Approaching a Green Optimisation Criteria for Order Orchestration in E-commerce

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1 Context

The rise of omnichannel commerce -where e-commerce orders may be placed through any sale channel and fulfilled from any stock location- has raised new challenges for retailers [1]. First, they had to adapt their stock management policies as their products can be purchased by both in-store or online customers. Secondly, they had to set up fulfilment strategies to determine which stock location will be in charge of each online order: a process called order orchestration. Retailers rely on an Order Management System (OMS) to fulfil their orders and their objectives are mainly related to economic costs or quality of service for customers. In the vast majority of OMS, the order orchestration process is performed continuously, one order after another, and it relies on business rules to filter one or more candidate stock locations. Each order is assigned to stock locations prioritized with criteria such as shipping costs or delivery time.

In [2] we propose an optimisation model to perform a green order orchestration over a batch of orders, denoted as `GTP-ED` (Green Transportation Problem for E-commerce Deliveries). It is identified as a variant of the Fixed-Charge Transportation Problem [4] that includes a comprehensive environmental objective function (denoted as $\mathcal{F}_G$) and packing constraints. It takes into account the set of boxes that can be used to ship items from a source to a customer, and packing constraints which ensure that boxes shipped from a source to a customer are large enough to contain items shipped on the same path. Whereas most of green objective functions in `TP` literature only consider transportation environmental impacts, $\mathcal{F}_G$ also includes impacts due to packaging, replenishment, storage and handling. Experiments have been performed over two sets of instances, based on real world and realistic data. It showed that the comprehensive environmental objective function permits significant savings compared to the minimisation of the travelled distance, which is a classic environmental objective. Then, in the paper extension, we compared the environmental costs of historical orchestration for real world instances and the costs obtained with our optimisation model [3]. Results show that significant savings are achievable with optimisation. However, the model orchestrates small batches of orders up to 20-40 orders in a few seconds but struggles to reach optimality when the batch size increases and even fails to orchestrate batches over 100 orders, which is a standard amount of orders a retailer may receive per hour. In addition, the objective function is comprehensive but relies on various input data that may be difficult to gather by retailers, such as replenishment, storage or carrier environmental impacts.

2 Contributions

Our goal is to propose a green order orchestration that can be rolled out to retailers in the very short term.

Firstly, to address the scalability issues of batch optimization, we investigate an on-line optimization that processes orders sequentially rather than simultaneously. Results show that the surplus of costs induced by on-line optimisation compared to batch optimisation is very negligible on most real world and realistic retailers instances. Indeed, the characteristics of retailers networks, and especially their large stock coverage, lead to similar choices for both orchestration processes when it is performed with mathematical optimisation.

Secondly, we want to facilitate the adoption of an environmental optimisation criteria. In this purpose, we propose several alternative criteria based on combination of data easily accessible for retailers (items weight, items volume and distance travelled). Then, for each criteria, we perform experiments and compute the associated environmental costs of the solution, using the comprehensive function $\mathcal{F}_G$, to assess the environmental performances of an orchestration using this criteria.
Preliminary results show that the criteria that best approximates the comprehensive environmental function depends on instance characteristics. More experiments and analyses still need to be done. The latests results will be presented during the conference

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