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Συντονιστές: Α. Παπαπαντολέων, Σ. Σαμπάνης, Α. Σαπλαούρας

Ομιλητές

Σέργιος Αγαπίου (Πανεπιστήμιο Κύπρου)

A Bayesian path to adaptive function estimation: from Gaussian to Cauchy through Laplace priors

In this talk we will overview recent results in the study of function estimation in typical nonparametric statistical models. In particular, we will consider a Bayesian approach, in which we postulate a *prior* distribution on the unknown function, which combined with the available data (through the *likelihood*), gives rise to an updated distribution on the unknown function termed the *posterior* distribution. We will be interested in studying the asymptotic performance of the posterior distribution in the infinitely informative data limit, in terms of rates of contraction around a postulated true function underlying the data. We will be especially interested in priors which are adaptive to the smoothness of the unknown function (in the minimax sense).

In the last two decades this problem has received great attention in the Bayesian nonparametric statistics literature, with early work mainly studying Gaussian process priors. We will present our own contribution, which started with a study of a class of logarithmically concave priors (including Laplace) based on abstract concentration of measure results, and ultimately led to the remarkable result that oversmoothing heavy-tailed priors (including Cauchy) have fantastic adaptation properties.

Μιχάλης Ανθρωπέλος (Πανεπιστήμιο Πειραιώς)

Continuous-time Equilibrium Returns in Markets with Price Impact and Transaction Costs

The topic of this talk is to explore the interplay between (endogenous) price impact and (exogenous) transaction costs, within a dynamic equilibrium model. In particular, we will consider an Itô financial market in which the returns of risky assets are determined endogenously through a market-clearing condition amongst heterogeneous risk-averse investors with quadratic preferences and random endowments. Therein, investors act strategically by taking into account the effect of their orders on the assets' drift. In order to fix ideas, we will begin with the simpler case of a frictionless market—focusing on the (unique) Nash equilibrium. In this setting, the investors' demand processes reveal hedging needs that differ from their true ones, resulting in a deviation from the competitive equilibrium returns. When transaction costs are introduced, the Nash equilibrium is characterized via the unique solution of a system of Forward–Backward Stochastic Differential Equations (FBSDEs), from which we will obtain an explicit expression for the resulting equilibrium returns. Within this framework, when investors share the same risk aversion and no noise traders are present, transaction costs leave equilibrium returns unaffected. By contrast, once noise traders enter the market, the effect of transaction costs on returns is amplified through price impact.

Joint work with Constantinos Stefanakis.

Δήμητρα Αντωνοπούλου (Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών)

Stochastic Numerical Methods for Phase Transitions

We consider a class of stochastic equations from phase transitions such as the ε-dependent stochastic Cahn-Hilliard and stochastic Allen-Cahn equations where ε parameterises the width of transitional layers in binary alloys during phase separation. We present continuous and discontinuous Galerkin finite element methods for the numerical approximation of the stochastic solutions and the associated stochastic regularity of the continuous problems. Finally, we discuss briefly some recent results for the stochastic Stefan problem from finance where the two phases are separated by a moving boundary enclosing the financial spread and introduce a path-wise numerical approximation suitable for maximal solutions.

Αθανάσιος Βασιλειάδης (Karslsruhe Institute of Technology)

A new implicit Policy Gradient for Distributional Reinforcement Learning

Distributional Reinforcement Learning (DRL) has been a recent generalization of classical RL where instead of focusing on the conditional expectation of a (discounted) cumulative reward given the initial state, the classical value function of control literature, we are interested in the whole distribution of the terminal cumulative reward. Our goal in this talk is to develop a new Policy Gradient algorithm to find optimal controls that match this distribution of the terminal cumulative reward with a target one. We will present a probabilistic convergence proof and illustrate with numerical examples.

Ιωάννης Γαστεράτος (TU Berlin)

Kolmogorov equations for stochastic Volterra processes with singular kernels

We associate backward and forward Kolmogorov equations to a class of fully nonlinear Stochastic Volterra Equations (SVEs) with convolution kernels K that are singular at the origin. Working on a carefully chosen Hilbert space $\mathcal{H}_1$, we rigorously establish a link between solutions of SVEs and Markovian mild solutions of a Stochastic Partial Differential Equation (SPDE) of transport-type. Using this Markovian lift, we obtain novel Itô formulae for functionals of mild solutions and, as a byproduct, show that their laws solve corresponding Fokker–Planck equations. Finally, we introduce a natural notion of "singular" directional derivatives along K and prove that (conditional) expectations of SVE solutions can be expressed in terms of the unique solution to a backward Kolmogorov equation on $\mathcal{H}_1$. Our analysis relies on stochastic calculus in Hilbert spaces, the reproducing kernel property of the state space $\mathcal{H}_1$, as well as crucial invariance and smoothing properties that are specific to the SPDEs of interest. In the special case of singular power-law kernels, our conditions guarantee well-posedness of the backward equation either for all values of the Hurst parameter H, when the noise is additive, or for all $H > 1/4$ when the noise is multiplicative. Time permitting, we shall discuss applications to mathematical finance as well as a few open problems.

Based on joint work with Alexandre Pannier (Université Paris Cité).

Κωνσταντίνος Δαρειώτης (University of Leeds)

Regularisation by Gaussian rough path lifts of fractional Brownian motions

In this talk we will discuss the solvability of rough differential equations with distributional drift driven by the Gaussian rough path lift of fractional Brownian motion with Hurst parameter $H \in (1/3, 1/2)$. Under the assumption that the noise coefficient is uniformly elliptic and sufficiently regular and that the drift is a distribution in the Hölder-Besov space $\mathcal{C}^\alpha$ with $\alpha > 1 - 1/(2H)$, we will see that the equation admits a unique strong solution. The condition $\alpha > 1 - 1/(2H)$ matches the one of the additive noise setting from [Catellier-Gubinelli, 2016] thereby providing a complete multiplicative analogue.

This is joint work with M. Gerencsér, K. Lê, and C. Ling.

Ευαγγελία Δραγάζη (Εθνικό Μετσόβιο Πολυτεχνείο)

Improved model-free bounds for multi-asset options using option-implied information

We consider the computation of model-free bounds for multi-asset options in a setting that combines dependence uncertainty with additional information on the dependence structure. More specifically, we consider the setting where the marginal distributions are known and partial information, in the form of known prices for multi-asset options, is also available in the market. We provide a fundamental theorem of asset pricing in this setting, as well as a superhedging duality that allows to transform the maximization problem over probability measures in a more tractable minimization problem over trading strategies. The latter is solved using a penalization approach. The numerical method is fast and the computational time scales linearly with respect to the number of traded assets. We finally examine the significance of various pieces of additional information. Empirical evidence suggests that "relevant" information, i.e. prices of derivatives with the same payoff structure as the target payoff, are more useful that other information, and should be prioritized in view of the trade-off between accuracy and computational efficiency.

Στέφανος Θεοδωρακόπουλος (Technische Universität Berlin)

Particle systems and the backward propagation of chaos

The notion of propagation of chaos received renewed interest after Lasry and Lions used it to show that mean field games are "good" aproximators for N-player games. Although the propagation of chaos property has been extensively studied for forward stochastic differential equations, only a handful of papers have been published so far for backward stochastic differential equations (BSDEs). In this talk we are going to see what is backward propagation of chaos, and we are going to establish it under very general conditions that allow for asymmetric N-player games, both in terminal conditions and generators, where the drivers are general square integrable martingales with independent increaments, in other words, we study discrete- and continuous-time systems of mean-field BSDEs and McKean-Vlasov BSDEs in a unified setting. Furthermore, the usual convergence rates will hold under mild assumptions. Finally, we are going to introduce and establish a notion of stability for the backward propagation of chaos with respect to (initial) data sets, we shall consider the convergence scheme of the backward propagation of chaos as the image of the corresponding data set under which this scheme is established. Then, using an appropriate notion of convergence for data sets, we are able to show a variety of continuity properties for this functional point of view.

Ευαγγελία Καλλιγιαννάκη (Πανεπιστήμιο Αιγαίου)

Transient-time inference for Stochastic Differential Equations

Transient dynamics play a decisive role in many complex stochastic systems, yet most modeling frameworks remain oriented toward long-time or steady-state behavior. This presentation develops a methodology for transient-time modeling, grounded in path-space formulations and information-theoretic principles. Central tools include path-space force matching, and relative-entropy–based inference, which together enable the systematic extraction of short-time and intermediate-time behavior directly from data or detailed simulations. These methods provide rigorous ways to characterize out of equilibrium evolution, and quantify uncertainty during fast transient regimes. Molecular systems illustrate how early-time and metastable behaviors can be captured. The resulting framework offers a principled and versatile approach to predicting and interpreting transient phenomena across diverse stochastic settings.

Στέλλα Καποδίστρια (Eindhoven University of Technology)

Model-Based Analysis of Bitcoin Confirmation Times and Optimal Fee Selection

Bitcoin confirmation times are highly variable and strongly influenced by transaction fees. Existing fee calculators, though fast, are often opaque and limited in scope. We present a transparent, model-based framework using the Cramér-Lundberg model to estimate the minimum fee needed for confirmation within a desired timeframe. The model's simplicity enables parameter estimation directly from publicly available mempool data, thereby combining the strengths of model-based and data-driven methods.

Our contributions are threefold: (1) we show that the model effectively captures mempool dynamics while unifying existing approaches, (2) we validate the model against real-world data, confirming close alignment with observed confirmation times, and (3) we propose a Brownian motion approximation that yields accurate, near-instant predictions under heavy traffic. Since the underlying model is càdlàg, convergence in the Skorohod $D[0,\tau]$ space ($\tau > 0$) can be extended to show the convergence in distribution of confirmation times.

This holistic approach balances theoretical rigor with practical usability, offering Bitcoin users and researchers a robust tool for fee optimization and transaction time prediction.

This is joint work with Rowel C. Gündlach, Ivo V. Stoepker, and Jacques A. C. Resing.

Νικόλαος Κολλιόπουλος (Πανεπιστήμιο Κύπρου)

Minimal regret and minimizing strategy in prediction with advice from 5 *experts*

Prediction with Expert Advice refers to a classical problem that arises in Machine Learning, which concerns the optimal choice of a subset of a set of N experts to follow their advice at multiple times before a terminal time T, with the objective being the minimization of the expected total number of bad choices and non-choices until the terminal time T (which is called "regret"). Works started in the 1960s have given the optimal strategy and the minimum regret when $N \leqslant 4$. In a setup where $T \sim \mathrm{Geom}(\delta)$, the problem of finding the asymptotically optimal strategy as $\delta \to 0^+$ reduces to a continuous-time stochastic optimal control problem, where the value functions of various strategies are given in terms of $(N-1)$-dimensional reflected Brownian motions. In that setup, we obtain a precise formula for the value function of the conjectured optimal strategy for $N = 5$, which becomes possible by finding closed-form solutions to certain 2nd order PDEs with non-constant coefficients and gives a regret $\frac{45\pi^2}{512\sqrt{2\delta}} + o(\delta^{-1/2})$. Proving or disproving the conjecture is now a matter of checking whether the computed value function satisfies a nonlinear PDE of Hamilton-Jacobi-Bellman type.

Joint work with Erhan Bayraktar and Ibrahim Ekren

Δημήτριος Κωνσταντινίδης (Πανεπιστήμιο Αιγαίου)

Uniform asymptotics for a multidimensional renewal risk model with multivariate subexponential claims

We investigate a multidimensional risk model driven by a common renewal process under a constant force of interest. The claim sizes generated by each line of business are independent and identically distributed random vectors with possibly dependent components, and their common distribution belongs to the class of multivariate subexponential distributions. We derive locally uniform asymptotic estimates for the probability that discounted aggregate claims enter certain 'rare sets', and extend these to uniform estimates over all time horizons under some extra mild conditions. As a direct application, we obtain uniform estimates for the finite-time ruin probability defined using various ruin sets. Additionally, we provide examples of distributions belonging to these multivariate heavy-tailed classes, which are not limited to the case of multivariate regular variation.

Joint work with Jiajun Liu and Charalampos Passalidis.

Ιωσήφ Λύτρας (Archimedes Research Unit / Athena Research Centre και Εθνικό Μετσόβιο Πολυτεχνείο)

Contractive kinetic Langevin samplers beyond global Lipschitz continuity

We examine the problem of sampling from log-concave distributions with (possibly) superlinear gradient growth under kinetic (underdamped) Langevin algorithms. Using a carefully tailored taming scheme, we propose two novel discretizations of the kinetic Langevin SDE, and we show that they are both contractive and satisfy a log-Sobolev inequality. Building on this, we establish a series of non-asymptotic bounds in Wasserstein distance between the law reached by each algorithm and the underlying target measure.

This a joint work with Panagiotis Mertikopoulos.

Χαράλαμπος Πασσαλίδης (Πανεπιστήμιο Αιγαίου)

Asymptotics for aggregated interdependent multivariate subexponential claims with general investment returns

We investigate asymptotic estimates for the entrance probability of the discounted aggregate claim vector from a multivariate renewal risk model into some rare set. We provide asymptotic results for the entrance probability on both finite and infinite time horizons under various assumptions regarding the stochastic price process of the investment portfolio, the distribution class of claim vectors, and the dependence structure among the claim vectors. We note that the main results extend beyond the class of multivariate regular variation. Furthermore, we introduce two dependence structures to model the dependence among the claim vectors. The immediate consequence of the main results is the asymptotic estimates of the ruin probabilities on finite and infinite time horizons.

Joint work with Zhangting Chen and Dimitrios Konstantinides.