Building

The Wolfson Theatre
New Academic Building

The Venue
Basement, SAW

Vera Anstey Room
Between ground and first floor, Old Building
(Step free access is not available to this venue)

3 Tuns Ground floor, SAW

Bean Counter
Basement, 32 Lincoln's Inn Fields

Café 54
Ground floor, New Academic Building

Daily Grind Tower 1/2 Reception

Denning Learning Cafe
First floor, SAW

Fourth Floor Café Bar Old Building

Fourth Floor Restaurant
Old Building

George IV pub Portugal Street

LSE Garrick Ground floor, Columbia House

Mezzanine Café New Academic Building

Plaza Café John Watkins Plaza

Senior Common Room and Dining Room Fifth floor, Old Building

Student Common Room
Ground floor, King's Chambers

Weston Café Sixth floor, SAW

June 2015

Get the discussion going: when tweeting about the Colloquia, please use the hashtag **#CC2016**

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