Probabilistic Algorithms Project

Comparing heuristics for TSP

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1 Introduction

The Traveling Salesman Problem (TSP) is an old problem, having written sources as old as almost 300 years. The problem consists of a person needing to visit n cities, but with constraints. The constraints are that the person must visit each of the n cities only once, and must do it in an optimal way, i.e., the total traveled distance must be the smallest possible.

This problem is hard to solve deterministically. Indeed, to find the optimal solution, we would need to test every possible path in the graph composed of the n cities, and the paths between them. If there are n cities, the number of paths to test is $n!$, and the computations become impractical when n is as small as 20.

This hardness justifies the need to use heuristics, and probabilistic algorithms to solve the problem. Of course, there is no guarantee that we will find the optimal path, but the heuristics return good enough paths. The goal of this project is to compare a few heuristics that can be used to solve the TSP. We will compare the best solutions found by each algorithms, the differences for the routes, the performance of the algorithms, and pairwise statistical comparison of the algorithms.

2 Comparison of loss values

Denote by $\mathcal{L}$ the sequence $\{L(\sigma_1^*), \ldots, L(\sigma_m^*)\}$ of the best solutions generated after calling each implemented algorithms $m = 30$ times. We will present tables showing the minimum of $\mathcal{L}$, the maximum, the average and the 95% condidence interval for this average for each implemented algorithms.

Table 1: Construction heuristics

Algorithms	min($\mathcal{L}$)	max($\mathcal{L}$)	mean($\mathcal{L}$)	Confidence interval at 95%
best insertion	1470.1821	1563.2285	1516.5628	[1506.6866, 1526.4391]
shortest edge	1584.0766	1753.079	1671.8119	[1656.668, 1686.9558]

Table 2: Improvement heuristics

Algorithms	min($\mathcal{L}$)	max($\mathcal{L}$)	mean($\mathcal{L}$)	Confidence interval at 95%
swap	1459.2188	1557.0646	1506.8777	[1497.346, 1516.4094]
translation	1443.1734	1513.6743	1483.3338	[1476.954, 1489.7137]
inversion	1441.9932	1538.6809	1486.538	[1477.6003, 1495.4757]
mixed	1417.9906	1497.824	1457.8618	[1451.398, 1464.3255]

Table 3: Simulated annealing

Algorithms	min($\mathcal{L}$)	max($\mathcal{L}$)	mean($\mathcal{L}$)	Confidence interval at 95%
Metropolis	1484.3271	1570.1874	1520.7171	[1512.8956, 1528.5386]
Heat Bath	1494.7218	1571.5438	1524.188	[1517.14, 1531.236]