6th Austrian Stochastics Days

Organizer: W. Trutschnig (Salzburg)

Organized in frame of the ÖMG-DMV-Congress 2017, September 11-15, 2017 at the Paris-Lodron-University of Salzburg.

Program

6th Austrian Stochastics Days
Tuesday, 10:15 – 12:45
Lecture Room: HS 434

10:15 **Wolfgang Woess**: *Heat kernel oscillations for isotropicrandom processes on ultrametric spaces.*
11:15 **Judith Kloas**: *On the recurrence of queuing processes in two dimensions*
11:45 **Antti Luoto**: *Expected first exit time of a Brownian bridge*
12:15 **Gundelinde Wiegel**: *Lyapunov exponents on trees*

6th Austrian Stochastics Days
Tuesday, 13:30 – 15:00
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13:30 **Mathias Pohl**, Georg Ch. Pflug: *A Short Story on Concentration and Diversification*
14:00 **Sándor Guzmics**: *An exponential lifetime model and its resulting copula*
14:30 **Andreas Wittmann**: *The effect of climate change on flood risks in Europe*

6th Austrian Stochastics Days
Tuesday, 15:30 – 18:30
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15:30 **Manuela Schreyer**: *Some results on two-dimensional extreme-value copulas*
16:00 **Thomas Mroz**: *Distributions with fixed marginals maximizing the mass of the endograph and the graph of a function*
16:30 **Noppadon Kamnitui**, Wolfgang Trutschnig: *Idempotence in some standard classes of copulas*
17:00 **Irene Tubikanec**, Massimiliano Tamborrino, Evelyn Buckwar: *Statistical inference through Approximate Bayesian Computation for a stochastic Jansen and Rit Neural Mass Model.*
17:30 **Valentin Sturm**: *Animal activity recognition with hidden Markov models based on acceleration data*
18:00 **Massimiliano Tamborrino**: *Approximate Bayesian Computation for the inference of multivariate partially observed stochastic processes with application to neuroscience*

6th Austrian Stochastics Days

Wednesday, 10:15 – 12:45

Lecture Room: HS 434

10:15 **Christian Bayer**: *Rough Volatility models in Finance*

11:15 Andreas Eichler, Gunther Leobacher, **Michaela Szölgyenyi**: *Utility indifference pricing of insurance catastrophe derivatives*

11:45 **Thuan Nguyen**: *A note on approximation for stochastic integrals driven by a Lévy process*

12:15 **Christian Kuehn**: *Uncertainty transformation via Hopf bifurcation in fast-slow systems*

12.09.2017 10:15	Wolfgang Woess	HS 434

Heat kernel oscillations for isotropic random processes on ultrametric spaces.
Wolfgang Woess (TU Graz)

The family of hierarchical Laplacians on an ultrametric space is introduced and the associated isotropic semigroups of Markov transition operators are displayed. Focussing on the space-homogeneous situation, typical classes of such processes and operators are studied in more detail, where the return probabilities exhibit periodic oscillations.

This comprises the operator of fractional derivative (Taibleson Laplacian) on the p-adic numbers and random walks on locally finite groups such as the infinite sum of copies of a finite group and the infinite symmetric group ("shuffling an infinite deck of cards").

This is joint work with Alexander Bendikov (Wroclaw) and Wojciech Cygan (Wroclaw and Graz), based on previous joint work with Bendikov an Alexander Grigor'yan (Bielefeld).

12.09.2017 11:15	Judith Kloas	HS 434

On the recurrence of queuing processes in two dimensions
Judith Kloas (TU Graz)

Recall the one-dimensional queuing process $(W_n)_{n\geq 1}$, which is defined by setting $W_0 = 0$ and $W_n = \max\{0, W_{n-1} - Y_n\}$, $n \geq 1$, where $Y_1, Y_2, \ldots$ is a sequence of independent and identically distributed discrete random variables.

In this talk we introduce a certain Markov chain $(W_n^{(1)}, W_n^{(2)})_{n\geq 1}$ in the two-dimensional case which is build upon the process $(W_n)_{n\geq 1}$.

We study the recurrence behavior of $(W_n^{(1)}, W_n^{(2)})_{n\geq 1}$ and present our approach which is based on the technique of discrete subordination and the theory of regular variation.

12.09.2017 11:45	Antti Luoto	HS 434

Expected first exit time of a Brownian bridge
Antti Luoto (University of Jyväskylä)

It is well known that the expected exit time of a standard Brownian motion from the interval $(-h,h)$, where $h > 0$, is h^2. Let $(B_t^{0,T,y})_{t\in[0,T]}$ denote a Brownian bridge from 0 to y of length $T > 0$ and $\tau_{(-h,h)}$ its first exit time from $(-h,h)$. I will present a new representation for the expected first exit time $\mathbb{E}\tau_{(-h,h)}$. This representation allows to investigate the asymptotic behavior of $\mathbb{E}\tau_{(-h,h)}$ for $h \downarrow 0$, and it turns out that it coincides with that of the standard Brownian motion. This effect is crucial for computing the weak rate of convergence for a random walk approximation of Brownian motion, which is carried out in [1] in the spirit of [2].

A similar representation is derived also for certain Bessel bridges, and the limiting behavior as $h \downarrow 0$ is addressed.

The talk is based on joint work with C. Geiss and P. Salminen.

References

[1] A. Luoto, *Time-dependent rate of convergence for binomial approximations*, in preparation.

[2] J. B. Walsh, *The rate of convergence of the binomial tree scheme*, Finance Stochast. **7**, p. 337–361 (2003).

12.09.2017 12:15	Gundelinde Wiegel	HS 434

Lyapunov exponents on trees

Gundelinde Wiegel (Technische Universität Graz)

We consider a symmetric nearest neighbour random walk on an infinite regular tree moving in random potential. The potentials represent a random risk of dying for the random walk at each vertex. A measurement for the riskiness of moving in this random medium is provided by the Lyapunov exponents. They observe the long time behaviour of the probability of reaching a certain vertex after starting at a fixed vertex. There are two different ways of treating the random potentials in this observation: the annealed (or averaged) and the quenched approach. We will see that here we can directly relate these two approaches to each other.

12.09.2017 13:30	Mathias Pohl	HS 434

A Short Story on Concentration and Diversification

Mathias Pohl (Universität Wien), Georg Ch. Pflug (Universität Wien)

In mean-risk portfolio optimization, it is typically assumed that the assets follow a known distribution P_0, which is estimated from observed data. Aiming at an investment strategy which is robust against possible misspecification of P_0, the portfolio selection problem is solved with respect to the worst-case distribution within a Wasserstein-neighborhood of P_0. We review tractable formulations of this portfolio selection problem under model ambiguity, as it is called in the literature. Pflug et al. (2012) established that high model ambiguity leads to equally-weighted portfolio diversification. However, it often happens that the marginal distributions of the assets can be estimated with high accuracy, whereas the dependence structure between the assets remains ambiguous. This leads to the problem of portfolio selection under dependence uncertainty. We show that in this case portfolio concentration becomes optimal as the uncertainty with respect to the estimated dependence structure increases. Hence, distributionally robust portfolio optimization can have two very distinct implications: Diversification on the one hand and concentration on the other hand.

12.09.2017 14:00	Sándor Guzmics	HS 434

An exponential lifetime model and its resulting copula

Sándor Guzmics (Universität Wien)

In lifetime modelling the use of exponential distributions is one of the most standard ways.

There are also several approaches that aim to model the dependency structure among the entities. One such method is the well-known Marshall-Olkin model, which partly also motivates our work. However, while the Marshall-Olkin distribution allows common shocks for subsets of entities (which is not typical in banking systems), in our suggested model we consider cascading effects, where the default of a particular institution affects the remaining lifetime of (some) other institutions.

We assume that the original lifetime parameters $\lambda_1, \lambda_2, \ldots, \lambda_n$ of the institutions will be modified as $\lambda_i + a_{ji}$ $(i = 1, \ldots, n, i \neq j)$, when the default of institution j occurs. This leads to a joint lifetime model, which enables a very flexible dependence modelling due to the fact, that for each pair (i, j) there is a parameter a_{ij} defined. Our model also includes the Marshall-Olkin type models as a special case.

We present the fundamentals of this lifetime model as well as some interesting properties of the multivariate copula which stems from the model. First we examine our copula – under a symmetric parameter setting – with respect to Archimedeanity, then we investigate the monotonicity of the copula in certain copula orderings as the parameters of the copula vary.

Finally we relate our copula model to the quantification of systemic risk in financial systems.

12.09.2017 14:30	Andreas Wittmann	HS 434

The effect of climate change on flood risks in Europe
Andreas Wittmann (Universität Wien)

Estimating the joint distribution even of a relatively small number of variables is a challenging endeavour. In this work the joint distribution of water-discharges in over 770 river-basins across Europe is assessed, with the largest group to be simultaneously estimated numbering 86 individual basins.

The method used to accomplish this arduous task is a Vine-Copula approach. In particular different Vine-Copulae are fitted to the data and subsequently compared for goodness of fit. The resulting dependency structure is then combined with predictions for individual losses, provided by the JRCs LISFLOOD model, to estimate the total annual flood-losses in European regions. Using this method the effect of climate change on floods across Europe can be determined.

12.09.2017 15:30	Manuela Schreyer	HS 434

Some results on two-dimensional extreme-value copulas
Manuela Schreyer (Universität Salzburg)

Working with Markov kernels (conditional distributions) and right-hand deri-vatives D^+A of Pickands dependence functions A we study some results of two-dimensional extreme-value copulas (EVCs) C_A. Underlining the usefulness of working directly with the right-hand derivatives D^+A, we give an alternative simple proof of the fact that EVCs with piecewise linear A can be expressed as weighted geometric mean of some EVCs whose dependence functions A have at most two edges, a result by Mai and Scherer (2011), and present a generalization of

this result.
Furthermore we sketch an elegant extension of the proof of the validity of the Hutchinson-Lai conjecture for EVCs to arbitrary, non-smooth A, and state a new conjecture on the precise region determined by all possible values of Kendall's τ and Spearman's ρ for EVCs.

12.09.2017 16:00	Thomas Mroz	HS 434

Distributions with fixed marginals maximizing the mass of the endograph and the graph of a function
Thomas Mroz (Uni Salzburg)

For given distribution functions F, G we consider the problem of maximizing the probability of the event $X \leq Y$ within the class of all two-dimensional distribution functions having F and G as marginals. Translating to the copula setting, we not only solve the much more general problem of finding $\sup_{A\in\mathscr{C}} \mu_A(\Gamma^{\leq}(T))$, where $\mathscr{C}$ is the family of all two-dimensional copulas and $\Gamma^{\leq}(T)$ is the endograph of some measurable (and not necessarily non-decreasing) function $T\colon [0,1] \to [0,1]$, but also prove the existence of a copula A_T such that $\mu_{A_T}(\Gamma^{\leq}(T)) = \sup_{A\in\mathscr{C}} \mu_A(\Gamma^{\leq}(T))$ and show how to construct it. Furthermore, we look at the closely related problem of determining $\sup_{A\in\mathscr{C}} \mu_A(\Gamma(T))$, where $\Gamma(T)$ is the graph of some measurable function $T\colon [0,1] \to [0,1]$ and give a characterization of all measurable functions $T\colon [0,1] \to [0,1]$ for which $\sup_{A\in\mathscr{C}} \mu_A(\Gamma(T)) = \sup_{A\in\mathscr{C}} \mu_A(\Gamma^{\leq}(T))$.

12.09.2017 16:30	Noppadon Kamnitui	HS 434

Idempotence in some standard classes of copulas
Noppadon Kamnitui (University of Salzburg), Wolfgang Trutschnig (University of Salzburg)

We extend and sharpen some results concerning the notion of idempotence in some standard classes of copulas as recently given in [1]. In particular we show that in the class of extreme-value copulas, in the class of Bernstein copulas and in some special class of copulas represented by measure-preserving transformations only the usual suspects are idempotent, namely Π and M. Additionally, we prove that idempotent strict Archimedean copulas necessarily have full support.

References

[1] A. Albanese, C. Sempi, Idempotent copulae: *Ordinal sums and Archimedean copulae.* J. Math. Anal. Appl. **438(2)** (2016), 1055–1065.

12.09.2017 17:00	Irene Tubikanec	HS 434

Statistical inference through Approximate Bayesian Computation for a stochastic Jansen and Rit Neural Mass Model.
Irene Tubikanec (Johannes Kepler Universität Linz), Massimiliano Tamborrino (Johannes Kepler Universität Linz), Evelyn Buckwar (Johannes Kepler Universität Linz)

Neural mass models provide a useful framework for modelling mesoscopic neural population dynamics and are able to generate different types of electroencephalography (EEG) rhythms. In this talk, we focus on parameter estimation for a stochastic formulation of the Jansen and Rit Neural Mass Model (JR-NMM). This is a system of SDEs, which has the structure of a stochastic Hamiltonian with a nonlinear displacement. None of the components is directly observed, making the inference problem more challenging. We tackle this by considering an Approximate Bayesian Computation (ABC) approach. This is a Bayesian technique that necessitates plenty of data simulations from the original model. Each simulation is performed using an efficient numerical splitting method that, differently from the commonly used Euler-Maruyama method, preserves the structural properties of the system. We finally show how the proposed ABC algorithm with the adopted splitting method is able to provide satisfactory estimates of parameters of interest, outperforming the corresponding ABC algorithm using the standard method.

12.09.2017 17:30	Valentin Sturm	HS 434

Animal activity recognition with hidden Markov models based on acceleration data
Valentin Sturm (JKU)

Activity plays a key role in quantifying well being of farm animals. Moreover the drinking and eating behaviour of such animals has the potential to indicate possible illnesses. We take a look at a approach to automatically classify the behaviour of calves, based on recorded acceleration data. In this setting, we distinguish between nine different, not mutually exclusive states. We try to characterize these states and find a suitable hidden Markov Model which is ought to describe the true nature of the problem. With the help of this model we try to estimate the true behaviour. The achieved results show a good accuracy in correctly classifying the different states and is therefor suitable for further usage in finding indications of wellbeing.

12.09.2017 18:00	Massimiliano Tamborrino	HS 434

Approximate Bayesian Computation for the inference of multivariate partially observed stochastic processes with application to neuroscience
Massimiliano Tamborrino (JKU Linz)

In many signal-processing applications, it is of primary interest to decode/reconstruct the unobserved signal based on some partially observed information. Some examples are automatic speech, face, gesture and handwriting recognition, and neuroscience (ion channels modeling). From a mathematical point of view, this corresponds to estimate model parameters of an unknown coordinate based on discrete observations of one or more other coordinates. Here we consider a partially observed bivariate stochastic process and discuss it in the framework of stochastic modelling of single neuron dynamics. None of the two components is directly observed: the available observations correspond to hitting times of the first component to the

second component. Our goal is to provide statistical inference of the underlying model parameters. This is particularly difficult because: 1. the considered process does not fit into the well-known class of hidden Markov models; 2. the available data consists of a point process with not iid consecutive intertime intervals; 3. the likelihood of the model is intractable. We tackle this problem using Approximate Bayesian Computation, a likelihood-free method requiring the development of suitable distances to apply in an algorithm similar to the important-sampling. After presenting the method (proposing several possible distances), I illustrate how to use it on the considered model.

13.09.2017 10:15	Christian Bayer	HS 434

Rough Volatility models in Finance
Christian Bayer (Weierstrass Institut)

We consider rough stochastic volatility models. Specifically, volatility has fractional – worse than diffusive – scaling, a regime which recently attracted considerable attention both from the statistical and option pricing point of view due to the excellent fits to market prices. However, the roughness (in terms of Hoelder regularity) poses particular challenges both from an analytical and from a computational point of view. For instance, rough volatility processes are neither semi-martingales nor Markov processes which makes many numerical and analytical techniques unapplicable. Starting from evidence in favor of volatility being rough, we discuss some of the implications, in particular with respect to simulation and asymptotics based on large deviation.

13.09.2017 11:15	Michaela Szölgyenyi	HS 434

Utility indifference pricing of insurance catastrophe derivatives
Andreas Eichler (FH Upper Austria), Gunther Leobacher (University of Graz), Michaela Szölgyenyi (ETH Zürich)

We propose a model for an insurance loss index and the claims process of a single insurance company holding a fraction of the total number of contracts that captures both ordinary losses and losses due to catastrophes. In this model we price a catastrophe derivative by the method of utility indifference pricing. The associated stochastic control problem is treated by techniques for piecewise deterministic Markov processes (PDMPs).

We perform a numerical study that illustrates our results. This motivates research on the simulation of PDMPs in general.

13.09.2017 11:45	Thuan Nguyen	HS 434

A note on approximation for stochastic integrals driven by a Lévy process
Thuan Nguyen (Jyväskylä University)

The Riemann approximation in L_2 for stochastic integrals driven by a Lévy process or exponential Lévy process was studied recently in [1] by C. Geiss et al. In [2], the same problem

was studied in weighted BMO-spaces for the Brownian motion. The aim of this talk is to combine [1] and [2].

We will discuss this type of approximation in the BMO_2^+-space, where the driving process is a Lévy process $(X_t)_{t\in[0,1]}$. When one considers the problem in the Brownian setting, then the BMO_2^+-norm becomes the classical BMO_2-norm. As one result we show for the Riemann approximation of $\int_{(0,1]} \varphi_t dX_t$ with a deterministic time-net $0 = t_0 < t_1 < \cdots < t_n = 1$ that

$$\Big\| \int_{(0,1]} \varphi_t dX_t - \sum_{i=1}^{n} \varphi_{t_{i-1}} (X_{t_i} - X_{t_{i-1}}) \Big\|_{\mathrm{BMO}_2^+} \sim_C \sqrt{\max_{1\leqslant i\leqslant n} |t_i - t_{i-1}|}$$

for suitable integrands φ. Some examples are also given to illustrate the result. This is a join work with S. Geiss.

References

[1] C. Geiss, S. Geiss, E. Laukkarinen, A note on Malliavin fractional smoothness for Lévy processes and approximation, *Potential Anal.* 39, 203–230, 2013.

[2] S. Geiss, Weighted BMO and discrete time hedging within the Black-Scholes model, *Probab. Theory Related Fields* 132, 13–38, 2005.

13.09.2017 12:15 | Christian Kuehn | HS 434

Uncertainty transformation via Hopf bifurcation in fast-slow systems

Christian Kuehn (TU Munich)

Propagation of uncertainty in dynamical systems is a significant challenge. Here we focus on random multiscale ordinary differential equation models. In particular, we study Hopf bifurcation in the fast subsystem for random initial conditions. We show that a random initial condition distribution can be transformed during the passage near a delayed/dynamic Hopf bifurcation: (i) to certain classes of symmetric copies, (ii) to an almost deterministic output, (iii) to a mixture distribution with differing moments and (iv) to a very restricted class of general distributions. We prove under which conditions the cases (i)–(iv) occur in certain classes vector fields.