

## AN EVOLUTIONARY MULTI-AGENT BASED SEARCH METHOD FOR STACKELBERG SOLUTIONS OF BILEVEL FACILITY LOCATION PROBLEMS

TAKESHI UNO<sup>1</sup>, HIDEKI KATAGIRI<sup>2</sup> AND KOSUKE KATO<sup>2</sup>

<sup>1</sup>Department of Mathematics and Computer Science  
Faculty of Integrated Arts and Sciences  
The University of Tokushima  
1-1, Minamijosanjima-cho, Tokushima-shi 770-8502, Japan  
uno@ias.tokushima-u.ac.jp

<sup>2</sup>Department of Artificial Complex Systems Engineering  
Graduate School of Engineering  
Hiroshima University  
1-4-1, Kagamiyama, Higashihiroshima-shi, Hiroshima 739-8527, Japan  
{ katagiri-h; kosuke-kato }@hiroshima-u.ac.jp

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**ABSTRACT.** *This paper considers the bilevel facility location problem (BFLP) on a plane with the situation that a facility must be located at more than a certain distance from another facility. Since the strict solution method for finding a Stackelberg solution of the BFLP needs much computational time for large scale BFLPs, the evolutionary multi-agent system is proposed for finding an approximate Stackelberg solution efficiently by utilizing characteristics of the BFLP. The efficiency of the solution method is shown by applying it to numerical examples of the BFLP.*

**Keywords:** Bilevel programming problem, Facility location, Stackelberg solution, Evolutionary multi-agent system

**1. Introduction.** Facility location problems have been studied by many researchers and are divided into the following two types; one is a noncompetitive facility location problem recently studied by Liu et al [15], De Camargo et al. [6], etc., and the other is a competitive facility location problem (CFLP) for commercial facilities, e.g. shops and stores. In this paper, we consider the latter type of facility location problems. Mathematical studies for CFLP are originated by Hotelling [12]. He considered the CFLP under the conditions that (i) customers are uniformly distributed on a line segment, (ii) each of decision makers (DMs) can locate and move her/his facilities at any times, and (iii) all customers only use the nearest facility. For such CFLPs, an optimal location for all facilities is defined as a Nash equilibrium solution. As an extension of Hotelling's CFLP, Cintioa [5] considered the Hotelling's CFLP with price competition and linear transportation costs. Wendell and McKelvey [22] assumed that there exist customers on a finite number of points, called demand points (DPs), and considered CFLP on a network by regarding DPs as nodes.

Based on the CFLP of Wendell and McKelvey, Hakimi [10] considered the CFLP on a network with the situations that there are two types of DMs; one DM, called the upper DM, has a priority about facility location, and the other, called the lower DM, locates her/his facilities after the upper DM does. Such CFLPs are called bilevel facility location problems (BFLPs), and for convenience sake, the facilities of the upper and the lower DM are called the upper and the lower facilities, respectively. For the BFLPs, an optimal