THIRD ITALIAN MEETING ON PROBABILITY & MATHEMATICAL STATISTICS

BOLOGNA | JUNE 13TH –16TH, 2022

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

PROGRAM

Plenary Speakers

Federico Camia, Sandra Cerrai,
Andrea Montanari, Igor Prünster,
Wolfgang Runggaldier

SCIENTIFIC COMMITTEE

Claudia Ceci, Paolo Dai Pra, Antonio Di Crescenzo, Franco Fagnola, Marco Ferrante, Franco Flandoli, Antonio Lijoi, Domenico Marinucci, Andrea Pascucci, Franco Pellerey, Laura Sacerdote.

ORGANIZING COMMITTEE

Fabio Antonelli, Elena Bandini, Massimo Campanino, Andrea Cosso, Marco Di Francesco, Cristina Di Girolami, Alberto Lanconelli, Giacomo Lucertini, Stefano Pagliarani, Andrea Pascucci, Antonello Pesce, Pietro Rigo, Tiziano Vargiolu.

PARTNERS

Third Italian Meeting on Probability and Mathematical Statistics

June 13-16, 2022, Bologna

Venue: Building A of "Complesso Belmeloro", located in Via Andreatta 8, Bologna.

Conference rooms:

- **Ground floor**: Room A, Room G
- **First floor**: Room B, Room C, Room F
- **Second floor**: Room E

Working spaces:

- Room D at the second floor of Building A
- Room located at the ground floor in Via Filopanti 5 (see the map on the conference website)

QR-code to the program:

Program

Monday 13th, June

09:30	Registration
10:30	Opening
11:00	Plenary talk (Room B) *Wolfgang Runggaldier*
12:00	Lunch

Sessions

	Room A	Room B	Room C	Room E	Room F	Room G
	Recent perspectives on moment problems Organizers/Chairs *Maria Infusino* *Tobias Kuna*	*Partial information: stochastic models and applications* Organizer/Chair *Claudia Ceci*	*Scaling limits, criticality, and random media in statistical physics* Organizers/Chairs *Lorenzo Dello Schiavo* *Federico Sau*	*Markov processes and first passage time problems* Organizer/Chair *Barbara Martinucci*	*Reliability of systems and measures of discrimination* Organizers/Chairs *Francesco Buono* *Maria Longobardi*	*Nonlocal operators in probability: anomalous diffusions* Organizers/Chairs *Mirko D'Ovidio* *Giacomo Ascione*
13:50	Tobias Kuna	Giorgia Callegaro	Vittoria Silvestri	Mario Abundo	Fabio Spizzichino	Luisa Beghin
14:15	Raul Curto	Alessandro Calvia	Tal Orenshtein	Bernardo D'Auria	Marco Capaldo	Lorenzo Cristofaro
14:40	Valter Moretti	Katia Colaneri	Francesca Collet	Elvira Di Nardo	Francesco Buono	Costantino Ricciuti
15:05	Pier Luigi Novi Inverardi	Tiziano De Angelis	Alice Callegaro	José Antonio Salmerón	Maria Longobardi	Andrea Ghiglietti

15:30	Coffee break

Sessions

	Room A	Room B	Room C	Room E	Room F	Room G
	Stochastic optimal transport Organizer/Chair *Alberto Chiarini*	*Stochastic models for energy, management, and environmental issues* Organizers/Chairs *Alessandro Calvia* *Katia Colaneri*	*Interacting particle systems* Organizer/Chair *Matteo Quattropani*	*Stochastic methods in quantum theory* Organizers/Chairs *Sonia Mazzucchi* *Stefania Ugolini*	*Nonparametric inference on complex dependence structures* Organizer/Chair *Stefano Rizzelli*	*Nonlocal operators in probability: nonlocal boundary conditions* Organizer/Chair *Bruno Toaldo*
16:00	Katharina Eichinger	Sara Biagini	Federico Sau	Francesco De Vecchi	Marta Catalano	Fausto Colantoni
16:25	Giacomo Greco	Athena Picarelli	Assaf Shapira	Nicolò Drago	Alessia Caponera	Mirko D'Ovidio
16:50	Richard Kraaij	Salvatore Federico	Nicolas Forien	Salvatore Ivan Trapasso	Nicola Gnecco	Francesco Iafrate
17:15	Luca Tamanini	Tiziano Vargiolu	Enrico Di Gaspero	Luigi Borasi	Daniela De Canditiis	

17:40 18:30	Poster session (first floor): Luis Mario Chaparro Jáquez, Serena Della Corte, Giulia Della Croce, Giacomo Giorgio, Elena Sabbioni

Tuesday 14th, June

9:20	Plenary talk (Room B) *Sandra Cerrai*
10:20	Coffee break

	Sessions					
	Room A	Room B	Room C	Room E	Room F	Room G
	Mean field games: a probabilistic approach Organizers/Chairs *Luciano Campi* *Markus Fischer*	*PDEs and their applications to stochastic analysis* Organizer/Chair *Elena Issoglio*	*On stochastic methods, models and applications* Organizer/Chair *Elvira Di Nardo*	*Options, algebra and probability: in memory of Peter Carr* Organizer/Chair *Umberto Cherubini*	*Semi-Markov dynamics* Organizers/Chairs *Giacomo Ascione* *Bruno Toaldo*	*Contributed session I* Chair *Giuseppe Sanfilippo*
10:50	Ofelia Bonesini	Enrico Priola	Verdiana Mustaro	Lorenzo Torricelli	Enrico Scalas	Giovanni Pistone
11:15	Matteo Burzoni	Antonello Pesce	Giuseppe D'Onofrio	Sabrina Mulinacci	Bruno Toaldo	Giuseppe Sanfilippo
11:40	Jodi Dianetti	Antonio Agresti	Antonella Iuliano	Paolo Neri	Enrica Pirozzi	Serena Doria
12:05	Giorgio Ferrari	Elena Issoglio	Barbara Martinucci	Umberto Cherubini	Alessandro Zocca	Rita Giuliano

12:30	Lunch

	Sessions					
	Room A	Room B	Room C	Room E	Room F	Room G
	Mathematics of machine learning Organizers/Chairs *Ernesto De Vito* *Lorenzo Rosasco*	*SPDEs arising in physical models* Organizer/Chair *Michele Coghi*	*Stochastic processes with applications to the natural sciences* Organizer/Chair *Giuseppe D'Onofrio*	*Risk management* Organizers/Chairs *Matteo Burzoni* *Alessandro Doldi*	*Stochastic processes motivated by applications in life and social sciences* Organizer/Chair *Francesca Collet*	*Discrete to continuum: interacting particle and mean field games* Organizers/Chairs *Giulia Livieri* *Marta Leocata* *Alekos Cecchin* *Maddalena Ghio*
13:50	Andrea Agazzi	Luigi Amedeo Bianchi	Giacomo Ascione	Emanuela Rosazza Gianin	Michele Aleandri	Maddalena Ghio
14:15	Nicolas Schreuder	Benedetta Ferrario	Martina Favero	Cosimo Munari	Marco Formentin	Ruojun Huang
14:40	Luca Ratti	Mario Maurelli	Alessandra Meoli	Elisa Mastrogiacomo	Ida Germana Minelli	Alekos Cecchin
15:05	Stefano Vigogna	Margherita Zanella	Cristina Zucca	Maria Arduca		Marta Leocata

15:30	Coffee break
16:00	Plenary talk (Room B) *Andrea Montanari*
17:00	Presentation by IFAB (Room B)
17:30 18:30	Round table on Big Data and Artificial Intelligence (Room B)
19:30	Visit to Palazzo Re Enzo
20:00	Social dinner at Palazzo Re Enzo

Wednesday 15th, June

9:20	Plenary talk (Room B) *Federico Camia*
10:20	Coffee break

	Sessions					
	Room A	Room B	Room C	Room E	Room F	Room G
	Large scale random structures Organizers/Chairs *Gianmarco Bet* *Alessandro Zocca*	*Modeling financial asset prices* Organizer/Chair *Cecilia Mancini*	*SPDEs and Kolmogorov equations* Organizers/Chairs *Davide Addona* *Margherita Zanella*	*Probabilistic approximations via chaotic decompositions* Organizer/Chair *Anna Vidotto*	*Contributed session II* Chair *Patrizia Semeraro*	*Advances in stochastic games with applications* Organizers/Chairs *Tiziano De Angelis* *Giorgio Ferrari*
10:50	Alessandra Bianchi	Jean Jacod	Federica Masiero	Valentina Cammarota	Patrizia Semeraro	Alessandro Milazzo
11:15	Alberto Chiarini	Josè Figueroa-Lopez	Luca Scarpa	Francesca Cottini	Imma Valentina Curato	Andrea Bovo
11:40	Riccardo Michielan	Catia Scricciolo	Cristiano Ricci	Anna Paola Todino	Greta Goracci	Giovanni Zanco
12:05	Alexander Zass	Matteo Garbelli	Davide Augusto Bignamini	Nicola Turchi	Margherita Doria	Francesco Mattesini

12:30	Lunch

	Sessions					
	Room A	Room B	Room C	Room E	Room F	Room G
	Random processes on complex networks Organizer/Chair *Michele Salvi*	*Confined diffusions and fractional diffusions with applications* Organizer/Chair *Enrica Pirozzi*	*Rough analysis and applications* Organizer/Chair *Carlo Bellingeri* *Lucio Galeati*	*Probabilistic and statistical properties of sphere-cross-time random fields* Organizer/Chair *Alessia Caponera*	*Metastability for interacting particle systems* Organizers/Chairs *Vanessa Jacquier* *Simone Baldassarri* *Saeda Marello*	*Advances in stochastic control with applications* Organizers/Chairs *Tiziano De Angelis* *Giorgio Ferrari*
13:50	Luca Avena	Giulia Di Nunno	Carlo Bellingeri	Anna Vidotto	Vanessa Jacquier	Fausto Gozzi
14:15	Elisabetta Candellero	Yuliya Mishura	Michele Coghi	Maurizia Rossi	Simone Baldassarri	Alessandra Cretarola
14:40	Matteo Quattropani	Gianni Pagnini	Francesco De Vecchi	Claudio Durastanti	Saeda Marello	Fulvia Confortola
15:05	Michele Salvi	Serena Spina	Lucio Galeati			Pietro Siorpaes

15:30	Coffee break

	Sessions					
	Room A	Room B	Room C	Room E	Room F	Room G
	Random graphs Organizer/Chair *Umberto De Ambroggio*	*Advances in statistical inference for continuous-time stochastic processes* Organizer/Chair *Paolo Pigato*	*Monte Carlo sampling with piecewise deterministic Markov processes* Organizer/Chair *Andrea Bertazzi*	*Stochastic processes and geometry* Organizer/Chair *Anna Paola Todino*	*Contributed session III* Chair *Giulia Carigi*	*New trends in stochastic control: delay, partial and exogenous information* Organizers/Chairs *Giuseppina Guatteri* *Fulvia Confortola* *Federica Masiero*
16:00	Luisa Andreis	Sara Mazzonetto	Alice Corbella	Francesco Grotto	Giulia Carigi	Filippo De Feo
16:25	Elena Magnanini	Ester Mariucci	Filippo Pagani	Michele Stecconi	Emanuela Gussetti	Mattia Martini
16:50	Gianmarco Bet	Chiara Amorino	Sebastiano Grazzi	Riccardo Walter Maffucci	Eliseo Luongo	Paolo Di Tella
17:15	Umberto De Ambroggio	Riccardo Passeggeri	Andrea Bertazzi		Andrea Clini	Antonio Ocello

17:40 18:30	Round table on the “Italian Meeting on Probability and Mathematical Statistics” (Room B)
19:00 20:30	Aperitivo at Chiostro di San Giovanni in Monte (Piazza di San Giovanni in Monte, 3, Bologna)

Thursday 16th, June

9:20	Plenary talk (Room B) *Igor Prünster*
10:20	Coffee break

	Sessions					
	Room A	Room B	Room C	Room E	Room F	Room G
	Regularisation by noise and Kolmogorov equations Organizers/Chairs *Luca Scarpa* *Carlo Orrieri*	*Advances in Bayesian nonparametric inference* Organizer/Chair *Antonio Lijoi*	*Stochastic chemical reaction network dynamics* Organizer/Chair *Andrea Agazzi*	*Interacting particle systems and inference* Organizer/Chair *Martina Favero*	*Scaling limits for interacting particle systems* Organizer/Chair *Chiara Franceschini*	*Inequalities in quantum probability* Organizer/Chair *Dario Trevisan*
10:50	Mario Maurelli	Maria Fernanda Gil-Leyva	Daniele Cappelletti	Dario Spanò	Gioia Carinci	Dario Trevisan
11:15	Davide Addona	Mario Beraha	Francesco Avanzini	Matteo Ruggiero	Simone Floreani	Angelo Lucia
11:40	Mattia Turra	Filippo Ascolani	Enrico Bibbona	Jere Koskela	Frank Redig	Lorenzo Portinale
12:05	Florian Bechtold	Francesco Gaffi	Roberta Sirovich	Francesca Crucinio	Lorenzo Dello Schiavo	Jacopo Borga

12:30	Lunch

	Sessions					
	Room A	Room B	Room C	Room E	Room F	Room G
	Generalized fractional processes Organizer *Giacomo Ascione* Chair *Lorenzo Cristofaro*	*Improved inference in statistical models* Organizers/Chairs *Silvia Sarpietro* *Stanislav Anatolyev*	*Integrable systems and the KPZ universality class* Organizer/Chair *Alessandra Occelli*	*Opinion dynamics in biased communication models* Organizer/Chair *Hlafo Alfie Mimun*	*Duality and integrability for interacting particle systems* Organizer/Chair *Simone Floreani*	*Contributed session IV* Chair *Paolo Pigato*
13:50	Federico Polito	Dennis Kristensen	Alessandra Occelli	Emilio Cruciani	Chiara Franceschini	Paolo Pigato
14:15	Alessandro De Gregorio	Giuseppe Cavaliere	Dan Betea	Hlafo Alfie Mimun	Cristian Giardinà	Luca Maria Giordano
14:40	Fabrizio Cinque	Stanislav Anatolyev	Harriet Walsh	Francesco D'Amore	Rouven Frassek	Edoardo Lombardo
15:05	Andrea Pallavicini	Silvia Sarpietro	Gioele Gallo	Fabrizio Durante	Hasan Akin	

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BOOK OF ABSTRACTS

www.site.unibo.it/probstat

Mario Abundo

Università di Roma "Tor Vergata"

An inverse problem for the first-passage place of a jump-diffusion process

We study an inverse problem for the first-passage place of a one-dimensional jump-diffusion process $X(t)$, starting from a random position u in the interval $[a,b]$. Let T be the first-exit time of $X(t)$ from the interval (a,b), and $p(a)$ the probability that the process $X(t)$ first exits the interval (a,b) from the left, namely $p(a)$ equals the probability that $X(T)$ is less or equal a. Given a probability q, the problem consists in finding the density g of u (if it exists) such that $p(a) = q$. Some explicit examples are reported.

This is an invited talk in the session Markov processes and first passage time problems *organized by* **Barbara Martinucci**.

Davide Addona

Università degli Studi di Parma

Regularization by noise in infinite dimension by approximation

Let H be a real separable Hilbert space. The deterministic equation $(*)$ $dX_t = AX_tdt + B(t, X_t)dt$, $X_0 = x_0 \in H$, where A is the infinitesimal generator of a strongly continuous semigroup and B is only Holder continuous is, in general, ill-posed, see for instance [2] for $A = \Delta$ and [3] when A it the infinitesimal generator of the wave group. However, for equation $(**)$ $dX_t = AX_tdt + B(t, X_t)dt + GdW_t$, $X_0 = x_0 \in H$, where $(*)$ has been perturbed by an infinite dimensional noise, it is possible to provide suitable assumptions on the coefficients A, B and G which guarantee existence and uniqueness of a strong solution. This has been proved in [2], under the hypothesis that A has compact resolvent, and in [3], by assuming that A generates a strongly continuous group and by replacing Ito's formula with a system of infinite dimensional forward-backward SDEs. In [1] we generalize the approach of [3]: we consider equation $(**)$ where the operator A generates a semigroup of bounded linear operators and we take some approximations A_n of A which satisfy suitable conditions. Thanks to a family of systems of FBSDE associated to A_n we prove strong existence and uniqueness for $(**)$. We provide two concrete examples to which our results apply: in the former we consider a stochastic damped wave equation with irregular drift and A_n are the Yosida approximants of A, in the latter we consider a stochastic heat equation and A_n are the finite dimensional approximations of A, and we recover (with some improvement) the results in [2]. Finally, we stress that in the paper we prove "directional" energy estimates for the control problem associated to the damped wave equation which, to the best of our knowledge, are new and have their own interest.

References

1. D. Addona, F. Masiero, E. Priola, A BSDEs approach to pathwise uniqueness for stochastic evolution equations, submitted.

2. G. Da Prato, F. Flandoli, Pathwise uniqueness for a class of SDE in Hilbert Spaces and applications, J. Funct. Anal., 2009.

3. F. Masiero, E. Priola, Well-posedeness of semilinear stochastic wave equations with Holder continuous coefficients, J. Diff. Equat., 2017.

This is an invited talk in the session Regularisation by noise and Kolmogorov equations *organized by* **Luca Scarpa** *and* **Carlo Orrieri**.

Andrea Agazzi

Università degli Studi di Pisa

Convergence and optimality of neural networks for reinforcement learning

Recent groundbreaking results have established a convergence theory for wide neural networks in the supervised learning setting. Under an appropriate scaling of parameters at initialization, the (stochastic) gradient descent dynamics of these models converge towards a so-called "mean-field" limit, identified as a Wasserstein gradient flow. In this talk, we extend some of these recent results to examples of prototypical algorithms in reinforcement learning: Temporal-Difference learning and Policy Gradients. In the first case, we prove convergence and optimality of wide neural network training dynamics, bypassing the lack of gradient flow structure in this context by leveraging sufficient expressivity of the activation function. We further show that similar optimality results hold for wide, single layer neural networks trained by entropy-regularized softmax Policy Gradients despite the nonlinear and nonconvex nature of the risk function.

This is an invited talk in the session MATHEMATICS OF MACHINE LEARNING *organized by* **Ernesto De Vito** *and* **Lorenzo Rosasco**.

Antonio Agresti

Institute of Science and Technology Austria (ISTA)

The stochastic primitive equations with transport noise

The primitive equations are one of the fundamental models for geophysical flows used to describe oceanic and atmospheric dynamics. They are derived from the Navier-Stokes equations in domains where the vertical scale is much smaller than the horizontal one by the small aspect ratio limit. Starting from the seminal work of R.H. Kraichnan, transport type noise has been widely used in fluid mechanics to model turbulent behaviors. In this talk we will discuss physical motivations and some recent results on the stochastic primitive equations with transport noise. The presence of the transport noise gives rise to several mathematical problems that naturally lead to the use of stochastic maximal regularity techniques, as well as to the theory of critical spaces for stochastic evolution equations. Among others, we will discuss the global well-posedness of the stochastic primitive equations in three dimensions. The latter extends the celebrated result by C. Cao, E.S. Titi and R.M. Kobelkov on the deterministic model. Finally we will present some open problems. This talk is based on a joint work with M. Hieber (TU Darmstadt), A. Hussein (TU Kaiserslautern) and M. Saal (TU Darmstadt).

This is an invited talk in the session PDEs and their applications to stochastic analysis *organized by* **Elena Issoglio**.

Hasan Akin
ICTP

The extremality of disordered phase for the Ising model with mixed spin-1 and spin-1/2 on Cayley Tree of arbitrary order

We continue our study of the set of translation-invariant splitting Gibbs measures (TISGMs) for the Ising model with the mixed spin-1 and spin-1/2 on a Cayley tree of arbitrary order. We construct TISGMs, translation-invariant tree-indexed Markov chains corresponding to the model. In our previous work [Akin and Mukhamedov, arXiv:2201.12615], we gave a full description of the TISGMs and studied the extremity of disordered phases by means of a tree-indexed Markov chain on Cayley tree of order two. In this present paper, we study the non-extremity and the extremity of disordered phases by means of a tree-indexed Markov chain on the Cayley tree of arbitrary order.

This is a contributed talk in the session Duality and integrability for interacting particle systems *organized by* **Simone Floreani**.

Michele Aleandri

Università di Roma “La Sapienza”

Delay-induced periodic behaviour in competitive populations

We study a model of binary decisions in a fully connected network of interacting agents. Individual decisions are determined by social influence, coming from direct interactions with neighbours, and a group level pressure that accounts for social environment. In a competitive environment, the interplay of these two aspects results in the presence of a persistent disordered phase where no majority is formed. We show how the introduction of a delay mechanism in the agent’s detection of the global average choice may drastically change this scenario, giving rise to a coordinated self sustained periodic behaviour.

This is an invited talk in the session Stochastic processes motivated by applications in life and social sciences *organized by* **Francesca Collet**.

Chiara Amorino

Université du Luxembourg

On the rate of estimation for the stationary distribution of stochastic differential equations

In this talk, we will discuss some results on the estimation of the invariant density associated to a multivariate diffusion $X = (X_t)_{t\geq 0}$, solution of a stochastic differential equation. The estimation of the invariant density is a problem of great relevance because of the huge amount of applications in physics and numerical methods, the Markov Chain Monte Carlo above all. Evidence of the attractiveness of the non-parametric estimation for the stationary measure of a continuous mixing process is the fact such a subject is both a long-standing problem and a living topic. We propose kernel density estimators, based on the continuous record of the trajectory $X^T = (X_t)_{0\leq t\leq T}$, and we measure their accuracy by studying the size of their pointwise L^2 error. We first of all find the convergence rates associated to the proposed estimators. After that, we wonder if it possible to propose other estimators which achieve better convergence rates.

This is an invited talk in the session Advances in statistical inference for continuous-time stochastic processes *organized by* **Paolo Pigato**.

Stanislav Anatolyev

CERGE-EI

Leave-cluster-out and variance estimation

We introduce the leave-cluster-out (LCO) machinery for clustered samples, a generalization of leave-one-out methods that prove useful for independent data. We use LCO to construct an estimator of the asymptotic variance of the OLS estimator in a linear regression characterized by possibly numerous regressors and arbitrary within-cluster heteroskedasticity. We show consistency of the LCO variance estimator when regressors may be many, regression errors may be heteroskedastic, clusters may be unbalanced and heterogeneous, and cluster sizes may be moderately large. Simulations reveal amazing robustness of the LCO estimator to regressor numerosity and heteroskedasticity.

This is an invited talk in the session Improved inference in statistical models *organized by* **Silvia Sarpietro** *and* **Stanislav Anatolyev**.

Luisa Andreis

Università degli Studi di Firenze

Large deviations and phase transition in sparse inhomogeneous random graphs

Inhomogeneous random graphs are a natural generalization of the well-known Erdös-Rényi random graph, where vertices are characterized by a type and edges are present independently according to the type of the vertices that they are connecting. In the sparse regime, these graphs undergo a phase transition in terms of the emergence of a giant component exactly as the classical Erdös-Rényi model. In this talk we will present an alternative approach, via large deviations, to prove this phase transition. This allows a comparison with the gelation phase transition that characterizes some coagulation process and with phase transitions of condensation type emerging in several systems of interacting components.
This is ongoing joint works with Wolfgang König (WIAS and TU Berlin), Tejas Iyer (WIAS), Heide Langhammer (WIAS), Elena Magnanini (WIAS), Robert Patterson (WIAS).

This is an invited talk in the session Random graphs *organized by* **Umberto De Ambroggio**.

Maria Arduca

LUISS Guido Carli

Risk measures beyond frictionless markets

We develop a general theory of risk measures that determine the optimal amount of capital to raise and invest in a portfolio of reference traded securities in order to meet a pre-specified regulatory requirement. The distinguishing feature of our approach is that we embed portfolio constraints and transaction costs into the securities market. As a consequence, we have to dispense with the property of translation invariance, which plays a key role in the classical theory. We provide a comprehensive analysis of relevant properties such as star shapedness, positive homogeneity, convexity, quasiconvexity, subadditivity, and lower semicontinuity. In addition, we establish dual representations for convex and quasiconvex risk measures. In the convex case, the absence of a special kind of arbitrage opportunities allows to obtain dual representations in terms of pricing rules that respect market bid-ask spreads and assign a strictly positive price to each nonzero position in the regulator's acceptance set.

This is an invited talk in the session Risk management *organized by* **Matteo Burzoni** *and* **Alessandro Doldi**.

Giacomo Ascione

Università degli Studi di Napoli "Federico II", Scuola Superiore Meridionale

Mean field sparse optimal control of systems with additive white noise

In recent times, herding problems have been widely studied thanks to their several applications, both in natural sciences and engineering. In this talk we analyze the problem of controlling a multi-agent system with additive white noise by applying a suitable control on a selected subset of the agents, that we call the herders, whose dynamics influences the behaviour of the passive agents that costitute the herd. For such a controlled system with a SDE constraint, we introduce a rigorous limit process towards an infinite dimensional optimal control problem constrained by the coupling of a system of ODE for the leaders with a McKean-Vlasov-type SDE, governing the dynamics of the prototypical follower. The Fokker-Planck equation of the limit system is given by a nonlinear PDE-ODE system, whose well-posedness is explored under suitable assumptions on the distribution of the initial data. The derivation of the limit optimal control problem is achieved by linking the mean-field limit of the governing equations together with the Γ-limit of the cost functionals for the finite dimensional problems.
This is based on a joint work with Daniele Castorina and Francesco Solombrino from Università degli Studi di Napoli "Federico II".

This is an invited talk in the session **Stochastic processes with applications to the natural sciences** *organized by* **Giuseppe D'Onofrio**.

Filippo Ascolani

Università Bocconi

Clustering consistency with Dirichlet process mixtures

Dirichlet process mixtures are flexible non-parametric models, particularly suited to density estimation and probabilistic clustering. In this work we study the posterior distribution induced by Dirichlet process mixtures as the sample size increases, and more specifically focus on consistency for the unknown number of clusters when the observed data are generated from a finite mixture. Crucially, we consider the situation where a prior is placed on the concentration parameter of the underlying Dirichlet process. Previous findings in the literature suggest that Dirichlet process mixtures are typically not consistent for the number of clusters if the concentration parameter is held fixed and data come from a finite mixture. Here we show that consistency for the number of clusters can be achieved if the concentration parameter is adapted in a fully Bayesian way, as commonly done in practice. Our results are derived for data coming from a class of finite mixtures, with mild assumptions on the prior for the concentration parameter and for a variety of choices of likelihood kernels for the mixture.

This is an invited talk in the session Advances in Bayesian nonparametric inference *organized by* **Antonio Lijoi**.

Francesco Avanzini

University of Luxembourg

Thermodynamics of Chemical Reaction Networks

We formulate a nonequilibrium thermodynamic theory for open chemical reaction networks (CRNs) described by a chemical master equation with mass-action rates [1]. The conservation laws of CRNs are used to decompose the entropy production into a potential change and two work contributions. One work contribution is due to time dependent changes in the externally controlled chemostat concentrations. The other accounts for the flows maintained across the CRN by nonconservative forces breaking the detailed balance condition. The thermodynamic theory is shown to hold for CRNs not satisfying mass-action rates, namely when the chemical species interact [2].

References

1. R. Rao and M. Esposito, Conservation laws and work fluctuation relations in chemical reaction networks, J. Chem. Phys. 149, 245101 (2018).

2. F. Avanzini, E. Penocchio, G. Falasco, M. Esposito, Nonequilibrium thermodynamics of non-ideal chemical reaction networks, J. Chem. Phys. 154, 094114 (2021).

This is an invited talk in the session **Stochastic chemical reaction network dynamics** *organized by* **Andrea Agazzi**.

Luca Avena

Leiden University

Evolution of discordances in voter dynamics on random regular graphs

We consider the classical continuous-time interacting particle system for 2-opinion dynamics known as the voter model on a random d-regular graph. It is well known that this particle system is dual to a system of coalescing random walkers and that in this geometrical setting, as the graph size increases, the time to reach consensus grows linearly with the number of nodes n. We study the time-evolution of the density of the discordant edges (i.e. edges with different opinions at their end vertices) until the consensus is reached. This observable can be thought as the dynamic "perimeter" associated to the density of opinions of one type in the given network (the latter to be seen as the "volume"). While the volume of one opinion evolves as a martingale until the consensus time, the density of discordant edges (i.e. the perimeter) undergoes a very different quasi-stationary-like evolution which we make precise. In particular, starting from a Bernoulli independent assignment of the two initial opinions of parameter u in $(1/2, 1)$, we prove that, on time-scale of order one, the fraction of discordant edges goes down and stabilizes to an explicit constant function of d and u related to the meeting time of two random walks in an infinity tree. Then, at time scale n, this density of discordances moves out of the constant plateau and converges in an exponential fashion to zero. Underlying proofs are built on delicate coupling constructions exploiting the locally tree-like geometry, the dual coalescing system and the so-called first visit time lemma. In particular we introduce ad-hoc novel exploration algorithms to generate the local geometry of this system, sufficiently rich to decode the subtle dependent structure of this discordant perimeter and related concentration properties.
Joint work with Rangel Baldasso, Rajat Hazra, Frank den Hollander and Matteo Quattropani.

This is an invited talk in the session Random processes on complex networks *organized by* **Michele Salvi**.

Simone Baldassarri

Università degli Studi di Firenze

Critical Droplets and sharp asymptotics for Kawasaki dynamics with strongly anisotropic interactions

In this talk we analyze metastability and nucleation in the context of the Kawasaki dynamics for the two-dimensional Ising lattice gas at very low temperature. Let $\Lambda \subset \mathbb{Z}^2$ be a finite box. Particles perform simple exclusion on Λ, but when they occupy neighboring sites they feel a binding energy $-U_1 < 0$ in the horizontal direction and $-U_2 < 0$ in the vertical one. Along each bond touching the boundary of Λ from the outside to the inside, particles are created with rate $\rho = e^{-\Delta\beta}$, while along each bond from the inside to the outside, particles are annihilated with rate 1, where $\beta > 0$ is the inverse temperature and $\Delta > 0$ is an activity parameter. We consider the parameter regime $U_1 > 2U_2$ also known as the strongly anisotropic regime. We take $\Delta \in (U_1, U_1 + U_2)$, so that the empty (respectively full) configuration is a metastable (respectively stable) configuration. We consider the asymptotic regime corresponding to finite volume in the limit as $\beta \to \infty$. We investigate how the transition from empty to full takes place with particular attention to the critical configurations that asymptotically have to be crossed with probability 1. To this end, we provide a model-independent strategy to identify some unessential saddles (that are not in the union of minimal gates) for the transition from the metastable (or stable) to the stable states and we apply this method to our model. The derivation of some geometrical properties of the saddles allows us to identify the full geometry of the minimal gates and their boundaries for the nucleation in the strongly anisotropic case. Moreover, we derive sharp estimates for the asymptotic transition time for the strongly anisotropic case.
This is a joint work with F. R. Nardi.

This is an invited talk in the session Metastability for interacting particle systems *organized by* **Vanessa Jacquier**, **Simone Baldassarri**, **Saeda Marello**.

Florian Bechtold

Universität Bielefeld

Weak solutions for singular multiplicative SDEs via regularization by noise

We study multiplicative SDEs perturbed by an additive fractional Brownian motion on another probability space. Provided the Hurst parameter is chosen in a specified regime, we establish existence of probabilistically weak solutions to the SDE if the measurable diffusion coefficient merely satisfies an integrability condition. In particular, this allows to consider certain singular diffusion coefficients.

This is a contributed talk in the session **Regularisation by noise and Kolmogorov equations** *organized by* **Luca Scarpa** *and* **Carlo Orrieri**.

Luisa Beghin

Università di Roma "La Sapienza"

Gamma-grey noise and gamma-grey Brownian motion

The grey noise has been introduced for the first time by Schneider; based on it, the grey Brownian motion and the generalized grey Brownian motion were constructed, in order to model anomalous diffusions, by mimicking the procedure for white noise and ordinary Brownian motion. These models include, as special cases, both the standard and the fractional Brownian motion. We construct and study the so-called gamma-grey noise and the gamma-grey Brownian motion, defined by means of the incomplete-gamma function (thanks to its complete monotonicity) and the Riemann-Liouville fractional derivative. Different characterizations of the process are also provided, together with the integro-differential equation satisfied by its transition density.

This is an invited talk in the session Nonlocal operators in probability: anomalous diffusions *organized by* **Mirko D'Ovidio** *and* **Giacomo Ascione**.

Carlo Bellingeri

TU Berlin

Between singular SPDEs and stochastic calculus: the KPZ equation

Considered one of the most important stochastic processes in the last decades, the KPZ equation has played an enormous role to motivate the study of singular SPDEs, becoming a foundational object in rough analysis. The presence of an explicit solution also made it possible to study its law and most of its properties in detail using standard tools of stochastic analysis. However, the connections between regularity structures and stochastic calculus are still not developed well enough to offer a joint perspective on the KPZ equation, even though both study the same object. In this talk, we will discuss how one can use regularity structures to derive a pathwise change of variable formula for the KPZ equation and some possible interpretations of it.
Joint work with Tom Klose (TU Berlin).

This is an invited talk in the session Rough analysis and applications *organized by* **Carlo Bellingeri** *and* **Lucio Galeati**.

Mario Beraha

Politecnico di Milano

Beyond CRMs: normalized random measures with atoms' interaction for Bayesian mixture models

Discrete random probability measures (RPMs) are one of the founding blocks of Bayesian nonparametrics (BNP). They are routinely used as mixing measures in mixture models. Normalized completely random measures are the prominent class of priors in BNP, thanks to their analytical tractability. In the context of mixture models, such priors assume that the cluster-specific parameters are i.i.d. from some base distribution. This might come with drawbacks such as inconsistency for the number of detected clusters and lack of robustness to model misspecification.
A large class of RPMs based on the normalization of non-completely-random measures will be described in this talk. In particular, by assuming a point process as the joint distribution for the number of support points of the measure and their location, the model could favor repulsiveness or attractiveness among the clusters. Several theoretical properties such as the posterior distribution of the underlying random measure and the marginal distribution of a sample will be discussed, together with numerical illustrations on simulated and real-world applications.

This is an invited talk in the session Advances in Bayesian nonparametric inference *organized by* **Antonio Lijoi**.

Andrea Bertazzi

TU Delft

Approximations of piecewise deterministic Markov processes

Piecewise deterministic Markov processes (PDMPs) received substantial interest in recent years as an alternative to classical Markov chain Monte Carlo algorithms. While theoretical properties of PDMPs have been studied extensively, their practical implementation remains limited to specific applications in which bounds on the gradient of the negative log-target can be derived. In order to address this problem, we propose to approximate PDMPs using splitting schemes, that means simulating the deterministic dynamics and the random jumps in two different stages. First we show that as expected basic symmetric splittings of PDMPs are of second order. Then we focus on the Zig-Zag sampler (ZZS) and the Bouncy Particle sampler (BPS) and discuss convergence properties of the approximations obtained using different splitting schemes. Numerical experiments are given to support our theoretical findings. (This is a joint work with Paul Dobson and Pierre Monmarchè.)

This is an invited talk in the session Monte Carlo sampling with piecewise deterministic Markov processes *organized by* **Andrea Bertazzi**.

Gianmarco Bet

Università degli Studi di Firenze

Detecting anomalies in geometric networks

Recently there has been an increasing interest in the development of statistical techniques and algorithms that exploit the structure of large complex-network data to analyze networks more efficiently. For this talk, I will focus on detection problems. In this context, the goal is to detect the presence of some sort of anomaly in the network, and possibly even identify the nodes/edges responsible. Our work is inspired by the problem of detecting so-called botnets. Examples are fake user profiles in a social network or servers infected by a computer virus on the internet. Typically a botnet represents a potentially malicious anomaly in the network, and thus it is of great practical interest to detect its presence and, when detected, to identify the corresponding vertices. Accordingly, numerous empirical studies have analyzed botnet detection problems and techniques. However, theoretical models and algorithmic guarantees are missing so far. We introduce a simplified model for a botnet, and approach the detection problem from a statistical perspective. More precisely, under the null hypothesis we model the network as a sample from a geometric random graph, whereas under the alternative hypothesis there are a few botnet vertices that ignore the underlying geometry and simply connect to other vertices in an independent fashion. We present two statistical tests to detect the presence of these botnets, and we show that they are asymptotically powerful, i.e., they correctly distinguish the null and the alternative with probability tending to one as the number of vertices increases. We also propose a method to identify the botnet vertices. We will argue, using numerical simulations, that our tests perform well for finite networks, even when the underlying graph model is slightly perturbed. Our work is not limited in scope to botnet detection, and in fact is relevant whenever the nature of the anomaly to be detected is a change in the underlying connection criteria.
Based on joint work with Kay Bogerd (TU/e), Rui Pires da Silva Castro (TU/e) and Remco van der Hofstad (TU/e).

This is an invited talk in the session **Random graphs** *organized by* **Umberto De Ambroggio**.

Dan Betea

Université d'Angers

From Gumbel to Tracy–Widom statistics in discrete systems random

We present a few natural measures on discrete particle systems: partitions, plane partitions, and cylindric plane partitions. We show how extremal statistics of such measures (laws of the largest parts) interpolate—via a 'natural' finite temperature parameter—between the Gumbel distribution of classical statistics of iid random variables and the Tracy–Widom GUE distribution of correlated systems (eigenvalues) from random matrix theory. We also obtain the random matrix theory hard-edge behavior (Bessel kernel and distribution) in some cases. Connections to last passage percolation models will be discussed.
The results are based on joint works with Jérémie Bouttier and Alessandra Occelli.

This is an invited talk in the session Integrable systems and the KPZ universality class *organized by* **Alessandra Occelli**.

Sara Biagini

LUISS Guido Carli

Optimal dynamic regulation of carbon emissions market

We deal with optimal dynamic carbon emission regulation of a set of firms. On the one hand, the regulator dynamically allocates emission allowances to each firm. On the other hand, firms face idiosyncratic, as well as common, economic shocks on emissions, and they have linear quadratic abatement costs. Firms can trade allowances so as to minimise total expected costs, which arise from abatement, trading and terminal penalty. Using variational methods, we first exhibit in closed-form the market equilibrium in function of the regulator's dynamic allocation. We then solve the Stackelberg game between the regulator and the firms. The result is a closed-form expression of the optimal dynamic allocation policies that allow a desired expected emission reduction. Optimal policies are not unique but share common properties, which rigorously confirm economic intuition. The optimal policies are fully responsive, and therefore induce a constant abatement effort and a constant price of allowances. Our results are robust to some extensions, like risk aversion of firms or different penalty functions. We conclude by providing analytical and numerical comparisons of the optimal dynamic policy with three existing policies, namely static allocation, Market Stability Reserve and pure tax mechanisms.

This is an invited talk in the session Stochastic models for energy, management, and environmental issues *organized by* **Alessandro Calvia** *and* **Katia Colaneri**.

Alessandra Bianchi

Università degli Studi di Padova

Random walks on a Lévy-type random media

We consider a one-dimensional process in random media that generalizes a model known in the physical literature as Lévy-Lorentz gas. The medium is provided by a renewal point process in which the inter-distances between points are i.i.d. heavy-tailed random variables, while the dynamics is obtained as the linear interpolation of - possibly long jump - random walks on the point process. These models have been used to describe phenomena that exhibit superdiffusion, and the main focus of this investigation is on the derivation of the scaling behavior of the process as a function of the parameters that enter in the definition. We give an account on a number of recent theorems, which include non-standard functional limit theorems for the process in discrete and continuous time, and a comparison between the annealed and the quenched settings.

This is an invited talk in the session Large scale random structures *organized by* **Gianmarco Bet** *and* **Alessandro Zocca**.

Luigi Amedeo Bianchi

Università di Trento

Linear stochastic dyadic model

We discuss a stochastic interacting particles' system connected to dyadic models of turbulence, defining suitable classes of solutions and proving their existence and uniqueness. We investigate the regularity of a particular family of solutions, called moderate, and we conclude with the existence and uniqueness of invariant measures associated with such moderate solutions.
Based on joint work with Francesco Morandin, Università di Parma.

This is an invited talk in the session **SPDEs arising in physical models** *organized by* **Michele Coghi**.

Enrico Bibbona

Politecnico di Torino

Multiscale limits of chemical reaction networks with Fast Absorption and Slow Escape (FASE)

Motivated by the Togashi-Kaneko model in dimension two, we define a set of conditions named FASE, Fast Absorption and Slow Escape, under which a properly scaled family of chemical reaction networks allows for a switching limit process that we can fully characterize. FASE networks include a fast subsystem that is quickly absorbed, possibly in different absorbing classes. At a slower time scale, we observe a dynamics within the absorbing class (which remains active in the limit process), while a mechanism can bring the system back into the transient states, restarting the fast cascade, and quickly leading to another absorption. In the limit, such fast sequence of reactions becomes either an instantaneous switch, if the absorbing state is far apart from the latest one visited, or the instantaneous effect of some new reaction that we incorporate in the slower system, if the fast cascade brings the system back close to where it started.

This is an invited talk in the session **Stochastic chemical reaction network dynamics** *organized by* **Andrea Agazzi**.

Davide Augusto Bignamini

Università degli Studi di Pavia

Transition semigroups and second order Kolmogorov operators in L^2 type spaces

The connection between Markov processes and problems in analysis already appears in the early works of Kolmogorov in the 1930s. Particular Hilbert space valued Markov processes were introduced by Gross and Daleckii in the 1960s to study some classes of parabolic equations for functions of infinitely variables. The main topic of this talk is the relation between the solution of a non-linear stochastic partial differential equation and a second order Kolmogorov operator in L^2 type spaces. Let H be a real separable Hilbert space. Let R be a linear, bounded self-adjoint and positive operator on H and let A be the infinitesimal generator of a strongly continuous semigroup on H. Let $W(t)$ be a H-cylindrical Wiener process. Let F be a H-valued function defined on a domain contained in H. Under suitable conditions the following semilinear stochastic partial differential equation (SPDE) $dX(t,x) = (AX(t,x) + F(X(t,x))dt + RdW(t)$, $t > 0$; $X(0,x) = x$, has a unique generalized mild solution $X(t,x)$. We denote by $P(t)$ the transition semigroup associated with the SPDE. Let O be an open set of H we denote by $S_O(t)$ the stopped (or Dirichlet) semigroup associated with the SPDE. Under suitable conditions $P(t)$ has a unique invariant probability measure m. This talk is focused on the relation in $L^2(H,m)$ (risp $L^2(O,m)$) between $P(t)$ (risp $S_O(t)$) and the second order Kolmogorov operator formally defined by $Nf(x) := (1/2)\mathrm{Tr}[R^2D^2f(x)]+$.

This is an invited talk in the session **SPDEs and Kolmogorov equations** *organized by* **Davide Addona** *and* **Margherita Zanella**.

Ofelia Bonesini

Università degli Studi di Padova

On correlated equilibria and mean field games in progressive strategies

In Game Theory, Correlated Equilibria are a generalization of Nash Equilibria introduced to consider the possibility of a correlation between the strategies of the players. We study these equilibria in the context of N-player and mean-field games. This work aims at extending the results in [Correlated Equilibria and Mean-Field Games: a simple model (2020); L. Campi, M. Fischer], relaxing the hypothesis that the strategies used by the players are restricted, i.e. they only depend on the state of the player himself. Instead, we consider more general deviations that also depend on the states of the other players through the empirical measure. This generalization is highly non-trivial and introduces several technical difficulties in the problem. Our first concern is to provide a good definition for the concept of Correlated solution in the mean-field context. The consistency of this definition is then checked proving that a correlated solution for the MFG can be used to build εN-Correlated Equilibria for the N-player game, with an infinitesimal sequence εN. Finally, we display an example of a two-state MFG possessing correlated solutions with non-deterministic flow of measures that satisfies all the assumptions.

This is an invited talk in the session Mean field games: a probabilistic approach *organized by* **Luciano Campi** *and* **Markus Fischer**.

Luigi Borasi

University of Bonn

Grassmann stochastic analysis and Euclidean Fermion Fields

We formulate a stochastic analysis for Grassmann (i.e. anticommuting) random variables suitable for describing Euclidean Fermionic field theories. We define the notion of Gaussian process, Brownian motion, and stochastic differential equation in this Grassmann context. We sketch some applications to the stochastic quantization of Euclidean Fermionic field theories.

This is an invited talk in the session **Stochastic methods in quantum theory** *organized by* **Sonia Mazzucchi** *and* **Stefania Ugolini**.

Jacopo Borga

Stanford University

Skew Brownian permuton and Liouville quantum gravity

Consider a large random permutation satisfying some constraints or biased according to some statistics. What does it look like? In this talk we make sense of this question introducing the notion of permuton. Permuton convergence has been established for several models of random permutations in various works: we give an overview of some of these results, mainly focusing on the case of pattern-avoiding permutations. The main goal of the talk is to present a new family of universal limiting permutons, called skew Brownian permuton. This family includes (as particular cases) some already studied limiting permutons, such as the biased Brownian separable permuton and the Baxter permuton. The construction of these new limiting objects will lead us to investigate an intriguing connection with some perturbed versions of the Tanaka SDE and the SDEs encoding skew Brownian motions. We finally explain how it is possible to construct these new limiting permutons directly from a Liouville quantum gravity decorated with two space-filling SLE curves. Building on the latter connection, we compute the density of the intensity measure of the Baxter permuton.

This is a contributed talk in the session **Inequalities in quantum probability** *organized by* **Dario Trevisan**.

Andrea Bovo

University of Leeds

Variational inequalities on unbounded domains for zero-sum singular-controller vs. stopper games

We study a class of zero-sum games between a singular-controller and a stopper over finite-time horizon. The underlying process is a multi-dimensional (locally non-degenerate) controlled stochastic differential equation (SDE) evolving in an unbounded domain. We prove that such games admit a value and provide an optimal strategy for the stopper. The value of the game is shown to be the maximal solution, in a suitable Sobolev class, of a variational inequality of 'min-max' type with obstacle constraint and gradient constraint. Although the variational inequality and the game are solved on an unbounded domain we do not require boundedness of either the coefficients of the controlled SDE or of the cost functions in the game.

This is an invited talk in the session **Advances in stochastic games with applications** *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Francesco Buono

Università degli Studi di Napoli "Federico II"

On some different versions of extropy for lifetime distributions

Lad, Sanfilippo and Agrò [4] introduced the extropy as a measure of uncertainty dual to the entropy and they studied it for continuous and discrete distributions. In analogy with Shannon entropy and in connection with the reliability theory, it is interesting to study the extropy for lifetimes by conditioning with respect to some known information about them. Here, the concepts of past extropy [3] and interval extropy [2] are defined and some properties are studied. Moreover, in order to obtain a measure which is shift-dependent, a weighted version of extropy [1] is presented. Keywords: Measures of uncertainty, Extropy, Reliability Theory.

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This is an invited talk in the session Reliability of systems and measures of discrimination *organized by* **Francesco Buono** *and* **Maria Longobardi**.

Matteo Burzoni

Università degli Studi di Milano

Viscosity solutions for mean-field controlled jump-diffusions

We study a class of non linear integro-differential equations on the Wasserstein space related to mean-field optimal control problems for jump-diffusions models. We develop an intrinsic notion of viscosity solutions that does not rely on the lifting to an Hilbert space and prove a comparison theorem for these solutions. We also show that the value function is the unique viscosity solution. This is a joint work with V. Ignazio, M. Reppen and H.M. Soner.

This is an invited talk in the session Mean field games: a probabilistic approach *organized by* **Luciano Campi** *and* **Markus Fischer**.

Alice Callegaro

Technical University of Munich

Branching annihilating random walk with local self-regulations

Branching annihilating random walks are interacting particle systems that appear as a natural mathematical tool to model the spread of a population competing for spatial resources. The classical methods for proving survival heavily rely on monotonicity properties of the system and are therefore not applicable in this context. We consider a model on the lattice in which particles branch, perform jumps within a certain radius of their parent and are killed whenever they occupy the same site. We study the extinction and survival of the system under different parameter regimes and prove results about the particle density on the survival cluster.
The talk is based on ongoing joint works with Nina Gantert (TU Munich), Matthias Birkner (University of Mainz), Jiri Cérny (University of Basel) and Pascal Oswald (University of Basel).

This is a contributed talk in the session Scaling limits, criticality, and random media in statistical physics *organized by* **Lorenzo Dello Schiavo** *and* **Federico Sau**.

Giorgia Callegaro

Università degli Studi di Padova

Optimal reinsurance and risk measures in a partially observable contagion model

We investigate the optimal reinsurance problem when the loss process exhibits jump clustering features and the insurance company has restricted information about the loss process. We maximize expected exponential utility and show that an optimal solution exists. We provide the equation governing the dynamics of the (infinite-dimensional) filter and characterize the solution of the stochastic optimization problem as the solution of a BSDE. By considering the features of the generator of the BSDE obtained, we investigate the properties of the dynamic risk measure associated with the BSDE solution.

This is an invited talk in the session **Partial information: stochastic models and applications** *organized by* **Claudia Ceci**.

Alessandro Calvia

LUISS Guido Carli

Nonlinear filtering of partially observed systems arising in singular stochastic optimal control

Partially observed systems model phenomena that appear in various disciplines, such as engineering, economics, and finance, where some quantity of interest, described by a stochastic process called signal, is not directly measurable or observable. The signal process affects another quantity, the observed process, through which one can obtain probabilistic estimates of the state of the unobserved signal. The estimate that one seeks is provided by the filtering process, defined as the conditional distribution of the signal at each time $t \geq 0$, given the observation available at time t. This estimate is required, for instance, in optimal control problems with partial observation, where an agent (or controller) aims at optimizing some functional, depending on the stochastic processes previously introduced, by means of a control process. These problems have been deeply studied in the literature. However, to the best of our knowledge, a particularly relevant case for applications has not yet received proper attention: the singular control case. Indeed, few papers study singular control problems for partially observed systems and they do so only (apart from the linear-Gaussian setting) in the case where the control process acts on the observation. Instead, the case where the control acts on the signal process is more delicate, from a technical point of view, and requires a careful novel analysis. In this talk, we will introduce a class of singular control problems with partial information, underline their relevance in applications, and provide the explicit filtering equation (i.e., the SPDE satisfied by the filtering process), together with a uniqueness result. These results lay the ground to solve the corresponding singular optimal control problem under partial observation, that we will introduce and discuss.
This is joint work with Giorgio Ferrari, Bielefeld University.

This is an invited talk in the session **Partial information: stochastic models and applications** *organized by* **Claudia Ceci**.

Federico Camia

New York University Abu Dhabi & Courant Institute of Mathematical Sciences

Conformal probability: a personal perspective

The last two decades have seen the emergence of a new area of probability theory concerned with random fractal structures characterized by a certain invariance under conformal (angle-preserving) transformations. These structures often emerge from the analysis of two-dimensional models of statistical mechanics when their parameters are set at those values where a continuous phase transition occurs. The study of such structures has had deep repercussions on both mathematics and physics, generating tremendous progress in different fields, from probability theory to statistical mechanics to conformal field theory. In this talk, I will give a personal perspective on some aspects of this new area of probability theory, focusing for concreteness on two specific examples, the Ising model and percolation.

This is a **Plenary talk**.

Valentina Cammarota

Università di Roma "La Sapienza"

Boundary effect on the nodal length for arithmetic random waves, and spectral semi-correlations

We discuss the chaotic decomposition of the nodal area for 3-d Arithmetic Random Waves. We also test M. Berry's ansatz on nodal deficiency in presence of boundary, as a result of a precise asymptotic analysis, two terms in the asymptotic expansion of the expected nodal length are derived, in the high energy limit along a generic sequence of energy levels. It is found that the precise nodal deficiency or surplus of the nodal length depends on arithmetic properties of the energy levels, in an explicit way. The derivation of these results uncovers major obstacles, e.g. the occurrence of "bad" subdomains in the Kac-Rice method, that, one hopes, contribute insignificantly to the nodal length. Fortunately, we were able to reduce this contribution to a number theoretic question of counting the "spectral semi-correlations", a concept joining the likes of "spectral correlations" and "spectral quasi-correlations" in having impact on the nodal length for arithmetic dynamical systems.

This is an invited talk in the session **Probabilistic approximations via chaotic decompositions** *organized by* **Anna Vidotto**.

Elisabetta Candellero

Roma Tre University

Competition processes on graphs

We consider two first-passage percolation processes, FPP_1 and FPP_2, spreading with rates 1 and $\lambda > 0$ respectively, on a graph G with bounded degree. FPP_1 starts from a single source, while the initial configuration of FPP_2 consists of countably many seeds distributed according to a product of iid Bernoulli random variables of parameter 0.

This is an invited talk in the session Random processes on complex networks *organized by* **Michele Salvi**.

Marco Capaldo

Università degli Studi di Salerno

Some results on the cumulative information generating function

The entropy was introduced by Shannon in 1948 in order to describe the information amount of a random variable. Several generalizations and variations have been proposed in the literature. Among them, we recall the cumulative residual entropy and the cumulative entropy introduced respectively by Rao et al. [6] and by Di Crescenzo and Longobardi [3]. Recently, generalized and fractional versions of these information measures have been defined respectively in [5] and [7] for the cumulative residual entropy, and in [4] and [2] for the cumulative entropy. It is noteworthy the connections between these entropies and various notions of interest in reliability theory. Aiming to introduce a mathematical tool suitable to deal with these measures, we define the cumulative information generating function (CIGF) of a nondegenerate random variable X as

$$G_X(\alpha,\beta) := \int_l^r \left[F(x)\right]^\alpha \left[\overline{F}(x)\right]^\beta \mathrm{d}x,$$

where F and $\overline{F}$ are respectively the cumulative distribution function and the survival function of X, and where $l = \inf\{x \in \mathbb{R} : F(x) > 0\}$ and $r = \sup\{x \in \mathbb{R} : \overline{F}(x) > 0\}$. The CIGF allows to recover the information measures mentioned above. We study several results for the CIGF, with some bounds. We illustrate also some properties, including that the CIGF is a variability measure along the definition given in [1].

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This is an invited talk in the session Reliability of systems and measures of discrimination *organized by* **Francesco Buono** *and* **Maria Longobardi**.

Alessia Caponera

EPFL

On the rate of convergence for the autocorrelation operator in functional autoregression

We consider the problem of estimating the autocorrelation operator of an autoregressive Hilbertian process. By means of a Tikhonov approach, we establish a general result that yields the convergence rate of the estimated autocorrelation operator as a function of the rate of convergence of the estimated lag zero and lag one autocovariance operators. The result is general in that it can accommodate any consistent estimators of the lagged autocovariances. Consequently it can be applied to processes under any mode of observation: complete, discrete, sparse, and/or with measurement errors. An appealing feature is that the result does not require delicate spectral decay assumptions on the autocovariances but instead rests on natural source conditions. The result is illustrated by application to important special cases.

This is an invited talk in the session Nonparametric inference on complex dependence structures *organized by* **Stefano Rizzelli**.

Daniele Cappelletti

Politecnico di Torino

Stochastic reaction networks in stochastic environment

Stochastic reaction networks are mathematical models heavily utilized in biochemistry. Usually it is assumed the rates at which biochemical transformations occur only depend on the current chemical configuration. Motivated by biological applications, in this study we considered the more general case of the rates depending on both the current configuration and another stochastic process. We study the positive recurrence of this more general model, and under certain conditions characterize the stationary distribution (when it exists) as a mixture of Poisson distributions, which is uniquely identified as the law of a fixed point of a stochastic recurrence equation. This recursion can be utilized for the statistical computation of moments and other distributional features.

This is an invited talk in the session **Stochastic chemical reaction network dynamics** *organized by* **Andrea Agazzi**.

Giulia Carigi

Università degli Studi dell'Aquila

Linear and fractional response for dissipative SPDEs

A framework suitable to establish response theory for a class of nonlinear stochastic partial differential equations is provided. More specifically, it is shown that the averages of a class of observables against the stationary measure are differentiable (linear response) and locally Hölder continuous (fractional response) as functions of a deterministic additive forcing. Moreover, the method allows for observables not necessarily spatially differentiable to be considered. The results are applied to the 2D stochastic Navier-Stokes equation and the stochastic two-layer quasi-geostrophic model, an intermediate complexity model popular in the geosciences to study atmosphere and ocean dynamics. In particular, studying the response to perturbations in the forcings for models in geophysical fluid dynamics gives a mathematical insight into whether statistical properties derived under current conditions will be valid under different forcing scenarios.

This is a contributed talk in the **Contributed session III**.

Gioia Carinci

Università degli Studi di Modena e Reggio Emilia

Condensation of SIP particles and sticky Brownian motion

The symmetric inclusion process (SIP) is a particle system with attractive interaction. We study its behavior in the condensation regime attained for large values of the attraction intensity. Using Mosco convergence of Dirichlet forms, we prove convergence to sticky Brownian motion for the distance of two SIP particles. We use this result to obtain, via duality, an explicit scaling for the variance of the density field in this regime, for the SIP initially started from a homogeneous product measure. This provides relevant new information on the coarsening dynamics of condensing particle systems on the infinite lattice.
Joint works with M. Ayala, C. Giardinà and F. Redig.

This is an invited talk in the session **Scaling limits for interacting particle systems** *organized by* **Chiara Franceschini**.

Marta Catalano

University of Warwick

Optimal transport methods for Bayesian nonparametric model comparison

Optimal transport (OT) methods and Wasserstein distances are flourishing in many scientific fields as an effective means for comparing and connecting different random structures. In this talk we describe the first use of an OT distance between Lévy measures with infinite mass to solve a statistical problem. Complex phenomena often yield data from different but related sources, which are ideally suited to Bayesian modeling because of its inherent borrowing of information. In a nonparametric setting, this is regulated by the dependence between random measures: we derive a general Wasserstein index for a principled quantification of the dependence gaining insight into the models' deep structure. It also allows for an informed prior elicitation and provides a fair ground for model comparison. Our analysis unravels many key properties of the OT distance between Lévy measures, whose interest goes beyond Bayesian statistics, spanning to the theory of partial differential equations and of Lévy processes.

This is an invited talk in the session Nonparametric inference on complex dependence structures *organized by* **Stefano Rizzelli**.

Giuseppe Cavaliere

Università di Bologna

Bootstrap Inference in the Presence of Bias

In this paper we consider bootstrap inference for estimators which are (asymptotically) biased. We show that, even in cases where the bias term cannot be consistently estimated, valid inference can successfully be restored by proper implementations of the bootstrap. We do this by focusing on the properties of the bootstrap p-values, and on the fact that, for some bootstrap schemes, the large-sample distribution of the bootstrap p-values, albeit not uniformly distributed, do not depend on the bias. When such schemes are found, we show that the prepivoting approach of Beran (1987, 1988), originally proposed to deliver higher-order refinements, restores bootstrap validity by properly transforming the original bootstrap p-values into asymptotically uniform random variables. We further propose different methods for feasible implementation of prepivoting. Specifically, we introduce a plug-in approach, based on estimation of the nuisance parameters appearing in the asymptotic distribution of the bootstrap p-values, and an automated method based on the double bootstrap. For both approaches, we provide very general high-level conditions that imply validity of bootstrap inference. Importantly, our assumptions cover estimators and statistics which are not asymptotically Gaussian. To illustrate the practical relevance of our results, and to show how to implement them in applied problems, we discuss five applications of the main ideas: (i) a simple location model for i.i.d. data, possibly with infinite variance; (ii) regression models with omitted controls; (iii) inference on a target parameter based on model averaging; (iv) ridge-type regularized estimators; and (v) dynamic panel data models.

This is an invited talk in the session **Improved inference in statistical models** *organized by* **Silvia Sarpietro** *and* **Stanislav Anatolyev**.

Alekos Cecchin

Università degli Studi di Padova

Mean field game master equations: from finite to continuous state space

We analyze mean field games for diffusion-based models and their space discretization. For simplicity, the dynamics evolves on the one-dimensional torus, and there is no common noise. We examine a space discretization of the dynamics, which is reminiscent of the Markov chain approximation method in stochastic optimal control, but also of finite difference numerical schemes for Hamilton-Jacobi equations. The discretized problem turns out to be a mean field game over a finite state space, still in continuous time. Assuming monotonicity, which ensures uniqueness and also stability, we show that the discrete mean field games converge to the continuous limit, the main result being to provide a rate for the convergence both of the master equations governing the games and of the optimal trajectories. We consider first the case in which there exists a smooth solution to the limit master equation and then the case where there is no such solution.

This is an invited talk in the session Discrete to continuum: interacting particle and mean field games *organized by* **Giulia Livieri**, **Marta Leocata**, **Alekos Cecchin**, **Maddalena Ghio**.

Sandra Cerrai

University of Maryland

Incompressible viscous fluids in the plane and SPDEs on graphs

I will present some results about the asymptotic behavior of a class of stochastic reaction-diffusion-advection equations in the plane. I will show that as the divergence-free advection term becomes larger the solutions of such equations converge to the solution of a suitable stochastic PDE defined on the graph associated with the Hamiltonian. I will deal with the case when the stochastic perturbation is given by a singular spatially homogeneous Wiener process taking values in the space of Schwartz distributions. As in previous works, I will assume that the derivative of the period of the motion on the level sets of the Hamiltonian does not vanish. Time permitting, without assuming this condition on the derivative of the period, I will study a weaker type of convergence for the solutions of a suitable class of linear SPDEs.

This is a Plenary talk.

Luis Mario Chaparro Jáquez
University of Leeds

Convergence rate for the numerical solution of SDEs with distributional drift in Besov spaces

This poster presents the convergence rate for the numerical solution of SDEs when the drift of these equations belongs to a Besov space of negative index. We provide a convergence rate for the Euler scheme applied to a regularised version of the equations, and the convergence rate of the regularised solution to the original solution, combining those two results we obtain the full convergence result in a suitable L^1-norm.

This is a contribution in the **Poster session**.

Umberto Cherubini

Università di Bologna

Long term risk: a time change approach

We study an asset pricing model in which a Stochastic Discount Factor (SDF) and a growth process have independent increments and are affected by a common stochastic clock. The stochastic clock is a strictly increasing process that may include a persistent component, that we call comonotonic, and represents sources of long run uncertainty, such as those induced by climate change issues. We find that long term log-returns are lower the higher the variance of the clock, and the more relevant its comonotonic component. The comonotonic component in the clock induces a separation of the SDF dynamics between persistent and transitory shocks similar to that assumed in the long term risk literature, with the difference that the system is non Markovian. We also provide an axiomatic definition of the compounding operation leading to an associative algebraic structure, with generator represented by the Laplace transform of the stochastic clock increments. The same generator characterizes the Archimedean copula function linking the SDF and the growth process.

This is an invited talk in the session **Options, algebra and probability: in memory of Peter Carr** *organized by* **Umberto Cherubini**.

Alberto Chiarini

Università degli Studi di Padova

Disconnection and entropic repulsion for the harmonic crystal with random conductances

We study level-set percolation of the discrete Gaussian free field on the Euclidean lattice in three and more dimensions, equipped with uniformly elliptic random conductances. We prove that this percolation model undergoes a non-trivial phase transition at a deterministic level. Furthermore, for a compact set A, we study the disconnection event that the level-set of the field below a given level disconnects the discrete blow-up of from the boundary of an enclosing box, in a strongly percolative regime. We present quenched asymptotic upper and lower bounds on this probability in terms of the homogenized capacity of A. Moreover, we investigate the behavior of the field conditioned on the disconnection event.
Joint work with M. Nitzschner (NYU Courant).

This is an invited talk in the session Large scale random structures *organized by* **Gianmarco Bet** *and* **Alessandro Zocca**.

Fabrizio Cinque

Università di Roma "La Sapienza"

Sum of independent generalized Mittag-Leffler random variables and related fractional processes

We discuss about the sum of independent and non-identically distributed generalized Mittag-Leffler random variables. In particular, its probability density can be expressed in terms of a multivariate analogue of the Mittag-Leffler function, that is, for $N \in \mathbb{N}$,

$$E^{\gamma}_{\nu,\delta}(x) = \sum_{k_1,\dots,k_N=0}^{\infty} \prod_{i=1}^{N} \frac{\Gamma(\gamma_i + k_i)}{\Gamma(\gamma_i)\, k_i!}\, x_i^{k_i}\, \frac{1}{\Gamma(\sum_{i=1}^{N} \nu_i k_i + \delta)}$$

where $\gamma = (\gamma_1, \dots, \gamma_N) \in \mathbb{C}^N$, $\nu = (\nu_1, \dots, \nu_N) \in \mathbb{C}^N$ with $Re(\nu_i) > 0$ for $i = 1, \dots, N$, and $\delta \in \mathbb{C}$, $x \in \mathbb{R}^N$.

We apply the result on the previous convolution to the study of state-dependent fractional point processes with Mittag-Leffler waiting times. We present their explicit probability mass functions as well as their connections with the fractional integral/differential equations. We focus on the point process whose waiting times are given by independent Mittag-Leffler random variables which alternate $N \in \mathbb{N}$ couples of parameters $(\nu_i, \lambda_i) \in (0, 1] \times (0, \infty)$, $i = 1, \dots, N$. In the case of two alternating kind of Mittag-Leffler distributed waiting times we present the conditional arrival times and we show an application to the one-dimensional telegraph process.

This is an invited talk in the session Generalized fractional processes *organized by* **Giacomo Ascione**.

Andrea Clini

University of Oxford

Mean-field type neural models with reflecting boundary conditions

Even in the absence of external sensory cues, foraging rodents maintain an estimate of their position, allowing them to return home in roughly straight lines. This computation is known as dead reckoning or path integration. Recently, a specific region of the neural cortex has been identified as the location in the rat's brain where this computation is performed, and specific mean-field type neural models have been proposed to mimic the activity of the relevant neurons in the brain. On the side of the mathematics, these models consist of systems of SDEs describing the activity level of MN neurons stacked along N columns with M neurons each. To prevent the noise from driving the activity level of some neurons to be negative, which is clearly not desirable from the point of view of the modelling, reflecting boundary conditions are added at the SDE level. When investigating the limiting behavior, these boundary conditions persist in the associated McKean-Vlasov equation and in turn translate into no-flux boundary conditions for the corresponding Fokker-Planck PDE. The combination of the spatial interaction and the interaction along columns further complicates the picture, reducing the usual properties of mutual independence of the limiting particles. We discuss and answer classical questions in the mean-field theory setting: well-posedness of the relevant systems and equations, limiting behavior, sharp estimates for the rate of convergence of empirical measures.

This is a contributed talk in the Contributed session III.

Michele Coghi

Università degli Studi di Trento

Rough McKean-Vlasov dynamics for robust ensemble Kalman filtering

Motivated by the challenge of incorporating data into misspecified and multiscale dynamical models, we study a McKean-Vlasov equation that contains the data stream as a common driving rough path. This setting allows us to prove well-posedness as well as continuity with respect to the driver in an appropriate rough-path topology. The latter property is key in our subsequent development of a robust data assimilation methodology: We establish propagation of chaos for the associated interacting particle system, which in turn is suggestive of a numerical scheme that can be viewed as an extension of the ensemble Kalman filter to a rough-path framework. Finally, we discuss a data-driven method based on subsampling to construct suitable rough path lifts and demonstrate the robustness of our scheme in a number of numerical experiments related to parameter estimation problems in multiscale contexts.

This is an invited talk in the session Rough analysis and applications *organized by* **Carlo Bellingeri** *and* **Lucio Galeati**.

Katia Colaneri

Università di Roma "Tor Vergata"

A model for Covid Pandemic under partial information: filtering and parameter estimation

We provide a discrete time model for the evolution of Covid pandemic, which represents a modification, in a partial information setting, of the well know SIR model for epidemics. We assume that the current number of infected people is unknown and use particle filtering to derive the reproduction rate and estimate parameters such as the intensity of new infections and the probability of infecting other people. Our results are applied to Austrian data of Covid-19 infections.
This is a joint work with Camilla Damian and Ruediger Frey.

This is an invited talk in the session **Partial information: stochastic models and applications** *organized by* **Claudia Ceci**.

Fausto Colantoni

Università di Roma "La Sapienza"

Fractional boundary conditions and related stochastic processes

We study some right and left non-local operators and discuss their connection with probability. In particular, these operators turn out to be naturally involved in the governing equations of subordinators with non-zero starting points. Moreover, we focus on fractional boundary conditions for Brownian motions and discuss the related stochastic solutions.

This is an invited talk in the session Nonlocal operators in probability: nonlocal boundary conditions *organized by* **Bruno Toaldo**.

Francesca Collet

Università degli Studi di Verona

Critical fluctuations for the edge-triangle model: a conjecture

The edge-triangle model is a two-parameter family of random graphs defined by a tilted probability measure depending on the triangle and edge densities. Our aim is to characterise the asymptotic behaviour of the edge density at criticality, as the graph size tends to infinity. After having briefly illustrated classical limit theorems, we will focus on the fluctuations at the critical point and we will formulate our conjecture, based on a mean-field approximation of the model.
Joint work with Alessandra Bianchi (Padova) and Elena Magnanini (Berlin).

This is an invited talk in the session Scaling limits, criticality, and random media in statistical physics *organized by* **Lorenzo Dello Schiavo** *and* **Federico Sau**.

Fulvia Confortola

Politecnico di Milano

Stochastic control problems of infinite-dimensional jump-diffusions

We address optimal control problems for infinite dimensional jump-diffusion processes in non dominated models. To be more precise, the state process lives in a real separable Hilbert space and is driven by a cylindrical Brownian motion and a Poisson random measure in a non Markovian setting; the coefficients are also allowed to be path-dependent and the diffusion coefficient can be degenerate. The stochastic optimal control problem is studied by means of the so-called randomization method. This latter is a purely probabilistic methodology which allows to prove directly, that the value itself admits a representation formula in terms of a suitable backward stochastic differential equation, avoiding completely analytical tools. This procedure has been previously applied to a stochastic control problem in finite dimension for diffusive processes (without jumps) ([4,1]). We recall that in the context of controlled diffusions, probabilistic formulae for the value function for non dominated models have been discovered only in recent years. There are only a few available techniques: the theory of second-order BSDEs ([3,6]) or the theory of G-expectations ([5]). In the Markovian case such a representation allows to show that the value function satisfies the so-called randomized dynamic programming principle. As a consequence, we are able to prove that the value function is a viscosity solution of the corresponding Hamilton-Jacobi-Bellman equation, which turns out to be a second-order fully non-linear integro-differential equation in Hilbert space.

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This is an invited talk in the session Advances in stochastic control with applications *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Alice Corbella

University of Warwick

Automatic Zig Zag sampling in practice

Novel Monte Carlo methods to generate samples from a target distribution have rapidly grown in the past decade. These include special continuous-time processes, Piecewise Deterministic Markov Processes (PDMPs), that have been proven promising thanks to their important properties and some convenient features (e.g. super-efficiency). The use of PDMP methods in practice is not widespread yet, mainly due to the several implementation challenges that PDMP-based samplers present. During this talk I address these implementation challenges, guided by a specific PDMP, the Zig-Zag sampler. I propose an "automatic" algorithm that allows to draw samples from a target distribution of interest. By "automatic" we mean that the main requirement of the algorithm is only a closed-form function to evaluate the target density, and, unlike previous implementations, no further information is needed. The performance of the proposed algorithm is evaluated against other, well established, gradient-based samplers and it is proven to be competitive, both in simulation settings and in real-data examples. Lastly, this algorithm is further extended and, and the appealing property of super-efficiency via sub-sampling is obtained for a general target, again without the need of further information.

This is an invited talk in the session Monte Carlo sampling with piecewise deterministic Markov processes *organized by* **Andrea Bertazzi**.

Francesca Cottini

Università degli Studi di Milano-Bicocca

Gaussian limits for subcritical chaos

In this talk we will present a general and novel criterion, only based on second moment assumptions, to show the convergence towards a Gaussian limit for polynomial chaos (a multi-linear polynomial of independent random variables). This result is motivated by the study of 2d directed polymers in the subcritical regime and of the related 2d Stochastic Heat Equation, whose asymptotic behavior has been throughly investigated in recent years. In particular, we will show how this criterion allow us to recover the existing results in a simpler way and, furthermore, to obtain new information on our models of interest.
This is a joint work with Francesco Caravenna.

This is an invited talk in the session **Probabilistic approximations via chaotic decompositions** *organized by* **Anna Vidotto**.

Alessandra Cretarola

Università degli Studi di Perugia

Optimal reinsurance and investment under exponential forward preferences

We study the optimal proportional reinsurance-investment strategy of an insurance company whose preferences are described via a forward dynamic exponential utility, when both the risky asset price dynamics and the intensity of the claims arrival process are affected by an exogenous stochastic factor. This model, which also allows for stochastic risk premia, implies a mutual dependence between the financial and the insurance framework. Using the classical stochastic control approach based on the Hamilton-Jacobi-Bellman equation, we construct a forward dynamic exponential utility and characterize the optimal reinsurance-investment strategy. We investigate in detail the zero-volatility case and provide a comparison analysis with classical results in an analogous setting under backward utility preferences.

This is an invited talk in the session Advances in stochastic control with applications *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Lorenzo Cristofaro

Università di Roma “La Sapienza”

Non-gaussian analysis based on a class of completely monotone functions

During the last decades infinite-dimensional analysis has been developed through the use of non-Gaussian measures. Indeed, the tools of White Noise Analysis have been generalized for non-Gaussian measures to obtain notions and characterizations similar to Gaussian Analysis. In this talk, we present the cases of measures and generalized processes based on the Gamma incomplete function and a class of completely monotone functions.

This is an invited talk in the session Nonlocal operators in probability: anomalous diffusions *organized by* **Mirko D’Ovidio** *and* **Giacomo Ascione**.

Emilio Cruciani

Paris-Lodron University of Salzburg

Biased opinion dynamics: when the devil is in the details

We investigate opinion dynamics in multi-agent networks when a bias toward one of two possible opinions exists; for example, reflecting a status quo vs a superior alternative. Starting with all agents sharing an initial opinion representing the status quo, the system evolves in steps. In each step, one agent selected uniformly at random adopts the superior opinion with some probability α, and with probability $1-\alpha$ it follows an underlying update rule to revise its opinion on the basis of those held by its neighbors. We analyze convergence of the resulting process under two well-known update rules, namely majority and voter. The framework we propose exhibits a rich structure, with a non-obvious interplay between topology and underlying update rule. For example, for the voter rule we show that the speed of convergence bears no significant dependence on the underlying topology, whereas the picture changes completely under the majority rule, where network density negatively affects convergence. We believe that the model we propose is at the same time simple, rich, and modular, affording mathematical characterization of the interplay between bias, underlying opinion dynamics, and social structure in a unified setting.
The talk is based on the following paper: https://doi.org/10.1016/j.ins.2022.01.072.

This is an invited talk in the session **Opinion dynamics in biased communication models** *organized by* **Hlafo Alfie Mimun**.

Francesca Romana Crucinio

University of Warwick

Solving Fredholm integral equations of the first kind via Wasserstein gradient flows

Solving Fredholm equations of the first kind is crucial in many areas of applied sciences. In this work we adopt a probabilistic and variational point of view by considering a minimization problem in the space of probability measures with an entropic regularization. Contrary to classical approaches which discretize the domain of the solutions, we introduce an algorithm to asymptotically sample from the unique solution of the regularized minimization problem. As a result our estimators do not depend on any underlying grid and have better scalability properties than most existing methods. Our algorithm is based on a particle approximation of the solution of a McKean-Vlasov stochastic differential equation associated with the Wasserstein gradient flow of our variational formulation. We prove the convergence towards a minimizer and provide practical guidelines for its numerical implementation. Finally, our method is compared with other approaches on several examples including density deconvolution and epidemiology.

This is an invited talk in the session **Interacting particle systems and inference** *organized by* **Martina Favero**.

Imma Valentina Curato

Ulm University

PAC Bayesian bounds for light cones data

Many interesting data in Earth science and physics consist of observations on regular spatial lattices across time (*frames*), each composed of a fixed amount of elements (*pixels*). We assume that each observation is influenced by neighboring observations in the past (except for the ones on the lattice boundaries). Following [2], we adopt the concept of *light cones* to model this local dynamic. We then define a linear regression task (with an absolute loss) to make predictions in new pixel positions and use the PAC Bayesian framework to determine a randomized estimator for the model parameters. In order to select the latter, we proceed as follows. Firstly, we pre-process our data in a set of possible training data sets obtained using different light-cones-shaped sampling schemes. Secondly, we extend the PAC Bayesian framework to work for identically distributed spatio-temporal data that are generated by an influenced mixed moving average field [1]. So doing, we determine an empirical bound for the theoretical risk while modeling the typical high correlation observed along the temporal and spatial dimensions of the data. Finally, we show that the Gibbs distribution minimizes the empirical PAC Bayesian bound we find. We obtain different Gibbs distribution for each chosen sampling scheme. Among the latter, we finally select the best one and prove that it satisfies an oracle inequality.

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This is a contributed talk in the **Contributed session II**.

Raul Curto

University of Iowa, USA

The Truncated Moment Problem for Unital Commutative $\mathbb{R}$-Algebras

Let A be a unital commutative $\mathbb{R}$-algebra, K a closed subset of the character space of A, and B a linear subspace of A. For a linear functional $L : B \to \mathbb{R}$, we investigate conditions under which L admits an integral representation with respect to a positive Radon measure supported in K. When A is equipped with a submultiplicative seminorm, we employ techniques from the theory of positive extensions of linear functionals to prove a criterion for the existence of such an integral representation for L. When no topology is prescribed on A, we identify suitable assumptions on A, K, B and L which allow us to construct a seminormed structure on A, so as to exploit our previous result to get an integral representation for L. Our main theorems allow us to extend some well-known results on the Classical Truncated Moment Problem, the Truncated Moment Problem for point processes, and the Subnormal Completion Problem for 2–variable weighted shifts. We also analyze the relation between the Full and the Truncated Moment Problem in our general setting; we obtain a suitable generalization of Stochel's Theorem, which readily applies to Full Moment Problems for localized algebras.
The talk is based on joint work with Mehdi Ghasemi, Maria Infusino and Salma Kuhlmann.

This is an invited talk in the session **Recent perspectives on moment problems** *organized by* **Maria Infusino** *and* **Tobias Kuna**.

Francesco D'Amore

Université Côte d'Azur, Inria, I3S, CNRS

Phase transition of the 3-Majority dynamics with uniform communication noise

Communication noise is a common feature in several real-world scenarios where systems of agents need to communicate in order to pursue some collective task. In particular, many biologically inspired systems that try to achieve agreements on some opinion must implement resilient dynamics that are not strongly affected by noisy communications. In this work, we study the popular 3-Majority dynamics, an opinion dynamics which has been proved to be an efficient protocol for the majority consensus problem, in which we introduce a simple feature of uniform communication noise, following (d'Amore et al. 2020). We prove that in the fully connected communication network of n agents and in the binary opinion case, the process induced by the 3-Majority dynamics exhibits a phase transition. For a noise probability $p < 1/3$, the dynamics reaches in logarithmic time an almost-consensus metastable phase which lasts for a polynomial number of rounds with high probability. Furthermore, departing from previous analyses, we further characterize this phase by showing that there exists an attractive equilibrium value $s_{eq} \in [n]$ for the bias of the system, i.e. the difference between the majority community size and the minority one. Moreover, the agreement opinion turns out to be the initial majority one if the bias towards it is of magnitude $\Omega(\sqrt{n \log n})$ in the initial configuration. If, instead, $p > 1/3$, no form of consensus is possible, and any information regarding the initial majority opinion is lost in logarithmic time with high probability. Despite more communications per-round are allowed, the 3-Majority dynamics surprisingly turns out to be less resilient to noise than the Undecided-State dynamics (d'Amore et al. 2020), whose noise threshold value is $p = 1/2$.

This is an invited talk in the session **Opinion dynamics in biased communication models** *organized by* **Hlafo Alfie Mimun**.

Bernardo D'Auria

Università degli Studi "G. d'Annunzio" Chieti-Pescara

Time-space transformations and optimal stopping: the Ornstein-Uhlenbeck bridge case

In this talk, we analyse the optimal stopping problem of an Ornstein-Uhlenbeck bridge, having as objective the expected value of the process itself. This model is non-homogeneous and shows unbounded drift near the expiration date; it includes the Brownian bridge problem as a limit case. We show that a feasible way to deal with the optimal stopping problem is to use a time-space transformation that allows to reduce it to an infinite horizon problem about a Brownian motion. As numerical solutions show the optimal barrier is not in general monotone as it is known to be in the limiting case of the Brownian bridge.

This is an invited talk in the session Markov processes and first passage time problems *organized by* **Barbara Martinucci**.

Giuseppe D'Onofrio

Università degli Studi di Torino

A non-local Jacobi operator for neuronal modeling

To overcome some limits of classical neuronal models, we introduce downward jumps in a class of Jacobi processes to model the activity of a single neuron. The mathematical study of the model requests the development of general results for the first-passage time, T, of the proposed Jacobi process with jumps through a constant boundary. We characterize the Laplace transform of T in terms of generalized hypergeometric functions that we introduce, getting a new closed-form expression of the expectation of T. We follow an original approach based on intertwining relations, which have been recently established, between the semigroup of classical Jacobi processes with the one of their generalized versions. A numerical investigation of these results is considered in the case of neuronal modeling for some choices of the involved parameters and of the jumps distributions.
Based on a joint work with Pierre Patie (Cornell University) and Laura Sacerdote (Università degli Studi di Torino).

This is an invited talk in the session **On stochastic methods, models and applications** *organized by* **Elvira Di Nardo**.

Mirko D'Ovidio

Università di Roma "La Sapienza"

Nonlocal boundary conditions, some recent results

We discuss some recent results about non-local boundary value problems in the framework of fractional dynamic boundary conditions. We present the probabilistic representation of the problem.

This is an invited talk in the session Nonlocal operators in probability: nonlocal boundary conditions *organized by* **Bruno Toaldo**.

Umberto De Ambroggio

University of Bath

The probability of unusually large maximal components in critical random graphs

We consider the classical Erdös-Rényi random graph as well as percolation on a random regular graph, and provide matching upper and lower bounds for the probability of observing unusually large maximal components in these models when considered near-criticality. We sketch the proof for the upper bounds, which is based on a ballot-type estimate (that could be of independent interest) for the probability that a random walk stays positive for n steps and finishes at some level j. Time permitting, we will also present a simple, yet general result which yields polynomial upper bounds for the probability of observing large components in several models of random graphs when considered at criticality.

This is an invited talk in the session **Random graphs** *organized by* **Umberto De Ambroggio**.

Tiziano De Angelis

Università di Torino e Collegio Carlo Alberto

Quickest detection of a Brownian drift with false negatives: a recursive approach

We study the canonical problem of detecting the appearence of a constant drift in an otherwise driftless Brownian motion on the real line. The time at which the drift appears is exponentially distributed, independent of the Brownian motion and not observable. In line with the traditional literature on the subject, the optimisation criterion consists of the simultaneous minimisation of the probability of a false alarm and a delayed detection. For the first time we introduce the novel feature of false negatives and repeated detection attempts: when the optimiser decides to observe the drift of the underlying process, if the drift has appeared, she will not detect it due to measurement errors with some probability; in that case the optimisation resumes and the pattern repeats until the drift is eventually detected. After applying filtering techniques we reduce the problem to a Markovian recursive optimal stopping problem whose underlying process is the posterior probability of the appearence of the drift. From that formulation we are able to find the optimal strategy in closed form by solving a non-standard free boundary problem with a recursive structure.
Joint work with Jhanvi Garg and Quan Zhou (Texas A&M University).

This is an invited talk in the session **Partial information: stochastic models and applications** *organized by* **Claudia Ceci**.

Daniela De Canditiis

CNR

The adaptive Lasso estimator of AR(p) time series with applications to INAR(p) and Hawkes processes

We study the consistency and the oracle properties of the adaptive Lasso estimator for the coefficients of a linear AR(p) time series with a strictly stationary white noise (not necessarily described by i.i.d. r.v.'s). We apply the results to INAR(p) time series and to the non-parametric inference of the fertility function of a Hawkes point process. We present some numerical simulations to emphasize the advantages of the proposed procedure with respect to more classical ones and finally we apply it to a set of epidemiological data.

This is a contributed talk in the session Nonparametric inference on complex dependence structures *organized by* **Stefano Rizzelli**.

Filippo De Feo

Politecnico di Milano

Optimal control of stochastic differential delay equations

Optimal control problems of infinite-dimensional stochastic systems arise in many areas of physics, engineering, economics, mathematical finance and many others. These problems have been studied over the last years and various methods have been developed. We will focus on the dynamic programming approach via B-continuous viscosity solutions on Hilbert spaces. For a system of this kind a general theory, able to characterize the value function of the problem as the unique B-continuous viscosity solution of the corresponding infinite-dimensional Hamilton-Jacobi-Bellman (HJB) partial differential equation, is available. The main issue with this theory is that it presents non-trivial assumptions that must be verified and adapted when considering a specific problem. Many applied problems have been studied with success with this approach, however up to now the question of uniqueness of B-continuous viscosity solutions of HJB equations associated to optimal control problems of stochastic differential delay equations has remained open. We have to mention that except some particular cases, in which the HJB equation corresponding to the stochastic optimal control problem reduces to a finite-dimensional one, the HJB equation related to optimal control of stochastic differential delay equations is indeed infinite dimensional. We consider then an optimal control problem for a general class of systems of stochastic differential delay equations. In order to treat this mathematically we rewrite the problem into an equivalent Markovian form on the Hilbert space $X = \mathbb{R}^d \times L^2([-d, 0], \mathbb{R}^d)$ where $\mathbb{R}^d$ is the state space of the present variable and $L^2([-d, 0], \mathbb{R}^d)$ is the state space of past variable. Then we investigate the infinite-dimensional optimal control problem using the dynamic programming approach: in particular we first show that the value function of the problem is the unique B-continuous viscosity solution of the corresponding infinite-dimensional Hamilton-Jacobi-Bellman equation. Finally we study some differentiability properties of the value function, i.e. that it is differentiable with respect to the present variable. This result is interesting since it permits to define formally a "candidate" optimal-feedback strategy. The investigation for which this "candidate" optimal-feedback strategy is actually optimal is left for a future work.

This is an invited talk in the session New trends in stochastic control: delay, partial and exogenous information *organized by* **Giuseppina Guatteri**, **Fulvia Confortola**, **Federica Masiero**.

Alessandro De Gregorio

Università di Roma "La Sapienza"

Stochastic solutions for time-fractional heat equations with complex spatial variables

We deal with complex spatial diffusion equations with time-fractional derivative and study their stochastic solutions. In particular, we complexify the integral operator solution to the heat-type equation where the time derivative is replaced with the convolution-type generalization of the regularized Caputo derivative. We prove that this operator is solution of a complex time-fractional heat equation with complex spatial variable. This approach leads to a wrapped Brownian motion on a circle time-changed by the inverse of the related subordinator. This time-changed Brownian motion is analyzed and, in particular, some results on its moments, as well as its construction as weak limit of continuous-time random walks, are obtained. The extension of our approach to the higher dimensional case is also provided.

This is an invited talk in the session **Generalized fractional processes** *organized by* **Giacomo Ascione**.

Francesco De Vecchi

University of Bonn

Bose-Einstein condensation and McKean-Vlasov optimal control problems

In this talk, we show the connection between the mathematical formulation of Bose-Einstein condensation and a family of (ergodic) optimal control problems of McKean-Vlasov type with linear control and quadratic dependence on control of the cost function. Thanks to this reformulation of these optimal control problems, we establish the existence and uniqueness of the optimal control in these cases. Furthermore, we prove the convergence in relative entropy and total variation of a suitable approximating N-particle Markovian optimal control problem.
The seminar is based on a joint work with Sergio Albeverio, Andrea Romano and Stefania Ugolini.

This is an invited talk in the session **Stochastic methods in quantum theory** *organized by* **Sonia Mazzucchi** *and* **Stefania Ugolini**.

Francesco De Vecchi

University of Bonn

Stochastic quantization of exponential-type quantum field theories

Stochastic quantization is a method, proposed by Parisi and Wu, of constructive Euclidean quantum field theory for building the Schwinger functions of a quantum model from the invariant solutions of suitable (parabolic, hyperbolic or elliptic) stochastic partial differential equations (SPDEs). In the talk, we provide an introduction of the topic and of some recent developments in the field, focusing on the analytic and probabilistic aspects of the problem. We propose a more detailed analysis of the SPDEs related to the two-dimensional exponential-type models such as the Hoegh-Krohn, or Liouville quantum gravity, quantum field theory and the massive Sinh interaction.
The talk is based on a joint work with Sergio Albeverio and Massimiliano Gubinelli, and on a joint with Nikolay Barashkov.

This is an invited talk in the session Rough analysis and applications *organized by* **Carlo Bellingeri** *and* **Lucio Galeati**.

Serena Della Corte

TU Delft

On the motion of motor proteins: A Large deviation approach

We consider the context of molecular motors modeled by a small noise diffusion. In this setting, the potential depends on a variable modeling a molecular switch. In the large time limit, we prove Large deviation principle of trajectories by the analysis of an associated Hamilton- Jacobi equation. Following the Jin Feng and Thomas Kurtz's method, we prove comparison principle for an equation in which the Hamiltonian is the principle eigenvalue of a cell problem, depending both on points and on momenta. We start analysing a particular model leading to a more general theorem. Moreover, we give the action-integral representation of the rate function.

This is a contribution in the **Poster session**.

Giulia Della Croce

Politecnico di Torino

A new approach for the estimation of the contagiousness ratio between omicron and delta variants

This work proposes a new method for the estimation of the ratio between the basic reproduction numbers of a new emerging variant and the one currently dominating, based on incidence data from random samples, and given the epidemic curves of total infections and recoveries. Our method is based on a discrete time SIR model with two strains, and it is considered both in the deterministic and in the stochastic version. In the deterministic case we can directly apply the method of maximum likelihood. In the stochastic setting, instead, we need to reconstruct the missing information about the incidence and prevalence of the new variant within a hierarchical Bayesian model. This new methodology is applied to the ISS quick surveys data focusing on the Piedmont Italian region in December-January 2022, the period when the omicron variants started to be observed and quickly became prevalent. We show how it is possible, with both approaches, to obtain an estimate of such contagiousness ratio from public data that is consistent with the other studies specifically designed to the aim.

This is a contribution in the **Poster session**.

Lorenzo Dello Schiavo

IST Austria

Scaling limits of random walks, harmonic profiles, and stationary non-equilibrium states in Lipschitz domains

We consider the open symmetric exclusion (SEP) and inclusion (SIP) processes on a bounded Lipschitz domain Ω, with both fast and slow boundary. For the random walks on Ω dual to SEP/SIP we establish a functional-CLT-type convergence to the Brownian motion on Ω with either Neumann (slow boundary), Dirichlet (fast boundary), or Robin (at criticality) boundary conditions. We further show the discrete-to-continuum convergence of the corresponding harmonic profiles. As a consequence, we rigorously derive the hydrodynamic and hydrostatic limits for SEP/SIP on Ω, and analyze their stationary non-equilibrium fluctuations.
Based on joint work arXiv:2112.14196 with Lorenzo Portinale (IAM Bonn) and Federico Sau (IST Austria).

This is an invited talk in the session **Scaling limits for interacting particle systems** *organized by* **Chiara Franceschini**.

Enrico Di Gaspero

Bielefeld University

The Moran Model of population genetics: a new link between forward-time and backward-time perspectives

In the context of the Moran model of population genetics with two types, mutation, and selection, two probabilistic tools have played a central role in recent studies: the killed ancestral selection graph (kASG), which allows to understand the type of an individual at present based on its potential ancestry, and the pruned lookdown ancestral selection graph (pLD-ASG), which gives access to the ancestral types. These processes provide graphical interpretations for two well-known recursions: the sampling recursion, which describes the moments of the proportion of the unfit individuals at stationarity, and the Fearnhead recursion, which describes the stationary distribution of the line-counting process of the pLD-ASG. While these two recursions have appeared unrelated so far, we now express the solution of Fearnhead's recursion in terms of the solution of the sampling recursions and vice versa. The crucial idea is the decomposition of both the kASG and the pLD-ASG into a family of elementary processes. This decomposition also leads to a graphical interpretation of the connections between the recursions.
This is joint work with Ellen Baake and Fernando Cordero.

This is a contributed talk in the session **Interacting particle systems** *organized by* **Matteo Quattropani**.

Elvira Di Nardo

Università degli Studi di Torino

A cumulant approach for the first-passage-time problem

An approximation of the probability density function (pdf) of the first passage time (FPT) through a constant boundary is proposed relied on its cumulants and a Laguerre-Gamma polynomial approximation. To apply this method, the starting point is the availability of a closed-form expression of the Laplace transform of the FPT random variable in terms of power series. Thanks to the use of the algebra of formal power series, a closed-form expressions for cumulants is recovered and the method consisting in expanding the FPT pdf as an infinite series involving the generalized Laguerre polynomials and the gamma pdf is applied. The resulting procedure is made easier to implement by a recursive structure and a rational choice of the polynomial degree depending on a suitable normalization condition. The method has been successfully applied to the Feller square-root process. Its performance has been tested on the Geometric Brownian motion.

This is an invited talk in the session Markov processes and first passage time problems *organized by* **Barbara Martinucci**.

Giulia Di Nunno

University of Oslo

Sandwiched SDEs with unbounded drift and Hölder noise

We study a stochastic differential equation with an unbounded drift and a Hölder continuous noise, which lay in a sandwich (upper and lower bounds, or just one of them). We discuss the existence of moments of all order, including the negative ones. These turn out to be essential to develop a numerical scheme for the solution. These sandwiched SDEs are interesting in the modelling of stochastic volatility in financial prices. Examples are provided as generalisations of CIR and CEV processes.
The presentation is based on joint works with Yuliya Mishura and Anton Yurchenko-Tytarenko.

This is an invited talk in the session Confined diffusions and fractional diffusions with applications *organized by* **Enrica Pirozzi**.

Paolo Di Tella

Technische Universitaet Dresden

Progressively enlargement of filtrations and control problems for step processes

In the present paper we address stochastic optimal control problems for a step process $(X, \mathbb{F})$ under a progressive enlargement of the filtration. The global information is obtained adding to the reference filtration $\mathbb{F}$ the point process $H = 1_{[\tau,+\infty)}$. Here τ is a random time that can be regarded as the occurrence time of an external shock event. We study two classes of control problems, over $[0, T]$ and over the random horizon $[0, T \wedge \tau]$. We solve these control problems following a dynamical approach based on a class of BSDEs driven by the jump measure μ^Z of the semimartingale $Z = (X, H)$, which is a step process with respect to the enlarged filtration $\mathbb{G}$. The BSDEs that we consider can be solved in $\mathbb{G}$ thanks to a martingale representation theorem which we also establish here. To solve the BSDEs and the control problems we need to ensure that Z is quasi-left continuous in the enlarged filtration $\mathbb{G}$. Therefore, in addition to the $\mathbb{F}$-quasi left continuity of X, we assume some further conditions on τ.
This is a joint work with Elena Bandini (Università di Bologna) and Fulvia Confortola (Politecnico di Milano).

This is an invited talk in the session New trends in stochastic control: delay, partial and exogenous information *organized by* **Giuseppina Guatteri**, **Fulvia Confortola**, **Federica Masiero**.

Jodi Dianetti

Bielefeld University

Submodular mean field games: Existence and approximation of solutions

We study mean field games with scalar Itô-type dynamics and costs that are submodular with respect to a suitable order relation on the state and measure space. The submodularity assumption has a number of interesting consequences. Firstly, it allows us to prove existence of solutions via an application of Tarski's fixed point theorem, covering cases with discontinuous dependence on the measure variable. Secondly, it ensures that the set of solutions enjoys a lattice structure: in particular, there exist a minimal and a maximal solution. Thirdly, it guarantees that those two solutions can be obtained through a simple learning procedure based on the iterations of the best-response-map. Our approach also allows to treat submodular mean field games with common noise, as well as mean field games with singular controls, optimal stopping and reflecting boundary conditions.
This talk is based on some joint works together with Giorgio Ferrari, Markus Fischer and Max Nendel.

This is an invited talk in the session Mean field games: a probabilistic approach *organized by* **Luciano Campi** *and* **Markus Fischer**.

Margherita Doria

Politecnico di Torino

Machine learning techniques in joint default assessment

This paper studies the consequences of capturing non linear dependence among the covariates that drive the default of different obligors in the overall riskiness of their credit portfolio. Joint default modeling is, without loss of generality, the classical Bernoulli mixture model. Marginal and joint defaults depend on a set of covariates, common to all obligors. Linear and nonlinear dependence among covariates is captured by ML methods, while LR captures linear dependence only. We show through an application to credit card dataset that the ability of matching learning methods to capture nonlinear dependence among the covariates produces higher default correlation and therefore more conservative risk measures of the quantile type.

This is a contributed talk in the **Contributed session II**.

Serena Doria

Università degli Studi "G. d'Annunzio" Chieti-Pescara

Merging of coherent conditional probabilities defined through Hausdorff measures with respect to bi-Lipschitz equivalent metrics

A natural interpretation of conditional probability is to represent subject's belief or subject's opinion about events, given information represented by a sigma-field or a partition. If conditional probabilities are defined in a metric space, different individuals can define conditional probability in different metric spaces. If different opinions are represented by coherent conditional probabilities defined on the Borel sigma-field by Hausdorff measures in different metric spaces, with bi-Lipschitz equivalent metrics, they are proven to represent merging opinions with increasing information.

This is a contributed talk in the **Contributed session I**.

Nicolò Drago

Università degli Studi di Trento

A microlocal approach to renormalization in stochastic PDEs

We present a framework for the study of a large class of non-linear stochastic PDEs, which is inspired by the algebraic approach to quantum field theory. By realizing random fields within a suitable algebra of functional-valued distributions, we are able to use techniques proper of microlocal analysis which allow us to discuss renormalization and its associated freedom without resorting to any regularization scheme and to the subtraction of infinities.
Joint work with C. Dappiaggi, P. Rinaldi, L. Zambotti.

This is an invited talk in the session **Stochastic methods in quantum theory** *organized by* **Sonia Mazzucchi** *and* **Stefania Ugolini**.

Fabrizio Durante

Università del Salento

Multivariate tail dependence with conditional value-at-risk

Understanding the behavior of the tail of a multivariate distribution function is fundamental in order to quantify the probability of occurrence of extreme (i.e. very large or very small) values in two or more vector components. In the bivariate case, tail dependence coefficients are nowadays standard tools to differentiate various distributions. In the multivariate case, however, due to the lack of a natural order in $\mathbb{R}^d$, various proposals have been made in the literature. Here, we focus on the notion of Conditional Value-at-Risk (CoVaR), introduced by Adrian and Brunnermeier (2016) in an economic framework, as a possible way to quantify the tail behavior of a random pair. In particular, we discuss two alternative definitions of CoVaR and present its calculations under various dependence structures. Moreover, we present a multivariate generalization of CoVaR and show its possible use.

This is a contributed talk in the session **Opinion dynamics in biased communication models** *organized by* **Hlafo Alfie Mimun**.

Claudio Durastanti

Università di Roma "La Sapienza"

Spherical Poisson waves

We introduce a model of Poisson random waves in the two-dimensional sphere and we study Quantitative Central Limit Theorems when both the rate of the Poisson process and the energy (i.e., frequency) of the waves diverge to infinity. We consider finite-dimensional distributions, harmonic coefficients, and convergence in law in functional spaces, and we investigate carefully the interplay between the rates of divergence of eigenvalues and Poisson governing measures.
This is a joint work with D. Marinucci and A. P. Todino.

This is an invited talk in the session **Probabilistic and statistical properties of sphere-cross-time** *organized by* **Alessia Caponera**.

Katharina Eichinger

CEREMADE - Université Paris Dauphine PSL

(Regularized) barycenters in the Wasserstein space

In this talk I will present the notion of Fréchet mean on the L^2 Wasserstein space. In the literature it is commonly called Wasserstein barycenter in line with the name given by Agueh and Carlier who introduced it in 2011. I will start by establishing existence, giving conditions for uniqueness and providing some further analytical properties. Then, I will pass to the stochastic setting. After showing a law of large numbers in this case, I will give a formal argument for proving a central limit theorem based on the formal geometric structure of the Wasserstein space. In order to make the last argument rigorous a regularization introduced by Bigot, Cazelles and Papadakis in 2019 is used.

This is an invited talk in the session Stochastic optimal transport *organized by* **Alberto Chiarini**.

Martina Favero

University of Warwick

Asymptotic behaviour of the Kingman coalescent

The Kingman coalescent is a classical stochastic process modeling genealogies in mathematical population genetics. We study the large-sample-size asymptotic behaviour of some sequences related to the coalescent, assuming a finite-allele, parent-dependent mutation model. We start by showing that the sampling probabilities under the coalescent decay polynomially in the sample size. The degree of the polynomial depends on the number of types in the model, and its coefficient on the stationary density of the dual Wright-Fisher diffusion. Then, we present a convergence result for a sequence of Markov chains that are composed of block-counting jump chains, counting-mutations components, and cost components. The limiting process includes a deterministic part and Poisson processes. Finally, we illustrate how these results may be used to analyse asymptotic properties of backward sampling algorithms based on the coalescent, in particular the asymptotic behaviour of importance sampling weights.
This talk is based on joint work with H. Hult.

This is an invited talk in the session **Stochastic processes with applications to the natural sciences** *organized by* **Giuseppe D'Onofrio**.

Salvatore Federico

Università degli Studi di Genova

Two-sided singular control of an inventory with unknown demand trend

We study the problem of optimally managing an inventory with unknown demand trend. Our formulation leads to a stochastic control problem under partial observation, in which a Brownian motion with non-observable drift can be singularly controlled in both an upward and downward direction. We first derive the equivalent separated problem under full information with state-space components given by the Brownian motion and the filtering estimate of its unknown drift, and we then completely solve the latter. Our approach uses the transition amongst three different but equivalent problem formulations, links between two-dimensional bounded-variation stochastic control problems and games of optimal stopping, and probabilistic methods in combination with refined viscosity theory arguments. We show substantial regularity of (a transformed version of) the value function, we construct an optimal control rule, and we show that the free boundaries delineating (transformed) action and inaction regions are bounded globally Lipschitz continuous functions. To our knowledge this is the first time that such a problem has been solved in the literature.

This is an invited talk in the session Stochastic models for energy, management, and environmental issues *organized by* **Alessandro Calvia** *and* **Katia Colaneri**.

Giorgio Ferrari

Center for Mathematical Economics (IMW) - Bielefeld University

A stationary mean-field game of capacity expansion with regime-switching

In this talk I will present results on stationary mean-field games with singular controls for a Markov-modulated Itô-diffusion, in which the representative player interacts with a long-time conditional weighted average of the population through a discounted performance criterion. This class of games finds natural applications in the context of irreversible production expansion in dynamic oligopolies, where the dynamics of the production capacity depends on the economy's business cycles modeled through a continuous-time Markov chain. We characterize equilibria through a system of nonlinear equations and provide explicit results for the joint stationary distribution of the controlled production capacity and the Markov chain at equilibrium. A detailed numerical analysis allows to understand the dependency of the mean-field equilibrium with respect to the model's parameters.
This is based on a joint ongoing work with René Aid and Matteo Basei.

This is an invited talk in the session Mean field games: a probabilistic approach *organized by* **Luciano Campi** *and* **Markus Fischer**.

Benedetta Ferrario

Università degli Studi di Pavia

Stationary solutions for the equations of 2D inviscid fluids

For the 2D Euler equations modeling the motion of inviscid fluids, we present some results on existence of stationary solutions, obtained by means of stochastic analysis. Introducing a damping term and a stochastic force (time white noise), we prove the existence of invariant measures.

This is an invited talk in the session SPDEs arising in physical models *organized by* **Michele Coghi**.

Josè Figueroa-Lopez

Washington University in Saint Louis

Efficient volatility estimation for Itô semimartingales with jumps of unbounded variation

Statistical inference for stochastic processes based on high-frequency observations has been an active research area for more than a decade. One of the most well-known and widely studied problems is that of estimation of the quadratic variation of the continuous component of an Itô semimartingale with jumps. Several rate- and variance-efficient estimators have been proposed in the literature when the jump component is of bounded variation. However, to date, very few methods can deal with jumps of unbounded variation. By developing new high-order expansions of the truncated moments of a Lévy process, we construct a new rate- and variance-efficient volatility estimator for a class of Itô semimartingales whose jumps behave locally like those of a stable Lévy process with a Blumenthal-Getoor index less than 8/5 (hence, of unbounded variation). The proposed method is based on a two-step debiasing procedure for the truncated realized quadratic variation of the process. Our Monte Carlo experiments indicate that the method outperforms other efficient alternatives in the literature in the setting covered by our theoretical framework.
This joint work with B. Cooper Boniece and Yuchen Han.

This is an invited talk in the session Modeling financial asset prices *organized by* **Cecilia Mancini**.

Simone Floreani

TU Delft

Hydrodynamics for the partial exclusion process in random environment

In this talk, I present a partial exclusion process in random environment, a system of random walks where the random environment is obtained by assigning a maximal occupancy to each site of the Euclidean lattice. This maximal occupancy is allowed to randomly vary among sites, and partial exclusion occurs. Under the assumption of ergodicity under translation and uniform ellipticity of the environment, we prove that the quenched hydrodynamic limit is a heat equation with a homogenized diffusion matrix. To this purpose, we exploit the stochastic self-duality property to transfer a homogenization result concerning random walks in the same environment with arbitrary starting points to the particle system.
The first part of the talk is based on a joint work with Frank Redig (TU Delft) and Federico Sau (IST Austria).
Finally, I will discuss some recent progresses in the understanding of what happens when removing the uniform ellipticity assumption. After recalling some results on the Bouchaud's trap model, I will show that, when assuming that the maximal occupancies are heavy tailed and i.i.d., the hydrodynamic limit is the fractional-kinetics equation.
The second part of the talk is based on an ongoing project with Alberto Chiarini (University of Padova) and Frank Redig (TU Delft).

This is an invited talk in the session SCALING LIMITS FOR INTERACTING PARTICLE SYSTEMS *organized by* **Chiara Franceschini**.

Nicolas Forien

Università di Roma "La Sapienza"

On the phase transition of activated random walks

The Activated Random Walk model consists of particles which perform independent random walks on a graph and fall asleep with a certain rate. Sleeping particles stop moving and are awaken when another particle arrives on the same site. The model on $\mathbb{Z}^d$ presents a phase transition: depending on the density of particles (initially all active) and on the sleep rate, either almost surely each particle eventually falls asleep forever (fixating phase), or almost surely no particle falls asleep forever (active phase). In this talk, I will present a joint work with Alexandre Gaudillière (arxiv.org/abs/2203.02476) showing the existence of an active phase on $\mathbb{Z}^2$: for every positive initial density of particles, for a sufficiently low sleep rate, almost surely no particle falls asleep forever.

This is an invited talk in the session Interacting particle systems *organized by* **Matteo Quattropani**.

Marco Formentin

Università degli Studi di Padova

Noise-induced periodicity in a simple network of interacting diffusions

We investigate the emergence of collective periodic behaviors in a simple network of interacting diffusions. Particles are divided into two communities and intra-population interactions are positive/cooperative within both communities whereas inter-population interactions have different signs. We show that this system features the phenomenon of excitability by noise. That is, in a certain range of interaction strengths, although the system has no periodic behavior in the zero-noise limit, a moderate amount of noise may generate a stable periodic law.
Joint work with Luisa Andreis, Francesca Collet and Elisa Marini.

This is an invited talk in the session **Stochastic processes motivated by applications in life and social sciences** *organized by* **Francesca Collet**.

Chiara Franceschini

Università degli Studi di Modena e Reggio Emilia

The role of duality in boundary-driven interacting particle systems

I will review how it is possible to frame several classical duality relations for interacting particle systems and interacting diffusions into an algebraic approach which relies on Lie algebra representation theory. The examples are for systems with an open boundary: such dualities can be used to gather information on the non-equilibrium steady state, even if the complete closed formula for the non-equilibrium stationary measure is not known in these cases. Only a recently developed method which relies on integrability allows to completely characterize such measure, see next talks.

This is an invited talk in the session Duality and integrability for interacting particle systems *organized by* **Simone Floreani**.

Rouven Frassek

Università degli Studi di Modena e Reggio Emilia

The integrable structure of the harmonic process

Within Sklyanin's framework of the quantum inverse scattering method we shall describe the integrable structure of the "harmonic process" which is at the root of its solvability. We construct the transfer matrix corresponding to the model from the Yang-Baxter relation and discuss how to extract symmetries (commuting operators) of the process from it. We finally relate the non-equilibrium process to the process in equilibrium using a non-local transformation that arises from the derived symmetries. In particular, this allows us to compute the steady state exactly.

This is an invited talk in the session Duality and integrability for interacting particle systems *organized by* **Simone Floreani**.

Francesco Gaffi

Università Bocconi

Partially-exchangeable multilayer stochastic block models

There is an increasing availability of complex network data encoding connectivity information among a set of nodes, often belonging to different layers. A challenging task is represented by inferring grouping structures among nodes based on common connectivity patterns, while considering the layer division. Although it could be reasonable in some cases to expect such connectivity blocks to coincide with layers, this assumption is in general too strong and fails to learn sub-blocks within each layer as well as across-layer clusters. To incorporate these mixed architectures while accounting for layer information in a principled manner, we propose a new generation of partially-exchangeable multilayer stochastic block models relying on a hierarchical random partition prior for the node allocations driven by the urn scheme of a hierarchical normalized completely random measure (H-NRMI) or a hierarchical Pitman-Yor process (H-PYP). The partial exchangeability assumption among nodes according to layer partitions allows to infer both within- and across-layer blocks, while preserving probabilistic coherence, principled uncertainty quantification and formal inclusion of prior information from layer membership. The mathematical tractability of such priors further allows to analytically derive and compare predictive within- and across-layer co-clustering probabilities, thereby providing conditions on hyperparameters to enforce interpretable features on the grouping structures. The applied potentials of this new class of Bayesian nonparametric models are illustrated in criminal network studies.

This is a joint work with Daniele Durante, Antonio Lijoi, Igor Prünster.

This is an invited talk in the session Advances in Bayesian nonparametric inference *organized by* **Antonio Lijoi**.

Lucio Galeati

University of Bonn

Some recent advances on SDEs with fractional noise

In recent years, there has been a lot of interest in regularization by noise for SDEs driven by fractional Brownian motion of parameter $H \in (0, 1)$, with first results going back to Nualart, Ouknine (2002) and Catellier, Gubinelli (2016). The main challenges when dealing with these equations are the presence of a non-Lipschitz (possibly singular) drift and the lack of any martingale or Markovian structure; in particular, classical stochastic analysis and PDE tools break down for $H \neq 1/2$ and new techniques must be developed. In this talk I will present some novel results on the topic, including generalizations to the regime $H \in (1, \infty)$, construction of the associated stochastic flow of solutions and stability estimates for SDEs driven by different drifts. The key tools in our analysis come from rough path theory and are given by Young integration and suitable versions of the stochastic sewing lemma. Based on an ongoing joint work with M. Gerencser (TU Wien).

This is an invited talk in the session Rough analysis and applications *organized by* **Carlo Bellingeri** *and* **Lucio Galeati**.

Gioele Gallo

Universitaet zu Koeln

Level set percolation of the Gaussian free field on a Galton-Watson tree

The study of Gaussian free field level sets on supercritical Galton-Watson trees has been initiated in Ann. Inst. Henri Poincaré Probab. Stat., 54(1):173–201, 2018. We continue this investigation by means of different tools in order to generalize the main result $h_* > 0$ to the setting of Galton-Watson trees with arbitrary supercritical offspring distribution and random conductances. Our proof proceeds by first constructing the Galton-Watson tree through an exploration via finite random walk trajectories. This way we are able to construct an infinite connected component in the random interlacements process of the underlying Galton-Watson tree. Using a Dynkin-type isomorphism theorem we then infer the strict positivity of the critical parameter h_*.

This is an invited talk in the session **Integrable systems and the KPZ universality class** *organized by* **Alessandra Occelli**.

Matteo Garbelli

Università di Trento/Università di Verona

Deep learning approaches for risk parity investment strategies

Recent years have been characterized by an increasing interest within both risk management and asset pricing as well as concerning portfolios selection tasks to rely on effective and accurate forecasting methods exploiting historical volatility as a proxy for risk investment tasks. Accordingly, we focused our attention on hybrid methods combining classical statistical models, such as the GARCH one, with those based on Neural Network approaches to then obtain precise volatility forecasts feeding risk-controlled investment strategies. Moving from volatility forecasts, we have then considered the so-called Risk Parity methods, characterized by considering allocation choices across various assets of an investment portfolio equally contributes to the total risk of the portfolio. Latter analysis has been the subject of a set of historical portfolio simulations where different reference time-periods have been considered.

This is an invited talk in the session Modeling financial asset prices *organized by* **Cecilia Mancini**.

Andrea Ghiglietti

Università degli Studi di Torino

Dynamics of reinforced stochastic processes with a network-based interaction

We study the asymptotic behaviour of a set of discrete-time *reinforced stochastic processes* (RSPs) that depend among each other with an interaction defined by a finite *weighted direct graph*. These processes are interpreted as "actions" of agents positioned at the vertices of the graph. Dynamics of other relevant processes derived from the original RSPs, such as the empirical means and the weighted means, are also investigated and the corresponding asymptotic properties are characterized. The interacting RSPs and their means are shown to synchronize almost surely under very mild conditions, e.g. the graph is strongly connected. The common limit at which all the processes converge is also investigated, and some interesting results regarding its probability to lie within the domain or to touch the barriers are obtained. Stable Central Limit Theorems with different convergence rates are established for both convergence to the common limit and synchronization, as function of (i) the eigen-structure of the weighted adjacency matrix that models the graph and (ii) the strength of the reinforcement mechanism that define the updating rates of the RSPs. Finally, confidence intervals and critical regions are derived in order to implement inferential procedures on the type of network in the system.

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This is a contributed talk in the session **Nonlocal operators in probability: anomalous diffusions** *organized by* **Mirko D'Ovidio** *and* **Giacomo Ascione**.

Maddalena Ghio

Exprivia S.p.A.

N-PLAYER GAMES AND MEAN FIELD GAMES OF MODERATE INTERACTIONS

We study the asymptotic organization among many optimizing agents interacting in a “moderate” or “intermediate” way, a kind of interaction that was first proposed by Oelschläger (1985) for interacting particles. We formulate this problem as a mean-field game and justify it by proving that its solution provides approximate Nash equilibria for N-player games, where the players interact only within a finite intermediate range. The proof depends upon the derivation of a law of large numbers for the empirical processes in the limit as the number of players tends to infinity.
This talk is based on a joint work with Franco Flandoli and Giulia Livieri (Scuola Normale Superiore).

This is an invited talk in the session **DISCRETE TO CONTINUUM: INTERACTING PARTICLE AND MEAN FIELD GAMES** *organized by* **Giulia Livieri**, **Marta Leocata**, **Alekos Cecchin**, **Maddalena Ghio**.

Cristian Giardinà

Università degli Studi di Modena e Reggio Emilia

The harmonic process: an exactly solvable non-equilibrium system

We shall discuss a Markov process (the so-called "harmonic process") that can be exactly solved by a combination of duality and integrability methods. The harmonic process is a model of a non-equilibrium system with a stationary current due to the presence of boundary reservoirs. We shall be interested in the unique stationary measure that the system approaches in the long-time limit. This will be characterized by computing all the moments. We shall further show how local equilibrium emerges from the solution. If time allows, other integrable models similar to the harmonic process will be discussed.

This is an invited talk in the session Duality and integrability for interacting particle systems *organized by* **Simone Floreani**.

Maria Fernanda Gil-Levya

Università Bocconi

The ordered allocation sampler

Motivated by Pitman's theory on species sampling models, we propose a novel Gibbs sampling algorithm for the implementation of Bayesian nonparametric models. The key idea is to work with the atoms and weights of the species sampling process in the order in which they were discovered in a species sampling sequence. This allows us to describe the model in terms of a conditional Pólya urn scheme, and thus derive a Gibbs sampler that shares nice mixing properties with the so-called marginal samplers. We compare our proposal with other Gibbs sampling methods and discuss their main advantages and drawbacks.

This is an invited talk in the session **Advances in Bayesian nonparametric inference** *organized by* **Antonio Lijoi**.

Luca Maria Giordano

Università degli Studi di Milano

Stochastic energy pricing models based on Lévy and fractional Brownian processes. Estimation and forecasting

We propose an estimation procedure of an additive two-factor stochastic model, driven by both a Hawkes and a fractional Brownian processes. The model describes the daily prices of electricity in the Italian energy market, which show the presence of self-correlations in the price increments and clustered jumps over short time periods. We perform a calibration procedure, discussing the seasonality, spikes and the estimation of the Hurst coefficient. We consider the forecasting performance via a class of distributional evaluation metrics. We also discuss the performance of the model in relation with the recent (late 2021/early 2022) deviation of the evolution of electricity prices from the quasi-stationary behaviour of previous years.

This is a contributed talk in the **Contributed session IV**.

Giacomo Giorgio

Università di Roma "Tor Vergata"

Convergence in total variation for nonlinear functionals of random hyperspherical harmonics

We study the convergence in Total Variation distance for suitably regular nonlinear functionals of Gaussian eigenfunctions of the unit sphere in any dimension. Our approach takes advantage of a recent result by Bally, Caramellino and Poly [EJP20]: combining the central limit theorem in Wasserstein distance obtained by Marinucci and Rossi [JFA15] and some new results on the asymptotic behavior of the sequence of the Malliavin derivatives, we are able to establish a central limit theorem in a stronger sense for statistics of these random models.

This is a contribution in the **Poster session**.

Rita Giuliano

Università degli Studi di Pisa

Convergence results for Oppenheim Series expansions and Oppenheim Continued Fractions expansions

We prove convergence in probability for particular sequences defined in terms of the digits appearing in Oppenheim Series expansions and Oppenheim Continued Fractions expansions of real numbers. Our results are obtained by first proving a general theorem having both kinds of expansion as particular cases. We also investigate the asymptotic behaviour of weighted partial sums of a particular class of random variables related to Oppenheim series expansions, i.e. we verify convergence in probability as well as almost sure convergence to a strictly positive and finite constant without assuming any dependence structure or the existence of means. Results of this kind are known as exact weak and exact strong laws.

This is a contributed talk in the **Contributed session I**.

Nicola Gnecco

University of Geneva

Causal discovery in heavy-tailed models

Causal questions are omnipresent in many scientific problems. While much progress has been made in the analysis of causal relationships between random variables, these methods are not well suited if the causal mechanisms only manifest themselves in extremes. This work aims to connect the two fields of causal inference and extreme value theory. We define the causal tail coefficient that captures asymmetries in the extremal dependence of two random variables. In the population case, the causal tail coefficient is shown to reveal the causal structure if the distribution follows a linear structural causal model. This holds even in the presence of latent common causes that have the same tail index as the observed variables. Based on a consistent estimator of the causal tail coefficient, we propose a computationally highly efficient algorithm that estimates the causal structure. We prove that our method consistently recovers the causal order and we compare it to other well-established and non-extremal approaches in causal discovery on synthetic and real data. The code is available as an open-access R package.

This is an invited talk in the session **Nonparametric inference on complex dependence structures** *organized by* **Stefano Rizzelli**.

Greta Goracci

Free University of Bolzano-Bozen

On the ergodicity of first-order threshold autoregressive moving-average processes

We introduce a novel Markovian representation for the threshold autoregressive moving-average (TARMA) process with which we solve the long-standing problem regarding the irreducibility condition of a first-order TARMA model. Under some mild regularity conditions, we obtain a complete classification of the parameter space of an invertible first-order TARMA model into parametric regions over which the model is either transient or recurrent, and the recurrence region is further subdivided into regions of null recurrence or positive recurrence, or even geometric recurrence. We derive a set of necessary and sufficient conditions for the ergodicity of invertible first-order TARMA processes.

This is a contributed talk in the **Contributed session II**.

Fausto Gozzi

LUISS Guido Carli

On mean field control in infinite dimension

The aim of this talk is to report on recent work (with A. Cosso, I. Kharroubi, H. Pham, M. Rosestolato) on the optimal control of path-dependent McKean-Vlasov equations valued in Hilbert spaces. This seems the first paper in this direction. We present some motivating examples and the main results (the dynamic programming principle, the law invariance property of the value function V, Itô's formula and the fact that V is a viscosity solution of the HJB equation). We also briefly discuss the issue of uniqueness of the HJB equation presenting a first result in finite dimension.

This is an invited talk in the session **Advances in stochastic control with applications** *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Sebastiano Grazzi

TU Delft

Sticky PDMP samplers for sparse Bayesian problems

During the talk, I will present the sticky PDMP samplers. This is a new class of efficient Monte Carlo methods based on continuous-time piecewise deterministic Markov processes (PDMPs) suitable for inference in high dimensional sparse models, i.e. models for which there is prior knowledge that many coordinates are likely to be exactly 0. This is achieved with the fairly simple idea of endowing existing PDMP samplers with sticky coordinate axes, coordinate planes etc. Upon hitting those subspaces, an event is triggered, during which the process sticks to the subspace, this way spending some time in a sub-model. I will demonstrate the competitiveness of our method by comparing some properties of the algorithms and the underlying processes with other established methods. Finally, I will illustrate the method in a number of challenging statistical models.

This is an invited talk in the session **Monte Carlo sampling with piecewise deterministic Markov processes** *organized by* **Andrea Bertazzi**.

Giacomo Greco

Eindhoven University of Technology

Entropic turnpike estimates in the kinetic Schrödinger problem

The kinetic Schrödinger problem consists in finding the most likely evolution of a system of i.i.d. particles driven by the underdamped Langevin dynamics, conditionally on their initial and final spatial configurations. In this model each particle is described both by its position and velocity, but there is no a priori knowledge of the velocities at the initial and final time. This most-likely evolution can be seen as the solution of a stochastic optimal transport problem where we would like to drive an initial spatial distribution into a final one while minimizing the relative entropy. We will investigate the long-time behaviour of this kinetic system, by proving that its most likely evolution is exactly the one that spends most of the time exponentially close to the equilibrium configuration (this property is commonly known as the turnpike property).
Based on a joint work with A. Chiarini, G. Conforti, Z. Ren: https://arxiv.org/abs/2108.09161.

This is an invited talk in the session **Stochastic optimal transport** *organized by* **Alberto Chiarini**.

Francesco Grotto

Università degli Studi di Pisa

Random Waves on Hyperbolic Space

Berry's model is a Gaussian random field on Euclidean space describing whose samples are Laplacian eigenfunctions, and it was originally introduced in the study of high-frequency behaviour of chaotic quantum billiards on flat domains. Gaussian random waves, that is Gaussian random fields whose samples are Laplacian eigenfunctions, have also been the object of extensive research in other geometrical settings, such as on spheres and on tori (arithmetic random waves). More generally, results have been obtained on local behaviour of Gaussian random waves on compact manifolds. After a brief outline of these previous results, we will describe how it is possible to define an analogous Gaussian model on hyperbolic space, moving a step forward towards non-compact negatively curved surfaces, a classical geometric setting for chaotic dynamics. We will outline how high-frequency and large-domain limiting behaviours of random waves in this new setting mirror the ones on Euclidean space, notwithstanding the different underlying geometry. We will in particular discuss nonlinear functionals such as excursion areas and the length of nodal sets, their moments, their Wiener chaos expansions and CLTs they satisfy.
Joint work with Giovanni Peccati.

This is an invited talk in the session Stochastic processes and geometry *organized by* **Anna Paola Todino**.

Emanuela Gussetti

Universität Bielefeld

Existence of an invariant measure for the stochastic Landau-Lifschitz-Gilbert equation in 1D

The Landau-Lifshitz-Gilbert equation describes the behaviour of a ferromagnetic material on a bounded domain D. In this talk I will present a result concerning the existence of an invariant measure in $H^1(D, \mathbb{R}^3) \cap L^2(D, \mathbb{S}^2)$ for the stochastic Landau-Lifschitz-Gilbert equation on a one dimensional interval. The conclusion is achieved by employing the classical Krylov-Bogoliubov theorem and by means rough paths techniques. In some specific cases, we show that there exists a unique Gibbsian invariant measure and we establish the qualitative behaviour of the unique stationary solution.

This is a contributed talk in the Contributed session III.

Ruojun Huang

Scuola Normale Superiore

Scaling limit for a second-order particle system with local annihilation

For a second-order particle system in $\mathbb{R}^d$ subject to locally-in-space pairwise annihilation, we prove a scaling limit for its empirical measure on position and velocity towards a degenerate elliptic partial differential equation. Crucial ingredients are Green's function estimates for the associated hypoelliptic operator and an Itô-Tanaka trick.

This is an invited talk in the session **Discrete to continuum: interacting particle and mean field games** *organized by* **Giulia Livieri**, **Marta Leocata**, **Alekos Cecchin**, **Maddalena Ghio**.

Francesco Iafrate

Università di Roma "La Sapienza"

Elastic drifted Brownian motions and non-local boundary conditions

We provide a deep connection between elastic drifted Brownian motions and inverses to tempered subordinators. Based on this connection, we establish a link between multiplicative functionals and dynamical boundary conditions given in terms of non-local equations in time. Indeed, we show that the multiplicative functional associated to the elastic Brownian motion with drift is equivalent to a multiplicative functional associated with fractional boundary conditions of tempered type. By exploiting such connection we write some functionals in terms of a simple (positive and non-decreasing) process. In our view, such a representation is useful in many applications.
This is based on joint work with M. D'Ovidio.

This is an invited talk in the session **Nonlocal operators in probability: nonlocal boundary conditions** *organized by* **Bruno Toaldo**.

Elena Issoglio

Università degli Studi di Torino

On a class of PDEs with linear growth solutions and their use in stochastic analysis

We present a class of PDEs with coefficients which are elements of Besov spaces of negative order. Their solutions are unbounded functions, more precisely their derivatives are in a Besov space of positive order. We obtain existence and uniqueness of the solution and various continuity results. These are used in the framework of stochastic analysis to define the solution of an SDE with a distributional drift by means of a suitable martingale problem. We notice that the solutions to the martingale problem are not semimartingales in general, but only weak Dirichlet processes.
This is a joint work with Francesco Russo.

This is an invited talk in the session **PDEs and their applications to stochastic analysis** *organized by* **Elena Issoglio**.

Antonella Iuliano

Università degli Studi della Basilicata

On some finite-velocity random motions with underlying geometric counting processes

We analyse the probability law of a stochastic process which describes the location of a particle performing a finite-velocity random motion whose velocities alternate cyclically. We consider two cases, in which the state-space of the process is (i) $\mathbb{R} \times \{v_1, v_2\}$, with velocities $v_1 > v_2$, and (ii) $\mathbb{R}^2 \times \{v_1, v_2, v_3\}$, where the particle moves along three different directions with possibly unequal velocities. Assuming that the random inter-times between consecutive changes of directions are governed by a geometric counting process, we first construct the stochastic models of the particle motion. Then we investigate various features of the considered processes and obtain the formal expression of their probability laws. In particular, in the case (ii) we study a planar random motion with three specific directions and determine the exact transition probability density functions of the process when the initial velocity is fixed.

This is an invited talk in the session **On stochastic methods, models and applications** *organized by* **Elvira Di Nardo**.

Jean Jacod

Université Paris Sorbonne

Systematic jump risk

In a factor model for a large panel of N asset prices, a random time S is called a "systematic jump time" if it is not a jump time of any of the factors, but nevertheless is a jump time for a significant number of prices: one might for example think that those S's are jump times of some hidden or unspecified factors. Our aim is to test whether such systematic jumps exist and, if they do, to estimate a suitably defined "aggregated measure" of their sizes. The setting is the usual high frequency setting with a finite time horizon T and observations of all prices and factors at the times iT/n for $i = 0, \ldots, n$. We suppose that both n and N are large, and the asymptotic results (including feasible estimation of the above aggregated measure) are given when both go to infinity, without imposing restrictions on their relative size. In an empirical application, we document the existence of systematic jumps and further show that the associated risk commands a nontrivial risk premium.

This is an invited talk in the session Modeling financial asset prices *organized by* **Cecilia Mancini**.

Vanessa Jacquier

Scuola Normale Superiore

Metastability for Blume-Capel model evolving with Kawasaki dynamics

We introduce the metastability phenomena and then we focus on the metastable behavior of the stochastic Blume-Capel model with Kawasaki dynamics. We consider the Blume-Capel model at finite volume and temperature tending to zero. With our choice of parametrization, the Kawasaki dynamics is reversible with respect to the Gibbs measure. The choice of three different types of spins, $-1, 0, +1$, makes the study of the energy landscape very complicated. Consequently, finding the stability level of any configuration requires delicate computations. In particular, we show how the three different spins and the particle conservation represents a serious obstacle in controlling the stability level of a configuration. In this talk, we focus on the parameter region where $\underline{+1}$ is the stable state and $\underline{-1}$ is the unique metastable state.

This is an invited talk in the session Metastability for interacting particle systems *organized by* **Vanessa Jacquier**, **Simone Baldassarri**, **Saeda Marello**.

Jere Koskela

University of Warwick

Genealogies of sequential Monte Carlo methods

Sequential Monte Carlo methods are a flexible class of genetic algorithms in which an ensemble of candidate solutions to a problem are refined by assigning them weights according to their quality, resampling solutions based upon their weights, and mutating them to explore the space of solutions. The resampling operation gives rise to an embedded genealogy within the method. I will demonstrate that, when suitably rescaled, these genealogies converge to the Kingman coalescent in the large ensemble limit. This has implications for variance estimation from sequential Monte Carlo methods, mixing of the particle MCMC algorithm, and also expands the known domain of attraction of the Kingman coalescent to include a broad class of non-neutral models of evolution.

This is an invited talk in the session Interacting particle systems and inference *organized by* **Martina Favero**.

Richard Kraaij

TU Delft

Large deviations for coupled slow-fast systems and Hamilton-Jacobi-Bellman equations

We will consider the large deviations of coupled Markovian systems with two-time scales. The large deviations can arise from two sources: deviations of the slow process itself, or fluctuations of the large time averages of the fast process, effectively leading to a competition of two deviation effects. Arguing via the non-linear analogue of the "martingale problem approach" that applies for large deviations of Markov processes, we arrive at a uniqueness problem for a Hamilton-Jacobi-Bellman equation. We establish a new uniqueness result in this context, and obtain new large deviation principles as a consequence.

This is an invited talk in the session **Stochastic optimal transport** *organized by* **Alberto Chiarini**.

Dennis Kristensen

University College London

Bias-correction of maximum-likelihood estimator in state space models

We propose two bias correction procedures that work in general linear state space models. The first procedure assumes the model is correctly specified while the second is robust to departures from the parametric specification. Both procedures remove the leading bias term but their relative performance in finite samples depends on the degree of departure from the parametric specification. We demonstrate their good performance through simulations and an empirical application to interest rate modeling.

This is an invited talk in the session **Improved inference in statistical models** *organized by* **Silvia Sarpietro** *and* **Stanislav Anatolyev**.

Tobias Kuna

Università degli Studi dell'Aquila

Infinite dimensional full moment problems

Let K be a closed subset of $\mathbb{R}^d$. The d-dimensional full K-moment problem asks when a linear functional on the algebra of polynomials in d variables, that is a sequence of putative moments, has an integral representation w.r.t. a measure supported in K. The same question can be posed for a general algebra A (not necessarily the polynomial one) where the linear space $\mathbb{R}^d$ is replaced by the space of characters of A. In this talk, I will present recent results on the infinite dimensional full K-moment problem, that is either K spans an infinite dimensional vector space or A can be generated by infinitely many elements. In 1991 K. Schmüdgen in a seminal work treated the case K-compact and finite dimensional. I will present a new result, which in particular, gives an exact characterization of the compact support of the representing measure. In fact, all previous results only provide necessary and sufficient conditions for the existence of a representing measure with compact support contained in K and typically strictly smaller, while we can provide exact descriptions of the support.
The talk is based on a joint work with Maria Infusino, Salma Kuhlmann and Patrick Michalski.

This is an invited talk in the session Recent perspectives on moment problems *organized by* **Maria Infusino** *and* **Tobias Kuna**.

Marta Leocata

LUISS Guido Carli

Derivation of the viscoelastic stress in the Stokes flow induced by non-spherical Brownian rigid particles

We consider a microscopic model, composed by n identical rod-like particles, embedded in a fluid. The aim of the talk is to understand the appearance of the stress term in the macroscopic fluid equation in the Doi model, through a microscopic description. Since the derivation of the full model is out of reach, we focus on a toy model where evolution in time of particles is frozen, the rotational motion of particles is decoupled from the fluid motion and the fluid motion is modeled by Stokes equation. Using the method of reflections, we derive the macroscpic model described above as the homogenization limit of many small particles (randomly rotating).
This is a joint work with R. Höfer and A. Mecherbet.

This is an invited talk in the session **Discrete to continuum: interacting particle and mean field games** *organized by* **Giulia Livieri**, **Marta Leocata**, **Alekos Cecchin**, **Maddalena Ghio**.

Edoardo Lombardo

Università di Roma "Tor Vergata" e École des Ponts ParisTech

High order approximations for the Cox-Ingersoll-Ross process using random grids

We present new high order approximations schemes for the Cox-Ingersoll-Ross (CIR) process that are obtained by using a recent technique developed by Alfonsi and Bally [Numer. Math. 2021] for the approximation of semigroups. The idea consists in using a suitable combination of discretization schemes calculated on different random grids to increase the order of convergence. This technique coupled with the second order scheme proposed by Alfonsi [Math. Comp. 2010] for the CIR leads to weak approximations of any (even) order. Despite the singularity of the square-root volatility coefficient, we show rigorously this order of convergence under some restrictions on the volatility parameters. We illustrate numerically the convergence of these approximations for the CIR process and for the Heston stochastic volatility model.

This is a contributed talk in the **Contributed session IV**.

Maria Longobardi

Università degli Studi di Napoli "Federico II"

A general expression of entropy in probability theory and in Dempster-Shafer theory

We propose a unified formulation of entropy. It depends on two parameters and includes, all as special cases, Shannon, Tsallis and fractional entropy. This measure of information is referred to as fractional Tsallis entropy and some of its properties are then presented. Before introducing the corresponding entropy in the context of Dempster-Shafer theory of evidence, the definition and some properties of the fractional Deng entropy are explained. Then, an application of fractional version of Tsallis-Deng entropy to a classification problem is carried out.

This is an invited talk in the session Reliability of systems and measures of discrimination *organized by* **Francesco Buono** *and* **Maria Longobardi**.

Angelo Lucia

Universidad Complutense de Madrid

Logarithmic Sobolev inequality for quantum spin chains

Logarithmic Sobolev inequalities (LSI) for Quantum Markov Semigroups on spin lattice models have profound implications for many relevant physical properties of the system, ranging from strong estimates on the mixing time to stability of the semigroup against perturbations. At the same time, they are notoriously hard to establish rigorously, a task which has been accomplished only in a few cases so far.
In this talk, I will present some recent progress on this problem for a class of generators due to Davies, which model the thermalization of a quantum system with finite range, commuting interactions in contact with a large heath bath. I will show that it is possible to obtain a modified logarithmic Sobolev inequality (MLSI) for one dimensional systems (spin chains) at any finite temperature, with a MLSI constant that decays logarithmically in the chain length.
This is based on joint work with I. Bardet, Á. Capel, L. Gao, D, Pérez-García, C. Rouzé, *arXiv:2112.00601*.

This is an invited talk in the session Inequalities in quantum probability *organized by* **Dario Trevisan**.

Eliseo Luongo

Scuola Normale Superiore

Inviscid limit for stochastic Navier-Stokes equations in 2D domains with boundary

One proves some conditioned results for the inviscid limit of the stochastic Navier-Stokes equations with additive noise, in a smooth, 2 dimensional bounded domain in the case of no-slip boundary conditions. This resembles some classical deterministic results of T. Kato. Contrary to the results of T. Kato we do not always assume that the solution of the Euler equations is classical, but we prove that under suitable initial conditions the inviscid limit to a weak solution of the Euler equations holds true.

This is a contributed talk in the **Contributed session III**.

Riccardo Walter Maffucci

EPFL

Distribution of nodal intersections for random waves

Random waves are Gaussian Laplacian eigenfunctions on the 3D torus. We investigate the length of intersection between the zero (nodal) set, and a fixed surface. Expectation, and variance in a general scenario are prior work. In the generic setting we prove a CLT. We will discuss (smaller order) variance and (non-Gaussian) limiting distribution in the case of 'static' surfaces (e.g. sphere). Under a certain assumption, there is asymptotic full correlation between intersection length and nodal area.
This is work is in collaboration with Maurizia Rossi.

This is an invited talk in the session **Stochastic processes and geometry** *organized by* **Anna Paola Todino**.

Elena Magnanini

WIAS Berlin

Limit theorems for the edge density in exponential random graphs

In the present talk we focus on the derivation of some asymptotic properties for the family of exponential random graphs. This model can be seen as the generalization of the dense Erdös-Rényi random graph and is defined via a Hamiltonian that assigns higher weight to graphs with "desirable" properties. In particular our analysis will be focused on the edge-triangle model, a two-parameter family of exponential random graphs where the Hamiltonian only includes edge and triangle densities. We borrow tools from statistical mechanics to obtain limit theorems for the edge density in the so-called replica symmetric regime, where the limiting free energy of the model is known together with a complete characterization of the phase diagram.
Joint work with Alessandra Bianchi and Francesca Collet.

This is an invited talk in the session Random graphs *organized by* **Umberto De Ambroggio**.

Saeda Marello

University of Bonn

Metastability for the Ising model on random graphs

In the last years the study of metastability for random systems has been capturing increasing attention. The Curie-Weiss model is a well known Ising spin flip model on a complete graph and its metastable behaviour has been thoroughly analysed. Adding randomness to this model creates various challenges, depending on the nature of the randomness involved. In this talk we will focus on the recent studies of metastability for the Ising model on random graphs, namely for modifications of the Curie-Weiss model in which the interactions are random. Using the potential theoretic approach to metastability and concentration inequalities, we obtain results on the metastable behaviour of the Curie-Weiss model on the Erdös-Rényi random graph and on some inhomogeneous random graphs.
Based on joint works with A. Bovier, F. den Hollander and E. Pulvirenti.

This is an invited talk in the session Metastability for interacting particle systems *organized by* **Vanessa Jacquier**, **Simone Baldassarri**, **Saeda Marello**.

Ester Mariucci

Université Versailles Saint-Quentin

Non-asymptotic bounds of the CDF of Lévy processes and applications in Statistics

We propose new non-asymptotic bounds of the cumulative distribution function of Lévy processes with Lévy density bounded from above by the density of an alpha-stable type Lévy process in a neighborhood of the origin. These bounds are then applied to derive non-asymptotic risk bounds for estimators of the Lévy density from discrete observations.
It is a joint work with Céline Duval.

This is an invited talk in the session **Advances in statistical inference for continuous-time stochastic processes** *organized by* **Paolo Pigato**.

Mattia Martini

Università degli Studi di Milano

Kolmogorov equations on spaces of measures associated to nonlinear filtering processes

Backward Kolmogorov equations are partial differential equations of parabolic type with given final condition. The relation among them and certain stochastic processes has been intensively investigated in both finite and infinite dimensional case. Moreover, their comprehension represent a preliminary step in the study of the Hamilton-Jacobi-Bellman equations, that are nonlinear partial differential equations strongly connected to stochastic optimal control problems. The aim of this talk is to present a class of backward Kolmogorov equations on spaces of probability and positive measures, associated to measure-valued stochastic processes arising in the context of nonlinear filtering. Indeed, in the filtering framework one can formulate two stochastic differential equations, called Zakai and Kushner-Stratonovich equations, that are satisfied by a positive measure and a probability measure-valued process respectively. Thus, one can study the associated backward Kolmogorov equations, that are partial differential equations of parabolic type on the space of measures. In the literature, the Kolmogorov equations associated to nonlinear filtering processes have been studied assuming that the measure-valued processes admit a density and then by exploiting stochastic calculus techniques in Hilbert spaces. The approach used here differs from that one, since the existence of a density is not assumed and everything is done directly in the context of measures. The study of these equations on spaces of measures is a preparatory step to address the control problems with partial observation. These problems are shown to be equivalent, via a separation principle relying on results from nonlinear filtering, to full observation problems formulated on a different filtered probability space, with the filtration generated by the observation process; the conditional distribution of the state process, solution to a filtering equation, becomes a new state variable. It follows that it is natural to formulate the associated Hamilton-Jacobi-Bellman equations on the spaces of measures (for instance, on Wasserstein spaces). In the talk, we will introduce tools that allow us to write the backward Kolmogorov equations on spaces of measures and then present an existence and uniqueness result for classical solutions. If it remains time, we will discuss also a well-posedness result for viscosity solutions.

This is an invited talk in the session New trends in stochastic control: delay, partial and exogenous information *organized by* **Giuseppina Guatteri**, **Fulvia Confortola**, **Federica Masiero**.

Barbara Martinucci

Università degli Studi di Salerno

Some results on a vessels arrival process and its applications

In modeling of port dynamics it seems reasonable to assume that the ships arrive on a somewhat scheduled basis and that there is a constant lay period during which, in a uniform way, each vessel can arrive at the port. In the present contribution, we analyze the counting process $N(t)$ which represents the number of scheduled vessels arriving during the time interval $(0, t]$, $t > 0$. In some special cases, we obtain the probability law of the stationary counting process representing the number of arrivals in a time interval of length t when the initial time is an arbitrarily chosen instant. This leads to various results concerning the autocorrelations of the random variables X_i, $i \in \mathbb{Z}$, which give the actual interarrival time between the $(i-1)$-th and the i-th vessel arrival. Finally, an application to a queueing system characterized by interarrival times X_i, exponential service times and an infinite number of servers is provided.

This is an invited talk in the session **On stochastic methods, models and applications** *organized by* **Elvira Di Nardo**.

Federica Masiero

Università degli Studi di Milano-Bicocca

Partial smoothing of delay transition semigroups acting on special functions

It is well known that the transition semigroup of an Ornstein Uhlenbeck process with delay is not strong Feller for small times, so it has no regularizing effects when acting on bounded and continuous functions. In this talk we present regularizing properties of this transition semigroup when acting on special functions of the past trajectory. With this regularizing property, we are able to prove existence and uniqueness of a mild solution for a special class of semilinear Kolmogorov equations. The talk is mainly based on a joint work with G. Tessitore.

This is an invited talk in the session **SPDEs and Kolmogorov equations** *organized by* **Davide Addona** *and* **Margherita Zanella**.

Elisa Mastrogiacomo

Università dell'Insubria

Dynamic capital allocation rules via BSDEs: an axiomatic approach

In the theory of risk measures, capital allocation is a well-known problem consisting in sharing "ad hoc" the margin required for a position among the different sources of riskiness. Such a problem has been faced in the literature by using different approaches (depending on the nature of the risk measure behind) also in connection with systemic risk and game theory. Although there is a wide literature on the relation between dynamic risk measures and BSDEs and on capital allocation rules in a static setting, only a few recent papers on capital allocation work in a dynamic setting and, moreover, those papers mainly focus on the gradient approach. In this talk, we discuss new perspectives to the capital allocation problem going beyond those already existing in the literature. In particular, we introduce and investigate a general axiomatic approach to dynamic capital allocations as well as an approach suitable for risk measures induced by g-expectations under weaker assumptions than Gateaux differentiability.
The talk is based on a joint paper with E. Rosazza Gianin.

This is an invited talk in the session Risk management *organized by* **Matteo Burzoni** *and* **Alessandro Doldi**.

Francesco Mattesini

Münster Universität/MPI Leipzig

There is no invariant cyclically monotone Poisson matching in 2d

The optimal matching problem is a classical random variational problem that received interest in the last 30 years. We show that there exists no cyclically monotone invariant matching of two independent Poisson processes in the critical dimension $d = 2$. Our argument relies on a recent harmonic approximation theorem together with the two-dimensional local asymptotics for the bipartite matching problem, for which we provide a new self-contained proof based on martingale arguments.
Joint work with M. Huesmann (WWU Münster) and F. Otto (MPI Leipzig).

This is a contributed talk in the session Advances in stochastic games with applications *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Mario Maurelli

Università degli Studi di Milano

Stochastic Euler equations: a geometric approach

In their celebrated work [Ann. Math. 1970], Ebin and Marsden have shown local well-posedness of the incompressible Euler equations in any dimension by solving a smooth ODE on the infinite-dimensional space of volume-preserving Sobolev diffeomorphisms.
In this talk, we will develop this approach for the incompressible Euler equations driven by an additive, stochastic force term: we will solve a stochastic ODE with smooth coefficients on the space of volume-preserving Sobolev diffeomorphisms and get in turn local well-posedness of the stochastic Euler equations. This approach is quite flexible and we believe it can be used for other stochastic PDEs.
Based on joint works with Z. Brzezniak, K. Modin and A. Schmeding.

This is an invited talk in the session SPDEs arising in physical models *organized by* **Michele Coghi**.

Mario Maurelli

Università degli Studi di Milano

Non-explosion by Stratonovich noise for ODEs

For an ODE where the drift has superlinear growth, explosion may occur in finite time. Here we show that, in dimension two or higher, the addition of a suitable multiplicative noise of Stratonovich type prevents explosion almost surely. We give two proofs for this phenomenon, one based on compactification and regularization by noise, the other based on finding a suitable Lyapunov function. The latter proof leads also to existence of an invariant measure and to geometric ergodicity. The results and the proofs extend previous results and proofs on non-explosion by noise for ODEs.

This is an invited talk in the session **Regularisation by noise and Kolmogorov equations** *organized by* **Luca Scarpa** *and* **Carlo Orrieri**.

Sara Mazzonetto

IECL/Inria Nancy

Maximum likelihood estimation: an asymptotic expansion

Maximum likelihood estimation (MLE) is one of the most common estimation techniques in statistics. Often, finding the MLE corresponds to finding the zero of a random function. This is the case for simple models, such as the binomial one but also in models from statistics of diffusions. Motivated by the study of the asymptotic behavior of an MLE for the parameter of a particular process, known as skew Brownian motion, we provide expansions of MLE in a much more general context. The expansions are based on a sort of asymptotic version of the implicit function theorem. Based on a joint work with Antoine Lejay (IECL/Inria Nancy).

This is an invited talk in the session **Advances in statistical inference for continuous-time stochastic processes** *organized by* **Paolo Pigato**.

Alessandra Meoli

Università degli Studi di Salerno

Some growth processes with a geometric random clock

Compositions of stochastic processes are useful to model the evolution of a population when, under some particular experimental circumstances, the time t must be randomized. Among others, considerable attention has been devoted so far to the cases of a Poisson process with a Poisson subordinator [2] and of a compound Poisson process with a Poisson subordinator [1]. We will discuss a possible alternative to a Poisson random time, represented by a geometric time-change, i.e. a mixed Poisson process with exponentially distributed intensity. Specifically, we will provide the probability distribution of the resulting processes, examine the first passage time distributions and the hitting probabilities, as well as their long-range behaviour, and focus on some special cases.

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This is an invited talk in the session **Stochastic processes with applications to the natural sciences** *organized by* **Giuseppe D'Onofrio**.

Riccardo Michielan

University of Twente

Influence of geometry in the structure of large scale-free networks

Large real-world networks are complex in general. This is due to various factors, including inhomogeneity of the system. Although it is reasonable to expect that complexity in a network increases with its size, many real-world networks have been found to be scale-free: the size scale does not influence the structural properties of the system. Then, many different scale-free inhomogeneous random graphs have been proposed as models for large networks. Some of these models take into account geometry as well, that is, they describe spatial features of networks embedding the vertices in some metric space. Whether the model is geometric or not, an interesting problem is to recover the structure of the random graph. Thus, it is essential to count the occurrences of any fixed subgraph, and establish in which region of the graph a specific pattern is more likely to appear. It turns out that, in a certain regime, the results in geometric and non-geometric models coincide. This leads to an unexpected conclusion: sometimes the structure of a network does not depend on its geometry.

This is an invited talk in the session Large scale random structures *organized by* **Gianmarco Bet** *and* **Alessandro Zocca**.

Alessandro Milazzo

Uppsala University

The de Finetti problem with unknown competition

We consider a resource extraction problem which extends the classical de Finetti problem for a Wiener process to include the case when a competitor, who is equipped with the possibility to extract all the remaining resources in one piece, may exist; we interpret this unknown competition as the agent being subject to possible fraud. This situation is modelled as a controller-and-stopper non-zero-sum stochastic game with incomplete information. In order to allow the fraudster to hide his existence, we consider strategies where his action time is randomised. Under these conditions, we provide a Nash equilibrium which is fully described in terms of the corresponding single-player de Finetti problem. In this equilibrium, the agent and the fraudster use singular strategies in such a way that a two-dimensional process, which represents available resources and the filtering estimate of active competition, reflects in a specific direction along a given boundary.

This is an invited talk in the session Advances in stochastic games with applications *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Hlafo Alfie Mimun

LUISS Guido Carli

Phase transition of the k-Majority dynamics in biased communication models

Consider a graph where each of the n nodes is either in state $\mathcal{R}$ or $\mathcal{B}$. Herein, we analyze the synchronous k-Majority dynamics, where in each discrete-time round nodes simultaneously sample k neighbors uniformly at random with replacement and adopt the majority state among the nodes in the sample (breaking ties uniformly at random). Differently from previous work, we study the robustness of the k-Majority in maintaining a majority, that we consider $\mathcal{R}$ w.l.o.g., when the dynamics is subject to two forms of adversarial noise, or bias, toward state $\mathcal{B}$. We consider an external agent that wants to subvert the initial majority and, in each round, either tries to alter the communication between each pair of nodes transmitting state $\mathcal{B}$ (first form of bias), or tries to corrupt each node directly making it update to $\mathcal{B}$ (second form of bias), with a probability of success p. Our results show a phase transition in both forms of bias and on the same critical value. By considering initial configurations in which each node has probability $q > 1/2$ of being in state $\mathcal{R}$, we prove that for every $k \geq 3$ there exists a critical value $p^*_{k,q}$ such that, with high probability: if $p > p^*_{k,q}$, the external agent is able to subvert the initial majority within a constant number of rounds; if $p < p^*_{k,q}$, the external agent needs at least a superpolynomial number of rounds to subvert the initial majority.

This is an invited talk in the session **Opinion dynamics in biased communication models** *organized by* **Hlafo Alfie Mimun**.

Ida Germana Minelli

Università degli Studi dell'Aquila

Urn models with random multiple drawing and random addition

We consider a general two-color urn model with random multiple drawing and random time-dependent addition matrix, which is not balanced. The model may be applied in the context of "technology adoption" or in opinion dynamics. For the process describing the proportion of balls of a given color, we prove almost sure convergence results. In the particular case of equal reinforcement means, we prove Central Limit Theorems (in the sense of stable convergence and of almost sure conditional convergence, which are stronger than weak convergence) and we give asymptotic confidence intervals for the limit proportion of balls of a given color, whose distribution is generally unknown.

This is an invited talk in the session **Stochastic processes motivated by applications in life and social sciences** *organized by* **Francesca Collet**.

Yuliya Mishura

Taras Shevchenko National University of Kyiv

Relation between standard and fractional reflected Ornstein-Uhlenbeck processes and their Cox-Ingersoll-Ross counterparts

We establish a new connection between Cox-Ingersoll-Ross (CIR) and reflected Ornstein-Uhlenbeck (ROU) models driven by either a standard Wiener process or a fractional Brownian motion with $H > 1/2$. We prove that, with probability 1, the square root of the CIR process converges uniformly on compacts to the ROU process as the mean reversion parameter tends to either $\sigma^2/4$ (in the standard case) or to 0 (in the fractional case). This also allows us to obtain a new representation of the reflection function of the ROU as the limit of integral functionals of the CIR processes.

This is an invited talk in the session Confined diffusions and fractional diffusions with applications *organized by* **Enrica Pirozzi**.

Andrea Montanari

Stanford University

The generalization error of overparametrized models: Insights from exact asymptotics

In a canonical supervised learning setting, we are given n data samples, each comprising a feature vector and a label, or response variable. We are asked to learn a function f that can predict the the label associated to a new –unseen– feature vector. How is it possible that the model learnt from observed data generalizes to new points? Classical learning theory assumes that data points are drawn i.i.d. from a common distribution and argue that this phenomenon is a consequence of uniform convergence: the training error is close to its expectation uniformly over all models in a certain class. Modern deep learning systems appear to defy this viewpoint: they achieve training error that is significantly smaller than the test error, and yet generalize well to new data. I will present a sequence of high-dimensional examples in which this phenomenon can be understood in detail.

Based on joint work with Song Mei, Feng Ruan, Youngtak Sohn, Jun Yan.

This is a **Plenary talk**.

Valter Moretti

University of Trento

The notion of observable and the moment problem for $*$-algebras and their GNS representations

I will present some usually overlooked, but of crucial relevance, issues and results concerning the use of $*$-algebras in quantum theory and their physical interpretation. In particular I will discuss some new achievements regarding the interplay of the moment problem for a state on a $*$-algebra and the (essential) self-adjoint property/maximal symmetricity of the representatives in the GNS Hilbert space of Hermitian elements of the $*$-algebra.

Talk based on the joint work with Nicolò Drago, *The notion of observable and the moment problem for $*$-algebras and their GNS representations*, **Letters in Mathematical Physics**, 110(7), (2020), 1711-1758, DOI: 10.1007/s11005-020-01277-x, arXiv.org:1903.07496.

This is an invited talk in the session **Recent perspectives on moment problems** *organized by* **Maria Infusino** *and* **Tobias Kuna**.

Sabrina Mulinacci

Università di Bologna

Pseudo-calculus and pseudo-expectation: application to dependence structures of Archimedean type

Based on the definition of the pseudo algebra, there exists a wide literature in which the definition of pseudo-additive fuzzy measures, new integrals and a suitable calculus are introduced, studied and applied to many fields. The focus of this talk is the analysis of how to apply this theory in order to generalize the notion of classical tools of probability, like the probability generating function and the moment generating function. We will analize their properties and we will see how these tools result to be particularly suitable and useful in the study of Archimedean type dependence.
The talk is based on a joint work with M. Ricci.

This is an invited talk in the session **Options, algebra and probability: in memory of Peter Carr** *organized by* **Umberto Cherubini**.

Cosimo Munari

University of Zurich

The limitations of law invariance

We establish general "collapse to the mean" principles that provide conditions under which a law-invariant functional reduces to an expectation. In the convex setting, we retrieve and sharpen known results from the literature. However, our results also apply beyond the convex setting. We illustrate this by providing a complete account of the "collapse to the mean" for quasiconvex functionals. In the special cases of consistent risk measures and Choquet integrals, we can even dispense with quasiconvexity. In addition, we relate the "collapse to the mean" to the study of solutions of a broad class of optimisation problems with law-invariant objectives that appear in mathematical finance, insurance, and economics. We show that the corresponding quantile formulations studied in the literature are sometimes illegitimate and require further analysis.

This is an invited talk in the session **Risk management** *organized by* **Matteo Burzoni** *and* **Alessandro Doldi**.

Verdiana Mustaro

Università degli Studi di Salerno

On the analysis of the temperature fluctuations in the Campi Flegrei caldera through a fractional Brownian motion-based model

The aim of this research is to identify an efficient model to describe the fluctuations around the trend of the soil temperatures monitored in the volcanic caldera of the Campi Flegrei area in Naples (Italy). The study focuses on the data concerning the temperatures in the mentioned area through a seven-year period (cf. [1]). The research is initially finalized to identify the deterministic component of the model, given by the seasonal trend of the temperatures, which is obtained through a regression method on the time series. Subsequently, the series of the residuals obtained by substracting the deterministic component from the time series is tested to represent a fractional Brownian motion (fBm). An estimation based on the periodogram of the data is used to determine whether they follow the fBm motion or the fractional Gaussian noise. An estimation of the Hurst exponent H of the process is also obtained. Finally, an inference test based on the detrended moving average of the data is adopted in order to assess the hypothesis that the time series follows a suitably estimated fBm.

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This is an invited talk in the session **On stochastic methods, models and applications** *organized by* **Elvira Di Nardo**.

Paolo Neri

Università degli Studi di Brescia

Time change, generalized compounding and the term structure

We apply the concept of “generalised compounding” proposed in Carr and Cherubini (2020) to the Stochastic Discount Factor dynamics and term structure models. We propose a class of time change models that preserve the lognormal distribution of one period SDFs while changing the compounding structure. These models decompose the SDF into lognormal marginal SDFs and a compounding function, that takes the shape of an Archimedean copula function. We show that stochastic clocks generally leads to a decrease of the yields, particularly pronounced on long term maturities.

This is an invited talk in the session **Options, algebra and probability: in memory of Peter Carr** *organized by* **Umberto Cherubini**.

Pier Luigi Novi Inverardi

Università di Trento

On different roles played by Maximum Entropy Principle in the moment problem

In Applied Sciences Maximum Entropy (MaxEnt) methods are traditionally used to select a probability distribution in situations when some prior knowledge (the integers moments) about the true probability distribution is available and several (up to an infinite set of) different probability distributions are consistent with it. In such a situation MaxEnt methods represent correct methods for doing inference about the true but unknown underlying distribution generating the data that have been observed. Due to the non-uniqueness of the recovered density, the best choice among the (potentially, infinite) competitors may be done by invoking the Maximum Entropy (MaxEnt) Principle (Jaynes) which consists in maximizing the Shannon-entropy under the constraints of integer moments. Since entropy may be regarded as an objective measure of the uncertainty in a distribution, "... the MaxEnt distribution is uniquely determined as the one which is maximally non-committal with regard the missing information..." so that "... It agrees with is known but expresses maximum uncertainty with respect to all other matters, and thus leaves a maximum possible freedom for our final decisions to be influenced by the subsequent sample data" (Jaynes). In other words, the MaxEnt method dictates the most "reasonable and objective" distribution subject to given constraints. The aim of our talk is mainly devoted to: 1. illustrate the previous well-established statements by finding, once a finite moments set is assigned, a family of distributions continuously dependent on a parameter capable of spanning all possible entropy values. The corresponding densities will be graphically illustrated and will provide a vivid experimental support to the reasons for the choice of the MaxEnt Principle. 2. find the best choice for a sequence of approximants based on a measure of residual uncertainty about the random variable in which we are interested in and to prove by an unitary technique, including two cases $X \in [0, 1]$ and $X \in [0, \infty]$, that MaxEnt approximations, constrained by fractional moments, converge in entropy to the underlying distribution. 3. prove that the MaxEnt Principle can be used in the context of full Stieltjes moment problem as a theoretical tool to provide on one hand, a criterion of determinacy/indeterminacy in terms of entropy asymptotic values of MaxEnt distributions having the assigned moments and on the other, a sufficient condition to guarantee the existence of a density.

This is an invited talk in the session Recent perspectives on moment problems *organized by* **Maria Infusino** *and* **Tobias Kuna**.

Alessandra Occelli

École normale supérieure de Lyon

Time-time covariance for last passage percolation in half-space

We consider a last passage percolation model in half-space with exponential weights. We show that, when the two endpoints are at small macroscopic distance, the first order correction to the two-time covariance for the point-to-point model is the same as the one of the stationary model. In order to obtain the result, we first derive comparison inequalities of the last passage increments for different models. This is used to prove tightness of the point-to-point process as well as localization of the geodesics. Unlike for the full-space case, for half-space we have to overcome the difficulty that the point-to-point model in half-space with generic start and end points is not known.
Based on joint work with Patrik Ferrari.

This is an invited talk in the session Integrable systems and the KPZ universality class *organized by* **Alessandra Occelli**.

Antonio Ocello

LPSM - Sorbonne Université

A stochastic target problem for branching diffusions

We consider an optimal stochastic target problem for branching diffusion processes. This problem consists in finding the minimal condition for which a control allows the underlying branching process to reach a target set at a finite terminal time for each of its branches. This problem is motivated by an example from fintech where we look for the super-replication price of options on blockchain based cryptocurrencies. We first state a dynamic programming principle for the value function of the stochastic target problem. We then show that the value function function can be reduced to a new function with a finite dimensional argument by a so called branching property. Under wide conditions, this last function is shown to be the unique viscosity solution to an HJB variational inequality.

This is a contributed talk in the session **New trends in stochastic control: delay, partial and exogenous information** *organized by* **Giuseppina Guatteri**, **Fulvia Confortola**, **Federica Masiero**.

Tal Orenshtein

Università degli Studi di Milano-Bicocca

Rough walks in random environments

We shall discuss functional CLTs for regenerative processes and additive functionals of Markov processes lifted to the rough path space. The limiting rough path has two levels of which the first one is a Brownian motion with a well-known covariance matrix. However, in the second level we see a new feature: it is the iterated integral of the same Brownian motion perturbed by a deterministic linear function called the area anomaly and characterized in terms of the model. With that one obtains sharper information on the limiting path. The construction of new examples for SDE approximations is an immediate application. Two prototypical classes of random walks in random environments are covered as special cases: the ballistic class and the random conductance model, both with respect to the annealed law. For the random conductance model we shall present a more delicate treatment which yields a quenched result under additional assumptions.

This is an invited talk in the session Scaling limits, criticality, and random media in statistical physics *organized by* **Lorenzo Dello Schiavo** *and* **Federico Sau**.

Filippo Pagani

University of Cambridge

NuZZ: numerical Zig-Zag for general models

Markov chain Monte Carlo (MCMC) is a key algorithm in computational statistics, and as datasets grow larger and models grow more complex, many popular MCMC algorithms become too computationally expensive to be practical. Recent progress has been made on this problem through development of MCMC algorithms based on Piecewise Deterministic Markov Processes (PDMPs), irreversible processes that can be engineered to converge at a rate which is independent of the size of data. While there has understandably been a surge of theoretical studies following these results, PDMPs have so far only been implemented for models where certain gradients can be bounded, which is not possible in many statistical contexts. Focusing on the Zig-Zag process, we present the Numerical Zig-Zag (NuZZ) algorithm, which is applicable to general statistical models without the need for bounds on the gradient of the log posterior. This allows us to perform numerical experiments on: (i) how the Zig-Zag dynamics behaves on some test problems with common challenging features; and (ii) how the error between the target and sampled distributions evolves as a function of computational effort for different MCMC algorithms including NuZZ. Moreover, due to the specifics of the NuZZ algorithms, we are able to give an explicit bound on the Wasserstein distance between the exact posterior and its numerically perturbed counterpart in terms of the user-specified numerical tolerances of NuZZ.

This is an invited talk in the session Monte Carlo sampling with piecewise deterministic Markov processes *organized by* **Andrea Bertazzi**.

Gianni Pagnini

BCAM - Basque Center for Applied Mathematics, Bilbao, Basque Country - Spain

Should I stay or should I go? Zero-size jumps in random walks for Lévy flights

Motivated by the fact that, in the literature dedicated to random walks for anomalous diffusion, it is disregarded if the walker does not move in the majority of the iterations because the most frequent jump-size is zero (i.e., the jump-size distribution is unimodal with mode located in zero) or, in opposition, if the walker always moves because the jumps with zero-size never occur (i.e., the jump-size distribution is bi-modal and equal to zero in zero), we provide an example in which indeed the shape of the jump-distribution plays a role. In particular, we show that the convergence of Markovian continuous-time random walk (CTRW) models for Lévy flights to a density function that solves the fractional diffusion equation is not guaranteed when the jumps follow a bi-modal power-law distribution equal to zero in zero, but, as a matter of fact, the resulting diffusive process converges to a density function that solves a double-order fractional diffusion equation [1]. Within this framework, self-similarity is lost. The consequence of this loss of self-similarity is the emergence of a time-scale for realizing the large-time limit. Such time-scale results to span from zero to infinity accordingly to the power-law displayed by the tails of the walker's density function. Hence, the large-time limit could not be reached in real systems. The significance of this result is two-fold: i) with regard to the probabilistic derivation of the fractional diffusion equation [2] and also ii) with regard to recurrence [3] and the related concept of site fidelity in the framework of Lévy-like motion for wild animals [4].

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This is an invited talk in the session Confined diffusions and fractional diffusions with applications *organized by* **Enrica Pirozzi**.

Andrea Pallavicini

Intesa Sanpaolo Group Milano

Local-stochastic volatility models mimicking rough behaviours

In industrial applications stochastic volatility models are usually extended by adding a local volatility term to fit exactly market volatilities. These extended models are usually driven by semi-martingale Markov volatility processes. Here, we consider the case of singular Volterra processes, and we extend them by adding a local volatility term to their Markov lift by preserving the stylized results implied by these models on plain-vanilla options. In particular, we focus on the rough-Heston model, and we analyze the small time asymptotics of the implied local-volatility function in order to provide a proper extrapolation scheme.

This is a contributed talk in the session Generalized fractional processes *organized by* **Giacomo Ascione**.

Riccardo Passeggeri

Imperial College London

On quantiles, continuity, and robustness

In this talk I will present novel properties of the quantile of empirical distributions. I will consider both the geometric and the component-wise quantiles in both finite and infinite dimensions. I will show their existence, uniqueness, and continuity as function of the data. Building on these results, I will introduce a novel class of estimators: the quantile-of-estimators (QoE); which extends the celebrated median-of-means, see Lugosi and Mendelson J. Eur. Math. Soc. 22 (3), 925-965. The QoE estimator is a robustification of a large class of estimators. In particular, given an estimator that is consistent and asymptotically normal the QoE estimator is consistent and asymptotically normal and both these properties are robust to an increasing number of contaminated data. Moreover, consider an estimator that is consistent and posses an asymptotic distribution (not necessary normal) then in almost all the cases the QoE estimator is consistent and asymptotically normal and both these properties are robust to an increasing number of contaminated data.

This is a contributed talk in the session **Advances in statistical inference for continuous-time stochastic processes** *organized by* **Paolo Pigato**.

Antonello Pesce

Università di Bologna

Density and gradient estimates for Kinetic SDEs with low regularity coefficients

We discuss some recent results on Kinetic degenerate Kolmogorov SDEs: we show two sided bounds and pointwise controls of its derivatives, under somehow minimal assumptions that guarantee that the equation is weakly well posed. These estimates reflect the transport of the initial condition by the unbounded drift through an auxiliary, possibly regularized flow.

This is an invited talk in the session **PDEs and their applications to stochastic analysis** *organized by* **Elena Issoglio**.

Athena Picarelli

Università degli Studi di Verona

Optimal management of pumped hydroelectric production with state constrained optimal control

We present a novel technique to solve the problem of managing optimally a pumped hydroelectric storage system. This technique relies on representing the system as a stochastic optimal control problem with state constraints, these latter corresponding to the finite volume of the reservoirs. Following the recent level-set approach presented in O. Bokanowski, A. Picarelli, H. Zidani, State-constrained stochastic optimal control problems via reachability approach, SIAM J. Control and Optim. 54 (5) (2016), we transform the original constrained problem in an auxiliary unconstrained one in augmented state and control spaces, obtained by introducing an exact penalization of the original state constraints. The latter problem is fully treatable by classical dynamic programming arguments.

This is an invited talk in the session Stochastic models for energy, management, and environmental issues *organized by* **Alessandro Calvia** *and* **Katia Colaneri**.

Paolo Pigato

Università di Roma "Tor Vergata"

Local volatility models and the short-maturity behaviour of the implied volatility skew

We discuss how the short-maturity explosion of the implied volatility skew, observed on market volatility surfaces, can be obtained pricing options under local volatility dynamics. We discuss this issue in relation to local-stochastic volatility and rough volatility models.

This is a contributed talk in the **Contributed session IV**.

Enrica Pirozzi

Università degli Studi di Napoli "Federico II"

On some semi-Markov discrete processes and their continuous approximation

Examples of semi-Markov processes are the time-changed birth-death processes. We investigated some of them to provide new queueing models such as fractional time-changed M/M/1 and Erlang queues with heavy-tailed interarrival and service times. In this framework it reveals of particular interest the study of such systems in heavy traffic regimes for which diffusive approximations can be derived in terms of the Reflected Brownian Motion. Specifically, we introduce the Delayed Reflected Brownian Motion by either solving the Skorohod reflection problem on the trajectories of the delayed Brownian motion or by composing the Reflected Brownian Motion with an inverse stable subordinator. The heavy traffic limit is achieved via the continuous mapping theorem.
This is joint work with Giacomo Ascione and Nikolai Leonenko.

This is an invited talk in the session Semi-Markov dynamics *organized by* **Giacomo Ascione** *and* **Bruno Toaldo**.

Giovanni Pistone

de Castro Statistics, Collegio Carlo Alberto

Lagrangian and Hamiltonian formalism on an affine space of probability densities

A maximal exponential model $\mathcal{E}$ is a set of probability densities connected by open Hellinger arcs. A statistical bundle $S\mathcal{E}$ is set of (q, u) with $q \in \mathcal{E}$ and u random variable with $E_q(u) = 0$. A statistically natural affine atlas on the statistical bundle allows for the definition of kinematic quantities on smooth curves: velocity, covariant derivative, acceleration, curvature. The affine structure allows for the study of Lagrangian and Hamiltonian formalism. For the finite state space case, see my joint work with G. Chirco e L. Malagò arXiv:2009.09431. This talk generalizes the construction by considering a Gaussian-Orlicz-Sobolev setup as in arXiv:2012.03376.

This is a contributed talk in the **Contributed session I**.

Federico Polito

Università degli Studi di Torino

Fractionality in discrete time: theory and examples

Fractionality in continuous time is usually achieved by suitable random time-changes and it is commonly seen as a tool to extend Markov processes to models in which the presence of persistent memory is taken into consideration. Interestingly enough, these models are non-Markov, still they represent a class of processes retaining a certain mathematical tractability. Even though the literature on continuous-time fractional processes is vast and growing, only few studies on their discrete-time counterparts have appeared so far. In this talk we present a theory for processes in discrete time admitting in some cases persistent memory. This is achieved by considering discrete infinite divisibility of random variables and defining time-changes resembling and actually converging to inverse subordinators. An example of a discrete-time renewal process having as a scaling limit the time-fractional Poisson process is described. Finally, we will present some applications of the theory.
The talk collects joint works with Angelica Pachon, Costantino Ricciuti, Thomas M. Michelitsch and Alejandro P. Riascos.

This is an invited talk in the session **Generalized fractional processes** *organized by* **Giacomo Ascione**.

Lorenzo Portinale

Hausdorff Center for Mathematics, Bonn

A non-commutative entropic optimal transport approach to quantum composite systems at positive temperature

The Schrödinger problem consists in finding the most likely evolution of a (random) Brownian particles which evolves from a given initial law to a given target one. It is in fact possible to equivalently describe this problem in terms of entropy regularisation of an optimal transport problem, by perturbing the classical quadratic Wasserstein transport problem with an entropy contribution, weighted by a factor that plays the role of the inverse of the temperature. In this talk, we study a multimarginal, non-commutative analogue of this problem, meaning an entropic regularised optimal transport problem between density matrices on finite dimensional Hilbert spaces. Physically, this can describe a composite quantum system at positive temperature, under the knowledge of all its subsystems. Our main contributions are the proof of a suitable duality formula for the multimarginal entropic problem and the introduction and proof of convergence to the optimal states of a non-commutative analogue of the Sinkhorn algorithm. The settings of Bosonic and Fermionic systems are also discussed.
This is a joint work with Dario Feliciangeli and Augusto Gerolin, *arXiv:2106.11217*.

This is an invited talk in the session Inequalities in quantum probability *organized by* **Dario Trevisan**.

Enrico Priola

Università degli Studi di Pavia

Some results in PDEs obtained by the Poisson process

We show that some sharp regularity results in parabolic PDEs can be obtained by using the Poisson process. We point out the such results can be used to prove uniqueness for some diffusion processes.

This is an invited talk in the session PDEs and their applications to stochastic analysis *organized by* **Elena Issoglio**.

Igor Prünster

Università Bocconi

Hierarchies of random measures in Bayesian Nonparametrics

The Hierarchical Dirichlet Process enjoyed a huge success in the Machine Learning literature. It originated in the context of topic modeling as a powerful generalization of the ubiquitous Latent Dirichlet Allocation model that allows to learn the number of topics from the data. The Hierarchical Dirichlet Process and more general Bayesian nonparametric models constructed as hierarchies of random probability measures can be naturally embedded within the framework of partial exchangeability, a neat probabilistic representation for multiple distinct yet related populations. Moreover, the discrete nature of these models yields ties across populations, resulting in a shrinkage property often described as "sharing of information" and crucial for the learning mechanism. Distributional results, including a characterization of the induced random partitions and a complete posterior representation, are derived. Further interesting extensions deal with tree structures and hierarchies of random measures. Illustrations concerning species sampling, survival analysis, network theory and topic modeling are provided.

This is a **Plenary talk**.

Matteo Quattropani

Leiden University

Random walks on random DFAs

Deterministic Finite Automata (DFAs) are one of the most classical models in theoretical computer science, serving as a building block in the development of the theory of computational learning. It is known that learning all DFAs is computationally intractable. For this reason, in the last decade the community has made an effort to understand whether it could be possible to design algorithms that efficiently solve the learning problem at least in the average case. It turns out that the average case can be translated into the analysis of a random walk moving on a random DFA, which is essentially a random directed graph with constant out-degree. In this talk I will present some recent results on the behaviour of random walks on random DFAs. In particular, I will focus on the meeting time of two independent random walks evolving on the same random DFA and, along the way, I will provide some links with a recent conjecture by Fish et al. [1]. The results are part of a joint work with F. Sau (IST Austria).

Reference

1. Fish, Benjamin, and Lev Reyzin, *Open problem: Meeting times for learning random automata,* Conference on Learning Theory. PMLR, 2017.

This is an invited talk in the session **Random processes on complex networks** *organized by* **Michele Salvi**.

Luca Ratti

Università degli Studi di Genova

Generalized Tikhonov regularization for infinite-dimensional inverse problems: a statistical learning perspective

The task of an inverse problem is to determine an unknown function from measurements obtained through a forward operator, possibly corrupted by noise. One main difficulty is represented by the instability of the forward operator: small perturbations in the observed measurements may cause large deviations in the reconstructed solutions. Variational regularizers are (families of) continuous operators providing a stable approximation of the pseudoinverse of the forward map. From a statistical learning perspective, one might take advantage of partial knowledge of the joint distribution of unknowns and measurements (e.g. by means of a training set) to design data-driven regularization operators.

In this talk, I will consider a linear inverse problem defined on (infinite-dimensional) Hilbert spaces, and tackle the problem of learning the optimal operator in the family of generalized Tikhonov regularizers. After setting a statistical framework for the proposed learning problem, allowing to consider a sufficiently large class of noise models, I will characterize the optimal regularizer, showing that it is completely independent of the forward operator. Then, I will propose two strategies to learn such a regularizer from a finite training set: a supervised one, based on samples of both inputs and outputs, and an unsupervised one, based only on a sample of outputs. In both cases, I will prove asimptotic bounds (in probability) on the excess risk. The strength of the proposed approach rests on its infinite-dimensional setting, which ultimately shows that finer and finer discretizations do not make the learning problem harder. I will finally provide a validation of the discussed results by means of a set of numerical examples, both related to a denoising problem and to an ill-posed problem.

This is based on joint work with G. S. Alberti, E. De Vito, M. Santacesaria (University of Genoa), and M. Lassas (University of Helsinki).

This is an invited talk in the session Mathematics of machine learning *organized by* **Ernesto De Vito** *and* **Lorenzo Rosasco**.

Frank Redig
TU Delft

Multi-layer particle systems: invariant measures and fluctuations

We study a class of multi-layer particle systems, inspired by interacting active particles. We study the structure of the set of invariant measures and discuss results and problems related to stationary density fluctuations for such models.
Based on joint work with Hidde Van Wiechen.

This is an invited talk in the session **Scaling limits for interacting particle systems** *organized by* **Chiara Franceschini**.

Cristiano Ricci

Università degli Studi di Pisa

Numerical applications of Kolmogorov equations and Girsanov trasformation for SPDEs

The Girsanov transformation and Kolmogorov equations are two useful methods for studying SPDEs. For Kolmogorov equations associated to finite dimensional stochastic differential equations (SDEs) in high dimension, a numerical method alternative to Monte Carlo simulations is proposed. The structure of the SDE is inspired by stochastic Partial Differential Equations (SPDE) and thus contains an underlying Gaussian process which is the key of the algorithm. A series development of the solution in terms of iterated integrals of the Gaussian process is given, it is proved to converge - also in the infinite dimensional limit. It is shown that, under suitable conditions, the series expansion obtained from the Girsanov transform coincides with the one generated by the iteration scheme for Kolmogorov equations.

This is an invited talk in the session **SPDEs and Kolmogorov equations** *organized by* **Davide Addona** *and* **Margherita Zanella**.

Costantino Ricciuti

Università di Roma "La Sapienza"

Multivariate subordination and multiparameter Lévy processes

We consider two models related to the so-called multivariate subordinators. The first one concerns compositions of $\mathbb{R}^d$-valued Markov processes with the components of an independent multivariate inverse subordinator. As a possible application of this model, we study anomalous diffusion in anisotropic medium, which is obtained as a weak limit of suitable continuous-time random walks. The second one concerns subordination of multiparameter Lévy processes.

This is an invited talk in the session Nonlocal operators in probability: anomalous diffusions *organized by* **Mirko D'Ovidio** *and* **Giacomo Ascione**.

Emanuela Rosazza Gianin

Università degli Studi di Milano-Bicocca

Fully-dynamic risk measures: time-consistency, horizon risk, and relations with BSDEs and BSVIEs

In a dynamic framework, we identify a new concept associated with the risk of assessing the financial exposure by a measure that is not adequate to the actual time horizon of the position. This will be called horizon risk. We clarify that dynamic risk measures are subject to horizon risk, so we propose to use the fully-dynamic version. To quantify the horizon risk we introduce the h-longevity as an indicator. We investigate these concepts together with other properties of risk measures as normalization, restriction property and different formulations of time-consistency. We also consider these concepts for fully-dynamic risk measures generated by backward stochastic differential equations (BSDEs), backward stochastic Volterra integral equations (BSVIEs) and families of these. Within this study we provide new results for BSVIEs: a converse comparison theorem and the dual representation of the associated risk measures.
Joint work with Giulia Di Nunno.

This is an invited talk in the session **Risk management** *organized by* **Matteo Burzoni** *and* **Alessandro Doldi**.

Maurizia Rossi

Università degli Studi di Milano-Bicocca

Non-universal fluctuations of the empirical measure for time-dependent spherical random fields

In this talk, we consider isotropic and stationary real Gaussian random fields on the sphere evolving over time, and we investigate the asymptotic behavior, for large time T, of the empirical measure (excursion area) of the process on the sphere cross the interval $[0, T]$ at any threshold, covering both cases when the field exhibits short and long memory, i.e. integrable and non-integrable temporal covariance structure. It turns out that the limiting distribution is not universal, depending both on the memory parameters and the threshold. In particular, in the long memory case a form of Berry's cancellation phenomenon occurs at zero-level, inducing phase transitions for both variance rates and limiting laws.
This is a joint work with Domenico Marinucci and Anna Vidotto.

This is an invited talk in the session **Probabilistic and statistical properties of sphere-cross-time** *organized by* **Alessia Caponera**.

Matteo Ruggiero

Università di Torino e Collegio Carlo Alberto

Computable inference for hidden Markov models via duality

We present some recent advances on the use of duality for inference on hidden Markov models and on its parameters, providing sufficient conditions that allow to drastically reduce the complexity required for computing all posterior distributions of interest, typically due to the intractability of the transition density of the signal. Under these conditions, one can compute exactly filtering and smoothing distributions of the signal as well as the likelihood and the predictive distribution of new observations, which take the form of finite mixtures or products thereof. We devise efficient computational strategies through an informed pruning of the involved mixtures and apply our results to dependent Dirichlet and Gamma signals, showing improvement by some orders of magnitude over usage of particle filters. We also show how some of these results are extended to measure-valued Dirichlet and gamma signals, and discuss a generalized Chinese restaurant process describing the clustering when predicting new observations.

This is an invited talk in the session **Interacting particle systems and inference** *organized by* **Martina Favero**.

Wolfgang Runggaldier

Università degli Studi di Padova

On the separation of estimation and control in stochastic dynamic optimization problems under incomplete information

Stochastic (dynamic) optimization models often include quantities that cannot be observed directly, but can be estimated, in particular via filtering methods. The question arises: is it correct to first estimate the unobserved quantities and then to optimize with the observed quantities replaced by their point estimates (mean of the filter distribution)? If yes, we say that a (strict) separation property holds.

We start by recalling the separation property in the classical linear-quadratic Gaussian stochastic control problems under incomplete information. We then consider portfolio optimization with a risk-sensitive criterion function and under incomplete information on some of the driving factors, assuming the existence of a finite-dimensional filter for them. The main purpose is to investigate what can be said about the separation property in this situation.

Based on ongoing joint work with Sebastien Lleo.

This is a **Plenary talk**.

Elena Sabbioni

Politecnico di Torino

Bayesian approach for modelling RNA transcription

Gene expression is regulated through the fundamental processes of transcription, splicing and degradation, that can be modelled as an ODE system, whose parameters need to be estimated from experimental data collected by single-cell RNA sequencing. By this technique, biologists can take only a single snapshot of the cellular states: they obtain the counts of unspliced and spliced mRNA molecules, for each gene and for each cell altogether at the moment of the sequencing, that actually corresponds to different levels of maturity in the evolution of the different cells, and then the cells are destroyed. The aim of this work is to reconsider part of the method introduced in "Generalizing RNA velocity to transient cell states through dynamical modeling" (Bergen, V., Lange, M., Peidli, S. et al., Nature Biotechnology, 2020) to analyze scRNA-seq data and to describe the evolution of some cells over different cell types, exploiting the level of expression of their genes and the concept of RNA-velocity. We reformulate it in a way that is mathematically better founded, using Bayesian statistics. We discuss the advantages of our approach in terms of the quality and the interpretability of the results.

This is a contribution in the **Poster session**.

José Antonio Salmerón

University Carlos III of Madrid

A Markovian modulation in the optimal portfolio problem via anticipative calculus

The optimal portfolio problem has been deeply studied from the perspective of the stochastic calculus with several variants. In our talk, we focus on a Markovian modulation of the market coefficients, also known as a regime-switching, with the novelty that such modulation can be anticipative with respect to the future market trends. In the anticipative context, enlargement of filtration techniques arise naturally and, in particular, we see what impact the so-called Jacod's hypothesis has on our model. We solve the optimization problem for a general utility function, in both complete and incomplete markets and we provide a variety of examples.

This is an invited talk in the session Markov processes and first passage time problems *organized by* **Barbara Martinucci**.

Michele Salvi

Università di Roma "Tor Vergata"

Scale-free percolation mixing time

Scale-free percolation is a spatial inhomogeneous random graph model which features three fundamental properties that are often present in real-world networks: (1) Scale-free: the degree of the nodes follows a power law; (2) Small-world: two far-away nodes have typically a small graph distance; (3) Positive clustering coefficient: two nodes with a common neighbour have a good chance to be linked. We study the mixing time of the simple random walk on this structure in one dimension and depict a rich phase diagram in the parameters of the model. In particular, we prove that the presence of hubs can speed up the mixing of the chain.
Joint work with Alessandra Cipriani (UCL).

This is an invited talk in the session **Random processes on complex networks** *organized by* **Michele Salvi**.

Giuseppe Sanfilippo

Università degli Studi di Palermo

Compound conditionals as random quantities, Fréchet-Hoeffding bounds, and Frank t-norms

We illustrate the notions of compound conditionals introduced, in recent papers, as suitable conditional random quantities, in the framework of coherence. Usually, in the literature of conditionals the study of compound conditionals, that is to say, those expressions obtained by combining basic conditionals like $A|B$ by usual logical operations of 'and', 'or', 'negation' and so forth, have been defined as suitable conditional events (three-valued objects). However, in this way many classical logical and probabilistic properties are lost. In particular, differently from the case of unconditional events, the lower and upper probability bounds for the conjunction of conditional events are no more the Fréchet-Hoeffding bounds. In our approach the results of the logical operations among conditional events are conditional random quantities that satisfy the basic logic and probabilistic properties valid for unconditional events. In this talk we discuss the validity of the Fréchet-Hoeffding and give a probabilistic interpretation of Frank t-norms. More precisely, we show, under logical independence, the sharpness of the Fréchet-Hoeffding bounds for the prevision of conjunctions and disjunctions of n conditional events by studying the solvability of suitable linear systems. We study the set of all coherent prevision assessments on a family containing conditional events and their conjunctions, by verifying that it is convex. We discuss the case where the prevision of conjunctions is assessed by Lukasiewicz t-norms and we give explicit solutions for the linear systems. We obtain a probabilistic interpretation of Frank t-norms and t-conorms as prevision of conjunctions and disjunctions of conditional events, respectively. Then, we characterize the sets of coherent prevision assessments on a family containing n conditional events and their conjunction, or their disjunction, by using Frank t-norms, or Frank t-conorms. By assuming logical independence, we show that any Frank t-norm (resp., t-conorm) of two conditional events is a conjunction (resp., a disjunction). We analyze some case of logical dependence. We give some results on Frank t-norms and coherence of the prevision assessments on F. By assuming logical independence, we show that it is coherent to assess the previsions of all the conjunctions by means of Minimum and Product t-norms. In this case all the conjunctions coincide with the t-norms of the corresponding conditional events. We verify by a counterexample that, when the previsions of conjunctions are assessed by the Lukasiewicz t-norm, coherence is not assured. Then, the Lukasiewicz t-norm of conditional events may not be interpreted as their conjunction. Finally, we give two sufficient conditions for coherence and incoherence when using the Lukasiewicz t-norm.

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This is a contributed talk in the Contributed session I.

Silvia Sarpietro

Università di Bologna

Regularized CUE: a Quasi-Likelihood approach

We propose a regularized version of the Continuously Updated Estimator (CUE), which we call the quasi-likelihood GMM (QL-GMM) estimator, as a solution to the no-moment problem of the CUE. The estimator is obtained by adding the log-determinant of the optimal weighting matrix to the usual GMM objective function that defines the CUE. The motivation for this term is asymptotic: The QL-GMM objective function is the large-sample log-likelihood of the sample moments. The additional term works as a finite-sample penalization. Monte Carlo simulations show that QL-GMM has tighter tails than CUE, restoring its finite sample moments, and that this comes with a small price in terms of slightly bigger biases compared to the CUE in some settings.

This is an invited talk in the session Improved inference in statistical models *organized by* **Silvia Sarpietro** *and* **Stanislav Anatolyev**.

Federico Sau

IST Austria

The Averaging process and its discrete dual

Introduced by David Aldous in a series of lectures and expository articles, the Averaging process is a Markovian mass redistribution model on a graph, roughly described as follows: each vertex is initially assigned a real-valued mass, and at exponential times pairs of neighboring vertices split their mass equally among them. The aim of this talk is to present some recent results on the mixing and scaling limits of a generalization of the Averaging process and its discrete dual.
Based on a joint work with Matteo Quattropani (Leiden University).

This is an invited talk in the session Interacting particle systems *organized by* **Matteo Quattropani**.

Enrico Scalas

University of Sussex, UK

Prices of options written on semi-Markov processes I: introduction and renewal equations

In this talk, I discuss the problem of pricing a plain vanilla option in the case the underlying asset is given by a continuous-time semi-Markov process. I introduce the problem and discuss some motivating examples. I focus on how semi-Markov processes can capture the granularity of intraday prices generated by an asynchronous trading mechanism known as continuous double auction. This is joint work with Bruno Toaldo.

Reference

E. Scalas and B. Toaldo, *Limit theorems for prices of options written on semi-Markov processes,* Theor. Probability and Math. Statist. 105 (2021), 3-33, https://arxiv.org/abs/2104.04817, https://www.ams.org/journals/tpms/2021-105-00/S0094-9000-2021-01153-X/home.html.

This is an invited talk in the session Semi-Markov dynamics *organized by* **Giacomo Ascione** *and* **Bruno Toaldo**.

Luca Scarpa

Politecnico di Milano

The effect of noise on doubly nonlinear evolution equations

We give an overview of some recent results for doubly nonlinear stochastic evolution equations in Hilbert spaces. In the first part of the talk we introduce the prototypes of the problems in consideration and we discuss the main existence results. Secondly, we focus on the direction of uniqueness by noise for doubly nonlinear evolutions by means of the associated Kolmogorov equations, highlighting some recent contributions and open problems. The works presented in the talk are based on joint collaborations with Prof. Ulisse Stefanelli (University of Vienna, Austria) and Dr. Carlo Orrieri (University of Pavia, Italy).

This is an invited talk in the session **SPDEs and Kolmogorov equations** *organized by* **Davide Addona** *and* **Margherita Zanella**.

Nicolas Schreuder

Università degli Studi di Genova

A minimax framework for quantifying risk-fairness trade-off in regression

Data driven algorithms are deployed in almost all areas of modern daily life and it becomes increasingly more important to adequately address the fundamental issue of historical biases present in the data. We propose a theoretical framework for the problem of learning a real-valued function which meets fairness requirements. This framework is built upon the notion of α-relative (fairness) improvement of the regression function which we introduce using the theory of optimal transport. Setting $\alpha = 0$ corresponds to the regression problem under the Demographic Parity constraint, while $\alpha = 1$ corresponds to the classical regression problem without any constraints. For $\alpha \in (0, 1)$ the proposed framework allows to continuously interpolate between these two extreme cases and to study partially fair predictors. Within this framework we precisely quantify the cost in risk induced by the introduction of the fairness constraint. We put forward a statistical minimax setup and derive a general problem-dependent lower bound on the risk of any estimator satisfying α-relative improvement constraint. We provide a general post-processing strategy which enjoys fairness, risk guarantees and can be applied on top of any black-box algorithm.

This is an invited talk in the session Mathematics of machine learning *organized by* **Ernesto De Vito** *and* **Lorenzo Rosasco**.

Catia Scricciolo

Università degli Studi di Verona

Wasserstein convergence in Bayesian deconvolution models

We study the reknown deconvolution problem of recovering a distribution function from independent replicates (signal) additively contaminated with random errors (noise), whose distribution is known. We investigate whether a Bayesian nonparametric approach for modeling the latent distribution of the signal can yield inferences with asymptotic frequentist validity under the L^1-Wasserstein metric. When the error density is ordinary smooth, we develop two inversion inequalities relating either the L^1- or the 1-Wasserstein distance between two mixture probabilities (of the observations) to the 1-Wasserstein distance between the corresponding distributions of the signal. This smoothing inequality improves on those in the literature. We apply this general result to a Bayesian approach on a Dirichlet process mixture of normal distributions as a prior on the mixing distribution, with a Laplace or Linnik noise. In particular, we construct an adaptive approximation of the density of the observations by the convolution of a Laplace (or Linnik) density with a well-chosen mixture of normal densities and show that the posterior concentrates at the minimax rate up to a logarithmic factor. The same prior law is shown to also adapt to the Sobolev regularity level of the mixing density, thus leading to a new Bayesian estimation method, relative to the Wasserstein distance, for distributions with smooth densities.

This is an invited talk in the session Modeling financial asset prices *organized by* **Cecilia Mancini**.

Patrizia Semeraro

Politecnico di Torino

High dimensional Bernoulli distributions: representation and simulation

The main contributions of this paper are, even for high dimensions, algorithms to sample from exchangeable multivariate Bernoulli distributions and to determine the distributions and the bounds of a wide class of indices and measures of probability mass functions. Unlike the algorithms present in the literature the proposed method gives the possibility to simulate also from negatively correlated distributions. Such a method is based on the geometrical structure of the class of exchangeable Bernoulli probability mass functions, which are points in a convex polytope whose extremal points are analytically known. The more general class of multivariate Bernoulli distributions with mean p is also a convex polytope, but to find its extremal points is a more challenging task. Our novel theoretical contribution is to use an algebraic approach to find a lot of them very easily and analytically. Extremal points are important to solve the problem extensively addressed in the statistical literature to find bounds for statistical indices and distributions in a given class. Here, we solve the problem to find the lower bond in convex order of multivariate Bernoulli distributions with given margins, but with unspecified dependence structure.
Joint work with Roberto Fontana.

This is a contributed talk in the **Contributed session II**.

Assaf Shapira

Université Paris Cité

Hydrodynamic limit of the Kob-Andersen model

The Kob-Andersen model is an interacting particle system on the lattice, in which sites can contain at most one particle. Each particle is allowed to jump to an empty neighboring site only if there are sufficiently many empty sites in its neighborhood. This way, when the density is very high, many particles are unable to move, and the system slows down. In particular, the time it takes particles to diffuse, moving from high density regions to lower density ones, is very long. We will discuss the diffusion coefficient, and see how it decays as the density approaches 1.

This is an invited talk in the session Interacting particle systems *organized by* **Matteo Quattropani**.

Vittoria Silvestri

Università di Roma "La Sapienza"

How far do activated random walkers spread from a single source?

Activated Random Walks (ARW) is an interacting particle system which is believed to be an example of Self-Organised Criticality (SOC), in that the competition between the particles' activity and inactivity spontaneously drives the system to a critical state. In this talk I will discuss several notions of criticality and, specialising to ARW on the one-dimensional lattice, I will illustrate how some of them relate to each other.
Based on joint work with Lionel Levine (Cornell).

This is an invited talk in the session Scaling limits, criticality, and random media in statistical physics *organized by* **Lorenzo Dello Schiavo** *and* **Federico Sau**.

Pietro Siorpaes

Imperial College London

How to discretise the martingale optimal transport problem

Given a vector $P = (P_i)_{i=1}^n$ of probabilities on a Banach space B, consider an optimisation problem of the form $v(P) := \inf \mathbb{E}[c(X)]$, where the infimum runs over all the (laws J of) random vectors $X = (X_i)_{i=1}^n$, whose marginals X_i, $i = 1, \ldots, n$ have law P_i, $i = 1, \ldots, n$, and which satisfy some additional linear constraints. When P is finitely supported, this is a linear program, and thus is well understood and can be solved numerically with high efficiency. It is then of interest to approximate general P with some finitely supported P^k which satisfy the same linear constraints, ideally in a way that the optimal values $v(P^k) \to v(P)$ converge as $k \to \infty$, and so do the corresponding minimisers $J^k \to J$, and possibly P^k satisfy some optimality property and/or some additional constraint. We consider the case where X is required to be a vector-valued martingale, thus constructing a quantisation method which preserves the convex order on measures on a separable Banach space.
This is joint work with Marco Massa.

This is a contributed talk in the session Advances in stochastic control with applications *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Roberta Sirovich

Università degli Studi di Torino

Fast and exact simulation of multitype continuous-time Markov branching process with application to cancer evolutionary dynamics

It is now well accepted that cancer derives from the accumulated mutations in genes that may increase the fitness of cells or confer resistance, with resulting competition between clones and cell types. Multitype branching processes are widely used to model complex cellular systems and hierarchies as characterized by growth, death and mutation rates of various cell types, see [1]. Reconciliation of models with cancer genetic data is a major challenge which requires advances in different fields, see [2,3]. In this framework we present a doubly multitype continuous-time Markov branching process that models the accumulation of both driver and passenger mutations. We derive an exact simulation algorithm for the population sizes. Moreover, we prove some theoretical results on the asymptotical evolution of the (i, j)-th population in order to speed up the simulation task for large population sizes.

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This is a contributed talk in the session Stochastic chemical reaction network dynamics *organized by* **Andrea Agazzi**.

Dario Spanò

University of Warwick

Population genetic models with heavy-tailed dormancy

It has been observed that many organisms (and remarkably, the vast majority of the microbiome) evolve through dormancy: they produce sleepy spores or seeds which will not open up until randomly many generations later in time, at which point they will finally produce offspring, to propagate their own genetic makeup. Dormancy has been absent from mathematical models of population genetics until relatvely recently. To date, the main tractable models of evolution through dormancy (the "seedbank coalescent", by Blath et al. (2016)) are built upon the assumption of exponentially distributed "wake up" times. There is empirical evidence that this assumption is too restrictive for several populations. I will discuss possible ways of introducing possibly heavy-tailed seedbank effect in evolutionary dynamic, starting from classical individual-based interacting particle systems of Wright-Fisher or Moran type, and illustrate possible avenues for nonparametric inference of the seedbank effect.

This is an invited talk in the session **Interacting particle systems and inference** *organized by* **Martina Favero**.

Serena Spina

Università degli Studi di Salerno

First exit time problem for the two-dimensional Wiener and Ornstein-Uhlenbeck diffusion processes through ellipses

The study of the first exit time (FET) problem through suitable boundaries is a key topic in the theory of the stochastic processes due to its relevance in several applied contexts, such as chemistry, biology, epidemiology, economics and finance, medicine, engineering, physics. Typically, the study of the FET problem becomes more complicate when the boundaries are time dependent, and, in particular, when the processes are multi-dimensional. In spite of the great interest for the FET problem, only for some processes and for particular boundaries the analytical expression of the FET density can be determined in a closed form. Our study is focused on the FET through specific time dependent ellipses for the two-dimensional Wiener and OU diffusion processes. In particular, for both processes we obtain the closed form of the Laplace Transforms of the FET probability density functions. This leads to a connection between the FET through the time dependent curve and the first-passage-time density through a constant boundary for a suitable one-dimensional diffusion process. Moreover, we analyse the mean, the variance, the coefficient of variation and the skewness of the FET through the time dependent ellipses for the two-dimensional Wiener and OU diffusion processes. Finally, we analyse the asymptotic behaviour of the FET moments when the axes of the ellipse tend to infinity.

This research has been carried out jointly with A. Di Crescenzo, V. Giorno and A.G. Nobile.

This is an invited talk in the session Confined diffusions and fractional diffusions with applications *organized by* **Enrica Pirozzi**.

Fabio L. Spizzichino

Università di Roma "La Sapienza"

Order-dependent load sharing models

Let $X_1, \ldots, X_m$ be non-negative random variables with an absolutely continuous joint probability distribution.
Besides the joint density function, an alternative tool to describe such distribution is the family of the *multivariate conditional hazard rate* (m.c.h.r.) functions. Let $X_{1:m}, ..., X_{m:m}$ denote the order statistics of $X_1, \ldots, X_m$; then the m.c.h.r. functions are defined as follows:

$$\lambda_j(t|i_1, \ldots, i_k; t_1, \ldots, t_k) :=$$

$$\lim_{\Delta t \to 0^+} \frac{1}{\Delta t} \mathbb{P}(X_j \leq t + \Delta t | X_{i_1} = t_1, \ldots, X_{i_k} = t_k, X_{k+1:m} > t), \tag{1}$$

for $k = 1, ..., n-1$, $0 \leq t_1 < ... < t_k \leq t$ and, finally,

$$\lambda_j(t|\emptyset) := \lim_{\Delta t \to 0^+} \frac{1}{\Delta t} \mathbb{P}(X_j \leq t + \Delta t | X_{1:m} > t). \tag{2}$$

From a purely analytical viewpoint the two descriptions are completely equivalent. For what concerns stochastic dependence among $X_1, \ldots, X_m$, there are however remarkable differences between aspects which can be respectively described by means of the two methods.
In particular, dependence models that emerge by imposing idealized conditions on the joint density (or on the survival copula) are very different from models which admit simple characterizations in terms of the m.c.h.r. functions.
Among models of the latter type, specially relevant are those characterized by the property of *load-sharing.* This is a Markovian-type property which emerges in a natural way in the field of systems' reliability or - possibly under different terminology - in the frame of financial risk and default contagion.

Definition. *The m-tuple $(X_1, \ldots, X_m)$ is distributed according to a load-sharing model when*

$$\lambda_j(t|i_1, \ldots, i_k; t_1, \ldots, t_k) = \mu_j(i_1, \ldots, i_k); \lambda_j(t|\emptyset) = \mu_j(\emptyset) \tag{3}$$

for suitable non-negative quantities $\mu_j(i_1, \ldots, i_k)$ and $\mu_j(\emptyset)$.

The simplest and more often considered cases correspond to the condition that the functions $\mu_j(i_1, \ldots, i_k)$ do not depend on the ordering among the components of the vector $(i_1, \ldots, i_k)$. One can however admit the possibility for the function μ_j to actually depend on the ordering of $i_1, \ldots, i_k$. To designate the latter case we use the term "*order-dependent*" load-sharing model.
Even though it has not been commonly considered so far in applied contexts, the possibility of dealing with order-dependence can be interesting from a conceptual viewpoint. In any case it has recently emerged in a natural way in the search of simple dependence models that manifest some special types of probabilistic properties.
In this respect, it has been shown in [2] that the order-dependent load-sharing condition leads us to the construction of non-exchangeable probability models which however satisfy the interesting symmetry property of *minimal stability.*
Let furthermore ρ be an arbitrary probability distribution over the set Π_m of all the permutations of $[m] \equiv \{1, ..., m\}$. It has been shown in [1] how to construct an appropriate load-sharing model such that ρ coincides with the probability distribution of the random permutation $\boldsymbol{J} \equiv (J_1, ..., J_m)$ where, for $i, r \in [n]$,

$$J_r = i \Leftrightarrow X_i = X_{r:m}.$$

Generally, such a model will turn out to be of order-dependent type.
Along the talk, I will demonstrate and discuss the applied meaning of the afore-mentioned constructions.
Let $X_1, \ldots, X_m$ be non-negative random variables with an absolutely continuous joint probability distribution. Besides the joint density function, an alternative tool to describe such distribution

is the family of the *multivariate conditional hazard rate* (m.c.h.r.) functions. Let $X_{1:m}, ..., X_{m:m}$ denote the order statistics of $X_1, \ldots, X_m$; then the m.c.h.r. functions are defined as follows:

$$\lambda_j(t|i_1, \ldots, i_k; t_1, \ldots, t_k) := \lim_{\Delta t \to 0^+} \frac{1}{\Delta t} \mathbb{P}(X_j \leq t + \Delta t | X_{i_1} = t_1, \ldots, X_{i_k} = t_k, X_{k+1:m} > t), \quad (4)$$

for $k = 1, ..., n-1$, $0 \leq t_1 < \ldots t)$. From a purely analytical viewpoint the two descriptions are completely equivalent. For what concerns stochastic dependence among $X_1, \ldots, X_m$, there are however remarkable differences between aspects which can be respectively described by means of the two methods. In particular, dependence models that emerge by imposing idealized conditions on the joint density (or on the survival copula) are very different from models which admit simple characterizations in terms of the m.c.h.r. functions. Among models of the latter type, specially relevant are those characterized by the property of *load-sharing*. This is a Markovian-type property which emerges in a natural way in the field of systems' reliability or - possibly under different terminology - in the frame of financial risk and default contagion. The m-tuple $(X_1, \ldots, X_m)$ is distributed according to a *load-sharing model* when

$$\lambda_j(t|i_1, \ldots, i_k; t_1, \ldots, t_k) = \mu_j(i_1, \ldots, i_k), \lambda_j(t|\emptyset) = \mu_j(\emptyset) \quad (5)$$

for suitable non negative quantities $\mu_j(i_1, \ldots, i_k)$ and $\mu_j(\emptyset)$. The simplest, and more often considered, cases correspond to the condition that the functions $\mu_j(i_1, \ldots, i_k)$ do not depend on the ordering among the components of the vector $(i_1, \ldots, i_k)$. One can however admit the possibility for the function μ_j to actually depend on the ordering of $i_1, \ldots, i_k$. To distinguish the latter case from the one in (2), we use the term *order-dependent* load-sharing model. Even though it has not commonly considered so far in applied contexts, the possibility of considering order-dependence can be interesting from a conceptual viewpoint. In any case it has recently emerged in a natural way in the search of simple dependence models that manifest some special types of probabilistic properties. In this respect, it has been shown in [2] that the order-dependent load-sharing condition leads us to the construction of non-exchangeable probability models which however satisfy the interesting symmetry properties of *minimal stability*. Let furthermore ρ be an arbitrary probability distribution over the set Π_m of all the permutations of $[m] \equiv \{1, ..., m\}$. It has been shown in [1] how to construct an appropriate load-sharing model such that ρ coincides with the probability distribution of the random permutation $\boldsymbol{J} \equiv (J_1, ..., J_m)$ where, for $i, r \in [n]$,

$$J_r = i \Leftrightarrow X_i = X_{r:m}.$$

Generally, such a model will turn out to be of order-dependent type. Along the talk, I will demonstrate and discuss the applied meaning of the afore-mentioned constructions.

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2. R . Foschi, G. Nappo, F. Spizzichino (2021). Diagonal sections of copulas, multivariate conditional hazard rates and distributions of order statistics for minimally stable lifetimes. *Dependence Modeling*, https://doi-org.ezproxy.uniroma1.it/10.1515/demo-2021-0119.

This is an invited talk in the session RELIABILITY OF SYSTEMS AND MEASURES OF DISCRIMINATION *organized by* **Francesco Buono** *and* **Maria Longobardi**.

Michele Stecconi

University of Nantes

Geometry of Gaussian isotropic spin fields on the sphere

I will talk about Gaussian isotropic spin-weighted functions on the Riemann sphere, i.e. Gaussian random sections of a complex line bundle (the spin weight is half of the degree of the bundle) that are invariant under rotations. I will consider those models that exhibit a scaling limit when a parameter grows to infinity. This setting includes sequences of Gaussian spin-weighted spherical harmonics, with different asymptotic regimes of the spin and the eigenvalue, that yield different complex fields on the plane as their scaling limit: the Berry (when the spin grows more slowly than the eigenvalue) and the Bargmann-Fock (when the spin grows as fast as the eigenvalue) models, in particular. I will discuss how the scaling limit determines the leading term of the asymptotic expected geometry in the form of the averages of Betti numbers and Lipschitz-Killing curvatures of a class of singular loci of such fields including: zeroes, excursion sets, critical points of the norm, and semialgebraic singularities in general. In particular, the asymptotic of the above quantities is the same for all sequences of Gaussian spin-weighted spherical harmonics for which the spin weight grows more slowly than the eigenvalue.
This is a joint work with Domenico Marinucci and Maurizia Rossi.

This is an invited talk in the session Stochastic processes and geometry *organized by* **Anna Paola Todino**.

Lorenzo Tamanini

Università Bocconi

Convergence rate of general entropic optimal transport costs

It is by now well understood that the Schrödinger problem is a “noised” quadratic optimal transport problem and, in this perspective, it is tightly linked with Entropic Optimal Transport (EOT). Even if the two problems are different in general, nonetheless they share several analogies and therefore the study of the one can be useful for the other. In particular, while Schrödinger problem is better suited for applications to particle systems, EOT is instead more suitable for approaching transport problems more general than the quadratic one and related applications in machine learning. Indeed, EOT consists in the minimization of a transport functional penalized by an entropy term, so that when the penalization/noise parameter vanishes, the original transport problem is recovered. This viewpoint yields several natural questions, as for instance the convergence rate (as the noise parameter goes to 0) of many quantities: optimal value, optimal solutions and potentials... A Taylor expansion for the optimal value has recently been the subject of a deep investigation, which covers the quadratic case up to the second order [Conforti-T. ‘21] and suitable smooth perturbations of the quadratic cost up to the first order [Pal ‘19]. Aim of this talk is to review the existing literature and to present an ongoing work, which extends the previous contributions not from the point of view of the accuracy, but from the point of view of the admissible cost functions. Indeed, we obtain an almost first-order Taylor expansion for EOT problems induced by costs which are only C^2 and infinitesimally twisted. In particular, our result applies to certain costs for which the solutions of the unregularized problem are not induced by a transport map and are not even unique.
Based on a joint work with G. Carlier and P. Pegon.

This is an invited talk in the session Stochastic optimal transport *organized by* **Alberto Chiarini**.

Bruno Toaldo

Università degli Studi di Torino

Prices of options written on semi-Markov processes II: limit theorems and governing equations

In this talk, I further discuss the problem of pricing a plain vanilla option in the case the underlying asset is given by a continuous-time semi-Markov process. I present several properties of the option's price process: time-change relationship, martingale property and equivalent martingale measures, limit theorems and governing integro-differential equations. This is joint work with Enrico Scalas.

Reference

E. Scalas and B. Toaldo, *Limit theorems for prices of options written on semi-Markov processes,* Theor. Probability and Math. Statist. 105 (2021), 3-33, https://arxiv.org/abs/2104.04817, https://www.ams.org/journals/tpms/2021-105-00/S0094-9000-2021-01153-X/home.html.

This is an invited talk in the session Semi-Markov dynamics *organized by* **Giacomo Ascione** *and* **Bruno Toaldo**.

Anna Paola Todino

Politecnico di Torino

On the correlation between critical points and the critical values for random spherical harmonics

We study the correlation between the total number of critical points of random spherical harmonics and the number of critical points with value in any interval $I \subset \mathbb{R}$. We show that the correlation is asymptotically zero, while the partial correlation, after controlling the random L^2-norm on the sphere of the eigenfunctions, is asymptotically one. Our findings complement the results obtained by Wigman (2012) and Marinucci and Rossi (2021) on the correlation between nodal and boundary length of random spherical harmonics.
This is a joint work with Valentina Cammarota.

This is an invited talk in the session **Probabilistic approximations via chaotic decompositions** *organized by* **Anna Vidotto**.

Lorenzo Torricelli

Università di Bologna

Tempered positive Linnik processes, their extensions, and the negative binomial subordination

We study several classes of processes associated with the tempered positive Linnik (TPL) distribution, in both the purely absolutely-continuous and mixed law regimes. We analyze several subordinated representations of TPL Lévy processes; in particular we establish a stochastic self-similarity property of positive Linnik (PL) Lévy processes, connecting TPL processes with negative binomial subordination. In finite activity regimes we show that the explicit compound Poisson representations gives rise to innovations following novel Mittag-Leffler type laws. We characterize two inhomogeneous TPL processes, namely the Ornstein-Uhlenbeck (OU) Lévy-driven processes with stationary distribution and the additive process generated by a TPL law. Moreover we propose a multivariate TPL Lévy process based on a negative binomial mixing methodology of independent interest. Finally we outline possible further extensions of the TPL law which interpolate between the tempered stable and Linnik regime, and outline possible applications of the binomial subordination to financial markets.
Based on a joint work with Lucio Barabesi (Università di Siena) and Andrea Cerioli (Università di Parma).

This is an invited talk in the session **Options, algebra and probability: in memory of Peter Carr** *organized by* **Umberto Cherubini**.

Salvatore Ivan Trapasso

Università degli Studi di Genova

Harmonic analysis of Feynman path integrals

The Feynman path integral formulation of quantum mechanics is universally recognized as a milestone of modern theoretical physics. Roughly speaking, the core principle of this picture provides that the integral kernel of the time-evolution operator shall be expressed as a "sum over all possible histories of the system". This phrase entails a sort of integral on the infinite-dimensional space of suitable paths, to be interpreted in some sense as the limit of a finite-dimensional approximation procedure. In spite of the suggestive heuristic insight, the quest for a rigorous theory of Feynman path integrals is far from over, as evidenced by the wide variety of mathematical approaches developed over the last seventy years.

Among the several proposed frameworks, the closest one to Feynman's original intuition is probably the time-slicing approximation due to E. Nelson [Nelson, *J. Math. Phys.*, 1964]. In short, if $U(t)$ is the Schrödinger time evolution operator with Hamiltonian $H = H_0 + V$ (free particle plus a suitable potential perturbation), then the Trotter product formula holds for all $f \in L^2(\mathbb{R}^d)$:

$$U(t)f = e^{-\frac{i}{\hbar}t(H_0+V)}f = \lim_{n\to\infty} E_n(t)f, \qquad E_n(t) = \left(e^{-\frac{i}{\hbar}\frac{t}{n}H_0}e^{-\frac{i}{\hbar}\frac{t}{n}V}\right)^n.$$

Integral representations for the approximate propagators $E_n(t)$ can be derived, so that the Trotter formula allows one to give a precise meaning to path integrals by means of a sequence of integral operators.

Notwithstanding the convergence results in suitable operator topologies, a closer inspection of Feynman's writings suggests that his original intuition underlay the much more difficult and widely open problem of the pointwise convergence of the integral kernels of the approximation operators $E_n(t)$ to that of $U(t)$. In the recent paper [Nicola and Trapasso, *Comm. Math. Phys.*, 2020] we addressed this problem by means of function spaces and techniques arising in the context of harmonic analysis. The toolkit of Gabor analysis has been fruitfully applied to the study of path integrals only in recent times, leading to promising outcomes [Nicola, *Adv. Math.* (2016) and *J. Anal. Math.* (2019); Nicola and Trapasso, *J. Math. Phys.* (2019)].

With reference to the notation above, we consider a setting where H_0 is the Weyl quantization of a real quadratic form, hence covering fundamental examples such as the free particle or the harmonic oscillator. In addition, we introduce a bounded potential perturbation V whose regularity is characterized in terms of the decay in phase space of its windowed Fourier transform (such levels of regularity are encoded by the so-called modulation spaces).

We exploit techniques of Gabor analysis of pseudodifferential operators to prove that the problem of pointwise convergence has a positive answer under the previous assumptions. Precisely, we prove stronger convergence results which imply uniform convergence on compact subsets for the integral kernels in the Trotter formula.

Our results hold for any fixed value of $t \in \mathbb{R}\setminus\mathfrak{E}$, where $\mathfrak{E}$ is a discrete set of exceptional times - in that case the integral kernels are genuine distributions. Even in this case we are able to characterize the properties of such distribution kernels (they are mild distributions) and we derive weaker convergence results in the sense of modulation spaces.

We will also discuss the issue of rates of convergence for such results, obtained with a modification of the Trotter approximate propagators.

This is an invited talk in the session Stochastic methods in quantum theory *organized by* **Sonia Mazzucchi** *and* **Stefania Ugolini**.

Dario Trevisan

Università degli Studi di Pisa

Brascamp-Lieb inequalities for quantum Gaussian systems

The classical Brascamp-Lieb inequalities generalize several functional inequalities at once, such as Hölder integral inequality, Young convolution inequality, Loomis-Whitney inequality, with plenty of applications in analysis, probability and information theory. Carlen, Lieb and Loss first noticed that they can be equivalently formulated in terms of subadditivity inequalities for Shannon differential entropies of random variables. After briefly reviewing these classical facts, in this talk I will discuss their non-commutative counterparts in the setting of quantum Gaussian systems, recently obtained jointly with G. De Palma, via heat semigroup interpolation, as well as some conjectured extensions for their reverse forms, related to non-commutative optimal transport. *arXiv:2105.05627*.

This is an invited talk in the session Inequalities in quantum probability *organized by* **Dario Trevisan**.

Nicola Turchi

Università degli Studi di Milano-Bicocca

The discrepancy between min-max statistics of random matrices

We compute quantitative bounds for measuring the discrepancy between the distribution of two min-max statistics involving either pairs of Gaussian random matrices, or one Gaussian and one Gaussian-subordinated random matrix. In the fully Gaussian setup, our approach allows us to recover quantitative versions of well-known inequalities by Gordon, thus generalising the quantitative version of the Sudakov-Fernique inequality deduced by Chatterjee. On the other hand, the Gaussian-subordinated case yields generalizations of estimates obtained in the framework of the CCK theory. As applications, we establish comparison bounds for order statistics of random vectors and fourth moment bounds for matrices of multiple stochastic Wiener-Itô integrals.

This is an invited talk in the session **Probabilistic approximations via chaotic decompositions** *organized by* **Anna Vidotto**.

Mattia Turra

University of Bonn

A martingale problem for hyperviscous stochastic Navier-Stokes equation

We study a martingale problem for a hyperviscous stochastic Navier-Stokes equation with white noise invariant measure. We prove existence and uniqueness in both the 2-dimensional torus and the whole plane. Uniqueness is obtained via duality with the Kolmogorov backward equation associated with the infinitesimal generator of the martingale solution.
Based on a joint work with Massimiliano Gubinelli.

This is an invited talk in the session **Regularisation by noise and Kolmogorov equations** *organized by* **Luca Scarpa** *and* **Carlo Orrieri**.

Tiziano Vargiolu

Università degli Studi di Padova

Optimal installation of renewable electricity sources: the case of Italy

In this seminar we present results about empirically validation of the theoretical results developed in Koch-Vargiolu (SICON 2021) for the Italian power market. In that paper, it was assumed that a company is a large market player, affecting negatively the electricity price by its irreversible installation of renewable sources: this originates a nontrivial singular control problem, where the free boundary is solution to a suitable ODE. We also extend those results to the case when there are several energy producers in the market. First we study the cooperative situation, where the players aim to maximize the sum of their utilities net their installation cost. Then we analyze the competitive case, where each player aims to maximize its own utility. In the two player case, we are able to explicitly solve the situation with no price impact: differently from the usual cases in literature, where a player usually installs only when the others are not acting, here the solution is that the players install simultaneously all the available capacity as soon as the price is greater than a certain threshold. This result is similar to the one in the cooperative case, but we prove that the threshold in that case is greater than the one in the competitive case.

This is a contributed talk in the session **Stochastic models for energy, management, and environmental issues** *organized by* **Alessandro Calvia** *and* **Katia Colaneri**.

Anna Vidotto

Università degli Studi di Napoli "Federico II"

LASSO estimation for spherical autoregressive processes

In this talk we present a class of spherical functional autoregressive processes in order to introduce and study LASSO (Least Absolute Shrinkage and Selection Operator) type estimators for the corresponding autoregressive kernels, defined in the harmonic domain by means of their spectral decompositions. We show some crucial properties of these estimators, in particular, consistency and oracle inequalities.

This is an invited talk in the session **Probabilistic and statistical properties of sphere-cross-time** *organized by* **Alessia Caponera**.

Stefano Vigogna

Università di Roma "Tor Vergata"

On the bias-variance trade-off in classification: hard margin and exponential convergence

Optimizing the misclassification risk is in general NP-hard. Tractable solvers can be obtained by considering a surrogate regression problem. While convergence to the regression function is typically sublinear, the corresponding classification error can decay much faster. In this talk we analyze such a phenomenon in a general multiclass framework, encompassing general surrogates and common learning models. Reviewing the peculiar structure of the bias-variance trade-off in classification, we show that, under special margin conditions, fast and super fast rates can be achieved. In particular, we exhibit exponentially fast learning without any bias-variance trade-off.

This is an invited talk in the session Mathematics of machine learning *organized by* **Ernesto De Vito** *and* **Lorenzo Rosasco**.

Harriet Walsh

Laboratoire de Physique, ENS de Lyon

Hermitian Schur measures: from quantum mechanics to new asymptotic statistics for random partitions

We consider a class of probability measures on integer partitions which arise not from combinatorics but from certain natural quantum mechanical models. We show that these models can be tuned to have "multicritical" asymptotic edge fluctuations outside of the KPZ universality class, governed by natural higher order generalizations of the Tracy–Widom distribution, and we discuss how this relates to integrable differential equations and to a family of unitary matrix models, which are multicritical in their own way. When tuned in a different way, they exhibit decorrelation, and new asymptotic behavior in the bulk. We discuss a possible combinatorial interpretations for these models involving discretized surfaces, or maps.
Based on joint work with Dan Betea and Jérémie Bouttier.

This is an invited talk in the session Integrable systems and the KPZ universality class *organized by* **Alessandra Occelli**.

Giovanni Zanco

LUISS Guido Carli

Mean-field games with Hölder coefficients and space-time evolution of human capital

We study a mean-field game that arises heuristically as the continuum limit of a system of interacting agents who control their position in space with the goal of maximizing their gain from human capital due to interaction with others. The model has micro- and macro-economic motivations that result in the presence of Hölder coefficients in the equations, making their analysis nontrivial. We provide existence of a solution of the mean-field game in the finite horizon case, as well as numerical simulations of a stationary solution for the infinite horizon problem.

This is an invited talk in the session Advances in stochastic games with applications *organized by* **Tiziano De Angelis** *and* **Giorgio Ferrari**.

Margherita Zanella

Politecnico di Milano

Invariant measures for a stochastic nonlinear and damped 2D Schrödinger equation

We consider a two-dimensional stochastic nonlinear defocusing Schrödinger equation with zero-order linear damping, where the stochastic forcing term is given by a combination of a linear multiplicative noise in Stratonovich form and a nonlinear noise in Itô form. We work at the same time on compact Riemannian manifolds without boundary and on compact smooth domains with either Dirichlet or Neumann boundary conditions. We construct a martingale solution using a modified Faedo-Galerkin's method, then by means of suitable Strichartz estimates we show the pathwise uniqueness of solutions. Finally, we prove the existence of invariant measures by means of a version of the Krylov-Bogoliubov method, which involves the weak topology, as proposed by Maslowski and Seidler. Some remarks on the uniqueness in a particular case are provided as well.

This is an invited talk in the session **SPDEs arising in physical models** *organized by* **Michele Coghi**.

Alexander Zass

WIAS Berlin

Existence of infinite-volume marked Gibbs point processes: a path space example

The motivation for this work comes from seeing a class of infinite-dimensional diffusions under Gibbsian interactions as marked point configurations: the starting points belong to $\mathbb{R}^d$, the marks are the paths of Langevin diffusions, and the interaction between two diffusions is given by the integration of a pair potential along their paths. In this talk, after presenting this example, we use the entropy method to show the existence of an infinite-volume Gibbs point process in a general setting.

This is an invited talk in the session Large scale random structures *organized by* **Gianmarco Bet** *and* **Alessandro Zocca**.

Alessandro Zocca

Vrije Universiteit Amsterdam

Hopping between distant basins: a journey from rare event sampling to global optimization

In this talk I will introduce a new Metropolis-class algorithm, named "skipping sampler". We developed it aiming to improve upon the exploration of the general-purpose random walk Metropolis algorithm when the target has non-convex support A by reusing proposals in A^c which would otherwise be rejected. I will provide theoretical and numerical evidence of improved performance relative to random walk Metropolis. In this talk I will focus on two different applications of this skipping sampler. The first one (and the reason this method was originally developed) is rare event sampling, motivated by reliability analysis for power systems. The second application I will present is in the context of global optimisation. Skipping sampler can indeed be used to augment an existing stochastic optimization algorithm called Basin Hopping (BH). Empirical results on benchmark optimization surfaces demonstrate that BH with skipping (BH-S) very often outperforms vanilla BH by encouraging non-local exploration, that is, by hopping between distant basins.
Based on a joint work with J. Moriarty, J. Vogrinc and M. Goodridge.

This is a contributed talk in the session Semi-Markov dynamics *organized by* **Giacomo Ascione** *and* **Bruno Toaldo**.

Cristina Zucca

Università degli Studi di Torino

Exact simulation of first exit times for one-dimensional diffusion processes

A precise description of the first time a given stochastic process exits from a domain is required in many mathematical applications: it can for instance be related to the evaluation of risk of default in mathematical finance or to the description of spike trains in neuroscience, or in reliability. Unfortunately, in the diffusion framework a simple and explicit expression of the first exit time distribution is not attainable except in a few specific cases. It is therefore challenging to find out how to generate such variates. The usual procedure is to use discretization schemes which unfortunately introduce some error in the target distribution. Our aim is to present an algorithm which simulates exactly the exit time for one-dimensional diffusions. The efficiency of the method is described through theoretical results and numerical examples.

References

1. S. Herrmann and C. Zucca (2020) Exact simulation of first exit times for one-dimensional diffusion processes ESAIM: Mathematical Modelling and Numerical Analysis 54(3), pp. 811-844.
2. S. Herrmann and C. Zucca (2019) Exact Simulation of the First-Passage Time of Diffusions. Journal of Scientific Computing 79(3), pp. 1477-1504.

This is an invited talk in the session **Stochastic processes with applications to the natural sciences** *organized by* **Giuseppe D'Onofrio**.

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