Research project offer

Location : ISAE SUPAERO, Toulouse, France **Department** : Department of Complex Systems Engineering (DISC) **Research group** : MA **Supervisor** : Florian Simatos and Jérôme Morio **Email** : florian.simatos@isae.fr and jerome.morio@onera.fr	
OFFER DESCRIPTION	
Title : Optimal projection for high-dimensional importance sampling **Proposed duration and period** : 5-6 months, starting in April	
Context (max 10 lines)	The method of importance sampling consists of estimating an expectation $m = E(\psi(X))$ with X of law f, using a sample drawn from of another law, called auxiliary law, and then estimating the sought-after mean by incorporating likelihood ratios. If the auxiliary is chosen appropriately, then the importance sampling estimator can have a much lower variance than the naive Monte-Carlo estimator. However, importance sampling methods are known to behave poorly in high dimension, and the goal of this project is to study adaptations of the importance sampling scheme that have good performance in high dimension.
Objectives and work (max 20 lines)	For that, the goal will be to study a projection method that was recently proposed in [1]: the idea is to reduce the effective dimension of the parameter space by projecting on a suitable lower-dimensional space. In [1], the authors identified an optimal subspace on which to project, which is the subspace spanned by the eigenvectors associated to the extreme (smallest or largest) eigenvalues of some covariance matrix. However, this theoretical result faces numerical problems, namely in estimating efficiently these eigenvectors. The goal of the project will thus be to review the literature on estimation of eigenvectors, for instance [2], and try to implement these methods in the importance sampling scheme suggested in [1] in order to lead to an efficient estimation scheme in high dimension. [1] M. El Masri, J. Morio and F. Simatos, Optimal projection to improve parametric importance sampling in high dimension. arX)) avec X deiv preprint arX)) avec X deiv:2107.06091, 2021. [2] O. Ledoit and M. Wolf, A well-conditioned estimator for large-dimensional covariance matrices. Journal of multivariate analysis, 2004.

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 profile and skills	
Other useful information	