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**Routing and Order Batching in a non-standard Warehouse**
(joint work with Joachim Schauer)

**Abstract**

We consider the warehouse logistics system of Blue Tomato, a sporting goods and apparel sales company with a strong e-commerce business. We focus on the order picking process in its central warehouse where every day articles for a few thousand orders are manually picked from the shelfs. This is done by human pickers, who use a cart to store at most 15 different orders comprising a total of at most 40 articles. The resulting planning task consists of two parts: At first, the orders have to be partitioned into batches allowing an efficient picking tour in the warehouse. Secondly, for each batch a routing problem for the picker has to be solved, which can be modelled as an instance of a TSP on a special graph. There are a number of non-standard aspects to consider: The warehouse consists of parallel aisles with two cross aisles and additional shelf space of irregular structure. Moreover, the warehouse consists of two floors which are connected by two elevators. For most products copies are stored in several different storage locations. Thus, the order batching process also has to decide from which location each product should be picked. We develop a heuristic strategy for order batching which tries to build batches in a close spatial neighborhood. The definition of this neighborhood is based on a general graph model which allows a flexible adaptation to changes in the warehouse structure. The subsequent routing problem can be solved to optimality by a TSP algorithm. However, we also employ an insertion type heuristic with k-opt improvement, which deviates from the optimal TSP solution by less than 1% for the considered real-world instances. The resulting algorithmic framework yields a significant improvement on the total tour lengths of 34.4% on average.