Robust optimization based on quantile minimization

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Context

Robust optimization strategies typically aim at minimizing some statistics of the uncertain objective function and can be expensive to solve when the statistic is costly to estimate at each design point. Surrogate models of the uncertain objective function can be used to reduce this computational cost. However, such surrogate approaches classically require a low-dimensional parametrization of the uncertainties, limiting their applicability. We concentrate here on the minimization of the quantile and the direct construction of a quantile regression model over the design space (see [1] for more details and Fig.1 for an illustration), from a limited number of training samples.

Objective

Previous works [2,3] mainly focused on the generalization of the quantile regression to another type of representation, for instance, substituting the RBF approximation (used in [1]) with a Gaussian process.

The objective of this work is to develop efficient infilling procedures for optimization favoring for instance points with higher potential in being optimal or in reducing the regression error in areas of interest. Secondly, the method should be assessed in more challenging problems in terms of the number of dimensions.

This work will be held in the Platon Team at CMAP-X. It will be supervised by P.M. Congedo, and O. Le Maître.

For further details, please contact P.M. Congedo or O. Le Maître (pietro.congedo@inria.fr, Olivier.le-maitre@polytechnique.edu).

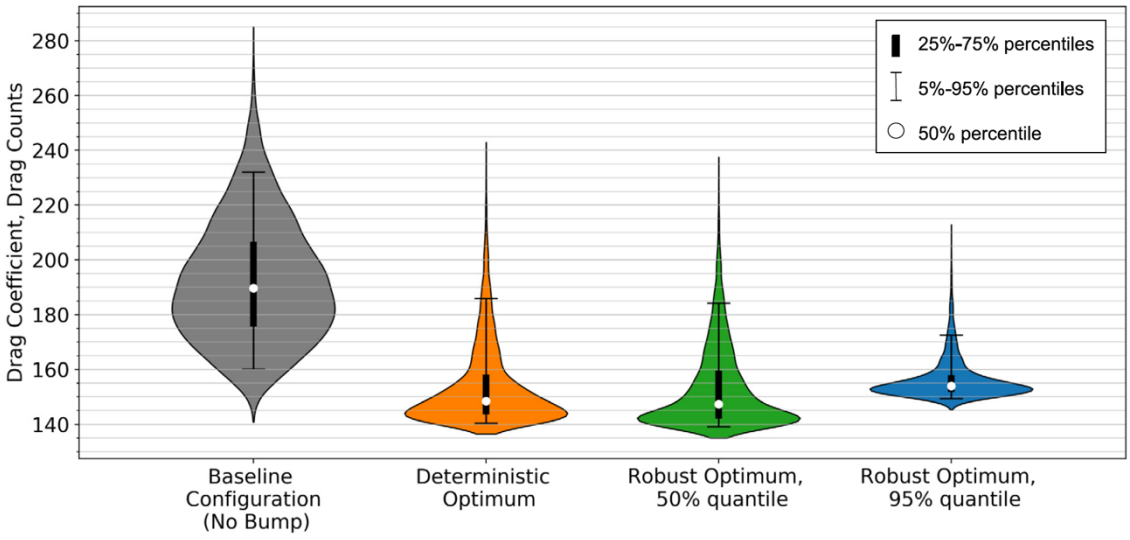

Figure 1 : Drag distributions due to geometrical and operational uncertainties and for different airfoils..

References

[1] Christian Sabater, Olivier Le Maître, Pietro Marco Congedo, and Stefan Görtz. A bayesian approach for quantile optimization problems with high-dimensional uncertainty sources. Computer Methods in Applied Mechanics and Engineering, 376 :113632, 2021.

[2] Théo Bourdais, Régression de quantile. Stage de recherche, Ecole Polytechnique, 2020.

[3] Mao Sicheng, Quantile regression with Gaussian process model. Stage de Recherche, Ecole Polytechnique 2022.