17. Doktorand:innentreffen der Stochastik

Wednesday 03 August 2022 - Friday 05 August 2022

Universität Klagenfurt

Book of Abstracts

Contents

Session A1 Stochastics / 39

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

Author: Kristof Wiedermann[1]

[1] *TU Wien*

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.

Session A1 Stochastics / 20

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

Author: Kathrin Spendier[1]

Co-authors: Michaela Szölgyenyi [2]; Andreas Neuenkirch [3]

[1] *Universität Klagenfurt*

[2] *University of Klagenfurt*

[3] *University of Mannheim*

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 Szölgyenyi (University of Klagenfurt).

Session A1 Stochastics / 31

Stochastic Optimal Control of Occupational Pension Funds Under Dynamic Risk Constraints

Authors: Mohamed Elfatih Hady[1]; Ralf Wunderlich[1]

[1] *BTU Cottbus-Senftenberg*

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.

Session A2 Stochastics / 3

Clustering financial institutions based on Wasserstein distance

Authors: Julio Backhoff[1]; Mathias Beiglböck[1]; Lorenz Riess[1]

[1] *University of Vienna*

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.

Session A2 Stochastics / 4

The Wasserstein space of stochastic processes

Authors: Daniel Bartl[1]; Gudmund Pammer[2]; Mathias Beigböck[1]; Stefan Schrott[1]; Xin Zhang[1]

[1] *University of Vienna*

[2] *ETH Zurich*

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 FP. We also observe that $(\mathrm{FP}, \mathcal{AW})$ exhibits several desirable properties. Specifically, $(\mathrm{FP}, \mathcal{AW})$ 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.

Session A3 Stochastics / 13

Sharp Constants in Normal an Edgeworth Approximation

Author: Patrick van Nerven[1]

[1] *Uni Trier*

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{gather}
\frac{1}{2\sqrt{2\pi} n^{3/2}}
\end{gather}
and in the global CLT with simple continuity correction it is

\begin{gather}
2\Phi\bigg(-\frac{3}{\sqrt{2}}\bigg) \frac{1}{n}
\end{gather}

where Φ 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/.

Session A3 Stochastics / 7

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

Authors: Kathrin Meier[1]; Christian Stump[None]

[1] *Ruhr-University Bochum*

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.

Session A3 Stochastics / 32

Maximum interpoint distance of high-dimensional random vectors

Author: Carolin Kleemann[1]

Co-author: Johannes Heiny

[1] *Ruhr University Bochum*

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.

Session A4 Stochastics / **24**

Random walks on graphs and the Floyd boundary

Author: Panagiotis Spanos[1]

[1] *Graz University of Technology*

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.

Session A4 Stochastics / **28**

Component sizes of scale-free inhomogeneous random graphs

Authors: Matthias Lienau[1]; Matthias Schulte[1]

[1] *Hamburg University of Technology*

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 abscence 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.

Session A4 Stochastics / **17**

Short paths in scale-free percolation

Author: Nannan Hao[1]

Co-author: Markus Heydenreich [1]

[1] *LMU München*

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.

Session A5 Stochastics / 33

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

Author: Benedikt Rednoß[1]

Co-authors: Peter Eichelsbacher [1]; Christoph Thäle [1]; Guangqu Zheng [2]

[1] *Ruhr University Bochum*

[2] *The University of Edinburgh*

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.

Session A5 Stochastics / 29

Lower variance bounds for Poisson functionals

Author: Vanessa Trapp[None]

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.

Session A6 Stochastics / 6

Parabolic Fractal Geometry

Authors: Peter Kern[None]; Leonard Pleschberger[1]

[1] *Heinrich Heine University Düsseldorf*

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.

Session A6 Stochastics / 10

Quantifying the almost sure uniform convergence of eigenvalue-counting functions

Author: Max Kämper[None]

Co-authors: Ivan Veselic [1]; Fabian Schwarzenberger [2]; Christoph Schumacher [1]

[1] *TU Dortmund*

[2] *HTW Dresden*

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.

Session A6 Stochastics / 18

Applying monoid duality to interacting particle systems

Author: Jan Niklas Latz[1]

[1] *Czech Academy of Sciences & Charles University*

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.

Session A7 Stochastics / 19

The maximum of branching Brownian motion

Author: Alexander Alban[1]

[1] *Gutenberg University Mainz*

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.

Session A7 Stochastics / 37

Geodesic slice sampling on the sphere

Author: Mareike Hasenpflug[1]

Co-authors: Michael Habeck [2]; Shantanu Kodgirwar [2]; Daniel Rudolf [3]

[1] *Unversity of Passau*

[2] *University of Jena*

[3] *University of Passau*

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.

Session B1 Statistics / 11

Half-Trek Criterion for Identifiability of Latent Variable Models

Author: Nils Sturma[1]

Co-authors: Rina Foygel Barber ; Mathias Drton ; Luca Weihs

[1] *Technical University of Munich*

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.

Session B1 Statistics / 14

Confidence in Causal Discovery with Linear Causal Models

Author: David Strieder[1]

Co-authors: Mathias Drton ; Tobias Freidling ; Stefan Haffner

[1] *Technical University of Munich*

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.

Session B1 Statistics / 8

Construction of Admissible Decision Procedures in Statistical Classification

Author: Lea Riebschläger[1]

[1] *University of Trier*

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.

Session B2 Statistics / 23

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

Author: Maximilian Steffen[1]

Co-author: Mathias Trabs [1]

[1] *Karlsruhe Institute of Technology*

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.

Session B2 Statistics / **36**

Using Statistics to Determine the Learning Rate for Gradient Descent

Author: Felix Benning[1]

[1] *Universität Mannheim*

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.

Session B2 Statistics / **22**

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

Author: Jan Rabe[1]

[1] *Universität Hamburg*

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.

Session B3 Statistics / 15

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

Author: Niklas Rosar[None]

In general regression models the equation $Y = m(X) + \epsilon$ holds, where X, Y and ϵ 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.

Session B3 Statistics / 30

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

Author: Nicolai Amann[1]

Co-authors: Lukas Steinberger [1]; Hannes Leeb [1]

[1] *University of Vienna*

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 ore 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.

Session B3 Statistics / 16

Identification in Graphical Continuous Lyapunov Models

Author: Philipp Dettling[1]

[1] *Technical University of Munich*

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.

Session B4 Statistics / 9

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

Author: Leopold Mareis[1]

Co-authors: Narges Ahmidi [2]; Mathias Drton [1]

[1] *Technical University of Munich*

[2] *Fraunhofer Institute for Cognitive Systems*

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.

Session B4 Statistics / 25

Extrema of high dimensional data

Author: Lucas Butsch[None]

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.

Session B4 Statistics / 38

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

Authors: Pavel Tafo[1]; Hajo Holzmann[2]

[1] *University Marburg*

[2] *Philipps-Universität Marburg*

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 $\mathcal{L}^2((R)^d)$. 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 α-modulation spaces, providing a flexible Gabor-wavelet transform of signals.

Session B5 Statistics / 5

Measuring statistical dependency with optimal transport

Authors: Thomas Giacomo Nies[1]; Thomas Staudt[1]; Axel Munk[1]

[1] *University of Göttingen*

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 emphasizes 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.

Session B5 Statistics / 2

Multiplicative deconvolution under unknown error distribution

Authors: Sergio Brenner Miguel[1]; Maximilian Siebel[1]; Jan Johannes[1]

[1] *Heidelberg University*

In this talk, we construct a nonparametric estimator of the density $f : \mathbb{R}_+ \to \mathbb{R}_+$ of a positive random variable X based on an i.i.d. sample $(Y_1, \ldots, Y_n)$ of
\begin{equation}Y=X\cdot U,
\end{equation} 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 $(\widetilde{U}_1, \ldots, \widetilde{U}_m)$ 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.

Session C1 Applications / 26

Adaptive MCMC for doubly intractable distributions

Author: Julian Hofstadler[1]

[1] *University of Passau*

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 mounded measurable functions.

Session C1 Applications / 34

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

Author: Florent Ouabo Kamkumo[1]

Co-authors: Ibrahim Mbouandi Njiasse [1]; Ralf Wunderlich [2]

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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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Stochastic Epidemic Models with Partial Information: Optimal Control Problems

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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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Hegelsmann-Krause model with environmental noise

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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.

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Long-range voter model on the real line

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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 α-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.