Global sensitivity analysis for optimization with variable selection

A. Spagnol
Ecole des Mines de Saint-Etienne / Safran Tech

Supervisor(s): R. Le Riche (CNRS / Ecole des Mines de Saint-Etienne), S. Da Veiga (Safran Tech) and O. Roustant (Ecole des Mines de Saint-Etienne / CNRS)

Ph.D. expected duration: Feb. 2017 - Jan. 2020

Adress: Safran Tech, 1 Rue Genevieve Aube, 78114 Magny-les-Hameaux

Email: adrien.spagnol@safrangroup.com

Abstract:

The optimization of high dimensional functions is a key issue in engineering problems but it often comes at a cost that is not acceptable since it usually involves a complex and expensive computer code. In practive, engineers usually overcome this limitation by first identifying which parameters drive the most the function variations: non-influential variabes are set to a fixed value and the optimization procedure is then carried out with the remaining influential variables only [2]. However, such variable selection is performed through influence measures typically designed for regression problems, and does not account for the specific structure of an optimization problem. Ideally, we would like to identify which variables have an impact on constraints satisfaction and lead to low values of the objective function.

In this paper, we propose a new sensitivity analysis that incorporates the specifics aspects of optimization problems. In particular, we introduce an influence measure based on the Hilbert-Schmidt Independence Criterion [1] to characterize whether a design variable matters to reach low values of the objective function and to satisfy the constraints. This measure makes it possible to sort the inputs and reduce the problem dimension. We estimate the sensitivity for optimization measure from a design of experiments and propose a random and a greedy strategies to set the values of the non-influential variables before conducting a local optimization. We apply our methods to several test-cases from common optimization benchmarks. Our results show how variable selection for optimization and the greedy strategy can significantly reduce the number of function evaluations while still attaining satisfying minima.

References

[1] Arthur Gretton, Olivier Bousquet, Alex Smola, and Bernhard Schölkopf. Measuring statistical dependence with hilbert-schmidt norms. In *International conference on algorithmic learning theory*, pages 63–77. Springer, 2005.

[2] Songqing Shan and G Gary Wang. Survey of modeling and optimization strategies to solve high-dimensional design problems with computationally-expensive black-box functions. *Structural and Multidisciplinary Optimization*, 41(2):219–241, 2010.

Short biography – Adrien Spagnol is a first-year PhD student in applied mathematics at Safran Tech, in collaboration with the Ecole des Mines de Saint-Etienne. He received a master's degree in

structural and mechanical engineering from the French Institute of Mechanics in Clermont-Ferrand (France).