

Research project offer



Location : ISAE SUPAERO, Toulouse, France

Department : DISC

Research group : MA

Supervisor : Florian SIMATOS

Email : florian.simatos@isae.fr

OFFER DESCRIPTION

Title : Uncertainty propagation and sensitivity analysis with random and dependent hyperparameters

Proposed duration and period : 6 months, march – june 2022

Context
(max 10 lines)

Many physical systems can be modeled by a relation $Y = \varphi(X)$ where the multidimensional input X is random. Uncertainty quantification consists in modeling and propagating the input uncertainty via the numerical model φ in order to estimate a quantity of interest on Y , such as a failure probability. Usually, X is modeled by a random vector with a known probability density and the uncertainty propagation is done with Monte-Carlo methods.

Objectives and work
(max 20 lines)

The goal of this internship is to investigate the case where X 's distribution is unknown, for instance because of epistemic uncertainty on its distribution parameters: this is a case with a double layer of randomness, and the goal is to assess how this double uncertainty affects the estimation of the quantity of interest. We will be particularly interested in the case where X 's coordinates are dependent, and dependent of the hyperparameters, which is typically the case if X 's distribution is first estimated from a correlated sample. Three main questions will be investigated: 1/ how to model this double layer of randomness with dependency? The bayesian framework seems promising [1], but other methods could consist in p-boxes [2]. 2/ How to propagate this double-layer uncertainty to estimate a quantity of interest? And 3/ how to perform a sensitivity analysis in this context? For the last question we will in particular consider Shapley indices [3].

[1] V. Chabridon. Analyse de sensibilité fiabiliste avec prise en compte d'incertitudes sur le modèle probabiliste - Application aux systèmes aérospatiaux. 2018. Thèse de doctorat de l'Université Clermont Auvergne.

[2] R. Schöbi, B. Sudret. Structural reliability analysis for p-boxes using multi-level meta-models. Probabilistic Engineering Mechanics, 48, 27-38, 2017.

[3] A. B. Owen, C. Prieur. On Shapley value for measuring importance of dependent inputs. SIAM/ASA Journal on Uncertainty Quantification, 5(1), 986-1002, 2017.

Illustration(s) / picture(s)

Possibility to continue with a PhD (Yes/No) : Yes

REQUIRED APPLICANT PROFILE AND SKILLS

Study level
(tick possible choices)

Undergraduate students (3rd or 4th year)
 Master students (1st or 2nd year)
 PhD students

Required skills

Applied mathematics; statistics; Monte Carlo methods

