MSc thesis project

"Uncertainty quantification in Stochastic Differential Equations" (MSIAM)

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Phd forseen: A PhD in relation with the Master internship can be discussed.

Project objectives and required competences:

In this project we aim at exploring the question of uncertainty quantification in models based on Stochastic Differential Equations (SDE).

Uncertainty analysis aims to understand the impact of input variables or noise on these input variables on the output of any kind of system. Concerning dynamical systems uncertainty analysis for Partial Differential Equations (PDE) has been the subject of several papers in the past years: for example one aims at quantifying the sensitivity of the solution of the PDE (or of an observation of the solution) to the random pertubation of a coefficient of this PDE. To this purpose Monte Carlo methods are used, combined with model reduction techniques in order to get faster but information preserving computations (see for example [JNC14]).

Concerning uncertainty analysis for SDE however the literature is far less developed. The recent paper [LMK15] points out that model reduction still makes sense for uncertainty quantification in SDE: the authors use a proper Polynomial Chaos (PS) analysis of SDE driven by Wiener noise, that allows to identify the modes of the SDE that are the most relevant for uncertainty quantification. But so far, the link between uncertainty quantification for SDE and PDE has not been studied. Yet, the link between SDE and PDE is well known via Feynman-Kac formulae. These are examples of questions that could be investigated during this project.

Prerequisite are the Msc courses "Stochastic Calculus and Applications to Finance" and "Stochastic approaches for uncertainty quantification". Some knowledge of scientific computing is suitable (R and/or Matlab, C/C++...).

References

[LMK15] O.P. Le Maître, and O.M. Knio. *PC analysis of stochastic differential equations driven by Wiener noise.* Reliability Engineering and System Safety, 2015, pp 107-124.

[JNC14] A. Janon, M. Nodet, C. Prieur, *Uncertainties assessment in global sensitivity indices estimation from metamodels.* International Journal for Uncertainty Quantification 4 (2014), no. 1, pages 21-36.