# Rare event probability estimation in the presence of epistemic uncertainty

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**Abstract**

The accurate estimation of rare event probabilities is a crucial problem in engineering to characterize the reliability of complex systems. Several methods such as Importance Sampling or Subset Sampling have been proposed to perform the estimation of such events more accurately (i.e. with a lower variance) than crude Monte-Carlo method. However, these methods often do not take into account epistemic uncertainty either on the probability distributions of the input variables either on the limit state function modeling. Aleatory uncertainties are usually described through probabilistic formalism and epistemic uncertainties with using intervals. Such problems typically induce intricate optimization and numerous probability estimations in order to determine the upper and lower bounds of the probability estimate. The calculation of these bounds is often numerically intractable for rare event probability, due to the high computational cost required. In this presentation, two methodologies are described in order to handle both types of uncertainty with reduced simulation budget. These methods combine rare event simulation algorithms (Importance Sampling and Subset Simulation), Kriging-based surrogate model of the simulation code, and optimization process. To reduce the simulation cost, dedicated refinement strategies of the surrogate model are proposed taking into account the presence of both aleatory and epistemic uncertainties. The efficiency of the proposed approaches, in terms of accuracy of the found results and computational cost, is assessed on academic and launch vehicle stage fallout test cases.

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