Inventory Routing Problems: a multiobjective approach

Marc Sevaux\(^1\), Martin J. Geiger\(^2\)

\(^1\) Université de Bretagne-Sud – Lab-STICC
Lorient (France)
marc.sevaux@univ-ubs.fr
\(^2\) Helmut Schmidt Universität
Hamburg (Germany)
m.j.geiger@hsu-hh.de

Keywords: inventory, routing, multi-objective optimisation, decision support.

1 Introduction

Logistic activities, from a certain point of view, are often structured around two concepts, the transportation of goods and the management of the same goods. Of course, these two activities are highly interlinked. It is possible to combine at the same time the problem of defining the amount of goods that have to be shipped (the Inventory Management problem – the quantity decision) and the routes that have to be taken by the vehicle for delivering the same goods (the Vehicle Routing Problem – the routing decision). These two problems intersect to a considerable degree and have been given a name: the Inventory Routing Problem. Recent research can be found in [2, 3].

The academics and the people in industry have a completely different view of this problem. Academics are usually searching for statistical or stochastic laws, but reality is more complex. In our relation with different companies, we have observed that they have a partial knowledge of the demand over the planning horizon. Hence, we propose a new type of data for further experimental investigations. Demand of the current period is known at the beginning of the period. In addition, an approximate overview of the demand is known for the 5 next periods, the 20 next periods and the 60 next periods. This prediction is rather good (differing from reality by not more than ±10\%).

The global objective of our research is to provide practical optimization methods to companies involved in inventory routing problems, taking into account this new type of data. This work is a long term research project and in a first phase, we focused on the Inventory Routing problem with a single product, deterministic known demand over a finite horizon. In one of the recent paper [1], the authors assume that the routing costs and the inventory costs are comparable and used as a single combined objective. In our case, we are going to handle the two costs as separate objectives. To our knowledge, this is the first time that a bi-objective approach is considered for this problem.

2 Problem definition

Since our problem is somehow similar to [1], we keep some of their notations in common. We consider a distribution network (usually a complete graph or a distance matrix) where a single product is shipped from a depot (denoted by 0) of unlimited capacity to a set \(C = \{1, \ldots, n\}\) of customers over a time finite horizon \(H\) of \(p\) periods. A homogeneous fleet of vehicles of capacity \(K\) serves the customers (the number of vehicles that can be used at every time period is not limited). Alternatively, a single vehicle can be used to do several tours over the same period. Each customer \(i\) has a maximum capacity \(U_i\) and an initial inventory level \(I_{i0}\). The goal is to
minimize two cost functions, namely the total routing costs (the sum of routing costs in each period) and the total inventory costs (the sum of the inventory levels at the end of each period for all customers).

3 Proposed methodology

Since this work is conducted in order to be used in practice, we have decided to develop different policies that can be understood and used on an every-day-basis by companies. Of course, the order-up-to-level-policy is provided as a choice as well as the day-to-day policy. In between, many policies exist. To make them simple, we intend to use a frequency-policy which will serve a customer for several periods in a row. Each customer will have its own frequency of delivery. Hence we will have to search for the best vector of frequencies that will propose non-dominated solutions for our two objectives. Initial routing is determined by saving heuristics and later improved using the Record-To-Record Travel algorithm [5].

4 Results and future work

The final goal of this work is to be able to solve instances up to 250 customers over a long term horizon (240 periods). Instances have been generated based on geographical data from [4] and with three types of demand evolution (constant, increasing and sinusoid). Files are available on the web1 and the file format is described in [6].

Several directions are now followed for the perspectives of our work. First, we are now improving our routing solver to avoid using an external software and create more intricate and embedded delivery strategies. Using a visual tool, we have already also noted some side effects that we could improve in our future research. A possible output might be to change the synchronization of the customers at the beginning of deliveries or group customers depending on their geographical location.

References


1. http://www2.hsu-hh.de/logistik/research/irp/GS-irp.zip