中国科学院数学与系统科学研究院应用数学研究所
Institute of Applied Mathematics, AMSS, CAS

运筹与信息科学研究室
Department of Operations Research and Information Science

学术报告

题　　目： The Storage Locations Assignment Problem in a Robotic Mobile Fulfillment System Considering Uncertain Orders

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时　　间： 6 月 20 日（星期四）下午 15:00-16:00

地　　点： 数学院南楼 733 室

摘　　要： The Robotic Mobile Fulfillment System (RMFS) represents a novel intelligent warehousing, where Stock Keeping Units (SKUs), are stored within movable pods. These pods can be transported by Automated Guided Vehicles (AGVs) to stationary workstations for workers to deposit or retrieve SKUs to fulfill orders. The strategy to assign storage locations to SKUs plays a pivotal role in influencing both the costs of replenishment and picking in an RMFS.Traditionally, studies on storage location assignment have relied on SKU similarity measures, derived from historical orders, to define their objective function, while also presuming that all storage locations are vacant prior to replenishment. This paper investigates the storage location assignment problem in the RMFS, considering the uncertainty of future orders to be picked and the existence of both empty and occupied storage locations before replenishment. The problem is to identify one or multiple empty storage locations for each SKU, by minimizing both the replenishment and expected picking costs. We formulated this problem as a two-stage stochastic programming model, where the first stage assigns one or more empty storage locations for each SKU to be replenished, and the second stage identifies the optimal picking decisions with minimal expected picking cost.

The uncertainty of orders is represented by a finite number of scenarios with known probabilities, and the implicitly expressed stochastic programming model is transformed into an explicit integer programming model. By analyzing the structure of its Lagrangian relaxation model, we developed a Lagrangian relaxation-based heuristic algorithm to solve the model. Finally, we conducted numerous numerical experiments with different scales to verify the effectiveness of the proposed Lagrangian relaxation heuristic algorithm. The experimental results show that the proposed algorithm can find the global optimal solutions for small-scale examples. For medium to large-scale examples, by comparing with three other storage location assignment strategies. the Lagrangian relaxation heuristic algorithm always derives the best solution. Compared to the most popular SKU similarity-based strategy, our algorithm can reduce the gap between the optimal solution and the lower bound by 30%-50%.

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