Solving a financial supply chain network design model with a large neighborhood search

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1 Introduction

Supply Chain Network Design (SCND) models deal with determining the strategic decisions such as where and when to locate facilities, the facilities' capacity and the product flows in the network. Classically these models are optimized either by minimizing the total logistics costs or maximizing the profit generated by the distribution of goods. These models often omit financial considerations. Locating new facilities and running an international logistics network requires investments, which can be financed in different ways. The way of financing substantially affects the company's financial situation and future value.

In order to integrate the financial dimensions into strategic supply chain decisions, the typical objective functions, such as cost minimization or profit maximization, should be replaced by a financial term. For this purpose, [4] identified Adjusted Present Value (APV) a suitable financial indicator to be replaced by the classical objective functions in SCND models. In their work, a SCND mathematical model maximizing the company's value through the Adjusted Present Value (APV) is proposed. The main contribution of this study is to solve the model proposed in [4] with a Large Neighborhood Search (LNS) metaheuristic [5].

2 Large Neighborhood Search framework for our SCND model

The underlying principle of the LNS is to improve an incumbent solution by iteratively removing and repairing a part of it. This procedure uses several problem-dependent *destroy* and *rebuild* operators. First, a destroy operator is applied to destruct a part of the solution ; then a repair operator is invoked to rebuild the destroyed solution. Using a destroy operator immediately followed by a rebuild operator thus yields a neighbor solution.

LNS has wide applications in Vehicle Routing Problem, public transport, lot-sizing, scheduling. In addition, LNS has been used for facility location problems [1, 2, 3, 6]. This research extends the previous studies by adapting the LNS algorithm to a dynamic location model.

The model deals with three main decision variables which values fully determine the solutions : i) facility location (binary variables), ii) product flows within the network (continuous variables), and iii) choice of financial variables (continuous variables). The impact of binary location variables is more global than that of continuous variables, corresponding to more local decisions. Figure 1 illustrates the process to determine the value of all decision variables in each LNS iteration. The key decision is to determine the set of operating facilities and their opening periods. This is done through dedicated LNS destroy and repair operators. Afterward, the product flows are determined by solving a relaxed assignment problem with Cplex. Then, the financial variables are set according to a simple dichotomic heuristic.

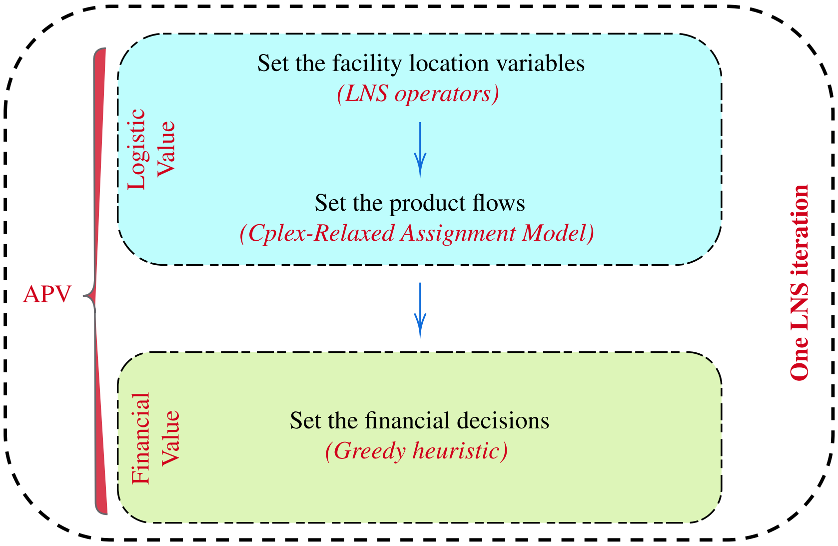

FIG. 1 – Sequence of decisions in one LNS iteration

3 Numerical experiments

We assess the quality of the proposed solution method on a generated set of benchmark instances with up to 480 customers and 48 facilities. We present the results of our LNS implementation and prove its efficiency by comparing with the results obtained by Cplex. We also show how this single objective LNS can be embedded in a multi-directional local search (MDLS) algorithm that separately optimizes logistic and financial objective functions.

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