Two one-day Colloquium 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
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) 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.

<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Presentation title</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00</td>
<td><strong>Coffee</strong> (Graduate Centre Foyer)</td>
<td></td>
</tr>
<tr>
<td>10:30</td>
<td>Péter Pál Pach</td>
<td>Polynomial Schur’s theorem</td>
</tr>
<tr>
<td>11:20</td>
<td>Julia Wolf</td>
<td>Efficient regularity lemmas</td>
</tr>
<tr>
<td>12:05</td>
<td><strong>Lunch</strong> (own arrangements – options on campus and nearby)</td>
<td></td>
</tr>
<tr>
<td>13:40</td>
<td>Eoin Long</td>
<td>Sharp thresholds and expanded hypergraphs</td>
</tr>
<tr>
<td>14:30</td>
<td>Natasha Morrison</td>
<td>Invertibility of random symmetric matrices</td>
</tr>
<tr>
<td>15:15</td>
<td><strong>Afternoon tea break</strong> (Graduate Centre Foyer)</td>
<td></td>
</tr>
<tr>
<td>15:50</td>
<td>Keith Ball</td>
<td>Hadamard matrices and 1-factorization</td>
</tr>
<tr>
<td>16:40</td>
<td>Ola Svensson</td>
<td>Online matching with general arrivals</td>
</tr>
<tr>
<td>17:30</td>
<td><strong>Reception</strong> (Senior Common Room, 1st Floor, Queen’s Building)</td>
<td></td>
</tr>
</tbody>
</table>
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 $x, y, z \in \{1, 2, \ldots, n\}$ is at least $n^{2/d^2 - o(1)}$, 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, Leticia 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**
- ArtsOne 37
- ArtsTwo 35
- Arts Research Centre 39
- Bancroft Building 31
- Bancroft Road Teaching Rooms 10
- Peter Landin Building (Computer Science) 6
- Engineering Building 15
- G.E. Fogg Building 13
- G.O. Jones Building 25
- Geography 26
- Graduate Centre 18
- Informatics Teaching Laboratories 5
- Joseph Priestley Building 41
- Library 32
- Law 36
- Lock-keeper’s Cottage 42
- Occupational Health and Safety Directorate 12
- People’s Palace/Great Hall 16
- Queens’ Building 19
- Scape Building 64
- 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
- Felden 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
- Bookshop 22
- Canalside 63
- Careers Centre 19
- Clock Tower 20
- CopyShop 56
- The Curve 47
- Disability and Dyslexia Service 31
- Drapers’ Bar and Kitchen 8
- Ground Cafe 33
- The Hive 24
- Housing Hub 48
- 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 7
- Santander Bank 62
- Security 38/54
- St Benet’s Chaplaincy 23
- Student Enquiry Centre 19
- Students’ Union Hub 34
- Union Shop 9
- 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
- Refreshment: Bar/Eatery/Coffee place
- Staff car park
- Bicycle parking
- Bicycle lockers
- Cash machine
- Smoking area / shelter

**Building construction site** 14
**Building closed for major refurbishment** 4
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.

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Institute</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natalie Behague</td>
<td>QMUL</td>
<td>Semi-perfect 1-factorizations of the hypercube</td>
</tr>
<tr>
<td>Olie Clarke</td>
<td>Bristol</td>
<td>Semi-standard young tableaux and toric degenerations of flag varieties</td>
</tr>
<tr>
<td>Jan Corsten</td>
<td>LSE</td>
<td>Tiling edge-coloured graphs with few monochromatic tiles</td>
</tr>
<tr>
<td>Clément Dallard</td>
<td>Portsmouth</td>
<td>New results for colourful components problems</td>
</tr>
<tr>
<td>Attila Dankovics</td>
<td>LSE</td>
<td>Erdős-Rothschild problem for five and six colours</td>
</tr>
<tr>
<td>Alberto Espuny Díaz</td>
<td>Birmingham</td>
<td>Resilient degree sequences with respect to hamiltonicity in random graphs</td>
</tr>
<tr>
<td>Nóra Frankl</td>
<td>LSE</td>
<td>Almost monochromatic point sets in grids and the chromatic number of the plane</td>
</tr>
<tr>
<td>Mani Ghahremani</td>
<td>Portsmouth</td>
<td>On monotonicity of minimum cost inert node searching</td>
</tr>
<tr>
<td>Keat Hng</td>
<td>LSE</td>
<td>Minimum degree conditions for powers of cycles and paths</td>
</tr>
<tr>
<td>Joseph Hyde</td>
<td>Birmingham</td>
<td>A degree sequence Komlós theorem</td>
</tr>
<tr>
<td>Stan Kučera</td>
<td>LSE</td>
<td>Partial colourings and Hadwiger's conjecture</td>
</tr>
<tr>
<td>Gwen McKinley</td>
<td>MIT</td>
<td>Super-logarithmic cliques in dense inhomogeneous random graphs</td>
</tr>
<tr>
<td>Lewis Mead</td>
<td>QMUL</td>
<td>Random simplicial complexes</td>
</tr>
<tr>
<td>Akshat Mudgal</td>
<td>Bristol</td>
<td>Sums of linear transformations in higher dimensions</td>
</tr>
<tr>
<td>Yani Pehova</td>
<td>Warwick</td>
<td>On a Ramsey-Turán variant of the Hajnal-Szemerédi theorem</td>
</tr>
<tr>
<td>Xinyi Xu</td>
<td>LSE</td>
<td>On the partial correspondence colouring and the AGH conjecture</td>
</tr>
</tbody>
</table>
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
Get the discussion going: when tweeting about the Colloquia, please use the hashtag #CC2019

Follow us at:
@LSEMaths
@QMULMaths