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Lift and Project Systems for Tightening $0/1$ Linear Programs: Algorithmic Aspects and Complexity Bounds

A standard approach to approximating NP-hard problems is to formulate the problem as a $0/1$ integer program and then relax the integrality condition to get a linear program relaxation which can be solved efficiently. In order to remedy the discrepancy between integral and fractional solutions, several procedures were developed in order to obtain tightenings of relaxations in a systematic manner. These are normally referred to as *Lift and Project* systems and include the Lovász–Schrijver system, Sherali–Adams system, and Lasserre system.

Lift and Project systems have attracted much attention because of both their potential and their limitations. On one hand, some of the systems are at least as strong as many celebrated algorithms (e.g. for *Vertex-Cover*, *Max-Cut*, and *Sparsest-Cut*) or can even yield polynomial-time approximation-schemes on special instances. On the other hand, proving that these systems fail to behave well in the worst case, rules out a very promising family of algorithms for attacking NP-hard problems.

In this talk we will present the Lovász–Schrijver, Sherali–Adams, and Lasserre systems in a unified framework. We will discuss their algorithmic potential and limitations based on recent results. We will also discuss the long and active series of unconditional negative results that aim to match inapproximability lower bounds based on the conjecture that $P \neq NP$.