

Assignment#3: Migros Delivery Using Ant Colony Optimization

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Console and Graphical Outputs for different input files:

Input01:

Console output for Brute-Force:

Method: Brute-Force Method

Shortest distance: 1.79529

Shortest path: [1, 4, 9, 8, 11, 10, 7, 6, 5, 3, 2, 1]

Time it takes to find the shortest path: 0.12 seconds

Console output for Ant Colony optimization:

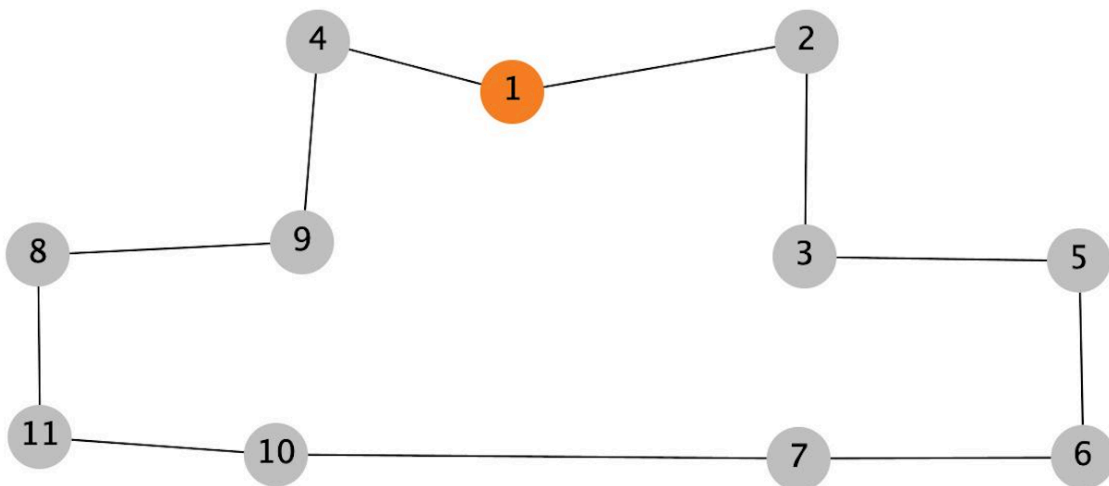
Method: Ant Colony Optimization Method

Shortest distance: 1.79529

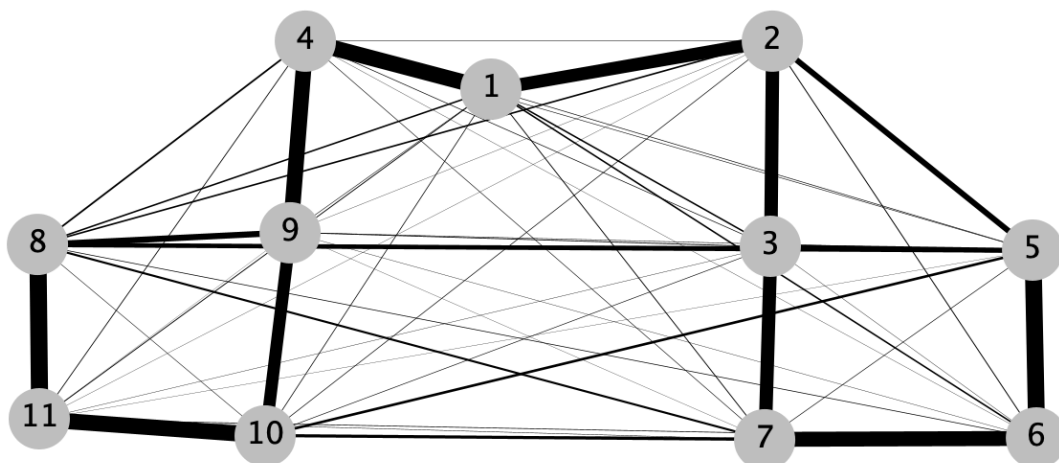
Shortest path: [1, 4, 9, 8, 11, 10, 7, 6, 5, 3, 2, 1]

Time it takes to find the shortest path: 0.02 seconds

Graphical output for Shortest Path:



Graphical output for Pheromone Intensities:



Input02:

Console output for Brute-Force:

Method: Brute-Force Method

Shortest distance: 2.93588

Shortest path: [1, 8, 7, 11, 10, 9, 6, 5, 4, 12, 3, 2, 1]

Time it takes to find the shortest path: 1.44 seconds

Console output for Ant Colony optimization:

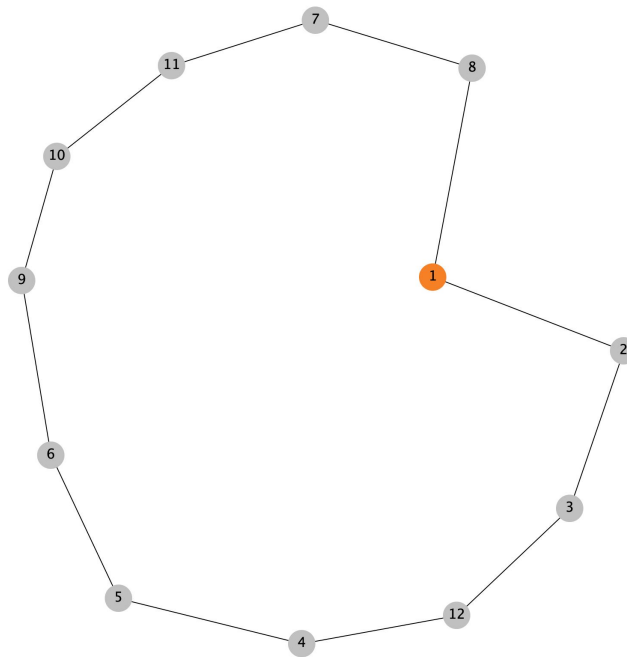
Method: Ant Colony Optimization Method

Shortest distance: 2.93588

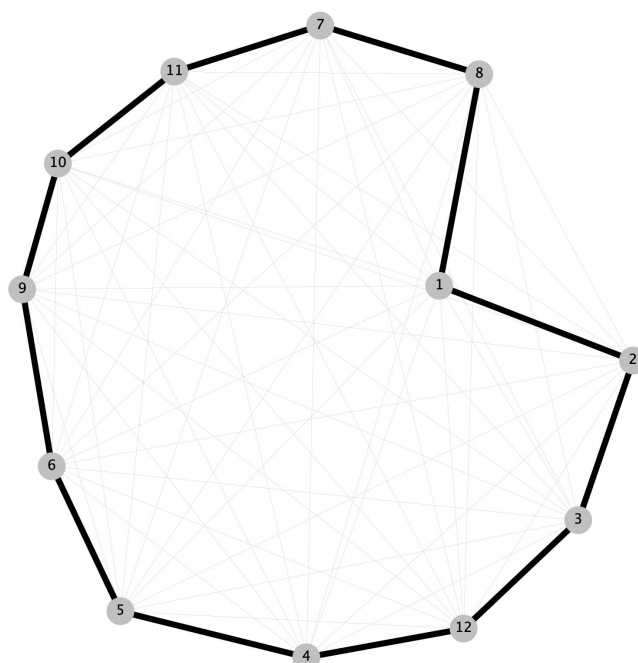
Shortest path: [1, 2, 3, 12, 4, 5, 6, 9, 10, 11, 7, 8, 1]

Time it takes to find the shortest path: 0.02 seconds

Graphical output for Shortest Path:



Graphical output for Pheromone Intensities:



Input03:

Console output for Brute-Force:

Method: Brute-Force Method

Shortest distance: 3.80292

Shortest path: [1, 2, 4, 3, 5, 9, 8, 13, 12, 11, 10, 7, 6, 1]

Time it takes to find the shortest path: 16.31 seconds

Console output for Ant Colony Optimization:

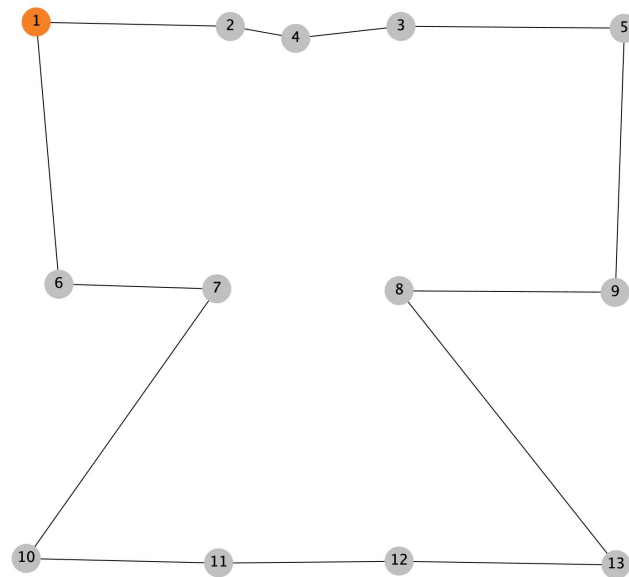
Method: Ant Colony Optimization Method

Shortest distance: 3.80292

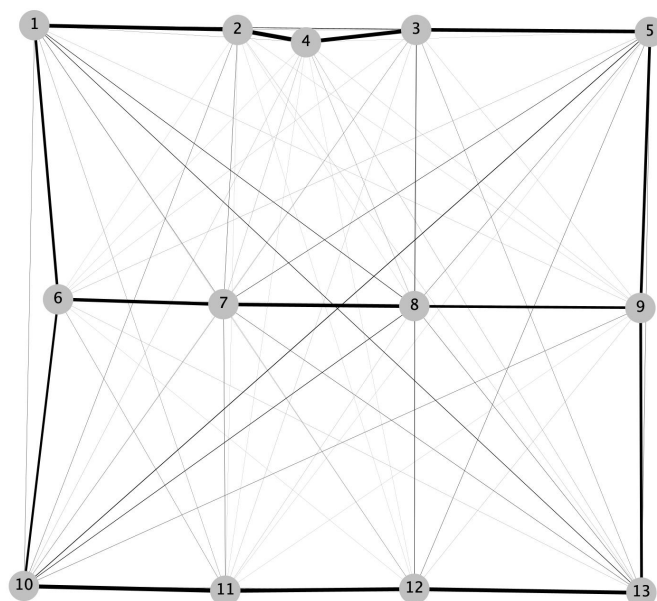
Shortest path: [1, 6, 7, 10, 11, 12, 13, 8, 9, 5, 3, 4, 2, 1]

Time it takes to find the shortest path: 0.02 seconds

Graphical output for Shortest Path:



Graphical output for Pheromone Intensities:



Input04:

Console output for Brute-Force:

Method: Brute-Force Method

Shortest distance: 3.71091

Shortest path: [1, 2, 3, 13, 10, 14, 11, 9, 5, 6, 4, 8, 7, 12, 1]

Time it takes to find the shortest path: 241.29 seconds

Console output for Ant Colony Optimization:

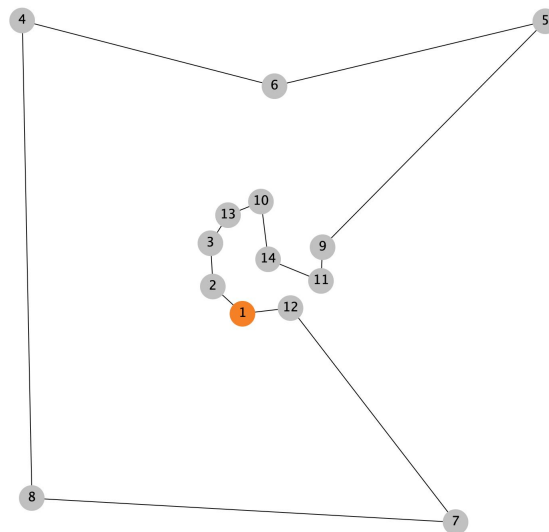
Method: Ant Colony Optimization Method

Shortest distance: 3.71091

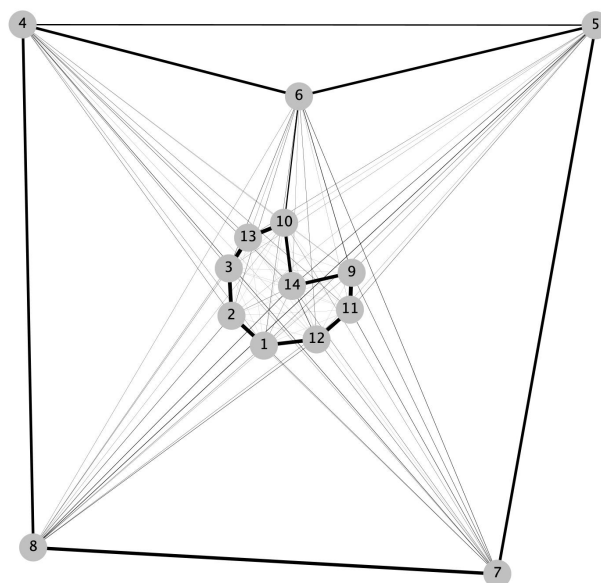
Shortest path: [1, 2, 3, 13, 10, 14, 11, 9, 5, 6, 4, 8, 7, 12, 1]

Time it takes to find the shortest path: 0.02 seconds

Graphical output for Shortest Path:



Graphical output for Pheromone Intensities:



Input05:

Console output for Ant Colony Optimization:

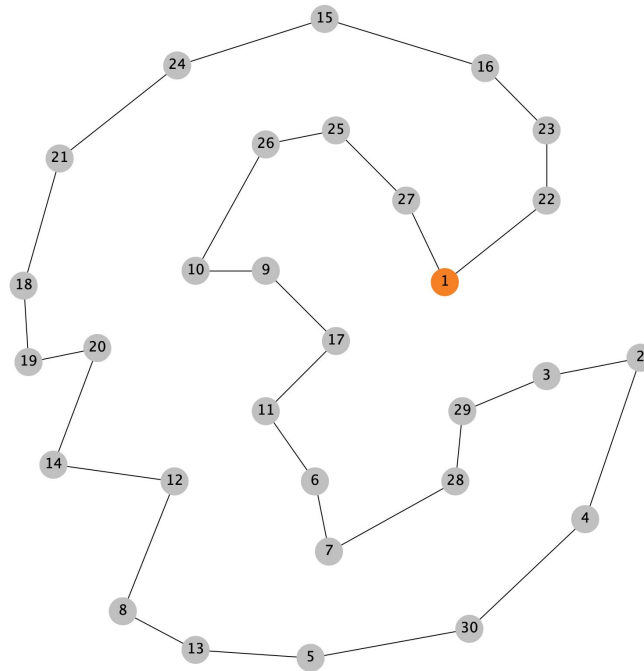
Method: Ant Colony Optimization Method

Shortest distance: 4.77238

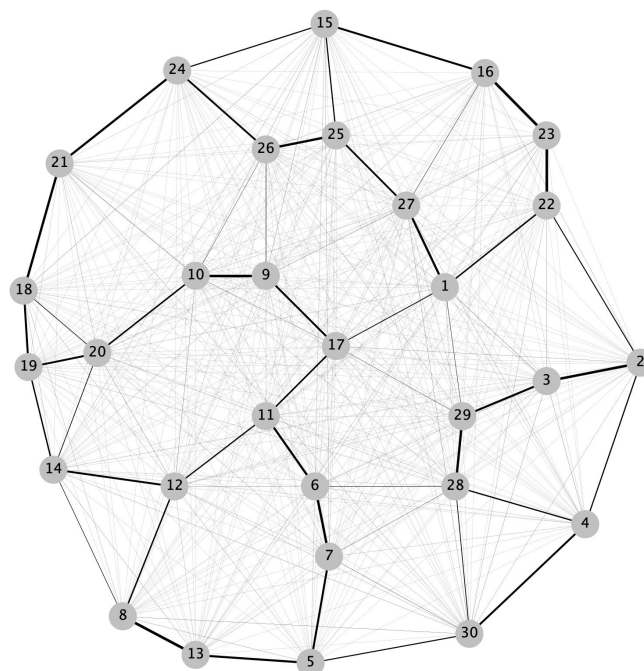
Shortest path: [1, 22, 23, 16, 15, 24, 21, 18, 20, 19, 14, 12, 8, 13, 5, 30, 4, 2, 3, 29, 28, 7, 6, 11, 17, 9, 10, 26, 25, 27, 1]

Time it takes to find the shortest path: 0.05 seconds

Graphical output for Shortest Path:



Graphical output for Pheromone Intensities:



Hyperparameters for Ant Colony Optimization Approach:

Iteration count = 100

Ant count per iteration = 50

Degradation factor = 0.8

Alpha = 1.0

Beta = 1.6

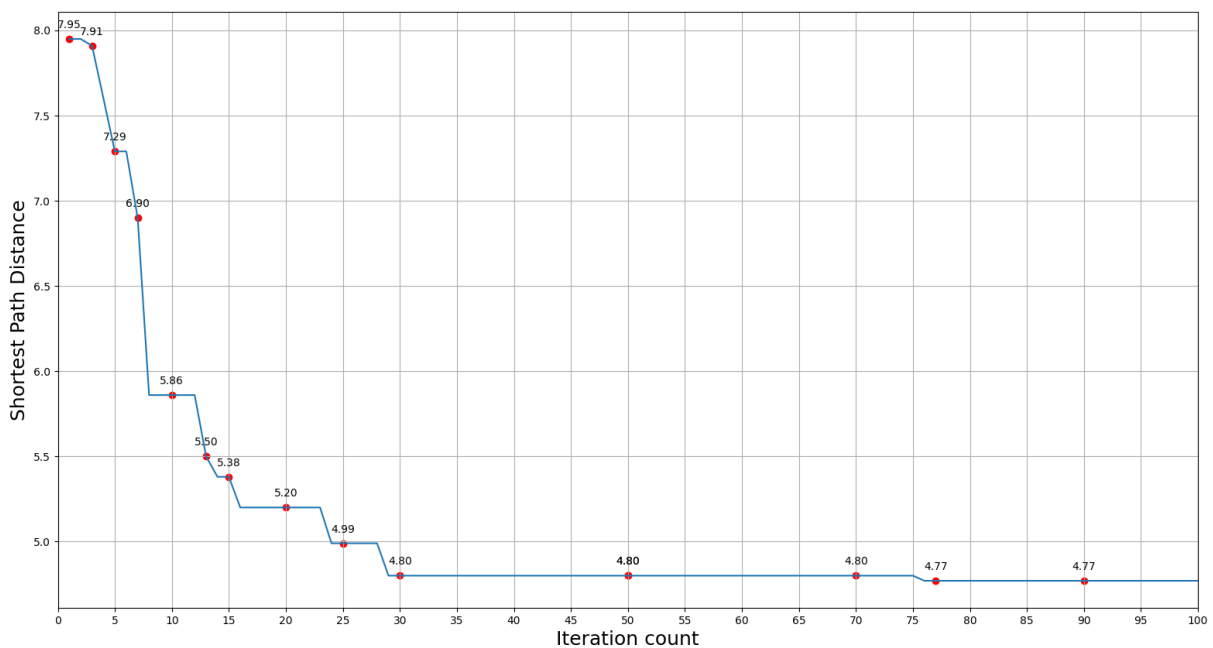
Initial Pheromone = 0.001

Q = 0.0001

Table 1. Comparison of methods.

Input file	Number of Houses + Migros	Brute-Force Time (Seconds)	Ant Colony Time (Seconds)	Speed Up Factor
input01.txt	11	0.12 (Distance: 1.79529)	0.02 (Distance: 1.79529)	6 times faster
input02.txt	12	1.44 (Distance: 2.93588)	0.02 (Distance: 2.93588)	72 times faster
input03.txt	13	16.31 (Distance: 3.80292)	0.02 (Distance: 3.80292)	815.5 times faster
input04.txt	14	241.29 (Distance: 3.71091)	0.02 (Distance: 3.71091)	12064.5 times faster
input05.txt	30	7.34×10^{23} (Estimated)	0.05 (Distance: 4.77238)	1.47×10^{25} times faster (Estimated)

Best distance vs Iteration count graph for input05



Advantages and Disadvantages of the Ant colony optimization method.

Advantages

- Ant colony method is much faster when compared to Brute Force Method
- Ant colony optimization allows very large number of houses while Brute Force Method is impractical for house numbers more than 17.
- Although Ant colony method is an heuristic approach, it often gives the optimal or a very close solution when hyperparameters are selected well.

Disadvantages

- The shortest route and the shortest path are not always the best since it's an heuristic approach.
- Finding the best hyperparameters is not that easy and choosing bad hyperparameters can lead to inaccurate results.
- For larger number of cities, ant colonization method may provide inconsistent results.