Approximation Algorithms for Robust and Stochastic Combinatorial Optimization Problems

Date Tuesday, April 3

Time 3:30 pm

Location 317 Mudd

Abstract: Most real-world optimization problems do not have accurate estimates of the problem parameters at the optimization phase. Stochastic and robust optimization models have been studied widely in the literature to address the uncertainty in problem parameters and constraint. We consider a two-stage set covering problem where we are given a family of sets but the elements that are required to be covered are uncertain and are specified by a set of scenarios. The goal is to select a first-stage solution (that can be extended in the second-stage) such that the total worst-case cost is minimized over all scenarios.

In this talk, I will present an $O(logn)$-approximation for the robust set cover problem. The algorithm is based on an interesting structural property of a class of near-optimal first-stage solutions. We also consider special cases of the set covering problem including shortest path and minimum cut and minimum multi-cut. While these problems can be formulated as set-covering problems, the general algorithm does not extend directly (even to give an $O(logn)$-approximation) since the set-covering formulations for these problems have exponentially many constraints.

I will describe constant factor approximations for the robust shortest path and robust minimum-cut problems. Both these algorithms are based on a 'guess-and-prune' paradigm where we 'guess' the worst case second stage cost and 'prune' away the set of scenarios which can be completely satisfied within this bound in the second-stage. The remaining scenarios are completely covered in the first-stage. While this algorithm appears to be focussed on minimizing the worst-case, interestingly, it also gives a constant factor approximation for the stochastic minimum cut problem. The analysis relies on the laminar structure of pairwise minimum cuts and also the structural property of near-optimal first-stage solutions.