

Abstract Submission

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Title: A new Contraction Technique with Applications to Congruency-Constrained Cuts

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Minimum cut problems are among the most classical problems in Combinatorial Optimization and are used in a wide set of applications. Some of the best-known efficiently solvable variants include global minimum cuts, minimum s - t cuts, and minimum odd cuts in undirected graphs. We study a problem class that can be seen to generalize the above variants, namely finding congruency-constrained minimum cuts, i.e., we consider cuts whose number of vertices is congruent to r modulo m , for some integers r and m . Apart from being a natural generalization of odd cuts, congruency-constrained minimum cuts exhibit an interesting link to a long-standing open problem in Integer Programming, namely whether integer programs described by an integer constraint matrix with bounded subdeterminants can be solved efficiently.

We develop a new contraction technique inspired by Karger's celebrated contraction algorithm for minimum cuts, which, together with further insights, leads to a polynomial time randomized approximation scheme for congruency-constrained minimum cuts for any constant modulus m . Instead of contracting edges of the original graph, we use splitting-off techniques to create an auxiliary graph on a smaller vertex set, which is used for performing random edge contractions. This way, a well-structured distribution of candidate pairs of vertices to be contracted is obtained, where the involved pairs are generally not connected by an edge. As a byproduct, our technique reveals new structural insights into near-minimum odd cuts, and, more generally, near-minimum congruency-constrained cuts.

An extended abstract on the above results appeared in the 20th Conference on Integer Programming and Combinatorial Optimization (IPCO 2019).