Workshop Junior female researchers in probability

Berlin

4^{th} October – 6^{th} October 2021

Contents

1. Welcome

On behalf of the IRTG 2544 it is our great pleasure to welcome you to the workshop **Junior female researchers in probability**. We hope you enjoy illustrative talks and an interactive and inspiring exchange and networking.

Conference organisers
Luisa Andreis (University if Florence), Peter Bank (TU Berlin), Dörte Kreher (HU Berlin), Laura Körber (TU Berlin), Noemi Kurt (TU Berlin), Alexandra Quitmann (WIAS, Berlin), Weile Weng (TU Berlin)

Venue

The whole conference takes place in a hybrid format. The only exception is the poster session, which takes place fully online in the morning of Wednesday, October 6. The Zoom-links are sent out to registered participants. In addition, shortly before the conference we will send out a link to a virtual lounge in gather.town which can be used during the breaks as virtual networking lounge.

Presentations

The talks of the keynote and invited speakers each last one hour and the contributed talks each last 20 minutes including questions. During the poster session, the presenters each have 3 to 5 minutes for illustrating their work to the full audience via Zoom. After this session of presentations, each poster presenter will be given a zoom breakout room, where participants can join and leave at any time to interact with the presenter.

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2. Keynote speakers

2.0.1 Exclusion processes: some recent results and open questions, *Nina Gantert, TU Munich*

Exclusion processes are interacting particle systems which generalize the basic model of simple random walk. They can model traffic flows or molecules in a low-density gas. Exclusion processes have been investigated recently in analysis, statistical mechanics as well as in combinatorics.
We first explain some of the classical questions about such processes: invariant measures, the speed of a tagged particle, the current and its fluctuations. We then turn to more recent results about the convergence of a finite system to its invariant distribution, introducing mixing times and the cutoff phenomenon.
The question about cutoff is of independent interest and may be asked for many (sequences of) Markov chains. We present some recent results for a finite system with open boundaries. In the end, we mention open questions about the current and about second class particles.
The talk is based on joint work(s) with Nicos Georgiou, Evita Nestoridi and Dominik Schmid.

2.0.2 Conditional propagation of chaos for systems of interacting neurons with random synaptic weights, *Eva Löcherbach, University Paris 1*

We study a system of N neurons with mean field interactions, in a diffusive regime: jumps are random, centered and renormalized by $\frac{1}{\sqrt{N}}$. In this frame, the classical propagation of chaos property does no longer hold true. As the size of the system tends to infinity, the neurons are only conditionally independent, when one conditions with respect to the Brownian motion that is created at the limit by the central limit theorem.
I will explain how the notion of infinite exchangeable systems helps understanding the structure of the limit non linear SDE. In a second part I will discuss two types of convergence to the limit system. The first is weak convergence, proven by means of a new martingale problem. Then I will discuss strong convergence based on a particular coupling going back to Komlos, Major and Tusnady. This coupling provides a joint construction of a centered compound Poisson process together with Brownian motion and enables us to obtain an explicit rate of convergence.
This is a joint work with Xavier Erny and Dasha Loukianova.

3. Invited speakers

3.0.1 Measure-Valued Martingales & Mathematical Finance, *Sigrid Källblad, KTH Royal Institute of Technology*

In this talk we focus on measure-valued martingales and their role within mathematical finance. To this end, we first recall the problem of pricing financial derivatives under model uncertainty and show how this problem can be related to martingale optimal transport and optimisation problems featuring measure-valued martingales (MVMs). We then discuss some recent results on how to address such problems via stochastic control methods; this includes results on the existence of solutions to MVM-valued SDEs, an Ito formula for measure-valued processes, and a characterisation of the value function as the unique viscosity solution to an associated HJB equation. A key motivation for the study of control problems featuring MVMs is that a number of (probabilistic) problems can be (re-)formulated as such control problems; we illustrate this by applying our results to Skorokhod embedding problems, two player games with asymmetric information, and certain functional inequalities. The talk is based on joint works with A. Cox, M. Larsson and S. Svaluto-Ferro.

3.0.2 Connecting random fields on manifolds and stochastic partial differential equations in simulations, *Annika Lang, Chalmers University of Technology and University of Gothenburg*

Random fields on manifolds can be used as building blocks for solutions to stochastic partial differential equations or they can be described by stochastic partial differential equations. In this talk I present recent developments in numerical approximations of random fields and solutions to stochastic partial differential equations on manifolds and connect the two. More specifically, we look at the stochastic wave equation on the sphere and approximations of Gaussian random fields on manifolds using suitable finite element methods. Throughout the talk, theory and convergence analysis are combined with numerical examples and simulations. This talk is based on joint work with David Cohen, Erik Jansson, Mihály Kovács, and Mike Pereira.

3.0.3 Metastability for the dilute Curie-Weiss model with Glauber dynamics, *Elena Pulvirenti, TU Delft*

We analyse the metastable behaviour of the dilute Curie–Weiss model subject to a Glauber dynamics. The model is a random version of a mean-field Ising model, where the coupling coefficients are replaced by i.i.d. random coefficients, e.g. Bernoulli random variables with fixed parameter p. This model can be also viewed as an Ising model on the Erdos–Renyi random graph with edge probability p. The system is a Markov chain where spins flip according to a Metropolis dynamics at inverse temperature β. We compute the average time the system takes to reach the stable phase when it starts from a certain probability distribution on the metastable state (called the last-exit biased distribution), in the regime where the system size goes to infinity, the inverse temperature is larger than 1 and the magnetic field is positive and small enough. We obtain asymptotic bounds on the probability of the event that the mean metastable hitting time is approximated by that of the Curie–Weiss model. The proof uses the potential theoretic approach to metastability and concentration of measure inequalities. This is a joint collaboration with Anton Bovier (Bonn) and Saeda Marello (Bonn).

3.0.4 Rare selection and coordination, *Maite Wilke Berenguer, HU Berlin*

We analyse a family of two-types Wright-Fisher models with selection in a random environment. In addition to weak selection we introduce rare selection (aka selection in a random environment) to the model and provide a criterion to quantify the impact of different shapes of selection on the fate of the weakest allele.
As is common for these models we obtain a dual pair of a branching-coalescing process describing the genealogy and a "diffusion with jumps" describing the evolution of the frequency of a selectively weaker allele. The jumps in the "diffusion" result from coordination in the dual particle system. The generator of the jump component has a representation in terms of the generator of the the non-coordinated (weak) selection, which we refer to as Griffiths' representation.
This representation, observed and used by Griffiths in the case of Λ-coalescents and the Wright-Fisher diffusion, is a key ingredient in the proof of the criterion for extinction, because it allows for a Lypaunov-function-type argument.
This is joint work with A. González Casanova (UNAM) and D. Spanó (Warwick).

4. Contributed speakers

4.0.1 Refined Large Deviation Principle for Branching Brownian Motion Conditioned to Have a Low Maximum, *Yanjia Bai, University of Bonn*

Conditioning a branching Brownian motion to have an atypically low maximum leads to a suppression of the branching mechanism. In this talk, we consider a branching Brownian motion conditioned to have a maximum below $\sqrt{2\alpha t}$ ($\alpha < 1$). We study the precise effects of an early/late first branching time and a low/high first branching location under this condition. We do so by imposing additional constraints on the first branching time and location. We present large deviation estimates, as well as the optimal first branching time and location given the additional constraints.
This is a joint work with Prof. Lisa Hartung from the Johannes Gutenberg University Mainz. The link of the corresponding arXiv paper (with a slightly different title) is https://arxiv.org/abs/2102.09513.

4.0.2 A spatially-dependent fragmentation process, *Allice Callegaro, TU Munich*

We define a fragmentation process in which rectangles break up into progressively smaller pieces at rates that depend on their shape. Long, thin rectangles are more likely to break quickly, and are also more likely to split along their longest side. We are interested in the evolution of the system at large times: how many fragments are there of different shapes and sizes, and how did they reach that state? We give an almost sure growth rate along paths by studying an equivalent branching random walk with spatially dependent rates. The talk is based on a joint work with Matt Roberts.

4.0.3 Estimating the roughness of a path: application to volatility, *Purba Das, University of Oxford*

We introduce a method for estimating the roughness of a function based on a discrete sample, using the concept of weighted p-th variation along a sequence of partitions, and discuss the consistency of the estimator in a pathwise setting.
We investigate the finite sample performance of our estimator for measuring the roughness of sample paths of stochastic processes using detailed numerical experiments based on sample paths of Fractional Brownian motion and other fractional processes.
We then apply this method to estimate the roughness of realized volatility signals based on high-frequency observations. Through a detailed numerical experiment based on a stochastic volatility model, we show that even when the instantaneous volatility has diffusive dynamics with the same roughness as Brownian motion, the realized volatility exhibits rough behaviour corresponding to a Hurst exponent significantly smaller than 0.5. Similar behaviour is observed in financial data, which suggests that the origin of the roughness observed in realized volatility time-series lie in the estimation error rather than the volatility process itself.

4.0.4 Universality for the directed configuration model at criticality, *Serte Donderwinkel, University of Oxford*

Universal scaling limits of random graph models can be considered the Central Limit Theorems of graph theory and have attracted a lot of interest in recent years. We consider the strongly connected components (SCC) of a uniform directed graph on n vertices with i.i.d. degree tuples, under suitable moment conditions on the degree distribution. The moment conditions ensure that the graph is critical: the largest SCC contains $O(n^{1/3})$ vertices, and there are many other SCC of that order. We show that the sequence of SCC ordered by decreasing length converges under rescaling of the edge lengths to a random sequence of directed multigraphs with edge lengths that are all 3-regular or loops. This is the first result on the directed configuration model at criticality, and has several previously unknown corollaries. The talk is based on joint work with Zheneng Xie.

4.0.5 A sharp stochastic Bihari-LaSalle inequality, *Sarah Geiss, TU Berlin*

The Bihari-LaSalle inequality is a nonlinear generalisation of the Gronwall inequality. We study the following stochastic generalisation of the Bihari-LaSalle inequality: Let $\{X(t), t \geq 0\}$ be a càdlàg non-negative process, satisfying

$$X(t) \leq \int_0^t \eta(X^*(s^-))dA(s) + M(t) + H(t),$$

where, $X^*(s) := \sup_{u \leq s} X(s)$ denotes the running supremum, M is a local martingale and $A : [0,\infty) \to [0,\infty)$ a nondecreasing càdlàg function. Furthermore, let $\eta : [0,\infty) \to [0,\infty)$ be a suitable nondecreasing function and H a suitable stochastic process. Then, we can provide a sharp upper bound for $\mathbb{E}[\sup_{t\in[0,T]} X(t)^p]$ for $p \in (0,1)$ which does not depend on the local martingale M. This generalises the stochastic Gronwall inequality [2, Theorem 2.1]. These types of stochastic inequalities are applied to show well-posedness of path-dependent SDEs. Furthermore, they are applied to study stochastic filtering algorithms. The talk is based on joint work with Michael Scheutzow.

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[2] Sima Mehri and Michael Scheutzow, A stochastic Gronwall lemma and well-posedness of path-dependent SDEs driven by martingale noise, ALEA, Lat. Am. J. Probab. Math. Stat.18(2021), 193-209. MR-4198874

4.0.6 The speed of random walk on Galton-Watson trees with vanishing conductances, *Tabea Glatzel, TU Dortmund*

We consider random walks on Galton-Watson trees with random conductances. That is, given a Galton-Watson tree, the edges are assigned positive random conductances and the random walk traverses an edge with a probability proportional to its conductance. On these trees, the distance of the walker to the root satisfies a law of large numbers with limit the effective velocity, or speed of the walk. The speed is given as an expectation of ratios of effective conductances which means that it cannot be explicity computed. We study the regularity of the speed as a function of the distribution of conductances. In particular, we investigate how the speed changes when the conductances on a positive fraction of edges tend to zero. In this case the limit of the speed is smaller than the speed of the random walk as usually defined on trees with positive extinction probability.

4.0.7 Self-intersection local times of random fields in stochastic flows, *Olga Izyumtseva, University College Dublin*

The present talk is devoted to the geometric characteristics of planar Gaussian field evolving in a stochastic flow of interacting particles. A large amount of literature is devoted to randomly moving curves and manifolds, see, for example, [2-5]. Our model has two new features. Firstly, our field is nonsmooth and its geometric characteristics are "numbers of self-intersections." Secondly, the motion of particles depends on the field. Stochastic flow is generated by the following equation with interaction invented by Andrey Dorogovtsev in 2003 [1]

$$\begin{cases} dx(u,t) = a(x(u,t)), \mu_t)dt + \int_{\mathbb{R}^2} b(x(u,t), \mu_t, p)W(dp,dt) \\ x(u,0) = u, \quad u \in \mathbb{R}^2 \\ \mu_t = \mu_0 \circ x(\cdot,t)^{-1}. \end{cases}$$

The probability measure μ_0 is the initial distribution of mass of particles moving in a random media, W is a Brownian sheet. Let μ_0 be the occupation measure of some planar Gaussian field η. Assume that for the field η there exists the k-multiple self-intersection local time. One can see that μ_t is the occupation measure of

the new field $x(\eta(u),t)$, $u \in \mathbb{R}^2$. In the talk we prove that for this field the k-multiple self-intersection local time exists as well. Moreover, we describe its asymptotics in the isotropic Brownian flow and in some flow generated by the equation with interaction.
This is joint work with Andrey Dorogovtsev and Alexander Gnedin.
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3. M. Kardar, G. Parisi, Y.-C. Zhang, Dynamic Scaling of Growing Interfaces, Physical Review Letters 56 (1986), 9, 889-892.
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5. C. L. Zirbel, E. Cinlar, Dispersion of particle systems in Brownian flows, Adv. Appl. Probab. 28 (1996), 53-74.

4.0.8 Metastability for the Ising model on the hexagonal lattice, *Vanessa Jacquier, University of Florence*

We consider the Ising model on the hexagonal lattice evolving according to Metropolis dynamics. We study its metastable behavior in the limit of vanishing temperature when the system is immersed in a small external magnetic field. We determine the asymptotic properties of the transition time from the metastable to the stable state up to a multiplicative factor and study the relaxation time and the spectral gap of the Markov process. We give a geometrical description of the critical configurations and show how not only their size but their shape varies depending on the thermodynamical parameters. Finally we provide some results concerning polyiamonds of maximal area and minimal perimeter.

4.0.9 Convergence of Densities for Stochastic Heat Equation, *Sefika Kuzgun, University of Kansas*

In this talk, we will consider two cases of stochastic heat equation in dimension one, driven by a space-time white noise. First, we present the one-dimensional stochastic heat equation driven by a space-time white noise with constant initial condition and then we continue with parabolic Anderson model with delta initial condition. The purpose of this talk is to show a recent result on the uniform convergence of the density of the normalized spatial averages on an interval $[-R,R]$, as R tends to infinity, to the density of the standard normal distribution, assuming some non-degeneracy and regularity conditions on the nonlinear coefficient σ in the first case and after renormalization of the solution in the second case. The proof is based on a combination of the techniques of Malliavin calculus with Stein's method for normal approximations. This is a joint work with David Nualart.

4.0.10 Universal Height and Width Bounds for Random Trees, *Céline Kerriou, University of Cologne*

We present non-asymptotic stretched exponential tail bounds on the height of a randomly sampled node in a tree with a given degree statistics. To prove such bounds, we introduce a sampling procedure that generates a random variable with the same law as the height of a random node, and then adapt a Poissonization trick from Camarri and Pitman. We further state bounds on the heights and widths of random trees that can be deduced from the previously presented bounds. The above results stem from joint work with L. Addario-Berry, A. Brandenberger, J. Hamdan and C. K. , presented in the paper *Universal Height and Width Bounds for Random Trees*.

4.0.11 Regularization by noise of an averaged version of the Navier-Stokes equations, *Theresa Lange, University of Bielefeld*

In [T16], T. Tao constructs an averaged version of the deterministic three-dimensional Navier-Stokes equations (3D NSE) which experiences blow-up in finite time. In the last decades, various works employed suitable choices of noise in order to prevent or delay such behavior, a method now known as regularization by noise. For the vorticity form of 3D NSE, the authors of [FL19] establish results for a particular stochastic transport noise which they extend in [FGL20] to hold for more general models. In this talk, we analyze Tao's averaged version in view of [FGL20] and discuss the regularization skills in this context. This is joint work with Martina Hofmanová.

References:
[T16] T. Tao, Finite time blowup of an averaged three-dimensional Navier-Stokes equation. Journal of the American Mathematical Society, Vol. 29, No. 3, pp. 601-674 (2016)
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[FGL20] F. Flandoli, L. Galeati, D. Luo, Delayed blow-up by transport noise. Communications in Partial Differential Equations, 2021

4.0.12 A large-deviations approach to the phase transition in inhomogeneous random graphs, *Heide Langhammer, WIAS Berlin*

An inhomogeneous random graph consists of N vertices that are each equipped with a certain type. The random edges of the graph are set independently of each other with a probability that is depending only on the types of the incident vertices. We are interested in studying how such a random graph decomposes into its connected components. It is known that this model exhibits a *phase transition*. Once the model parameters surpass a certain threshold, a giant component whose vertex number is of order N forms with high probability. Going beyond the existing literature, we derive a *large deviation principle* for the decomposition of the graph into its components. By this we can recover the well-known phase transition, but we can also describe how certain unlikely events are typically realized in this model.
We consider the inhomogeneous random graph model as an important step in understanding coagulation processes that describe successive merging events of particles and reach the point of gelation when a giant particle forms.
This is an ongoing joint work with Luisa Andreis, Wolfgang König and Robert Patterson.

4.0.13 Limit theorems for the edge density in exponential random graphs, *Elena Magnanini, WIAS Berlin*

The exponential random graph is a model of random graph that can be seen as the generalization of the dense Erdös-Rényi random graph. It follows the statistical mechanics approach of defining a Hamiltonian to weight the probability measure on the space of graphs, enhancing (respectively penalizing) graphs with *desirable* properties. In this talk we will focus on the so-called edge triangle model, where the Hamiltonian of the system only collects edge and triangle densities, properly tuned by real parameters. We make use of statistical mechanics tools and large deviations techniques for proving limit theorems for the edge density in the so-called replica symmetric regime, where the limiting free energy of the model is known, together with a complete characterization of the phase diagram. First, we determine the asymptotic distribution of the edge density, as the graph size tends to infinity, in replica symmetric regime. We then study the fluctuations of the edge density around its average for all parameter values outside the critical curve and off the critical point and we formulate conjectures about the behavior at criticality based on the analysis of a mean-field approximation of the model.
Joint work with Alessandra Bianchi and Francesca Collet.

4.0.14 Metastability for stochastic modifications of the Curie-Weiss model, *Saeda Marello, University of Bonn (IAM)*

The Curie-Weiss model (CW) is a classical model of a ferromagnetic spin system in which all spins interact with each other, namely the interaction graph is complete.
In some parameter regime, a phenomenon called metastability occurs in CW and is very well known. There has been recent interest in studying metastability on spin systems having random interaction graphs.
We will talk about the Randomly Dilute CW, the CW with disorder and further stochastic modifications of the Curie-Weiss models. After introducing them and pointing out the links with random graphs, we will focus on recent results on metastability for some of those models. Our results were obtained using the potential-theoretic approach to metastability.
Based on joint works with Anton Bovier, Frank den Hollander and Elena Pulvirenti.

4.0.15 A cross border market model with limited transmission capacities,*Cassandra Milbradt, HU Berlin*

The integrated Cross Border Intraday (XBID) market summarizes the limit orders of 22 European countries in a shared order book. This heavily increases the liquidity in contrast to single national intraday electricity

markets with continuous trading. As a starting point of an appropriate model for the XBID market we consider the reduced form representation of two limit order book (LOB) models. In this model, each LOB is represented by the bid and ask prices and the queue length, i.e. the number of orders at the best bid and ask price. We extend this model in two ways: First, in order to describe possible cross border trading, we include interactions between the two order books to the market microstructure. Second, since in the XBID market there is limited transmission capacity, we need to restrict the number of possible cross border trades. In doing so, it is crucial to keep track of the origin of an incoming order and to count the number of cross border trades in both directions. Latter is done by introducing a two-sided capacity process to the microscopic description.
If the order arrival time and the size of an individual order converges to zero, we show that the discrete-time model can be approximated in the limit by a continuous-time regime switching process. The heavy traffic limit switches between an active regime in which the national order books are coupled and an inactive regime in which traders can only execute market orders against limit orders with the same origin.

4.0.16 Competition versus Cooperation: A class of solvable mean field impulse control problems, *Berenice Anne Neumann, University of Trier*

We discuss a class of explicitly solvable mean field type control problems/mean field games with a clear economic interpretation. More precisely, we consider long term average impulse control problems with underlying general one-dimensional diffusion processes motivated by optimal harvesting problems in natural resource management. We extend the classical stochastic Faustmann models by allowing the prices to depend on the state of the market using a mean field structure. In a competitive market model, we prove that, under natural conditions, there exists an equilibrium strategy of threshold-type and furthermore characterize the threshold explicitly. If the agents cooperate with each other, we are faced with the mean field type control problem. Using a Lagrange-type argument, we prove that the optimizer of this non-standard impulse control problem is of threshold-type as well and characterize the optimal threshold. Furthermore, we compare the solutions and illustrate the findings in an example.
This is joint work with Sören Christensen and Tobias Sohr (Christian-Albrechts-Universität zu Kiel).

4.0.17 Lévy type signature models, *Francesca Primavera, University of Vienna*

Signature models have recently entered the field of Mathematical Finance. However, despite the presence of jumps in financial data, the signature models for asset prices proposed so far have only dealt with the continuous-path setting. Based on recent results on the signature of càdlàg paths, we define signature-based models which include jumps. The approach that we follow consists of parameterizing the model itself or its characteristics as linear functions of the signature of an augmented Lévy process, interpreted as market's primary underlying process. We discuss the validity of first principles like absence of arbitrage and solve the hedging problem by adopting a local risk minimization approach. Finally, we prove that the signature of a generic $\mathbb{R}^d$-valued Lévy process is a polynomial process on the extended tensor algebra and derive its expected value via polynomial technology. We show that this result, when applied to the market's primary process, is efficient in terms of calibration to market data.
This is based on ongoing joint work with Christa Cuchiero and Sara Svaluto-Ferro.

4.0.18 Power rate of convergence of discrete curves: framework and applications, *Larissa Richards, Lancaster University*

Based on recent joint project with Ilia Binder. I will discuss the general framework developed for powerlaw convergence rates of random discrete model curves approaching Schramm Loewner Evolution in the scaling limit. Also, I will explain how this framework can be applied to certain discrete models such as percolation, harmonic explorer and Ising model.

4.0.19 On a nonhierarchical generalization of the perceptron GREM, *Giulia Sebastiani, Goethe University Frankfurt)*

We introduce a nonlinear, nonhierarchical generalization of Derrida's GREM and establish through a Sanov-type large deviation analysis both a Boltzmann-Gibbs principle as well as a Parisi formula for the limiting free energy. In line with the predictions of the Parisi theory, the free energy is given by the minimal value over all Parisi functionals/hierarchical structures in which the original model can be coarse-grained.
This is joint work with Nicola Kistler (Goethe University Frankfurt).

4.0.20 A generalized Ehrenfest process on a star graph, *Serena Spina, University of Salerno*

The study is focused on a continuous-time stochastic process describing the dynamics of an evolutionary system characterized by d classes, represented with d semiaxis joined at the origin, that can accommodate at most N particles. After visiting the origin, the process can move toward any semiaxis with different rates, according to the elements of a stochastic matrix. The dynamics on each ray evolves according to a one-dimensional birth-death process with suitable linear transition rates. For $d = 2$ the process coincides with the celebrated continuous-time Ehrenfest model, which is a Markov chain proposed to describe the diffusion of gas molecules in a container. A probability generating function-based approach is exploited to study the dynamics of this process, leading to the determination of the transient transition probabilities (in closed form for a particular choice of the parameter), and of the asymptotic distribution, in general. Moreover, some results on the asymptotic mean, variance and coefficient of variation are discussed. The difficulties related to the analysis of the discrete evolution model on the star graph stimulate up to investigate a continuous approximation of the process. Hence, following an appropriate scaling procedure, we obtain a diffusion process on the state space formed by d semiaxis of infinite length joined at the origin (also known as spider), that leads to an Ornstein-Uhlenbeck process. The analysis of this process allows to determine the asymptotic probability distribution for each ray of the spider. Finally, we analyse the correspondence between the diffusion process and the discrete model.

This is joint work with A. Di Crescenzo and B. Martinucci.

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4.0.21 Universal signature-based models, *Sara Svaluto-Ferro, University of Vienna*

Universal classes of dynamic processes based on neural networks and signature methods have recently entered the area of stochastic modeling and Mathematical Finance. This has opened the door to robust and more data-driven model selection mechanisms, while first principles like no arbitrage still apply. Here we focus on signature SDEs whose characteristics are linear functions of a primary underlying process, which can range from a (market-inferred) Brownian motion to a general multidimensional tractable stochastic process. The framework is universal in the sense that any classical model can be approximated arbitrarily well and that the model characteristics can be learned from all sources of available data by simple methods. Indeed, we derive formulas for the expected signature in terms of the expected signature of the primary underlying process. These formulas enter directly in the calibration procedure to option prices, while time series data calibration just reduces to a simple regression.

Joint work with Christa Cuchiero and Guido Gazzani.

4.0.22 Genealogy and spatial distribution of the N-particle branching random walk with polynomial tails, *Zsófia Talyigás, University of Bath*

The N-particle branching random walk is a discrete time branching particle system with selection. We have N particles located on the real line at all times. At every time step each particle is replaced by two offspring, and each offspring particle makes a jump of non-negative size from its parent's location, independently from the other jumps, according to a given jump distribution. Then only the N rightmost particles survive; the other particles are removed from the system to keep the population size constant.

Inspired by work of J. Bérard and P. Maillard, we examine the long term behaviour of this particle system in the case where the jump distribution has regularly varying tails and the number of particles is large. In this talk I will explain the ideas behind our result, which says that at a typical large time the genealogy of the population is given by a star-shaped coalescent, and that almost the whole population is near the leftmost particle on the relevant space scale.

Joint work with Sarah Penington and Matthew Roberts.

4.0.23 Noise induced stabilization for gradient-type SDEs, *Isabell Vorkastner, TU Berlin*

The inclusion of noise can have a stabilizing effect on the long-time dynamics of a system. At first this may seem counter-intuitive, but this phenomenon occurs in various forms. In this talk we present two gradient-type stochastic differential equations which are stabilized by noise.

In the first system, the addition of noise prevents explosion. While the deterministic system explodes, the stochastic system does not and even possesses an invariant measure.

In the second system, the addition of noise stabilizes the long-time dynamics of the system. While the deterministic dynamics are not asymptotically globally stable, the stochastic dynamics are and the attractor collapses to a single random point.

4.0.24 Convergence of the Distribution of the Trajectories of a Conditional Renewal Random Walk, *Clara Wallace, Durham University*

We consider the trajectories of a renewal random walk, that is, a random walk on the two-dimensional integer lattice whose jumps have positive horizontal component. We prove a Functional Law of Large Numbers, and a Functional Central Limit Theorem for these trajectories: the distribution of their fluctuations around a limiting profile converges weakly to that of Brownian motion. We derive conditional versions of both of these theorems, under large-deviations conditions on the terminal height and the integral of the trajectories. We find the shape of the corresponding limiting profile, and discuss the convergence of the distribution of the fluctuations around this profile to that of a conditioned Gaussian process.

5. Poster session

5.0.1 Optimal trade execution in a stochastic order book model, *Julia Ackermann, Justus Liebig University Giessen*

We analyze an optimal trade execution problem in a financial market with stochastic liquidity. To this end we set up a limit order book model in continuous time where both order book depth and resilience may evolve randomly in time. We allow for trading in both directions and for càdlàg semimartingales as execution strategies. We find that, under appropriate assumptions, the minimal execution costs are characterized by a quadratic BSDE. We further identify conditions under which an optimal execution strategy exists and investigate qualitative aspects of optimal strategies such as appearance of strategies with infinite variation or existence of block trades. This talk is based on a joint work with Thomas Kruse and Mikhail Urusov.

5.0.2 Quantile Processes and Applications to Actuarial Valuation, *Holly Brannelly, University College London*

This research focuses on the construction of a novel class of quantile processes governing the stochastic dynamics of quantiles in continuous time. The marginals of such quantile processes are obtained by transforming the marginals of a diffusion process under a composite map consisting of a distribution and a quantile function, akin to rank transmutation maps. The models feature a random quantile level and are directly interpretable with regard to skewness and kurtosis dynamics. We focus on the Tukey distributional family whereby skewness and kurtosis are directly parameterized. This built-in flexibility in the higher-order statistical properties largely motivates the construction of these quantile processes from a data-modelling perspective, as well as their application to induce measure distortions in the setting of actuarial premium calculation and financial valuation. We present an axiomatically justified pricing mechanism that can generate insurance premiums, which account for varying investor risk preferences and market conditions through the induced properties of the quantile process. Such a valuation framework is analogous to those produced using distortion operators, e.g., the well-known Wang and Esscher transforms. A connection to arbitrage-free pricing of financial contracts is also given.
Joint work with A. Macrina and G. W. Peters.

5.0.3 Linear spectral statistics of sequential sample covariance matrices, *Nina Dörnemann, Ruhr University Bochum*

Let $\boldsymbol{x}_1, \dots, \boldsymbol{x}_n$ denote independent p-dimensional vectors with independent complex or real valued entries such that $\mathbb{E}[\boldsymbol{x}_i] = 0$, $Var(\boldsymbol{x}_i) = \boldsymbol{I}_p$, $i = 1, \dots, n$, $\boldsymbol{T}_n$ be a $p \times p$ Hermitian nonnegative definite matrix and f be a given function. Under additional assumptions we prove that an approriately standardized version of the stochastic process $\left(tr(f(\boldsymbol{B}_{n,t}))\right)_{t\in[t_0,1]}$ corresponding to a linear spectral statistic of the sequential empirical covariance estimator

$$(\boldsymbol{B}_{n,t})_{t\in[t_0,1]} = \left(\frac{1}{n}\sum_{i=1}^{\lfloor nt\rfloor} \boldsymbol{T}_n^{1/2}\boldsymbol{x}_i\boldsymbol{x}_i^*\boldsymbol{T}_n^{1/2}\right)_{t\in[t_0,1]}$$

converges weakly to a non-standard Gaussian process for $n, p \to \infty$. As an application we use these results to develop a novel approach for monitoring the sphericity assumption in a high-dimensional framework, even if the dimension of the underlying data is larger than the sample size.
This is joint work with Holger Dette (Ruhr University Bochum).

5.0.4 Metastability for the Potts and Ising Models with zero and non-zero external magnetic field evolving under Glauber dynamics, *Anna Gallo, University of Florence*

We focus on metastability and on tunneling behavior for the ferromagnetic q-state Potts model on a finite two-dimensional grid-graph Λ with periodic boundary conditions. The system evolves according to a Glauber-type dynamics described by the Metropolis algorithm, and the resulting microscopic stochastic dynamics is reversible with respect to the Gibbs measure. To each Potts configuration we associate an energy value that depends on the local ferromagnetic interaction between nearest-neighbors, and on the external magnetic field related only to a specific spin value. Without loss of generality, we choose this spin equal to the spin 1. We study the q-Potts model with both non-zero and zero external magnetic field in the limit of large inverse temperature $\beta \to \infty$. We analyze separately the case of negative, positive and zero external magnetic field. In the first scenario there are $q-1$ stable configurations and an unique metastable state. In the second scenario there are $q-1$ degenerate-metastable configurations and only one global minimum. In the third scenario the system has q stable equilibria. In the negative and positive cases we study the asymptotic behavior of the first hitting time from the metastable to the stable state as $\beta \to \infty$ in probability, in expectation, and in distribution. We also characterize the behavior of the mixing time in the low-temperature regime and give an estimate of the spectral gap. Moreover, in both cases we identify the union of gates and prove that this union has to be crossed with high probability during the transition. In the scenario with zero external magnetic field, we focus on the tunneling transition between two stable states and from one stable state to the set of all other stable configurations. We identify the set of gates for both the transitions and prove that these sets have to be crossed with high probability. Furthermore, we identify the tube of typical paths for both the transitions and we show that the probability to deviate from the tube of typical paths during the transition is exponentially small.

5.0.5 Exact simulation of coupled Wright-Fisher diffusions, *Celia García Pareja, EPFL Swiss Federal Institute of Technology in Lausanne*

In this talk I introduce an exact rejection algorithm for simulating paths of the coupled Wright-Fisher diffusion, which models the coevolution of interacting networks of genes, such as those encountered in studies of antibiotic resistance. Our work presents the first extension of exact rejection algorithms to the multivariate case for diffusion processes with non-unit diffusion coefficient. Candidate proposals in our rejection scheme are independent multivariate neutral Wright-Fisher diffusions, whose transition density is only known in infinite series form but can be sampled exactly by means of a modification of the alternating series method. Our algorithm provides samples of the diffusion's paths at a finite (random) number of time points, the so-called *skeletons*, and the remaining of the paths can be recovered without further reference to the target distribution by sampling from neutral multivariate Wright-Fisher bridges, for which an exact sampling strategy is also developed. Results on the algorithm's complexity and its performance in a simulation study will also be discussed. To put this work in context, I will start presenting the type of population genetics' problems that motivate the coupled Wright-Fisher model, as well as giving a brief introduction to exact rejection algorithms.

5.0.6 Interacting Particle Systems and Jacobi Style Identities, *Jessica Jay, University of Bristol*

The study of nearest neighbour interacting particle systems on the integer line has a rich history. Although most work in this area concerns the case of translation invariant measures, it can be fruitful to look beyond this case. In 2018, Balázs and Bowen considered stationary product blocking measures for ASEP and ZRP. By relating the two they found a probabilistic proof of the Jacobi triple product identity, a well-known classical identity appearing throughout Mathematics and Physics.
Naturally, one asks if other systems give rise to identities with combinatorial significance, via their stationary blocking measures. In this talk we parameterise such a family and show that it gives rise to new 3 variable combinatorial identities.
(This is based on joint work with M. Balázs and D. Fretwell, arXiv:2011.05006).

5.0.7 Approximations for singular SDEs, *Chengcheng Ling, TU Berlin*

By approximating the singular drift and the Stratonovich-type noise at the same time, we first show the Wong-Zakai approximation for the following SDE with singular drift $b \in L^p(\mathbb{R}^d)$, $p > d$, and driven by multiplicative noise:

$$dX_t = b(X_t)dt + \sigma(X_t) \circ dW_t, \quad X_0 = x_0 \in \mathbb{R}^d, \quad t \geq 0. \tag{5.1}$$

Here $\circ$ denotes Stratonovich stochastic integral. We also obtain the support theory for singular SDE (5.1). This is a joint work with Sebastian Riedel (Leibniz Universität Hannover) and Michael Scheutzow (TU Berlin).

5.0.8 Reduced-form framework for multiple default times under model uncertainty, *Katharina Oberpriller, Gran Sasso Science Institute (GSSI), L'Aquila*

In this paper we introduce a sublinear conditional operator with respect to a family of possibly nondominated probability measures in a setting modeling successive defaults. In this way we generalize the results in [1] where a consistent reduced-form framework under model uncertainty for a single default is developed. Moreover, we use this operator for the valuation of credit portfolio derivatives under model uncertainty. To define our operator we first prove a pricing result in the multi-default setting on a fixed probability space, by using an intensity approach. This is a joint work with Francesca Biagini and Andrea Mazzon.

References

[1] Francesca Biagini and Yinglin Zhang. Reduced-form framework under model uncertainty. *The Annals of Applied Probability*, 29(4):2481–2522, 2019.

5.0.9 The role of Stochastic Duality in the study of simple symmetric exclusion and inclusion processes in contact with reservoirs, *Beatriz Salvador, Instituto Superior Técnico (IST)*

The Simple Symmetric Exclusion - SSEP - and Inclusion - SIP(α) - processes have been vastly studied in the past years in very different settings. For purpose of this talk, we will consider these two processes defined in a discretization of the interval $[0,1]$ with a Glauber's dynamic at the boundary points. Because of the injection and extraction of particles via the boundary reservoirs, these processes, as time evolves, no longer have conservation of number of particles. Thereby, the density of the *bulk* becomes a function of time which can be seen as solution to a parabolic type PDE with some initial and boundary conditions (Dirichlet, Neumann or Robin, depending on the strength of the reservoirs). In this talk, we present how to obtain the density profile and the k-point correlation function for SSEP and SIP(α) in contact with reservoirs using Stochastic Duality, a probabilistic technique that allows us to convert the problem of finding these two functions studying, for each of the processes, a simpler one - its dual. We also present explicit formulas for the density and 2-point correlation functions. This work is part of my master's thesis supervised by professor Patrícia Gonçalves and Dr. Chiara Franceschini.

6. Participants

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