Waste collection inventory routing with non-stationary stochastic demands

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Abstract

We solve a complex logistical problem inspired from practice, in which a heterogeneous fixed fleet of vehicles is used for collecting recyclable waste over a planning horizon. Each tour starts and ends at the depot, and is a sequence of collections followed by disposals at the available dumps, which can be used when and as needed along the tour. We impose a mandatory dump visit just before the end of the tour, as well as time windows and a maximum tour duration. Each container is equipped with a sensor, which communicates the waste level at the start of the day. Given a history of observations, a forecasting model is used to estimate for each container the point demand forecasts for each day of the planning horizon. The problem falls under the framework of inventory routing. Our main contribution lies in the direct incorporation of probabilistic information, which affects the cost through the probabilities of container overflows and route failures. We develop a mixed integer non-linear program and an adaptive large neighborhood search algorithm, which is integrated with a demand forecasting model specifically designed for our purpose, and tested and validated on real data. We will present numerical experiments on benchmark instances of the vehicle routing and inventory routing problems, and on state-of-practice data. Furthermore, we will analyze the value of stochastic information and the importance of the emergency collection cost, and will present ideas for future research based on model reformulations for different container overflow risk profiles.

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