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Adaptive Sub-Space Metamodel Building for Large-Scale MDO Problems with Disparate Discipline Attributes

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Abstract

In a multi-disciplinary optimization problem, different disciplines often depend on different subsets of the total design variable space. An approach to building such discipline-related metamodels in their own sub-spaces while running the optimization problem in the full design variable space has been proposed. These results in reduction of the computational budget required for building these metamodels.

In its simplest form this approach relies on the designer's ability to make reasonable assumptions on the selection of subsets of the design variables for each response function in the problem. If such assumptions are incorrect, approximation errors will be introduced that are impossible to reduce by increasing the computational budget, i.e. additional sampling. Therefore it is important to enable the algorithm to recover from a possibly erroneous partitioning of the design variable space into the discipline subspaces.

Two approaches have been proposed:

- The first approach adaptively accounts for incorrect assumptions by updating the values of the eliminated variables (that remain present in the full space) in each iteration of trust region-based optimization.
- The second is a fully automatic approach which makes use of the Tu-Jones variable screening approach. In each iteration of the trust-region based optimization, the previously evaluated designs are used to determine the dimensionality of the response produced by each model, and eliminate insignificant variables.

This technique is demonstrated by an analytical example and an example with FE models of different complexity.