IMEN281 Information System Technology
Pohang University of Science and Technology
Fall 2020

Homework 3: Travelling Salesman Problem

Due Date: Dec. 27 (Sunday) 11:59 p.m.

Problem Description

The traveling salesman problem (TSP) is about "Given a list of cities and the distances between each pair of cities, what is the shortest possible route that visits each city exactly once and returns to the origin city?". In the theory of computational complexity, the decision version of the TSP, which is deciding whether the graph has a tour of at most L, belongs to the class of NP-complete problems. Thus, it is possible that the worst-case running time for any algorithm for the TSP can not be solved in polynomial time concerning the number of cities.
The problem was first formulated in 1930 by Merrill M. Flood who was looking to solve a school bus routing problem and is one of the most well-known and intensively studied problems in optimization. It is used as a benchmark for many optimization methods. Even though the problem is computationally difficult, many heuristics and exact algorithms are known, so complicated problems can be solved easily in polynomial times in practice.
The TSP has several applications even in its purest formulation, such as planning, logistics, and the manufacture of microchips. Slightly modified, it appears as a sub-problem in many areas, such as DNA sequencing. Also, TSP is the special case of the traveling purchaser problem and the vehicle routing problem.

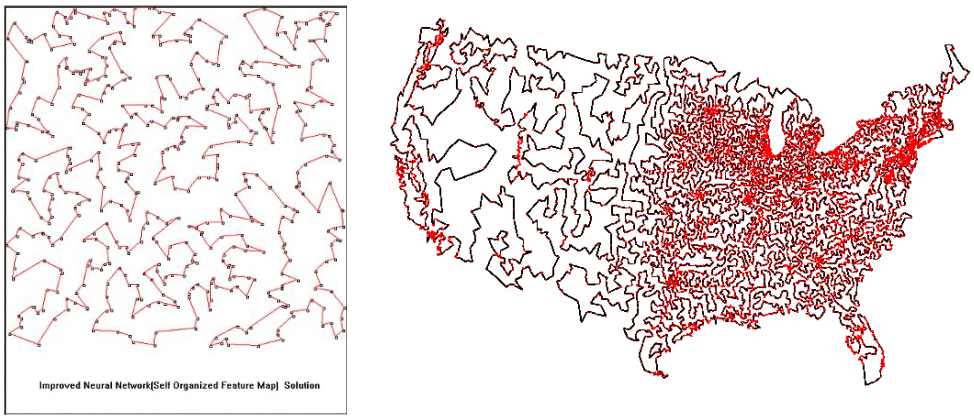

Figure 1: Example of Travelling Salesman Problem (TSP)

Heuristic Algorithms

As we discussed before in the class, full enumeration or linear programming is not proper to solve the large size problems. For this reason, many heuristic algorithms for TSP have been invented. There are two kinds of algorithms in TSP: construction algorithms and improvement algorithms.

Construction Algorithm

In this homework, we are going to implement one of the simple greedy algorithm: Nearest Neighbor, Nearest Addition, Farthest addition. For a detailed explanation, please refer to the Lab week12 class note.

Improvement Algorithms

Improvement algorithms start from a complete tour computed by another heuristic and improve tours in various ways. In this homework, we are going to implement 2-OPT Algorithms (full, greedy).

Definition of tour

In the complete tour, each cites should be visited once and the salesman must return to the origin cities at the end of the journey.

Distance Metric

For this homework, use euclidean distance as a measure of the distance between two cites.

Problem

1. Read the input data files (TSP_10.txt, TSP_100.txt, TSP_1000.txt)
2. Implement three construction Algorithms: Nearest Neighbor, Nearest Addition, Farthest addition.
3. Implement two improvement Algorithms: 2-OPT full, 2-OPT greedy.
4. Test three construction algorithms on given datasets and report the total length of tours on the report.
5. Starting from the solution of Nearest Neighbor, test two improvement Algorithms and report the total length of tours on the report
6. BONUS) Propose and test your own algorithm. Specify your algorithms and total length of tours on the report.

Input Data Format

* Each row of input data correspond to one data point, containing index, x, y.

Special Note

* For each solution, run 10 sample runs and report the average performance in the report.
* You can use the following external libraries: numpy, matplotlib
* Please organize your thoughts and write down them in the report.

Submission

1. **Implemented code with comment**
2. **Report**
   (a) Objective
   (b) Method and Algorithm
   (c) Discussion
   (d) If you receive help from someone else on the homework, you must specify who, which part (debugging, logic, coding) and how much (time) in the report.
   (e) Time spent on assignment

Due Date and Late Submission

* Due Date is Dec.27 (Sunday) 11:59 p.m.
* 20% deduction for one day late and not received after 3 days (zero point) - No exception applies unless there is a special reason.