

Title:

Solving Very Large Scale Covering Location Problems using Branch-and-Benders-Cuts

Abstract:

Covering problems constitute an important family of facility location problems with widespread applications. These problems embed a notion of proximity (or coverage radius) that specifies whether a given demand point can be served or “covered” by a potential facility location. Proximity is often defined in terms of distance or travel time between points. A demand point is then said to be covered by a facility if it lies within the coverage radius of this facility. Location problems with covering objectives or constraints are commonplace in the service sector (schools, hospitals, libraries, restaurants, retail outlets, bank branches) as well as in the location of emergency facilities or vehicles (fire stations, ambulances, oil spill equipments). They also find applications in the location of access points for the wireless communication in the smart grid deployments.

Many of these applications involve a relatively small number of potential facility locations while the number of demand points can run in the thousands or even millions. Such very large scale problem instances remain out of reach for modern MIP solvers.

In this talk we address the maximal covering location problem (MCLP) which requires choosing a subset of facilities that maximize the demand covered while respecting a budget constraint on the cost of the facilities and the partial set covering location problem (PSCLP) which minimizes the cost of the open facilities while forcing a certain amount of demand to be covered. We propose an effective decomposition approach based on the branch-and-Benders-cut reformulation. We also exploit the submodularity of the covering function and derive a formulation based on submodular cuts. A connection between Benders and submodular cuts is drawn as well.

The results of our computational study demonstrate that, thanks to decomposition, optimal solutions can be found very quickly, even for benchmark instances involving up to twenty million demand points.

The talk is based on a joint work with S. Coniglio, J.F. Cordeau and F. Furini