Projet de Master proposals

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1 Invariant measure approximation

Goal. Investigate (and propose) methods for the approximation of nontrivial invariant measures of chaotic ODEs (and SDEs).
Literature research. What is the state of the art for ODEs? Covering-based methods (e.g., Dellnitz et al. 1997) with Galerkin approximation of Frobenius-Perron operator are expensive (and old).
First research question. Random time-stepping (AA & GG, work in progress) or additive noise (Conrad et al. 2016) on Runge-Kutta could be useful? Comparison with fully Bayesian approach (e.g., Kersting and Hennig 2017).

2 Adaptive random time-stepping for stiff equations

Goal. Propose an adaptive time-stepping technique combined with RTS-RK for stiff equations with non-trivial invariant measures (or chaotic behavior).

3 Probabilistic FEM for PDEs

Goal. Investigate random meshing (AA & GG, work in progress) vs. basis functions perturbations (Conrad et al. 2016) and fully Bayesian meshless methods (Cockayne et al. 2017).
Coding challenge. Find conditions on mesh perturbations in d-dimensional domains and implement modifications on matrix and RHS assemblers.
First research question. Performance in the approximation of forward problem using random meshing vs. basis functions perturbations vs. meshless methods. Convergence and stability analysis for random meshing in the d-dimensional case.
Second research question. After a study of Bayesian inverse problems, test unknown parameters estimation with the different proposed methods. How to quantify the convergence of the posterior distribution? Analysis of different MCMC techniques and post-processing.