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Optimization-based methods for effecting multidisciplinary simulation and optimization

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Abstract

Engineers and scientists faced with solving multidisciplinary simulation problems often have in hand unidisciplinary simulation codes that represent years of developmental effort. Understandably, they would like to use these codes for multidisciplinary simulations but, due to the complexity of the codes involved, are reluctant to make significant changes to the existing codes. We discuss an optimization-based approach to solving multidisciplinary simulation problems which essentially allows for the use of the unidisciplinary codes as black boxes. One advantage of the optimization-based approach is that the coupling between the codes can be tailored to those codes. For example, if coupling occurs at interface boundaries between the disciplinary domains, full advantage can be taken of the built-in boundary conditions in each unidisciplinary code.

Of course, multidisciplinary optimization problems yield additional challenges. For example, one again may have available complex, unidisciplinary simulation codes, but the development of the adjoint or sensitivity codes necessary for gradient-based and other optimization approaches may not be practical. We show how one can turn such problems into multi-objective optimization problems wherein one has the twin goals of extremizing the functional (or functionals) that are part of the given optimization problem and also the functional invoked to effect the coupling between the unidisciplinary simulation codes. How to do this all efficiently, including the use of reduced-order modeling, will be part of the presentation.