

DISSERTATION PROPOSAL

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“Non-recursive Cut Generation”

Friday, May 1, 2015

3:00 pm

147 Posner Hall

In recent mixed-integer programming research, there has been reinvigorated interest in finding new general-purpose cutting planes. One such approach, proposed by Balas and Margot (2013), is the generalized intersection cut (GIC) family of cuts. In this paradigm, intersection points are obtained from the linear programming relaxation of a given MIP instance. A linear program formulated from these points is then used to generate a large collection of cuts, without the need for recursion. Recursion is typically used in cutting plane methods but is known to be a source of numerical issues (cf. Balas et al. (2010); Zanette et al. (2011)).

This dissertation focuses on a practical-minded development of generalized intersection cuts, with both theoretical and computational contributions. The computational experiments use simple splits as the cut-generating sets, comparing the strength of the GICs to standard intersection cuts on a test library collected from MIPLIB and other sources.

In the first chapter, we consider a partial hyperplane activation technique to obtain a proper collection of intersection points, in which we use information from the hyperplanes defining the instance. In the second chapter, based on discoveries in the first chapter, we investigate a novel procedure that generates intersection points directly on the facets of the cut-generating set. The dissertation work will expand on some initial promising computational results. In the process, we will develop new algorithms designed to counteract the exponential-sized collections of intersection points that arise from naïve approaches. We will also identify ways to take advantage of the structural information gained in the process of gathering a proper collection of points.

As both of the point-generation techniques are computationally expensive, the third chapter of the thesis will generate cuts in a subspace of the original problem and then lift the cuts to be valid for the original space. In assessing the strength of these cuts, we find that we may actually obtain stronger cuts by working in the subspace than by working in the full space.

For each approach used, we also test the safety of the cut generator, building on recent investigations into cut safety by Cornuéjols et al. (2013). Previous experiments focus on simpler cuts, such as Gomory mixed integer cuts. As GICs are substantially more complex, our safety results are an important contribution to understanding sources and likelihood of invalid cuts in other cut-generating procedures.

Finally, other potential topics that may be explored in this dissertation include strengthening cuts, testing crooked splits or triangles as the cut-generating sets, and incorporating GICs in a branch-and-cut framework.