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A convex optimization approach for solving the single-vehicle cyclic inventory routing problem

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Abstract

This paper investigates the mathematical structure of the Single-Vehicle Cyclic Inventory Routing Problem (SV-CIRP). The SV-CIRP is an optimization problem consisting of finding a recurring distribution plan, from a single depot to a selected subset of retailers, that maximizes the collected rewards from the visited retailers while minimizing transportation and inventory costs. It appears as fundamental building block for all variants of the cyclic inventory routing problem (CIRP). One of the main complications in developing solution methods for the SV-CIRP using the current formulations, is the non-convexity of the objective function. We demonstrate how the problem can be reformulated so that its continuous relaxation is a convex optimization problem. We further examine its mathematical properties and compare our findings with statements previously done in literature. Based of these findings we propose an algorithm that solves the SV-CIRP more effectively. We present experimental results on well-known benchmark instances, for which we are able to find optimal solutions for 22 out of 50 instances and obtained new best known solutions to 23 other instances.

Keywords: Routing, Inventory, Single-vehicle cyclic inventory routing problem, Convex optimization

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