Solutions to the Facility Location Problem with General Bernoulli Demands

M. Albareda-Sambola[1], Elena Fernández[1], and Francisco Saldanha da Gama[2]

[1]*Universitat Politècnica de Catalunya. Barcelona Tech,*
maria.albareda@upc.edu, e.fernandez@upc.edu

[2]*University of Lisbon,* fsgama@fc.ul.pt

In this work we address the facility location problem with general Bernoulli demands. Extended formulations are proposed for two different outsourcing policies, which allow using sample average approximation for estimating optimal values. In addition, solutions are obtained heuristically and their values compared with the obtained estimates. Numerical results of a series of computational experiments are presented and analyzed.

1.   Facility Location with Bernoulli Demands

The Facility Location Problem with Bernoulli Demands (FLPBD) is a discrete facility location problem where the demands of the customers are independent random variables following a Bernoulli distribution. That is, a set of potential customers is given but, after the location and assignment decisions are made, only a subset of them will actually have to be served. Facilities locations have to be chosen among a finite set of sites, each having associated a fixed set-up cost and a capacity. If, after the demands are revealed, the capacity of a facility is not sufficient to serve all its allocated customers with demand, then the facility resorts to outsourcing incurring an extra cost.

The goal is to decide what facilities to open and allocate each potential customer to an opened facility in such a way that the sum of set-up costs plus the expected service and outsourcing costs is minimized.

The FLPBD was first presented in [1]. That work focuses on the homogeneous case, i.e., the case where the probability of having demand is the same for all the customers. For this case, the paper gives a closed form for the recourse function (expected service plus outsourcing cost) and a compact formulation of the deterministic equivalent problem, that allows solving the problem in reasonable times. Here we address the general case when demand probabilities need not be the same.

2.   Solution Algorithms

We present a heuristic for the FLPBD based on path relinking. In an initial step, solutions are generated using a GRASP procedure, where the constructive phase focuses on plant selection and the local search on customers assignment. Path Relinking is then applied to a pool of elite solutions. Throughout the algorithm cost approximations are used, since the evaluation of feasible solutions to the FLPBD is computationally expensive.

Alternatively, estimates of optimal values and good quality solutions are obtained via sample average approximation. This requires extended formulations where scenarios are explicitly considered. Such formulations with tractable sizes are proposed for two alternative outsourcing policies.

The numerical results obtained with both algorithms are presented and analyzed. For the particular case with homogeneous demand the results are compared with the optimal solutions given by the exact algorithm of [1].

References

[1] Albareda-Sambola, M., Fernández, E. and Saldanha da Gama, F. The facility location problem with Bernoulli demands. *Omega*, 39:335–345, 2009.