Assignment 2 - Greedy Regret Heuristics for Selective TSP

Authors

- Mateusz Idziejczak 155842
- Mateusz Stawicki 155900

Problem Description

This is a variant of the Traveling Salesman Problem where:

- Select exactly 50% of nodes (rounded up if odd)
- Form a Hamiltonian cycle through selected nodes
- Minimize: total path length + sum of selected node costs
- Distances are Euclidean distances rounded to integers

Algorithm Pseudocode

Greedy 2-Regret

```
1. Start with given node
2. Add nearest node to form initial 2-node cycle
3. While not enough nodes selected:
   a. For each unselected node i:
      For each edge (u,v) in cycle:
         Calculate delta = dist[u][i] + dist[i][v] - dist[u][v] + cost[i]
      Find best (minimum delta) and 2nd-best insertion positions
      Calculate regret = 2nd_best_delta - best_delta
   b. Select node with maximum regret (ties broken by minimum best_delta)
   c. Insert at its best position
4. Return cycle
```

Greedy Weighted (2-Regret + BestDelta)

```
1. Start with given node
2. Add nearest node to form initial 2-node cycle
3. While not enough nodes selected:
   a. For each unselected node i:
      For each edge (u,v) in cycle:
         Calculate delta = dist[u][i] + dist[i][v] - dist[u][v] + cost[i]
      Find best (minimum delta) and 2nd-best insertion positions
      Calculate regret = 2nd_best_delta - best_delta
      Calculate score = wRegret × regret - wBest × best_delta
   b. Select node with maximum score (default weights: wRegret=1.0,
wBest=1.0)
   c. Insert at its best position
4. Return cycle
```

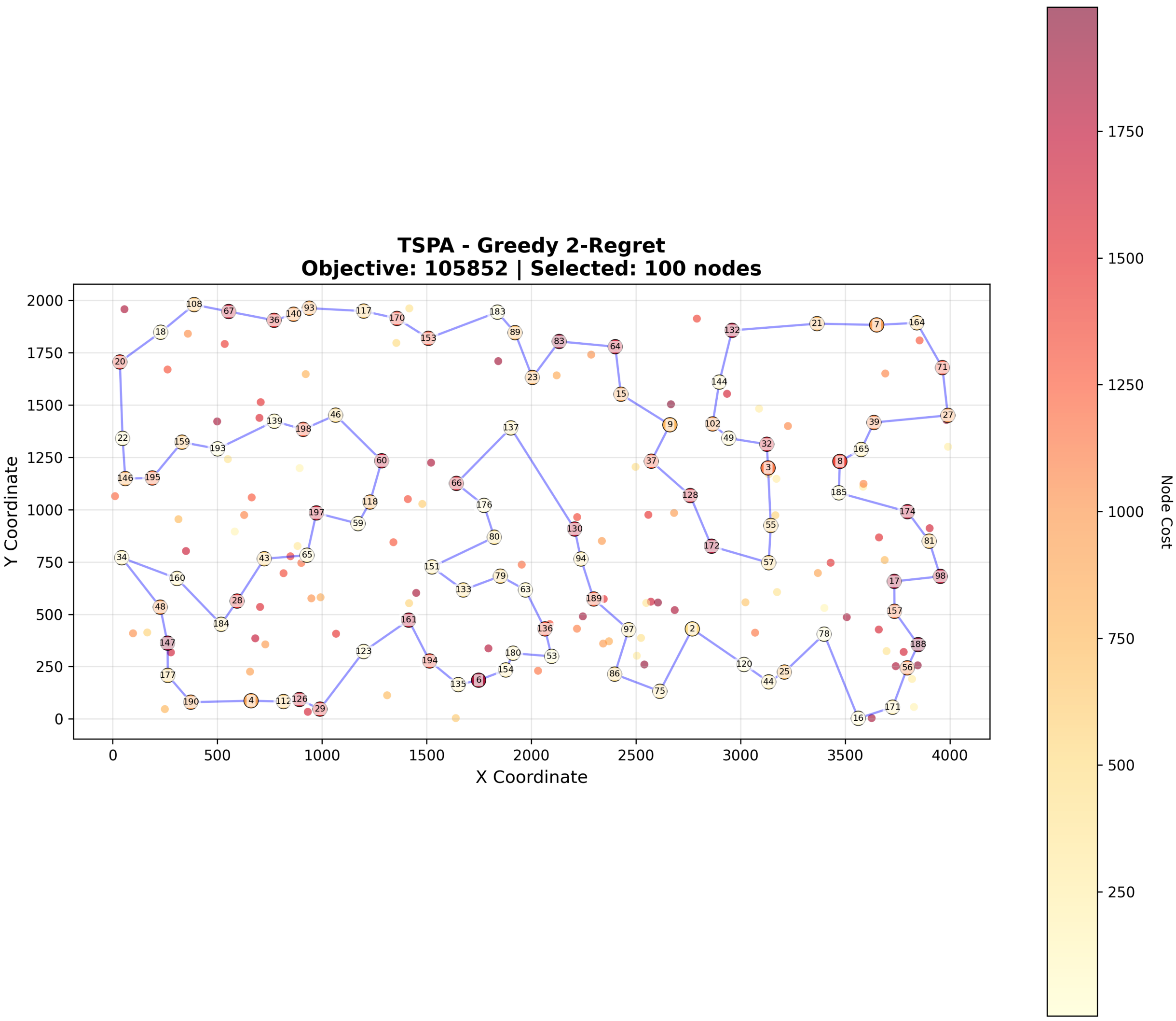
Key Results

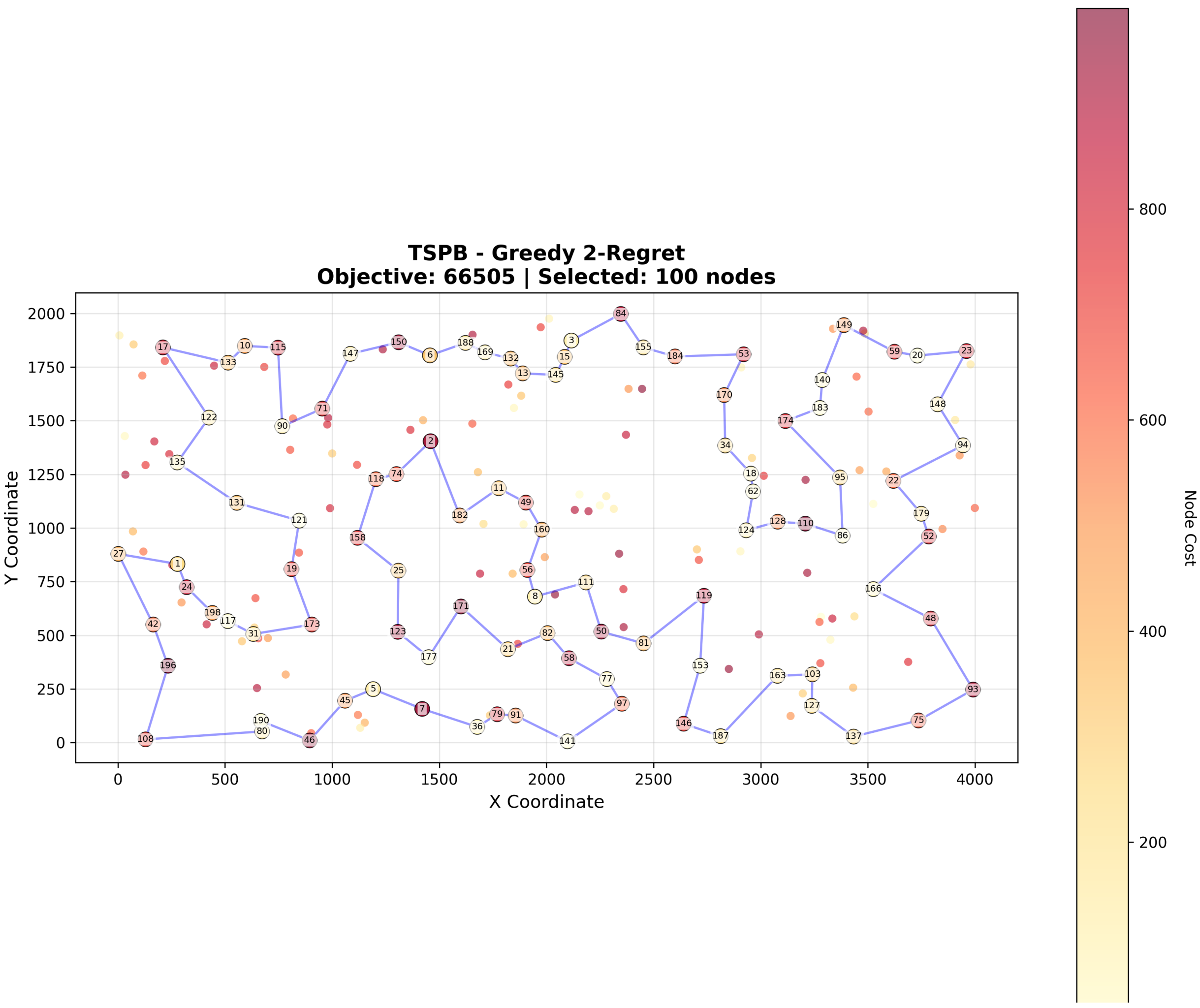
TSPA.csv (200 nodes, select 100)

Method	Min	Max	Avg
Random	242247	288959	265582
Nearest Neighbor (end only)	83182	89433	85108
Nearest Neighbor (any position)	71179	75450	73178
Greedy Cycle	71488	74410	72646
Greedy 2-Regret	105852	123428	115474
Greedy Weighted (2-Regret + BestDelta)	71108	73395	72129

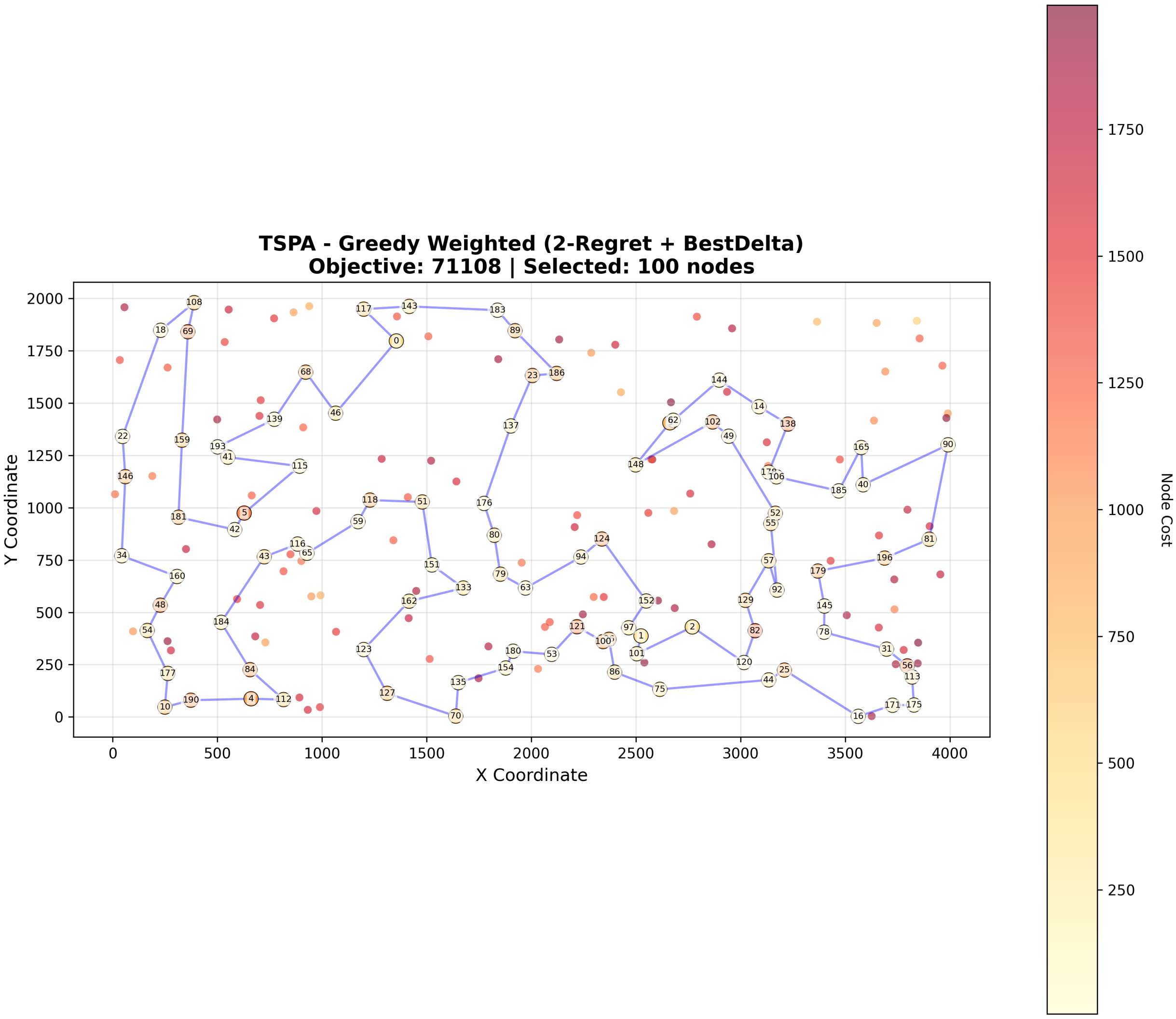
TSPB.csv (200 nodes, select 100)

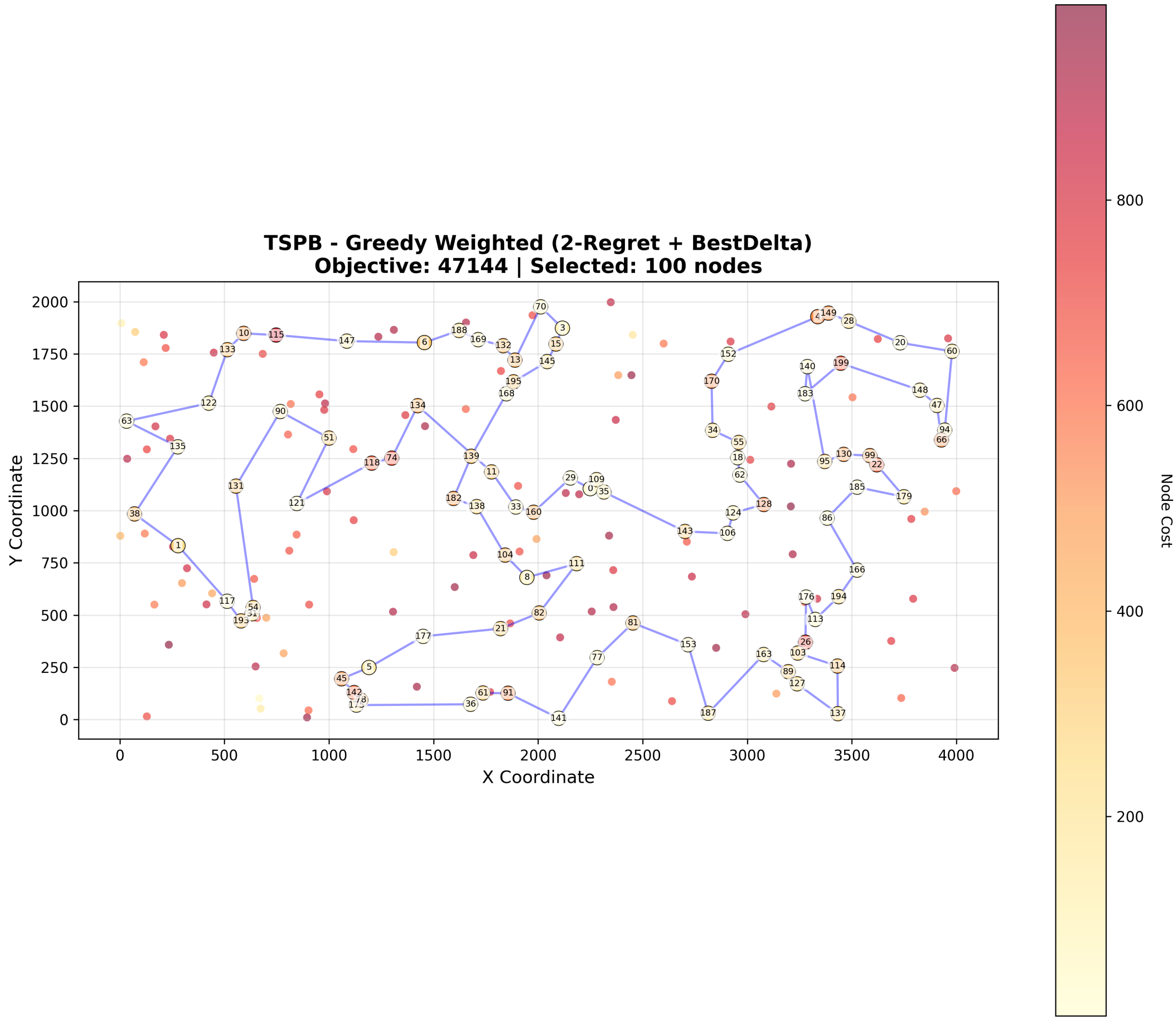
Method	Min	Max	Avg
Random	188533	235611	212974
Nearest Neighbor (end only)	52319	59030	54390
Nearest Neighbor (any position)	44417	53438	45870
Greedy Cycle	49001	57324	51400
Greedy 2-Regret	66505	77072	72454
Greedy Weighted (2-Regret + BestDelta)	47144	55700	50950


TSPA - Greedy 2-Regret
Objective: 105852 | Selected: 100 nodes
X Coordinate
Y Coordinate
Node Cost


TSPB - Greedy 2-Regret
Objective: 66505 | Selected: 100 nodes
X Coordinate
Y Coordinate
Node Cost

Mateusz Stawicki 2025-10-19





The solutions were checked using Solution checker.xlsx

Github

> https://github.com/Luncenok/EvolutionaryComputingLab1

Conclusions

The experimental results reveal critical insights about regret-based greedy heuristics:

Greedy 2-Regret performs poorly, producing solutions significantly worse than simpler methods (avg 115k for TSPA vs 72k for Greedy Cycle; 72k for TSPB vs 51k for Greedy Cycle). This counterintuitive result demonstrates that **maximizing regret alone is insufficient** - prioritizing only "picky" nodes without considering insertion cost leads to poor early decisions that constrain later choices.

Greedy Weighted (2-Regret + BestDelta) achieves excellent performance, ranking among the best methods tested:

- TSPA: 72.1k average (competitive with Greedy Cycle at 72.6k)
- TSPB: 51k average (between Nearest Neighbor any-position at 45.8k and Greedy Cycle at 51.4k)

- Lower variance than pure 2-Regret (narrower min-max ranges)

The **weighted criterion successfully balances two competing objectives**:

- High regret → prioritize nodes with few good placement options
- Low insertion cost → avoid expensive additions to the current cycle

Key insight: The weights (default 1.0, 1.0) allow the algorithm to consider both urgency (regret) and efficiency (cost), avoiding the myopic behavior of pure regret maximization. The weighted approach effectively combines the "look-ahead" benefit of regret with immediate cost optimization.

Comparison to baseline methods:

- Outperforms Nearest Neighbor (end-only) by ~15-6%
- Competitive with or slightly better than Greedy Cycle
- Slightly behind Nearest Neighbor (any-position) on TSPB, but more consistent

The weighted regret heuristic demonstrates that **sophisticated selection criteria require balancing multiple factors** rather than optimizing a single metric, making it a robust choice for practical selective TSP instances.