Chapter XLII
Solving Facility Location Problems with a Tool for Rapid Development of Multi-Objective Evolutionary Algorithms (MOEAs)

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ABSTRACT

The low price of coffee in the international markets has forced the Federación Nacional de Cafeteros de Colombia (FNCC) to look for cost-cutting opportunities. An alternative that has been considered is the reduction of the operating infrastructure by closing some of the FNCC-owned depots. This new proposal of the coffee supplier network is supported by (uncapacitated and capacitated) facility location models that minimize operating costs while maximizing service level (coverage). These bi-objective optimization models are solved by means of NSGA II, a multi-objective evolutionary algorithm (MOEA). From a computational perspective, this chapter presents the multi-objective Java Genetic Algorithm (MO-JGA) framework, a new tool for the rapid development of MOEAs built on top of the Java Genetic Algorithm (JGA). We illustrate MO-JGA by implementing NSGA II-based solutions for the bi-objective location models.

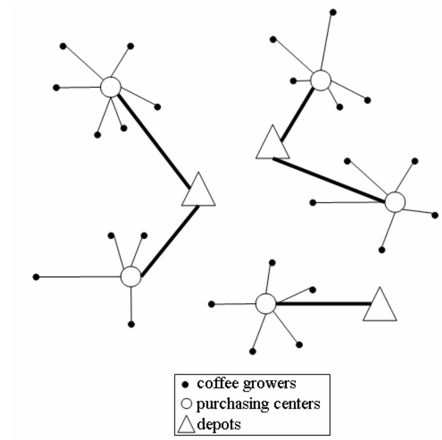
THE CASE OF THE COLOMBIAN COFFEE SUPPLIER NETWORK

Colombia is the second largest coffee producer in the world. The Colombian National Coffee Growers Federation (in Spanish, Federación Nacional de Cafeteros de Colombia—FNCC), is a nonprofit private organization whose main activities include: supporting worldwide marketing activities for the Café de Colombia and Juan Valdez® brands; conducting research on coffee-related topics; providing technical and financial assistance to the coffee growers; guaranteeing the quality of the Colombian coffee exports; and buying, storing, processing, and exporting Colombian top-quality coffee. During the last six years, the FNCC exported about 30% of the Colombian coffee production (FNCC, 2005).

The coffee supplier network operates as follows. First, the coffee growers sell their crops to purchasing centers located in towns nearby their farms. Once these centers—which are cooperatives owned by coffee growers—have collected enough coffee, they send them to a larger FNCC-owned depot. Coffee is stored in these depots until the time comes for processing followed by exportation. This supplier network is composed of over 400 purchasing centers and over 30 FNCC owned depots. Figure 1 shows the structure of the coffee supplier network.

Due to the low prices of coffee in international markets, the FNCC has been looking for opportunities to reduce operating costs on its supplier network. One of the possible alternatives that has been considered is to reduce the operating infrastructure by shutting down some of the FNCC-owned depots (CAIC, 2002). However, by doing so, it may not always be possible to ship coffee from a purchasing center to a nearby FNCC-owned depot. This guarantee of being covered by a nearby depot is deeply appreciated among cooperatives (purchasing centers), and ultimately, among coffee growers who own the FNCC.

Figure 1. Coffee supplier network



Following the same approach of Bramel and Simchi-Levi (1997), the 450 purchasing centers were aggregated into 47 clustered purchasing centers by considering both distance and purchasing volume. Each purchasing center is represented by its main purchasing agencies (from one to three agencies per coop), and the total amount of coffee purchased from the coffee growers was consolidated into those agencies. The supply for each purchasing center comes from the operation of year 2001 (FNCC, 2001). The location of the purchasing agencies and their distance to the FNCC-owned depots are known, and the covering distance was set to 150 kilometers. After consolidating the storage capacity of the depots located in the same town, the supplier network ends up with a total of 25 candidate depots. Figure 2 shows the geographical distribution of the purchasing centers and depots after consolidation.

Clearly, reducing costs and operating depots located near the purchasing centers are two conflicting objectives. Making the supplier