Abstracts

On Stein's method for multivariate self-decomposable laws

Benjamin Arras

Université de Lille, France

ABSTRACT

Stein's method is a powerful technique to quantify proximity between probability measures, which has been mainly developed in the Gaussian and the Poisson settings. It is based on a covariance representation which completely characterizes the target probability measure. In this talk, I will present some recent general results regarding Stein's method for infinitely divisible laws. In particular, I will present new results regarding multivariate self-decomposable distributions with or without a first moment first assumption. This is based on several joint works with Christian Houdré.

Some applications of Stein's method

Andrew Barbour

Universität Zürich, Switzerland

ABSTRACT

In this talk, we sketch a number of examples that illustrate the flexibility of Stein's method.

High-order accuracy steady-state diffusion approximations

Jim Dai

Institute for Data and Decision Analytics (iDDA), The Chinese University of Hong Kong, Shenzhen

School of Operations Research and Information Engineering, Cornell University

ABSTRACT

Through numerical work and error bounds via Stein's method on selected queueing systems, I will demonstrate the benefit of developing diffusion approximations whose diffusion coefficients are state-dependent; these coefficients have been set to be constants in most of the literature in the last 50 years.

This talk is based on the joint work with Anton Braverman and Xiao Fang.

Fluctuations in a general preferential attachment model

Hanna Döring

Universität Osnabrück, Germany

ABSTRACT

We consider a general preferential attachment model, where the probability that a newly arriving vertex connects to an older vertex is proportional to a sublinear function of the indegree of the older vertex at that time. It is well known that the indegree distribution of a uniformly chosen vertex converges to a limiting distribution. Using Stein's method and the generator approach we provide rates of convergence in total variation distance. This is joint work with Carina Betken and Marcel Ortgiese.

Higher order approximation for sequences converging in the mod-Gaussian sense

Peter Eichelsbacher

Ruhr-Universität Bochum, Germany

ABSTRACT

Recently, Barhoumi-Andreani connected the notion of mod-convergence with Stein's method, developing and applying Stein's method for certain penalised Gaussian distributions. We go on in this direction with applications for some dependence structures like the exchangeable pair approach as well as the theory of dependency graphs. This is joint work with Carolin Kleemann and Marius Butzek.

Skewness correction in tail probability approximations for sums of local statistics

Xiao Fang

The Chinese University of Hong Kong, Hong Kong

ABSTRACT

Correcting for skewness can result in more accurate tail probability approximations in the central limit theorem for sums of independent random variables. In this paper, we extend the theory to sums of local statistics of independent random variables and apply the result to k-runs, U-statistics, and subgraph counts in the Erdös-Rényi random graph. To prove our main result, we develop exponential concentration inequalities and higher-order Cramér-type moderate deviations via Stein's method. This is joint work with Li Luo and Qi-Man Shao.

Constructing Stein kernels

Max Fathi

Institut de Mathematiques de Toulouse, France

ABSTRACT

Stein kernels are a way of encoding integration by parts formulas and comparing them, in order to implement Stein's method. In this talk, I will review a few techniques for constructing such kernels, and their relationship with functional inequalities.

Dickman approximation in quickselect sorting and probabilistic number theory

Larry Goldstein

University of Southern California, USA

ABSTRACT

The generalized Dickman distribution $\mathcal{D}_\theta$ with parameter $\theta > 0$ is the unique solution to the distributional equality $W =_d W^*$, where

$$W^* =_d U^{1/\theta}(W+1), \tag{1}$$

with W non-negative with probability one, $U \sim \mathcal{U}[0,1]$ independent of W, and $=_d$ denoting equality in distribution. Members of this family appear in the study of algorithms, number theory, stochastic geometry, and perpetuities.

The Wasserstein distance $d(\cdot,\cdot)$ between such a W with finite mean, and $D \sim \mathcal{D}_\theta$ obeys

$$d(W,D) \le (1+\theta)d(W^*,W).$$

The specialization of this bound to the case $\theta = 1$ and coupling constructions yield for $n \ge 1$ that

$$d_1(W_n, D) \le \frac{8\log(n/2)+10}{n} \quad \text{where} \quad W_n = \frac{1}{n}C_n - 1,$$

and C_n is the number of comparisons made by the Quickselect algorithm to find the smallest element of a list of n distinct numbers.

Joint with Bhattacharjee, using Stein's method, bounds for Wasserstein type distances can also be computed between $\mathcal{D}_\theta$ and weighted sums arising in probabilistic number theory of the form

$$S_n = \frac{1}{\log(p_n)}\sum_{k=1}^{n} X_k \log(p_k)$$

where $(p_k)_{k\ge1}$ is an enumeration of the prime numbers in increasing order and X_k is, for instance, Geometric with parameter $1 - 1/p_k$.

Stein's method and random matrix theory

Elizabeth Meckes

Case Western Reserve University, USA

ABSTRACT

Random matrix theory is an enormous area of mathematics with connections to physics, statistics, computer science, and many other applied fields. Most of the features of random matrices which are of interest have complicated dependency structure, and Stein's method has become an important tool in analyzing such objects. I will survey various applications of Stein's method in random matrix theory, old and new.

Stein's method on Wiener chaos, and limit theorems for level sets of Gaussian fields

Giovanni Peccati

Université du Luxembourg, Luxembourg

ABSTRACT

I will review some recent advances in our understanding of high-energy fluctuations for geometric functionals of level sets of Gaussian fields, that directly make use of Stein-Malliavin techniques on a Gaussian space. One of the main themes of my talk will be the universal role of the so-called "Berry's Random Wave model", corresponding to a canonical Gaussian Laplace eigenfunction on a Euclidean space, emerging e.g. as the scaling limit of monochromatic random waves on generic manifolds.

Some recent developments of LLN and CLT under probability and distribution uncertainties

Shige Peng

Shandong University, China

ABSTRACT

Law of large numbers (LLN) and central limit theorem (CLT) are foundamental and powerful tools. But in our real world, many types of time sequences are not i.i.d. and the uncertainty of probability/distribution measures are non-negligible. In this situation we can robustly apply the method of nonlinear expectation. In principle, one can always find a robust sublinear expectation under which a time sequence satisfies i.i.d. condition. In this talk, we review some recent progress of LLN and CLT under sublinear expectations. Nonlinear version of Stein method plays an important role to obtain convergence rates.

Central limit theorems for densities on Wiener chaoses

Guillaume Poly

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ABSTRACT

The so called Malliavin-Stein theory, pioneered by I. Nourdin and G. Peccati, combines the formalism of integrations by parts which is provided by Malliavin calculus with Stein's method in order to derive criteria of central convergence in total variation. After introducing the main features of the method, we will explore some phenomenon of regularization on Wiener chaoses along central convergence. This phenomenon roughly asserts that, in some contexts, the non-degeneracy of the Malliavin derivative increases as we we are getting close to the normal distribution. In particular, the distributions are getting smoother and the total variation metric can be strongly upgraded. Some relations with anti-concentration estimates, random matrix theory and decoupling method will also be discussed.

On Götze's multivariate central limit theorem: doubts, clarification and improvements

Martin Raič

University of Ljubljana, Slovenia

ABSTRACT

In 1991, Götze published a paper where Stein's method is used to bound the error in the classical multivariate central limit theorem measured in terms of the probabilities of measurable convex sets. However, certain parts of the argument turned out not to be entirely clear; many members of the community actually doubted that the proof is correct at all. In 2010, Bhattacharya and Holmes wrote an exposition of Götze's paper, but they were unable to retrieve the dependence of the constant on the dimension.

In this talk, it will be presented how certain dubious parts of Götze's argument can be fixed, and where Bhattacharya and Holmes fail to retrieve Götze's dependence of the constant on the dimension. Moreover, replacing the smoothing by the one due to Bentkus, the dependence on the dimension can be reduced drastically. Finally, possible extensions to dependent random vectors will be sketched briefly.

Central moment inequalities using Stein's method

Nathan Ross

The University of Melbourne, Australia

ABSTRACT

We derive explicit central moment inequalities for random variables that admit a Stein coupling, such as exchangeable pairs, size-bias couplings or local dependence, among others. The bounds are in terms of moments (not necessarily central) of variables in the Stein coupling, which are typically local in some sense, and therefore easier to bound. In cases where the Stein couplings have the kind of behaviour leading to good normal approximation, the central moments are closely bounded by those of a normal. We show how the bounds can be used to produce concentration inequalities, and compare to those existing in related settings. Finally, we illustrate the power of the theory by bounding the central moments of sums of neighbourhood statistics in sparse Erdős-Rényi random graphs. Joint work with A.D. Barbour and Yuting Wen.

Chi-square approximations with Stein's method

Gesine Reinert

University of Oxford, UK

ABSTRACT

Chi-square approximations such as for Pearson's chi-square statistics and for log-likelihood ratio statistics are a cornerstone of theoretical statistics. In this talk we shall quantify these approximations. The tools are mainlhy based on Stein's method for the chi-square distribution, but Stein's method for normal distributions will also appear.

This talk is based on joint work with A. Anastasiou, R. Gaunt and A. Pickett.

Berry-Esseen bounds for functionals of independent random variables

Qi-Man Shao

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Southern University of Science and Technology, China

ABSTRACT

Let $X_1, X_2, \ldots, X_n$ be independent random variables and let $W = W(X_1, \ldots, X_n)$. Assume that $EW = 0$ and $EW^2 = 1$. Concerning normal approximation of W , Chatterjee (2008) introduced a new Stein approach and obtained the Wasserstein distance, while Lachieze-Rey and Peccati (2017) established the Berry-Esseen bounds. In this talk, we will give a new Berry-Esseen bound as well as a simple version of the di?erence operators. Applications to certain dependent random variables will also be discussed. The talk is based on a joint work with Ding Chu and Zhuosong Zhang.

Covariance identities and expansions via Stein's method

Yvik Swan

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ABSTRACT

We propose probabilistic representations for inverse Stein operators (i.e. solutions to Stein equations) under general conditions; in particular we deduce new simple expressions for the Stein kernel. These representations allow to deduce uniform and non-uniform Stein factors (i.e. bounds on solutions to Stein equations) and lead to new covariance identities expressing the covariance between arbitrary functionals of an arbitrary univariate target in terms of a weighted covariance of the derivatives of the functionals. Our weights are explicit, easily computable in most cases, and expressed in terms of objects familiar within the context of Stein's method. Applications of the Cauchy-Schwarz inequality to these weighted covariance identities lead to sharp upper and lower covariance bounds and, in particular, weighted Poincaré inequalities. Higher order extensions are also easily available, and the sequence of weights hereby constructed is studied. Many examples are given and, in particular, classical variance bounds due to Klaassen, Brascamp and Lieb or Otto and Menz are corollaries. Connections with more recent literature are also detailed. This is joint work with Marie Ernst and Gesine Reinert.

On moderate deviations in Poisson approximation

Aihua Xia

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ABSTRACT

The tail behaviour of Poisson distribution is very different from that of normal distribution and the right tail probabilities of counts of rare events are generally better approximated by the moderate deviations in Poisson distribution. We demonstrate that the moderate deviations in Poisson approximation generally require an adjustment and, with suitable adjustment, we establish better error estimates of the moderate deviations in Poisson approximation than those in [Chen, Fang & Shao (2013)]. Our estimates contain no unspecified constants and are easy to apply. We illustrate the use of the theorems in various applications. The paper complements the works of [Chen & Choi (1992), Barbour, Chen & Choi (1995), Chen, Fang & Shao (2013)]. The talk is based on a joint work with Qingwei Liu.

Multivariate normal approximation for statistics in geometric probability

Joseph Yukich

Lehigh University, USA

ABSTRACT

Given a vector $F = (F_1, ..., F_m)$ of Poisson functionals $F_1, ..., F_m$, we establish quantitative bounds for the proximity between F and an m-dimensional centered Gaussian random vector N_Σ with covariance matrix $\Sigma \in \mathbb{R}^{m\times m}$. We derive results for the d_2- and d_3-distances based on smooth test functions as well as for the d_{convex} -distance and the d_{H_ℓ} -distance given by $d_{H_\ell}(F, N_\Sigma) := \sup_{h\in H_\ell} |\mathbb{E}\,(F) - \mathbb{E}\,h(N_\Sigma)|$, a multi-dimensional generalization of the Kolmogorov distance, where $l \in \mathbb{N}$, and H_ℓ is the set of indicator functions of intersections of ℓ closed half-spaces in $\mathbb{R}^m$. The bounds are multivariate counterparts of the second order Poincaré inequalities of Last, Peccati, and Schulte (2016) and, as such, are expressed in terms of integrated moments of first and second order difference operators. We show that the bounds remarkably simplify when the Poisson functionals consist of sums of stabilizing score functions. We use the general results to deduce presumably optimal rates of multivariate normal convergence for statistics arising in random graphs and topological data analysis as well as for multivariate statistics used to test equality of distributions. This is based on joint work with M. Schulte.

Cramér-type moderate deviation of normal approximation for unbounded exchangeable pairs

Zhuosong Zhang

University of Melbourne, Australia and
National University of Singapore, Singapore

ABSTRACT

In Stein's method, the exchangeable pair approach is commonly used to estimate the convergence rate of normal and nonnormal approximation. In this talk, a Cramér-type moderate deviation theorem of normal approximation for unbounded exchangeable pairs will be discussed. Meanwhile, a new version of Berry–Esseen inequality for normal approximation under a general setting is also obtained. The results are applied to subgraph counts in the Erdös–Rényi random graph and the general Curie–Weiss model.