STAR Workshop on Random Graphs 2015

Radboud University Nijmegen

9 & 10 April 2015

http://www.math.ru.nl/~rkang/SWRG2015/

(Last updated 8 April 2015.)

We welcome you to Nijmegen for a workshop on random graphs and related topics.

This contains important practical and scientific information about the meeting.
To conserve paper, we provide at the meeting printed copies of only the programme.
This document has links, via hyperref, to other parts of the document and the web.

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Practical matters

Almost the entire workshop takes place in the Huygensgebouw (Huygens building) on the campus of Radboud University Nijmegen. All talks are in the auditorium HG00.303, located on the ground floor not far from the pendulum. Here is a map of key locations.

The campus is about 3 kilometres south of the city centre. To get there by bus (stop "Huygensgebouw"), use 13, 15, 300 from the east side of the centre, or take the shuttle bus service 10 if nearer the train station. It can be a 10 minute journey if you have a bicycle.

There is eduroam. Remember to configure it at your home institution beforehand.

During the meeting, we provide caffeine, lunch and other refreshments at the right moments. There is a buffet reception on Thursday, and drinks with nibbles on Friday.

Nijmegen can be reached by a 90-minute train journey from Schiphol airport (possibly with a quick change at Utrecht Centraal). Other airports nearby are Eindhoven and Weeze. Consult 9292 to check the overall route. Note that limited free internet access is usually provided at Schiphol airport, major train stations, and on Intercity trains. To plan meals for Wednesday or Friday evening, search on the website iens.

Programme

Embedded below are links to Google maps, as well as to abstracts.

Thursday, 9 April

10:00 – 10:30	Welcome coffee/tea and opening
10:30 – 11:30	Andrzej Ruciński — Embedding the Erdős-Rényi Hypergraph into the Random Regular Hypergraph and Hamiltonicity
11:30 – 11:40	Break
11:40 – 12:30	Two short talks (Warnke, Pachon Pinzon)
12:30 – 13:30	Lunch
13:30 – 14:30	Remco van der Hofstad — Competition on scale-free random graphs
14:30 – 14:55	One short talk (Conijn)
14:55 – 15:15	Coffee/tea break (conference photo first)
15:15 – 16:05	Two short talks (Sen, Schulte)
16:05 – 17:05	Mathew Penrose — Random bipartite geometric graphs
17:05 – 19:00	Drinks (Cultuurcafé) or bicycle ride (starting at Comeniuslaan 4)
19:00 –	Dinner reception (Huize Heyendael)

Friday, 10 April

09:50 – 10:05	Welcome coffee/tea
10:05 – 10:30	One short talk (Pokrovskiy)
10:30 – 11:30	Andrew Thomason — List colourings of hypergraphs
11:30 – 11:40	Break
11:40 – 12:30	Two short talks (Abiad, Mehrabian)
12:30 – 13:30	Lunch
13:30 – 14:30	Nelly Litvak — Ranking in random graphs
14:30 – 14:45	Coffee/tea break
14:45 – 16:00	Three short talks (van der Hoorn, Tabor, Reichenbachs)
16:00 – 16:15	Break
16:15 – 17:15	Angelika Steger — Games on Random Graphs
17:15 –	Closing drinks (third floor, between wings 7 and 8)

Invited lectures

Remco van der Hofstad (TU Eindhoven)

"Competition on scale-free random graphs".

Empirical findings have shown that many real-world networks share fascinating features. Indeed, many real-world networks are small worlds, in the sense that typical distances are much smaller than the size of the network. Further, many real-world networks are scale-free in the sense that there is a high variability in the number of connections of the elements of the networks, making these networks highly inhomogeneous. Such networks are typically modeled using random graphs with power-law degree sequences.

In this lecture, we will investigate the behavior of competition processes on scale-free random graphs with finite-mean, but infinite-variance degrees. Take two vertices uniformly at random, or at either side of an edge chosen uniformly at random, and place an individual of two distinct species at these two vertices. Equip the edges with traversal times, which could be different for the two species. Then let each of the two species invade the graph, such that any other vertex can only be occupied by the species that gets there first. Let the speed of the species be the inverse of the expected traversal times of an edge by that species.

We distinguish two cases. When the traversal times have an exponential distribution, we see that one (not necessarily the faster) species will occupy almost all vertices, while the losing species only occupied a bounded number of vertices, i.e., the winner takes it all, the loser's standing small. In particular, no asymptotic coexistence can occur. On the other hand, for deterministic traversal times, the fastest species always gets the majority of the vertices, while the other occupies a subpolynomial number. When the speeds are the same, asymptotic coexistence (in the sense that both species occupy a positive proportion of the vertices) occurs with positive probability.

This lecture is based on joint work with Mia Deijfen, Julia Komjathy and Enrico Baroni, and builds on earlier work with Gerard Hooghiemstra, Shankar Bhamidi and Dmitri Znamenski.

Nelly Litvak (University of Twente)

"Ranking in random graphs".

Ranking algorithms are crucial for assessing the importance of a node in a network, and have a wide range of applications, from clustering of networks to link prediction. An example is the famous Google PageRank algorithm for ranking web pages. In this talk I will discuss several topics related to the mathematical properties of ranking algorithms in random graphs. One of the examples is the distribution of a family of rankings, which includes Google's PageRank, on a directed configuration model. I will show that the rank of a randomly chosen node in the graph converges in distribution to a finite random variable, which is an endogenous solution to a stochastic fixed point equation. This result shows a remarkable accuracy when compared to the PageRank distribution on the Wikipedia. Next, I will discuss an problem of finding most important nodes when the network is unknown. This is the case, for example, in the Twitter follower network, that can be only accesses via the Twitter API. I will show that most important nodes can be found very efficiently using Monte Carlo-type methods. These methods are surprisingly efficient because of the high variability in the nodes' importance.

Mathew Penrose (University of Bath)

"Random Bipartite Geometric Graphs".

Consider a bipartite random geometric graph (RGG) on the union of two independent homogeneous Poisson point processes in the plane, with distance parameter r and intensities λ, μ. If λ is supercritical for the one-type RGG with distance parameter $2r$ then there exists μ such that (λ, μ) is supercritical; this also holds in higher dimensions.

Consider also the restriction of this graph to points in the unit square. We descibe a strong law of a large numbers as $\lambda \to \infty$ with μ/λ fixed, for the connectivity threshold of this graph. These results add to earlier work of Iyer and Yogeshwaran (Adv. Appl. Probab. 2012).

Andrzej Ruciński (Adam Mickiewicz University)

"Embedding the Erdős-Rényi Hypergraph into the Random Regular Hypergraph and Hamiltonicity".

We establish a relation between two uniform models of random k-graphs (for constant $k \geq 2$) on n labeled vertices: $\mathbb{G}^{(k)}(n, m)$, the random k-graph with exactly m edges, and $\mathbb{G}^{(k)}(n, d)$, the random d-regular k-graph. We show that if $n \log n \ll m \ll n^k$ then one can couple $\mathbb{G}^{(k)}(n, m)$ and $\mathbb{G}^{(k)}(n, d)$ with $d \sim km/n$ so that the latter contains the former with probability tending to one as $n \to \infty$. This complements some previous results of Kim and Vu about "sandwiching random graphs". In view of known results on the existence of different types of Hamilton cycles, this allows us to find the conditions under which $\mathbb{G}^{(k)}(n, d)$ is hamiltonian. In particular, we conclude that for $k \geq 3$ if $n^{k-2} \ll d \ll n^{k-1}$, then a.a.s. $\mathbb{G}^{(k)}(n, d)$ contains a tight Hamilton cycle. This is joint work with Andrzej Dudek, Alan Frieze, and Matas Šileikis.

Angelika Steger (ETH Zürich)

"Games on Random Graphs".

Playing games has always been a central part of human social interaction. In this talk we study so-called perfect information or combinatorial games. Here, a player has all the information that any other player has when she decides her next move, as for example in chess, Nim or Tic-Tac-Toe. Analyzing such games in a deterministic setting is often quite complicated (which is why we enjoy playing them). On the other hand, moving from a deterministic setup to a randomly generated board often allows the use of different methods, which in turn yield surprising answers. The aim of this talk is to provide an overview of methods and results for various games on random graphs. In particular, we will discuss Maker-Breaker games, Ramsey games, and Achlioptas processes.

Andrew Thomason (University of Cambridge)

"List colourings of hypergraphs".

The list colouring number χ_ℓ of a graph grows with its average degree d, indeed like $\log d$, as Alon proved. Saxton and Thomason proved that the same is true for simple uniform hypergraphs, by means of the container method. A new, more streamlined, proof of the container theorem allows the method to be applied to non-simple hypergraphs. So $\chi_\ell = \Omega(\log d)$, but what is the implied constant? It seems that containers don't give the best constant and that something more entertaining might be going on. We describe recent work with Méroueh that illuminates this.

Contributed talks

Aida Abiad (Tilburg University),
"Spectral characterizations of graphs".

We look at the spectrum (eigenvalues) of the adjacency matrix of a graph, and ask whether the eigenvalues determine the graph. This is a difficult, but important problem which plays a special role in the famous graph isomorphism problem. It has been conjectured by van Dam and Haemers (2003) that almost every graph is determined by its spectrum. A weaker version of the conjecture states that almost every graph is determined by its spectrum together with that of its complement. The mentioned problem has been solved for several families of graphs; sometimes by proving that the spectrum determines the graph, and sometimes by constructing nonisomorphic graphs with the same spectrum (cospectral graphs). In recent years this problem has attracted much interest. Both conjectures are still open, but Wang and Xu (2010) have a number of results that support them. For example, Wang and Xu showed that for many randomly generated graphs, its spectrum and the spectrum of its complement determine the graph. Let A be the adjacency matrix of a graph G. A key concept is the so-called walk matrix of a graph $W = [\underline{1}\ A\underline{1}\ \cdots\ A^{k-1}\underline{1}]$, where $\underline{1}$ is the all-one vector. Wang (2014) showed that some arithmetic properties of $\det(W)$ are closely related to whether the graph is determined by its spectrum together with that of its complement. It is known that if $\det(W) \neq 0$, then the graph has simple spectrum (i.e. all eigenvalues have multiplicity 1). Recently, Tao and Vu (2014) proved that the adjacency matrix of an Erdös-Rényi random graph has simple spectrum asymptotically almost surely.

If A and A' are the adjacency matrices of the cospectral graphs G and G', then there exists an orthogonal matrix Q such that $Q^{\top}AQ = A'$. We investigate when $Q^{\top}AQ$ is a $(0,1)$-matrix again in the special situation when Q has constant row sum and $2Q$ is integral. If Q is integral, G and G' are isomorphic. But if Q is not integral, then the graphs may be nonisomorphic; in this case we call G and G' semi-isomorphic graphs. In Abiad and Haemers (2012) we investigate semi-isomorphism. This concept is interesting since in 2010 Wang and Xu conjectured that almost all pairs of nonisomorphic cospectral graphs are semi-isomorphic.

René Conijn (VU Amsterdam),
"The largest clusters in 2D critical percolation".

Consider an $n \times n$-box in the triangular lattice. The asymptotic behaviour, as n tends to infinity, of the largest percolation clusters in this box was well studied by Borgs, Chayes, Kesten and Spencer in (1999 and 2001). However some questions remained open. If we restrict ourself to critical percolation the size of the largest cluster is of the order $n^{91/48}$. The first natural question is: does there exist a limiting distribution for the size of the largest cluster scaled by its order? Furthermore if it exists: what is its support and does it have atoms? In this talk we "assume" that the limiting distribution exists and prove some properties. Based on joint work with Rob van den Berg, Federico Camia and Demeter Kiss.

Pim van der Hoorn (University of Twente),
"Phase transitions for scaling of structural correlations in directed networks".

Analysis of degree-degree dependencies in complex networks and their impact on processes on networks requires null models, i.e. models that generated uncorrelated scale-free networks. Most models to date however show structural negative dependencies, generated by finite size effects. We analyze the behavior of these structural negative degree-degree dependencies, using rank based correlation measures, in the directed Erased Configuration Model. We obtain expressions for the scaling as a function of the exponents of the distributions. Moreover, we show that this scaling undergoes a phase transition, where one region exhibits scaling similar to the natural cut-off of the network while another region has scaling similar to the structural cut-off for uncorrelated networks. By establishing the speed of convergence of these structural dependencies we are able to asses statistical significance of degree-degree dependencies on finite complex networks when compared to networks generated by the directed Erased Configuration Model.

Abbas Mehrabian (University of Waterloo),
"Justifying the small-world phenomenon via random recursive trees".

We present a new technique for proving logarithmic upper bounds for diameters of evolving random graph models, which is based on defining a coupling between random graphs and variants of random recursive trees. This technique is quite simple and provides short proofs, is applicable to a broad variety of models including those incorporating preferential attachment, and provides bounds with small constants. We illustrate this by proving logarithmic upper bounds for diameters of the following well-known models: forest fire model, copying model, PageRank-based selection model, Aiello-Chung-Lu models, generalized linear preference model, directed scale-free graphs, Cooper-Frieze model, and random unordered increasing k-trees.

Angelica Pachon Pinzon (University of Turin),
"Preferential attachment models. Discrete and Continuous time relation".

In recent years, power laws have been conjectured to characterize the behavior of the upper tails of the degree distribution in many real phenomena and real-worlds networks. Historically, the first one to propose a model with a power law behavior was Yule (1925) in the context of the creation of new genus and the evolution of species inside of these genus. Later, Simon (1955) provides another version of the Yule model in discrete time and finds also a power law behavior. In the context of random graphs the first model created to obey the power law property was introduced by Barabási and Albert (1999).

All these models look very related, even sometimes they are considered equivalent on the basis of heuristic approach. However, we believe that each of them has its peculiarity and a rigorous comparison should be performed.

In this talk we will give first a common description of the discrete models, specifically Simon and Barabási-Albert models, by using random graph processes with preferential attachment mechanisms, and also introduce a continuous time preferential attachment model, the Yule model. Then, we prove and explain why in some cases the asymptotic degree distribution of the Barabási-Albert model coincide with the asymptotic in-degree distribution of the Simon model. Furthermore, we also prove that when the number of vertices in a Simon model (with parameter α) goes to infinite, it behaves as a Yule model with parameters $\lambda = (1 - \alpha)$ and $\beta = 1$.

Alexey Pokrovskiy (FU Berlin),
"Nonnegative sums in a set of numbers".

Suppose that we have a set of numbers $x_1, \ldots, x_n$ which have nonnegative sum. How many subsets of k numbers from $\{x_1, \ldots, x_n\}$ must have nonnegative sum? By choosing $x_1 = n - 1$ and $x_2 = \cdots = x_n = -1$, it is easy to see that there are such sets with only $\binom{n-1}{k-1}$ nonnegative k-sums. Manickam, Miklós, and Singhi conjectured that for n at least $4k$ there are always at least $\binom{n-1}{k-1}$ nonnegative k-sums in any set of n numbers. This conjecture is known to hold when n is large compared to k. The best known bounds are due to Alon, Huang, and Sudakov who proved the conjecture when $n > 33k^2$. We will discuss a proof of the conjecture in a range when n is linear compared to k, i.e. there is a constant C such that the conjecture holds when $n > Ck$.

Anselm Reichenbachs (Ruhr University Bochum),
"Discrete Malliavin-Stein method and random graphs".

We present results on the error in the normal approximation of a functional F depending on an infinite sequence of independent Rademacher random variables. Bounds on the Kolmogorov distance between the distribution of F and the standard normal distribution are derived by means of a discrete version of the so called Malliavin-Stein method. For functionals on the Wiener or Poisson space, this goes back to the seminal works of Nourdin and Peccati. As an application we consider the triangle count statistics in the Erdős?Rényi random graph with size-dependent success probability. While there are known results on the error in the normal approximation with respect to a class of smooth test functions, we present a new Berry-Esseen bound. (This is joint work with Kai Krokowski and Christoph Thäle.)

Matthias Schulte (Karlsruher Institut für Technologie),
"Limit theorems for random geometric graphs".

A random geometric graph is constructed by connecting the points of a Poisson process in a compact convex set whenever their distance does not exceed a prescribed distance. The aim of this talk is to investigate the asymptotic behaviour of the total edge length or, more general, sums of powers of the edge lengths of this random graph as the intensity of the underlying Poisson process is increased and the threshold for connecting points is adjusted. Depending on the interplay of these two parameters one obtains limit theorems where the limiting distribution can be Gaussian, compound Poisson or stable. This talk is based on joint work with Laurent Decreusefond, Matthias Reitzner and Christoph Thäle.

Sanchayan Sen (TU Eindhoven),
"Geometry of critical random graphs".

In the last few years, lot of progress has been made towards understanding the structure of many critical random graph models (including Erdos-Renyi random graph, inhomogeneous random graphs, configuration model) when the components are viewed as metric measure spaces. We will discuss some recent results in this direction.

Justyna Tabor (Adam Mickiewicz University),
"k-factors in stochastic Kronecker graphs".

The Kronecker graph generator was proposed by Leskovec, Chackrabati, Kleinberg and Faloutsos in 2005. They showed their model approximates the real-world networks as it obeys power law degree distribution and the "small world" phenomenon. They also noticed that this model is easy to examine, comparing to other real-world network models. Their generator was based on the Kronecker product.

However it is shown that graphs created that way have desired properties, their deterministic nature does not allow to mimic real-world networks. The formal definition of stochastic Kronecker graphs was given by Mahdian and Xu (2011). In their paper they gave the threshold for connectivity of SKG.

In this talk we will examine the threshold for a stochastic Kronecker graph to contain a k-factor for a finite k. We will show that they appear in this graph with high probability, as soon as the graph is a.a.s. connected.

Lutz Warnke (University of Cambridge),
"The phase transition in Achlioptas processes".

In the *Erdős–Rényi random graph process*, starting from an empty graph, in each step a new random edge is added to the evolving graph. One of its most interesting features is the 'percolation phase transition': as the ratio of the number of edges to vertices increases past a certain critical density, the global structure changes radically, from only small components to a single giant component plus small ones.

In this talk we consider *Achlioptas processes*, which have become a key example for random graph processes with dependencies between the edges. Starting from an empty graph these proceed as follows: in each step *two* potential edges are chosen uniformly at random, and using some rule *one* of them is selected and added to the evolving graph. We discuss why, for a large class of rules, the percolation phase transition is qualitatively comparable to the classical Erdős–Rényi process.

Based on joint work with Oliver Riordan.

Participants

Invited speakers:
Remco van der Hofstad (Eindhoven), Nelly Litvak (Twente), Mathew Penrose (Bath), Andrzej Ruciński (Poznań/Emory), Angelika Steger (ETH Zürich), Andrew Thomason (Cambridge).

Registered participants:
Aida Abiad (Tilburg), Enrico Baroni (Eindhoven), Georgios Bartzis (Leiden LUMC), Koen de Boer (Nijmegen), Wieb Bosma (Nijmegen), Wouter Cames van Batenburg (Nijmegen), Eric Cator (Nijmegen), René Conijn (VU Amsterdam), Souvik Dhara (Eindhoven), Henk Don (Nijmegen), Istvan Fazekas (Debrecen), Lorenzo Federico (Eindhoven), Robbert Fokkink (Delft), Alessandro Garavaglia (Eindhoven), Harald Gropp (Heidelberg), Pim van der Hoorn (Twente), Julia Hörrmann (Bochum), Michael Keane (Delft), Bas Kleijn (Amsterdam), Erik Koelink (Nijmegen), Sándor Kolumbán (Eindhoven), Anshui Li (Utrecht), Ines Lindner (VU Amsterdam), Abbas Mehrabian (Waterloo), Debankur Mukherjee (Eindhoven), Angelica Pachon Pinzon (Turin), Viresh Patel (QMUL), Christos Pelekis (Leuven), Attila Perecsényi (Debrecen), François Pirot (ENS Lyon), Alexey Pokrovskiy (FU Berlin), Guus Regts (Amsterdam), Anselm Reichenbachs (Bochum), Matthias Schulte (Karlsruhe), Sanchayan Sen (Eindhoven), Justyna Tabor (Poznań), Christoph Thäle (Bochum), Pieter Trapman (Stockholm), Lutz Warnke (Cambridge).

Organisers: Ross Kang (Nijmegen) and Tobias Müller (Utrecht).

Sponsorship

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