Statistical methodology for second level sensitivity analysis for numerical simulators

A. Meynaoui
CEA, DEN, DER

Supervisor(s): B. Laurent-Bonneau (INSA Toulouse) and A. Marrel (CEA)

Ph.D. expected duration: Oct. 2016 - Sep. 2019

Adress: CEA Cadarache, F-13108, Saint-Paul-lez-Durance, France

Email: anouar.meynaoui@cea.fr

Abstract:

Many physical phenomena are modeled by numerical simulators, which take several uncertain parameters as inputs and can be time expensive. Global sensitivity analyses are then performed to evaluate how the input uncertainties contribute to the variation of the code output. For this, we focus here on dependence measures based on reproducing kernel Hilbert spaces (HSIC). In some cases, the distributions of the inputs may be themselves uncertain and it is important to quantify the impact of this uncertainty on global sensitivity analysis results. We call it the second-level sensitivity analysis. To achieve this, we propose a statistical methodology based on a single Monte Carlo loop:

- First, we draw a unique sample S built from a unique (suitably chosen as a reference) probability distribution of the inputs and the computation of corresponding code outputs.
- Then, for various probability distributions of the input parameters, we perform a global sensitivity analysis: HSIC are computed from sample S and using modified estimators.
- Finally, we realize the 2^{nd}-level sensitivity analysis by estimating 2^{nd}-level HSIC between the probability distributions of the inputs and the results of global sensitivity analysis. For this, specific kernels are chosen.

We apply this methodology on an analytical example to evaluate the performances of our procedures and illustrate how it allows for an efficient 2^{nd}-level sensitivity analysis with very few computer experiments.

Short biography – After a master's degree in mathematics in Toulouse, Anouar Meynaoui began his PhD in october 2016 with INSA Toulouse and the comissariat à l'énergie atomique. This PhD thesis is funded by the CEA, and its objective is to propose new statistical methods for sensitivity analysis.