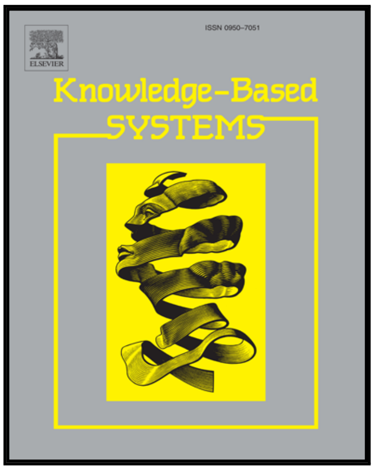

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J.M. Colmenar, R. Martí, A. Duarte

PII: S0950-7051(17)30606-8
DOI: 10.1016/j.knosys.2017.12.028
Reference: KNOSYS 4164

To appear in: *Knowledge-Based Systems*

Received date: 2 December 2016
Revised date: 24 November 2017
Accepted date: 26 December 2017

Multi-objective Memetic Optimization for the Bi-objective Obnoxious p-Median Problem

J. M. Colmenar[a], R. Martí[b], A. Duarte[a]

[a] *Dept. de Ciencias de la Computación, Universidad Rey Juan Carlos, Móstoles, 28933 (Madrid), Spain*
[b] *Dept. de Estadística e Investigación Operativa, Universidad de Valencia, Burjassot, 46100 (Valencia), Spain*

Abstract

Location problems have been studied extensively in the optimization literature, the p-median being probably one of the most tackled models. The obnoxious p-median is an interesting variant that appears in the context of hazardous location. The aim of this paper is to formally introduce a bi-objective optimization model for this problem, in which a solution consists of a set of p locations, and two conflicting objectives arise. On the one hand, the sum of the minimum distance between each client and their nearest open facility and, on the other hand, the dispersion among facilities. Both objective values should be kept as large as possible for a convenient location of dangerous facilities.

We propose a Multi-Objective Memetic Algorithm (MOMA) to obtain high-quality approximations to the efficient front of the bi-objective obnoxious p-median problem, denoted as *Bi-OpM*. In particular, we introduce efficient crossover and mutation mechanisms. Additionally, we present several multi-objective local search methods. All the strategies are finally incorporated in a memetic algorithm which limits the search to the feasible region, thus performing an efficient exploration of the solutions space. Our experimentation compares several state-of-the-art procedures with the introduced MOMA emerging as the best performing method in all considered multi-objective metrics.

Keywords: Memetic algorithms, local search, multi-objective optimization, combinatorial problems, obnoxious p-median.

1. Introduction

In general terms, multi-objective optimization is the area devoted to optimizing (either maximizing or minimizing) several objective functions. These objectives usually present low or negative correlations, and the optimization of one of them normally leads to solutions that perform poorly with respect to the others. This is why we cannot seek for a single optimal solution, such as in single-objective optimization, and we search for a set of efficient solutions, which makes multi-objective optimization especially hard.

In mathematical terms, we denote with $\mathbf{y} = \mathbf{f}(\mathbf{x})$ the m-dimensional objective function (i.e., $\mathbf{f}(\mathbf{x}) = [f_1(x), f_2(x), ..., f_m(x)]$), where $\mathbf{x}$ is a vector of n decision variables, (i.e., $\mathbf{x} = (x_1, x_2, ..., x_n) \in X$, being X the feasible region in the decision space). Additionally, we denote with Y the feasible objective region. In other words, Y is the image of X in the objective space.

The feasible objective region is not a totally ordered set in terms of the relation induced by the optimization problem. This implies that given any two solutions, we cannot always compare them. On the contrary, Y is usually a partially ordered set, and the so-called Pareto dominance [1] introduced in 1896, allows us to compare certain solutions. In particular, when considering the maximization of the objectives, we say that $\mathbf{x} \in X$ dominates $\mathbf{x}' \in X$ if there is at least one index j for which $f_j(x) > f_j(x')$ and $f_i(x) \leq f_i(x')$ for the

Email addresses: josemanuel.colmenar@urjc.es (J. M. Colmenar), rafael.marti@uv.es (R. Martí), abraham.duarte@urjc.es (A. Duarte)