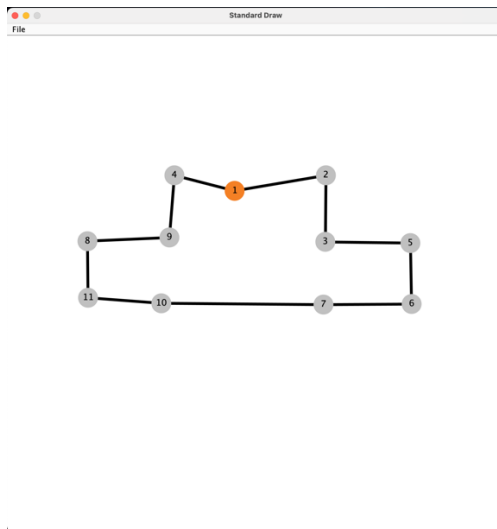CMPE 160 Project 3 – Ant Colony Optimization
Name Surname: Serhat Tay
Student ID: 2022400201

Outputs for Provided Inputs
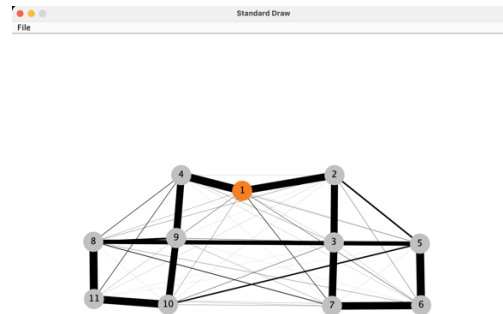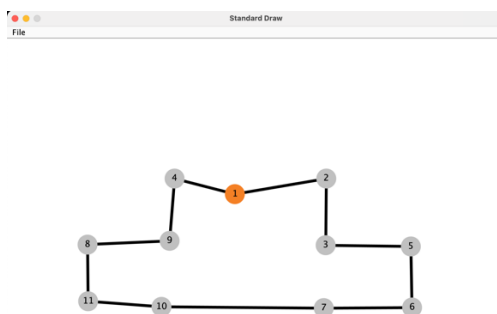
input01.txt

Brute-Force Method


```
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: 1.50 seconds.
```
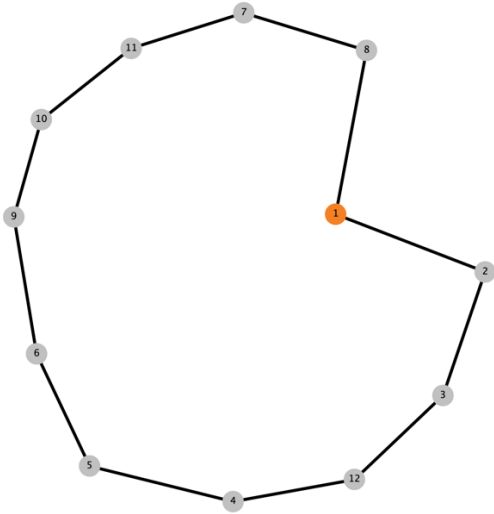
Ant Colony Optimization


```
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: 1.14 seconds.
```
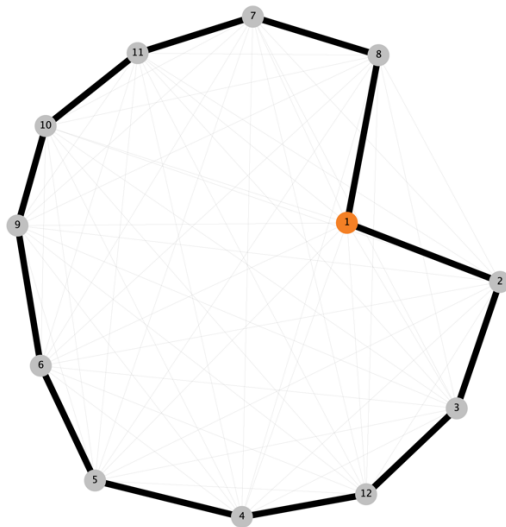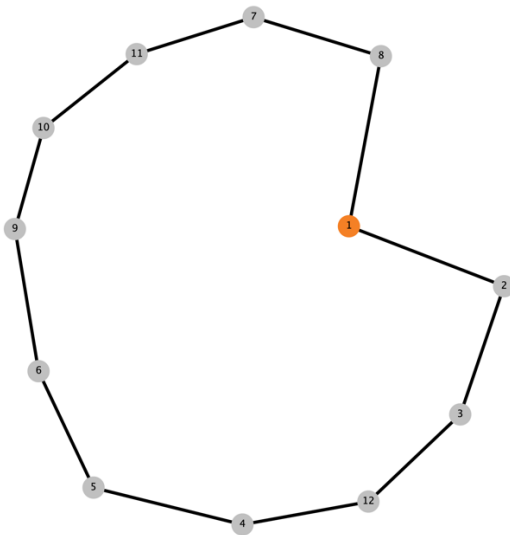
input02.txt

Brute-Force Method


```
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: 2.92 seconds.
```
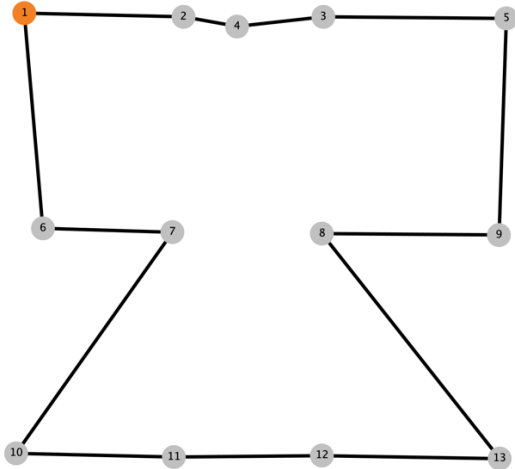
Ant Colony Optimization


```
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: 1.64 seconds.
```
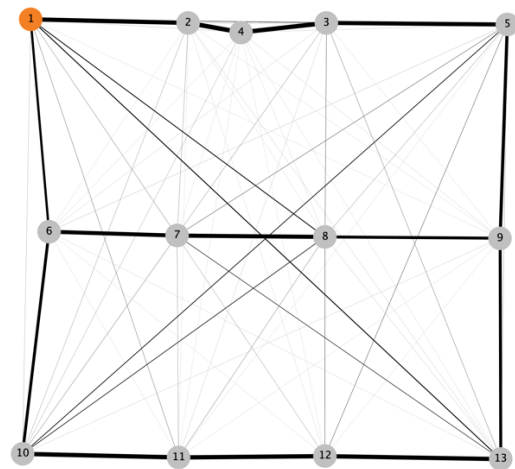
input03.txt

Brute-Force Method


```
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: 21.10 seconds.
```

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: 1.50 seconds.
```
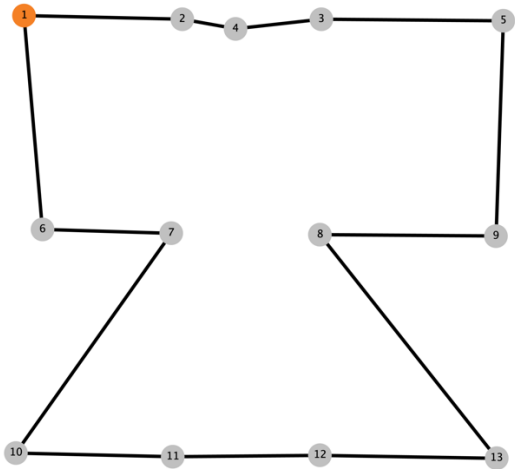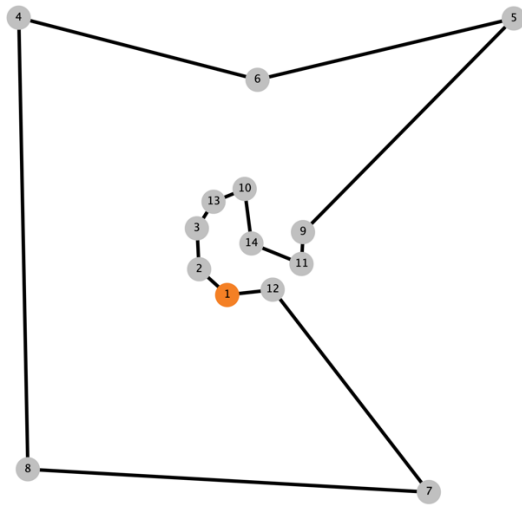
input04.txt

Brute-Force Method


```
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: 280.43 seconds.
```

Ant Colony Optimization


```
Method: Ant Colony Optimization Method
Shortest Distance: 3.72629
Shortest Path: [1, 2, 8, 7, 5, 6, 4, 3, 13, 10, 14, 9, 11, 12, 1]
Time it takes to find the shortest path: 1.22 seconds.
Process finished with exit code 0
```
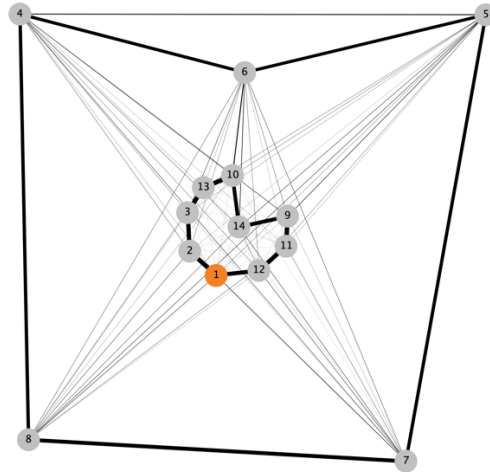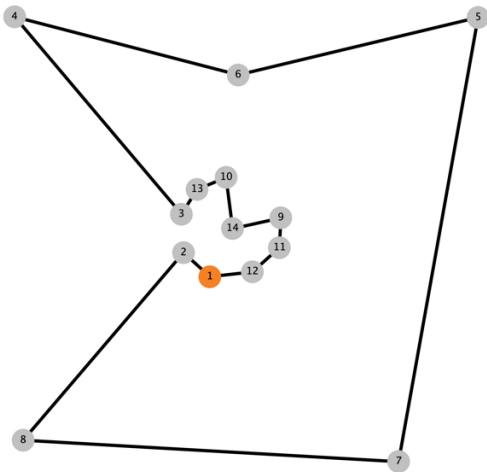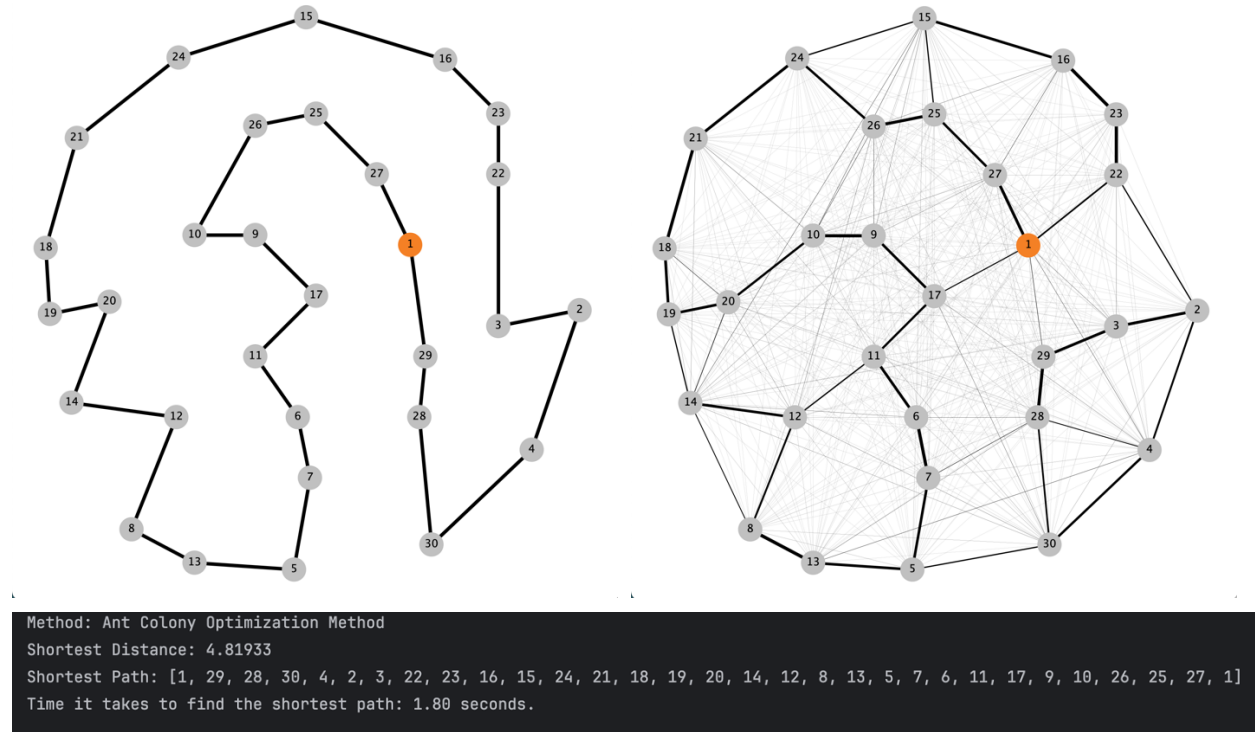
input05.txt

Brute-Force Method

Ant Colony Optimization


```
Method: Ant Colony Optimization Method
Shortest Distance: 4.81933
Shortest Path: [1, 29, 28, 30, 4, 2, 3, 22, 23, 16, 15, 24, 21, 18, 19, 20, 14, 12, 8, 13, 5, 7, 6, 11, 17, 9, 10, 26, 25, 27, 1]
Time it takes to find the shortest path: 1.80 seconds.
```

Maximum Iteration Count: 100
Ant per Iteration: 50
Degradation Factor: 0.8
Alpha: 1.1
Beta: 1.6
Initial Pheromone Intensity: 0.01
Q Value: 0.0001

Table 1. Comparison of methods

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Input File	**Number of Houses + Migros**	**Brute-Force Time (seconds)**	**Ant Colony Time (seconds)**	**Speed Up Factor**
input01.txt	11	1.50s (Distance: 1.79529)	1.14s (Distance: 1.79529)	1.31 times faster
input02.txt	12	2.92s (Distance: 2.93588)	1.64s (Distance: 2.93588)	1.78 times faster
input03.txt	13	21.10s (Distance: 3.80292)	1.50s (Distance: 3.80292)	14 times faster
input04.txt	14	280.43s (Distance: 3.71091)	1.22s (Distance: 3.72629)	229.8 times faster
input05.txt	30	Takes too long to compute.	1.80s (Distance: 4.81933)	Not comparable

Best Distance vs. Iteration Count Graph

BEST DISTANCE VS. ITERATION GRAPH OF INPUT05.TXT
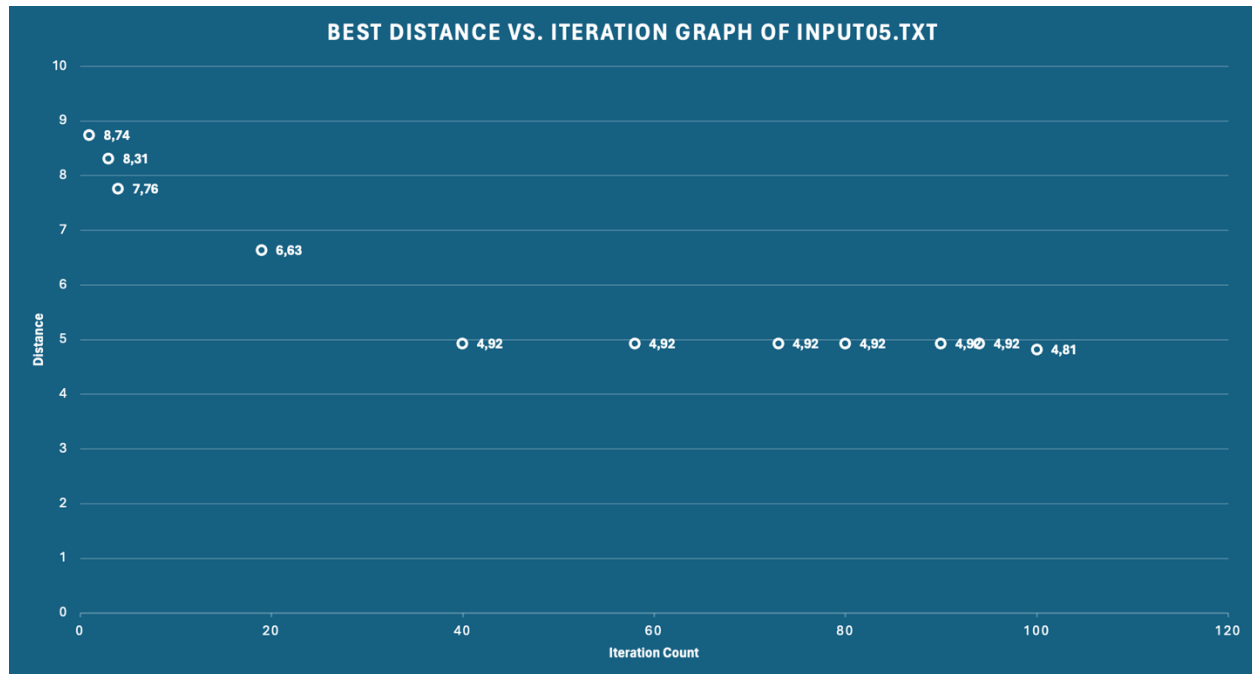
Advantages of the Ant Colony Optimization

This method is used to calculate a shortest-like path for the Traveling Salesman Problem (TSP). If brute-force method is used instead of this optimized one, it takes a vast amount of time and brute force method's time complexity is $O(n!)$. As it can be imagined it takes years for large inputs. Ant colony optimization method is so much faster, it takes a few seconds even for very large inputs.

+The ant colony optimization method is really fast compared to brute-force approach.

+It almost finds the shortest path.

+It is not necessary for the ant colony optimization method to try every possibility.

Disadvantages of the Ant Colony Optimization

One of the drawbacks of this method is its probabilistic approach. This approach makes the calculation process so much faster, nonetheless, it does not guarantee that the result is the best path. It is comparatively better than most of the paths, but it might not be the shortest.

-It does not guarantee that the found path is the shortest.