

Optimization and Simulation

Optimization lab 2: VRPTW improvement heuristics

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April 26, 2016



Overview

- 1 Solomon (1987) Algorithms
- 2 Exercise
- 3 Bibliography

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Solomon (1987) Algorithms

- The algorithms developed by Solomon (1987) can be classified as construction heuristics.
- Their purpose is to provide a good initial solution for improvement (meta-)heuristics such as local search, tabu search, simulated annealing, etc. to work on.
- Hence, a lot of solution methodologies for the VRP, especially developed in the 90s and early 2000s, follow this construction-improvement principle.
- On the other hand, modern state-of-the-art algorithms tend to be insensitive to the initial solution, and may often start from an empty solution.

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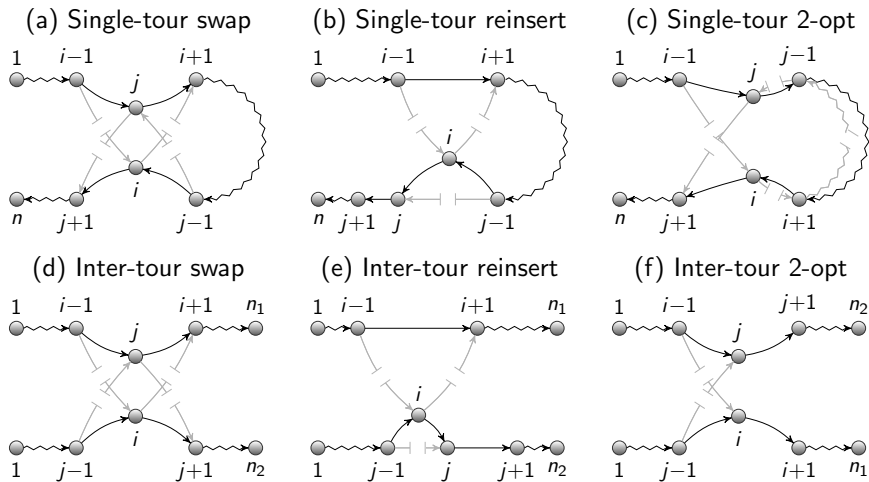
Exercise

- Your second lab exercise is to implement and compare several simple improvement heuristics:
 - First improvement local search
 - Best improvement local search
 - Simulated annealing
- When designing and implementing heuristics, we can either:
 - Only accept feasible solutions in the neighborhood defined by our operator(s).
 - Or relax some or all of the constraints but penalize dynamically the degree of violation in the objective function.
- In this lab, we will only accept feasible solutions in the neighborhood. We can provide references about the second approach to the interested students.

Neighborhood operators

- Your search space is defined by your neighborhood operators.
- Operators allow you to move from one solution to another.
- They need to reflect the structure of your problem.
- Some of the most used operators for the VRP are swap, reinsert and 2-opt.
- For this exercise, you can base your search on the reinsert operator.

Figure: VRP Neighborhood Operators



Source Markov et al. (2016)

A few notes on the improvement algorithms

- Best improvement local search fully explores the neighborhood at each iteration and moves to the best improving solution.
- First improvement local search moves to the first improving solution in the order of neighborhood exploration that you have defined.
- Depending on the quality of the initial solution, one or the other may perform better.
- Both methods terminate when they cannot find an improving solution.
- Simulated annealing, on the other hand, is a randomized search. It draws a random solution from the neighborhood and applies an acceptance criterion to decide whether it is accepted or not. Theoretically, it should be less prone to becoming trapped in local optima, as it allows deteriorating solutions as well.

Bibliography

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- Solomon, M. M. (1987). Algorithms for the vehicle routing and scheduling problems with time window constraints. *Operations Research*, 35(2):254–265.