Facility Location Optimizer

A tool for solving location problems.

Classification: $\mathbf{1 \mid P \mid } v > 0 \mid d_1 \mid \textbf{median}$

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1. Problem formulation

The goal is to find one new facility $x \in \mathbb{R}^2$ in the plane such that the weighted sum of the distances between the new facility x and the given facilities located at the points $a^1, \ldots, a^m \in \mathbb{R}^2$ are minimized. Such problems are called

"Single facility median location problems in the plane"

in the literature of location theory and can be interpreted as a model for minimizing transportation costs. Using the well-known Manhattan metric (also called rectangular metric or l_1 metric), which is defined as

$$d_1(x, a^i) := |x_1 - a_1^i| + |x_2 - a_2^i|$$

for all $x := (x_1, x_2) \in \mathbb{R}^2$ and all $a^i := (a_1^i, a_2^i)$, $i = 1, \ldots, m$, the location problem is given by

$$\sum_{i=1}^{m} v_i \cdot d_1(x, a^i) = \sum_{i=1}^{m} v_i \cdot (|x_1 - a_1^i| + |x_2 - a_2^i|) \to \min_{x \in \mathbb{R}^2},$$

where $v_1, \ldots, v_m \in \mathbb{R}$ are positive weights (demands of the given facilities).

Summarizing, in our problem

$$1 \mid \mathrm{P} \mid v > 0 \mid d_1 \mid \text{median}$$

we search for one new facility (position 1: 1) in the plane (position 2: P), the given facilities have positive weights (position 3: $v > 0$, i.e., $v_i > 0$ for all $i = 1, \ldots, m$) and we consider a median problem (position 5: median), where we measure the distances between points using the Manhattan metric (position 4: d_1).

2. Algorithm information and implementation

The corresponding algorithm included in the current version of the Software FLO generates the whole set of solutions of the above location problem. The program uses an algorithm (Derivative Algorithm) formulated in the book by Hamacher (1995).

The algorithm was implemented in FLO by Christian Günther. Software FLO has been able to solve the underlying location problem since version 1.0.0 (released on 22/04/2015).

3. Selected References

Further model and algorithm-specific information can be found in the following literature:

(A) A. E. Bindschedler and J. M. Moore. *Optimal Location of New Machines in Existing Plant Layouts.* The Journal of Industrial Engineering, 12:41-47, 1961.

(B) R. L. Francis. *A Note on the Optimum Location of New Machines in Existing Plant Location.* AIIE Transactions, 14(1):57-59, 1963.

(C) R. F. Love, J. G. Morris and G. O. Wesolowsky. *Facility Location: Models and Methods.* North Holland, New York, 1988.

(D) H. W. Hamacher. *Mathematische Lösungsverfahren für planare Standortprobleme.* Vieweg Verlag, 1995.