01-greedy-heuristics

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1 Greedy Heuristics

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1.1 Description of a problem

We are given three columns of integers with a row for each node. The first two columns contain x and y coordinates of the node positions in a plane. The third column contains node costs. The goal is to select exactly 50% of the nodes (if the number of nodes is odd we round the number of nodes to be selected up) and form a Hamiltonian cycle (closed path) through this set of nodes such that the sum of the total length of the path plus the total cost of the selected nodes is minimized.

The distances between nodes are calculated as Euclidean distances rounded mathematically to integer values. The distance matrix should be calculated just after reading an instance and then only the distance matrix (no nodes coordinates) should be accessed by optimization methods to allow instances defined only by distance matrices.

2 Algorithms

2.1 Random Solution

Function init_random_solution$(dataset, distance\_matrix, start\_node)$:

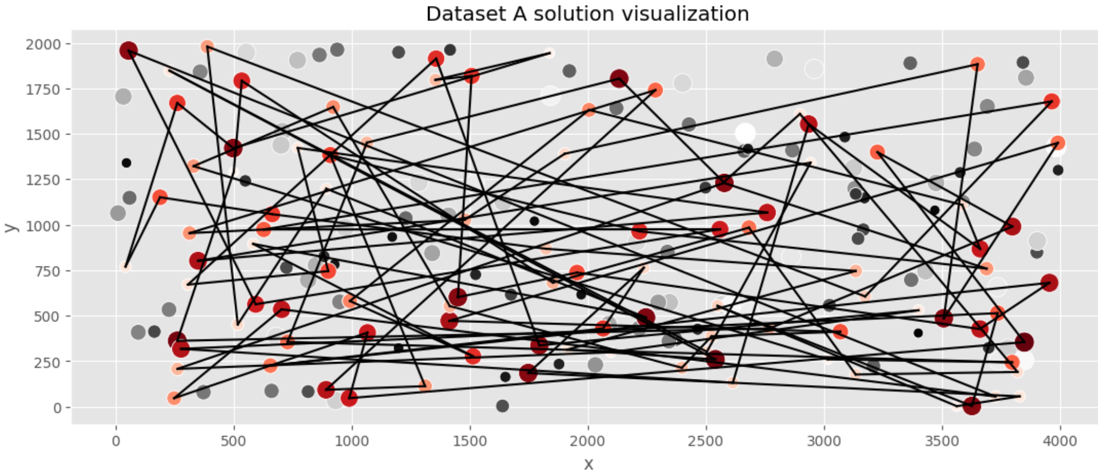
Calculate subset size as half of the dataset size (rounded)

Randomly sample nodes from the dataset to create a subset of calculated size

Returnthe randomly generated subset of nodes

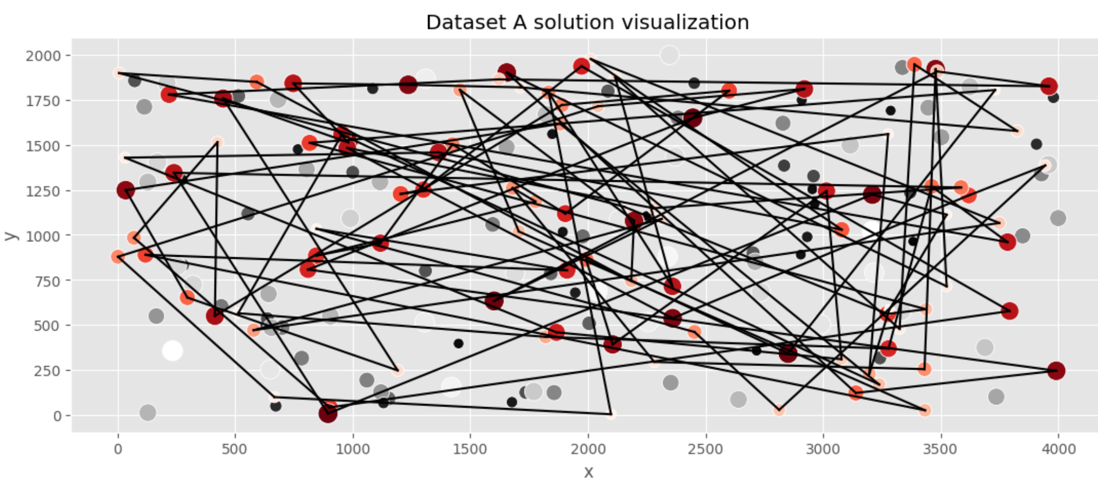
Dataset A

```
Best solution: [169, 40, 23, 149, 194, 42, 99, 115, 184, 108, 92, 71, 5, 111,
28, 134, 171, 166, 10, 24, 29, 188, 138, 174, 2, 147, 193, 163, 79, 167, 44,
113, 144, 37, 196, 12, 198, 127, 126, 114, 181, 51, 137, 7, 168, 27, 161, 82, 1,
86, 162, 68, 159, 120, 56, 35, 46, 83, 33, 177, 53, 145, 173, 170, 160, 47, 139,
128, 192, 49, 101, 18, 150, 180, 57, 80, 96, 195, 34, 199, 142, 183, 0, 153, 45,
122, 38, 98, 84, 136, 94, 6, 175, 16, 152, 88, 157, 104, 75, 155]
Objective function statistics:
minimum = 236601
mean = 262859.735
maximum = 297066
```



Dataset B

```
Best solution: [48, 162, 38, 122, 30, 13, 184, 49, 134, 158, 112, 11, 139, 77,
114, 101, 166, 65, 165, 93, 19, 167, 53, 145, 27, 190, 141, 132, 41, 3, 113,
149, 148, 169, 192, 115, 67, 44, 5, 156, 92, 195, 127, 71, 117, 21, 26, 130, 52,
72, 188, 23, 28, 171, 35, 193, 179, 70, 128, 85, 63, 87, 163, 83, 58, 144, 186,
20, 191, 194, 180, 29, 40, 10, 111, 12, 6, 138, 137, 16, 56, 121, 81, 187, 94,
22, 14, 120, 109, 99, 32, 46, 181, 185, 176, 89, 183, 118, 74, 161]
Objective function statistics:
minimum = 187699
mean = 212675.575
maximum = 244471
```



2.2 Nearest Neighbors Considering Adding the Node Only at the End of the Current Path

Function init_nearest_neighbor_end$(dataset, distance\_matrix, start\_node)$:

Calculate subset size as half of the dataset size (rounded)

Initialize solution with start_node

Mark start_node as visited

While solution size is smaller than subset size :

Find the last node in the solution

Calculate distances from the last node to all unvisited nodes

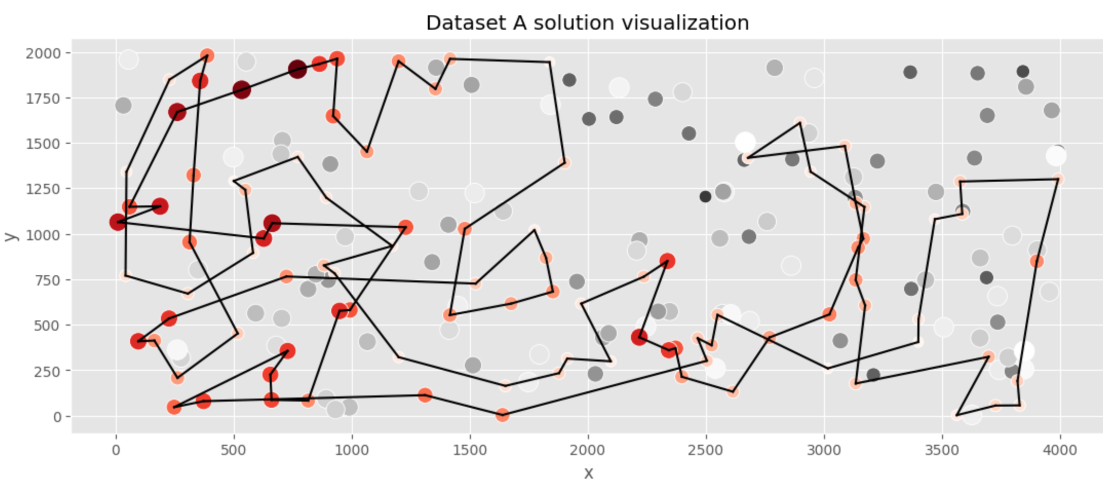
Select the nearest unvisited node and add it to the solution

Mark this node as visited

Returnthe solution as a subset of the dataset

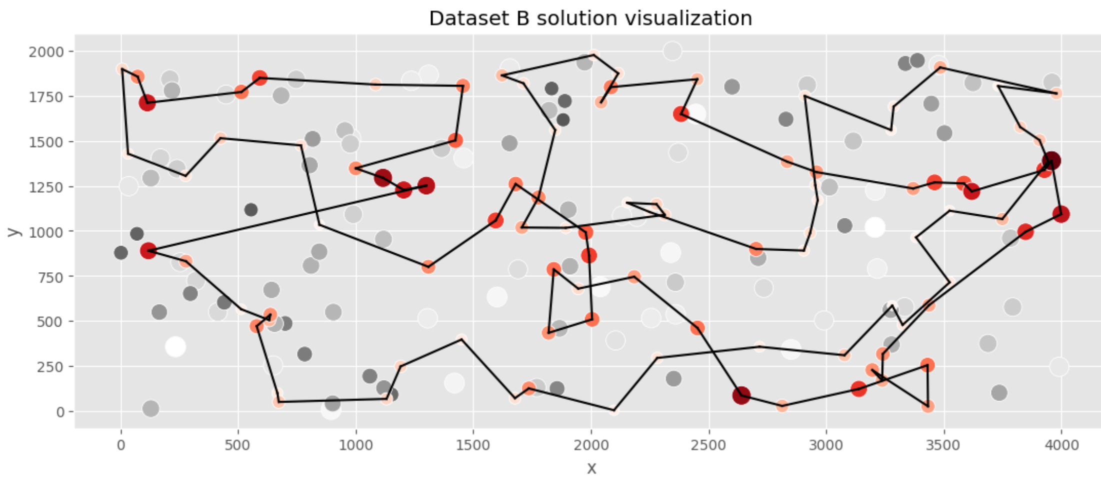
Dataset A

```
Best solution: [124, 94, 63, 53, 180, 154, 135, 123, 65, 116, 59, 115, 139, 193,
41, 42, 160, 34, 22, 18, 108, 69, 159, 181, 184, 177, 54, 30, 48, 43, 151, 176,
80, 79, 133, 162, 51, 137, 183, 143, 0, 117, 46, 68, 93, 140, 36, 163, 199, 146,
195, 103, 5, 96, 118, 149, 131, 112, 4, 84, 35, 10, 190, 127, 70, 101, 97, 1,
152, 120, 78, 145, 185, 40, 165, 90, 81, 113, 175, 171, 16, 31, 44, 92, 57, 106,
49, 144, 62, 14, 178, 52, 55, 129, 2, 75, 86, 26, 100, 121]
Objective function statistics:
minimum = 83182
mean = 85108.51
maximum = 89433
```



Dataset B

```
Best solution: [16, 1, 117, 31, 54, 193, 190, 80, 175, 5, 177, 36, 61, 141, 77,
153, 163, 176, 113, 166, 86, 185, 179, 94, 47, 148, 20, 60, 28, 140, 183, 152,
18, 62, 124, 106, 143, 0, 29, 109, 35, 33, 138, 11, 168, 169, 188, 70, 3, 145,
15, 155, 189, 34, 55, 95, 130, 99, 22, 66, 154, 57, 172, 194, 103, 127, 89, 137,
114, 165, 187, 146, 81, 111, 8, 104, 21, 82, 144, 160, 139, 182, 25, 121, 90,
122, 135, 63, 40, 107, 100, 133, 10, 147, 6, 134, 51, 98, 118, 74]
Objective function statistics:
minimum = 52319
mean = 54390.43
maximum = 59030
```



2.3 Nearest Neighbors Considering Adding the Node at the Best Position on the Current Path

Function init_nearest_neighbor_best_position$(dataset, distance\_matrix, start\_node)$:

Calculate subset size as half of the dataset size (rounded)

Initialize solution with start_node

Initialize remaining_nodes as all nodes except start_node

While solution size is smaller than subset size :

best_insertion_cost $\leftarrow \infty$

best_insertion $\leftarrow$ None

For each node in remaining_nodes :

For each possible position in the solution :

Calculate insertion cost of adding the node at the current position

If insertion cost is lower than best_insertion_cost :

Update best_insertion_cost and best_insertion position

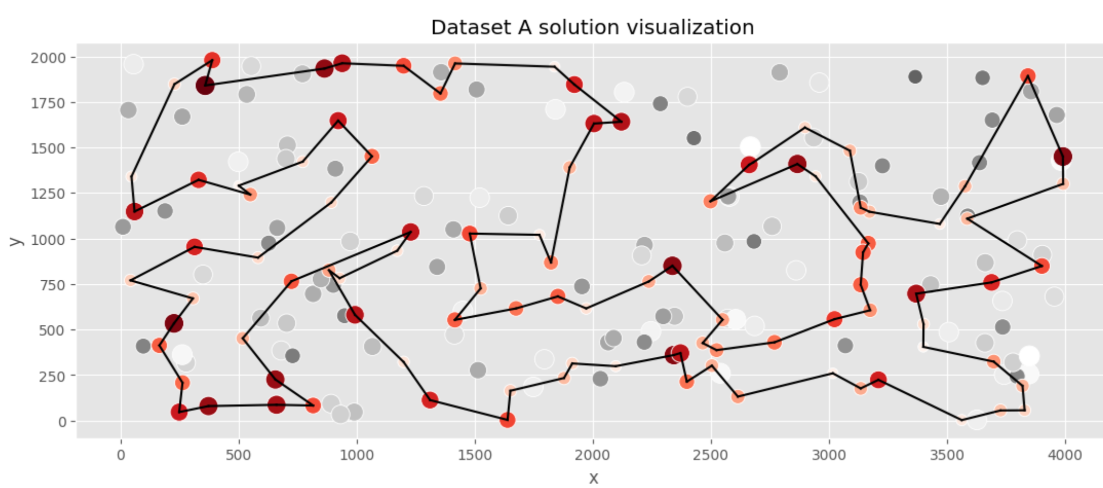
Insert the best_node into the solution at the best position

Remove this node from remaining_nodes

Returnthe solution as a subset of the dataset

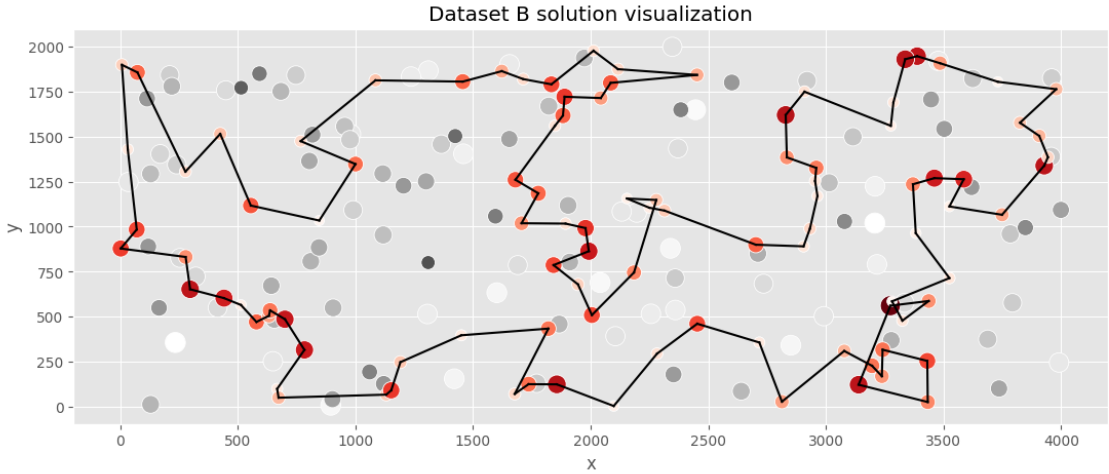
Dataset A

```
Best solution: [69, 108, 18, 22, 146, 159, 41, 193, 139, 68, 46, 115, 42, 181,
34, 160, 48, 54, 177, 10, 190, 4, 112, 84, 184, 43, 118, 59, 65, 116, 149, 123,
127, 70, 135, 154, 180, 53, 100, 26, 86, 101, 75, 120, 44, 25, 16, 171, 175,
113, 31, 78, 145, 179, 196, 81, 40, 90, 27, 164, 165, 185, 106, 178, 14, 144,
62, 9, 148, 102, 49, 52, 55, 57, 92, 129, 2, 1, 97, 152, 124, 94, 63, 79, 133,
162, 151, 51, 176, 80, 137, 23, 186, 89, 183, 143, 0, 117, 93, 140]
Objective function statistics:
minimum = 71114
mean = 72871.87
maximum = 74875
```



Dataset B

```
Best solution: [180, 194, 113, 176, 166, 86, 95, 130, 99, 185, 179, 66, 94, 47,
148, 60, 20, 28, 149, 4, 140, 183, 152, 170, 34, 55, 18, 62, 124, 106, 143, 35,
0, 29, 109, 111, 82, 8, 104, 144, 160, 33, 138, 11, 139, 168, 195, 13, 145, 15,
155, 3, 70, 132, 169, 188, 6, 147, 90, 51, 121, 131, 122, 135, 107, 40, 63, 38,
27, 1, 156, 198, 117, 193, 31, 54, 73, 136, 190, 80, 175, 78, 5, 177, 21, 36,
61, 91, 141, 77, 81, 153, 187, 163, 89, 127, 103, 114, 137, 165]
Objective function statistics:
minimum = 44762
mean = 47575.555
maximum = 49919
```



2.4 Greedy Cycle

Function init_greedy_cycle($dataset, distance\_matrix, start\_node$) :

Calculate subset size as half of the dataset size (rounded)

Initialize solution with start_node

Find the nearest node to start_node and add it to solution

Remove this node from remaining_nodes

While solution size is smaller than subset size :

best_insertion_cost ← ∞

best_insertion ← None

For each node in remaining_nodes :

For each possible insertion point in the solution :

Calculate insertion cost of adding the node at the current position, excluding closing edge

If insertion cost is lower than best_insertion_cost :

Update best_insertion_cost and best_insertion position

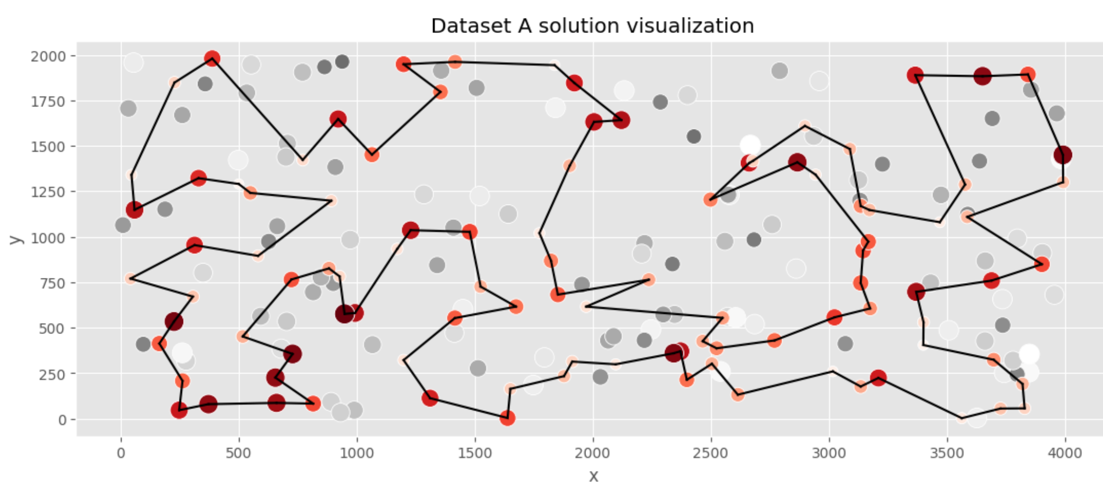
Insert the best_node into the solution at the best position

Remove this node from remaining_nodes

Returnthe solution as a subset of the dataset

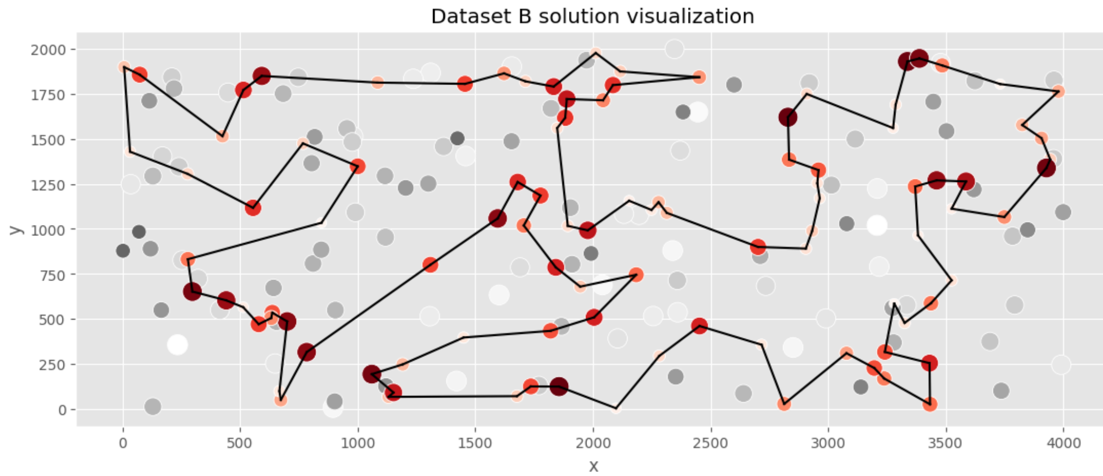
Dataset A

```
Best solution: [0, 117, 143, 183, 89, 186, 23, 137, 176, 80, 79, 94, 63, 152,
97, 1, 2, 129, 92, 57, 55, 52, 49, 102, 148, 9, 62, 144, 14, 178, 106, 185, 165,
21, 7, 164, 27, 90, 40, 81, 196, 179, 145, 78, 31, 113, 175, 171, 16, 25, 44,
120, 75, 101, 86, 26, 100, 53, 180, 154, 135, 70, 127, 123, 162, 133, 151, 51,
118, 59, 149, 131, 65, 116, 43, 184, 35, 84, 112, 4, 190, 10, 177, 54, 48, 160,
34, 181, 42, 115, 41, 193, 159, 146, 22, 18, 108, 139, 68, 46]
Objective function statistics:
minimum = 71263
mean = 72071.915
maximum = 73154
```



Dataset B

```
Best solution: [4, 149, 28, 20, 60, 148, 47, 94, 66, 179, 185, 99, 130, 95, 86,
166, 194, 113, 176, 103, 114, 137, 127, 89, 163, 187, 153, 81, 77, 141, 91, 61,
36, 175, 78, 45, 5, 177, 21, 82, 111, 8, 104, 138, 11, 139, 182, 25, 136, 80,
190, 73, 54, 31, 193, 117, 198, 156, 1, 121, 51, 90, 131, 135, 63, 40, 107, 122,
133, 10, 147, 6, 188, 169, 132, 70, 3, 155, 15, 145, 13, 195, 168, 33, 160, 29,
0, 109, 35, 143, 106, 124, 62, 18, 55, 34, 170, 152, 183, 140]
Objective function statistics:
minimum = 45312
mean = 46903.73
maximum = 48623
```



2.5 Conclusions

Overall, on the provided problem and data sets, the greedy cycle algorithm proved to be the most efficient on mean, however "NN" best position had lower minimum.