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Geometric and Computational Aspects for Attacking Combinatorial Optimization Problems Using Semi-Definite Programs

In this talk we will introduce the paradigm of Semi-Definite Programming (SDP) relaxations as a tool for attacking (intractable) Combinatorial Optimization problems. According to this cornerstone algorithmic technique, the optimization problem at hand is first formulated as an Integer/Quadratic Program. When the integrality condition is dropped, the resulting optimization problem is a SDP, i.e. a tractable (under mild assumptions) optimization problem.

SDP relaxations have given rise to numerous state-of-the-art approximation algorithms for Combinatorial Optimization Problems. Still, the discrepancy between the optimal exact solutions and the solutions to the relaxation is a natural barrier for the performance of any SDP-based algorithm. One way of coping with this obstacle is geometric. Solutions to SDPs give rise to so-called negative-type metrics, i.e. a subsets of $\mathbb{R}^n$ equipped with the ℓ_2^2 norm. The relaxation of the original formulation to a SDP can be actually interpreted as the relaxation of an ℓ_1 metric space to a negative-type metric. As such, a natural way for strengthening SDPs is to add ℓ_1 constraints, including k-gonal inequalities, or more generally, hypermetrics inequalities.

The main subject of the talk will be to further elaborate on computational aspects regarding the addition of ℓ_1 constraints in SDPs, and the induced approximability trade-offs for Combinatorial Optimization Problems.