Revisiting Benders decomposition

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Abstract

Benders decomposition is a divide-and-conquer approach for mixed integer programs that entails a decision-making process in two stages. First-stage decisions are optimized using a polyhedral approximation of the full-blown problem projection. Then, a separation subproblem in the second-stage variables is solved to check if the current first-stage solution is in fact feasible, and otherwise, it produces a violated inequality. The algorithm iterates over these two stages until no cuts can be generated. Such cutting-plane algorithms suffer from several drawbacks impairing performance. We review approaches which address these drawbacks and offer algorithmic speed-ups. Our contribution consists in explaining these techniques in simple terms, showing that in several cases, different methods from the literature boil down to the same key ideas. We classify methods into specific initialization modes, strategies to select the separation point, proximal stabilization techniques, and cut generation and management strategies. We report on preliminary tests comparing implementation variants on capacitated facility location, multicommodity capacitated fixed charge network design, unrelated parallel machine scheduling, and stochastic location routing problems.