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MULTIFIDELITY OPTIMIZATION UNDER UNCERTAINTY FOR A SCRAMJET INSPIRED PROBLEM

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With the addition of uncertainty analysis in almost every field of engineering there is now also a need to optimize under the influence of stochastic parameters. This stochastic optimization problem extends the classical deterministic problem by random parameters. They could for example model limited accuracy in measurement data or may reflect a lack of knowledge about model parameters. A general approach to tackle such problems is to reformulate the problem where optimizing measures of robustness or risk are used. The idea is to find solutions which are robust despite underlying uncertainty in the parameters.

SNOWPAC (Stochastic Nonlinear Optimization With Path-Augmented Constraints) [1] is a method for stochastic nonlinear constrained derivative-free optimization and developed to treat such kind of problems. For this, it extends the path-augmented constraints framework introduced by the deterministic optimization method NOWPAC and uses a noise-adapted trust region approach and Gaussian processes for noise reduction.

In recent developments, SNOWPAC is now available in the DAKOTA framework [3], which offers a highly flexible interface to couple the optimizer with different sampling strategies or surrogate models. In this presentation we display details of SNOWPAC and demonstrate the coupling with DAKOTA. Finally, we showcase the approach by presenting design optimization results of a shape in a 2D supersonic duct and of a highly sophisticated scramjet application. Here, we compare deterministic results with results obtained by introducing uncertainty on inflow parameters. As sampling strategies we compare classical Monte Carlo sampling with more sophisticated multilevel and multifidelity Monte Carlo approaches [2]. Here, DAKOTA serves as the driver of the optimization process, employing SNOWPAC as optimization method on the black box problem. We show that all approaches show a reasonable optimization of the design over the objective while maintaining or seeking feasibility. Furthermore, we see a gain with respect to computational cost by using multilevel approaches, thereby combining solutions from different grid resolutions compared to classical Monte Carlo sampling.

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