Random graphs and its applications for complex networks

Oct 3, 2018 - Oct 5, 2018, Saint Étienne, ICJ, Campus Métare
All talks will be held in A14, the opening buffet as well as all coffee breaks take place in room C112.

1 Program

Wednesday October 3

12h30-13h30 OPENING BUFFET

13h30-13h35 WELCOME by Stéphane Gaussent
13h35-14h20 Pierre Calka: Poisson-Voronoi graph on a Riemannian manifold
14h20-15h05 Julien Barré: Rigidity percolation and random graphs
15h05-15h50 Jérémie Bouttier: Some aspects of random maps coupled with matter systems

15h50-16h15 COFFEE BREAK

16h15-17h David Coupier: The Directed Spanning Forest converges to the Brownian Web
17h-17h45 Vlady Ravelomanana: Analytical Approach of Sparse Random Graphs Phase Transitions
17h45-18h30 Antoine Lejay: Diffusion on the lifted Sierpinski gasket

Thursday October 4

9h15-10h Roland Diel: Random graphs and Bradley-Terry model in random environment
10h-10h45 Oriane Blondel: Tagged particle diffusion in KA models

10h45-11h15 COFFEE BREAK

11h15-12h Fabio Toninelli: Random tiling dynamics
12h-12h45 Guillem Perarnau: Efficient sampling of random colorings

12h45-14h LUNCH (at CROUS university restaurant)

14h-14h45 Christophe Sabot: The edge reinforced random walk, its non-reversible counterpart, and related topics
14h45-15h30 Grégory Miermont: Study of percolation on triangulations by generating functions

15h30 GROUP PICTURE
15h35-16h COFFEE BREAK

16h-16h45 Bruno Schapira: Contact process on random graphs
16h45-17h30 Emmanuel Jacob: Contact process on evolving inhomogeneous random graphs
17h30-18h15 Philippe Chassaing: The impatient collector

19h30 WORKSHOP DINNER (Restaurant André Barcet https://www.restaurantbarcet.com/accueil_021.htm)

Friday October 5

9h15-10h Lefteris Kirousis: The Lovász Local Lemma: An introduction and some recent results
10h-10h45 Joachim Giesen: Ising Models with latent, conditional Gaussian Variables

10h45-11h15 COFFEE BREAK

11h15-12h Josep Díaz: Evolutionary Graph Theory
12h-12h45 Grigory Panasenko: Equations on a graph for the flows in thin tube structures

12h45 LUNCH (at CROUS university restaurant)

2 Titles and abstracts (in order of talks)

Pierre Calka

Title: Poisson-Voronoi graph on a Riemannian manifold
Abstract: In this talk, we consider a Riemannian manifold M and the Voronoi graph generated by the union of a fixed point x and a Poisson point process of intensity measure proportional to the volume measure of M. The aim is to connect the information of discrete nature of the random graph with the properties of the manifold itself which is a continuous object. We obtain asymptotic expansions up to the second order for the means of several characteristics of the Voronoi cell associated with x. In particular, the scalar curvature at x appears in the second term of the expansion of the mean number of vertices. This implies a probabilistic proof of the Gauss-Bonnet Theorem in dimension two. Moreover, we also deduce from that expansion the construction of a new estimator of the scalar curvature. The estimator is proved to have an explicit asymptotic variance and to satisfy a central limit theorem with precise convergence rate.
This talk is based on several joint works with Aurélie Chapron and Nathanaël Enriquez.

Julien Barré

Title: Rigidity percolation and random graphs
Abstract: Consider structures made with balls related by fixed lengths bars; the balls act as joints: the bars can freely rotate around the balls. We are interested in the question: is the structure rigid or floppy? I will first introduce rigidity theory, and how it relates with graph theory. For large structures with a probabilistic definition, a natural question is "rigidity percolation". I will present some old conjectures on the subject, and some recent results for random graphs.
Joint work with Marc Lelarge and Dieter Mitsche.

Jérémie Bouttier

Title: Some aspects of random maps coupled with matter systems
Abstract: A map is a graph drawn on a surface without edge crossings. Much attention has been devoted to the study of uniform random maps, and similar models. In particular, it has been shown that their metric structure admits a universal scaling limit called the Brownian map, which only depends on the topology of the underlying surface.
In contrast, much less is known in the physically-relevant case where a map is sampled with a probability proportional to the partition function of a statistical physics model (Ising, Potts...) defined on it. In this talk I will present some partial results on this topic.

David Coupier

Title: The Directed Spanning Forest converges to the Brownian Web
Abstract: The Directed Spanning Forest (DSF) is a geometric random graph built on a Poisson

Point Process. It has been introduced by Baccelli & Bordenave in 2008 as a tool to study communication networks but actually appears as interesting in itself. Indeed, Baccelli & Bordenave conjectured: 1. the DSF actually is a tree and 2. under a diffusive scaling, the DSF converges to the Brownian Web. This talk is mainly devoted to the second conjecture.
Joint work with C. Tran (Lille), K. Saha (Bangalore, India) and A. Sarkar (New Delhi, India).

Vlady Ravelomanana

Title: Analytical Approach of Sparse Random Graphs Phase Transitions
Abstract: Several combinatorial structures are subject to phase transitions as one of their parameters increases when their sizes are large but fixed. Such structures include random CNF formulas or random graphs.
In this talk, we will review various phase transitions of random graph properties or 2-CNF formulas, emphasizing the strengths (and limits?) of enumerative/analytic approaches. In particular, we will show how to shift the localization of a phase transition by restricting the degrees of the vertices of the graphs to an arbitrary set.

Antoine Lejay

Title: Diffusion on the lifted Sierpinski gasket
Abstract: The theory of rough paths allows one to integrate differential forms or solve differential equations driven by rough signals, at the price of enriching them with the equivalent of their iterated integrals. This theory typical applies to paths of stochastic processes which are irregular by nature.
In this talk, we consider the construction of a diffusion living in the horizontal lift of the Sierpinski gasket. Such a diffusion lives in the Heisenberg group. It is then a suitable candidate for being a rough path. B. Hambly and T. Lyons have already constructed the lift of a diffusion on the Sierpinski gasket using piecewise linear interpolation. We construct here a different process by lifting first the Sierpinski gasket to a fractal in the Heisenberg group and then by identifying a suitable Dirichet form from a discrete network of resistances.
From a joint work with Samia Haraketi (Tunis) and Ezedine Haouala (Monastir).

Roland Diel

Title: Random graphs and Bradley-Terry model in random environment
Abstract: We consider a model of paired comparaisons represented by an oriented random graph. Each vertex corresponds to a compared element and an oriented edge between two vertices describes the result of the comparison. A weight is associated to each vertex and the set of non-oriented edges is fixed but the orientation of each edge is randomly chosen according to the Bradley-Terry model and depends on the weights of the two vertices. In addition, the different weights are assumed to be drawn i.i.d. at random. We will examine two questions about this model. First in a tournament, that is an orientation of a complete graph, is the vertex with the highest weight also the vertex with the highest indegree? A second problem will be to try to obtain informations on the distribution of the weights by considering only the orientation of a small number of edges.

Oriane Blondel

Title: Tagged particle diffusion in KA models
Abstract: Kinetically constrained lattice gases (KCLG) are interacting particle systems on $\mathbb{Z}^d$ with hard core exclusion and Kawasaki type dynamics. Their peculiarity is that jumps are allowed only if the configuration satisfies a constraint which asks for enough empty sites in a certain local neighborhood. KCLG have been introduced and extensively studied in physics literature as models of glassy dynamics. We focus on the Kob Andersen (KA) models. We analyze the behavior of a tracer (i.e. a tagged particle) at equilibrium and prove that at any density, under diffusive rescaling the motion of the tracer converges to a d-dimensional Brownian motion with non-degenerate diffusion matrix. Therefore we disprove the occurrence of a diffusive/non diffusive transition which had been conjectured in physics literature.

Fabio Toninelli

Title: Random tiling dynamics
Abstract: We discuss Markov dynamics of planar tilings and the related questions of estimating their mixing time and of proving law of large numbers (aka hydrodynamic limit) for them.

Guillem Perarnau

Title: Efficient sampling of random colorings
Abstract: A well-known conjecture in computer science and statistical physics is that Glauber dynamics on the set of k-colorings of a graph G on n vertices with maximum degree Δ is rapidly mixing for $k \geq \Delta + 2$. In 1999, Vigoda showed rapid mixing of flip dynamics with certain flip parameters on the set of proper k-colorings for $k > (11/6)\Delta$, implying rapid mixing for Glauber dynamics. In this paper, we obtain the first improvement beyond the $(11/6)\Delta$ barrier for general graphs by showing rapid mixing for $k > (11/6 - \eta)\Delta$ for some positive constant η. The key to our proof is combining path coupling with a new kind of metric that incorporates a count of the extremal configurations of the chain. Additionally, our results extend to list coloring, a widely studied generalization of coloring. Combined, these results answer two open questions from Frieze and Vigoda's 2007 survey paper on Glauber dynamics for colorings.
(Joint work with Michelle Delcourt and Luke Postle)

Christophe Sabot

Title: The Edge reinforced random walk, its non-reversible counterpart, and related topics
Abstract: I will review some recent developpments on two self-interacting processes: the Edge-Reinforced Random Walk (ERRW) and the Vertex Reinforced Random Walk (VRJP), and explain their relation with some random Schrdinger operators. I will also give a glimpse of a recent non-reversible generalization.
(Based on joint works or (work in progress) with Pierre Tarrès, X. Zeng, S. Baccalado)

Grégory Miermont

Title: Study of percolation on triangulations by generating functions
Abstract: We are interested in the model of site percolation and bond percolation on random planar triangulations. Using a recursive decomposition of monochromatic maps with a boundary and generating function techniques that originated in Tutte's work, we identify the critical point of these models, as well as information about the size and geometry of the critical clusters in subcritical, critical, and supercritical regimes.
Work in collaboration with Olivier Bernardi and Nicolas Curien.

Bruno Schapira

Title: Contact process on random graphs
Abstract: We will review recent joint works with Daniel Valesin on the contact process on some finite and infinite (random) graphs.

Emmanuel Jacob

Title: Contact process on evolving inhomogeneous random graphs
Abstract: We study the contact process on inhomogeneous random graphs that evolve simultaneously as the process, and under stationary dynamics. Letting the graph evolve faster or slower than the process leads to a natural interpolation between the static graph and its "mean-field approximation".

Philippe Chassaing

Title: The impatient collector
Abstract: We discuss the asymptotic behaviour of some statistics of the coupon collector (for n coupons), conditioned to be completed after at most $(1 + \lambda)n$ tries, i.e., much faster than expected. Then we discuss the relation between the coupon collector and some large discrete structures relevant to computer science, with applications.
(Collaboration with Anis Amri)

Lefteris Kirousis

Title: The Lovász Local Lemma: An introduction and some recent results
Abstract: I will outline the algorithmic results for the Lovász Local Lemma by Moser and Tardos. Then I will describe a unifying direct probabilistic approach for the analysis of the algorithms that works for most variants. Finally, I will outline some recent work on generalizations of LLL.

Joachim Giesen

Title: Ising Models with Latent, Conditional Gaussian Variables
Abstract: Ising models describe the joint probability distribution of a vector of binary feature variables. Typically, not all the variables interact with each other and one is interested in learning the presumably sparse network structure of the interacting variables. However, in the presence

of latent variables,the conventional method of learning a sparse model might fail. This is because the latent variables induce indirect interactions of the observed variables. In the case of only a few latent, conditional Gaussian variables this spurious interaction contributes an additional low-rank component to the interaction parameters of the observed Ising model. Therefore, we propose to learn a sparse plus low-rank decomposition of the parameters of an Ising model using a convex regularized likelihood problem. The solution to the convex optimization problem has consistency properties in the high-dimensional setting, where the number of observed binary variables and the number of latent, conditional Gaussian variables are allowed to grow with the number of training samples.
Joint work with my PhD student Frank Nussbaum.

Josep Díaz

Title: Evolutionary Graph Theory
Abstract: We present the basic Moran-Nowak model for studying the spread of infections in an initially healthy population of agents. The model is based on an initial graph, where the vertices represent the population and the interactions are represented by edges. Initially a random node mutates/infects, and this provokes a finite stochastic process of infection and healings, that either finishes with all population infected or all population healed. We present the basic research done in the field as well as new recent related models.

Grigory Panasenko

Title: Equations on a graph for the flows in thin tube structures
Abstract: We consider partial derivative equations on graphs appearing in asymptotic analysis of viscous flows in thin tube structures. Existence and uniqueness of their solutions are studied. The talk follows the papers:

1. Panasenko G., Pileckas K., Flows in a tube structure: equation on the graph, Journal of Mathematical Physics, 55, 081505 (2014); doi: 10.1063/1.4891249.

2. Panasenko G., Pileckas K., Asymptotic analysis of the non-steady Navier-Stokes equations in a tube structure.I. The case without boundary layer-in-time. Nonlinear Analysis, Series A, Theory, Methods and Applications, 122, 2015, 125-168, http://dx.doi.org/10.1016/j.na.2015.03.008.

3. Panasenko G., Pileckas K., Asymptotic analysis of the non-steady Navier-Stokes equations in a tube structure. II. General case. Nonlinear Analysis, Series A, Theory, Methods and Applications, 125, 2015, 582-607, http://dx.doi.org/10.1016/j.na.2015.05.018.

3 List of participants

Julien Barré, Univ. d'Orléans
Oriane Blondel, CNRS, Univ. Lyon 1
Mahdi Boukrouche, Univ. Saint-Étienne
Jérémie Bouttier, ENS Lyon
Pierre Calka, Univ. Rouen
Ariane Carrance, Univ. Lyon 1
Philippe Chassaing, Univ. de Lorraine
Xinxin Chen, Univ. Lyon 1
David Coupier, Univ. Valenciennes
Josep Díaz, UPC Barcelona
Roland Diel, Univ. Nice Côte d'Azur
Kunal Dutta, INRIA Sophia Antipolis
Thibault Espinasse, Univ. Lyon 1
Lucas Flammant, Univ. Valenciennes
Nicolas Frilet, Univ. Grenoble Alpes
Christophe Garban, Univ. Lyon 1
Joachim Giesen, Univ. Jena
Cong Bang Huynh, Univ. Grenoble Alpes
Emmanuel Jacob, ENS Lyon
Lefteris Kirousis, National and Kapodistrian Univ. Athens
Antoine Lejay, INRIA Nancy Grand-Est
Mickaël Maazoun, ENS Lyon
Grégory Miermont, ENS Lyon
Dieter Mitsche, Univ. Saint-Étienne
Nathan Noiry, Univ. Paris Nanterre
Grigory Panasenko, Univ. Saint-Étienne
Laetitia Paoli, Univ. Saint-Étienne
Guillem Perarnau, Univ. Birmingham
Romain Ravaille, Univ. Saint-Étienne
Vlady Ravelomanana, Univ. Paris 7
Éric Remila, Univ. Saint-Étienne
Christophe Sabot, Univ. Lyon 1
Christoper Salinas, Univ. Saint-Étienne
Bruno Schapira, Univ. Aix-Marseille
Marc Sebban, Univ. Saint-Étienne
Philippe Solal, Univ. Saint-Étienne
Fabio Toninelli, CNRS, Univ. Lyon 1
Julian Tugaut, Univ. Saint-Étienne
Rémi Vaudoine, Univ. Saint-Étienne
Fabien Vignes-Tourneret, CNRS, Univ. Lyon 1
Rémi Viola, Univ. Saint-Étienne