

# Facility Location Optimizer

A tool for solving location problems.

---

**Classification:**    **1** | **P** | **(+)** |  **$d_2^2$**  | **Eff-vector**

---

## 1. Problem formulation

The goal is to find one new facility  $x \in \mathbb{R}^2$  in the plane such that the distances between the new facility  $x$  and given facilities located at the points  $a^1, \dots, a^m \in \mathbb{R}^2$  are minimized simultaneously, where simultaneous minimization is understood in the sense of multi-objective optimization. Such problems are called

“Single facility multi-objective 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 squared Euclidean metric, which is defined by

$$d_2^2(x, a^i) := |x_1 - a_1^i|^2 + |x_2 - a_2^i|^2$$

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

$$\begin{pmatrix} d_2^2(x, a^1) \\ \dots \\ d_2^2(x, a^m) \end{pmatrix} \rightarrow \underset{x \in \mathbb{R}^2}{\text{v-min}}.$$

In our problem we search for Edgeworth-Pareto efficient solutions.

Summarizing, in our problem

$$1 \mid P \mid (+) \mid d_2^2 \mid \text{Eff-vector}$$

we search for one new facility (position 1: 1) in the plane (position 2: P), the given facilities are attraction points (position 3: (+)) and we consider a vector problem with regard to the solution concept of Edgeworth-Pareto efficiency (position 5: Eff-vector), where we measure the distances between points using the squared Euclidean metric (position 4:  $d_2^2$ ).

---

## 2. Algorithm information and implementation

The corresponding algorithm included in the current version of the Software FLO solves the above location problem and computes the whole set of Edgeworth-Pareto efficient solutions. Due to the fact that the set of efficient solutions of the above defined problem coincides with the set of efficient solutions of the problem

$$1 \mid P \mid (+) \mid d_2 \mid \text{Eff-vector}$$

(see, for instance, the thesis by Günther, 2013), the Software FLO uses the algorithm (Convex Hull Algorithm) proposed by Kuhn (1967). Note that for the above location problem the set of strictly efficient solutions, the set of efficient solutions and the set of weakly efficient solutions coincide (again, see Günther, 2013).

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

---

## 3. Selected References

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

- (A) H. W. Kuhn. *On a pair of dual nonlinear programs*. Nonlinear programming, Wiley, New York, 1967.

- (B) C. Günther, *Dekomposition mehrkriterieller Optimierungsprobleme und Anwendung bei nicht konvexen Standortproblemen*, Masterarbeit, Martin-Luther-Universität Halle-Wittenberg, 2013.