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Generating strong cuts for nonlinear programs by lifting inequalities

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Abstract

In this talk, we propose lifting techniques for generating strong globally-valid inequalities for nonlinear programs. Lifting is studied as the process that extends affine minorants of a function restricted to an affine subspace into affine minorants of the unrestricted function. This view of lifting allows us to extend its applicability to nonlinear programming problems and provides numerous geometric insights. In particular, it reveals short proofs of earlier results in mixed-integer programming. We then identify sufficient conditions that allow sequence independent lifting in nonlinear programming by studying convex extensions of related value functions. These conditions reduce to the classical superadditive lifting theory in the case of integer programs. We illustrate the use of sequence independent lifting in nonlinear programming by deriving exponential families of facet-defining inequalities for a mixed-integer bilinear knapsack set that also has a mixed-integer programming reformulation. More specifically, we show that the derived inequalities lie strictly inside an appropriately defined aggregation-tightening closure which is, in turn, tighter than most commonly studied elementary closures of the mixed-integer programming reformulation.

Join work with Jean-Philippe P. Richard (*Industrial Engineering, Purdue University*).