Algorithm design

Assignment 2: Local search algorithms

Instructions

- The assignment is worth 9% of the final grade.
- The deadline is Friday, December 10 at 23.59.
- Hand in (i) a report in pdf-format, (ii) your code as a zip-file (you can use the programming language of your choice), and (iii) your best solutions in a zip-file (see below for more details).
- The assignment can be made in groups of at most two students.

Problem description

Consider a capacitated vehicle routing problem (CVRP) with:

- a single depot,
- n customers having demands of different quantities,
- an unlimited number of identical trucks, and
- a capacity Q for each truck.

The goal is to design vehicle routes such that the total distance traveled by the vehicles is minimized, the customer demands are satisfied and the vehicle capacity is not exceeded. A route starts and ends at the depot and serves a number of customers such that the total demand of the served customers does not exceed the vehicle capacity. On Canvas you find 5 instances of the CVRP. In each file node 1 is the depot and hence has no demand. For each node you find the x and y coordinates, where the Euclidian distance (rounded to two decimal places) should be used when computing the distance between any two nodes. The rest of the file should be self explanatory.

Exercise 1

a. Develop a greedy constructive heuristic. Provide a clear but concise explanation of the main steps of your algorithm. Implement the greedy heuristic and report the objective values for all instances.

b. Define at least three neighborhoods for a CVRP solution and determine the size of each neighborhood.

c. Use the neighborhoods to develop a Variable Neighbourhood Descent (VND) heuristic. Provide a clear but concise explanation of your algorithm. Implement the VND heuristic, where you use the solution from the first part as starting solution. Report the objective values for each instance.

d. Develop a GRASP heuristic, where you use the VND as the local search component. Again provide a clear but concise explanation of the main steps. Report the best objective values found for each instance, where the allowed runtime is 10 minutes. Furthermore, hand in the best solutions in the following format:

- the filename is `solution_x.txt` for instance $\texttt{x} \in \{1, \ldots, 5\}$
- each line in the file corresponds to a route, given by the nodes visited (excluding the depot)
- example: if the solution consists of two routes $1 - 5 - 2 - 6 - 1$ and $1 - 4 - 3 - 1$ (with node 1 being the depot), then the file consists of the lines:
  ```
  5 2 6
  4 3
  ```

e. Compare the developed algorithms and report on your findings.