

Robustness in facility location models

Abstract

Facility location decisions are inherently strategic and long term, and play a critical role in the strategic design of a supply chain network. When making such strategic decisions, one needs to consider the presence of uncertainty in data and cost parameters in the optimization problem, and formulate models to obtain reliable or robust solutions from an economic point of view. In a typical robust model, uncertainty is modeled as finite set of scenarios, which are the plausible set of values for the data in the model. Our objective is to find a feasible solution that works well in all or most of the scenarios. We have studied various measures of robustness, including minimum cost (absolute robustness) and min-max regret (robust deviation), to support the decision process. In this dissertation, mathematical programming models for uncapacitated facility location problem (UFLP), which form the basis of other supply chain location models, is formulated for robustness under deep uncertainty. The robustness measures used for this mathematical programming are min-max regret and min-max cost. We devise dual-ascent methods that provide good lower bounds and heuristic primal solutions for these problems. In particular, we study the following problems:

- 1) Our first model for the robust location problem within the supply chain uses a min-max regret version of a basic facility location problem, considering a single product and single production echelon with uncapacitated facilities (UFLP). The aim is to minimize the maximum regret over all scenarios. We develop a dual-ascent algorithm for min-max regret UFLP. We investigate the polyhedral structure and introduce three classes of valid inequalities – base MIR, mixing inequality type 1 and type 2 to get a strong formulation. Using this strong formulation, we devise the method for dual ascent for solving the minmax regret UFLP problem.
- 2) Our second model considers the min-max cost version of the basic facility location problems (UFLP). We employ the Bertsimas and Sim (2003) robust optimization approach to the min-max cost version of UFLP problem. The objective is to optimize the min-max cost by allowing a degree of control that avoids overly conservative solutions. This control is achieved by imposing a so-called “budget of uncertainty”, which ensures that only some uncertain parameters can deviate from their nominal value. We develop a min-max cost version of the UFLP using the Bertsimas and Sim (2003) robust optimization approach. We then devise the method for dual ascent for solving this problem. The algorithm generates solutions on an average to be within 3-4 percent of optimality. The results in this thesis demonstrate the effectiveness of dual ascent in solving mixed-integer problems using a special structure of the problem.