Separating Product Design Optimization

Optimization

Designers use optimization techniques to determine values for design variables to optimize an objective function while satisfying performance requirements and other constraints.

Decomposition

The difficulty of solving large scale optimization problems has motivated various decomposition approaches, but many of these methods require multiple iterations to converge to a feasible, optimal solution, which leads to extensive effort in some cases.

Separation

Our approach, which we call separation, replaces a large design optimization problem with a set of subproblems, solves each subproblem once, and produces a feasible solution without iterative cycles. An exact separation finds an optimal solution to the original problem. Approximate separations find near-optimal solutions.

Profit Maximization without Competition

We considered different separations of the profit maximization problem for an universal electric motor and compared to the solution found from an all-at-once formulation. We found that maximizing customer satisfaction leads to better solutions that optimizing mass or efficiency.

Profit Maximization under Competition

We modeled the problem of designing an universal electric motor as a mixed motive game in which each manufacturer makes independent product design and pricing decisions. We found an exact separation with three subproblems that yield the optimal product design and price.

Product Family Design under Competition

We modeled the problem of designing a family of universal electric motors (with ten different torques) as a zero sum game. We compared different separations and found that a separation that maximized total utility yielded a near-optimal product family.