Metaheuristic Algorithms - Laboratory 4

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January 2024

Introduction

The aim of the laboratory is to implement a *genetic algorithm* solving the *Traveling Salesman Problem* (TSP).

0.1 Implementation Details

1. The initial population consists of a set of random permutations of vertices.
2. Parent selection - implementation of two methods:
   (a) Random individual from the population.
   (b) Tournament - the best individual from a randomly chosen subset of k individuals from the population.
3. Parent crossover - implementation of two methods:
   (a) Partially Mapped Crossover (PMX) [1] - **two** crossover points.
   (b) Insertion of genes at indices $[0, .., i]$ of the second parent of the pair into genes at indices $[0, .., i]$ of the first parent - **one** crossover point.
4. After each crossover, if necessary, **the worst** individuals of the population are discarded to maintain a constant population size.
5. Population mutation involves inverting vertices at indices: $[i, ..., j]$.

[1] `https://user.ceng.metu.edu.tr/~ucoluk/research/publications/tsp.pdf`

Results

0.2 Comparison of Crossovers

One-Point-Cross	**Two-Point-Cross**
647	643
1457	1199
2440	1659
2529	1752
2849	1827
2984	1963
3040	2052
3376	2237
3518	2247
8734	5343
21454	12480
36020	21341
59268	36276
80479	51505
112687	72344

Table 1: Comparison of Crossovers

0.3 Observations and Conclusions

The initial population consists of random individuals. The application of two-point crossover yields noticeably better results, nevertheless still deviating from previously implemented algorithms, see Table 0.3. The genetic algorithm itself is not a good tool for solving TSP. However, it serves as a good foundation upon which another algorithm (e.g., Local Search) can be used for further optimization.

Summary of All Implemented Algorithms

Data	Optimal	LS	SA	TS	TPC	OPC
xqf131	564	584	597	599	643	647
xqg237	1019	1043	1090	1119	1199	1457
pma343	1368	1434	1436	1481	1659	2440
pka379	1332	1385	1406	1443	1752	2529
bcl380	1621	1686	1785	1778	1827	2849
pbl395	1281	1363	1360	1439	1963	2984
pbk411	1343	1419	1466	1493	2052	3040
pbn423	1365	1446	1487	1531	2237	3376
pbm436	1443	1535	1541	1611	2247	3518
xql662	2513	2630	2766	2812	5343	8734
xit1083	3558	3733	3897	4090	12480	21454
icw1483	4416	4694	4906	5064	21341	36020
djc1785	6115	6440	6902	7124	36276	59268
dcb2086	6600	7016	7574	7720	51505	80479
pds2566	7643	8095	9333	8955	72344	112687

Table 2: Results - ***LS*** - *Local Search,* ***SA*** - *Simulated Annealing,* ***TS*** - *Tabu Search,* ***TCP*** - *genetic (two-point-crossing),* ***OCP*** - *genetic (one-point-crossing)*