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Fixed-charge transportation: a polyhedral study of a polynomially solvable special case

I will start by explaining why the polyhedral study of simple mixed-integer sets can substantially improve our ability to solve real-life optimization problems. Building on this, I will show that the fixed-charge transportation problem on a bipartite graph, on top of being a meaningful supply chain management problem by itself, is also of interest for solving more efficiently the difficult multi-item lot-sizing problem with joint capacity.

I will then continue with the more theoretical part of the talk. The special case that I consider is when the associated bipartite graph is a path. This corresponds to having depots and clients arranged in an alternating manner such that they can only serve/be served by their one or two immediate neighbours. I describe a $O(n^3)$-time optimization algorithm and two $O(n^2)$-size linear programming extended formulations.

Next I will discuss a combinatorial characterization of its projection, and a combinatorial polynomial-time algorithm for the separation problem associated to this polyhedron. An alternative description of the same set of valid inequalities obtained by projection is discussed, which leads to a much nicer alternative proof of validity (based on sub- and super-modularity of an associated set function). This also makes an interesting link with earlier work.

The talk will be concluded by discussing the next steps of this research programme.