Chapter 26
An Estimation of Distribution Algorithm-Based Approach for the Order Batching Problem: An Experimental Study

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ABSTRACT

In the supply chain and the planning and control of warehouse processes, the order picking is an aspect critical. Combining customer orders into picking orders to minimize the picking time is known such order batching. Extensive evolutionary algorithms haven been proposed to build better batches for the order picking. The authors think that any algorithm should preserve batches that appear frequently in all members of the population in order to keep track and inherit these characteristics exhibited by the parents to the next generation. However, the traditional evolutionary operators used in current research sometimes lose the characteristics mentioned. In order to describe the characteristics exhibited by the parents as a distribution of the solution space, the authors build a probability model. An acceptable performance using the model proposed is shown against different evolutionary algorithms known in the literature in a series of extensive numerical experiments.

INTRODUCTION

Order picking systems involving operators are common in warehouse environments. The order picking arises when different articles are stored in unit loads such as pallets, and the customers require a few quantities of different articles (de Koster et al. 2007). One of the manual order picking systems is picker-to-parts (Wäscher, 2004), where pickers normally walk through the warehouse and collect articles. Batches are used when the number of arriving orders is too large for processing each customer order

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separately; therefore batching is the process of grouping a set of customer orders into picking orders. It means that different customer orders can be simultaneously released for picking. In this chapter the authors analyze manual picking systems such as picker-to-parts where the activity of transformation of customer orders into batches exists.

Order pickers are guided by pick lists. A pick list comprises a set of order lines, each one identifying a particular article, the quantity of the article requested and the respective storage location. The order lines are already sorted into the sequence according to which the order picker is meant to collect the items; therefore the pick list is useful for making tours through the warehouse.

The order batching problem features some similarities with the capacitated vehicle routing problem. Both are combinatorial issues, however differs with respect to the customer order integrity condition, i.e. all items of a customer order must be picked on the same tour. Thus, traditional solutions approaches to the capacitated vehicle routing problem cannot be applied directly to the order batching problem (Bozer, 2008).

Different evolutionary algorithms such as Genetic Algorithms (GA), Memetic Algorithms (MA), and Tabu Search (TS) have studied and solved the order batching. An example can be found in Öncan (2013) where the algorithm proposed preserves batches or sequences of batches that appear frequently in all members of the population in order to keep track and inherit these characteristics exhibited by the parents to the next generation. However, the traditional evolutionary operators used in current research sometimes lose the characteristics mentioned.

The authors of this research propose an alternative approach consists of using Estimation of Distribution Algorithms (EDA), introduced by Mühlenbein and Paaß (1996). EDA is a relatively new paradigm in the field of evolutionary computation. Compared with other evolutionary algorithms, the EDA reproduces new population implicitly instead of using traditional evolutionary operators. In the EDA, a probability model of the most promising area is built by statistical information based on the search experience to describe the characteristics exhibited by the parents and then the probability model is used for sampling to generate new individuals. The EDA makes use of the probability model to describe the distribution of the solution space. The updating process reflects the evolutionary trend of the population. To the best of knowledge of the authors, this kind of algorithm has not been used to tackle the order batching problem in order-picking warehouses.

LITERATURE REVIEW

A discussion about the most current research on the order batching process is outlined below.

A practical batching problem where greeting cards are retrieved from a warehouse was analyzed by Kamin (1998). In that environment, the pickers use automated guided vehicles on a fixed course collecting the items according to given customer orders. The Kamin's research focuses on the minimization of average turnover times where the orders arrive throughout the study horizon.

The optimal number of customer orders that should be assigned to a batch such that the average turnover time is minimized is focused on Chew et al. (1999). They employ a queuing network with two queues. In the first queue, customer orders arrive according to a Poisson process and batches are generated by means of the FCFS rule (First Come First Serve). If a particular number of customer orders are in the first queue, those orders are assigned to a batch and move onto the second queue. Those orders are released according to the availability of pickers.