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Tradeoff exploration in decomposition-based optimization

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Abstract

In multidisciplinary design, the approaches based on decomposition formally describe the design tasks by means of interconnected optimization (sub)problems, each presenting objective and constraint functions specific to different disciplines or subsystems. The presence of multiple objectives implies that tradeoffs must be taken into account during the design process, which, in engineering design, has been addressed through the concept of Pareto optimality. Although a number of numerical methods have been developed for computing Pareto solutions in applied fields, such a concept has not been extensively investigated when applied to decomposition schemes for large-scale problems.

This paper responds to the need of understanding the impact of multicriteria decision making techniques on distributed multidisciplinary optimization. To rely on Lagrangian duality, that proved to be effective for subproblem coordination in the single objective case, scalarization techniques such as the weighted-sum method, e-constraint method, and Chebyshev-norm method, are considered in this paper. Scalarized optimization subproblems are properly formulated and a solution algorithm for computing Pareto designs, whose convergence is proven based on pre-existing results, is demonstrated on a numerical example, showing that subproblem negotiation is the mechanism that allows tradeoff exploration and the computation of Pareto designs for the overall system.

Keywords: Multidisciplinary optimization, multiobjective optimization, Lagrangian relaxation, Pareto design.