Assignment 2

This assignment is a group assignment and you should only collaborate with the students within your group. Do not copy or share code from/to other groups. The same holds for your report. Collaborate solely with your group members.

Hand in a .pdf on Canvas containing your answers to the questions and submit your R-code. Do not put them all together in a zip-file but upload the documents separately. The Deadline is June 23rd, 2022. To pass this course you need at least a grade of 4.5 for this assignment. Thus, if your grade is lower than 4.5, you must go for the improvement option to pass the course. If your grade for this assignment is lower than 5.5 (but higher than 4.5), you have an option to improve your assignment. The deadline to hand in the improvement option is 7 days after the grades of this assignment are released.

This assignment sums up to 100 point. Your grade can be computed by dividing your total points by 10. Note that, following the grading guidelines, the grade will be rounded to one decimal.

Arranging the deliveries for your product launch.

Tomorrow is an important day. You have launched a new sustainable product and you have to make sure it will be in all of your retail stores before they open. Therefore, today you have to visit all your stores and deliver the first items of this great product. Selling a product as sustainable will only work if also the transport of this product is arranged in a sustainable way. You are happy to have an electric van, so that is not the problem, however, then still it will be more sustainable if the total traveled distance is minimized.

It is now your task to come up with a route which has shortest total distance in which all of your retail stores are visited. In DistanceMarixAss2.csv the distances between each pair of shops is provided.

Note whenever you do something with random number. Make sure that at the start of your code you set the seed of the random number generator equal to 5 (this way you always get the same outcome if you run the algorithm again).

Question 1

In this part of the assignment, we aim to come up with (start) solutions. In Question 2, we are going to check whether we can improve these solutions.

a. (30 points) In the video of Approximation Algorithms of week 3 (Video 3.2) we have already discussed an approximation algorithm for the Traveling Salesman Problem. Apply this algorithm to the problem at hand. Report the tour found and the corresponding objective.
b. (15 points) Write 3 more small algorithms to create start solutions. Clearly describe how they work. Note: they can be as easy as going from 1 to 2 to 3 to 4 etc. It is about you defining 3 of these different algorithms and you being able to describe which steps you have taken. Run all these algorithms and provide the resulting routes and objective function values. *You will not be judged on the objective function values of the start solutions.*

Question 2

Now you will be asked to implement search heuristics to improve the solutions found in question 1. **For each question apply the search heuristic 4 times**, once for each start solution found in question 1.

a. (20 points) Implement the following neighborhood search algorithm. A neighbor solution is a solution in which 2 cities which are visited directly after each other are swapped in order.
   - Do 2000 iterations
   - Randomly select a city and swap it with the next city in a tour
   - Accept the new solution if it was better than the previous solution
   - For each start solution, report the best found solution and its corresponding objective function value.

b. (5 points) Implement the following neighborhood search algorithm. A neighbor solution is a solution in which 2 cities are swapped in order.
   - Do 2000 iterations
   - Randomly select 2 cities and swap them in the tour
   - Accept the new solution if it was better than the previous solution
   - For each start solution, report the best found solution and its corresponding objective function value.

c. (5 points) Implement the following neighborhood search algorithm. A neighbor solution is a solution in which the order of the route between 2 cities is reversed.
   - Do 2000 iterations
   - Randomly select 2 cities and reverse the order in which you visit the cities inbetween.
     - E.g. You have tour 1-2-3-4-5-6-7-8-9-10, and you randomly select city 3 and 7, then the new tour will be 1-2-***7-6-5-4-3***-8-9-10
   - Accept the new solution if it was better than the previous solution
   - For each start solution, report the best found solution and its corresponding objective function value.

d. (15 points) Create one neighborhood search algorithm yourself. Clearly explain (e.g. also with graphics) how the neighborhood is generated. Also include in this neighborhood search algorithm that with probability 1% you accept a worse solution to become the next solution. Do not forget to report the best found solution for each start solution and its corresponding objective function value.

e. (10 points) Comment on the neighborhood heuristics tested in questions a,b,c and d. Which one did perform best, do you have an idea why? What can you conclude about the quality of the solution found?