Industrial and Systems Engineering Seminar

Cutting Planes from Extended LP Formulations

Wednesday, April 20

3:15 PM – Refreshments before the Seminar

3:30 PM – Graduate Seminar

Mechanical Engineering Room 4125 A & B

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Given a mixed-integer set defined by linear inequalities and integrality requirements on some of the variables, we consider extended formulations of its continuous (LP) relaxation and study the effect of adding cutting planes in the extended space. In terms of optimization, extended LP formulations do not lead to better bounds as their projection onto the original space is precisely the original LP relaxation. However, adding cutting planes in the extended space can lead to stronger bounds. We show that for every 0-1 mixed-integer set with n integer and k continuous variables, there is an extended LP formulation with (2n+k-1) variables whose elementary 0-1 split closure is integral. The proof is constructive but it requires an inner description of the LP relaxation.

We then extend this idea to general mixed-integer sets and construct the best extended LP formulation for such sets with respect to lattice-free cuts. We also look at the Sherali-Adams and Lovasz-Schrijver lift-and-project operator hierarchies in this framework and observe that they can be viewed as applying specific 0-1 split cuts to an appropriate extended formulation. This leads to a new and stronger operator that obtains the integer hull in (n/2) steps compared to n steps for the original operator. We also present some computational results showing the strength of cutting planes derived from extended LP formulations.

BIO: Oktay Gunluk is the area head for the Mathematical Optimization and Algorithms group at IBM Research. He has received his BS and MS degrees from Bogazici University and his PhD degree from IEOR Department at Columbia University. His research mostly lies in the area of mixed-integer programming and discrete optimization. His applied work spans various industrial problems including production planning, fleet scheduling, port optimization, vehicle routing, oil pipeline scheduling and site selection in agriculture. He is currently an associate editor of Networks, Math. Programming Computation, Operations Research and has served on the editorial board of MOS/SIAM Book Series on Optimization (2008-2014). He has been on the program committee for MIP (2006,2007), IPCO (2010,2011,2016), and ISCO (2014). He has served as the chair of organizing committee for IPCO 2011 and currently serves in the IPCO steering committee.