Dial-a-ride with real-time disruptions

OR 2018
Brussels, Belgium

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The problem considered in this work stems from a non-profit organization in charge of transporting patients to medical appointment locations. The patient is picked up at home around half an hour before his appointment time and is then dropped at the appointment location (outward request). The patient may also ask to be picked up at the end of his appointment to be driven back home (return request). Some patients have specific requirements: they can require an accompanying person or to be transported in a wheelchair. The organization proposes door-to-door transportation services for these requests.

This problem is called a dial-a-ride problem (DARP) in the scientific literature. The DARP investigated in this application consists in determining a set of routes for a fleet of vehicles to satisfy the requests, taking into account several constraints: e.g. time window constraints (the pickups and the deliveries have to be achieved within given time intervals), maximum riding time constraints of patients, and vehicle capacity constraints. The objective function is composed of several aspects: minimizing the route length but also maximizing patient satisfaction (reduced waiting time or route duration).

In practice, an initial planning is generated in the evening for the following day. This planning is composed of a routing and a schedule. The routing represents the set of routes, that is the ordered sequences of locations to be visited, for each vehicle. The schedule is composed of the arrival and departure times for each route location, for each vehicle. The initial planning has to meet the set of constraints. However, in practice, even if patients have a fixed appointment time, the appointment duration may vary due to unforeseen circumstances. Thus, even if all requests are known in advance, it may happen that some transportation requests are modified, delayed or cancelled in real-time. For instance, the doctor can be late and thus the patient will be available later than expected. A patient can get sick and thus not able to attend his appointment. Hence, the associated requests are cancelled. The aim of this work is to propose recourse actions to adapt the planning in order to manage these real-time disruptions. The planning should be modified quickly, while trying to minimize the changes to avoid confusion for the drivers and the patients. For this purpose, several operators are defined to be able to temporarily delete a request, to insert a previously deleted request or to definitely cancel a request. Moreover, in practice, several choices can be made and some politics are thus introduced to assess the impact of these choices on several quality indicators, such as the waiting time of the patients, their ride time or the route length. Finally, simulation techniques are used to create scenarios with real-time disruptions.