Global sensitivity analysis for optimization with variable selection

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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 practice, engineers usually overcome this limitation by first identifying which parameters drive the most the function variations: non-influential variables are set to a fixed value and the optimization procedure is then carried out with the remaining influential variables only [1]. 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 specific aspects of optimization problems. In particular, we introduce an influence measure based on the Hilbert-Schmidt Independence Criterion to characterize [2] 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

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