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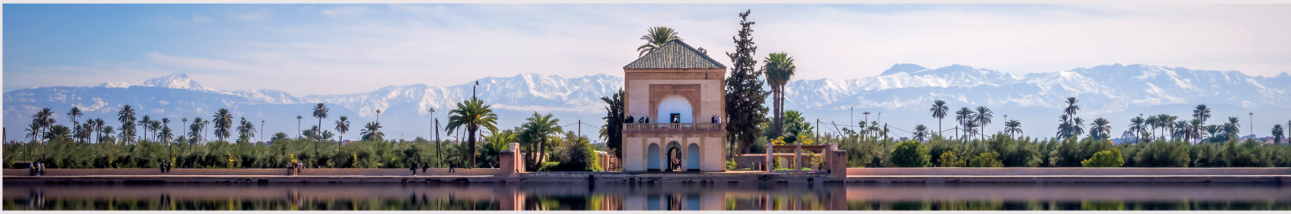
Book of Abstracts



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List of Speakers and Abstracts

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SIG-BSDE for Dynamic Risk Measures

Abstract: In this talk, we introduce SIG-BSDE, a novel algorithm for numerically solving backward stochastic differential equations (BSDEs). The method integrates path signatures with the backward Euler–Maruyama scheme, resulting in a robust and efficient numerical solver. We present a rigorous convergence analysis of SIG-BSDE and validate its effectiveness through a series of numerical experiments, benchmarking its performance against existing machine learning-based methods.

Our primary application focus is on BSDEs arising in the context of dynamic risk measures. In this setting, we also propose a new framework for modeling dynamic risk under generalized ambiguity. We demonstrate how a hybrid approach, combining deep learning techniques with the SIG-BSDE algorithm, can effectively tackle such problems and offer a promising direction for risk-aware decision-making under uncertainty.

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Some Extensions of the Central Limit Theorem and Applications in Non-Life Insurance

Abstract: This talk investigates the asymptotic behavior of aggregate claims in non-life insurance using the classical Central Limit Theorem and some of its key extensions. We focus particularly on non-independent and non-identically distributed cases, drawing on generalized versions such as those proposed by Lindeberg, Feller and Lyapunov. These extensions allow for a more accurate description of the limiting distribution of total claim costs, even under partial dependence or heterogeneity in risk profiles. The asymptotic results are then applied to estimate the probability of ruin, a fundamental measure in actuarial risk theory. **References**

[1] Cossette H., Côté M.-P., Marceau E., Mailhot M. *Collective risk models with dependence. Insurance: Mathematics and Economics*, vol. 87, 2019, pp. 153–168.

[2] Fischer H. *A History of the Central Limit Theorem: From Classical to Modern Probability Theory.* Springer, 2011.

[3] Klugman S. A., Panjer H. H., Willmot G. E. *Loss Models: From Data to Decisions. Annals of Actuarial Science*, vol. 4, no. 2, 2009, p. 343.

[4] Promislow S. D. *Fundamentals of Actuarial Mathematics*, Third Edition, Wiley, 2022.

[5] Rolski T., Schmidli H., Schmidt V., Teugels J. *Stochastic Processes for Insurance and Finance.* John Wiley & Sons, 1999.

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To be announced

Abstract: To be announced.

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Deep Learning for Energy Market Contracts: Dynkin Game with Doubly RBSDEs

Abstract: This paper examines a Contract for Difference (CfD) with early exit options, a key risk management tool in electricity markets. The contract, involving a producer and a regulatory entity, is modeled as a two-player Dynkin game with mean-reverting electricity prices and penalties for early termination.

We formulate the strategic interaction using Doubly Reflected Backward Stochastic Differential Equations (DRBSDEs), which characterize the fair contract value and optimal stopping strategies. We show that the first component of the DRBSDE solution represents the value of the Dynkin game, and that the first hitting times correspond to a Nash equilibrium. Additionally, we link the problem to a Skorokhod problem with time-dependent boundaries, deriving an explicit formula for the Skorokhod adjustment processes.

To solve the DRBSDE, we develop a deep learning-based numerical algorithm, leveraging neural networks for efficient computation. We analyze the convergence of the deep learning algorithm, as well as the value function and optimal stopping rules. Numerical experiments, including a CfD model calibrated on French electricity prices, highlight the impact of exit penalties, price volatility, and contract design. These findings offer insights for market regulators and energy producers in designing effective risk management strategies. Based on joint works with N. Agram, G. Pucci and J. Rems.

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On Carathéodory approximate scheme for a class of one-dimensional doubly perturbed diffusion processes

Abstract: In this talk, we introduce and study the convergence of new Carathéodory's approximate solution for one-dimensional α, β-doubly perturbed stochastic differential equations (DPSDEs) with parameters $\alpha < 1$ and $\beta < 1$ such that $|\rho| < 1$, where $\rho := \frac{\alpha\beta}{(1-\alpha)(1-\beta)}$. Under Lipschitz's condition on the coefficients, we establish the L^p-convergence of the Carathéodory

approximate solution uniformly in time, for all $p \geq 2$. As a consequence, and relying only on our scheme, we obtain the existence and uniqueness of strong solution for α, β-DPSDEs. Furthermore, an extension to non-Lipschitz coefficients are also studied. Our results improve earlier work by Mao and al. [2]. This talk is based on a joint work with L. Boulanba and Y. Ouknine [1].

References

1. Belfadli, R., Boulanba, L., and Ouknine, Y. (2025). On Carathéodory approximate scheme for a class of one-dimensional doubly perturbed diffusion processes. *Submitted*.
2. Mao, W., Hu, L., and Mao, X. (2018). Approximate solutions for a class of doubly perturbed stochastic differential equations. *Advances in Difference Equations*, 2018(1): 1–17.

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Malliavin-Watanabe regularity in White Noise Analysis

Abstract: In this talk we will give a slice through existing regularity theory in white noise analysis and give a direct interlink to domains of the Malliavin-Hida gradient. As examples we display the regularity of an SPDE and of certain generalized functions in white noise analysis.

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Optimal stopping problem in predictable setting

Abstract: We present some classical results concerning the optimal stopping problem, with a particular focus on the case in which the reward is given by a family $(\phi(\tau), \tau \in \mathcal{T})$ of nonnegative random variables indexed by predictable stopping times. We aim to elucidate various properties of the value function family within this context. We prove the existence of an optimal predictable stopping time, subject to specific assumptions regarding the reward function ϕ.

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Navigating Zero Returns: A Comprehensive Comparative Analysis of Log-GARCH and Stochastic Volatility Models in Financial Econometrics

Abstract: This paper presents a comprehensive comparative analysis of log-GARCH and stochastic volatility (SV) models, addressing the critical challenge of robust volatility modeling in financial econometrics, particularly in the presence of zero returns. By employing Quasi-Maximum Likelihood (QML) estimation with the Kalman filter for both asymmetric log-GARCH (ALGARCH) and asymmetric SV (ASV) models, we build upon and extend existing imputation techniques from the literature. (Franq (2013), Sucarrat (2013), and Settar (2021))
The log-GARCH model, an observation-driven approach pioneered by Geweke (1986) and Pantula (1986), is characterized by the following specification:

$$\begin{aligned} \varepsilon_t &= \sigma_t \eta_t, \quad \eta_t \sim iid(0,1) \\ \log(\sigma_{t+1}^2) &= \alpha_0 + \alpha \log(\varepsilon_t^2) + \beta \log(\sigma_t^2) \end{aligned} \tag{1}$$

where σ_t^2 denotes the conditional variance, ε_t represents the innovation term, and α_0, α, and β are parameters governing the persistence and dynamics of volatility. This approach ensures non-negativity of volatility and provides computational efficiency for real-time financial forecasting.
In contrast, the SV model introduced by Melino and Turnbull (1990) and Taylor (1994) offers greater flexibility by modeling volatility as a latent stochastic process. Our unified methodology addresses the persistent challenge of zero returns, which can significantly distort parameter estimates and hinder volatility forecasting (Sucarrat 2013).
By rigorously comparing the performance of ALGARCH and ASV models under our proposed framework, we provide novel insights into their relative strengths in capturing complex volatility dynamics. This contribution extends the existing literature by offering a comprehensive, computationally efficient solution applicable to both observation-driven and parameter-driven volatility models, with significant implications for financial risk management, option pricing, and asset allocation strategies.

References

1. Francq C., Wintenberger O., Zakoian J.M. (2013) GARCH models without positivity constraints: Exponential or log GARCH?. *J. Econom.* 177(1): 34–46. https://doi.org/10.1016/j.jeconom.2013.03.001

2. Geweke J. (1986) Modelling the Persistence of Conditional Variances: A Comment. *Econometric Rev.* 5(1): 57–61. https://doi.org/10.1080/07474938608800096

3. Melino A., Turnbull S.M. (1990) Pricing foreign currency options with stochastic volatility. *J. Econom.* 45(1–2): 239–265. https://doi.org/10.1016/0304-4076(90)90100-8

4. Pantula S.G. (1986) Modeling the persistence of conditional variances: A comment. *Econometric Reviews* 5(1): 71–74. https://doi.org/10.1080/07474938608800099

5. Settar A., Fatmi N.I., Badaoui M. (2021) Numerical estimation of log-GARCH model with relaxed moment assumptions. *J. Phys.: Conf. Ser.* IOP Publishing, p. 012036.

6. Sucarrat G., Escribano A. (2013) Unbiased QML estimation of log-GARCH models in the presence of zero returns.
7. Taylor S.J. (1994) Modeling stochastic volatility: A review and comparative study. *Math. Financ.* 4(2): 183–204.

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How martingales' space expands when its filtration is enlarged: Informational risks classification and management

Abstract: Our setting consists of the pair $(\mathbb{F}, (T_i)_{i\geq 1})$, defined on a probability space. Here, $\mathbb{F}$ is a filtration representing the "public" flow of information that is available to all agents over time. $(T_i)_i$ is a sequence of random times that might not be observable via the flow $\mathbb{F}$. These random times model the default times of firms and/or clients in credit risk, and the death time of insured in life insurance where mortality and longevity risks pose serious challenges. Thus, our framework covers these two areas and much beyond to cite a few.

As random times cannot be seen before they occur, the larger flow $\mathbb{G}$ — which incorporates $\mathbb{F}$ and makes the random times observable — is the resulting flow from the progressive enlargement of $\mathbb{F}$ with these random times. Thus, for this obtained new "informational system" represented by its filtration $\mathbb{G}$, we are interested in describing the space of all $\mathbb{G}$-martingales as explicitly as possible. In particular, we want to single out, with deep precision, the new structures that the additional information borne in the random time induces.

Precisely, we want to answer the following questions and beyond: Can we single out the martingale(s) that arise from the stochasticity of the random times only? How many are there of such martingale(s)? What are the $\mathbb{G}$-martingales that come from the flow $\mathbb{F}$ only? How do these martingales coming from $\mathbb{F}$ interplay with the martingale(s) coming from the random times? Above all, can we define a martingales-basis for the flow $\mathbb{G}$ where every $\mathbb{G}$-martingale can be decomposed with respect to this basis?

The applications of the answers to these questions, mainly in finance and economics, are numerous. Among these, I cite the explicit description of the set of all deflators for these informational markets, which is vital in solving any stochastic optimization in finance and insurance.

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A novel p-Poincaré inequality and a multiplication formula

Abstract: We show a novel family of p-Poincaré inequalities for almost surely finite random variables ($p \in [1, 2]$). Regarding the case of multiple Wiener-Itô integrals, our results yield general multiplication formulae on the Poisson space under minimal conditions, naturally expressed in terms of diagrams and/or contraction operators.

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Asymptotics of Yule's nonsense correlation for Ornstein-Uhlenbeck paths: The correlated case

Abstract: In this paper we study the asymptotics of the so-called Yule's nonsense correlation for two Ornstein-Uhlenbeck processes (X_1, X_2) that are assumed to be correlated and observed continuously over a time interval $[0, T]$. Using Malliavin Calculus and other tools from the analysis on Wiener spaces, we were able to prove that under the hypothesis of correlation, Yule's statistic is asymptotically Gaussian, and we found the rate of this convergence in law, which is of the order of $1/\sqrt{T}$ for the Wasserstein's metric. Several applications to statistical inference problems are proposed, including in particular a test of hypothesis that is proved to be asymptotically powerful.

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A new Mertens decomposition of $\mathcal{Y}^{g,\xi}$-submartingale systems and applications

Abstract: We introduce the concept of $\mathcal{Y}^{g,\xi}$-submartingale systems, where the nonlinear operator $\mathcal{Y}^{g,\xi}$ corresponds to the first component of the solution of a reflected BSDE with generator g and lower obstacle ξ. We first show that, in the case of a left-limited right-continuous obstacle, any $\mathcal{Y}^{g,\xi}$-submartingale system can be aggregated by a process which is right-lower semicontinuous.

We then prove a Mertens decomposition, by using an original approach which does not make use of the standard penalization technique. These results are in particular useful for the treatment of control/stopping game problems and, to the best of our knowledge, they are completely new in the literature. We finally present two applications in Finance.

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On a class of unbalanced step-reinforced random walks

Abstract: A step-reinforced random walk is a discrete-time stochastic process with long-range dependence. At each step, with a fixed probability α, the so-called positively step-reinforced random walk repeats one of its previous steps, chosen randomly and uniformly from its entire history. Alternatively, with probability $1 - \alpha$, it makes an independent move. For the so-called negatively step-reinforced random walk, the process is similar, but any repeated step is taken with its direction reversed.

These random walks have been introduced respectively by Simon (1955) and Bertoin (2024) and are sometimes referred to as the self-confident step-reinforced random walk and the counterbalanced step-reinforced random walk, respectively. In this work, we introduce a new class of unbalanced step-reinforced random walks for which we prove the strong law of large numbers and the central limit theorem. In particular, our work provides a unified treatment of the elephant random walk introduced by Schutz and Trimper (2004) and the positively and negatively step-reinforced random walks.

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Abstract: To be announced.

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Invariant measures for SDEs with singular and dissipative drifts

Abstract: We consider additive SDEs driven by (fractional) Brownian motion with both a dissipative and a singular drift. Under the Catellier–Gubinelli regime for the singularity, and usual growth and regularity assumptions for the dissipative drifts, we prove well-posedness of the SDE. Moreover, we prove existence and uniqueness of the invariant measure via an exponential contraction result in any m-moments.

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On Logarithmic Sobolev and Poincaré inequalities

Abstract: This course provides an introduction to Poincaré and logarithmic Sobolev inequalities, two fundamental tools in the analysis and geometry of Markov processes and diffusion-type evolution equations. Their range of applications has steadily expanded in recent years, particularly in understanding concentration of measure phenomena and in controlling convergence rates toward equilibrium for Markov semigroups. The course is aimed at young researchers and students who have completed at least the first year of a Master's program in mathematics.

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A Study of the $\frac{1}{H}$-Variation of the Divergence Integral with Respect to Fractional Brownian Motion for $H < \frac{1}{2}$

Abstract: In this talk, we study the $\frac{1}{H}$-variation of stochastic divergence integrals $X_t = \int_0^t u_s \delta B_s$ with respect to a fractional Brownian motion B with Hurst parameter $H < \frac{1}{2}$. Under suitable assumptions on the process u, we prove that the $\frac{1}{H}$-variation of X exists in $L^1(\Omega)$ and is given by

$$e_H \int_0^T |u_s|^{\frac{1}{H}} ds,$$

where $e_H = \mathbb{E}\left[|B_1|^{\frac{1}{H}}\right]$.

We also establish an integral representation for the fractional Bessel process $\|B_t\|$, where B_t is a d-dimensional fractional Brownian motion with Hurst parameter $H < \frac{1}{2}$. Using a multi-dimensional version of the result on the $\frac{1}{H}$-variation of divergence integrals, we prove that if $2dH^2 > 1$, then the divergence integral in the integral representation of the fractional Bessel process has a $\frac{1}{H}$-variation equal to a multiple of the Lebesgue measure.

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Volatility estimation of Gaussian mean-reverting Ornstein-Uhlenbeck process of the second kind

Abstract: We study the asymptotic behavior of the realised power variation of the stochastic integral $Z_t = \int_0^t u_s dY_{s,G}^{(1)}$, where u is a process with finite q-variation, $q < 1/(1-\alpha)$ and $Y_{t,G}^{(1)} = \int_0^t e^{-s} dG_{a(s)}$ with $a(t) = \alpha e^{\frac{t}{\alpha}}$, and $\{G_t, t \geq 0\}$ is a Gaussian process. In order to establish results on convergence in probability and in law stably for the realised power variation of Z, we impose some technical conditions on the process G, which are satisfied, for instance, if G is a fractional Brownian motion with Hurst parameter $\alpha \in (0,1)$, G is a subfractional Brownian motion with Hurst parameter $\alpha \in (0,1/2)$ or G is a bifractional Brownian motion with Hurst parameters $(\alpha, K) \in (0,1/2) \times (0,1]$. We use these results to construct an estimator for the integrated volatility parameter of Ornstein-Uhlenbeck processes driven by $Y_G^{(1)}$.

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McKean-Vlasov processes of bridge type

Abstract: In this paper, we introduce and study McKean–Vlasov processes of bridge type. Specifically, we examine a stochastic differential equation (SDE) of the form:

$$\mathrm{d}\xi_t = -\mu(t, \mathbb{E}[\varphi_1(\xi_t)])\frac{\xi_t}{T-t}\mathrm{d}t + \sigma(t, \mathbb{E}[\varphi_2(\xi_t)])\mathrm{d}W_t,\ t < T,$$

where μ and σ are deterministic functions that depend on time t and the expectation of given functions φ_1 and φ_2 of the process, and W is a Brownian motion. We establish the existence and uniqueness of solutions to this equation and analyze the behavior of the process as t approaches T. Furthermore, we provide conditions ensuring the pinned property of the process ξ. Finally, we explore explicit solutions in specific cases of interest, including power-weighted expectations and second moments in the drift.

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Risk Quantification of Cumulative Losses Exhibiting Contagion and Cross Dependencies

Abstract: Risk analysis for credit or actuarial portfolios is usually based on the study of the so-called cumulative loss process

$$L_T = \sum_{i=1}^{N_T} Y_i, \quad T \geq 0.$$

$(N_t)_{t\geq 0}$ is a counting process that models the arrivals of the claims, as the defaults for a credit portfolio, or the sinistres for an insurance portfolio, while the random variables $(Y_i)_i$ model the claims amounts.

We extend the classic Cramer-Lundberg model by allowing contagion and dependency phenomena, as observed in credit risk or cyber risk. This model (called Multivariate Self-Exciting Process with Dependencies) is an extension of the Hawkes process in which the excitation kernel is affected by the claims sizes, and thus introduces dependencies between the severity and the frequency components.

Using new technics at the crossroad of the so-called Poisson imbedding and Malliavin's calculus, we develop theoretical results on such processes and present several applications in terms of risk quantification.

Based on joint works with Thomas Peyrat and Anthony Réveillac.

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Fokker-Planck equations with terminal condition and related McKean probabilistic representation

Abstract: Stochastic differential equations (SDEs) in the sense of McKean are stochastic differential equations, whose coefficients do not only depend on time and on the position of the solution process, but also on its marginal laws. Often they constitute probabilistic representation of conservative PDEs, called Fokker-Planck equations.

In general, Fokker-Planck PDEs are well-posed if the initial condition is specified. Here, alternatively, we consider the inverse problem which consists in prescribing the final data: in particular we give sufficient conditions for existence and uniqueness.

We also provide a probabilistic representation of those PDEs in the form of a solution of a McKean type equation corresponding to the time-reversal dynamics of a diffusion process.

The research is motivated by some application consisting in representing some semilinear PDEs (typically Hamilton-Jacobi-Bellman in stochastic control) fully backwardly.

This work is based on a collaboration with L. Izydorczyk (Mazars), N. Oudjane (EDF), G. Tessitore (Milano Bicocca).

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Geometric properties of rough curves via dynamical systems: SBR measure, local time, Rademacher chaos and number theory

Abstract: We investigate geometric properties of graphs of Takagi and Weierstrass type functions, represented by series based on smooth functions. They are Hölder continuous, and can be embedded into smooth dynamical systems, where their graphs emerge as pullback attractors. It turns out that occupation measures and Sinai-Bowen-Ruelle (SBR) measures on their stable manifolds are dual by "time" reversal.

A suitable version of approximate self-similarity for deterministic functions allows to "telescope" small scale properties from macroscopic ones, and leads to representations of relevant functionals along dyadic expansions. As one consequence, absolute continuity of the SBR measure is seen to be dual to the existence of local time.

The investigation of questions of smoothness both for SBR and for occupation measures surprisingly leads us to the Rademacher version of Malliavin's calculus, Bernoulli convolutions, and into probabilistic number theory. The link between the rough curves considered and smooth dynamical systems can be generalized in various ways. For instance, Gaussian randomizations of Takagi curves just reproduce the trajectories of Brownian motion.

Applications to regularization of singular ODEs by rough signals are envisaged. This is joint work with O. Pamen (University of Liverpool and AIMS Ghana) and F. Proske (University of Oslo).

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MEASURE-VALUED CARMA PROCESSES

Abstract: In this paper, we examine continuous-time autoregressive moving-average (CARMA) processes on Banach spaces driven by Lévy subordinators. We show their existence and cone-invariance, investigate their first and second order moment structure, and derive explicit conditions for their stationarity.

Specifically, we define a measure-valued CARMA process as the analytically weak solution of a linear state-space model in the Banach space of finite signed measures. By selecting suitable input, transition, and output operators in the linear state-space model, we show that the resulting solution possesses CARMA dynamics and remains in the cone of positive measures defined on some spatial domain.

We also illustrate how positive measure-valued CARMA processes can be used to model the dynamics of functionals of spatio-temporal random fields and connect our framework to existing CARMA-type models from the literature, highlighting its flexibility and broader applicability.

This is a joint work with F.E. Benth and S. Karbach.

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Steady state coupled Hidden Markov Model

Abstract: We interest to the computation of the steady state probability law of coupled hidden Markov chains, whose state space and emission space are finite and bi-dimensional.

Principally, we use the Markov chain regenerative property to get estimation for steady state for both the Markov chain and the emission process. Also, we study the asymptotic normality of the proposed estimator for the emission steady state.

Performances of the proposed estimators are well tested through a sample of numerical Monte Carlo examples.

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A Modified Lévy-Based Information Process for Modeling Non-Markovian Information Flow

Abstract: In the classical information-based framework introduced by Brody, Hughston, and Macrina, the flow of information about a future payoff is modeled by a Markovian process. In this paper, we propose a modified approach in which the information process, although built from Markovian components, becomes non-Markovian due to its structural form. This leads to a richer but more intricate information flow, making key quantities such as the conditional expectation of the terminal payoff more difficult to compute.

We analyze the stochastic properties of the resulting process, derive its semimartingale decomposition, and demonstrate how it extends the information-based modeling framework to situations where the payoff evolves stochastically over time and may exhibit jumps.

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American option pricing using generalised stochastic hybrid systems

Abstract: In this work we present a novel approach to pricing American options using piecewise diffusion Markov processes (PDifMPs), a type of generalised stochastic hybrid system that integrates continuous dynamics with discrete jump processes. Standard models often rely on constant drift and volatility assumptions, which limits their ability to accurately capture the complex and erratic nature of financial markets.

By incorporating PDifMPs, our method accounts for sudden market fluctuations, providing a more realistic model of asset price dynamics. We benchmark our approach with the Longstaff-Schwartz algorithm, both in its original form and modified to include PDifMP asset price trajectories. Numerical simulations demonstrate that our PDifMP-based method not only provides a more accurate reflection of market behaviour but also offers practical advantages in terms of computational efficiency.

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Well-Posedness and Regularity of SDEs on the Plane with Non-Smooth Drift

Abstract: In this talk, we discuss the existence, uniqueness, and regularization by noise for stochastic differential equations (SDEs) on the plane. These equations can also be interpreted as quasi-linear hyperbolic stochastic partial differential equations (HSPDEs).

More specifically, we address path-by-path uniqueness for multidimensional SDEs on the plane, under the assumption that the drift coefficient satisfies a spatial linear growth condition and is componentwise non-decreasing.

In the case where the drift is only measurable and uniformly bounded, we show that the corresponding additive HSPDE on the plane admits a unique strong solution that is Malliavin differentiable. Our approach combines tools from Malliavin calculus with variational techniques originally introduced by Davie (2007), which we non-trivially extend to the setting of SDEs on the plane.

This talk is based on a joint works with A. M. Bogso, M. Dieye and F. Proske.

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Analysis of generalized negative binomial distributions attached to hyperbolic Landau levels

Abstract: To each hyperbolic Landau level of the Poincaré disc is attached a generalized negative binomial distribution. In this paper, we compute the moment generating function of this distribution and supply its atomic decomposition as a perturbation of the negative binomial distribution by a finitely supported measure. Using the Mandel parameter, we also discuss the nonclassical nature of the associated coherent states.

Next, we derive a Lévy-Khintchine-type representation of its characteristic function when the latter does not vanish and deduce that it is quasi-infinitely divisible except for the lowest hyperbolic Landau level corresponding to the negative binomial distribution. By considering the total variation of the obtained quasi-Lévy measure, we introduce a new infinitely divisible distribution for which we derive the characteristic function.

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On the uniqueness of solutions of quadratic BSDEs with convex generators

Abstract: We study the uniqueness of solutions of backward stochastic differential equations (BSDEs), whose generator has a growth condition with respect to z of the form $f(|y|)|z|^2$, where the function f is positive, continuous and increasing. The uniqueness of solutions of such BSDEs is derived when the generator is jointly convex.

As a byproduct, we show the existence of viscosity solutions to semilinear partial differential equations, which can contain nonlinearity that has quadratic growth in the gradient of the solution.

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Switching Problem and reflected backward stochastic differential equations

Abstract: We consider an electricity producing company which can produce electricity through different means, e.g., solar cells, wind power stations and oil power plants. Due to fluctuations in the spot price of electricity, spot price of oil, solar radiation and wind strength, the optimal way (in terms of revenue) to produce electricity varies. Changing the production mode will in many cases incur costs for the company as investements/disinvestments in technology and/or staff may be necessary.
The manager of the company must decide, based on her beliefs of unknown parameters such as weather, electricity spot price, etc..., which mode of production to use and when to switch to a new mode. An optimal management stragtegy is needed to manage the production and maximize the expected optimal profit.
Mathematically speaking, consider a production facility which can run the production in $d, d \geq 2$, different production modes. Denote the set of available modes by $\mathcal{D} = \{1, \ldots, d\}$ and let $\mathcal{D}^{-i} = \{1, \ldots, i-1, i+1, \ldots, d\}$. Let $X = \{X_t\}_{t \geq 0}$ be a vector-valued Markovian stochastic process representing random factors that influence the profitability of the production, e.g., the market price of the underlying commodities, weather, and market demand of the produced goods.
The process X may be a Brownian motion or some other more general stochastic process, possibly with jumps. Let the running payoff in production mode i, at time t, be $\psi_i(X_t, t)$ and let $c_{i,j}(X_t, t)$ denote the cost of switching from mode i to mode j at time t.
A management strategy is a combination of a non-decreasing sequence of stopping times $\{\tau_k\}_{k \geq 0}$, where at time τ_k, the manager decides to switch the production from its current mode to another, and a sequence of indicators $\{\xi_k\}_{k \geq 0}$, taking values in $\mathcal{D}$, indicating the mode to which the production is switched.
For a strategy starting in mode i at time t, we have $\tau_0 = t$ and $\xi_0 = i$. At τ_k the production is switched from mode ξ_{k-1} to ξ_k. A strategy $\left(\{\tau_k\}_{k \geq 0}, \{\xi_k\}_{k \geq 0}\right)$ can be represented by the function $\mu : [0, T] \to \mathcal{D}$ defined as

$$\mu_s = \sum_{k \geq 0} \xi_k \mathbf{1}_{(\tau_k, \tau_{k+1})}(s)$$

When the production is run using a strategy μ, defined by $\left(\{\tau_k\}_{k \geq 0}, \{\xi_k\}_{k \geq 0}\right)$, over a finite horizon $[0, T]$, the total expected profit is

$$\mathbb{E}\left[\int_0^T \psi_{\mu_s}(X_s, s)\, ds - \sum_{\substack{k \geq 1 \\ \tau_k \leq T}} c_{\xi_{k-1}, \xi_k}(X_{\tau_k}, \tau_k)\right].$$

Similarly, given that the stochastic process X starts from x at time t, the profit made using strategy μ, over the time horizon $[t, T]$, is

$$J(x, t, \mu) := \mathbb{E}\left[\int_t^T \psi_{\mu_s}(X_s, s)\, ds - \sum_{\substack{k \geq 1 \\ \tau_k \leq T}} c_{\xi_{k-1}, \xi_k}(X_{\tau_k}, \tau_k) \mid X_t = x\right].$$

The optimal switching problem now consists in finding the value function

$$v(x,t)=\sup_{\mu} J(x,t,\mu),$$

and an optimal management strategy μ^*, defined by $\left(\{\tau_k^*\}_{k\geq 0}, \{\xi_k^*\}_{k\geq 0}\right)$, such that

$$J\left(x,t,\mu^*\right) \geq J(x,t,\mu)$$

There are today basically three different approaches available to tackle the optimal switching problem. Two of them are based on stochastic techniques, in particular Snell envelopes and backward stochastic differential equations, and one is of deterministic type, making use of variational inequalities/obstacle problems.
The purpose of this presentation is to give a summary of the stochastic techniques used in the optimal switching control.

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To be announced

Abstract: To be announced.

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Doubly Reflected Backward Stochastic Differential Equations Driven by Jump Markov Process

Abstract: In this work, we investigate two classes of doubly reflected backward stochastic differential equations (DRBSDEs) driven by both pure jump Markov and jump semi-Markov processes. We establish both existence and uniqueness of solutions under the Mokobodzki condition, which requires the existence of a difference of non-negative supermartingales lying between the upper and lower reflecting barriers.

Our approach employs a combination of the Snell envelope method and a fixed point theorem, through which we construct two carefully chosen supermartingales that serve as the backbone of our analysis.

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BSDEs with central value reflection

Abstract: This work focuses on the well-posedness of a backward stochastic differential equation (BSDE) with jumps and central value reflection. The reflection constraint is applied to the real-valued function defined as the unique solution of the equation $\mathbb{E}(\arctan(Y_t - x)) = 0$ at each time $t \in [0, T]$.

The driver of the BSDE depends on the distribution of the component Y of the solution and follows a general quadratic-exponential structure, while the terminal value is assumed to be bounded. Using a fixed-point argument and BMO martingale theory, we establish the existence and uniqueness of local solutions, which are then combined to construct a global solution over the entire time interval $[0, T]$.

A joint work with my PhD student Kaoutar Nasroallah.

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Stability analysis of a branching diffusion solver for nonlinear PDEs

Abstract: Stochastic branching algorithms provide a useful alternative to grid-based schemes for the numerical solution of partial differential equations, particularly in high-dimensional settings. However, they require a strict control of the integrability of random functionals of branching processes in order to ensure the non-explosion of solutions.

In this talk, we study the stability of a functional branching representation of PDE solutions by deriving sufficient criteria for the integrability of the multiplicative weighted progeny of stochastic branching processes. We also prove the uniqueness of mild solutions under uniform integrability assumptions on random functionals.

(Joint work with Qiao Huang)

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Fokker-Planck equations with terminal condition and related McKean probabilistic representation

Abstract: Stochastic differential equations (SDEs) in the sense of McKean are stochastic differential equations, whose coefficients do not only depend on time and on the position of the solution process, but also on its marginal laws. Often they constitute probabilistic representation of conservative PDEs, called Fokker-Planck equations.

In general Fokker-Planck PDEs are well-posed if the initial condition is specified. Here, alternatively, we consider the inverse problem which consists in prescribing the final data: in particular we give sufficient conditions for existence and uniqueness.

We also provide a probabilistic representation of those PDEs in the form a solution of a McKean type equation corresponding to the time-reversal dynamics of a diffusion process.

The research is motivated by some application consisting in representing some semilinear PDEs (typically Hamilton-Jacobi-Bellman in stochastic control) fully backwardly.

This work is based on a collaboration with L. Izydorczyk (Mazars), N. Oudjane (EDF), G. Tessitore (Milano Bicocca).

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Identification and existence of Boltzmann processes

Abstract: The stochastic differential equation of McKean-Vlasov type is identified such that the Fokker-Planck equation associated to it is the Boltzmann equation. Hence, we call its solutions as Boltzmann processes. They describe the dynamics (in position and velocity) of particles expanding in vacuum in accordance with the Boltzmann equation. Given a solution $f := \{f(t,x,v)\}_{0\leq t\leq T}$ of the Boltzmann equation, the existence of solutions to the McKean-Vlasov SDE is established for the cut-off and (under suitable conditions) for the non-cutoff hard sphere case.

This is a joint work with P. Sundar (Louisiana State University).

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Strong solutions for singular SDEs driven by long-range dependent fractional Brownian motion and other Volterra processes

Abstract: We investigate the well-posedness of stochastic differential equations driven by fractional Brownian motion, focusing on the long-range dependent case $H \in (\frac{1}{2}, 1)$. While existing results on regularization by such noise typically require Hölder continuity of the drift, we establish new strong existence and uniqueness results for certain classes of singular drifts, including discontinuous and highly irregular functions.

More generally, we treat stochastic differential equations with additive noise given by a broader class of Volterra processes satisfying suitable kernel conditions, which, in addition to fractional Brownian motion, also includes the Riemann-Liouville process as a special case. Our approach relies on probabilistic arguments.

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Model Risk Hedging Through Distributionally Robust Sensitivity

Abstract: Distributionally robust optimization studies the worst deviation of an evaluation functional on the Wasserstein ball centered at the model of interest. We derive explicit sensitivity analysis under marginal and martingale constraints which provide first order semi-static hedge against model risk.

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Stein-Malliavin calculus and asymptotic independence

Abstract: We will present a generalization of the Stein-Malliavin calculus that allows to quantify the asymptotic independence. We will also discuss the applications of this method to central and non-central limit theorems and to the asymptotic behavior of some parameters estimators for stochastic (partial) differential equations.

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Latent SDE on Homogeneous Spaces

Abstract: We consider the problem of variational Bayesian inference in a latent variable model where a (possibly complex) observed stochastic process is governed by the solution of a latent stochastic differential equation (SDE). Motivated by the challenges that arise when trying to learn an (almost arbitrary) latent neural SDE from data, such as efficient gradient computation, we take a step back and study a specific subclass instead. In our case, the SDE evolves on a homogeneous latent space and is induced by stochastic dynamics of the corresponding (matrix) Lie group. In learning problems, SDEs on the unit n-sphere are arguably the most relevant incarnation of this setup. Notably, for variational inference, the sphere not only facilitates using a truly uninformative prior, but we also obtain a particularly simple and intuitive expression for the Kullback-Leibler divergence between the approximate posterior and prior process in the evidence lower bound. Experiments demonstrate that a latent SDE of the proposed type can be learned efficiently by means of an existing one-step geometric Euler-Maruyama scheme. Despite restricting ourselves to a less rich class of SDEs, we achieve competitive or even state-of-the-art results on various time series interpolation/classification problems.

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