Estimation of rare events probability and quantiles under monotonicity constraints

V. Moutoussamy
Université Toulouse Paul Sabatier

Affiliation: *EDF R&D - MRI*, 6 quai Watier, 78400 Chatou, France

Email: vincent.moutoussamy@edf.fr – **URL**: http://www.univ-tlse3.fr/

Master: Université Paris Descartes

Ph.D. (2012-2015): Université Toulouse Paul Sabatier

Supervisor(s): Prof. F. Gamboa (Université Toulouse Paul Sabatier) and Prof. T. Klein (Université Toulouse Paul Sabatier) and Dr. N. Bousquet (EDF)

Abstract:

A common task in structural reliability studies is to use a numerical computer code which simulates the physical behavior of a component. That computer code depends of inputs which represent some physical situation, an event is said undesirable if a function of an output is higher than a fixed threshold. The input parameters of the computer code can be uncertain, thus they are represented by random variables, so then the output become random. We are interested in the estimation of the probability that the computer code exceed the threshold. Here, the code is considered as black-box, deterministic (a set of input gives always the same output), time consuming and can be discontinous, so classical method to estimate probabilities are not adapted.

The knowledge of the component gives structural informations, here assumes that numerical code is monotonic. That allows us obtain deterministic bounds of the probability and delimits a set of input where it is not necessary to make new calls of the numerical code. To accelerate the convergence of these deterministic bounds, theoretical results shows that standard Monte Carlo method is not efficient. One propose here a general strategy to construct optimal design of experiment based on a sequential sampling, and construct a statistical estimator associated to the bounds.

As in the estimation of probability, the monotonic hypothesis provide information for the estimation of quantile. One propose a geometrical method to get deterministic bounds for quantile. Knowing a probability, that method is based on the construction of two sets which the volume is respectively lower and greater than the known probability. These bounds can be obtain from a given design of experiments or can be construct by a sequantial sampling.

We will compare classical methods dedicated to estimation of probability without monotonic hypothesis and their adaptation with monotonic assumption.

Short biography – During the previous year of the beginning of my thesis, I have worked on the development of that new class of method based on monotonic hypothesis for my final year internship. That thesis is a partnership between EDF and the University Toulouse Paul Sabatier and takes place on structural reliability of some passive components of an energy production unit.