A Support Vector regression Guided Genetic Algorithm for solving the Single-source Capacitated Facility Location Problems

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1 Introduction

Facility location is a critical component of strategic planning for a broad spectrum of public and private companies. For this, it is necessary to consider many criteria such as cost or distance from demand points. Many models has been made to help decision making in this area.The Multi-Source Weber Problem, which is known as the location-allocation problem. The objective of the location-allocation problem is to locate some new facilities among several customers with determined locations and fixed demands, and simultaneously allocate customer demands to facilities, so that the total cost of transportation between facilities and existing customers gets minimum. Recently, there have been much research focused on Single-Source Capacitated Multi-Facility Weber Problem (SSCMFWP) , but very few on Multi-Source Capacitated Multi-Facility Weber Problem (MSCMFWP). There are two levels of decisions involved with the MSCMFWP, namely determining optimal location of facilities and allocating customers to the opened facilities without violating the capacity constraints. The objective is to minimise the sum of the weighted total Euclidean distances to serve these n customers.

2 Single-Source Capacitated MultiFacility Weber Problem

The goal of the Single-Source Capacitated Multi Facility Weber Problem (SSCMFWP) is to find optimal location of facilities among existing customers and simultaneously determine how customers are allocated to facilities, so that each customer must provide all its demand just from one facility, and the total cost of transporting between customers and facilities gets minimum such that the total cost is the minimum. The SSCMFWP can be formulated as follows : Parameters :
m is the number of facilities, n is the number of customers, w_j is the demand of customer j, c_i is the capacity of facility i and $A_j = (a_j, b_j)$ are coordinates of customer j
Decision variables :
$X_i = (x_i, y_i)$: coordinates of facility i

$$z_{ij} = \begin{cases} 1 & \text{if customer j is assigned to facility i} \\ 0 & \text{otherwise} \end{cases}$$

Let $d(X_i, A_j)$ be the distance between facility i and customer j which is defined as follows :

$$d(X_i, A_j) = \sqrt{(x_i - a_j)^2 + (y_i - b_j)^2}$$

The mathematical model of the SSCMFWP can be formulated as follows :

$$\min \sum_{i=1}^{m} \sum_{j=1}^{n} z_{ij} \times d(X_i, A_j) \quad (1)$$

subject to

$$\sum_{i=1}^{m} z_{ij} = 1, \forall j = 1, 2, \ldots, n \quad (2)$$

$$\sum_{j=1}^{n} w_j \times z_{ij} \leq c_i, \forall i = 1, 2, \ldots, m \quad (3)$$

$$z_{ij} \in \{0, 1\}, i = 1, 2, \ldots, m, j = 1, 2, \ldots, n \quad (4)$$

The first objective function (1) minimizes the total transportation costs. The transportation costs are calculated as the product of the per unit transportation costs and the distance between facility i to demand j ; Eq. (2)ensure that each customer's demand has to be satisfied by exactly one facility. Eq. (3)ensures that the total demand, which is provided by each facility should not exceed its capacitylimit. Finally, constraint (4) is binary variables.

The contributions of this paper is adopting the Support Vector Regression Guided Genetic Algorithm (SVRGGA) presented as an improved version of traditional Genetic Algorithm (GA), which is inspired from the individual self-adaptive capability observed in nature with additional guidance information from a statistical response of cost distributions conditioned on the locations of facilities. In the proposed method, we used SVRGGA to solve the location problem and internal GA to challenge allocation issue. Since location and allocation are not two separate problems, we must solve the two problems simultaneously. Therefore, we combined the two genetic algorithms in one algorithm in such a manner that output of one is used as input to another.
Indeed, each individual solution is empowered in a GA population with the capability of self-adjustment to boost the fitness for the objective function. This is inspired by the observation of an individual's self-adaptivity to meet the requirement of the environment for many species in the natural world. In the SSCMFWP context, SVRGGA was proposed to allow the individuals in the conventional GA to adjust its fitness with the guiding information from a probability distribution aggregated from SVR surface[2, 4] and the Monte-Carlo simulation [3].

3 Conclusions et perspectives

In this paper, the proposed self-adjustment mechanism to boost the performance of the traditional genetic algorithm has a direct impact on SSCMFWP as it can conduct a self-check, find the worst individual in each population, and relocate to better of solution sampled from the SVR surfaces.

Références

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