# Reactive optimization methods for a field service routing problem with stochastic travel and service times

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## 1. The problem

In this talk, we consider a single period problem in which a service company must design tours for its field technicians in order to provide specific services to its customers in the most cost-effective fashion. Each tour (or route) corresponds to the sequence of customers that a given field service technician is scheduled to visit during that period.

A key feature of the problem is that both travel times between locations and service times of customers are stochastic. Furthermore, customers are divided into two types: mandatory and optional. Optional customers can be served at anytime during the planning horizon and may be postponed at any time to a future period. Mandatory customers have an associated hard time window during which they must be served.

We associate with each technician a vehicle and we suppose that this vehicle has unlimited capacity, its own origin and destination depots, and must return to its destination depot by the end of the period (hard time window). The objective is to visit as many optional customers as possible while minimizing the total travel time and visiting all mandatory customers.

To deal with the stochastic travel and service times, we consider reactive optimization approaches in which planned routes are adjusted in real-time. In particular, we allow technicians to drop optional customers from their route, in order to meet time windows at the mandatory customers and at the destination depots.

This problem is closely related to the deterministic multi-period technician routing problem with time windows problem dealt by Tricoire [3] and Bostel et al. [1]. Indeed, the problem that we are addressing is a single period variant of their problem with stochastic travel and service times.

## 2. Solution approaches

To solve this problem, we propose two different solution approaches consisting in a planning stage followed by an execution stage. In the planning stage, we assume that minimal, modal and maximal values for travel and service times are known a priori and we use these values to build routes (ensuring that, in the worst case, we can serve all the mandatory customers that have been planned without any delay). In the execution stage, we use a dynamic programming algorithm to determine the optimal policy, given the realization of the stochastic values for travel and service times.

In the first method, we first build a set of good quality routes containing optional and mandatory customers, using a dynamic programming based heuristic (inspired from Righini and Salani [2]). Then, we select among them one route for each vehicle by solving exactly an integer program. In the second one, we use a column generation based method to build routes. In this method, the subproblem consists, for each vehicle, in building feasible routes containing both optional and mandatory customers, whereas the master problem consists in assigning a feasible route to each vehicle, while ensuring that each mandatory customer is served at least once and that each optional customer is served at most once.

## 3. Experimental results

The proposed solution approaches have been tested and validated on instances based on realistic data. Simulations were also run to assess the effectiveness of these approaches with stochastic travel and service times. Results from the computational experiments and the simulations will be reported and discussed. The comparison with a previously implemented two-stage method will be made.

## References

[1] N. Bostel , P. Dejax , and P. Guez. Multi period planning and routing on a rolling horizon for field force optimization logistics. In B. Golden, S. Raghavan, and E. Wasil (Eds. ), Routing Problems: Latest Advances and New Challenges, pp. 503-526. Springer , 2008.

[2] G. Righini and M. Salani. Decremental state space relaxation strategies and initialization heuristics for solving the orienteering problem with time windows with dynamic programming. Computers and Operations Research, 36(4):1191-1203 , 2009.

[3] F. Tricoire. Optimisation des tournées de véhicules et de personnels de maintenance: application à la distribution et au traitement des eaux. Ph. D. dissertation, École des Mines de Nantes, 2006.