Proposition de thèse de doctorat

Début : 2017-2018

Titre de la thèse : Uncertainty quantification methods for models described by stochastic differential equations or partial differential equations with a probabilistic interpretation

Laboratoire : GeM UMR 6183

Equipe : Modélisation et Simulation

Localisation de la thèse : Nantes

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Description du sujet

Stochastic differential equations (SDEs) driven by white noise are encountered in many fields such as mechanics, physics, biology, finance… Numerical methods for uncertainty quantification and model order reduction methods have been extensively developed for models driven by algebraic equations, ordinary differential equations (ODEs) or partial differential equations (PDEs), but only a very few works have been devoted to models described by SDEs.

The objective of this thesis is twofold. On one side, we want to propose new numerical approaches for the quantification of uncertainties for models described by SDEs, based on recent advances on tensor methods for high-dimensional approximation. On the other side, for models described by PDEs with a probabilistic interpretation, whose solution can be expressed as some functional of the solution of an SDE, we want to develop sample-based approaches for the approximation of high-dimensional PDEs using numerical methods for SDEs, possibly taking into account the quantities of interest. This approach will be extended to the case of PDEs with uncertain parameters and will constitute an alternative to standard model order reduction methods for parameter-dependent PDEs. This thesis of the project aims at revisiting the practice of computational engineering with new methods allowing a massive use of parallel architectures, and a straightforward integration of the objectives of the numerical simulation.

[CD15] Albert Cohen and Ronald DeVore. Approximation of high-dimensional parametric pdes. Acta Numerica, 24:1-159, 2015.
[Gob16] Emmanuel Gobet. Monte-carlo methods and stochastic processes: from linear to non-linear. 2016.
[Hac12] W. Hackbusch. Tensor spaces and numerical tensor calculus, volume 42 of Springer series in computational mathematics. Springer, Heidelberg, 2012.
[BCOW16] P. Benner, A. Cohen, M. Ohlberger, and K. Willcox (eds.), Model Reduction and Approximation: Theory and Algorithms. SIAM, Philadelphia, PA, 2016.

Compétences requises

Mathématiques appliquées, Calcul scientifique, outils probabilistes et méthodes statistiques.

Commentaires Supplémentaires
Co-direction avec Clémentine Prieur, Professeur au laboratoire Jean Kuntzmann, Université Grenoble Alpes.