Application of Some Heuristic Algorithms for Facility Location and Design Problem

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1 Introduction

Recently much attention was given to the approximate methods of solution of combinatorial optimization problems. Special interest is associated with the algorithms which are constructed on analogies with biological and physical processes. Such algorithms are heuristic and, as a rule, work well from the point of view of CPU time and quality of solution obtained. The most known of them are genetic algorithms, ant colony, simulated annealing, variable neighbourhood search (see, for example [2, 5, 7]). This work is devoted to development of some heuristics for facility location and design problem.

2 Problem formulation

In this paper heuristics are developed for the following facility location problem [1]. There is a set of demand points N and a subset $P \subset N$ of potential location for plants with different design scenarios $r, r \in R$. There are pre-existing competitive facilities $C \subset P$. The goal is to optimize simultaneously the locations in $S = P \setminus C$, and scenarios taking into account the maximum level of budget B and pre-existing competitive facilities maximizing the attracted demand share.

The mathematical model of the problem look like:

$$\sum_{i \in N} w_i \cdot g(U_i) \cdot MS_i \to max$$

$$\sum_{j \in S} \sum_{r=1}^{R} c_{jr} x_{jr} \leq B,$$

$$\sum_{r=1}^{R} x_{jr} \leq 1,$$

$$x_{jr} \in \{0, 1\}, \quad r \in R, j \in S,$$

where w_i is the weight of demand of customer i; U_i is the total utility for a customer at $i \in N$; $g(U_i)$ is the demand function; MS_i is the total share of facility i; c_{jr} is opening cost; $x_{jr} = 1$, if facility is opened in point j with scenario r.

Unlike the majority facility location models the customer demand is flexible, it depends on the total utility the customer derives from this facility. In the some papers this demand is called "elastic" (see, for example [1]). It is known that this location problem is NP-hard [3].

3 Algorithms

The approximate methods for solution of discrete plant location problems are developed in this work. The intelligent water drops and fireflies algorithms, variable neighbourhood search were adapted for the problem considered above. The first two algorithms are nature-inspired swarm-based optimization algorithms. The Firefly algorithm was developed in [7] and it is based on idealized behavior of the flashing characteristics of fireflies. Intelligent Water Drops algorithm was first introduced in [6] and it imitates some processes which happen in nature between the water

drops of a river and the soil of the river bed. The third metaheuristic variable neighbourhood search is based on consistently changes in the neighbourhood structure within a search of solving of optimization problem. For the application of these algorithms to the facility location and design problem with elastic demand new type of neighbourhood, the rules for determining the attractiveness and others were proposed.

A new version of algorithms is realised on the compute and its experimental research is carried out. For the leadthrough of numerical experiment the sets of tests were created [4] on rules, to offered in [1]. The results of computational experiment are discussed.

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