Disruption management in vehicle routing: problems and models

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Abstract

When distributing goods from a depot to a set of customers, a route and schedule for each delivery vehicle is normally planned that will take into account the customer requirements and constraints such as the capacities of the vehicles and time windows for deliveries. However, after that plan has started to be executed, there may be different types of disruption that mean that the original plan is no longer feasible. Disruption management refers to the process of revising the original plan to reflect the new situation which minimizes the negative impact of the disruption.

In vehicle routing problems, disruptions may occur due to several different types of situations such as vehicle breakdowns, traffic congestion due to accidents, delays in receiving supplies at the depot and other unexpected events. In each case, the best response to the disruption will depend on further details of the distribution problem that is being considered and the relevant objectives for managing the disruption that may include additional costs to customers or the distributor due to deviating from the original plan.

The paper will consider examples of disruption management in vehicle routing, showing how the characteristics of the problem can affect the structure of the resulting optimization model.

In Mu et al. (2011) disruption management is considered when a single vehicle breaks down before it has completed all its deliveries. The case is considered where the delivery is of a single commodity (such as gas containers or oil) that is the same for all customers. This means that any vehicle can be diverted to serve any customer after leaving the depot. Taking the objective to be proportional to the total distance travelled by the vehicles, it is shown that the structure of the disruption management problem is equivalent to an Open Vehicle Routing Problem where each vehicle has a fixed starting point and finishing point at the depot. Two heuristic algorithms are devised and tested based on Tabu Search approaches and compared with results from an exact algorithm.

Mu and Eglese (2013) considers disruption management when there is a delay in orders being released at the depot which means that some, but not all vehicles can leave at the planned time. The objectives considered in the disruption management

problem include minimizing the delays to expected delivery times and minimizing the overtime required for drivers, as well as minimizing costs proportional to the total distance travelled. The structure of the disruption management problem has distinctive features that involve multiple trips for vehicles and the need to consider waiting times.

Zambirinis and Eglese (2014) consider disruption management for the case of a single vehicle breakdown, where the items carried by each vehicle from the depot are for specific customers on the vehicle route (for example in a home delivery operation). This means that to deal with the disruption, the broken down vehicle must be visited by any other vehicle that will take over the delivery of any of its undelivered items and the undelivered items will be transferred to the other vehicle before being transported to the appropriate customer. Minis et al. (2012) have considered this problem and devised a heuristic that has been tested in a real-time fleet management system. Zambirinis and Eglese (2014) provide a mixed integer linear programming formulation for this problem. Features of the formulation and the structure of the problem will be discussed.

References

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