PLANNING

All talks take place in *Amphi D* at the Faculty of Science of the Madrillet campus of the *Université de Rouen Normandie* in Saint-Étienne-du-Rouvray.

Monday, September 23rd

10:20 – 10:50	Reception of the participants
10:50 – 11:00	Welcome address
11:00 – 12:00	Matthias Reitzner. *Old and new results on random polytopes*
	Lunch break
14:00 – 15:00	Matthias Reitzner. *The random geometric graph*
15:00 – 15:30	Thibaut Vasseur. *Existence of Gibbs point processes with long range interactions*
	Coffee break
15:50 – 16:40	Peter Bürgisser. *Probabilistic Schubert calculus*
16:40 – 17:30	Thierry Lévy. *Determinantal linear subspace*

Tuesday, September 24th

09:20 – 10:10	Viet Chi Tran. *Random walks on simplicial complexes*
10:10 – 10:40	Lucas Flammant. *The Directed Spanning Forest in the hyperbolic space*
	Coffee break
11:00 – 12:00	Dieter Mitsche. *Random hyperbolic graphs 1/2*
	Lunch break
14:00 – 15:00	Dieter Mitsche. *Random hyperbolic graph 2/2*
15:00 – 15:30	Gilles Bonnet. *Spherical random polytopes in high dimension*
	Coffee break
15:50 – 16:20	Vincent Divol. *Adaptive manifold estimation with Rips complexes*
16:20 – 17:10	Jean-Baptiste Gouéré. *Absence of percolation in random geometrical outdegree one graphs*
18:30 – 22:00	Dinner cocktail and concert

Wednesday, September 25th

09:00 – 09:50	Vincent Cohen-Addad. *From Local to Global: Local Search Algorithms Beyond the Worst-Case Analysis*
09:50 – 10:40	Imre Bárány. *Limit shape of random polygons and lattice polygons: a survey*
	Coffee break
11:00 – 11:30	Nathan Noiry. *The Depth First Search algorithm on a Configuration Mode*
11:30 – 12:00	Matthieu Dien. *1-2 tree: let's twist*
	Lunch break
14:10 – 15:00	Ralph Neininger. *Process valued complexity measures of algorithms*
15:00 – 15:30	Pablo Rotondo. *Recurrence of substitutive Sturmian words*
	Coffee break
15:50 – 16:20	Przemysław Berk. *On induction of interval exchange intervals*
16:20 – 17:10	Cyril Nicaud. *Branch prediction in analysis of algorithms*

Thursday, September 26th

09:00 – 11:00	Valentin Féray. *Central limit theorems via (weighted) dependency graphs*
	Coffee break
11:20 – 12:20	Claudio Landim. *Metastable Markov chains 1/2*
	Lunch break
14:00 – 15:00	Claudio Landim. *Metastable Markov chains 2/2*
15:00 – 15:50	Alexandre Gaudillière. *Exponential transition law for the kinetic Ising model*
	Coffee break
16:10 – 17:00	Giambattista Giacomin. *Critical phenomena in pinning models: the role of disorder*
17:00 – 18:00	Patricia Gonçalves. *Hydrodynamics for symmetric exclusion with long range interactions 1/2*
19:00 – 22:00	Conference dinner

Friday, September 27th

09:00 – 10:00	Patricia Gonçalves. *Hydrodynamics for symmetric exclusion with long range interactions 2/2*
10:00 – 10:30	Ofer Busani. *Nonexistence of bi-infinite geodesics in exponential last passage percolation - a probabilistic way*
	Coffee break
10:50 – 11:20	Stefano Marchesani. *Hyperbolic hydrodynamic limit with boundary conditions*
11:20 – 12:10	Christophe Poquet. *Slow-fast dynamics and noise-induced periodic behaviors for mean-field excitable systems*
	Lunch break
13:30 – 14:00	Barbara Dembin. *The maximal flow from a compact convex subset to infinity in first passage percolation on* $\mathbb{Z}^d$
14:00 – 14:30	Réka Szabó. *From survival to extinction of the contact process by the removal of a single edge*
14:30 – 15:20	Dimitrios Tsagkarogiannis. *Nonequilibrium fluctuations for current reservoirs*

Monday, September 23rd

Old and new results on random polytopes (1h)

Matthias Reitzner
Universität Osnabrück

Random polytopes have been introduced in 1865 by Sylvester and then have been investigated intensively. This was inspired by many applications and connections e.g. to optimization, computational geometry, signal processing, and the local theory of Banach spaces. In this talk we emphasize the recent developments during the last years.

Followed by

The random geometric graph (1h)

Choose random points in $\mathbb{R}^d$ and connect two points if their distance is less than some bound c. This construction gives the random geometric graph (Gilbert graph, distance graph), and the set of complete cliques leads to the Vietoris-Rips complex. We will investigate interesting properties of the graph and the complex: percolation, numbers of k-faces, subgraph counts and crossing numbers.

Existence of Gibbs point processes with long range interactions (30')

Thibaut Vasseur
Université de Lille

The Gibbs point processes constitute a large class of point processes with interaction between the points. The existence of such processes in the infinite volume regime has a long history and is initially related to the existence of thermodynamic behaviours in statistical physics. We will remind the formalism of Dobroshin, Landford and Ruelle (DLR) used to described infinite-volume Gibbs measures and then present a result of existence in the case of pairwise and long range interactions.

Probabilistic Schubert calculus (50')

Peter Bürgisser
Technische Universität Berlin

Hermann Schubert developed in the 19th century a calculus for answering enumerative questions in algebraic geometry, e.g., "How many lines intersect four curves of degrees $d_1, ..., d_4$ in three-dimensional space in general position?". In his 15th problem, Hilberts asked for a rigorous foundation of Schubert's enumerative calculus, which led to important progress in algebraic geometry and topology (intersection theory of the Grassmannians). However, Schubert calculus only yields the typical number of complex solutions. Is there a meaningful way to speak about the typical number of REAL solutions?

One way to do so is to assume that the given objects (the four curves in the above example) are randomly rotated and to inquire about the expected number of real solutions. We shall outline the beginning of a new theory, which blends ideas from real algebraic geometry with integral geometry (stochastic geometry). The study of certain convex bodies (zonoids) turns out to be relevant for this.

The talk is based on joint work with Antonio Lerario.

Determinantal linear subspaces (50')

Thierry Lévy
Sorbonne Université

A determinantal point process (DPP) is, in the simplest of all possible settings, a random subset of a finite set, the incidence probabilities of which are given by the principal minors of a matrix. In our study of the geometry of connections on fibre bundles over graphs, Adrien Kassel and I were led to consider a class of random linear subspaces of a finite-dimensional vector space that shares many properties of DPP, and indeed contains, in a very concrete way, the class of finite DPP, and generalises it. This talk will be a presentation of these determinantal linear subspaces (DLS).

Tuesday, September 24th

Random walks on simplicial complexes (50')

Viet Chi Tran
Université de Lille

Joint work with T. Bonis, L. Decreusefond and Z. Zhang.

A natural and well-known way to discover the topology of random structures (such as a random graph G), is to have them explored by random walks. The usual random walk jumps from a vertex of G to a neighboring vertex, providing information on the connected components of the graph G. The number of these connected components is the Betti number β_0. To gather further information on the higher Betti numbers that describe the topology of the graph, we can consider the simplicial complex C associated to the graph G: a k-simplex (edge for $k = 1$, triangle for $k = 2$, tetrahedron for $k = 3$ etc.) belongs to C if all the lower $k-1$-simplices that constitute it also belong to the C. For example, a triangle belongs to C if its three edges are in the graph G. Several random walks have already been propose recently to explore these structures, mostly in Informatics Theory. We propose a new random walk, whose generator is related to a Laplacian of higher order of the graph, and to the Betti number β_k. A rescaling of the walk is also proposed.

The Directed Spanning Forest in the hyperbolic space (30')

Lucas Flammant
Université de Lille

Several works have shown that random objects generally present radically different macroscopic behaviours whether they are considered in an Euclidean or hyperbolic setting. In this talk, I present my results con- cerning a model of random forest, the DSF (Directed Spanning Forest), in hyperbolic geometry (work supervised by D. Coupier and C. Tran). In Euclidean geometry, the topological properties are well known: the DSF in $\mathbb{R}^d$ is a tree in dimension $d \leq 3$ and it is not connected in dimension $d \geq 4$. Moreover, it does not contain bi-infinite branches. I show that it presents different behaviours in the hyperbolic space H_d: whatever the dimension d, it is a tree and contains infinitely many bi-infinite branches.

Random hyperbolic graphs (2x1h)

Dieter Mitsche
Université Jean-Monnet-Saint-Étienne

Random hyperbolic graphs were introduced by Krioukov et al. about 10 years ago in order to model the existing Internet architecture and social networks: properties that can only be found in hyperbolic space allow to capture new phenomena such as inhomogeneity of vertex degrees more appropriately. In this mini-course we define the model, and look at three particular properties of this model: degree distribution, emergence of a gianbt component, and spectral gap.

Spherical random polytopes in high dimension (30')

Gilles Bonnet
Ruhr-Universität Bochum

Let $X_1, X_2, \ldots, X_n$ be i.i.d. random vectors distributed uniformly on the unit sphere S^{d-1} of the d-dimensional euclidean space. Their convex hull is a random polytopes which we denote by P_n. We let the number of points n be a function of the dimension d and both quantities go to infinity. Depending on the regime at which n grows with respect to d, we exhibit different behaviours concerning the volume and the facets of P_n.

This talked is based on the following articles:

- Threshold phenomena for high-dimensional random polytopes, joint work with Giorgos Chasapis, Julian Grote, Daniel Temesvari, Nicola Turchi, Communication in Contemporary Mathematics (2019), arXiv:1802.04089
- Facets of spherical random polytopes, joint work with Eliza O'Reilly, arXiv:1908.04033

Adaptive manifold estimation with Rips complexes (30')

Vincent Divol
Université Paris-Sud & INRIA Saclay

We focus on the problem of manifold estimation: given n i.i.d. observations $X_1, \dots, X_n$ in $\mathbb{R}^D$ sampled according to a law P supported on some unknown manifold $M \subset \mathbb{R}^D$, the goal of the statistician is to reconstruct the manifold using the observations. Minimax rates for this problem have been obtained under various model assumptions on the law P and the regularity of the underlying manifold M. The corresponding minimax estimators which have been proposed so far all depend crucially on the a priori knowledge of some parameters quantifying the regularity of M, whereas the statistician will not have access to those quantities in practice. Our contribution to the matter is twofold: first, we introduce a one-parameter family of estimators $(\hat{M}_t)_{t \geq 0}$, and show that for some choice of t (depending on the regularity parameters), the corresponding estimator is minimax. Second, we propose a completely data-driven selection procedure for the parameter t, leading to an adaptive minimax estimator on a large class of models.

Absence of percolation in random geometrical outdegree one graphs (50')

Jean-Baptiste Gouéré
Université de Tours

Consider a Poisson point process in the plane. At time 0, from each point of this process, a segment starts growing at some random speed in some random uniform direction. The segment stops its growth as soon as it hits another segment. Does the union of all the segments percolate ? How is it related to the title of the talk ? Work in collaboration with David Coupier and David Dereudre.

Wednesday, September 25th

From Local to Global: Local Search Algorithms Beyond the Worst-Case Analysis (50')

Vincent Cohen-Addad
CNRS/Sorbonne Université

A classic problem in data analysis consists in partitioning the vertices of a network in such a way that vertices in the same set are densely connected. In practice, the most popular approaches rely on local search algorithms; not only for the ease of implementation and the efficiency, but also because of the accuracy of these methods on many real-world graphs. For example, the Louvain algorithm – a local search based algorithm – has quickly become the method of choice for detecting communities in social networks, accumulating more than 8600 citations over the past 10 years. However, explaining the success of these methods remains an open problem: in the worst-case, their performances can be arbitrarily bad. In this work, we study these local search heuristics and aim at explaining their success and identifying the mechanisms that make them successful through a classic model for social networks, the stochastic block model. We give the first theoretical evidence that Louvain finds the underlying natural partition of the network.

Limit shape of random polygons and lattice polygons: a survey (50')

Imre Bárány
Hungarian Academy of Sciences

Assume K is a convex body in the plane and X is a (large) finite subset of K. How many convex polygons are there whose vertices belong to X? Is there a typical shape of such polygons? In this lecture I will talk about these questions mainly in two cases. The first is when X is a random sample of n uniform, independent points from K. In this case motivation comes from Sylvester's famous four-point problem and from the theory of random polytopes. The second case is when X is the set of lattice points contained in K and the questions come from integer programming and geometry of numbers.

The Depth First Search algorithm on a Configuration Model (30')

Nathan Noiry
Université Paris Nanterre

A configuration model is a random graph with a prescribed sequence of degrees. The depth first search algorithm performs an exploration of the graph which reveals a covering tree of the connected component it explores. After introducing these two notions, and assuming the existence of a giant component, I will present our main result about the asymptotic profile of the spanning tree of the giant component induced by the algorithm. (Joint work with N. Enriquez, G. Faraud and L. Ménard)

1-2 tree: let's twist (30')

Mathieu Dien
Université de Caen Normandie

In this presentation we will show some results about chordal graphs which are common in algorithmic context. We will see different characterizations of such graphs and their related random model. Then we will (briefly) present a new bijection between Cayley trees and 1-2 trees (chordal graphs with cliques of size ≤ 3) and its applications.

Process valued complexity measures of algorithms (50')

Ralph Neininger
Goethe-Universität Frankfurt

In this talk complexity measures of algorithms and data structures are considered which are linked to stochastic processes. Randomness comes either from the algorithm itself or from a stochastic model for the algorithm's input. The focus is on asymptotic properties of these complexities. The complexities reviewed include the cost of partial match queries in random point quadtrees, of quantile selection in data with a version of the FIND/Quickselect algorithm, and of radix selection with strings generated by Markov sources. The methods to derive process convergences are based on probability metrics. Properties of the respective limit processes are also discussed.

The talk is based on joint papers with Broutin and Sulzbach, with Sulzbach and Drmota and with Leckey and Sulzbach.

Recurrence of substitutive Sturmian words (30')

Pablo Rotondo
Université de Rouen Normandie

Sturmian words are a fundamental family of words, due to their low complexity without being periodic. In this talk we introduce a probabilistic study of the recurrence function of these words, and more particularly of substitutive Sturmian words, built with letter substitutions. The recurrence function can be viewed as a waiting time to discover all the factors of length n of a Sturmian word. During the talk we will introduce the recurrence function, the associated probabilistics models and results.

On induction of interval exchange intervals (30')

Przemysław Berk
Université de Rouen Normandie

I will present a concept of Rauzy-Veech induction for interval exchange transformation as a generalization of continued fraction expansion for rotation. In particular I will show the recurrence procedure of obtaining Rauzy-Veech matrices and some basic properties of this map. Time permitting, I will present some results from dynamical systems which use this concept as a tool.

Branch prediction in analysis of algorithms (50')

Cyril Nicaud
Université de Paris Est Marne-la-Vallée

Theoretical analysis of algorithms can fail to explain what is observed in practice, where naive solutions sometimes outperform 'theoretically optimal' ones. We present some examples of that kind, then explain why this is happening by enriching our computational model with some advanced features of modern processors. Finally, we explain how these theoretical model can be used to design new algorithms for basic problems like the binary search, which perform better in practice.

Thursday, September 26th

Central limit theorems via (weighted) dependency graphs (2x1h)

Valentin Féray
Universität Zürich

We present the theory of dependency graphs, and a generalization recently introduced by the speaker, weighted dependency graphs. These theories give criteria for the asymptotic normality of sequences of random variables, applicable in particular to numbers of occurrences of 'patterns' in various structures. We give examples ranging from probabilistic combinatorics (e.g., subwords in random texts) and stochastic geometry (length of the nearest neighbor graphs) to particle systems (symmetric simple exclusion process, Ising model).

Metastable Markov chains (2x1h)

Claudio Landim
CNRS/Université de Rouen Normandie/IMPA Rio

We review recent results on the metastable behavior of continuous-time Markov chains derived through the characterization of Markov chains as unique solutions of martingale problems.

Exponential transition law for the kinetic Ising model (50')

Alexandre Gaudillière

We prove that a metastable two-dimensional Ising model evolving at subcritical temperature in a finite but diverging box exhibits a transition from metastability to equilibrium at an asymptotically exponential time in the limit of vanishing magnetic field. We establish this result by following a pathwise approach combined with the introduction of soft-measures. We use the basics of the Wulff construction to prove that local relaxation times are short with respect to typical exit times from the basins of attraction of metastable and stable equilibria. Getting such an upper bound on local relaxation times is the key point of the proof and is based on a random path estimate inspired from block dynamics to control spectral gaps.

Critical phenomena in pinning models: the role of disorder (50')

Giambattista Giacomin
Université Paris Diderot

A natural question attacked since the 50s is the effect of disorder on phase transitions and critical phenomena. Disorder has typically a smoothing effect, possibly even to the point of completely smearing the transition. An approach, based on the renormalization group, lead in the 70s to a remarkably simple criterion, the 'Harris criterion', that predicts whether a system is insensitive to the introduction of a small amount of disorder. In this case the phase transition persists and the critical exponents are expected not to be affected by the disorde, which is therefore dubbed 'irrelevant'. If the Harris criterion fails the disorder is either called 'marginal' or 'relevant', with no general prediction on what it may happen to the transition. I will give an overview on recent progress obtained on relevant disorder cases for random polymers and interfaces with pinning potentials. Details will be given in a special case.

Hydrodynamics for symmetric exclusion with long range interactions (2x1h)

Patricia Gonçalves
Universidade de Lisbon

We consider the symmetric exclusion process with jumps given by a symmetric, translation invariant, transition probability p(·). The process is put in contact with stochastic reservoirs whose strength is tuned by a parameter $\theta \in \mathbb{R}$. Depending on the value of the param- eter θ and the range of the transition probability p(·) we obtain the hydrodynamical behavior of the system. The type of hydrodynamic equation depends on whether the underlying probability p(·) has fi- nite or infinite variance and the type of boundary condition depends on the strength of the stochastic reservoirs, that is, it depends on the value of θ. More precisely, when p(·) has finite variance we obtain either a reaction or reaction-diffusion equation with Dirichlet bound- ary conditions or the heat equation with different types of bound- ary conditions (of Dirichlet, Robin or Neumann type). When p(·) has infinite variance we obtain a fractional reaction-diffusion equa- tion given by the regional fractional laplacian with several types of boundary conditions which depend on the strength of the reservoirs. This is a joint work with Cédric Bernardin, Byon Jiménez-Oviedo and Stefano Scotta and it is based on the articles [1, 2, 3].

References

[1] Bernardin, C., Gonçalves, P., Oviedo, B., Slow to fast infinitely extended reservoirs for the symmetric exclusion pro- cess with long jumps, Markov Processes and Related Fields, no. 25, 217-274 (2019).

[2] Bernardin, C., Gonçalves, P., Oviedo, B., A micro- scopic model for the regional fractional Laplacian with Dirichlet boundary conditions, online at arxiv.org and submitted (2018).

[3] Bernardin, C., Gonçalves, P., Scotta, S., Hydrody- namic limit for a super-diffusive symmetric exclusion in contact with reservoirs, in preparation.

Friday, September 27th

Hydrodynamics for symmetric exclusion with long range interactions (2x1h)

Patricia Gonçalves
Universidade de Lisbon

Second part.

Nonexistence of bi-infinite geodesics in exponential last passage percolation - a probabilistic way (30')

Ofer Busani
University of Bristol

Joint work with Marton Balazs and Timo Seppäläinen.

Take a point on the 2-dimensional integer lattice and another one North-East from the first. Place i.i.d. Exponential weights on the vertices of the lattice; the point-to-point geodesic between the two points is the a.s. unique path of North and East steps that collects the maximal sum of these weights.

A bi-infinite geodesic is a doubly infinite North-East path such that any segment between two of its points is a point-to-point geodesic. We show that this thing a.s. does not exist (except for the trivial case of the coordinate axes). The intuition is roughly this: transversal fluctuations of a point-to-point geodesic are in the order of the 2/3rd power of its length, which becomes infinite for a bi-infinite geodesic. Hence we cannot see this path anywhere near the origin which, combined with the stationarity of the model, a.s. excludes its existence.

One needs to make this more quantitative to prove that even after taking the union for all possible directions we cannot see a bi-infinite geodesic, a program sketched by Newman. This has recently been completed rigorously by Basu, Hoffman and Sly with inputs from integrable probability. In this work we instead build on purely probabilistic arguments, such as couplings and maxima of drifted random walks, to arrive to this result.

Hyperbolic hydrodynamic limit with boundary conditions (50')

Stefano Marchesani
Università degli Studi dell'Aquila

We study the hydrodynamic limit for the isothermal dynamics of an anharmonic chain under hyperbolic space-time scaling under varying tension. The temperature is kept constant by a contact with a heat bath, realised via a stochastic momentum-preserving noise added to the dynamics. The noise is designed to be large at the microscopic level, but vanishing in the macroscopic scale. Boundary conditions are also considered: one end of the chain is kept fixed, while a time-varying tension is applied to the other end. We show that the volume stretch and momentum converge to a weak solution of the isothermal Euler equations in Lagrangian coordinates with boundary conditions.

Slow-fast dynamics and noise-induced periodic behaviors for mean-field excitable systems (50')

Christophe Poquet
Université Claude Bernard Lyon 1

We will study non-linear Fokker-Planck equations describing the infinite population limit of interacting noisy particles. Taking a slow-fast dynamics limit, we will describe the emergence of periodic behaviors induced by the noise and the interaction. We will consider in particular the case in which each unit evolves according to the FitzHugh Nagumo model.

The maximal flow from a compact convex subset to infinity in first passage percolation on $\mathbb{Z}^d$ (30')

Barbara Dembin
Université Paris Diderot

We consider the standard first passage percolation model on $\mathbb{Z}^d$ with a distribution G on $\mathbb{R}^+$ that admits an exponential moment. To each edge in the graph $\mathbb{Z}^d$, we assign a random i.i.d. capacity with distribution G. We interpret this capacity as a rate of flow. We will introduce the notion of maximal flow between a compact convex subset A of $\mathbb{R}^d$ and infinity. We will see that the study of maximal flow is associated with the study of sets of edges of minimal capacity that cut A from infinity. We can prove that the rescaled maximal flow between nA and infinity $\phi(nA)/n^{d-1}$ almost surely converges towards a deterministic constant depending on A. This constant corresponds to the capacity of the boundary ∂A of A and is the integral of a deterministic function over ∂A. This result was shown in dimension 2 and conjectured for higher dimensions by Garet.

From survival to extinction of the contact process by the removal of a single edge (30')

Réka Szabó
Université Paris Dauphine

We present an example of interest to the discussion of how the behavior of the contact process (a particular type of interacting particle system) can be affected by local changes in the graph on which they are defined. The contact process is usually taken as a model of epidemics on a graph: vertices are individuals, which can be healthy or infected. Infected individuals recover with rate 1 and transmit the infection to each neighbor with rate λ. We give a construction of a tree in which the contact process with any positive infection rate survives but, if a certain privileged edge is removed, one obtains two subtrees in which the contact process with infection rate smaller than 1/4 dies out. Joint work with D. Valesin.

Nonequilibrium fluctuations for current reservoirs (50')

Dimitrios Tsagkarogiannis
Università dell'Aquila

Stationary non equilibrium states are characterized by the presence of steady currents flowing through the system as a response to external forces. We model this process considering the simple exclusion process in one space dimension with appropriate boundary mechanisms which create particles on the one side and kill particles on the other. The system is designed to model Fick's law which relates the current to the density gradient. In this talk we focus on the fluctuations around the hydrodynamic limit of the system. The main technical difficulty lies on controlling the correlations induced by the boundary action. This is work in progress jointly with Panagiota Birmpa and Patricia Gonçalves.