

Topics for Master Theses 2025

I am offering Master thesis projects from various areas of stochastics, including in particular stochastic analysis, convergence of Markov processes, couplings, functional inequalities, Markov Chain Monte Carlo methods, probability and statistics in high dimension. Please contact me to discuss details if you are interested.

To give you some impression, you find below an incomplete list of recent research papers from various topics that I am interested in. Each of these could possibly form a basis for a Master thesis project.

a) Stochastic analysis and Markov processes

- **Brownian and Langevin transport maps**
 - Mikulincer, Shenfeld: The Brownian transport map
 - Conforti, Eichinger: A coupling approach to Lipschitz transport maps
- **Mixing times**
 - Salez: Cutoff for non-negatively curved diffusions
 - Blanca, Caputo, Chen, Parisi, Stefankovic, Vigoda: On mixing of Markov chains: Coupling, spectral independence and entropy factorization
 - Chen, Eldan: Localization schemes
 - Caputo, Labbé, Lacoïn: Spectral gap and cutoff for Gibbs sampler of nabla phi interfaces
 - Goel, Montenegro, Tetali: Mixing time bounds via the spectral profile
- **Hypocoercivity**
 - Bedrossian, Blumenthal, Punshon-Smith: Regularity method for lower bounds on Lyapunov exponents of SDEs
 - Bedrossian, Liss: Stationary measures for SDEs with degenerate damping
 - Albritton Beekie, Novack: Enhanced dissipation and Hörmander's hypoellipticity
 - Park: A variational perspective on the dissipative Hamiltonian structure of the Vlasov Fokker-Planck equation
- **Self-repelling diffusions, KPZ equation**
 - Toth, Werner: The true self-repelling motion
 - Beanim, Gauthier: Self-repelling diffusions
 - Adihkari, Chatterjee: An invariance principle for the 1D KPZ equation
- **Random dynamical systems, incompressible flows**
 - Blumenthal, Coti-Zelati, Gvalani: Exponential mixing for Random dynamical systems and an example of Pierrehumbert
 - Bedrossian, Blumenthal, Callis, Liss: Existence of stationary measures for partially damped SDEs with Euler type nonlinearities
- **Mean-field systems and nonlinear SDE**
 - Lacker: Hierarchies, entropy and quantitative propagation of chaos
 - Lacker, Le Flem: Sharp uniform in time propagation of chaos
 - Delgadino, Gvalani, Pavliotis, Smith: Phase transitions, LSI and uniform in time propagation of chaos
 - Hammersley, Siska, Szpruch: McKean-Vlasov SDEs under measure dependent Lyapunov conditions
 - Al Rachid, Bossy, Ricci, Szpruch: New particle representations for McKean Vlasov SDE

b) Sampling, filtering, optimization and learning

- **Markov Chain Monte Carlo in high dimension**
 - Robnik, Cohn-Gordon, Seljak: Metropolis-adjusted microcanonical Hamiltonian Monte Carlo
 - Lee, Vempala: Convergence rate of Riemannian Hamiltonian Monte Carlo and faster

- volume computation
- Chen, Chewi, Salim, Wibisono: Improved analysis for a proximal algorithm for sampling
- Qin, Wang: Spectral telescope: Convergence rate bounds for Gibbs samplers based on a hierarchical structure
- Ma, Chatterji, Cheng, Flammarion, Bartlett, Jordan: Is there an analog of Nesterov acceleration for MCMC?
- Goodman, Weare: Ensemble samplers with affine invariance
- Bierkens, Grazi, van der Meulen, Schauer: Sticky PDMP samplers for sparse inference
- **Multimodal sampling**
 - Koehler, Lee, Vuong: Efficiently learning and sampling multimodal distributions
 - Chehab, Korba, Stromme, Vacher: Provable convergence and limitations of geometric tempering for Langevin dynamics
 - Albergo, vanden Eijnden: NETS: A non-equilibrium transport sampler
 - Dupuis, Wu: Analysis and optimization of certain parallel MC methods in low temperature limit
- **Mixing times in statistical mechanics models**
 - Huang, Mohanty, Rajaraman, Wu: Weak Poincaré inequalities, simulated annealing and sampling from spherical spin glasses
 - El Alaoui, Montanari, Sellke: Sampling from mean-field Gibbs measures via diffusion processes
 - Bertini, Giacomin, Poquet: Synchronization and random long-time dynamics for mean field planar rotators
 - Bresler, Nagaraj, Nichani: Metastable Mixing of Markov Chains: Efficiently Sampling Low Temperature Exponential Random Graphs
 - Ding, Lubetzky, Peres: The mixing time evolution of Glauber dynamics for the mean-field Ising model
 - Ben Arous, Jagganath: Spectral gap estimates in mean field spin glasses
 - Blanca, Sinclair, Zhang: Critical mean field Chayes Machta dynamics
 - Chen, Liu, Vigoda: Optimal mixing of Glauber dynamics
- **Nonlinear filtering**
 - Ertl, Stannat: Analysis of ensemble Kalman Bucy filter
 - De Wiljes, Reich, Stannat: Long-time stability and accuracy of ensemble Kalman-Bucy filter
 - Stannat: Stability of the optimal filter
 - Kim, Taghvaei, Mehta, Meyn: Duality for nonlinear filtering
 - Kim, Mehta, Meyn: Conditional Poincaré for filter stability
 - Pathiraja, Reich, Stannat: McKean-Vlasov SDEs in nonlinear filtering
- **Fluctuation-dissipation theorem and sensitivity analysis**
 - Dembo, Deuschel: Markovian perturbation, response and fluctuation-dissipation
 - Roussel, Stoltz: A perturbative approach to control variates in molecular dynamics
 - Assarif, Jourdain, Lelièvre, Roux: Computation of sensitivities for the invariant measure of a parameter dependent diffusion
 - Pavliotis: Stochastic processes, last chapter

c) Other papers of interest

- Lee, Vempala: Eldan's stochastic localization and the KLS conjecture
- Rigollet, Stromme: Sample complexity of entropic optimal transport
- Dizdar, Menz, Otto, Wu: Quantitative hydrodynamic limit of Kawasaki dynamics
- Cortez, Fontbana: Quantitative uniform propagation of chaos for Maxwell molecules
- Chafai, Ferré, Stoltz: Coulomb gases under constraints
- Legoll, Lelièvre, Sharma: Effective dynamics for non-reversible SDE

- Barp, Takao, Betancourt, Arnaudon, Girolami: A unifying and canonical description of measure-preserving diffusions