Solving Vehicle Routing Problems with Profits

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Studied problems and applications

- The "Orienteering Problems" involve two decisions: which customers should be visited ? How to order their visits ?
- Problems with conflicting objectives: maximize the collected profit and minimize the routing costs.
- Several constraints: time windows, fleet size, vehicle with limited capacity, maximal tour length, drivers breaks, hotels selection...etc.
- Real applications : tourist trip planning, cash-in-transit transport, last kilometer logistics.

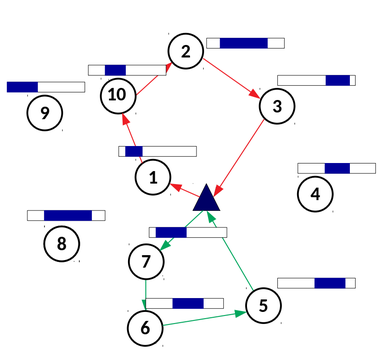

Figure 1: example of solution for the Orienteering Problem with Times Windows (TOPTW)

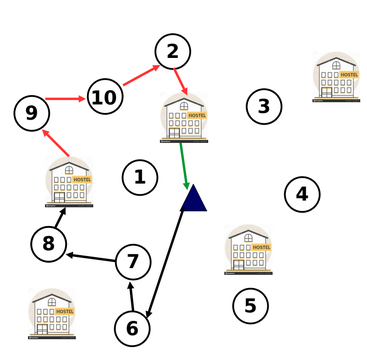

Figure 2: example of solution for the Orienteering Problem with Hotels Selection (OPHS)

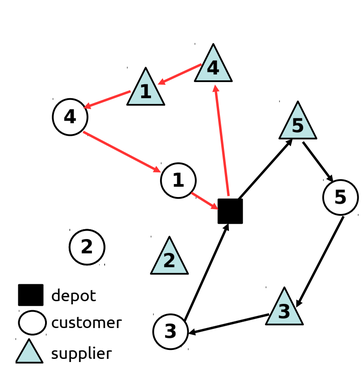

Figure 3: example of solution for the Pickup and Delivery Problem with Time Windows and Profits (PDPTWP))

Solution approaches

Mono-objective problems

- Using different representations of the same problem each one being associated with its proper search space and neighborhoods.

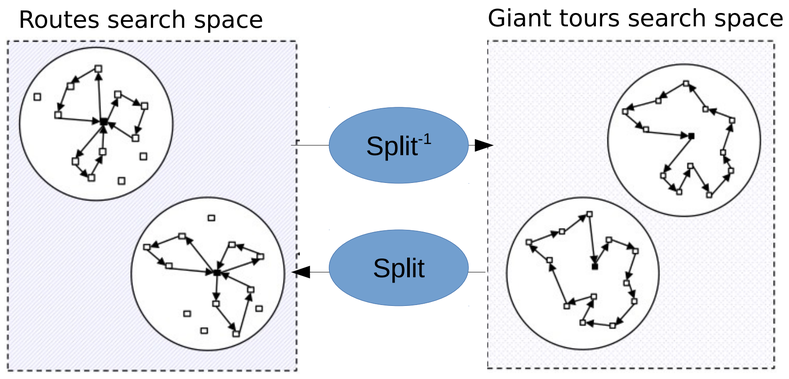

Figure 4: Variable Search Space approach

- "Order-first Route-second" with dedicated optimal splitting procedures: find the longest path on an auxiliary directed acyclic graph.

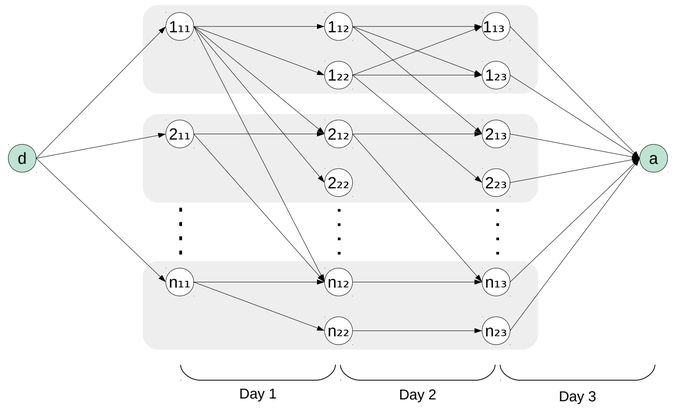

Figure 5: The auxiliary graph associated with a giant tour $\{1, 2, \ldots, n\}$, in an OPHS instance with 2 hotels and 3 periods

Multi-objective problems

- Handling simultaneously profit maximization and travel cost minimization in the Selective Pickup and Delivery Problem with Reserved Requests.
- Decomposition-based multi-objective approach: decomposition into single-objective optimization sub-problems, adaptive insertion criterion within Pareto Local Search framework, perturbation mechanisms to modify the search direction of sub-problems.

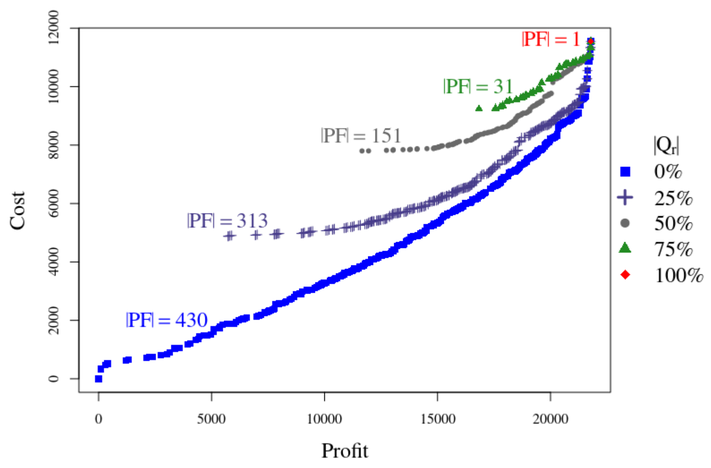

Figure 6: Pareto set approximation according to the percentage of reserved requests in the PDPTWP

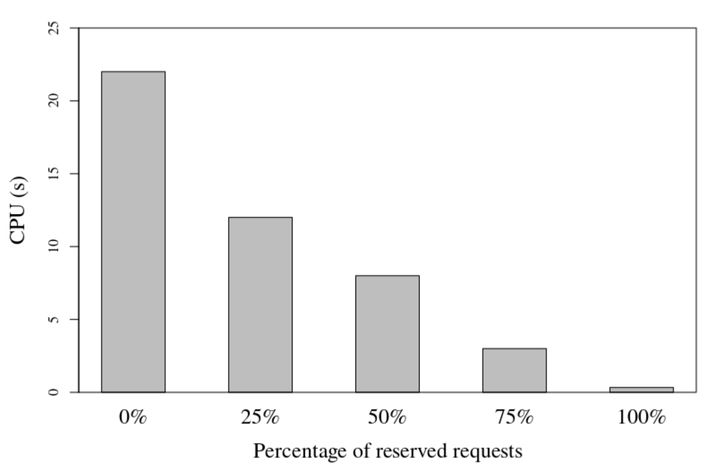

Figure 7: Computation time according to the percentage of reserved requests in the PDPTWP

Results

- The results obtained on the benchmark instances show the effectiveness of our approaches in comparison of the state-of-the-art algorithms: best relative gap, reduced cpu time and strict improvements.

Perspectives

- Understand what happens when a meta heuristic navigates between giant tours and complete solutions. It is probably possible to obtain better results by defining criteria to decide when Split or Split^{-}1 must be called.
- Develop a method able to recommend suitable operators/algorithms for different Selective VRP instances.
- Investigate the development of exact approaches.

References

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[2] Racha El-Hajj, **Rym Guibadj**, Aziz Moukrim, and Mehdi Serairi. A pso based algorithm with an efficient optimal split procedure for the multiperiod vehicle routing problem with profit. *Annals Of Operations Research*, 291(1):281–316, 2020.

[3] Asma Ben-Said, Aziz Moukrim, **Rym Guibadj**, and Jérôme Verny. Using decomposition-based multi-objective algorithm to solve selective pickup and delivery problems with time windows. *Computers & Operations Research, Submitted on January 2021.*