38th Finnish Summer School on Probability and Statistics, Lammi Biological Station

	Monday 28.5	Tuesday 29.5	Wednesday 30.5	Thursday 31.5	Friday 1.6
08:00 - 09:00		08:00 – 09:00 breakfast	08:00 – 09:00 breakfast	08:00 – 09:00 breakfast	08:00 – 09:00 breakfast
09:00 - 10:00		09:15 – 10:00 Possamaï	09:15 – 10:00 Nourdin	09:15 – 10:00 Nourdin	09:15 – 10:00 Zwiernik
10:00 - 11:00		10:15 – 11:00 Possamaï	10:15 – 11:00 Nourdin	10:15 – 11:00 Nourdin	10:15 – 11:00 Zwiernik
11:00 - 12:00		11:15 – 12:00 Mallasto, Karvonen	11:15 – 12:00 Possamaï	11:15 – 12:00 Kasprzak	11:15 – 12:00 Azmoodeh
12:00 - 13:00	12:00 – 12:50 lunch 12:50 – 13:00	12:00 – 13:00 lunch	12:00 – 13:00 lunch	12:00 – 13:00 lunch	12:05 – 13:00 lunch
13:00 - 14:00	13:00 – 13:45 Zwiernik	13:45 – 14:30 Nourdin	13:45 – 14:30 Possamaï	13:45 – 14:30 Zwiernik	
14:00 - 15:00	14:00 – 14:45 Zwiernik 14:45 – 15:15 coffee	14:30 – 15:00 coffee	14:30 – 15:00 coffee	14:30 – 15:00 coffee	
15:00 - 16:00	15:15 – 16:00 Possamaï	15:00 – 15:45 Nourdin 15:45 – 17:00 Exercise class	15:00 – 17:00 Guided Excursion	15:00 – 15:45 Zwiernik 15:45 – 17:00 Exercise class	
16:00 - 17:00	16:15 – 17:00 Possamaï				
	17:00 – 18:00 dinner	17:00 – 18:00 dinner	17:00 – 20:00 sauna by the lake (ladies first)	17:00 – 18:00 dinner	
	19:00 – 22:00 sauna by the lake (ladies first)	19:00 – 22:00 sauna by the lake (ladies first)	20:00 – 22:00 Summer school "gala" dinner	19:00 – 22:00 sauna by the lake (ladies first)	

1. Abstracts of minicourses

The Malliavin-Stein approach

Ivan Nourdin

Université du Luxembourg

Abstract Introduced by Paul Malliavin in 1978, Malliavin calculus can be roughly described as an infinite-dimensional differential calculus whose operators act on sets of random objects associated with Gaussian or more general noises. Originally introduced and exploited for studying the regularity of the laws of Wiener functionals (such as the solutions of stochastic differential equations), it has found many other applications during the last two decades, including concentration inequalities, anticipated stochastic calculus or computation of Greeks in mathematical finance.

Stein's method gathers a collection of probabilistic techniques for assessing the distance between probability distributions by means of differential operators. This approach was originally developed by Charles Stein in the seventies. In recent years, Stein's method has become one of the most popular and powerful tools for computing explicit bounds in probabilistic limit theorems, with applications to fields as diverse as random matrices, random graphs, probability on groups and spin glasses.

In 2009, it was discovered by Giovanni Peccati and the speaker that one can fruitfully combine Stein's method with Malliavin calculus, in order to obtain probability approximations for random systems that are driven by some underlying Gaussian noise. The introduction of such a method has been the starting point of many applications and generalizations by dozens of authors in a number of areas, ranging from Gaussian analysis to stochastic geometry, and from combinatorics to non-commutative probability, information theory, concentration inequalities and universality results.

The goal of this series of lectures is to introduce the audience to this combination of Malliavin calculus and Stein's method, nowadays called the Malliavin-Stein approach. We will also review some recent applications. All the needed material will be introduced progressively; no specific knowledge is required, beyond the definitions and very basic properties of Gaussian processes (mostly Brownian motion).

An introduction to backward stochastic differential equations and applications in finance and economics

Dylan Possamaï

Columbia University

Abstract Backward stochastic differential equations (BSDEs for short) have been introduced since the 90s, and have proved since then to be a fundamental tool in stochastic analysis, stochastic control, and even PDE analysis, with numerous applications in finance, economics and insurance. This course would be the occasion to provide an introduction to the theory as well as its latest developments. After going through some of the most important theoretical results, we will see as an illuminating application how BSDEs allow to treat in a general fashion several problems stemming from contract theory with moral hazard.

Latent-tree models

Piotr Zwiernik

Pompeu Fabra University

Abstract Latent tree models are graphical models defined on a tree, in which only a subset of variables is observed. They were first discussed by Judea Pearl as tree-decomposable distributions to generalise star-decomposable distributions such as the latent class model. Latent tree models, or their submodels, are widely used in: phylogenetic analysis, network tomography, computer vision, causal modeling, and data clustering. They also contain other well-known classes of models like hidden Markov models, Brownian motion tree model, the Ising model on a tree, and many popular models used in phylogenetics. This lecture offers a concise introduction to the theory of latent tree models. I will emphasise the role of tree metrics in the structural description of this model class, in designing learning algorithms, and in understanding fundamental limits of what and when can be learned.

This lecture course is divided into three parts. In part 1, I will present basic combinatorial concepts related to trees and tree metrics. In part 2, I will define latent tree graphical models and discuss their basic properties. I will also discuss linear latent tree models which provide a convenient general family of distributions whose second-order moment structure is tree-like. In the last part I will present main ideas used in the design of learning procedures for this model class. This includes the structural EM algorithm and various distance based methods.

This course will be based on my book P. Zwiernik, "Semialgebraic statistics and latent tree models", Chapman& Hall, 2015, and a forthcoming chapter in "Handbook of Graphical Models", see also arXiv:1708.00847.

2. Contributed talks

Optimal Gamma approximation on Wiener space

Ehsan Azmoodeh

Ruhr University Bochum, Faculty of Mathematics, ehsan.azmoodeh@rub.de

Abstract
In [NP09], Nourdin and Peccati established a neat characterization of Gamma approximation on a fixed Wiener chaos in terms of convergence of only the third and the fourth cumulants. In this talk, we discuss the rate of convergence in Gamma approximation on Wiener chaos in terms of the *iterated Gamma operators* of Malliavin Calculus, and provide an exact rate of convergence in a suitable probability metric d_2 in terms of the maximum of third and fourth cumulants, analogous to that of normal approximation in [NP15]. The talk is based on a joint work with P. Eichelsbacher and L. Knichel at Ruhr University Bochum.

References

[NP09] I. Nourdin and G. Peccati. *Noncentral convergence of multiple integrals.* Ann. Probab., 37(4), 2009, 1412–1426.
[NP15] I. Nourdin and G. Peccati. *The optimal fourth moment theorem.* Proc. Amer. Math. Soc., 143(7), 2015, 3123–3133.

Numerical integration as a statistical inference problem

Toni Karvonen

Aalto University

Abstract
This talk presents a short overview of *Bayesian cubature*, a probabilistic method for numerical integration that is typically based on assigning a Gaussian process prior for the integrand. This method belongs to the emergent field of *probabilistic numerics* that attempts to frame numerical computations as statistical inference problems, providing the user with richer probabilistic outputs instead of mere point estimates. We *(i)* give a concise introduction to the basics of Bayesian cubature, pointing out important connections to optimal approximation in Hilbert spaces; *(ii)* discuss uncertainty quantification for the unknown value of the integral provided by the method; and *(iii)* review some recent approaches on alleviating the cubic computational cost associated to Gaussian process regression by using symmetric point designs and on making the method more robust, in particular in high dimensions, by enforcing certain exactness conditions.

Functional approximations via exchangeable pairs with applications to degenerate U-statistics

Christian Döbler *Université du Luxembourg*, E-mail: christian.doebler@uni.lu
Mikolaj Kasprzak *University of Oxford*, E-mail: kasprzak@stats.ox.ac.uk
Giovanni Peccati *Université du Luxembourg*, E-mail: giovanni.peccati@uni.lu

Keywords: Stein's method, Exchangeable pairs, Functional de Jong's Theorem, Degenerate U-statistics, Hoeffding decomposition

Abstract: We prove a functional version of the results of [4]. Specifically, we consider processes in the Skorokhod space $D[0,1]$ of the form

$$W_n(t) = \sum_{i=1}^{n} X_i J_i(t), \quad t \in [0,1] \quad \text{and} \quad D_n(t) = \sum_{i=1}^{n} Z_i J_i(t), \quad t \in [0,1],$$

where $X = (X_1, \cdots, X_n)^T$ has the same covariance matrix as $Z = (Z_1, \cdots, Z_n)^T$ and Z is a centred Gaussian vector, independent of X. Furthermore, we assume that the functions $\{J_1, \cdots, J_n\} \subset D\left([0,1], \mathbb{R}^d\right)$ are independent of X and Z, that $\|J_i\| = 1$ for all $i = 1, \cdots, n$ and that they are linearly independent. We also suppose that (X, X') is an exchangeable pair, let $W_n'(t) = \sum_{i=1}^n X_i' J_i(t)$ and suppose that the following condition is satisfied:

$$\mathbb{E}\left[X' - X | X\right] = -\Lambda X + E \quad \text{and} \quad \mathbb{E}\left[(X' - X)(X' - X)^T | X\right] = 2\Lambda\Sigma + E'$$

for some invertible $\Lambda \in \mathbb{R}^{n\times n}$. Then, we provide a bound on the distance between W_n and D_n in terms of $\left\|\Lambda^{-1}\right\|_{op}$, $\mathbb{E}\left\|E'\right\|_{HS}$, $\mathbb{E}|E|$ and $\mathbb{E}|X-X'|^3$. The proof uses Stein's method for fuctional approximation, as introduced in [1] and extended, for instance, in [3].
We use this result extend the ideas of [2] and provide a quantitative functional version of de Jong's Theorem. Specifically, we cosider a sequence of scaled degenerate U-statistics W_n of order $d \geq 1$ given by

$$W_n(t) = \sum_{1\leq j_1,\cdots j_d \leq n} f_{j_1,\cdots,j_d}(X_{j_1},\cdots,X_{j_d})\mathbb{I}_{[j_d/n,1]}(t), \quad t\in[0,1]$$

for some independent data $X_1,\cdots,X_n$ and some measurable functions $f_{j_1,\cdots,j_d}$ and prove bounds on its pathwise distance from a Gaussian process on the Skorokhod space $D[0,1]$. We show that the bound converges to 0 if a Lindeberg-Feller-type condition and a certain fourth-moment condition hold. This is work in progress.

References

[1] A. Barbour. Stein's method for diffusion approximations. *Probability Theory and Related Fields*, **Volume 84**, Issue 3, 1990, pages 297—322

[2] C. Döbler and G. Peccati. Quantitative de Jong theorems in any dimension. *Electronic Journal of Probability*, **Volume 22**, 2017, paper no. 2.

[3] M. Kasprzak. Multivariate functional approximations with Stein's method of exchangeable pairs. arXiv:1710.09263

[4] E. Meckes. On Stein's method for multivariate normal approximation, *High Dimensional Probability V: The Luminy Volume*. Institute of Mathematical Statistics. 2009, pages 153–178.

Wrapped Gaussian Process Regression on Riemannian Manifolds

Anton Mallasto

University of Copenhagen, Department of Computer Science

Abstract Gaussian process regression is a popular tool in non-parametric regression that provides meaningful uncertainty estimates. In this talk, we will consider a generalization of the method on Riemannian manifolds employing wrapped Gaussian distributions.

3. Partecipants

Elja Arjas	elja.arjas@helsinki.fi	University of Oslo
Giacomo Ascione	ascione.giacomo0@gmail.com	Università degli Studi di Napoli Federico II Dip. di Matemati
Ehsan Azmoodeh	ehsan.azmoodeh@rub.de	Ruhr University Bochum Mathematics
Josephine Dufitinema	josephine.dufitinema@uva.fi	University of Vaasa Dept. of Mathematics & Statistics
Jordan Franks	jordan.j.franks@jyu.fi	University of Jyväskylä Dept. of Mathematics & Statistics
Dario Gasbarra	dario.gasbarra@helsinki.fi	University of Helsinki Dept. of Mathematics & Statistics
Stefan Geiss	stefan.geiss@jyu.fi	University of Jyväskylä Dept. Mathematics & Statistics
Christel Geiss	christel.geiss@jyu.fi	University of Jyväskylä Dept. of Mathematics & Statistics
Miriam Hägele	miriam.hagele@helsinki.fi	University of Helsinki Dept. of Mathematics and Statistics
Emma Hubert	emma_hubert@orange.fr	Université Paris-Est Marne-la-Vallée - ED MSCTIC Laborato
Joona Karjalainen	joona.karjalainen@aalto.fi	Aalto University Dept. of Mathematics & Systems Analysis
Henri Karttunen	henri.c.karttunen@helsinki.fi	University of Helsinki, Dept. of Mathematics & Statistics.
Toni Karvonen	toni.karvonen@aalto.fi	Aalto University Dept. of Electrical Engineering & Automati
Mikolaj Kasprzak	kasprzak@stats.ox.ac.uk	University of Oxford Statistics
Eija Laukkarinen	eija.laukkarinen@gmail.com	University of Jyväskylä Dept. of Mathematics & Statistics
Lasse Leskelä	lasse.leskela@aalto.fi	Aalto University Mathematics & Systems Analysis
Antti Luoto	antti.k.luoto@student.jyu.fi	University of Jyväskylä Dept. of Mathematics & Statistics
Anton Mallasto	mallasto@di.ku.dk	University of Copenhagen Dept. of Computer Science
Jyrki Möttönen	jyrki.mottonen@helsinki.fi	University of Helsinki Dept. of Mathematics & Statistics
Hoa Ngo	hoa.ngo@aalto.fi	Aalto University Mathematics & system analysis
Thuan Nguyen	thuan.t.nguyen@jyu.fi	University of Jyvaskyla Dept. of Mathematics & Statistics
Ivan Nourdin	inourdin@gmail.com	Université du Luxembourg
Petteri Piiroinen	petteri.piiroinen@helsinki.fi	University of Helsinki Dept. of Mathematics & Statistics
Jan Pleis	pleis@math.uni-luebeck.de	Universität zu Lübeck Institut of Mathematics
Dylan Possamaï	dylansmb@gmail.com	Columbia University, New York
Tommi Sottinen	tommi.sottinen@iki.fi	University of Vaasa Dept. of Mathematics & Statistics
Topias Tolonen	topias.tolonen@helsinki.fi	University of Helsinki Faculty of Social Sciences
Lauri Viitasaari	lauri.viitasaari@iki.fi	University of Helsinki Dept. of Mathematics & Statistics
Savi Virolainen	savi.virolainen@helsinki.fi	University of Helsinki Mathematics & Statistics
Henri Ylinen	henri.j.ylinen@jyu.fi	University of Jyväskylä Dept. of Mathematics & Statistics
Piotr Zwiernik	piotr.zwiernik@upf.edu	Pompeu Fabra University, Barcelona

4. Partecipation and Accomodation fees

The participation fee (20 €) is to be paid on location in cash.

The accomodation fee depends on the number of nights the partecipant is staying and the type of room. The partecipants who have been awarded a FDNSS-travel grant from the summer school organization do not need to pay the accomodation fee.

The partecipants who are visiting the summer school for the day and don't need accomodation, can pay on place their lunch or dinner directly to the biological station cantine.

The accomodation fee for each night is

- 74.50 € in single room with WC and shower
- 66,70 € in single room
- 59,05 € in double room with WC and shower
- 53,60 € in double room

which includes also breakfast, lunch, coffee and dinner (and the summer school "gala"-dinner on wednesday)

The accomodation fee (depending on the number of nights and the type of room) can be paid by the partecipants or their supporting institutions by bank transfer to the University of Helsinki, with the following information:

Bank account IBAN: FI58 5000 0120 3778 32
SWIFT (BIC): OKOYFIHH
Recipient: Helsingin Yliopisto
Payment: First-name Family-name Probability Summer School Lammi
Reference Number: H5160/75160014
Amount: ? €× number of nights

Please don't forget the reference number !

5. Useful Information

VENUE:

Lammi Biological Station
Pääjärventie 320
16900 Lammi, Finland
phone +358-(0)9 191 40733
fax +358-(0)9 191 40746

Organizer's phone numbers: +358503754069 , +358294151407 (Dario Gasbarra)

Free time activities The biological research station is surrounded by forest and it is next to a lake. Many activities are possible to relax during the free time, as cycling, rowing , swimming in the lake (bring your swim suit!), fishing, walking / jogging in the forest, and there is also a volleyball court and a frisbee-golf course. Let's hope that we will have nice summer weather, you can check the forecast here. Welcome to Lammi !