Book of Abstracts

Austrian Stochastics Days

September 07 - September 08, 2023

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Plenary Talks

Julio Backhoff-Veraguas

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Bass Martingales: existence, duality, and their properties

Motivated by robust mathematical finance, and also taking inspiration from the field of Optimal Transport, we ask: What is the martingale, with prescribed initial and terminal marginal distributions, which is closest to Brownian motion? Under suitable assumptions the answer to this question, in any dimension, is provided by the so-called Bass martingales. To imagine what these are, one pictures an underlying Brownian motion which is stretched in space in an order-preserving and martingale-preserving way. In this talk we discuss the properties of Bass martingales, their existence, and the duality theory required to study them. Based on joint work with Beiglböck, Schachermayer and Tschiderer.

Lisa Hartung

University of Mainz

The Feynman-Kac formula, reaction diffusion equations and Brownian excursions

In my talk I explain how the three items mentioned in the title are all interrelate. After a gentle introduction, we see how one can use the Feynman-Kac formula to solve F-KPP equations which is a simple form of a reaction-diffusion equation. F-KPP equations are well known to have so called travelling wave solutions. We then see why Brownian excursions play a key role when one wants to compute the speed of the travelling wave from the Feynman-Kac representation. Many of the ideas in my talk are based on Bramson (1983) but I will also talk about some recent applications for systems of equation. The latter is based on joint work with A. Bovier.

Contributed Talks

Andreas Celary

University of Economics and Business Vienna

Reproducing Kernel Based Methods For Modelling The Discount Curve

We consider term structure models from the perspective of the discount framework introduced in [1]. In analogy to the HJM setting, we formulate an arbitrage-free dynamic framework for modeling the discount curve. In the proposed setting, we derive no-arbitrage conditions to determine the set of admissible discount curves under the assumption of affine finite-dimensional realisations. Following [2], we introduce reproducing kernels as a possible regression basis for the corresponding estimation problem and derive a rich class of reproducing kernel Hilbert spaces which are admissible in the HJM framework.

References:

[1] Filipovic, Damir, Discount Models (May 30, 2023). Swiss Finance Institute Research Paper No. 23-34, Available at SSRN: https://ssrn.com/abstract=4466745 or http://dx.doi.org/10.2139/ssrn.4466745

[2] Filipovic, Damir and Pelger, Markus and Ye, Ye, Stripping the Discount Curve - a Robust Machine Learning Approach (March 15, 2022). Swiss Finance Institute Research Paper No. 22-24, Available at SSRN: https://ssrn.com/abstract=4058150 or http://dx.doi.org/10.2139/ssrn.4058150

Maximilian Diehl

University of Kaiserslautern-Landau

Compression and Simulation of Large Insurance Portfolios with New Business

We develop compression methods for large life insurance portfolios, where the insured collective is grouped into cohorts based on selected contract-related criteria. This allows us to simulate an extremely reduced number of representative contracts. We also show how to efficiently integrate new contracts into the existing insurance portfolio. Furthermore, we investigate the efficiency of the compression methods and their quality in approximating the uncompressed life insurance portfolio. In particular, we show how one can obtain bounds for the default probability of the life insurer as being part of conservative estimation procedures prescribed by regulating authorities. For the simulation of the insurance business, we devise a stochastic asset-liability management model. The incorporated balance sheet model is in line with the principle of double-entry bookkeeping as required in accounting. We provide a detailed modeling of the strategies for investing in the capital market and for financing the due obligations. Thereby, we take into account the complexity of managing a large insurance portfolio. In extensive simulation studies, we illustrate the short- and long-term behavior of our model and show impacts of different business forms, the predicted new business, and possible capital market crashes on the profitability and stability of a life insurer.

References:

[1] M. Diehl et al.: Long-term stability of a life insurer's balance sheet, Eur. Actuar. J., 13 (2023), 147–182.

Moritz Dober

University of Vienna

Invariance principle in the random-cluster and Ashkin–Teller models

The *random-cluster* model (also called FK-percolation) is a model for random subgraphs of some given graph, which we fix to be the square lattice $\mathbb{Z}^2$ in this talk. There are two parameters, an 'edge-weight' $p \in [0,1]$ and a 'cluster-weight' $q \in (0,\infty)$. For $q \geq 1$ fixed, there exists a *critical value* $p_c = p_c(q) \in (0,1)$ at which the behaviour of the model changes drastically, and where it is particularly interesting. If $q > 4$, the transition is known to be discontinuous and, at the transition point, boundary conditions have a drastic influence. We fix $q > 4$ and $p = p_c$, and consider the model on a square $\{-n,\dots,n\}^2$ with 'opposite' boundary conditions (*free* and *wired*) on the upper and the lower halves. This forces a natural interface separating different phases. We show that this interface typically has fluctuations of order $\sqrt{n}$ and, when re-scaled, converges to a *Brownian bridge*. We use couplings to the *Ashkin–Teller* model, where the problem can be tackled via rather robust techniques provided by Ornstein–Zernike theory.
This is ongoing joint work with Alexander Glazman and Sébastien Ott.

Maalvladedon Ganet Some

University of Rwanda

Stochastic Optimal Control of a Prosumer in a District Heating System

We consider networks of residential heating systems in which several prosumers satisfy their heating and hot water demand using solar thermal collectors and services of a central producer. Overproduction of heat can either be stored in a local thermal storage or sold to the network. Our focus is the minimization of the prosumers expected total cost from purchasing and selling thermal energy and running the system. This decision making problem under uncertainty about the future production and consumption of thermal energy is formulated as a stochastic optimal control problem and solved with dynamic programming techniques. We present numerical results for the value function and the optimal control.

Mate Gerencsér

Technical University of Vienna

Integration along stochastic processes

We consider integrals of expressions of the form f(Xt), where X is a stochastic process, and f is only a distribution. We overview some recent results on defining such integrals and discuss a variety of their applications in regularisation by noise for stochastic differential equations such as existence, uniqueness, stability, regularity, and approximation properties.

Lorenz A. Gilch

University of Passau

Capacity of the Range of Random Walks on Free Products

In this talk we study the capacity of the range of random walks on general free products. Let be V_1, V_2 disjoint, finite or countable sets with at least two elements, and denote by $V_1 * V_2$ the free product of V_1 and V_2, the set of finite words over the alphabet $V_1 \cup V_2$ such that no two consecutive letters arise from the same V_i, $i \in \{1,2\}$. We define a random walk $(X_n)_{n\in\mathbb{N}_0}$ on V which arises in a natural way as a lifted convex combination of random walks on the single factors V_i. The range of $(X_n)_{n\in\mathbb{N}}$ at time n is given by $R_n = \{X_0, \dots, X_n\}$, while the capacity of R_n is defined as $\mathrm{Cap}(R_n) = \sum_{x\in R_n} \mathbb{P}[S_{R_n} = \infty | X_0 = x]$, where S_{R_n} is the stopping time of the first return to R_n. The capacity is a mathematical analogue of the physcial ability of a set to store an electrical charge. We will study the asymptotic capacity of the range given by $\lim_{n\to\infty} \mathrm{Cap}(R_n)/n$.

The capacity of the range of random walks has been studied mainly on $\mathbb{Z}^d$ and groups. Jain and Orey [1] proved existence of the asymptotic capacity of the range for random walks on the integer lattice $\mathbb{Z}^d$, $d \geq 3$, where the asymptotic capacity is strictly positive if and only if $d \geq 5$. Mrazović, Sandrić and Šebek [2] proved that the asymptotic capacity of the range of symmetric simple random walks on finitely generated groups exists. In this talk we will go beyond group-invariant random walks and derive analogous statements on existence of the asymptotic capacity of the range. Furthermore, a central limit theorem will be provided. Finally, we show that the capacity varies real-analytically in terms of finitely many parameters which describe the underlying transition probabilities.

References:

[1] L. A. Gilch. Asymptotic capacity of the range of random walks on free products of graphs. Submitted, Arxiv: https://arxiv.org/abs/2209.09884, 2023.

[2] N. C. Jain and S. Orey. On the range of random walk. Israel J. Math., 6:373–380, 1968.

[3] R. Mrazovi ́c, N. Sandri ́c, and S. Sebek. Capacity of the range of random walks on groups. To appear in ˇ Kyoto J. of Mathematics, 2021.

Alexander Glazman

University of Innsbruck

Delocalisation of height functions

Take a Simple Random Walk in dimension 1 that starts at 0, makes $2N$ steps and ends at 0. It is elementary that the variance of the position of the walk at time N is of order square root of N.

We consider a version of this question with a two-dimensional time. A random Lipschitz function takes integer values at the faces of a box $2N \times 2N$ on the hexagonal lattice: the heights are 0 on the boundary and differ by 0, 1, or -1 at any two adjacent faces. The distribution depends on the number of pairs of adjacent faces having different heights and has parameter $x > 0$.

We show that the height function delocalises whenever $\frac{1}{2} \leq x^2 \leq 1$: the variance of the height at the origin diverges as log N. This is consistent with physics prediction from the 70s-80s stating that a localisation/delocalisation transition occurs at $x^2 = \frac{1}{2}$. In the delocalised region, one expects convergence to the Gaussian Free Field.

Our approach goes through graphical representations of this random Lipschitz function, positive correlation (FKG) inequalities and the non-coexistence theorem of Zhang and Sheffield. It applies also to the six-vertex (ice-type) model and gives a new proof of the continuity of the phase transition in the random-cluster model.

Based on a joint work with Piet Lammers, arXiv:2306.01527.

Sándor Guzmics

University of Vienna

Extreme value copulas based on Freund's multivariate lifetime model and some of their properties

The use of the exponential distribution and its multivariate generalizations is common in lifetime modeling. There are several models that explicitely incorporate a dependence structure among the components, e.g., Freund's bivariate distribution (1961). Its copula has been presented by Guzmics and Pflug (2019), and we also provided (2020) the corresponding bivariate extreme value copula and discussed a natural multivariate generalization of the model. The basic idea is that the remaining lifetime of any entity in a multivariate system is shortened, when one of the other entities defaults. In this current work, we extend some results of the bivariate model for more variables, assuming a symmetric parameter setting, i.e., when the original lifetime intensities, as well as the shock parameters are identical. Especially, we derive the parametric family of extreme value copulas which stems from Freund's multivariate distribution and we present some interesting properties of it.

Levi Haunschmid-Sibitz

Technical University of Vienna

The Stochastic Six Vertex Speed Process

The stochastic six vertex model was first introduced by Gwa and Spohn in 1992, as a specialization of the classical six vertex model, introduced by Pauling in 1935. It lies in the KPZ universality class and has many connections to a wide variety of probabilistic systems. In particular it is connected to the asymmetric simple exclusion process via a Poissonian limit. Using quantitative hydrodynamics we show almost sure convergence of the slope of a second class particle in step initial conditions. This uses the integrable structure of the model. The limiting law of the slope is given as an explicit function of the parameters of the model and also depends on the initial state of the second class particle. This was previously done in [1] for TASEP in 2008 and in [2] for ASEP in 2023. As in those cases this allows one to define a speed process for this model. Using results on symmetries of ASEP and the six vertex model from [3] one can again find certain stationarity properties of this process. They are, however, more intricate since the speed process depends on the domain of the process. The talk will focus on the definition of the model and the statement of the main theorems. If time permits the main methods of the proof will be sketched highlighting differences and challenges compared to previous works.

References:

1 Gideon Amir, Omer Angel, and Benedek Valk'o.: The Tasep Speed Process, The Annals of Probability, 2019.

2 Amol Aggarwal, Ivan Corwin, and Promit Ghosal: The ASEP Speed Process Advances in Mathematics 2023.

3 Alexei Borodin and Alexey Bufetov. Color-position symmetry in interacting particle systems. The Annals of Probability, 2019.

4 Hindy Drillick and Levi Haunschmid-Sibitz: The Stochastic Six Vertex Speed Process Work in Progress, 2023+

Michael L. Juhos

University of Passau

The large deviation behaviour of lacunary sums

We study the large deviation behavior of lacunary sums $(S_n/n)_{n\in\mathbb{N}}$ with $S_n := \sum_{k=1}^n f(a_k U)$, $n \in \mathbb{N}$, where U is uniformly distributed on $[0,1]$, $(a_k)_{k\in\mathbb{N}}$ is an Hadamard gap sequence, and $f\colon \mathbb{R} \to \mathbb{R}$ is a 1-periodic, (Lipschitz-)continuous mapping. In the case of large gaps, we show that the normalized partial sums satisfy a large deviation principle at speed n and with a good rate function which is the same as in the case of independent and identically distributed random variables U_k, $k \in \mathbb{N}$, having uniform distribution on $[0,1]$. When the lacunary sequence $(a_k)_{k\in\mathbb{N}}$ is a geometric progression, then we also obtain large deviation principles at speed n, but with a good rate function that is different from the independent case, its form depending in a subtle way on the interplay between the function f and the arithmetic properties of the gap sequence. Our work generalizes some results recently obtained by Aistleitner, Gantert, Kabluchko, Prochno, and Ramanan [1] who initiated this line of research for the case of lacunary *trigonometric* sums.

References:

1 Ch. Aistleitner, N. Gantert, Z. Kabluchko, J. Prochno, K. Ramanan: Large deviation principles for lacunary sums, Trans. Amer. Math. Soc. 376 (2023), 507–553.

Minoo Kamrani

University of Razi

Approximation of Solutions of SDEs Driven by a fBm with Applications in Mathematical Finance

This research aims to introduce a numerical method for solving stochastic differential equations (SDEs) involving fractional Brownian motion (fBM) with significant applications in mathematical finance. The proposed numerical approach offers an efficient solution to the complex dynamics exhibited by financial models with fBM components, which are prevalent in various financial applications. By leveraging the properties of Malliavin calculus, we rigorously establish the convergence of our proposed numerical method. The effectiveness of the method is demonstrated through numerical experiments on representative mathematical finance problems. Results indicate the robustness and reliability of the proposed approach, validating its suitability for addressing real-world financial scenarios.

References:

[1] T. E. Duncan, Y. Hu , B. Pasik-Duncan, Stochastic calculus for fractional Brownian motion. I. Theory, SIAM Journal on Control and Optimization, (2000), 38(2):582-612.

[2] J. Hong, M. Kamrani, X. Wang, Optimal strong convergence rate of a backward Euler type scheme for the CIR model driven by fractional Brownian motion, Stochastic Processes and their Applications, (2020), 130(5), 2675-2692.

[3] Y. Hu, D. Nualart, X. Song, A singular stochastic differential equation driven by fractional Brownian motion, Statistics and Probability Letters (2008), 78, 2075-2085.

Anna P. Kwossek

University of Mannheim

The Euler scheme for rough and stochastic differential equations revisited

First and higher order Euler schemes play a central role in the numerical approximations of stochastic differential equations. While the pathwise convergence of higher order Euler schemes can adequately be explained by rough path theory, the first order Euler scheme seems to be outside the scope of rough path theory, at least at first glance.
In this talk, we show the convergence of the first order Euler scheme for differential equations driven by càdlàg rough paths that satisfy a suitable criterion, namely the so-called Property (RIE), along time discretizations with mesh size going to zero. This property is verified for almost all sample paths of Brownian motion, Lévy processes, Itô processes and general càdlàg semimartingales, relative to various time discretizations. Consequently, we obtain the pathwise convergence in p-variation of the Euler–Maruyama scheme for stochastic differential equations driven by these stochastic processes.

Boris Jidjou Moghomye

University of Leoben

On a stochastic Chemotaxis-fluid flow model

In this talk, we present an existence and uniqueness result based on Galerkin method for a model describing the dynamic of collective behaviour of oxygen-driven swimming bacteria in an aquatic fluid flowing in a two dimensional bounded domain influenced by random external forces. The considered model consists of the stochastic Navier-Stokes equations coupled with Keller-Segel equations.

Jani Nykänen

University of Jyväskylä

Mean field SDEs with a diffusion coefficient discontinuous in the measure component

We consider $\mathbb{R}^d$-valued mean field stochastic differential equations of the type

$$X_t = x_0 + \int_0^t \sigma(s, X_s, \mathbb{P}_{X_s}, \|X_s\|_{L_p(\Omega)})\mathrm{d}B_s + \int_0^t b(s, X_s, \mathbb{P}_{X_s})\mathrm{d}s,$$

with an infinite time horizon, where $B = (B_t)_{t\in[0,\infty)}$ is a d-dimensional Brownian motion. We discuss the existence and non-existence of a global strong solution in the case that the diffusion and drift coefficients satisfy standard assumptions in the first three parameters, but we allow the diffusion coefficient σ to be discontinuous in the L_p-component. In particular we observe oscillation effects that prevent the existence of global solutions on the full time interval $[0, \infty)$.

This talk is based on [1].

References:

[1] Jani Nykänen: Mean field stochastic differential equations with a discontinuous diffusion coefficient, arXiv:2206.11538, 2023.

Francesco Pedrotti

Institute of Science and Technology Austria

Contractive coupling rates and curvature lower bounds for Markov chains

Ricci curvature lower bounds for Riemannian manifolds have been linked to many functional inequalities: this has motivated the seminal independent works of Sturm [5] and Lott and Villani [3], who extended the notion of curvature lower bound and many of its consequences to a large class of metric measure spaces. In spite of its generality, this theory does not apply to Markov chains on discrete spaces; for this reason, several adapted notions of curvature have been proposed, based on different equivalent characterisations of curvature of Riemannian manifolds. Different notions have different pros and cons: e.g., the entropic curvature of Erbar-Maas [2] is hard to compute in some examples, while Ollivier's coarse Ricci curvature [4] is not known to imply a modified logarithmic Sobolev inequality. It is still an open problem to compare these notions. In the present work, adapting arguments of a recent article by G. Conforti [1], we show how contractive couplings (a concept naturally connected to Ollivier's curvature) can be used to establish entropic curvature lower bounds for some examples of reversible Markov chains.

References:

[1] G. Conforti: *A probabilistic approach to convex ϕ-entropy decay for Markov chains*, Ann. Appl. Probab. 32.2, (2022).

[2] M. Erbar and J. Maas: *Ricci curvature of finite Markov chains via convexity of the entropy*, Arch. Ration. Mech. Anal. 206.3 (2012).

[3] J. Lott and C. Villani: *Ricci curvature for metric-measure spaces via optimal transport*, Ann. Math. (2) 169.3 (2009).

[4] Y. Ollivier: *Ricci curvature of Markov chains on metric spaces*, J. Funct. Anal. 256.3 (2009).

[5] K-T. Sturm: *On the geometry of metric measure spaces*, Acta Mathematica 196.1 (2006).

Tsiry A. Randrianasolo

University of Leoben

Strong convergence rate for stochastic Burgers equations

A Dynkin game is a gametheoretical version of an optimal stopping problem that was first introduced by Dynkin [1]. The game is set up between two players A and B. Each Player can stop the game at any time for an observable payoff. If a player chooses to stop the game, B receives some premium from A. In such a game, B attempts to maximize the amount he receives, while A tries to minimize the payout. Typically, the value of this game is a solution of a Hamilton–Jacobi–Bellman equation with two obstacles that characterizes the upper-lower limit that can take the value of the game and at which the game has to stop. In [2], Gr¨une considered the case where one player is informed about the payoff, while the other one only knows it up to a certain probability vector p. In this configuration, a third obstacle appears. It characterizes the fact that the value of the game has to be convex or concave with respect to the probability vector p. This brings numerical challenges that we will talk during this presentation. We will talk about a convergent numerical method based on the Semi-Lagrangian scheme that preserves the convexity or concavity of the value of the game, and show some numerical experiments. We will also see the limit of the Semi-Lagrangian approach and suggest other alternatives.

References:

[1] E. Dynkin. Game variant of a problem on optimal stopping. Soviet Math. Dokl., 10:270–274, 1969.

[2] C. Grün. On Dynkin games with incomplete information. SIAM J. Control Optim., 51(5):4039–4065, 2013.

Christopher Rauhögger

University of Passau

On the performance of the Euler-Maruyama scheme for multidimensional SDEs with a drift coefficient that is discontinuous in a compact set

Recently it was proven in [1] that the Euler-Maruyama scheme achieves an L_p error rate of order at least $1/2-$ for systems of SDEs with a piecewise Lipschitz drift coefficient and a Lipschitz diffusion coefficient, gereralizing a previous result [2] for scalar SDEs. We prove that if additionally the piecewise Lipschitz drift coefficient has a compact exceptional set, then an L_p-error rate of order at least $1/2$ is achieved, just like in the classical setting.

References:

[1] Müller-Gronbach, T., Rauhögger, C. and Yaroslavtseva, L. (2022+), *On the performance of the Euler-Maruyama scheme for multidimensional SDEs with discontinuous drift coefficient* , In preparation.

[2] Müller-Gronbach, T. and Yaroslavtseva, L. (2020), *On the performance of the Euler–Maruyama scheme for SDEs with discontinuous drift coefficient*, Ann. Inst. H. Poincaré Probab. Statist. **56**, 1162–1178.

Stefan Rigger

University of Verona

Probabilistic Solutions of the supercooled Stefan Problem

Supercooled Stefan problems describe the evolution of the interface between the liquid and solid phase of a material where the liquid is initially cooled below its freezing point. A supercooled Stefan problem is traditionally formulated as a partial differential equation with free boundary that is notoriously ill-posed.
A recent idea, put forth by Francois Delarue, Sergey Nadtochiy and Mykhaylo Shkolnikov [1], is to define solutions to the supercooled Stefan problem through the associated McKean–Vlasov equation, which is treated as a probabilistic reformulation that allows to define solutions globally in time even when finite-time blow-up occurs in the corresponding system of partial differential equations.
We expand on this idea and study the solution concepts of minimal and physical solutions, proving that minimal solutions are physical. Next, we prove the convergence of an efficient and robust numerical scheme that allows us to reliably approximate the minimal solution even in the presence of blow-ups. Finally, we illustrate how the preceding insights might be applied to the problem faced by a central bank that aims to prevent the default of a given proportion of banks with minimal costs.

References:

[1] F. Delarue, S. Nadtochiy, M. Shkolnikov: Global solutions to the supercooled Stefan problem with blowups: regularity and uniqueness. arXiv:1902.05174, To appear in Probab. Math. Phys.

[2] C. Cuchiero, S. Rigger, S. Svaluto-Ferro: Propagation of minimality in the supercooled Stefan problem arXiv:2010.03580, To apper in Annals of Applied Probability

[3] C. Cuchiero, C. Reisinger, S. Rigger: Implicit and fully discrete approximation of the supercooled Stefan problem in the presence of blow-ups arXiv:2206.14641.

[4] C. Cuchiero, C. Reisinger, S. Rigger: Optimal bailout strategies resulting from the drift-controlled supercooled Stefan problem arXiv:2111.01783

Benjamin A. Robinson

University of Vienna

A regularized Kellerer theorem in arbitrary dimension

We present a multidimensional extension of Kellerer's theorem on the existence of mimicking Markov martingales for peacocks, a term derived from the French for stochastic processes increasing in convex order. For a continuous-time peacock in arbitrary dimension, after Gaussian regularization, we show that there exists a strongly Markovian mimicking martingale Itô diffusion. A novel compactness result for martingale diffusions is a key tool in our proof. Moreover, we provide counterexamples to show, in dimension $d \geq 2$, that uniqueness may not hold, and that some regularization is necessary to guarantee existence of a mimicking Markov martingale.

References:

[1] G. Pammer, B. A. Robinson, W. Schachermayer, *A regularized Kellerer theorem in arbitrary dimension*, arXiv:2210.13847 Oct. 2022.

Mathias Sonnleitner

University of Passau

A probabilistic approach to Lorentz balls

In this talk, we present a probabilistic approach to understand volumetric and geometric properties of unit balls of finite-dimensional Lorentz spaces when the dimension tends to infinity. These spaces form a natural generalization of ℓ_p-spaces and appear in various contexts such as approximation theory. For a special case, we present a probabilistic representation of a random vector sampled uniformly in such a Lorentz ball. We use this to derive the asymptotic distribution of a coordinate, a weak Poincaré-Maxwell-Borel lemma, and limit theorems for norms. In this setting, we discover phenomena, some of which do not appear in the special case of ℓ_p-balls.

References:

[1] Z. Kabluchko, J. Prochno and M. Sonnleitner. A probabilistic approach to Lorentz balls, arXiv:2303.04728, 2023.

Panagiotis Spanos

Graz University of Technology

Spread-out Percolation

Let $\mathbb{Z}^d$ be the lattice, for $d \geq 2$, endowed with the graph distance. For a distance parameter and a degree parameter we form an infinite random graph. We connect any two vertices at distance smaller than the distance parameter at random, with probability that decreases polynomialy as the distance increases and average degree given by the degree parameter. This is a model of spread-out percolation.
In 1993 Penrose [1] proved that the threshold for the degree parameter, for the existence of an infinite component, converges to 1 as the distance grows to infinite. In this talk we will define a generalization of this model for groups and explain how this problem is connected with finite inhomogeneous random graphs (defined with respect to [2]). We will present similar results for the threshold, for the degree parameter, in the case of discrete nilpotent groups under certain assumptions on the group.
Joint work on progress with M. Tointon.

References:

[1] M. D. Penrose: On the spread-out limit for bond and continuum percolation, *Annals of Applied Probability*, 3 (1993), 253–276.

[2] B. Bollobás, S. Janson & O. Riordan: The phase transition in inhomogeneous random graphs, *Random Structures & Algorithms*, 31: (2007), 3-122.

Paul Honore Takam

BTU Cottbus-Senftenberg

Optimal Management of a Residential Heating System With a Geothermal Energy Storage

We consider the cost-optimal management of a residential heating system equipped with several heat production and consumption units. The manager is exposed to uncertainties about randomly fluctuating renewable heat production and environmental conditions driving the heat demand and supply. As a special feature the manager has access to a geothermal storage which allows for inter-temporal transfer of thermal energy. This leads to a challenging mathematical optimization problem. The optimization problem is treated as a continuous-time stochastic optimal control problem for a controlled state process whose dynamics is described by a system of ordinary differential equations (ODEs), stochastic differential equations (SDEs) and a partial differential equation (PDE). We first apply semi-discretization to the PDE and use model order reduction techniques to reduce the dimension of the associated system of ODEs. Our numerical experiments for the model reduction with the balanced truncation method show that the space-time dynamics of the temperature in the geothermal storage can be described by only a few controlled ODEs. Finally, time-discretization leads to a Markov decision process for which we apply numerical methods to determine a cost-optimal control and the associated value function.

Mohammad Reza Yeganegi

International Institute for Applied Systems Analysis

Wavelet Phase Difference and Granger Causality: A Simulation Study

Granger causality type tests are well-known tools for investigating the relations of multiple time series. The Granger causality test has its roots in classic frequency domains phase difference analysis[1]. The original Granger causality tests and its extensions can be used to test if one group of time series can be used to improve the estimation of another time series[1,2,3]. Whilst Granger Causality dose not prove actual causality, it can be used as a feasible test for testing the causality hypothesis. In other words, if a hypothesis has been constructed in scientific theory of given field, it can be tested using observed data and Granger causality tests. In exploratory data analysis, however, (e.g. in data mining) the theoretical hypothesis does not exist at beginning of data analysis procedure. In this case, the frequency domains phase difference analysis and its extension, wavelet phase difference analysis, can be used to investigate the coherence and phase difference between two time series. The coherence analysis can be used to measure the relation between periodic behavior of to series, whilst the phase difference analysis can reveal which signal is leading in a given periodic behavior. Although the original Granger casualty test has a clear relation to Fourier transform and its phase difference analysis results [1], the nonparametric/nonlinear extensions of the test are mostly focused on predictability in time domain. This study, is aimed to investigate the compatibility of between Granger causality tests and wavelet phase difference analysis results. After a brief review of two methods, each methods accuracy in detecting causalities are illustrated using simulation study. The results are used to illustrate how combination of two methods may increase the accuracy of the causality analysis results.

References:

[1] C. W. J. Granger: Investigating causal relations by econometric models and cross-spectral methods, Econometrica , 37 (1969), 424–438.

[2] H. Hassani, A. Zhigljavsky, K. Patterson, A. S. Soofi: A comprehensive causality test based on the singular spectrum analysis, in Phyllis McKay Illari, Federica Russo, and Jon Williamson (eds), Causality in the Sciences, (Oxford, 2011; online edn, Oxford Academic, 22 Sept. 2011), 379–404.

[3] A. Shojaie and E. B. Fox: Granger causality: A review and recent advances, Annual Review of Statistics and Its Application, 9 (2022), 289–319.

Xin Zhang

University of Vienna

Comparison of second order PDEs on Wasserstein space

Stochastic control problems with partial observation yield a class of second order PDEs on the space of measures. Such PDEs were studied by [1] on a lifted Hilbert space. However, it is not clear what is the relation between the lifted equation and the original one on the Wasserstein space. In this talk, we will prove a comparison principle for this kind of equations in an intrinsic way, so that characterize value functions of control problem as the unique viscosity solution.

References:

[1] E. Bandini, A. Cosso, M. Fuhrman, H. Pham, Randomized filtering and Bellman equation in Wasserstein space for partial observation control problem, Stochastic Processes and their Applications, (2018).