A different perspective on perspective cuts

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Abstract

Starting from first principles, we give an explicit characterization of the convex hull of the union of a point and a bounded convex set defined by analytic functions. The result can be applied to develop tight formulations of mixed integer nonlinear programs in which the nonlinear functions are separable and convex and in which variable upper (or lower) bounds play an important role. Frangioni and Gentile (2006) studied the same set and described a class of "perspective cuts" as first-order (outer)-approximations to the convex hull of the set in question. Our work provides a different perspective on the work of Frangioni and Gentile. Further, we show that for many classes of problems, the convex hull can be expressed via conic quadratic constraints, and thus relaxations can be solved via second-order cone programming. We conclude with computational results on two applications—quadratic facility location and network design with congestion—that show the power of the reformulation technique.

Join work with Oktay Gunluk.