

Seminario AGCO

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Título: A Water-Filling Primal-Dual Algorithm for Approximating Non-Linear Covering Problems

Dónde: <https://zoom.us/j/96413520511?pwd=dUVaZDdPNTF6dGFkTnYzNHVLckxrdz09>

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Cuándo: Miércoles 17 de Junio, 15:45.

Abstract: Obtaining strong linear relaxations of capacitated covering problems constitute a significant technical challenge even for simple settings. For one of the most basic cases, the Knapsack-Cover (Min-Knapsack) problem, the relaxation based on knapsack-cover inequalities has an integrality gap of 2. These inequalities are exploited in more general problems, many of which admit primal-dual approximation algorithms.

Inspired by problems from power and transport systems, we introduce a general setting in which items can be taken fractionally to cover a given demand. The cost incurred by an item is given by an arbitrary non-decreasing function of the chosen fraction. We generalize the knapsack-cover inequalities to this setting and use them to obtain a $(2+\epsilon)$ -approximate primal-dual algorithm. Our procedure has a natural interpretation as a bucket-filling algorithm which effectively overcomes the difficulties implied by having different slopes in the cost functions. More precisely, when some superior segment of an item presents a low slope, it helps to increase the priority of inferior segments. We also present a rounding algorithm with an approximation guarantee of 2.

We generalize our algorithm to the Unsplittable Flow-Cover problem on a line, also for the setting of fractional items with non-linear costs. For this problem we obtain a $(4+\epsilon)$ -approximation algorithm in polynomial time, almost matching the 4-approximation algorithm known for the classical setting.

This is joint work with Ignacio Morales y José Verschae.