BOOKLET OF CONFERENCE

FOREWORD

The GDR GeoSto is a french research structure created in 2012 which aims to federate the french community working on Stochastic Geometry and to foster collaborations with foreign researchers. More informations are available on its website : `http://gdr-geostoch.math.cnrs.fr/`.

Stochastic Geometry Days 2018 is the seventh yearly gathering of GDR GeoSto after, in the chronological order, Rouen, Grenoble, Lille, Poitiers, Nantes, and Marseille (CIRM). We would like to thank the University Paris Descartes for hosting this conference and the French National Center for Scientific Research (CNRS) for its financial support attributed to GeoSto.

Special thanks are also addressed to Marie-Hélène Gbaguidi for her precious help at each step of the organization !

The first two days are devoted to two introductory courses given Bartek Blaszczyszyn and Tobias Muller respectively on the analysis of wireless networks and the hyperbolic stochastic geometry. The organizing committee takes this opportunity to thank all the speakers of the conference for this very promising scientific program and to wish all participants a very fruitful week.

Finally, our colleague and friend Kiên Kiêu left us this year. Kiên was one of the very first members of the GDR GeoSto. Hence, the Wednesday's first talk given by Eva Vedel Jensen is dedicated to him.

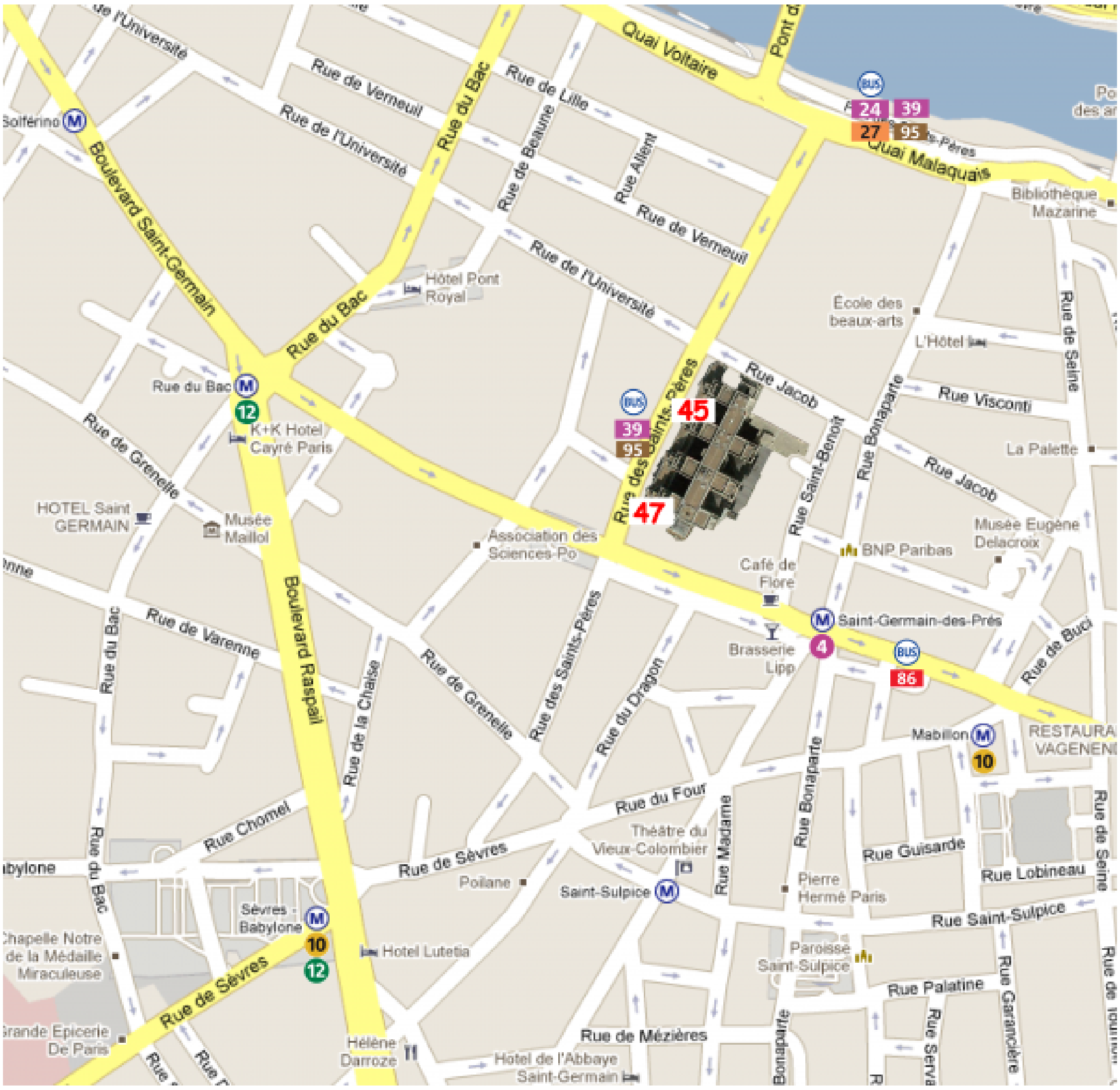
David Coupier, president of the GdR GEOSTO.

This conference is supported by

Conference Location

45 Rue des Saints-Pères, Paris

— Metro line 4 stop "Saint-Germain-des-prés"
— Metro line 12 "Rue du Bac"
— Bus 95 [1],39,24,27



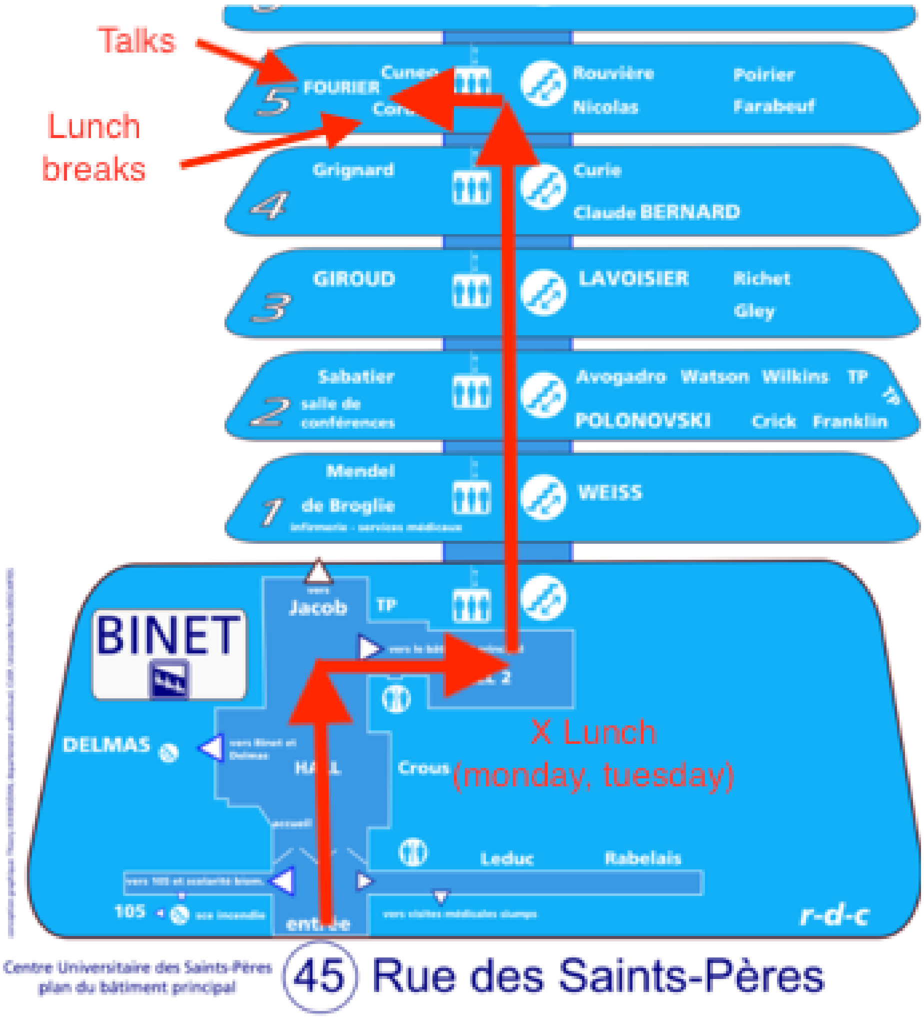
1. Bus 95 has two different stops depending on the bus direction - the stop indicated on the map is accurate when you come from the north

Amphithéâtre Fourier

(1) Cross the main hall and go to the right hall in the back

(2) Take the stairs or the elevator until the 5th floor.

(3) Go straight to your right and pass every door until you see "Espace Fourier". Cross this door, and go to the end of the corridor ; on the left you will have the "amphithéâtre Fourier", where talks take place.



Lunch

— Monday, tuesday : lunches will be at the CROUS (ground floor).
— Wednesday, thursday : in corridor "Cordier", close to "Fourier".
— Friday : At the Laboratoire MAP5 (7th floor) - take away possible.

Social event : visit of the Orsay museum, thursday from 6pm to 7.45pm. Tickets will be distributed on wednesday.

Musée d'Orsay
62, rue de Lille

Métro 12 Solférino
RER C Musée d'Orsay
Bus 24, 63, 68, 69, 73, 83, 84, 94
+33 (0)1 40 49 48 14

Conference dinner : dinner at the Orsay museum. Meeting at 7.45pm at the Orsay museum restaurant (inside the museum).

Planning

Monday 14th	Tuesday 15th	Wednesday 16th	Thursday 17th	Friday 18th
09:00 Welcoming participants	09:00 COURSE #1 Part 3/4	09:00 Welcoming Participants	09:00 Domenico MARINUCCI	09:00 Agnès DESOLNEUX
09:30 COURSE 1 Part 1/4	10:30 Coffee break	10:00 Eva VEDEL JENSEN *Dedicated talk to Kien Kieu*	09:45 Maurizia ROSSI	09:45 Elie CALI
10:45 Coffe break	11h COURSE #2 Part 4/4	10:45: break	10:30 Coffe break	10:30 Coffee break
11:15 COURSE #2 Part 1/4	12:30 Lunch Break	11:00 Céline LACAUX	11:00 Julien RANDON-FURLING	11:00 Christian LANTUEJOUL
12:30 Lunch Break	14:00 COURSE 1 Part 4/4	11:45 Lunch Break	11:45 Lunch Break	11:45 Pierre HOUDEBERT
14:00 COURSE 1 Part 2/4	15:30 Coffee break	14:00 Damien GAYET	14:00 Nicolas BROUTIN	12:15 Danivel NOVOTNA
15:30 Coffee break	16:00 COURSE #2 Part 4/4	14:45 Régine MARCHAND	14:45 Emmanuel JACOB	12:45 Lunch (boxes - take away possible)
16:00 COURSE #2 Part 2/4	17:30	15:30 Coffee break	15:30 Coffee break	
17:30		16:00 Dieter MITSCHE	16:00 Erik BROMAN	
		16:45 Arnaud POINAS	16:45 Sara MAZZONETTO	
		17:15 Adrien MAZOYER	17:15	
		18:00 GdR Meeting	18:00 Visit of Orsay museum	
		19:00 Welcome Cocktail	19:45 Dinner at Orsay Museum	

Mini course: Stochastic geometric modeling and analysis of wireless networks : Coverage - Connectivity - Capacity

Bartłomiej Błaszczyszyn

INRIA-ENS Paris

Performance analysis of wireless networks involves modeling of processes, which, due to their randomness, are amenable to probabilistic formalization. In this short course we shall focus mainly on stochastic geometry models particularly relevant for defining and computing macroscopic characteristics of wireless cellular networks. Simple Poisson models offer tractable approaches to the evaluation of the coverage and connectivity properties of such networks. More elaborated models, incorporating dynamic processes, in particular those studied in queueing theory, are required to study capacity sharing problems. Performance metrics of these space-time models usually have to be calculated in a semi-analytic way, involving simulation of some more complicated functionals of (Poisson) point processes, not amenable to analytic expressions. This is the price that one must pay for having adequate models, capable of explaining and predicting macroscopic performance of real, operational cellular networks. We shall show examples of a remarkably good agreement between model predictions and the statistical data collected in certain deployment scenarios.

Mini course: Hyperbolic Stochastic Geometry

Tobias Müller

Groningen University, Netherlands

Most standard models in stochastic geometry are defined in euclidean $d-$space. Usually there is a natural analogue defined in hyperbolic space. These hyperbolic analogues usually display behaviour that is spectacularly different from their euclidean counterparts. In this mini-course I will try to give an overview of the results in hyperbolic stochastic geometry with some emphasis on (hyperbolic) continuum percolation and Poisson-Voronoi diagrams, and on the intuition behind the results and proofs.

Phase transitions of scale invariant random fractals

Erik Broman

Chalmers University, Gothenburg, Sweden

In this talk we will consider scale invariant random fractals. We will start by briefly discussing some concrete examples (i.e. the Brownian loop soup and the scale invariant fractal snowflake model) and explain how these can be constructed. In all scale invariant random fractal models, there is an intensity parameter $\lambda > 0$ of the underlying Poisson process which essentially determines the nature of the resulting random fractal. As λ varies, the models undergo several phase transitions. On is when the fractal set transitions from the phase where it contains connected components, to the phase where it is almost surely totally disconnected. Another is when the fractal transitions from being totally disconnected to dissappearing completely (i.e. it is empty). As we will explain, this is intimately connected to the classical problem of covering a fixed set by other random sets (see for example the classical papers by Dvoretsky or Shepp).

Our results include determination of the exact value of the parameter λ at which the second transition occurs. Furthermore, we are also able to determine the behavior of the fractal sets at the critical points of both of these phase transitions.

Connectivity properties of sparsified random geometric graphs

Nicolas Broutin

UPMC-Sorbonne Universités

Consider a graph whose vertices represent n uniform points in the unit square. One forms a geometric graph by connecting two vertices if the distance between the corresponding points is at most some visibility radius r. It is well-known that for such graph to be connected with a decent probability, the average degree must be at least of order $\log n$, which may be two much for many applications. We will see and analyse one natural way to obtain a much sparser version of such graphs that is based on a decentralized protocol. Of course, one is interested in tuning the parameters (the average degree) so that the graph is then mostly connected. Quite interestingly, the phase transition for the apparition of a connected component of linear size is "explosive" in the sense that the graph goes from almost completely shattered to almost completely connected with the addition of only $o(n)$ edges.

I will be using this result mostly as a pretext to give an introduction to connectivity in geometric random graphs and to review some of the beautiful main ideas there.

This is based on joint work with L. Devroye and G. Lugosi.

Multi-hop device-to-device on streets

Élie Cali

Orange Labs

Several models have been proposed to represent street systems by random tessellations. Using Poisson Voronoi or Poisson Delaunay models, it is possible to model users on the streets with a Cox point process, and supposing a fixed communication radius, the corresponding Gilbert graph could represent the device-to-device communications between users. Studying percolation on this graph allows to analyze multi-hop long distance communications with device-to-device relaying. Some general theoretical results could be achieved, and simulations give numerical values.

Mean geometry of pixelized random fields

Agnès Desolgneux

ENS Paris Saclay

In applications, since digital images are defined on a finite grid of pixels, we generally have access only to a discretized version of a 2D random field. In this talk, I will explore the link between the mean geometry (perimeter, curvature) of the discretized random field and the one of the underlying ”true” random field, in order to understand the bias created by the pixelization.

This is a joint work with Hermine Biermé (Université de Poitiers).

Percolation of random nodal lines

Damien Gayet

Université Grenoble Alpes

If a real smooth function is given at random on the plane, what is the probability that its vanishing locus has a large connected component ? I will explain some recent answers we obtained with Vincent Beffara to this question, for some natural models coming from algebraic geometry and spectral analysis.

Phase transition for continuum Widom-Rowlinson model with random radii

Pierre Houdebert

Aix-Marseille Université

In this paper we study the phase transition of continuum Widom-Rowlinson measures in $\mathbb{R}^d$ with q types of particles and random radii. Each particle x_i of type i is marked by a random radius r_i distributed by a probability measure Q_i on $\mathbb{R}^+$. The particles of same type do not interact each other whereas particles x_i and x_j with different type $i \neq j$ interact via an exclusion hardcore interaction forcing $r_i + r_j$ to be smaller than $|x_i - x_j|$.

In the integrable case (i.e. $\int r^d Q_i(dr) < +\infty$, $1 \leq i \leq q$), we show that the Widom-Rowlinson measures exhibit a standard phase transition providing uniqueness, when the activity is small, and co-existence of q ordered phases, when the activity is large.

In the non-integrable case (i.e. $\int r^d Q_i(dr) = +\infty$, $1 \leq i \leq q$), we show another type of phase transition. We prove, when the activity is small, the existence of at least $q+1$ extremal phases and we conjecture that, when the activity is large, only the q ordered phases subsist. We prove a weak version of this conjecture by showing that the symmetric Widom-Rowlinson measure with free boundary condition is a mixing of the q ordered phases if and only if the activity is large.

Joint Work with David Dereudre, Université de Lille

A boolean model with preferential attachment

Emmanuel Jacob

ENS Lyon

We investigate a variation of the Poisson boolean model inspired by the preferential attachment paradigm, which is commonly used in the modelization of real-world complex networks as it provides a plausible explanation of the polynomial degree distribution feature of these scale-free networks.

In this model, the points of a Poisson point process on the euclidean space are given a random birth time, when we center a ball with radius decreasing with time and increasing with the number of new points born inside it. We study the percolation phase transition, exhibiting parameters of the model for which the percolation threshold can be shown to be zero or strictly positive, and parameters for which this is left as an open question.

Anisotropy and spatial random fields

Céline Lacaux

Université d'Avignon

In spatial modelling, isotropy may be very restrictive. Especially, in a stationary and Gaussian framework, isotropy may not be used if empirical semi-variogram exhibits different directional behaviors. This talk will present several anisotropic semi-variograms provided in the literature. It should be concluded, if time allows, by a discussion on the models for spatio-temporal data.

Elements of Geostatistics for spheres

Christian Lantuéjoul

MinesParisTech, Centre de Géosciences, F-77305 Fontainebleau, France

In several domains of the Geosciences (climatology, cosmology, geodesy or paleomagnetism), data are supported by spheres. As they often exhibit spatial strutures, it may be interesting to examine them using a geostatistical approach. Compared to the Euclidean one, the spherical framework posseses two distinctive features. First, the sphere is compact, which precludes any non-local form of ergodicity. Second, the translation group used to define stationarity is not commutative. This presentation draws the consequences from these two differences. Besides the classical Schoenberg representation of functions of positive type, two other topics are discussed on spheres, namely the development of a spectral method to simulate Gaussian random fields and the resolution of several spatial or spatiotemporal stochastic partial dif- ferential equations.

Continuity of the time constant in supercritical percolation.

Régine Marchand

Université de Lorraine

We consider Bernoulli percolation on $\mathbb{Z}^d$: edges are independently kept with probability p and erased with probability 1-p. In the supercritical regime, there exists a single infinite connected component, called the infinite cluster. The time constant describes the asymptotic behavior of the ratio between the graph distance and the euclidean distance in the infinite cluster, and we prove that this constant is continuous with respect to the opening parameter p. The result can be extended to the isoperimetric constant.

This is a joint work with Olivier Garet (Université de Lorraine), Eviatar Procaccia (Texas A&M University) et Marie Théret (Université Paris Diderot).

The Geometry of Random Eigenfunctions

Domenico Marinucci

Universita Roma Tor Vergata

We shall review some recent results concerning the asymptotic behaviour (in the high-frequency regime) of geometric functionals on the excursion sets of random spherical eigenfunctions. We shall show in particular how the Lipschitz-Killing curvatures (equivalently, the Minkowski functionals) evaluated on these excursion sets are dominated by a single component, corresponding to their projection on the so-called Wiener chaos of order 2. This component disappears for the excursion set corresponding to a zero threshold, where the asymptotic behaviour is hence different (the so-called Berry cancellation phenomenon). A similar behaviour can also be established for random eigenfunctions on the torus (arithmetic random waves).

The talk is mainly based on a joint work with Valentina Cammarota, and on some earlier papers involving also Giovanni Peccati, Maurizia Rossi and Igor Wigman.

Space filling design using determinantal point processes

Adrien Mazoyer

UQAM, Montréal, Canada

Determinantal point processes (DPP) form a class of repulsive (or regular) spatial point processes. The intensity functions of a DPP are given by the Gram determinant of a certain kernel symmetric function. Therefore, all moments are explicit. Given a DPP defined on a compact, consider its projection on a lower dimensional set. Are the intensity functions of the new point process explicit ? Is it a repulsive point process ? Is it a DPP ? These issues are studied in order to investigate the use of DPPs for "space filling design" in the field of computer experiments, the aim of which is to generate points in a set such that the set is "regularly" covered.

About some skewed Brownian diffusions : explicit representation of their transition densities and exact simulation

Sara Mazzonetto

Universität Duisburg-Essen, Germany

In this talk we first discuss an explicit representation of the transition density of Brownian dynamics undergoing their motion through semipermeable and semireflecting barriers, called skewed Brownian motions. We use this result to present an exact simulation of these diffusions, and comment some (still) open problems. Eventually we consider the exact simulation of Brownian diffusions whose drift admits finitely many jumps.

Clique colorings of random (geometric) graphs

Dieter Mitsche

Université de Nice Sophia Antipolis

A clique coloring is a coloring of the vertices such that no maximal clique is monochromatic (ignoring isolated vertices). The least number of colors in such a coloring is the clique chromatic number. We study the clique chromatic number of the random graph $G(n, p)$ and of the random geometric graph $G(n, r)$.

Gaussian approximation for functionals of Gibbs particle processes

Daniela Novotná

Charles University, Prague

Two known techniques from the point process theory in the Euclidean space $\mathbb{R}^d$ are extended to the space of compact sets on $\mathbb{R}^d$ equipped by the Hausdorff metric. First, conditions for the existence of the stationary Gibbs point process with given conditional intensity have been simplified recently. Secondly, the Malliavin-Stein calculus was applied to the estimation of the Wasserstein distance between the Gibbs input and standard Gaussian distribution. We transform these theories to the space of compact sets and use them to derive a central limit theorem for functionals of a planar Gibbs segment process.

Mixing properties and CLT for determinantal point processes

Arnaud Poinas

Université de Rennes

In this talk we focus on the negative association property of determinantal point process (DPP for short) and its consequences. Negative assocation is a property that characterizes the negative dependency of a stochastic process. Well studied in random field theory, this notion rarely appears in the point process litterature. We show that negative association implies alpha-mixing properties as well as a general CLT, stronger than classical CLT based on alpha-mixing. DPPs being negatively associated, we derive a CLT for a wide class of functionnals of non-stationnary DPPs, that include the type of statistitics involved in asymptotic inference of these processes.

Facets on the convex hull of $d-$dimensional Brownian and Lévy motion

Julien Randon-Furling

Université Panthéon Sorbonne

For stationary, homogeneous Markov processes (viz., Lévy processes, including Brownian motion) in dimension $d = 3$, we establish an exact formula for the average number of $(d-1)-$dimensional facets that can be defined by d points on the process's path. This formula defines a universality class in that it is independent of the increments' distribution, and it admits a closed form when $d = 3$, a case which is of particular interest for applications in biophysics, chemistry, and polymer science. We also show that the asymptotical average number of facets behaves as $\left\langle \mathcal{F}_T^{(d)} \right\rangle \sim 2[\ln(T/\Delta t)]^{d-1}$, where T is the total duration of the motion and Δt is the minimum time lapse separating points that define a facet.

Asymptotic distribution of nodal intersections for arithmetic random waves

Maurizia Rossi

Université Paris Descartes

In this talk we focus on the nodal intersections number of random Gaussian toral Laplace eigenfunctions ("arithmetic random waves") against a fixed smooth reference curve. The expected intersection number is proportional to the the square root of the eigenvalue times the length of curve, independent of its geometry. The asymptotic behaviour of the variance was addressed by Rudnick-Wigman ; they found a precise asymptotic law for "generic" curves with nowhere vanishing curvature, depending on both its geometry and the angular distribution of lattice points lying on circles corresponding to the Laplace eigenvalue. They also discovered that there exist peculiar "static" curves, with variance of smaller order of magnitude, though did not prescribe what the true asymptotic behaviour is in this case. In this talk we investigate the finer aspects of the limit distribution of the nodal intersections number. For "generic" curves we prove the Central Limit Theorem (at least, for "most" of the energies). For the aforementioned static curves we establish a non-Gaussian limit theorem for the distribution of nodal intersections, and on the way find the true asymptotic behaviour of their fluctuations, under the well-separatedness assumption on the corresponding lattice points, satisfied by most of the eigenvalues.

This talk is based on a joint work with Igor Wigman (King's College London).

Precision of systematic sampling

Eva B. Vedel Jensen

Department of Mathematics, Aarhus University, Denmark

Systematic sampling in continuous space is a useful technique in stereology, ecology and other spatial sciences. In one dimension, a systematic sample is a grid of equally-spaced sample points randomly shifted with respect to the origin. Similarly in two or three dimensions, a systematic sample is a randomly shifted regular grid of points with fixed geometry.

A simple geometric example of systematic sampling in one dimension concerns the estimation of the volume of a compact set in three dimensions. The volume can be expressed as an integral of the areas of intersection of the object with horizontal planes. A systematic set of such horizontal planes is used for estimation of the volume of the object. The resulting sampling design is called the 'egg-slicer design' and the corresponding estimator 'the Cavalieri estimator'.

Estimation of the precision of such Cavalieri type estimators based on systematic sampling is a challenging task. A breakthrough came around the millennium when Kiên Kiêu and coworkers derived a general form of the Euler-MacLaurin formula which revealed the connection between the variance of the estimator and the smoothness of the so-called measurement function. The subsequent paper, written for users in Journal of Micrsocopy, has been cited more than 1000 times. In the asymptotic variance theory for estimators based on systematic sampling with errors in sampling locations, the Euler-Maclaurin formula also plays a central role.

Estimation of the precision of estimators based on systematic sampling is still of great current interest. Research is focused on the construction of estimators with better variance behaviour, using knowledge of the actually spacings between noisy sampling locations.

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