

Assignment 7: Large neighborhood search

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Source: [link](#)

Reminder of the method

Generate an initial solution x

$x := \text{Local search } (x)$ (optional)

Repeat $y := \text{Destroy } (x)$

$y := \text{Repair } (y)$

$y := \text{Local search } (y)$ (optional)

If $f(y) > f(x)$ then

$x := y$

Until stopping conditions are met

Destroy operator should remove a relatively large fraction of nodes/edges from the current solution, e.g. 20-30%. The removed edges could be selected at random, as a single subpath, or several subpaths. You can try to propose some heuristic rules to remove “bad” nodes/edges, e.g. long edges or costly nodes. Such heuristics should be, however, randomized not completely deterministic. For example the probability of removal should depend on the length/cost.

As repair operator use the best greedy heuristic (including greedy-regret) from previous assignments.

The destroy-repair operators should be clearly described.

As the starting solution use random solution.

Implement two versions of LNS – using or not local search after destroy-repair operators. Use the best version of steepest local search. Always apply local search to the initial solution. Computational experiment: Run each of the methods (with and without local search) 20 times for each instance. Use the average running time of MSLS from the previous assignment. Report also the number of iterations of the main loop. Reporting results: Use tables as in the previous assignments. Add a table with the number of iterations of the main loop. Include results of MSLS, ILS, and the best greedy heuristic (including regret) and basic local search. The outline of the report as previously.

Pseudo code

```
Generate initial solution using LS and remember it as the best one

Calculate number of nodes to be destroyed in each destroy() operator
(e.g. 25%)

Calculate costs of connecting each node to each other node in the
problem

Calculate neighborhood costs of all nodes, used as weighted for
probability to choose nodes in destroy() operator

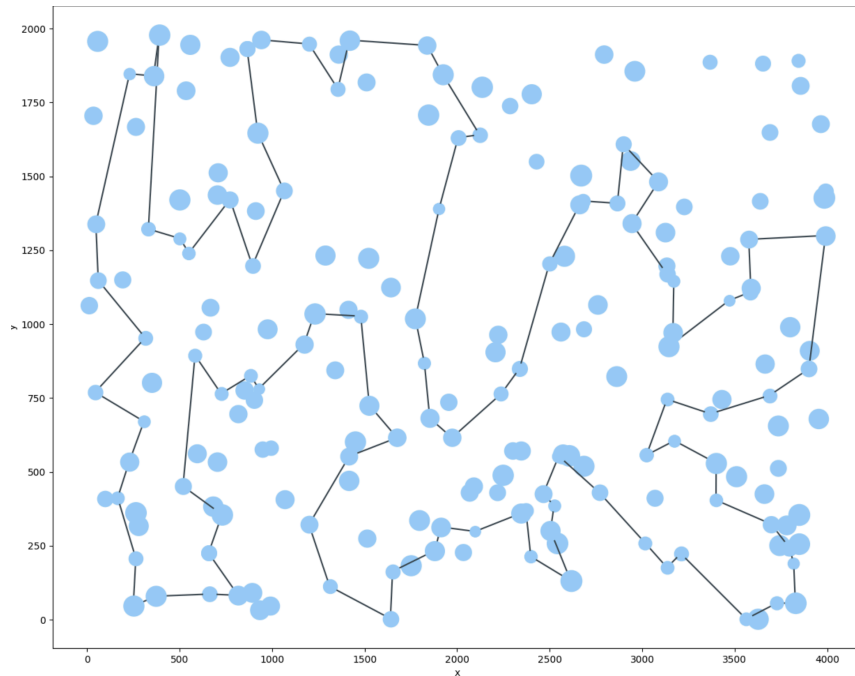
For each run in range(num_runs):
    Generate random initial solution
    Apply local search to solution with steepest strategy and
    edge-based intra-search
    Add solution and its cost to ratings

    While total running time is less than that of MSLS
        Create destroyed solution by applying destroy() to the best
        solution
        Create repaired solutions by using repair() on the destroyed
        solution
        Run Local Search on repaired solution (depending on algorithm)
        If objective function of the repaired solution is less, update
        the best solution

    Return the best solution
```

TSPA

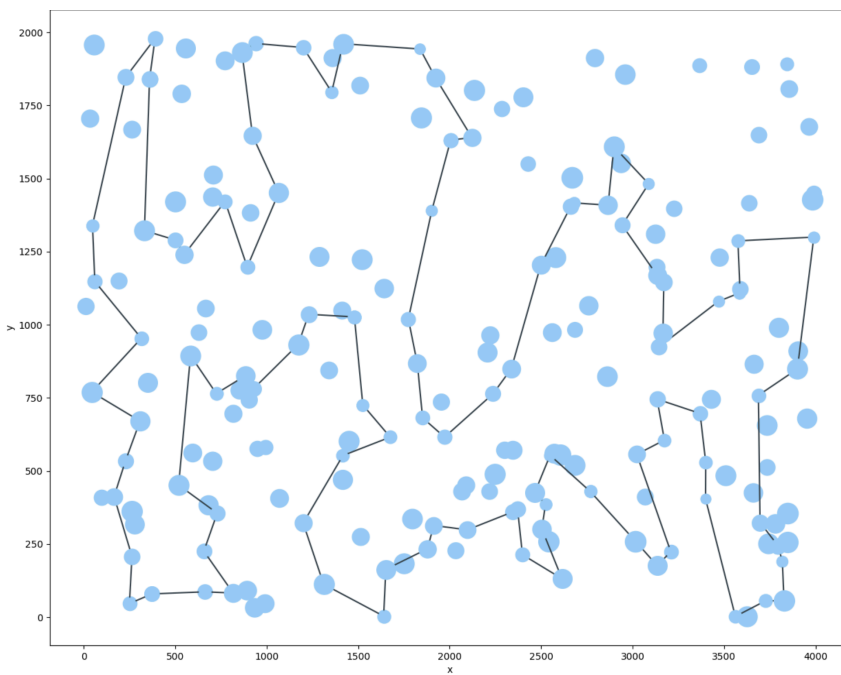
Without LS



Best solution:

[159,193,41,139,115,46,68,140,93,117,0,143,183,89,186,23,137,176,80,79,63,94,124,148,9,62,102,144,14,49,178,106,52,55,185,40,119,165,90,81,196,179,57,129,92,145,78,31,56,113,175,171,16,25,44,120,2,152,97,1,101,75,86,26,100,53,180,154,135,70,127,123,162,133,151,51,118,59,65,116,43,42,184,35,84,112,4,190,10,177,54,48,160,34,181,146,22,18,69,108]

With LS

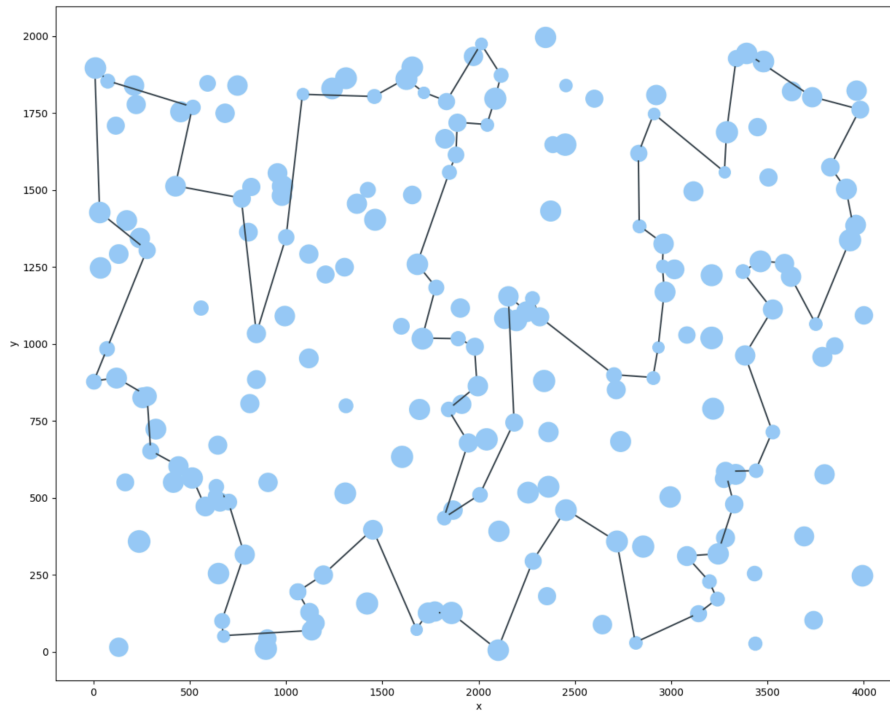


Best solution:

[181,146,22,18,108,69,159,193,41,139,115,46,68,140,93,117,0,143,183,89,186,23,137,176,80,
79,63,94,124,148,9,62,102,144,14,49,178,106,52,55,185,40,119,165,90,81,196,31,56,113,175,
171,16,78,145,179,57,92,129,25,44,120,2,152,97,1,101,75,86,26,100,53,180,154,135,70,127,1
23,162,133,151,51,118,59,65,116,43,42,184,35,84,112,4,190,10,177,54,48,160,34]

TSPB

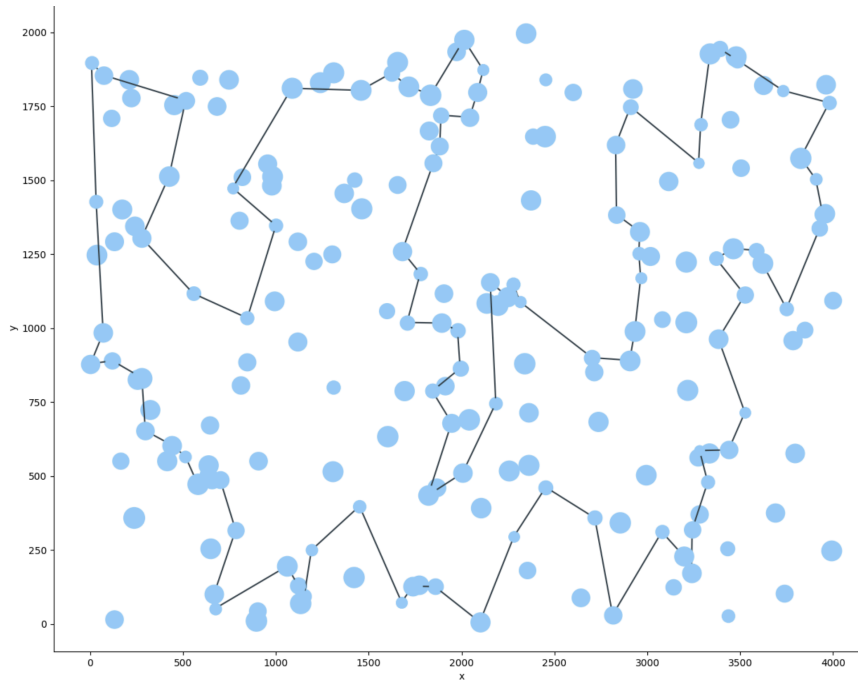
Without LS



Best solution:

[147,6,188,169,132,70,3,15,145,13,195,168,139,11,138,33,160,144,104,8,21,82,111,29,0,109,3
5,143,106,124,62,18,55,34,170,152,183,140,4,149,28,20,60,148,47,94,66,179,22,99,130,95,18
5,86,166,194,176,113,103,163,89,127,165,187,153,81,77,141,91,61,36,177,5,45,142,78,175,80
,190,136,73,54,31,193,117,198,156,1,16,27,38,135,63,40,107,133,122,90,121,51]

With LS



Best solution:

[183,140,4,149,28,20,60,148,47,94,66,179,22,99,130,95,185,86,166,194,176,113,103,127,89,163,187,153,81,77,141,91,61,36,177,5,78,175,142,45,80,190,136,73,54,31,193,117,198,156,1,16,27,38,63,40,107,133,122,135,131,121,51,90,147,6,188,169,132,70,3,15,145,13,195,168,139,11,138,33,160,144,104,8,21,82,111,29,0,109,35,143,106,124,62,18,55,34,170,152]

Comparison tables

Objective function values

Method	Dataset A	Dataset B
Random generation, edge, steepest	73855.835(70939-77610)	48296.625(45319-50992)
Multiple start local search	72010.48(70553-72972)	46477.23(45212-47381)
Iterated local search	70797.655(69875-72440)	45494.965(44070-47548)
Large Scale Neighborhood	69935(69230-71274)	44984(44437-46112)

Search without LS		
Large Scale Neighborhood Search with LS	69774(69230-70258)	44373(43550-45506)

Running times

Method	Dataset A	Dataset B
Random generation, edge, steepest	3.3 s	3.17 s
Multiple start local search	46.43 s	46.24 s
Iterated local search	46.42 s	46.23 s
Large Scale Neighborhood Search without LS	47.29 s	47.28 s
Large Scale Neighborhood Search with LS	47.26 s	47.31 s