DYNSTOCH 2026

Book of Abstracts

Workshop programme, talks, and posters

Gothenburg, June 2026

Foreword

DYNSTOCH 2026 is hosted by the Department of Mathematical Sciences at Chalmers University of Technology and the University of Gothenburg.

We gratefully acknowledge the generous support of our sponsors: Wilhelm och Martina Lundgrens Vetenskaps- och Understödsfond, the Royal Swedish Academy of Sciences, and the Wenner-Gren Foundations. Their support has been essential in making DYNSTOCH 2026 possible.

We would like to thank the scientific committee and DYNSTOCH coordinators, Frank van der Meulen and Mark Podolskij, for their guidance and support in shaping the scientific programme.

A special thanks is due to the administrative staff who have supported the organization of the conference: Ai-Linh Nguyen, Helena Rafstedt, and Malin Nilsarve. Their help with the many practical and administrative details has been invaluable.

Finally, we thank all speakers, poster presenters, and participants for contributing to DYNSTOCH 2026. We hope that the meeting will provide an inspiring setting for scientific exchange, new collaborations, and continued discussions within the DYNSTOCH community.

On behalf of the local organizing committee,

Kasper Bågmark, Annika Lang, Pierre Nyquist, Umberto Picchini, Moritz Schauer, and Ruben Seyer

Contents

Programme

The talks will be held in the lecture hall KA at the Chemistry department, visiting address Kemigården 4. Registration, coffee breaks and the poster session will be held in the foyer outside the lecture hall KA. Here is a map:
https://maps.chalmers.se/#61393995-42d3-4b0c-ba68-1fa7b4afe3c1

Day	Time	Activity
Day 1	08.00–	Registration
	08.50–09.00	Welcome intro
	09:00–10:15	**Session 1: Bayesian Inference and Gaussian Processes**
		Maximilian Siebel *Posterior contraction under misspecification and heteroscedasticity in non-linear inverse problems*
		Jan Glaubitz *Efficient inference for static and dynamic Bayesian models with sparsity-promoting priors*
		Erik Karlsson Strandh *Gaussian Processses on Directed Metric Graphs*
	10:15–10:45	Coffee break
	10:45–12:00	**Session 2: Learning-Based Diffusion Inference**
		Yating Liu *Learning drift functions in diffusion processes: from estimation to classification via neural networks*
		Elise Bayraktar *Sparse recovery of Diffusion Dynamics: Handling High-Dimensionality in Repeated Short Trajectories*
		Shanshan Meng *Supervised classification for Ornstein-Uhlenbeck diffusions with separation conditions*
	12:00–13:30	Lunch
	13:30–14:45	**Session 3: Numerical Methods for SDEs**
		Anna Melnykova *Splitting methods for stochastic Hodgkin-Huxley type systems*
		Predrag Pilipović *Strang Splitting Parameter Estimator for Nonlinear Multivariate Pearson-Type Diffusions*
		Massimiliano Tamborrino *Interface between stochastic numerics and (computational) statistics for SDEs*
	14:45–15:15	Coffee break
	15:15–16:55	**Session 4: Lévy Processes and Jumps**
		Anita Behme *Lévy-Langevin Monte Carlo*
		Stepan Mazur *Matrix gamma Levy motion*
		Cecilia Mancini *Filtering Out Infinite Activity Jumps Using Uniform Thresholding, Under Conditional Mean Square Error*
		Jiaming Chen *Lévy-Driven Graph Ornstein-Uhlenbeck Edge Processes for Network Time Series*
	17:15–19:00	Mingle and posters

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Day	Time	Activity
Day 2	09:00–10:15	**Session 5: Forecasting and Filtering**
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		Zheng Zhao *Diffusion differentiable resampling*
		Dennis Schroers *Realized Joint Approximate Diagonalization of Eigenmatrices*
	10:15–10:45	Coffee break
	10:45–12:00	**Session 6: Dependence and Prediction**
		Johannes Brutsche *Self-organized criticality under arbitrary sampling frequencies*
		Pavel Chigansky *Asymptotic analysis of the finite predictor for processes with seasonal long-range dependence*
		Fima Klebaner *Estimation of rates in population-age-dependent processes by means of test functions*
	12:00–13:30	Lunch
	13:30–15:10	**Session 7: Volatility and High-Dimensional Inference**
		Grégoire Szymanski *Statistical inference for rough volatility*
		Niklas Dexheimer *Sparse Estimation for High-Dimensional Lévy-driven Ornstein–Uhlenbeck Processes from Discrete Observations*
		Lukas Riepl *Sharp adaptive nonparametric testing for constant volatility*
		Orimar Sauri *Power variation for a class of volatility modulated random fields*
	15:10–15:15	Dynstoch matters
	17:45–21:00	Conference dinner on boat: 17:50 at the latest be at Lilla Bommens Torg. The boat departs at 18:00 sharp.

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Day	Time	Activity
Day 3	09:00–10:15	**Session 8: Density Estimation for Diffusions** **Yuga Iguchi** *A Closed-Form Transition Density Expansion for Elliptic and Hypo-Elliptic SDEs* **Felix Schürzinger** *Nonparametric estimation of the transition density in dependence of time* **Arnaud Gloter** *Drift estimation for rough processes under small noise asymptotic : QMLE approach*
	10:15–10:45	Coffee break
	10:45–12:00	**Session 9: SPDEs** **Masayuki Uchida** *Parametric estimation for SPDEs in two space dimensions with unknown damping parameters based on triple increments* **Salvador Ortiz-Latorre** *Convergence in law for quasi-linear SPDEs* **Björn Müller** *Long-time behavior of exact and numerical solutions of stochastic evolution equations on the sphere*
	12:00–13:30	Lunch
	13:30–14:45	**Session 10: Testing and Mean-Field Dynamics** **Justin R. Baars** *Asymptotically Distribution-Free Goodness-of-Fit Testing for Point Processes* **Fabrice Wunderlich** *Goodness-of-fit test for the drift in interacting McKean-Vlasov particle systems* **Ekaterina Morozova** *Statistical inference for Nemytskii-type McKean-Vlasov SDEs via Deep Neural Networks*
	14:45–15:15	Coffee break
	15:15–16:55	**Session 11: Inference for Structured Stochastic Models** **Hiroki Masuda** *Quasi-likelihood inference for SDE with mixed effects* **Henrik Häggström** *Semi-amortised simulation-based inference for stochastic nonlinear mixed-effects models* **Tobias Ambjörnsson** *Sub-sampling-time inference in single-molecule trajectories via a continuous-time hidden Markov framework* **Jhonier Rangel** *Classical and Bayesian Inference for the Multivariate Fractional Brownian Bridge*
	17.00–17.10	Closing

1 Talks

Maximilian Siebel

Posterior contraction under misspecification and heteroscedasticity in nonlinear inverse problems

Presenting author. Maximilian Siebel (Heidelberg University)

Co-authors. Fanny Seizilles (University of Cambridge)

Abstract.

In many practical and numerical inverse problems, the exact data log-likelihood is not fully accessible, motivating the use of surrogate likelihoods. We study heteroscedastic statistical nonparametric nonlinear inverse problems with Gaussian errors and establish posterior contraction results when inference is based on a surrogate log-likelihood constructed from proxy error variances and an approximate forward map. Under general assumptions on the approximation quality, we show that the resulting surrogate posterior is statistically reliable and contracts at rates comparable to those of the exact posterior. The analysis leverages consistency properties of the maximum a posteriori (MAP) estimator to effectively handle heteroscedastic noise and to control the impact of likelihood approximation errors. We apply the framework to PDE-constrained regression problems for a reaction–diffusion equation and the two-dimensional Navier–Stokes equations. In the latter case, we consider misspecified viscosity and forcing terms as well as Oseen-type linearization models, highlighting relevance for numerical analysis applications.

Jan Glaubitz

Efficient inference for static and dynamic Bayesian models with sparsity-promoting priors

Presenting author. Jan Glaubitz (Assistant Professor, Department of Mathematics, Linköping University, Sweden)

Co-authors. Youssef Marzouk (Breene M. Kerr (1951) Professor, Department of Aeronautics and Astronautics, MIT, USA)

Abstract.

Hierarchical sparsity-promoting priors play a central role in Bayesian inverse problems, enabling adaptive regularization and uncertainty quantification for problems with sparse or piecewise-smooth unknowns. In particular, hierarchical sparsity-promoting scale-mixtures-of-normals models combine conditionally Gaussian priors with heavy-tailed hyperpriors, yielding flexible hierarchical formulations—but also posterior distributions that are high-dimensional, strongly correlated, and often multimodal, making efficient inference challenging.

In this talk, I will present an approach to accelerate inference in hierarchical sparsity-promoting models via hierarchical prior normalization. The idea is to construct analytic transport maps that transform the full joint sparsity-promoting prior into a standard normal reference prior. I will further demonstrate how sampling the resulting prior-normalized posterior enables the use of efficient, structure-exploiting MCMC methods—such as elliptical slice sampling—and leads to improved mixing and robustness compared to conventional sampling from the original posterior, across a range of linear and nonlinear inverse problems

This talk is based on joint work with Youssef Marzouk (MIT).

Erik Karlsson Strandh

Gaussian Processses on Directed Metric Graphs

Presenting author. Erik Karlsson Strandh, Lund university

Co-authors. Jonas Wallin, Lund university, David Bolin, KAUST, Alex B. Simas, KAUST

Abstract.

We introduce directed Gaussian processes on metric graphs as solutions to a system of stochastic ordinary differential equations (SODE) defined on a metric graph. We relate this construction to earlier work on non-directed Gaussian processes on metric graphs and show that the distinction can be made precise through their reproducing kernel Hilbert spaces (RKHSs).

We also connect the proposed framework to earlier stream-network models, showing that these can be represented as solutions to the same SODE system under particular boundary conditions. In addition, we introduce new boundary conditions and argue that they yield more physically realistic processes than existing alternatives.

From a computational perspective, we show that the SODE representation enables efficient inference and prediction. In particular, we develop a novel domain-reduction technique that uses a minimal data-spanning subgraph while still providing exact inference for the full graph. This makes the method applicable to large data sets without requiring approximations. We illustrate and compare the methods through an application to temperature modelling on river networks, where we observe substantial computational speed-ups and improved performance when physically conservative confluence conditions are imposed at vertices.

Yating Liu

Learning drift functions in diffusion processes: from estimation to classification via neural networks

Presenting author. Yating Liu (Paris Dauphine University–PSL)

Co-authors. Marc Hoffmann and Yuzhen Zhao (Paris Dauphine University–PSL), Jiarong Fan (Universite Paris-Saclay)

Abstract.

We study learning problems for time-homogeneous diffusion processes observed at discrete times, focusing on both drift estimation and supervised classification. We propose a neural network–based nonparametric estimator for the drift function using high-frequency observations from independent trajectories, and derive non-asymptotic convergence rates. For compositional drift structures, the rates show weak dependence on the dimension, and numerical experiments show clear advantages over classical B- spline methods, especially in higher dimensions. Building on this estimation framework, we introduce a neural network–based plug-in classifier for multiclass diffusion models, where each class is defined by a distinct drift function. We establish convergence rates for the excess misclassification risk and demonstrate that exploiting the diffusion structure leads to improved classification performance compared to direct end-to-end neural network classifiers. The presentation is based on the results developed in [Zhao, Liu, Hoffmann (2025); Zhao, Fan, Liu (2026)].

Elise Bayraktar

Sparse recovery of Diffusion Dynamics: Handling High-Dimensionality in Repeated Short Trajectories

Presenting author. Elise Bayraktar, LPSM, Sorbonne Université

Co-authors. Charlotte Dion-Blanc, LPSM, Sorbonne Université & CMAP, Ecole Polytechnique

Abstract.

Viewed as systems of interacting particles, high-dimensional stochastic differential equations encode complex interaction structures within their drift component. We propose a novel approach to estimate this drift from independent high-frequency trajectory data observed over a short time horizon. Each trajectory is modelled as the solution of a Brownian-driven stochastic differential equation, while the number of time points within each path tends to infinity. We further assume that the drift function governing the dynamics can be expressed as a linear combination of a growing number of Lipschitz basis functions. To promote accurate recovery of the underlying dynamics under sparsity constraints, we propose a Lasso-regularised likelihood criterion. Under suitable regularity conditions, we establish convergence rates for the resulting estimator and emphasise how they depend on the dimensional parameters of the problem, in particular on the number of observed trajectories. We assess the performance of the estimator on synthetic datasets, both from an estimation and a generative perspective.

Shanshan Meng

Supervised classification for Ornstein-Uhlenbeck diffusions with separation conditions

Presenting author. Shanshan Meng, Humboldt University of Berlin

Abstract.

We study a binary supervised classification problem based on repeated independent observations of continuous sample paths. Our focus is a diffusion classification model in which the features follow an Ornstein-Uhlenbeck process with class-dependent drifts. We consider plug-in classifiers constructed from drift estimators and analyze the performance via the excess risk. Under a separation condition on the drift parameters, which are explicitly parametrized by the separation distance quantifying the difficulty of the problem, we establish upper bounds of the excess risk. Specifically, when the drift distance is bounded away from zero, the plug-in classifiers achieve a fast convergence rate of order 1/n (up to logarithmic factors) in the constant drift scenario. The theoretical approach utilizes the Wiener chaos representation and spectral theory to characterize the log-likelihood ratio as a quadratic form of Gaussian random variables, enabling a precise analysis of margin properties and concentration results. This extends the fast-rate results from classification problems with linear and Gaussian white noise models to dynamical diffusion systems with Gaussian structure under separation conditions.

Anna Melnykova

Splitting methods for stochastic Hodgkin-Huxley type systems

Presenting author. Anna Melnykova (Avignon Université, France)

Co-authors. Pierre Étoré (Grenoble INP, France), Irene Tubikanec (JKU Linz, Austria)

Abstract.

We introduce a novel localized version of the fundamental mean-square convergence theorem for SDEs with locally Lipschitz coefficients, which naturally arise in a wide range of applications. Specifically, we show that if a numerical scheme is locally consistent in the mean-square sense of order $q > 1$, then it is locally mean-square convergent with rate $q - 1$. Building on this result, we further prove that global mean-square convergence follows, provided that both the exact solution and its numerical approximation admit bounded $2p$th moments for some $p > 1$.

These new convergence results are illustrated on a class of locally Lipschitz SDEs of Hodgkin-Huxley type, characterized by a conditionally linear drift structure. For these systems, we construct different Lie-Trotter and Strang splitting methods exploiting their conditional linearity. The proposed convergence framework is then applied to these schemes, requiring innovative proofs of local consistency and boundedness of moments. In addition, we establish key structure-preserving properties of the splitting methods, in particular state-space preservation and geometric ergodicity. Numerical experiments support the theoretical results and demonstrate that the proposed splitting schemes significantly outperform Euler-Maruyama type methods in preserving the qualitative features of the model.

Predrag Pilipović

Strang Splitting Parameter Estimator for Nonlinear Multivariate Pearson-Type Diffusions

Presenting author. Predrag Pilipović, University of Copenhagen

Co-authors. Adeline Samson, Univ. Grenoble Alpes; Susanne Ditlevsen, Univesity of Copenhagen

Abstract.

A nonlinear multivariate Pearson-type diffusion is a stochastic differential equation (SDE) with nonlinear drift and a state-dependent diffusion matrix whose entries are quadratic functions of the state. Statistical inference for such models is challenging because the transition densities are not tractable. The proposed Strang splitting (SS) estimator first splits the SDE into a deterministic nonlinear ordinary differential equation (ODE) and a linear multivariate Pearson diffusion. For the Pearson diffusion, we derive closed-form expressions for the conditional mean and covariance using results on matrix exponential integrals, and approximate the solution with a Gaussian transition density that matches these exact first two moments. The nonlinear ODE part is then solved or numerically approximated separately. The SS estimator is obtained by composing these two steps. As an example of this model class, the multivariate Wright–Fisher diffusion from population genetics is considered. In addition, we introduce a new model within the class, the Student Kramers oscillator with heavy-tailed noise, and establish the existence and uniqueness of its strong solution as well as the existence of an invariant measure. We assess the Strang splitting estimator in simulation studies for both this model and the multivariate Wright–Fisher diffusion, showing that it outperforms the Euler–Maruyama, Gaussian approximation, and local linearization estimators, particularly at coarser sampling intervals. Finally, an application to Greenland ice-core data demonstrates the practical applicability of the SS estimator and the Student Kramers oscillator in modeling real climate proxy series.

Massimiliano Tamborrino

Interface between stochastic numerics and (computational) statistics for SDEs

Presenting author. Massimiliano Tamborrino, University of Warwick

Abstract.

Multivariate non-linear stochastic differential equations (SDEs) play a crucial role in several applications. Closed-form solutions or exact simulation schemes for nonlinear SDEs with non globally Lipschitz terms or multiplicative noise are commonly unavailable, requiring the development of advanced numerical schemes. To this end, we advocate the use of numerical splitting schemes, which are shown to be not only mean-square convergent, but also capable of preserving important structural properties of the SDEs, such as hypoellipticity, geometric ergodicity and oscillatory dynamics. The impact of such schemes goes well beyond the numerical level though. Indeed, we show that inferential approaches (such as maximum likelihood estimation, Approximate Bayesian Computation or controlled Sequential Monte Carlo) based on splitting schemes outperform those based on standard numerical schemes (e.g. Euler-Maruyama) in terms of accuracy and computational speed. These results are illustrated on two broad classes of SDEs, with additive and multiplicative noise.

Anita Behme

Lévy-Langevin Monte Carlo

Presenting author. Anita Behme, TU Dresden

Co-authors. David Oechsler and Claudius Lütke Schwienhorst, TU Dresden

Abstract.

We present a distributional equation for invariant measures of Markov processes that are associated to Lévy-type operators. Particular focus is put on the one-dimensional case where the distributional equation becomes a Volterra-Fredholm integral equation, and on solutions to Lévy-driven stochastic differential equations. The latter case is then used to develop a method to sample from a target distribution by simulating a solution of a stochastic differential equation. The approach is similar to the well-known Langevin Monte Carlo method based on stochastic differential equations driven by Brownian motion. However, using a general Lévy process as noise term yields an algorithm suitable to sample from non-smooth, multimodal or even heavy-tailed targets that are unreachable by classic approaches.

Stepan Mazur

Matrix gamma Levy motion

Presenting author. Stepan Mazur, Örebro University (Sweden)

Co-authors. Tomasz J. Kozubowski, University of Nevada (USA); Krzysztof Podgorski, Lund University (Sweden)

Abstract.

A connection of the matrix-variate gamma distributions to matrix-valued Lévy processes of a vector argument is made. Namely, a Lévy process, termed a matrix gamma-Laplace motion, is obtained by the subordination of the triangular Brownian motion of a vector argument to a vector-valued gamma motion of a vector argument. In this context, we introduce a triangular matrix-valued Rayleigh process, which, through symmetrization, leads to a new matrix-variate gamma process. This process

when taken at a properly defined one-dimensional argument has the matrix gamma marginal distribution with the shape parameter equal to its argument.

Cecilia Mancini

Filtering Out Infinite Activity Jumps Using Uniform Thresholding, Under Conditional Mean Square Error

Presenting author. Cecilia Mancini, University of Verona

Co-authors. José Figueroa-Lopez, Washington University in St. Louis

Abstract.

We analyse the minimization of error in finite samples when estimating the integrated squared volatility of a Lévy process with Y-stable jumps through the truncation method, from discrete, regularly spaced observations on a fixed time interval. This process is a semimartingale with infinite activity jumps, and when Y>1 the jumps are even of infinite variation; the volatility is constant. Our choice for the optimization criterion is to look for the uniform truncation level minimizing the mean squared error conditional to the jump process, because it allows to find the best estimator for the jump path we have at hand, rather than on average over all possible jump paths. Our findings are that for any observation step h, an optimal uniform threshold $\bar{\varepsilon}_h$ exists and the sequence $(\bar{\varepsilon}_h)_h$ is asymptotically unique. The leading term, when h is small, is $\sqrt{(2-Y)\sigma^2 h \ln \frac{1}{h}}$, and coincides with the one obtained under the mean squared error criterion. We also characterize the second order term of the expansion of $\bar{\varepsilon}_h$.

Jiaming Chen

Lévy-Driven Graph Ornstein-Uhlenbeck Edge Processes for Network Time Series

Presenting author. Jiaming Chen, Imperial College London

Co-authors. Almut E. D. Veraart, Imperial College London

Abstract.

We introduce a class of Lévy-driven graph Ornstein–Uhlenbeck (grOU) edge processes for modeling high-dimensional network time series. The proposed framework extends generalized network autoregressive (GNAR) and edge-based autoregressive models to their continuous-time counterparts. The model accommodates general Lévy noise and therefore captures jump behavior commonly observed in high-frequency data. We examine the finite-sample performance of the methodology through simulation studies and illustrate its practical relevance in an empirical application to real-world datasets. The results indicate that grOU edge models improve forecasting accuracy and reduce computational time relative to standard benchmarks while maintaining robustness through their network-based parametrization.

Leonardo Bardi

Probabilistic forecast for spatio-temporal Ornstein-Uhlenbeck processes

Presenting author. Leonardo Bardi, TU Chemnitz

Co-authors. Imma Curato, TU Chemnitz and Lorenzo Proietti, TU Chemnitz

Abstract.

We present a novel methodology, called mixed moving average field (MMAF, in short) guided learning, that can be employed to forecast spatio-temporal random fields as a spatio-temporal Ornstein-Uhlenbeck process or its mixed versions, the so-called STOU or MSTOU processes. We assume to observe 3D raster data generated from the latter processes, i.e., a set of spatio-temporal observations on a regular grid in space and time. STOU and MSTOU processes impose a dependence structure and a causal model on such data, based on the concept of cone-shaped ambit sets. However, in general, they have an unknown predictive distribution, and observed data cannot be directly employed to infer it. We then employ an ensemble of feedforward neural networks with Gaussian-distributed weights to produce probabilistic forecasts for such fields at specific spatial positions, incorporating the data generation process in the learning routine as follows. The networks are trained using a generalized Bayesian methodology on a specific embedding of the 3D raster data. Such embedding can be designed when the parameters shaping the autocovariance function and the causal model of the data-generating process are known. We then define a novel (weighted) least-squares estimator for theta-lex weakly dependent random fields to infer them, holding for exponential or power-shape covariogram functions, and prove its asymptotic properties. Finally, the trained networks in inference mode are used to generate ensemble forecasts, which we can show are calibrated across multiple time horizons.

Zheng Zhao

Diffusion differentiable resampling

Presenting author. Zheng Zhao, Linköpings universitet

Co-authors. Jennifer R. Andersson, Uppsala universitet

Abstract.

This paper is concerned with differentiable resampling in the context of sequential Monte Carlo (e.g., particle filtering). We propose a new informative resampling method that is instantly differentiable, based on an ensemble score diffusion model. We theoretically prove that our diffusion resampling method provides a consistent resampling distribution, and we show empirically that it outperforms the state-of-the-art differentiable resampling methods on multiple filtering and parameter estimation benchmarks. Finally, we show that it achieves competitive end-to-end performance when used in learning a complex dynamics-decoder model with high-dimensional image observations.

Dennis Schroers

Realized Joint Approximate Diagonalization of Eigenmatrices

Presenting author. Dennis Schroers (University of Bonn)

Co-authors. Fred E. Benth (BI Norwegian Business School) and Almut E.D. Veraart (Imperial College)

Abstract.

We develop a method to construct factor models in arbitrage-free term structure models nonparametrically using realized fourth-order tensor moments of excess returns.

Excess returns can be interpreted as discrete observations of continuous curves taking values in a reproducing kernel Hilbert space and are given for a resolution $\Delta > 0$ by

$$rx_t(x) = p_t(x) - p_{t-\Delta}(x+\Delta) + p_{t-\Delta}(\Delta),$$

where $p_t(x)$ is the logarithm of the price of a zero-coupon bond at time t with time-to-maturity x. Under the absence of arbitrage, these return curves are locally conditionally centered Gaussian with stochastic covariance kernel $\mathbf{q}_t(x, y)$. Empirically, we show that deviations from Gaussianity are largely explained by time variation in $\mathbf{q}_t$.

We consider factor representations of $\mathbf{q}_t$ and impose joint diagonalizability,

$$\mathbf{q}_t(x, y) = \sum_{i=1}^{d} s_i(t)\, e_i(x)e_i(y),$$

with linearly independent (not necessarily orthogonal) factors e_i reducing the volatility dynamics to a d-dimensional positive process.

Our main contribution is a method, *realized JADE*, to detect the latent factors $e_1, ..., e_d$ under this joint diagonalizability setting. It is based on particular fourth-order realized tensor moments of excess returns and requires mild assumptions to identify the latent factors under infill asymptotics ($\Delta \downarrow 0$).

Empirically, we demonstrate the benefits of the resulting factor structure in forecasting realized volatility kernels derived from U.S. Treasury excess returns.

Johannes Brutsche

Self-organized criticality under arbitrary sampling frequencies

Presenting author. Johannes Brutsche, University of Freiburg

Co-authors. Angelika Rohde, University of Freiburg

Abstract.

We derive the rate of convergence and limiting distribution of the profile MLE for the level of self-organized criticality ρ_0 of an oscillating Brownian motion (OBM) under equidistant sampling schemes, including low-frequency asymptotics for which the observations are realizations of a null recurrent Markov chain. The derived nonstandard Cox-type limit, caused by the discontinuity of the profile likelihood in the parameter of interest, turns out to be independent of the sampling frequency while the rate of convergence interpolates between $1/n$ and $1/\sqrt{n}$. The limit depends on the true level of self-organized criticality as well as the unknown volatility levels and this dependence is shown to be continuous w.r.t. the topology of weak convergence, enabling statistical inference. Our proof relies crucially on the observation that the OBM, if started in the true parameter ρ_0 and shifted by the latter, possesses a desirable distributional self-similarity. This relates the long-term behavior of the Markov chain to the infill asymptotics in this special case. On basis of the strong Markov property, the deficency of starting at ρ_0 is finally overcome by a coupling argument.

Pavel Chigansky

Asymptotic analysis of the finite predictor for processes with seasonal long-range dependence

Presenting author. Pavel Chigansky, The Hebrew University of Jerusalem, Israel

Co-authors. Marina Kleptsyna, Le Mans University, France

Abstract.

Let $X = (X_n, n \in \mathbb{Z})$ be a stationary sequence with spectral density f. Denote by $P_{k,m}$ the projection operator onto the subspace spanned by $\{X_k, \dots, X_m\}$. The finite and infinite predictors of X_1 are the projections $P_{-n,0}X_1$ and $P_{-\infty,0}X_1$, respectively. The Szegő-Kolmogorov theorem asserts that the mean squared error of the finite predictor, $\sigma^2(n) = \mathsf{E}(X_1 - P_{-n,0}X_1)^2$, converges to that of the infinite predictor, $\sigma^2(\infty) = \mathsf{E}(X_1 - P_{-\infty,0}X_1)^2$, which is equal to the geometric mean of the spectral density:

$$\sigma^2(n) \xrightarrow[n\to\infty]{} \sigma^2(\infty) = 2\pi \exp\left(\frac{1}{2\pi}\int_{-\pi}^{\pi} \log f(\lambda) d\lambda\right).$$

The rate of convergence in this limit depends on the regularity of f. It is geometric if f is regular–that is, smooth and bounded away from zero and infinity. I. Ibragimov and V. Solev (1968) showed that the rate is hyperbolic $\Theta(n^{-1})$ if f has power-type zeros or singularities. In a series of papers in the 2000s, A. Inoue discovered that if the spectral density has a power-type singularity at $\lambda = 0$ and is regular otherwise, then:

$$\sigma^2(n)/\sigma^2(\infty) - 1 \sim \frac{d^2}{n}, \quad n \to \infty. \tag{1}$$

This class includes processes with long-range dependence, such as FARIMA(p, d, q) and ARMA-type fGn sequences. Furthermore, it was shown that the partial correlation sequence $\alpha(n)$ of such processes follows the asymptotic:

$$\alpha(n) \sim \frac{d}{n}, \quad n \to \infty. \tag{2}$$

A curious feature of these results is the universality of the limits, which depend only on the exponent d and no other details of f.

In this talk, a broader picture of such exact asymptotics will be presented. We consider more general processes whose spectral density has multiple singularities with powers $d_j \in (-\frac{1}{2}, \frac{1}{2})$ located at distinct frequencies

$$\nu_0 = 0,\ \nu_{k+1} = \pi,\ \pm\nu_j \in (-\pi, \pi) \setminus \{0\}, \quad j = 1, ..., k.$$

Such processes are said to exhibit seasonal or cyclic long-range behavior, with a typical representative being the Gegenbauer process.

We show that the contributions of the singularities are additive. The asymptotics of the relative error retains its universality and satisfies:

$$\sigma^2(n)/\sigma^2(\infty) - 1 \sim \frac{d_0^2 + d_{k+1}^2}{n} + \frac{2}{n}\sum_{j=1}^{k} d_j^2, \quad n \to \infty,$$

while the partial correlation sequence depends on f in a rather intricate yet neat way:

$$\alpha(n) \sim \frac{d_0 + (-1)^n d_{k+1}}{n} + \frac{2}{n}\sum_{j=1}^{k} d_j \cos\big(\nu_j n + \mathcal{H}_{\log f}(\nu_j)\big), \quad n \to \infty,$$

where $\mathcal{H}_{\log f}$ is the Hilbert transform (i.e., the harmonic conjugate) of $\log f$. The proof is based on the asymptotic analysis of the Hilbert boundary value problem, which is associated with the prediction problem in a complex-analytic framework.

Fima Klebaner

Estimation of rates in population-age-dependent processes by means of test functions

Presenting author. Fima Klebaner Monash University, Australia

Co-authors. Jie Yen Fan, Kais Hamza, Monash University, Ziwen Zhong Monash University

Abstract.

This paper aims to develop inference for parameters in the model for the measure-valued populations developed by the authors in "Convergence of the age structure of general schemes of population processes", *Bernoulli* (2020), 26(2), 893–926. We consider the problem of estimation of individual birth $b_A(x)$ and death $h_A(x)$ rates when they depend not only on the age x of the individual but also on the whole population composition, measure A. We derive new estimators of the rates based on the use of test functions in the functional Law of Large Numbers for populations with a large carrying capacity. Use of the Central Limit Theorem for related martingales provides confidence bounds. We consider the rates to be simple functions in both age x and measure A, which leads to systems of linear equations. Some results for kernel estimators in a more general setup are also presented. The proposed method of using time-dependent test functions for estimation seems to be a novel approach which can be applied to a wide range of models of stochastic dynamical systems.

Grégoire Szymanski

Statistical inference for rough volatility

Presenting author. Grégoire Szymanski, University of Luxembourg

Co-authors. Carsten Chong (HKUST), Marc Hoffmann (Université Paris Dauphine), Yanghui Liu (Baruch College), Mathieu Rosenbaum (Université Paris Dauphine)

Abstract.

In recent years, there has been a substantive interest in rough volatility models. In this class of models, the local behavior of stochastic volatility is much more irregular than semimartingales and resembles that of a fractional Brownian motion with Hurst parameter H. In this paper, we derive a consistent and asymptotically mixed normal estimator of H based on high-frequency price observations. In contrast to previous works, we work in a semiparametric setting and do not assume any a priori relationship between volatility estimators and true volatility. Furthermore, our estimator attains a rate of convergence that is known to be optimal in a minimax sense in parametric rough volatility models.

Niklas Dexheimer

Sparse Estimation for High-Dimensional Lévy-driven Ornstein–Uhlenbeck Processes from Discrete Observations

Presenting author. Niklas Dexheimer, University of Twente

Co-authors. Natalia Jeszka, University of Twente

Abstract.

We study high-dimensional drift estimation for Lévy-driven Ornstein–Uhlenbeck processes based on discrete observations. Assuming sparsity of the drift matrix, we analyze Lasso and Slope estimators constructed from approximate likelihoods and derive sharp nonasymptotic oracle inequalities. Our bounds disentangle the contributions of discretization error and stochastic fluctuations, and establish minimax optimal convergence rates under suitable choices of tuning parameters in a high-frequency regime. We further quantify the sample complexity required to attain these rates depending on the Lévy noise. The results extend the theory of high-dimensional statistics for stochastic processes to a substantially broader class of noise mechanisms, in particular pure jump processes. They also demonstrate that Lasso and Slope remain competitive for jump-driven systems, providing practical guidance for inference in applications where Lévy processes are a natural modeling choice.

Lukas Riepl

Sharp adaptive nonparametric testing for constant volatility

Presenting author. Lukas Riepl, Department of Mathematics, Albert-Ludwigs-Universität Freiburg, Germany

Co-authors. Johannes Brutsche, Department of Mathematics, Albert-Ludwigs-Universität Freiburg, Germany

Abstract.

Based on discrete observations within the nonparametric Gaussian white noise model $dY_t = \sigma(t)dW_t$, we develop a test to infer if the volatility function $\sigma(\cdot)$ is constant. The testing procedure is shown to be minimax-optimal and adaptive for infill asymptotics and these results entail that a deviation from the null hypothesis of constancy is best measured in terms of $\sup_{t\in[0,1]} |\sigma(t)^2/\|\sigma\|_{L^2}^2 - 1|$. The derivation of optimal constants requires the construction of hypotheses with height solving $F_n(x) = 0$ for given functions F_n and understanding the asymptotic behavior of their solutions which is done using the implicit function theorem.

Orimar Sauri

Power variation for a class of volatility modulated random fields

Presenting author. Orimar Sauri, Department of Mathematical Sciences, Aalborg University, Denmark

Co-authors. J. Ulises Márquez-Urbina, Department of Statistics, Universidad Carlos III de Madrid, Spain

Abstract.

In this talk we present limit theorems for (lattice) power variations for random fields of the form

$$X_t(x) := \int_{A_t(x)} f(t,x,q)\sigma(q)W(\mathrm{d}q), \;\; A_t(x) := A + (t,x), (t,x) \in \mathbb{R}^2,$$

where A is a compact set, W is a white noise, and f is a deterministic kernel. Under an in-fill sampling scheme, we show that the asymptotic behavior of power variations is determined by the geometry of the set A, and not by the kernel function f, in contrast to existing literature. Exploiting this feature, we propose a change-of-frequency approach to infer geometric properties of A. In particular, we develop a method to test whether A is rectilinear, i.e. a countable union of horizontal and vertical line segments.

Yuga Iguchi

A Closed-Form Transition Density Expansion for Elliptic and Hypo-Elliptic SDEs

Presenting author. Yuga Iguchi, School of Mathematical Sciences, Lancaster University

Co-authors. Alexandros Beskos, Department of Statistical Science, University College London

Abstract.

We introduce a closed-form expansion for the transition density of elliptic and hypo-elliptic multivariate Stochastic Differential Equations (SDEs). Our methodology provides approximations of the transition density, easily evaluated via any software that performs symbolic calculations. A major part of the paper is devoted to an analytical control of the remainder in our expansion for fixed observation step-size. The obtained error bounds validate theoretically the methodology, by characterising the size of the distance from the true value. It is the first time that such a closed-form expansion becomes available for the important class of hypo-elliptic SDEs, to the best of our knowledge. For elliptic SDEs, closed-form expansions are available, with some works identifying the size of the error for fixed , as per our contribution. Our methodology allows for a uniform treatment of elliptic and hypo-elliptic SDEs, when earlier works are intrinsically restricted to an elliptic setting. We show numerical applications highlighting the effectiveness of our method, by carrying out parameter inference for hypo-elliptic SDEs that do not satisfy stated conditions. The latter are sufficient for controlling the remainder terms, but the closed-form expansion itself is applicable in general settings.

Felix Schürzinger

Nonparametric estimation of the transition density in dependence of time

Presenting author. Felix Schürzinger, Université Paris Cité, CNRS, MAP5, F-75006 Paris, France

Abstract.

We construct nonparametric, least-squares projection estimators of the transition density of a diffusion process as a function of the time t and a space variable $\mathbf{x}$. Consider N continuously or discretely observed paths solving a d-dimensional stochastic differential equation. We calculate our estimators by minimizing a contrast over a finite-dimensional subspace of $\mathbb{L}^2(\mathbb{R}_+ \times \mathbb{R}^d)$. This subspace is spanned by two families of orthonormal functions associated to t and $\mathbf{x}$ with respective dimensions m_1 and $\mathbf{m}_2$. Under mild assumptions ensuring existence of the transition density, we derive risk bounds for these estimators. We utilize these bounds to calculate the rate of convergence depending on the regularity of the density. Interestingly, the variance term in our risk bound is only dependent on the dimension of one of the families of orthonormal functions (namely $\mathbf{m}_2$ associated to $\mathbf{x}$). We propose an intuitive solution to this challenge: first, we give a model selection procedure by fixing m_1 large and automatically determining the correct dimension $\mathbf{m}_2$. Thereby, we reach the bias-variance trade-off and thus the optimal rate of convergence determined earlier. This is shown in an adaptive risk bound. Second, we give a penalization method to select both m_1 and $\mathbf{m}_2$. The resulting convergence rate is suboptimal in theory, but it can be brought back to the non-degraded rate found before, given specific conditions on the regularity of the target function. In total, we present an in-depth and thorough study of an estimation problem that is, while closely connected to existing works, new as such. Finally, we illustrate the performance of our estimator for Ornstein-Uhlenbeck and Cox-Ingersoll-Ross processes in a simulation study.

Arnaud Gloter

Drift estimation for rough processes under small noise asymptotic : QMLE approach

Presenting author. Arnaud Gloter, Université Evry Paris-Saclay

Co-authors. Nakahiro Yoshida, University of Tokyo

Abstract.

We consider a process X^ε solution of a stochastic Volterra equation with an unknown parameter $\theta^\star$ in the drift function. The Volterra kernel is singular near zero, exhibiting a behavior comparable to $K_0(u) = cu^{\alpha-1}\mathbb{1}_{u>0}$ with $\alpha \in (1/2, 1)$. It is assumed that the diffusion coefficient is proportional to $\varepsilon \to 0$. Based on discrete observations, with a mesh size $h \to 0$, of the Volterra process, we construct a Quasi Maximum Likelihood Estimator. The main step is to assess the error arising in the reconstruction of the path of a semi-martingale from the inversion of the Volterra kernel. We show that this error decreases as $h^{1/2}$ regardless of the value of α. Then, we can introduce an explicit contrast function, which yields an efficient estimator when $\varepsilon \to 0$.

Masayuki Uchida

Parametric estimation for SPDEs in two space dimensions with unknown damping parameters based on triple increments

Presenting author. Masayuki Uchida, The University of Osaka

Co-authors. Yozo Tonaki, The University of Osaka, and Yusuke Kaino, Kobe University

Abstract.

We investigate the problem of parametric inference for a class of second-order linear parabolic stochastic partial differential equations (SPDEs) defined on a two-dimensional spatial domain and driven by two types of Q-Wiener processes. Based on high-frequency spatio-temporal observations, we propose estimation procedures for the damping parameters associated with the Q-Wiener processes by leveraging realized quadratic variations of temporal and spatial increments (triple increments). In addition, we introduce minimum contrast estimators for four coefficient parameters of the SPDEs. For the remaining unknown parameters, we construct adaptive estimation methods based on approximate coordinate processes. We conduct numerical experiments to evaluate the asymptotic performance of the proposed estimators.

Salvador Ortiz-Latorre

Convergence in law for quasi-linear SPDEs

Presenting author. Salvador Ortiz-Latorre (University of Oslo)

Co-authors. Maria Jolis and Lluís Quer-Sardanyons (Universitat Autònoma de Barcelona)

Abstract.

We consider the quasi-linear stochastic wave and heat equations in $\mathbb{R}^d$ with $d \in \{1, 2, 3\}$ and $d \geq 1$, respectively, and perturbed by an additive Gaussian noise which is white in time and has a homogeneous spatial correlation with spectral measure μ_n. We allow the Fourier transform of μ_n to be a genuine distribution. Let u^n be the mild solution to these equations. We provide sufficient conditions on the measures μ_n and the initial data to ensure that u^n converges in law, in the space of continuous functions, to the solution of our equations driven by a noise with spectral measure μ, where $\mu_n \to \mu$ in some sense. We apply our main result to various types of noises, such as the anisotropic fractional noise. We also show that we cover existing results in the literature, such as the case of Riesz kernels and the fractional noise with $d = 1$.

Björn Müller

Long-time behavior of exact and numerical solutions of stochastic evolution equations on the sphere

Presenting author. Björn Müller, Chalmers University of Technology & University of Gothenburg

Co-authors. David Cohen and Andrea Papini, Chalmers University of Technology & University of Gothenburg

Abstract.

We investigate the long-time behavior of exact solutions and numerical approximations of linear stochastic evolution equations defined on the sphere. We focus on three classical models arising in mathematical physics: the stochastic wave equation, the stochastic Schrödinger equation, and the stochastic Maxwell's equations. For these SPDEs, we analyze several widely used time integrators with respect to trace formulas describing the evolution of physically relevant quantities such as energy, mass, and momentum dependent on the forcing term. In particular, we prove that the forward and backward Euler–Maruyama schemes fail to reproduce the correct long-time behavior of the exact solutions. In addition, we prove that the stochastic exponential integrator preserves the correct long-time behavior of the physical quantities of interest. Finally, several numerical experiments are provided to illustrate our theoretical findings.

Justin R. Baars

Asymptotically Distribution-Free Goodness-of-Fit Testing for Point Processes

Presenting author. Justin R. Baars, University of Amsterdam

Co-authors. Roger J. A. Laeven, University of Amsterdam; Sami Umut Can, University of Amsterdam

Abstract.

Consider an observation of a multivariate temporal point process N with law $\mathcal{P}$ on the time interval $[0, T]$. To test the null hypothesis that $\mathcal{P}$ belongs to a given parametric family, we construct a convergent compensated counting process to which we apply an innovation martingale transformation. We prove that the resulting process converges weakly to a standard Wiener process. Consequently, taking a suitable functional of this process yields an asymptotically distribution-free goodness-of-fit test for point processes. For several standard tests based on the increments of this transformed process, we establish consistency under alternative hypotheses. Finally, we assess the performance of the proposed testing procedure through a Monte Carlo simulation study and illustrate its practical utility with two real-data examples.

Fabrice Wunderlich

Goodness-of-fit test for the drift in interacting McKean-Vlasov particle systems

Presenting author. Fabrice Wunderlich

Co-authors. Mark Podolskij

Abstract.

We consider the problem of testing whether the drift of a McKean–Vlasov diffusion belongs to a given finite-dimensional class, based on continuous observation of the associated interacting particle system over a fixed time horizon. Using an L^2-projection characterisation of the null hypothesis, the problem reduces to estimating several bilinear functionals involving the drift and the empirical measure flow.

The main challenge is a quadratic term involving the unknown drift itself. To address this, we introduce smoothed cross-increment statistics that exploit the interaction structure while reducing diffusion noise, leading to a fully data-driven test adapted to the mean-field setting. On the theoretical side, the asymptotic analysis combines classical propagation of chaos for consistency with functional linearisation arguments and a novel PDE approach to establish a central limit theorem, while allowing comparatively mild assumptions on the drift and volatility coefficients. The talk will present the construction of the test statistic, the main asymptotic ideas, and the probabilistic challenges arising from interaction and distribution dependence.

This is joint work with Mark Podolskij.

Ekaterina Morozova

Statistical inference for Nemytskii-type McKean-Vlasov SDEs via Deep Neural Networks

Presenting author. Ekaterina Morozova, University of Duisburg-Essen

Co-authors. Denis Belomestny, University of Duisburg-Essen

Abstract.

The current talk is based on the joint research with Denis Belomestny, which is devoted to the statistical inference for a nonlinear drift coefficient and invariant distribution of the McKean-Vlasov SDEs of Nemytskii-type. The key feature of this type of equations is that their coefficients — in our case the drift — depend on the law of the solution through its density. This leads to certain theoretical challenges, as this dependence implies that the coefficients lack continuity in their measure component, which makes most of the results available for McKean-Vlasov SDEs inapplicable (see, e.g., [2]).

In this research, we are considering a particular form of such equations, which can be viewed as a nonlinear perturbation of the Ornstein-Uhlenbeck process. We study its analytical properties, comparing them to those of the classical Ornstein-Uhlenbeck process, and, in particular, establish the chi-squared convergence to the stationary distribution. On the statistical side, we propose an MLE-type approach allowing for a nonparametric estimation of the invariant density of this nonlinear process and the drift function using classes of deep neural networks, which develops the ideas of [1].

References:

1. Belomestny, D. and Orlova, T. (2025). Statistical Inference for Conservation Law McKean-Vlasov SDEs via Deep Neural Networks. SIAM/ASA Journal on Uncertainty Quantification, 13(2), 425–448.

2. Grube, S. (2023). Strong solutions to McKean-Vlasov SDEs with coefficients of Nemytskii-type. Electronic Communications in Probability, 28, 1–13.

Hiroki Masuda

Quasi-likelihood inference for SDE with mixed effects

Presenting author. Hiroki Masuda (University of Tokyo)

Co-authors. Maud Delattre (INRAE)

Abstract.

We consider statistical inference for a class of dynamic mixed-effect models described by stochastic differential equations (SDE) where both drift and diffusion coefficients depend on fixed- and random-effect parameters. Assuming that each process is observed at high frequency over a fixed period and that the number of individuals goes to infinity, we propose a stepwise inference procedure and prove its theoretical properties. The methodology is based on suitable quasi-likelihood functions by first profiling the random effect in the diffusion coefficient, and then taking the marginal distribution in the drift coefficient, resulting in a fully explicit and computationally convenient method. It is also the strength of the proposed approach that we can incorporate a wide class of random-effect distributions in the diffusion coefficient, while allowing both random and fixed effects in the drift term.

Henrik Häggström

Semi-amortised simulation-based inference for stochastic nonlinear mixed-effects models

Presenting author. Henrik Häggström; Department of Mathematical Sciences, Chalmers University of Technology and the University of Gothenburg

Co-authors. Sebastian Persson, Marija Cvijovic and Umberto Picchini; Department of Mathematical Sciences, Chalmers University of Technology and the University of Gothenburg

Abstract.

The analysis of data from multiple experiments, such as observations of several individuals, is commonly approached using mixed-effects models, which account for variation between individuals through hierarchical representations. This makes mixed-effects models widely applied in fields such as biology, pharmacokinetics, and sociology. In this work [1], we propose a novel methodology for scalable Bayesian inference in hierarchical mixed-effects models. Our framework first constructs amortized approximations of the likelihood and the posterior distribution, which are then rapidly refined for each individual dataset, to ultimately approximate the parameters posterior across many individuals. The framework is easily trainable, as it uses mixtures of experts but without neural networks, leading to parsimonious yet expressive surrogate models of the likelihood and the posterior. We demonstrate the effectiveness of our methodology using challenging stochastic models, such as mixed-effects stochastic differential equations emerging in systems biology-driven problems. However, the approach is broadly applicable and can accommodate both stochastic and deterministic models. We show that our approach can seamlessly handle inference for many parameters. Additionally, we applied our method to a real-data case study of mRNA transfection. When compared to exact pseudomarginal Bayesian inference, our approach proved to be both fast and competitive in terms of statistical accuracy.

[1] H. Häggström, S. Persson, M. Cvijovic and U. Picchini. Simulation-based inference for stochastic nonlinear mixed-effects models with applications in systems biology. Statistics and Computing, 36(99), https://doi.org/10.1007/s11222-026-10850-8, 2026.

Tobias Ambjörnsson

Sub-sampling-time inference in single-molecule trajectories via a continuous-time hidden Markov framework

Presenting author. Tobias Ambjörnsson, Lund University

Co-authors. Erik Clarkson, Lund University

Abstract.

Single-particle tracking data are often analyzed using discrete-time hidden Markov models, which assume that the underlying state remains constant between consecutive observations. However, in many experimental settings, each observation corresponds not to an instantaneous measurement but to an average over a finite observation interval. During such an interval, the system may undergo multiple transitions between hidden states. The observed data therefore arise from a continuous-time Markov jump process that is averaged over a sequence of observation windows, rather than from direct discrete-time sampling.

In this work, we introduce a sub-sampling-time hidden Markov model (stHMM) that accounts for these effects by explicitly modeling continuous-time state switching within each observation interval. Our approach is based on analytically derived transition-accretion probabilities, which describe the joint distribution of the end state and the occupation time (fraction of time spent in each state) during an interval. This enables the construction of a likelihood function that integrates over all hidden trajectories at sub-sampling-time resolution while remaining computationally tractable.

Within a Bayesian framework, we use this likelihood for both model selection and parameter inference in two-state stochastic processes. Using synthetic data, we show that the method substantially improves the estimation of kinetic rates and diffusion parameters compared to standard hidden Markov models, particularly when switching occurs on timescales shorter than the observation interval. The method is introduced and analyzed in Clarkson, E., & Ambjörnsson, T. (2026). Achieving subtemporal resolution in the analysis of two-state single-molecule trajectories. Physical Review Research, 8, 013115.

Jhonier Rangel

Classical and Bayesian Inference for the Multivariate Fractional Brownian Bridge

Presenting author. Jhonier Rangel - Department of Statistics - Universidad Nacional de Colombia - Bogota - Colombia

Co-authors. Viswanathan Arunachalam - Department of Statistics - Universidad Nacional de Colombia - Bogota - Colombia

Abstract.

The multivariate fractional Brownian bridge (mfBB) generalizes the classical Brownian bridge by incorporating long-range dependence and self-similarity through the Hurst parameter [1,2]. This paper investigates both classical and Bayesian approaches to statistical inference for mfBB models. From a classical perspective, we examine parameter estimation techniques, including maximum likelihood estimation and the method of moments [3], highlighting the challenges induced by the underlying dependence structure. From a Bayesian standpoint, we develop hierarchical modeling frameworks and prior specifications for the Hurst parameter and covariance structure, and discuss computational strategies based on Markov Chain Monte Carlo methods [4]. A comparative analysis indicates that Bayesian methods provide greater flexibility for incorporating prior information, whereas classical approaches may offer computational advantages under suitable assumptions. Potential applications in finance, environmental modeling, and signal processing are also outlined.

2 Posters

Habiba Khatun

Bivariate Load Sharing Model: Bayesian Inference

Presenting author. Habiba Khatun, Indian Institute of Technology Kanpur

Co-authors. Prof. Debasis Kundu, Indian Institute of Technology Kanpur

Abstract.

This study is motivated by a data set arising from an experiment on patients with diabetic retinopathy, designed to compare the effectiveness of two treatments: laser therapy and traditional therapy. Each treatment was administered to one eye of the same patient, allowing the paired outcomes to be modelled as a two-component load-sharing system. In such systems, the failure of one component may increase the stress on the other, potentially accelerating its failure. Unlike much of the existing literature, which assumes independence between component lifetimes, we consider a more realistic framework that allows for dependence between the two components. The proposed model also incorporates a positive probability of simultaneous failure. In cases where failures are not simultaneous, the lifetime of the surviving component is modified under a tampered failure rate assumption, leading to a bivariate distribution with a singular component. We develop Bayesian inference procedures for the unknown parameters under a broad class of prior distributions, considering exponential, Weibull, and piecewise constant hazard baseline models. Bayesian hypothesis testing is performed using the Bayes factor approach. Extensive simulation studies are conducted to evaluate the performance of the proposed methods. Finally, the methodology is illustrated through the analysis of the diabetic retinopathy data set, demonstrating the effectiveness of the Bayesian framework in practical applications.

Filipe P. de Farias

Security in Networked Stochastic Control Systems

Presenting author. Filipe P. de Farias, Uppsala University - Department of Information Technology

Co-authors. André M. H. Teixeira, Uppsala University - Department of Information Technology. Christos Verginis, Uppsala University - Department of Electrical Engineering.

Abstract.

Networked Control Systems (NCS) are vulnerable to cyber attacks on communication links and connected devices[teixeira2015,anand2025], ultimately affecting physical processes and compromising safety. A key challenge in designing resilient controllers is that the attacker's knowledge of the system is often unknown. While many existing works assume ideal attackers with perfect model knowledge, this assumption is not valid in practical settings and can thus lead to overly conservative countermeasures. In this work, we review the Output-to-Output Gain (OOG) approach as a security metric [ferrari]. OOG has proven useful for synthesizing controllers/observers, and for assessing risk when the perfect knowledge assumption is relaxed (e.g., [anandRisk]). We consider extending the OOG framework to stochastic linear systems, which raises the following fundamental open problems:

- How should one define a stochastic OOG when the system is driven by process and measurement noise? Possibilities include ratios of expected output energies, probability bounds on the cost given a constraint on the false-alarm rate, or the Kullback-Leibler divergence of the residual.
- How can we synthesize controllers and observers that minimize the stochastic OOG, and what are the tractable convex design problems?

We discuss preliminary insights and outline a research roadmap towards defining these problems in the presence of parametric uncertainty and stochastic processes. No complete solutions are offered; instead, we aim to stimulate discussion on these timely and challenging problems at the intersection of stochastic dynamics, security, and control theory.

Elham Rekabi Bana

Regularized Conditional Normalizing Flows for Non-Identifiable Inverse SDEs

Presenting author. Elham Rekabi Bana - Chalmers University of Technology - Department of Mechanical Engineering

Abstract.

In structurally non-identifiable inverse SDE problems, the goal is to characterize the posterior distribution over parameter configurations consistent with the observations. Conditional normalizing flow models provide a suitable framework for this task. However, in such settings, the standard maximum likelihood training may struggle to accurately recover the full geometry of the target distribution, especially when it is concentrated near lower dimensional manifolds. We propose a data-driven regularization strategy that augments the maximum-likelihood objective to improve both fidelity to and coverage of the posterior support. We demonstrate the approach on a non-identifiable SDE benchmark and show that the proposed regularization improves posterior support recovery compared with standard training.

Sacha Quayle

Hawkes processes with variable length memory

Presenting author. Sacha Quayle, LPSM, Sorbonne University

Co-authors. Anna Bonnet and Maxime Sangnier, LPSM, Sorbonne University

Abstract.

Hawkes processes are widely used to model temporal phenomena exhibiting dependence on the past. We study a generalised multivariate model, motivated by applications in neuroscience for the analysis of neuronal spike trains. First, the model incorporates a possible variable-length memory, in which the dynamics of a given subprocess depend only on the history since its last event. Second, it accounts for a refractory period, corresponding to a short period of time following an event during which the same subprocess cannot generate any new event. In this generalised setting, we develop parameter estimation procedures, which are illustrated on simulated data and neuronal data.

Gyana Ranjan Nayak

Estimating mixtures of stochastic ensembles as superposition of Schrödinger bridges

Presenting author. Gyana Ranjan Nayak, Uppsala University

Co-authors. Filip Elvander: Aalto University, Isabel Haasler: Uppsala University

Abstract.

In many estimation and tracking problems, only aggregate population-level measurements are available, yet understanding the behavior of individual subpopulations is of key interest. Examples of this include cell population dynamics and target tracking in crowded environments. In both settings individual targets cannot be tracked, and observations consist of unlabeled mixtures of distinct groups. We consider the problem of recovering the trajectories of several stochastic ensembles from observed superpositions of indistinguishable agents, without access to individual-level measurements, by modeling each ensemble as a Schrödinger bridge. We propose a computationally efficient algorithm for solving this problem, which exhibits a structure analogous to the classical Schrödinger system. The algorithm is validated on a particle tracking task, where distinct groups of particles are governed by different stochastic dynamics, but are observed only collectively. Numerical results demonstrate that the method successfully separates the ensemble trajectories with moderate error and remains robust to mismatches between the assumed and true underlying dynamics.

Erika Johanna Martínez Salinas

Stochastic Modeling of Dengue Spread in Colombia Using Hawkes Processes and Environmental Data

Presenting author. Erika Johanna Martínez Salinas - Universidad Nacional de Colombia, Bogotá Colombia

Co-authors. Viswanathan Arunachalam - Universidad Nacional de Colombia, Sede Bogotá, Paola Tardelli - Università degli Studi dell'Aquila, Italy

Abstract.

We propose a stochastic framework to model dengue transmission in Colombia by combining Hawkes self-exciting processes [Hawkes1971] with stochastic differential equations. The model captures temporal clustering of infection events while incorporating environmental covariates such as temperature, humidity, and precipitation. To account for uncertainty, Brownian motion is included, providing a realistic representation of stochastic fluctuations in disease dynamics.

Parameters are estimated using real epidemiological data, and the model is validated through simulations based on Poisson jumps and Hawkes-driven processes. This approach is complemented by previous work on Disease-Informed Neural Networks (DINNs) [Author.article1], which support parameter estimation and predictive performance in epidemiological models [Author.article2].

Our results demonstrate that integrating stochastic processes and data-driven methods provides a flexible and robust framework for understanding and predicting infectious disease spread.

Maximilian Klein

Metric Projection with Score-Based Diffusions

Presenting author. Maximilian Klein, Christian-Albrechts-Universität Kiel

Co-authors. Jan Kallsen, Christian-Albrechts-Universität Kiel; Sören Christensen, Christian-Albrechts-Universität Kiel, Claudia Strauch, Universtität Heidelberg; Lukas Trottner, Universität Stuttgart

Abstract.

We consider the problem of approximating the metric projection onto a low-dimensional manifold $\mathscr{M}$ in a high-dimensional Euclidian space. This is clearly related to the a-posteriori distribution of a denoising diffusion process. Indeed, in the limit of high-dimensions, a certain backward stochastic process starting in x_0 will hit $\mathscr{M}$ almost at the projection of x_0 onto $\mathscr{M}$ with high probability. More specifically, this process is a time-reversed killed Brownian motion whose drift can be obtained by using Doob's-h-transform.

In practice, as usual in generative modelling, the manifold is the support of an unkonwn distribuition which is only known through i.i.d. samples. Therefore the backward diffusion needs to be estimated by score matching. In this talk we consider upper bounds for error probabilites in terms of dimension, drift estimates the step-size of discretization-schemes.

Francesco Iafrate

Convergence Guarantees for Diffusion Models under Weak Log-Concavity

Presenting author. Francesco Iafrate, University of Hamburg

Co-authors. Gitte Kremling, Mahsa Taheri, Johannes Lederer, University of Hamburg

Abstract.

Score-based generative modeling, implemented through probability flow ODEs, has shown impressive results in numerous practical settings. However, most convergence guarantees rely on restrictive regularity assumptions on the target distribution, such as strong log-concavity or bounded support. This work establishes non-asymptotic convergence bounds in the 2-Wasserstein distance for a general class of probability flow ODEs under considerably weaker assumptions: weak log-concavity and Lipschitz continuity of the score function. Our framework accommodates non-log-concave distributions, such as Gaussian mixtures, and explicitly accounts for initialization errors, score approximation errors, and effects of discretization via an exponential integrator scheme. Bridging a key theoretical challenge in diffusion-based generative modeling, our results extend convergence theory to more realistic data distributions and practical ODE solvers. We provide concrete guarantees for the efficiency and correctness of the sampling algorithm, complementing the empirical success of diffusion models with rigorous theory. Moreover, from a practical perspective, our explicit rates might be helpful in choosing hyperparameters, such as the step size in the discretization.

Svitlana Drin

Estimation of minimum VaR and minimum CVaR optimal portfolios for small sample and singular covariance matrix.

Presenting author. Svitlana Drin (Örebro University)

Co-authors. Muhammad Asif (Örebro University); Stepan Mazur (Örebro University); Nataliya Shchestyuk (National University of Kyiv-Mohyla Academy, Ukraine)

Abstract.

This paper investigates sample estimators for minimum VaR and minimum CVaR optimal portfolios in the presence of double singularity, where both population and sample covariance matrices of asset returns are rank-deficient. By employing the Moore-Penrose inverse to ensure unique portfolio solutions, we derive exact stochastic representations for the portfolios' expected returns and variances. We provide a complete distributional characterization of these characteristics and obtain analytical expressions for their corresponding means and variances under small-sample constraints.

Lorenzo Proietti

Spatio-temporal probabilistic forecast using MMAF-guided learning

Presenting author. Lorenzo Proietti, TU Chemnitz

Co-authors. Leonardo Bardi (TU Chemnitz), Imma Valentina Curato (TU Chemnitz)

Abstract.

We employ stochastic feed-forward neural networks with Gaussian-distributed weights to determine a probabilistic forecast for spatio-temporal raster datasets. The networks are trained using MMAF-guided learning, a generalized Bayesian methodology in which the observed data are preprocessed using an embedding designed to produce a low-dimensional representation that captures their dependence and causal structure. The design of the embedding is theory-guided by the assumption that a spatio-temporal Ornstein-Uhlenbeck process with finite second-order moments generates the observed data. The trained networks, in inference mode, are then used to generate ensemble forecasts by applying different initial conditions at different horizons. Experiments conducted on both synthetic and real data demonstrate that our forecasts remain calibrated across multiple time horizons. Moreover, we show that on such data, simple feed-forward architectures can achieve performance comparable to, and in some cases better than, convolutional or diffusion deep learning architectures used in probabilistic forecasting tasks.

Nicklas Boserup

Parameter inference in sparsely observed SDEs using learned score-matching samplers

Presenting author. Nicklas Boserup, University of Copenhagen

Co-authors. Stefan Sommer, University of Copenhagen

Abstract.

Inferring parameters of stochastic differential equations from sparsely sampled discrete observations remains challenging for nonlinear and high-dimensional models, where transition densities are analytically unknown and computationally troublesome to approximate.

We develop techniques that allow parameter inference in SDEs using modern score matching-based diffusion bridge sampling [1, 2]. We do this by employing score-based approximate sample paths between observations as proposals in importance samplers estimating transition likelihoods [3, 4], by utilising that the score-based samplers provide score and hence drift term estimates of the conditional process in addition to the sampled paths, which can be used to construct first-order transition density approximations on a fine time-grid. This links recent score matching-based diffusion bridge sampling with classical simulated maximum likelihood methods [5, 6].

We derive efficient and numerically stable estimators by exploiting that these conditional path samplers exhibit the desirable properties of (a) approximately sampling from the actual conditional process, yielding more effective samples than previous samplers, and (b) sharing diffusion terms with the unconditional process, allowing cancellations of problematic terms, providing faster and more stable numerical computations. We further show how shared diffusion terms also allow application of Girsanov's theorem to establish a continous-time change-of-measure counterpart to the classical time-discretised importance samplers.

We demonstrate applicability in high-dimensional settings, and we show that the same estimators arise whether time-discretisation is introduced early in the derivation or only at implementation time.

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Filip Rydin

Neural likelihood surrogates for parameter inference via log-density PDE

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Abstract.

We propose a two-stage method for parameter inference in discretely observed stochastic differential equations. First, we extend a deep log-density filter to learn parameter-dependent conditional log-densities. Second, we learn a neural surrogate for the Bayesian update's log-normalizing constants, yielding a fast differentiable approximation of the log-likelihood. On a 10-dimensional Ornstein–Uhlenbeck model and a nonlinear bistable equation, we obtain smooth posteriors and orders of magnitude faster likelihood evaluation than particle- and Kalman-type baselines at comparable accuracy.

Aurélien Velleret

On the LAN and LAMN properties for mean-field model of interacting neurons

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Abstract.

We study a mean-field system of interacting particles represented by stochastic differential equations (SDE's) with jumps, introduced in [2] as a model describing the time evolution of neuronal potentials in the human brain. With the proper the renormalization of the interaction by (1/N), it was shown in [2] that, as the number of particles tends to infinity, the system exhibits the propagation of chaos property. Assuming that the jump intensity depends on an unknown parameter, we establish the Local Asymptotic Normality (LAN) property. The limiting Fisher information is expressed in terms of the limit of the empirical measure of the system. Several implications regarding the performance of the maximum likelihood estimator (MLE) are also derived, beyond the consistency and asymptotic normality notably local asymptotic minimax efficiency. It was proved in [3] that a different scaling of the interactions leads to the emergence of a diffusive component at the limit, for which conditional propagation of chaos property are to be derived. We establish in this case the Local Asymptotic Mixed Normality (LAMN) property, which differs from the LAN property in that the limiting Fisher information is random, and we similarly evaluate the performance of the MLE. This poster is based both on the preprint [1] with Aline Duarte and Dasha Loukianova and on ongoing works with Xavier Erny, Dasha Loukianova and Eva Löcherbach.

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