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Machine Learning heuristic for Variable Cost and Size Bin Packing Problem with Stochastic Items

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Abstract. Third-party logistics becomes an essential component of efficient delivery, enabling companies to rent transportation services instead of keeping an expensive fleet of vehicles. However, the contracts with the carriers usually have to be booked beforehand when the delivery demand is unknown. This decision process is strongly affected by uncertainty, provided with a long (tactical) planning horizon, and can be expressed as choosing an appropriate set of bins (fleet contracts). Formally, it can modeled as the Variable Cost and Size Bin Packing Problem with Stochastic Items [1]. It consists of packing the set of items (goods) with uncertain volumes and quantities into containers (bins) of different fixed costs and capacities. This problem is described via a two-stage stochastic programming approach, where the cost of the bins of the second stage is significantly higher. Since it cannot be solved for large realistic instances by means of exact solvers for a reasonable time and memory consumption, this paper introduces a Machine Learning heuristic to approximate the first stage decision variables. Several numerical experiments are outlined to show the effectiveness of the proposed approach to deal with realistic instances of up to 3000 items. Further, the proposed heuristic is compared to the recent Progressive Hedging-based heuristic and showed a significant computational time reduction. Finally, different classification approaches are compared, and the feature selection process is explained to gain insight into heuristic performance to deal with the outlined problem.

Keywords: Machine Learning; Variable Cost and Size Bin Packing with Stochastic Items, Progressive Hedging

References

[1] Crainic, T. G., Gobbato, L., Perboli, G., Rei, W., Watson, J. P., & Woodruff, D. L. (2014). Bin packing problems with uncertainty on item characteristics: An application to capacity planning in logistics. Procedia-Social and Behavioral Sciences, 111, 654-662.