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The Recoverable Robust Facility Location Problem

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In many real-world applications, when modeling network and transportation planning problems, one looks for solutions that should be robust for many different scenarios. For instance, when planning the location of medical service facilities and the corresponding allocation of urban areas to them, decision makers should make decisions before knowing with complete certainty potential location of facilities, or complete demographic characteristics of the surrounding areas. Such kind of uncertainty might arise in dynamic systems subject to geopolitical changes, natural disasters or economical crashes.

This work deals with a facility location problem in which location and allocation policy is defined in two stages such that a first-stage solution should be robust against the possible realizations (scenarios) of the input data that can only be revealed in a second stage. This solution should be robust enough so that it can be *recovered* promptly and at low cost in the second stage. In contrast to some related modeling approaches from the literature, this new recoverable robust model is more general in terms of the considered data uncertainty; it can address situations in which uncertainty may be present in any of the following four categories: "provider-side" uncertainty, "receiver-side" uncertainty, uncertainty "in-between", and uncertainty with respect to the cost parameters.

For this novel problem, a sophisticated algorithmic framework based on a Benders decomposition approach is designed and complemented by several non-trivial enhancements, including dual lifting, branching priorities, matheuristics and zero-half cuts. Two large sets of realistic instances that incorporate spatial and demographic information of countries such as Germany and US (in the context of transportation) and Bangladesh and the Philippines (in the context of disaster management) are introduced. They are used to analyze in detail the characteristics of the proposed model and the obtained solutions as well as the effectiveness, behavior and limitations of the designed algorithm.

Joint work with Eduardo Álvarez-Miranda, University of Bologna and Elena Fernández, UPC Barcelona

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