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REGULAR PAPER

Comparative analysis of different crossover structures for solving a periodic inventory routing problem

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Abstract

One of the most important challenges for a company is to manage its supply chain efficiently. One way to do this is to control and minimize its various logistics costs together to achieve an overall optimization of its supply network. One such system that integrates two of the most important logistics activities, namely inventory holding and transportation, is known as the inventory routing problem. Our replenishment network consists of a supplier that uses a single vehicle to distribute a single type of item during each period to a set of customers with independent and deterministic demand. The objectives considered are the management of supplier and customer inventories, the assignment of customers to replenishment periods, the determination of optimal delivery quantities to avoid customer stock-outs, the design and optimization of routes. A genetic algorithm (GA) is developed to solve our IRP. Different crossover structures are proposed and tested in two sets of reference instances. A comparison of the performance of different crossover structures was established. Then, it was used to find the most appropriate crossover structure that provides better results in a minor computation time. The obtained results prove the competitiveness of GAs compared to literature approaches, demonstrate the performance of our approach to best solve large scale instances and provide better solution quality in fast execution time.

Keywords Inventory routing problem · Supply chain · Genetic algorithm · Restructured crossover · Optimization

1 Introduction

Today's industrial environment has experienced exacerbated competitive pressure in the face of increasing variable demand that is strongly influenced by many cyclical factors. Traditional managers have been looking for a one-size-fits-all solution for supply chain integration. They have focused on developing new flows and management approaches that meet customer demands and minimize logistics costs. The biggest challenge in controlling logistics costs for industrial companies is to reduce transportation and holding costs across the supply chain network.

According to [1], the inventory routing problem (IRP) is an NP-hard problem that jointly solves the vehicle routing problem (VRP) and the inventory management problem (IMP). This problem can be modeled as an optimization problem with both the objectives of the classical VRP, which minimizes transportation costs over a predefined planning horizon, and the management of quantities and inventory movements between different locations in the network in each period.

The problem of our research is mainly concerned with the study, analysis and resolution of the IRP problem. Our objective is to develop a decision support tool for the distribution planner to provide an optimal distribution plan over a predefined horizon. Several studies have focused on solving this type of problem. Researchers have typically used both exact and approximate optimization methods to solve these IRP problems. In this work, we focus on approximate methods, and in particular on population-based algorithms that have been shown to be effective in subsequent studies.

Several approximate methods have been used to solve routing problems. Indeed, many authors have found it advantageous to use this type of methods to solve IRPs, as the case of [2] who used in his work the Tabu search algorithm (TB), other researchers like [3] used the variable neighborhood search (VNS), others used the ant colony algorithm (ACO) like [4], and many other methods. In our case, we

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