

# **17. Doktorand:innentreffen der Stochastik**

## **Report of Contributions**

Contribution ID: 2

Type: **Talk**

# Multiplicative deconvolution under unknown error distribution

*Thursday, 4 August 2022 16:00 (20 minutes)*

In this talk, we construct a nonparametric estimator of the density  $f : \mathbb{R}_+ \rightarrow \mathbb{R}_+$  of a positive random variable  $X$  based on an i.i.d. sample  $(Y_1, \dots, Y_n)$  of

$$Y = X \cdot U,$$

where  $U$  is a second positive random variable independent of  $X$ . More precisely, we consider the case where the distribution of  $U$  is unknown but an i.i.d. sample  $(\tilde{U}_1, \dots, \tilde{U}_m)$  of the error random variable  $U$  is given.

Based on the estimation of the Mellin transforms of  $Y$  and  $U$ , and a spectral cut-off regularisation of the inverse Mellin transform, we propose a fully data-driven density estimator where the choice of the spectral cut-off parameter is dealt by a model selection approach. We demonstrate the reasonable performance of our estimator using a Monte-Carlo simulation.

**Primary authors:** BRENNER MIGUEL, Sergio (Heidelberg University); SIEBEL, Maximilian (Heidelberg University); Prof. JOHANNES, Jan (Heidelberg University)

**Session Classification:** Session B5 Statistics

**Track Classification:** Statistics

Contribution ID: 3

Type: **Talk**

## Clustering financial institutions based on Wasserstein distance

*Wednesday, 3 August 2022 17:00 (20 minutes)*

Financial institutions submit data on their credit portfolios to regulators. An individual institution can be identified with a distribution that is representative of its respective credit portfolio. We are interested in finding representative clusters of financial institutions based on the notion of Wasserstein barycenter. A particular challenge arises from missing data since financial institutions are subject to different regulatory requirements. This leads us to establish a form of the k-means clustering algorithm in Wasserstein space which can deal with missing coordinates.

This is based on joint work with Julio Backhoff and Mathias Beiglböck.

**Primary authors:** BACKHOFF, Julio (University of Vienna); BEIGLBÖCK, Mathias (University of Vienna); RIESS, Lorenz (University of Vienna)

**Session Classification:** Session A2 Stochastics

**Track Classification:** Stochastics

Contribution ID: 4

Type: **Talk**

## The Wasserstein space of stochastic processes

Wednesday, 3 August 2022 17:30 (20 minutes)

Researchers from different areas have independently defined extensions of the usual weak topology between laws of stochastic processes. This includes Aldous' extended weak convergence, Hellwig's information topology and convergence in adapted distribution in the sense of Hoover-Keisler. We show that on the set of continuous processes with canonical filtration these topologies coincide and are metrized by a suitable *adapted Wasserstein distance*  $\mathcal{AW}$ . Moreover, we show that the resulting topology is the weakest topology that guarantees continuity of optimal stopping.

While the set of processes with natural filtration is not complete, we establish that its completion is precisely the space processes with filtration  $\mathcal{FP}$ . We also observe that  $(\mathcal{FP}, \mathcal{AW})$  exhibits several desirable properties. Specifically,  $(\mathcal{FP}, \mathcal{AW})$  is Polish, martingales form a closed subset and approximation results like Donsker's theorem extend to  $\mathcal{AW}$ .

This talk is based on joint work with Daniel Bartl, Mathias Beiglböck, Gudmund Pammer and Xin Zhang.

**Primary authors:** Mr BARTL, Daniel (University of Vienna); Mr PAMMER, Gudmund (ETH Zurich); Prof. BEIGBÖCK, Mathias (University of Vienna); SCHROTT, Stefan (University of Vienna); Mr ZHANG, Xin (University of Vienna)

**Session Classification:** Session A2 Stochastics

**Track Classification:** Stochastics

Contribution ID: 5

Type: **Talk**

## Measuring statistical dependency with optimal transport

*Thursday, 4 August 2022 15:30 (20 minutes)*

In this talk, we introduce a novel framework for measuring statistical dependency between two random variables  $X$  and  $Y$ , the *transport dependency*  $\tau(X, Y) \geq 0$ . This coefficient relies on the notion of optimal transport and is applicable to random variables, taking values in general Polish spaces. It can be estimated consistently via the corresponding empirical measure, is versatile and adaptable to various scenarios by proper choices of the cost function, and intrinsically respects metric properties of the ground spaces. Notably, statistical independence is characterized by  $\tau(X, Y) = 0$ , while large values of  $\tau(X, Y)$  indicate highly regular relations between  $X$  and  $Y$ . Indeed, for suitable base costs,  $\tau(X, Y)$  is maximized if and only if  $Y$  can be expressed as 1-Lipschitz function of  $X$  or vice versa.

We exploit this characterization and define a class of dependency coefficients with values in  $[0, 1]$ , which can emphasize different functional relations. In particular, for suitable costs the *transport correlations* is symmetric and attains the value 1 if and only if  $Y = f(X)$  where  $f$  is a multiple of an isometry, which makes it comparable to the distance correlation.

Finally we illustrate how the transport dependency can be used in practice to explore dependencies between random variables, in a gene expression study.

**Primary authors:** NIES, Thomas Giacomo (University of Göttingen); Mr STAUDT, Thomas (University of Göttingen); Prof. MUNK, Axel (University of Göttingen)

**Session Classification:** Session B5 Statistics

**Track Classification:** Statistics

Contribution ID: 6

Type: **Talk**

## Parabolic Fractal Geometry

*Friday, 5 August 2022 09:00 (20 minutes)*

The parabolic fractal geometry inheres a certain non-linear scaling between time and space. It is useful to determine the Hausdorff dimension of self-similar stochastic processes plus deterministic drift function in terms of the drift function alone. An explicit formula for the Hausdorff dimension of isotropic stable Lévy processes plus drift will be presented.

**Primary authors:** Prof. KERN, Peter; PLESCHBERGER, Leonard (Heinrich Heine University Düsseldorf)

**Session Classification:** Session A6 Stochastics

**Track Classification:** Stochastics

Contribution ID: 7

Type: **Talk**

## Central limit theorems for generalized descents and generalized inversions in finite root systems

*Thursday, 4 August 2022 09:30 (20 minutes)*

We start introducing generalized descents and generalized inversions in permutations as special cases of antichains and order ideals in the root poset for permutations. We provide the variance for generalized inversions and use a dependency graph method to conclude a central limit theorem for those and for antichains. We then generalize this result to antichains in root posets for finite Weyl groups and to generalized inversions for irreducible Weyl groups.

This is joint work with Christian Stump, generalising the study of  $d$ -descents by Pike and Bona.

**Primary authors:** MEIER, Kathrin (Ruhr-University Bochum); Prof. STUMP, Christian

**Session Classification:** Session A3 Stochastics

**Track Classification:** Stochastics

Contribution ID: 8

Type: **Talk**

## Construction of Admissible Decision Procedures in Statistical Classification

*Wednesday, 3 August 2022 14:30 (20 minutes)*

To classify an observation, we assume that each class can be represented by a probability distribution, which might be the result of a previous estimate. An older but famous example is provided by Fisher's classification of iris species based on length measurements of their sepals and petals with class-related distributions. With the increasing relevance of machine learning methods, classification is a current research topic. Applications include object classification in image recognition or text classification, often referring to the example of spam filters. Although classification problems arise almost everywhere in the digital world and numerous algorithmic solutions are being worked on, even elementary mathematical foundations seem to have been treated only incompletely or for special cases so far.

Framing classification in terms of statistical decision theory, we consider a classification problem as a family of probability distributions  $(P_i : i \in I)$  with a finite class index set  $I$  being the decision space, and investigate several optimality criteria of randomised decision procedures. In this regard, we obtained the result that a generalization of the Neyman-Pearson lemma characterizes all admissible procedures, that is, procedures with minimal error probabilities. In certain binary problems, this characterization yields procedures representable by class separating nonlinear hypersurfaces. Note that hyperplanes therefore generally do not provide admissible classification, even if the training data should be linearly separable. The aim of this talk is to present some further geometrical conditions for admissibility based on the risk set, and to deduce an analytical method for determining admissible procedures, in particular those that additionally fulfill the minimax condition, and to indicate further questions we intend to pursue.

**Primary author:** RIEBSCHLÄGER, Lea (University of Trier)

**Session Classification:** Session B1 Statistics

**Track Classification:** Statistics



Contribution ID: 9

Type: **Talk**

## Causal Interventions to Reduce the Risk of Adverse Events in Stent Procedures

*Thursday, 4 August 2022 13:30 (20 minutes)*

The main medical intervention for coronary artery disease is stent implantation. In this context, we statistically estimate causal effects of alternate treatment regimes with the aim to lower the risk of adverse events as e.g. heart attacks. For this, a causal DAG is designed by domain experts and refined by a causal discovery algorithm. The estimated graph allows for appropriate confounder adjustment in the associated graphical model. We show how to non-parametrically compute average effects of causal interventions on continuous treatment variables and propose a heuristic to find explainable treatment regimes decreasing the risk of adverse events. The results give directions to improve upon and thus reduce the space of costly, future medical studies.

**Primary author:** MAREIS, Leopold (Technical University of Munich)

**Co-authors:** Dr AHMIDI, Narges (Fraunhofer Institute for Cognitive Systems); Prof. DRTON, Mathias (Technical University of Munich)

**Session Classification:** Session B4 Statistics

**Track Classification:** Statistics

Contribution ID: 10

Type: **Talk**

## Quantifying the almost sure uniform convergence of eigenvalue-counting functions

*Friday, 5 August 2022 09:30 (20 minutes)*

This talk will introduce the concept of almost-additive functions on lattices with the special case of eigenvalue-counting functions of random Schrödinger operators and showcase how they can be used in conjunction with some results from empirical process theory to find explicit error estimates for their convergence to the integrated density of states. This talk is based on joint work with Christoph Schumacher, Fabian Schwarzenberger and Ivan Veselić.

**Primary author:** KÄMPER, Max

**Co-authors:** Prof. VESELIC, Ivan (TU Dortmund); Prof. SCHWARZENBERGER, Fabian (HTW Dresden); Dr SCHUMACHER, Christoph (TU Dortmund)

**Session Classification:** Session A6 Stochastics

**Track Classification:** Stochastics

Contribution ID: 11

Type: **Talk**

## Half-Trek Criterion for Identifiability of Latent Variable Models

*Wednesday, 3 August 2022 13:30 (20 minutes)*

Linear structural equation models relate random variables of interest via a linear equation system that features stochastic noise. Each model corresponds to a directed graph whose edges represent the non-zero coefficients in the equation system. Prior research has developed a variety of methods to decide parameter identifiability in models with latent variables. Identifiability holds if the coefficients associated with the edges of the graph can be uniquely recovered from the covariance matrix they define. The methods usually operate in a latent projection framework where the confounding effects of the latent variables are represented by correlation among noise terms and this approach is effective when latent confounding is sparse. In this talk I will present a new combinatorial criterion for parameter identifiability that operates on the original unprojected latent variable model and is able to certify identifiability in settings, where some latent variables may also have dense effects on many or even all of the observables.

**Primary author:** STURMA, Nils (Technical University of Munich)

**Co-authors:** FOYGEL BARBER, Rina; DRTON, Mathias; WEIHS, Luca

**Session Classification:** Session B1 Statistics

**Track Classification:** Statistics

Contribution ID: 13

Type: **Talk**

## Sharp Constants in Normal an Edgeworth Approximation

*Thursday, 4 August 2022 09:00 (20 minutes)*

We all know and love the central limit theorem (CLT) but there is a lot more to wish for. The Berry-Esseen theorem overestimates the actual error in the CLT and truly sharp error bounds for specific distributions are, as far as we are aware, only known in binomial cases and can be found in Schulz (2016). Even less seems to be known for other distances and higher-order approximations.

In order to make progress here we consider it to be advisable to solve these problems for specific distributions such as the binomial and the uniform distribution first. These are interesting in their own right and hopefully our solutions via Fourier inversion can be generalized to a wider set of distributions.

To give an example we plan to present the following two results. We found that the optimal bound in the local CLT for the symmetric binomial distribution is

$$\begin{gathered} \frac{1}{2\sqrt{2\pi}} n^{3/2} \end{gathered}$$

and in the global CLT with simple continuity correction it is

$$\begin{gathered} 2\Phi\left(-\frac{3}{\sqrt{2}}\right) \frac{1}{n} \end{gathered}$$

where  $\Phi$  is the standard normal distribution function.

### References

Schulz, J. (2016). The Optimal Berry-Esseen Constant in the Binomial Case. Dissertation, Universität Trier. <http://ubt.opus.hbz-nrw.de/volltexte/2016/1007/>.

**Primary author:** VAN NERVEN, Patrick (Uni Trier)

**Session Classification:** Session A3 Stochastics

**Track Classification:** Stochastics

Contribution ID: 14

Type: **Talk**

## Confidence in Causal Discovery with Linear Causal Models

*Wednesday, 3 August 2022 14:00 (20 minutes)*

Inferring causal relations of a system is a fundamental problem of statistics. A widely studied approach employs structural causal models that model noisy functional relations among a set of interacting variables. The underlying causal structure is naturally represented by a directed graph whose edges indicate direct causal dependencies. Under the assumption of linear relations with homoscedastic Gaussian errors this causal graph and, thus also, causal effects are identifiable from mere observational data. Over the past decade, two main lines of research evolved, learning the causal graph as well as estimating causal effects when the graph is known. However, a two-step method, that first learns a graph and then treats the graph as known yields confidence intervals that are overly optimistic and can drastically fail to account for the uncertain causal structure. In this talk, I will address this issue and present a framework based on test inversion that allows us to give confidence regions for total causal effects that capture both sources of uncertainty: causal structure and numerical size of nonzero effects.

**Primary author:** STRIEDER, David (Technical University of Munich)

**Co-authors:** DRTON, Mathias; FREIDLING, Tobias; HAFFNER, Stefan

**Session Classification:** Session B1 Statistics

**Track Classification:** Statistics

Contribution ID: 15

Type: **not specified**

## Regression estimation via best $L_2$ -approximation on spaces of step functions with two jumps

*Thursday, 4 August 2022 09:00 (20 minutes)*

In general regression models the equation  $Y = m(X) + \epsilon$  holds, where  $X, Y$  and  $\epsilon$  are random variables,  $m(X) = \mathbb{E}[Y|X]$  and the regression function  $m$  is unknown.

The approach by Nadine Albrecht, 2020, uses step functions with one jump, e.g. binary decision trees, as an approximation of  $m$  in  $L_2$  and assumes the unique existence of optimal step function parameters for the approximation. With given independent, identically distributed samples  $(X_i, Y_i)_{i \in \mathbb{N}}$  it is possible to formulate the empirical equivalent of the approximation via step functions. As a consequence stochastic processes appear in the multivariate Skorokhod space  $D(\mathbb{R}^d)$ . Our research interest is the extension to multiple step functions with arbitrary, finite jumps. Under certain conditions first results, similarly to the case with one jump, are examined for step functions with two jumps, including stochastic boundedness, convergence in distribution of the empirical processes and consistency of the estimators. By the usage of the Arginf theorems introduced by Dietmar Ferger, 2015, confidence regions for the parameters in the step functions can be constructed.

**Primary author:** ROSAR, Niklas

**Session Classification:** Session B3 Statistics

**Track Classification:** Statistics

Contribution ID: 16

Type: **Talk**

## Identification in Graphical Continuous Lyapunov Models

*Thursday, 4 August 2022 10:00 (20 minutes)*

Graphical continuous Lyapunov models offer a new perspective on modeling the causally interpretable dependence structure in multivariate data by treating each independent observation as a one-time cross-sectional snapshot of the multivariate Ornstein-Uhlenbeck process in equilibrium. This leads to Gaussian models in which the covariance matrix is determined by the continuous Lyapunov equation. In this setting, each graphical model assumes a sparse drift matrix with support determined by a directed graph. We study the crucial problem of parameter identifiability in the class of graphical continuous Lyapunov models. Indeed, given a statistical model induced by a graph, it is essential for statistical analysis to clarify if it is possible to uniquely recover the parameters from the joint distribution of the observed variables.

We show that this question can be reduced to analyzing the rank of certain sparse matrices with covariances as entries. Depending on the graph under consideration, the structure of these matrices changes in subtle ways. We study the identifiability for different classes of graphs. In our main result we prove that global identifiability holds if and only if the graph is simple (i.e., contains at most one edge between any two nodes). Furthermore, we present intriguing examples of non-simple graphs for which the associated model has generically identifiable parameters.

**Primary author:** DETTLING, Philipp (Technical University of Munich)

**Session Classification:** Session B3 Statistics

**Track Classification:** Statistics

Contribution ID: 17

Type: **Talk**

## Short paths in scale-free percolation

*Thursday, 4 August 2022 14:30 (20 minutes)*

Graph distances in real networks, in particular social networks, have been always in the focus of network research since Milgram's experiment in 60s. In this talk we specialise in a geometric random graph known as scale-free percolation, which shows a rich phase diagram, and focus on short paths in it. In this model,  $x, y \in \mathbb{Z}^d$  are connected with probability depending on i.i.d weights and their Euclidean distance  $|x - y|$ .

First we study asymptotic distances in a regime where graph distances are poly-logarithmic in Euclidean distance. With a multi-scale argument we obtain improved bounds on the logarithmic exponent. In the heavy tail regime, improvement of the upper bound shows a discrepancy with the long-range percolation. In the light tail regime, the correct exponent is identified.

In the following part we investigate navigation possibility in the model. More precisely, we study whether it is possible to find the shortest paths between two vertices, given only local information (weights and locations of neighbors). In the doubly logarithmic regime, a greedy routing algorithm enables us to find a comparably long path as the shortest one up to the prefactor.

**Primary author:** HAO, Nannan (LMU München)

**Co-author:** Prof. HEYDENREICH, Markus (LMU München)

**Session Classification:** Session A4 Stochastics

**Track Classification:** Stochastics



Contribution ID: 18

Type: **Talk**

## Applying monoid duality to interacting particle systems

*Friday, 5 August 2022 10:00 (20 minutes)*

In the study of interacting particle systems duality is an important tool used to prove various types of long-time behavior, for example convergence to an invariant distribution. The two most used types of dualities are additive and cancellative dualities, which we are able to treat in a unified framework considering commutative monoids (i.e. semigroups containing a neutral element) as cornerstones of such a duality. For interacting particle systems on local state spaces with more than two elements this approach revealed formerly unknown dualities.

As an application of one of the newly found dualities a convergence result of a combination of the *\emph{contact process}* and its cancellative version, formerly known as the *\emph{annihilating branching process}*, is presented.

**Primary author:** LATZ, Jan Niklas (Czech Academy of Sciences & Charles University)

**Session Classification:** Session A6 Stochastics

**Track Classification:** Stochastics

Contribution ID: 19

Type: **Talk**

## The maximum of branching Brownian motion

*Friday, 5 August 2022 11:00 (20 minutes)*

The order of the maximum of branching Brownian motion (BBM) differs in a logarithmic correction term from the one in corresponding independent setting. In this talk we zoom into this transition. We study “variable speed branching Brownian motions” where the “speed functions”, that describe the time-inhomogeneous variance, approach the one of BBM from below. We show that the logarithmic correction only depends on the initial and final diffusion parameters. We will see that the key to the above result is a precise understanding of the entropic repulsion experienced by an extremal particle.

Based on joint work in progress with Lisa Hartung.

**Primary author:** ALBAN, Alexander (Gutenberg University Mainz)

**Session Classification:** Session A7 Stochastics

**Track Classification:** Stochastics

Contribution ID: 20

Type: **Talk**

## Deep neural network discretization of the Wong-Zakai approximation of stochastic differential equations

*Wednesday, 3 August 2022 14:00 (20 minutes)*

In recent years, deep neural networks (DNNs) have been successfully used in many computational problems including, for example, fraud detection or pattern recognition. DNN algorithms have been also proven to be enormously successful in overcoming the curse of dimensionality, in particular for solving Kolmogorov-type partial differential equations in hundreds of dimensions in reasonable computation time. Nothing is known until now on using neural networks in connection with the so-called Wong-Zakai method that approximates stochastic differential equations by suitable random ordinary differential equations. We are exploring whether neural networks are numerically beneficial in this context and provide an algorithm for that.

This is joint work with Andreas Neuenkirch (University of Mannheim) and Michaela Szölgényi (University of Klagenfurt).

**Primary author:** SPENDIER, Kathrin (Universität Klagenfurt)

**Co-authors:** Dr SZÖLGYENYI, Michaela (University of Klagenfurt); Dr NEUENKIRCH, Andreas (University of Mannheim)

**Session Classification:** Session A1 Stochastics

**Track Classification:** Stochastics

Contribution ID: 21

Type: **Talk**

## Hegelsmann-Krause model with environmental noise

*Friday, 5 August 2022 11:00 (20 minutes)*

With the rapid development of the internet and social networks in the last decades, more people than ever can express and share their opinions. Even though everyone has access to this information, algorithms filter the opinions such that viewpoints, which lie outside your core beliefs, get ignored. The field of opinion dynamics describes such phenomenon through bounded confidence models. Based on the Hegelsmann-Krause model introduced by Rainer Hegelsmann and Ulrich Krause in 2002 we present a time continuous system of interacting particles, which is driven by idiosyncratic and environmental noise. In the limit we derive McKean-Vlasov equation. By employing a dual argument, the Ito-Wentzell formula in combination with reducing the time integrability via stopping time we show the existence and uniqueness of the non-local, non-linear McKean-Vlasov equation. Moreover, we present the propagation of chaos for the particle system by utilizing the associated stochastic partial differential equation.

**Primary authors:** NIKOLAEV, Paul; Prof. CHEN, Li; Prof. PRÖMEL, David

**Session Classification:** Session C2 Applications

**Track Classification:** Applications

Contribution ID: 22

Type: **Talk**

## A Central Limit Theorem for Centered Purely Random Forests using U-Statistic Theory

*Wednesday, 3 August 2022 18:00 (20 minutes)*

Random forests are a popular method in supervised learning and can be used for regression and classification problems. For a regression problem a random forest averages the results of several randomized decision trees that are constructed on different subsamples of the dataset. In practice random forests appear to be very successful and are therefore a commonly used algorithm. Contrary to this there is little known about the mathematical properties of classic random forests that use data dependent partitions. Most results in the literature cover simpler versions of random forests often with partitions that are independent of the dataset. One example of these simpler algorithms are centered purely random forests. Moreover the majority of the results in the literature are consistency theorems and there are noticeably less central limit theorems. In our work we prove a central limit theorem for centered purely random forests. The proof uses results by Peng et al. (2022) which are based on an interpretation of random forests as generalized U-Statistics.

### References

Wei Peng, Tim Coleman, and Lucas Mentch. Rates of convergence for random forests via generalized u-statistics. *Electronic Journal of Statistics*, 16(1):232–292, 2022.

**Primary author:** RABE, Jan (Universität Hamburg)

**Session Classification:** Session B2 Statistics

**Track Classification:** Statistics

Contribution ID: 23

Type: **Talk**

## **PAC-Bayes training for neural networks: sparsity and uncertainty quantification**

*Wednesday, 3 August 2022 17:00 (20 minutes)*

Increasing computational power and storage capacity have made high-dimensional datasets accessible to many areas of research such as medicine, natural and social sciences. While classical statistical methods are not compatible with high-dimensional data, especially due to the curse of dimensionality, machine learning methods have been successfully applied to regression problems in practice. On the theoretical level, a popular way to circumvent the curse of dimensionality is the concept of sparsity. We study the Gibbs posterior distribution from PAC-Bayes theory for sparse deep neural nets in a nonparametric regression setting. To access the posterior distribution, an efficient MCMC algorithm based on backpropagation is constructed. The training yields a Bayesian neural network with a joint distribution on the network parameters. Using a mixture over uniform priors on sparse sets of network weights, we prove an oracle inequality which shows that the method adapts to the unknown regularity and hierarchical structure of the regression function. Studying the Gibbs posterior distribution from a frequentist Bayesian perspective, we analyze the diameter and show high coverage probability of the resulting credible sets. The method is illustrated with an animation in a simulation example.

This talk is based on joint work with Mathias Trabs.

**Primary author:** STEFFEN, Maximilian (Karlsruhe Institute of Technology)

**Co-author:** Prof. TRABS, Mathias (Karlsruhe Institute of Technology)

**Session Classification:** Session B2 Statistics

**Track Classification:** Statistics

Contribution ID: 24

Type: **Talk**

## Random walks on graphs and the Floyd boundary

*Thursday, 4 August 2022 13:30 (20 minutes)*

We consider a random walk on a graph, in order to study its behavior at infinity, it is natural to consider a boundary for the graph. After obtaining such a structure, a question that arises is whether the limit of the random walk exists. In this talk we will define the Floyd boundary of a graph. Furthermore we will present some assumptions on the random walk that induce convergence to the boundary.

**Primary author:** SPANOS, Panagiotis (Graz University of Technology)

**Session Classification:** Session A4 Stochastics

**Track Classification:** Stochastics

Contribution ID: 25

Type: **Talk**

## Extrema of high dimensional data

*Thursday, 4 August 2022 14:00 (20 minutes)*

In this talk we present a method to determine the directions of multivariate extremes. Therefore the concept of sparse regular variation of Meyer and Wintenberger (2021b) is introduced. In contrast to regular variation the limit measure in the definition of sparse regular variation is more sparse. The limit measure is called spectral measure and models the dependence in extremes. Sparse regular variation is based on an Euclidean projection onto the simplex and allows the categorization of extremes with respect to the cones of the simplex. The support of the spectral measure is determined by finding components in the data which are very large, while all other components are small. This is done by categorization of extremes to cones of the simplex and fitting a multinomial model to the number of extremes in the different cones (Meyer and Wintenberger (2021a)). For estimating the number of extremal cones we derive some information criteria, e.g. AIC (Meyer and Wintenberger (2021a)).

References:

Meyer, N. and O. Wintenberger (2021a). "Multivariate sparse clustering for extremes". In: arXiv: 2007.11848 [math.ST].

Meyer, N. and O. Wintenberger (2021b). "Sparse regular variation". In: Advances in Applied Probability 53(4), pp. 1115-1148.

**Primary author:** BUTSCH, Lucas

**Session Classification:** Session B4 Statistics

**Track Classification:** Statistics



Contribution ID: 26

Type: **Talk**

## Adaptive MCMC for doubly intractable distributions

*Friday, 5 August 2022 09:00 (20 minutes)*

Bayesian inference in the context of biophysical problems may lead to posterior densities with two unknown quantities, the normalizing constant and an intractable multiplicative factor in the likelihood function.

Not being able to evaluate the likelihood function leads to computational issues in classical (adaptive) MCMC algorithms and in the past years various methods have been suggested to overcome this problem.

We discuss an adaptive MCMC scheme that relies on approximating the likelihood function and, moreover, we present a strong law of large numbers for bounded measurable functions.

**Primary author:** HOFSTADLER, Julian (University of Passau)

**Session Classification:** Session C1 Applications

**Track Classification:** Applications

Contribution ID: 27

Type: **Talk**

## Long-range voter model on the real line

*Friday, 5 August 2022 11:30 (20 minutes)*

In the voter model on  $\mathbb{Z}$  a countable number of people (called voters) have two opinions, say 0 or 1, and each voter is placed at a site of  $\mathbb{Z}$ . Each person has an exponential distributed clock. If the clock rings the voter adopts the opinion of a randomly chosen neighbour. It is well known that this process satisfies a moment duality with a coalescing random walk. We are interested in a situation where an uncountable number of voters is placed on the real line and we allow that they adopt their opinion of other voters that are far away. Hence we think of a measure valued process satisfying a moment duality relation with a coalescing system of symmetric  $\alpha$ -stable processes with  $\alpha \in (1, 2)$ . Such a process has been constructed by Steven N. Evans in 1997 where he allows more general coalescing mechanisms and infinitely many opinions. In the talk I will introduce the process and talk about some fractional properties. This is joint work in progress with my supervisor Achim Klenke and with Leonid Mytnik.

**Primary author:** MEIER, Andreas (Johannes Gutenberg University Mainz)

**Session Classification:** Session C2 Applications

**Track Classification:** Applications

Contribution ID: 28

Type: **Talk**

## Component sizes of scale-free inhomogeneous random graphs

*Thursday, 4 August 2022 14:00 (20 minutes)*

The Norros-Reittu model is an inhomogeneous random multigraph that exhibits the so-called scale-free or power-law behaviour, which is observed in real-world complex networks. We study the component sizes of the Norros-Reittu model in the subcritical regime, i.e. in the absence of a giant component, and show convergence of the point process of the component sizes to a Poisson process. The same result holds for closely related graphs such as the Chung-Lu model and the generalized random graph. It is planned to derive similar results for geometric graph models like the random connection model.

**Primary authors:** LIENAU, Matthias (Hamburg University of Technology); Prof. SCHULTE, Matthias (Hamburg University of Technology)

**Session Classification:** Session A4 Stochastics

**Track Classification:** Stochastics

Contribution ID: 29

Type: **not specified**

## Lower variance bounds for Poisson functionals

*Thursday, 4 August 2022 16:00 (20 minutes)*

Lower bounds for variances are often needed to derive central limit theorems. In this talk, we establish a specific lower bound for the variance of a Poisson functional that uses the difference operator of Malliavin calculus.

Poisson functionals, i.e. random variables that depend on a Poisson process, are widely used in stochastic geometry. In this talk, we show how to apply our lower variance bound to statistics of spatial random graphs, the  $L^p$  surface area of random polytopes and the volume of excursion sets of Poisson shot noise processes. This talk is based on joint work with M. Schulte.

**Primary author:** TRAPP, Vanessa

**Session Classification:** Session A5 Stochastics

**Track Classification:** Stochastics

Contribution ID: 30

Type: **Talk**

## Conditional predictive inference for linear sub-models of high-dimensional data

*Thursday, 4 August 2022 09:30 (20 minutes)*

We deal with the estimation of the distribution of the prediction error conditional on the training data based on a jackknife type approach in a setting where the number of regressors grows proportionally with the number of observations. That estimation may be used to construct (asymptotically valid) confidence intervals as well as estimating the MSE or MAE of the method used in the prediction. While both the true and the working model are restricted to be linear, we allow for a misspecified setting in the sense that only a lower-dimensional linear transformation of the true regressors are available. We show that for a range of estimators including the OLS estimator our approach leads to an asymptotically accurate estimation.

**Primary author:** AMANN, Nicolai (University of Vienna)

**Co-authors:** Mr STEINBERGER, Lukas (University of Vienna); Mr LEEB, Hannes (University of Vienna)

**Session Classification:** Session B3 Statistics

**Track Classification:** Statistics

Contribution ID: 31

Type: **Talk**

## Stochastic Optimal Control of Occupational Pension Funds Under Dynamic Risk Constraints

*Wednesday, 3 August 2022 14:30 (20 minutes)*

In this presentation we consider occupational pension funds provided by a company to its employees. A special feature of such pension funds is that collectives of insured persons are typically smaller and benefit payments depend on seniority and salary of the insured.

Therefore, temporal fluctuations of the composition of the collective of insured persons w.r.t. age, seniority and salary can not be neglected in the computation of actuarial liabilities and the company's financial contributions to the fund.

We describe the stochastic dynamics for the composition of the collective of insured by a discrete-time Markov-chain model. The resulting actuarial liabilities which are functional of the Markov-chain are approximated by a diffusion process. The latter is used to formulate stochastic optimal control arising in the cost-optimal management of occupational pension funds. We focus on discrete-time problems which can be treated as a Markov Decision Process (MDP). Numerical results are presented.

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**Session Classification:** Session A1 Stochastics

**Track Classification:** Stochastics

Contribution ID: 32

Type: **Talk**

## Maximum interpoint distance of high-dimensional random vectors

*Thursday, 4 August 2022 10:00 (20 minutes)*

A limit theorem for the largest interpoint distance of  $p$  i.i.d. points on  $\mathbb{R}^n$  to the Gumbel distribution is proven, where the number of points  $p = p_n$  tends to infinity as the dimension of the points  $n$  tends to infinity. The theorem holds under moment assumptions and corresponding assumptions on the rate of  $p$ . The proof is based on the Chen-Stein Poisson approximation method and uses the sum structure of the interpoint distances. Therefore, an asymptotic distribution of a more general object is derived.

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**Session Classification:** Session A3 Stochastics

**Track Classification:** Stochastics

Contribution ID: 33

Type: **Talk**

## A simplified second-order Gaussian Poincaré inequality with application to random subgraph counting

*Thursday, 4 August 2022 15:30 (20 minutes)*

A simplified second-order Gaussian Poincaré inequality for normal approximation of functionals over infinitely many Rademacher random variables is derived. It is based on a new bound for the Kolmogorov distance between a general Rademacher functional and a Gaussian random variable, which is established by means of the discrete Malliavin-Stein method and is of independent interest. As an application, standardized subgraph counts in the Erdős-Rényi random graph are discussed.

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**Session Classification:** Session A5 Stochastics

**Track Classification:** Stochastics



Contribution ID: 34

Type: **Talk**

## Stochastic Epidemic Models with Partial Information : Dark Figure and Parameters Estimation

*Friday, 5 August 2022 09:30 (20 minutes)*

Mathematical models of epidemics such as the current COVID-19 pandemics often use compartmental models dividing the population into several compartments. Based on a microscopic setting describing the temporal evolution of the subpopulation sizes in the compartments by stochastic counting processes one can derive macroscopic models for large populations describing the average behavior by associated ODEs such as the celebrated SIR model. Further, diffusion approximations allow to address fluctuations from the average and to describe the state dynamics also for smaller populations by stochastic differential equations (SDE).

Usually not all of the state variables are directly observable and we are facing the so-called “dark figure” problem addressing for example the unknown number of asymptomatic and non-detected infections. Such not directly observable states are problematic if it comes to the computation of characteristics of the epidemic such as the effective reproduction rate and the prevalence of the infection within the population. Further, the management and containment of epidemics relying on solutions of (stochastic) optimal control problems and the associated feedback controls need observations of the current state as input.

The estimation of unobservable states based on records of the observable states leads to a non-standard filtering problem for observable stochastic models. We adopt the extended Kalman filter approach coping with non-linearities in the state dynamics and the state-dependent diffusion coefficients in the SDEs. This allows to develop approximative solutions to that filtering problem.

The proposed model depends on a variety of parameters that can be time-dependent and have been calibrated to real-world data for COVID-19. There, we apply maximum-likelihood and Kalman filter methods. We illustrate our theoretical finding by numerical results.

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**Session Classification:** Session C1 Applications

**Track Classification:** Applications

Contribution ID: 35

Type: **Talk**

## Stochastic Epidemic Models with Partial Information: Optimal Control Problems

*Friday, 5 August 2022 10:00 (20 minutes)*

This presentation is based on and continues the companion talk of Florent Ouabo Kamkumo. We consider stochastic optimal control problems arising in the mathematical modeling of decision-making processes in the cost-optimal management and containment of epidemics. We focus on the impact of uncertainties such as dark figures which have been addressed in the companion talk and can be treated as optimal control problems under partial information. Working with the diffusion approximations for the population dynamics and the associated Kalman filter estimates of non-observable state variables leads to control problems for controlled diffusion processes.

This is joint work with Ralf Wunderlich

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**Session Classification:** Session C1 Applications

**Track Classification:** Applications

Contribution ID: 36

Type: **Talk**

## Using Statistics to Determine the Learning Rate for Gradient Descent

*Wednesday, 3 August 2022 17:30 (20 minutes)*

While gradient descent is ubiquitous in Machine Learning, there is no adaptive way to select a learning rate yet. This forces practitioners to do “hyperparameter tuning”. We review how optimization schemes can be motivated using Taylor approximations and develop intuition why this results in unknown hyperparameters. We then replace the Taylor approximation with a statistical Best Linear Unbiased Estimator (BLUE) and derive gradient descent again. But this time with calculable learning rates.

**Primary author:** BENNING, Felix (Universität Mannheim)

**Session Classification:** Session B2 Statistics

**Track Classification:** Statistics

Contribution ID: 37

Type: **Talk**

## Geodesic slice sampling on the sphere

*Friday, 5 August 2022 11:30 (20 minutes)*

We introduce a geodesic slice sampler on the Euclidean sphere (in arbitrary but fixed dimension) that can be used for approximate sampling from distributions that have a density with respect to the corresponding surface measure. Such distributions occur e.g. in the modelling of directional data or shapes. Under some mild conditions we show that the corresponding transition kernel is well-defined, in particular, that it is reversible with respect to the distribution of interest. Moreover, if the density is bounded away from zero and infinity, then we obtain a uniform ergodicity convergence result.

**Primary author:** HASENPFLUG, Mareike (University of Passau)

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**Session Classification:** Session A7 Stochastics

**Track Classification:** Stochastics

Contribution ID: 38

Type: **Talk**

## Signal Processing with Gabor Frames: Variational Problems, Compression, and Noise Removal

*Thursday, 4 August 2022 14:30 (20 minutes)*

We present solutions for variational problems, compression and noise removal using gabor frames. For an appropriate window function, a signal  $f \in \mathcal{L}^2(\mathbb{R}^d)$  possesses a non-orthogonal gabor frames expansions in terms of the dual frames with unconditional convergence in  $\mathcal{L}^2((\mathbb{R}^d)^d)$ . We derive approximate minimizers of variational problems and compression in modulation spaces. Within the Gaussian white noise model we provide minimax bounds for rates of convergence over modulation spaces using soft-thresholding of the Gabor coefficients. Numerical experiments complement the theoretical results. Furthermore we extend our results onto  $\alpha$ -modulation spaces, providing a flexible Gabor-wavelet transform of signals.

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**Session Classification:** Session B4 Statistics

**Track Classification:** Statistics

Contribution ID: 39

Type: **Talk**

## An SMP-Based Algorithm for Solving the Constrained Utility Maximization Problem via Deep Learning

*Wednesday, 3 August 2022 13:30 (20 minutes)*

We consider the utility maximization problem under convex constraints with regard to theoretical results which allow the formulation of algorithmic solvers which make use of deep learning techniques. In particular for the case of random coefficients, we prove a stochastic maximum principle (SMP) generalizing the SMP proved by Li and Zheng (2018). We use this SMP together with the strong duality property for defining a new algorithm, which we call deep primal SMP algorithm. Numerical examples illustrate the effectiveness of the proposed algorithm. Moreover, our numerical experiments for constrained problems show that the novel deep primal SMP algorithm overcomes the deep SMP algorithm's (see Davey and Zheng (2021)) weakness of erroneously producing the value of the corresponding unconstrained problem. Furthermore, in contrast to the deep controlled 2BSDE algorithm from Davey and Zheng (2021), this algorithm is also applicable to problems with path dependent coefficients. Finally, we propose a learning procedure based on epochs, which improved the results of our algorithm even further. Implementing a semi-recurrent network architecture for the control process turned out to be also a valuable advancement.

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**Session Classification:** Session A1 Stochastics

**Track Classification:** Stochastics