

NUMERICAL METHODS FOR HIGH-DIMENSIONAL FOKKER–PLANCK EQUATIONS AND MEAN-FIELD GAMES

OLGA MULA* AND AHMAD ZORKOT†

*University of Vienna
Faculty of Mathematics
olga.mula.hernandez@univie.ac.at

†University of Vienna
Faculty of Mathematics
ahmad.zorkot@univie.ac.at

ABSTRACT

Fokker–Planck (FP) equations describe the evolution of probability densities under stochastic dynamics, while Mean-Field Games (MFGs) couple such equations with backward Hamilton–Jacobi–Bellman equations to characterize equilibria in large populations of interacting agents. Their numerical approximation becomes particularly challenging in high dimensions, where conventional grid-based discretizations suffer from the curse of dimensionality. At the same time, developing accurate higher-order schemes is essential for resolving the underlying dynamics efficiently. A central challenge is therefore to combine the accuracy of high-order numerical methods with scalable representations that exploit the structure of high-dimensional problems.

This mini-symposium aims to explore the interplay between high-order discretizations, structured approximation techniques, and efficient numerical algorithms for FP equations and MFGs. Particular emphasis will be placed on higher-order semi-Lagrangian schemes combined with low-rank tensor representations, adaptive Gaussian-based time integration, and accurate approximations on low-dimensional manifolds. Additional perspectives include higher-order quadrature, derivative-enhanced neural approximations, data-dependent density estimation, and variational schemes based on optimal transport and Wasserstein gradient flows. These approaches raise important questions concerning approximation accuracy, temporal and spatial convergence, stability, preservation of geometric and probabilistic structures, and computational complexity as the dimension increases.

By bringing together researchers working on these complementary approaches, the mini-symposium will highlight existing developments in high-order numerical ap-

proximation and identify opportunities for extending higher-order accuracy to scalable methods for high-dimensional FP equations and MFGs. A central objective is to establish stronger connections between the communities working on spectral and high-order methods, high-dimensional approximation, optimal transport, and mean-field games.

Corresponding Organizer: Ahmad Zorkot

Co-organizer: Olga Mula

SPEAKERS

1. Isabella Carla Gonnella (SISSA, Italy) : A Dynamical Approximation Scheme on the Stiefel manifold for Wasserstein Gradient Flows.
2. Anastasiia Hraivoronska (Université Claude Bernard Lyon 1, France) : JKO-based numerical schemes.
3. Max Jensen (University College London, United Kingdom) : Data-dependent density estimation for the Fokker-Planck equation in higher dimensions.
4. Tianyu Jin (RWTH Aachen University, Germany) : An Adaptive Gaussian-Based Time Integrator for Fokker-Planck Equations.
5. Dante Kalise (Imperial College London, United Kingdom) : Hessian-augmented Supervised Learning for Hamilton-Jacobi-Bellman PDEs.
6. Wuchen Li (University of South Carolina, USA) : Accelerated attention blocks via Inertial Dynamics on Density Manifolds.
7. Luca Saluzzi (University of Ferrara, Italy): Tensor-Train-Based Semi-Lagrangian Schemes for High-Dimensional Mean Field Games.
8. Xianjin Yang (CUHK-Shenzhen, China) : Numerical Methods for High-Dimensional Mean Field Games.