DELIVERY APP REPORT
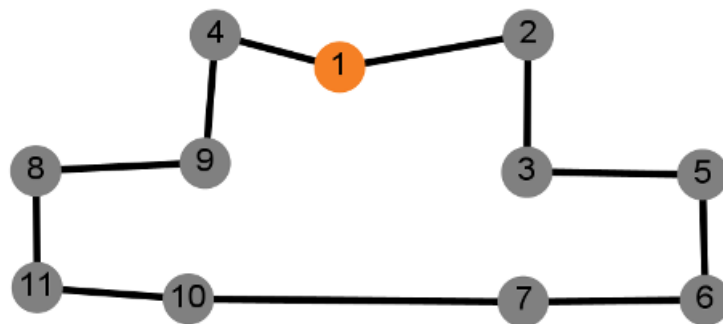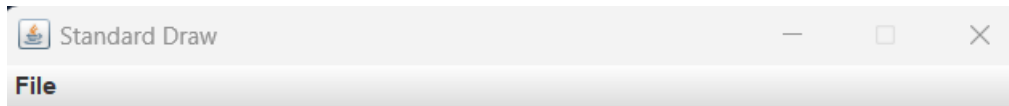
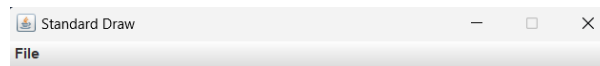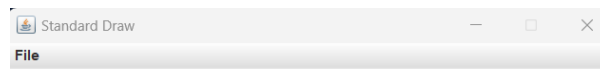## ALAADDİN EREN NAMLI

Input01

Brute Force Method


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
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.
```
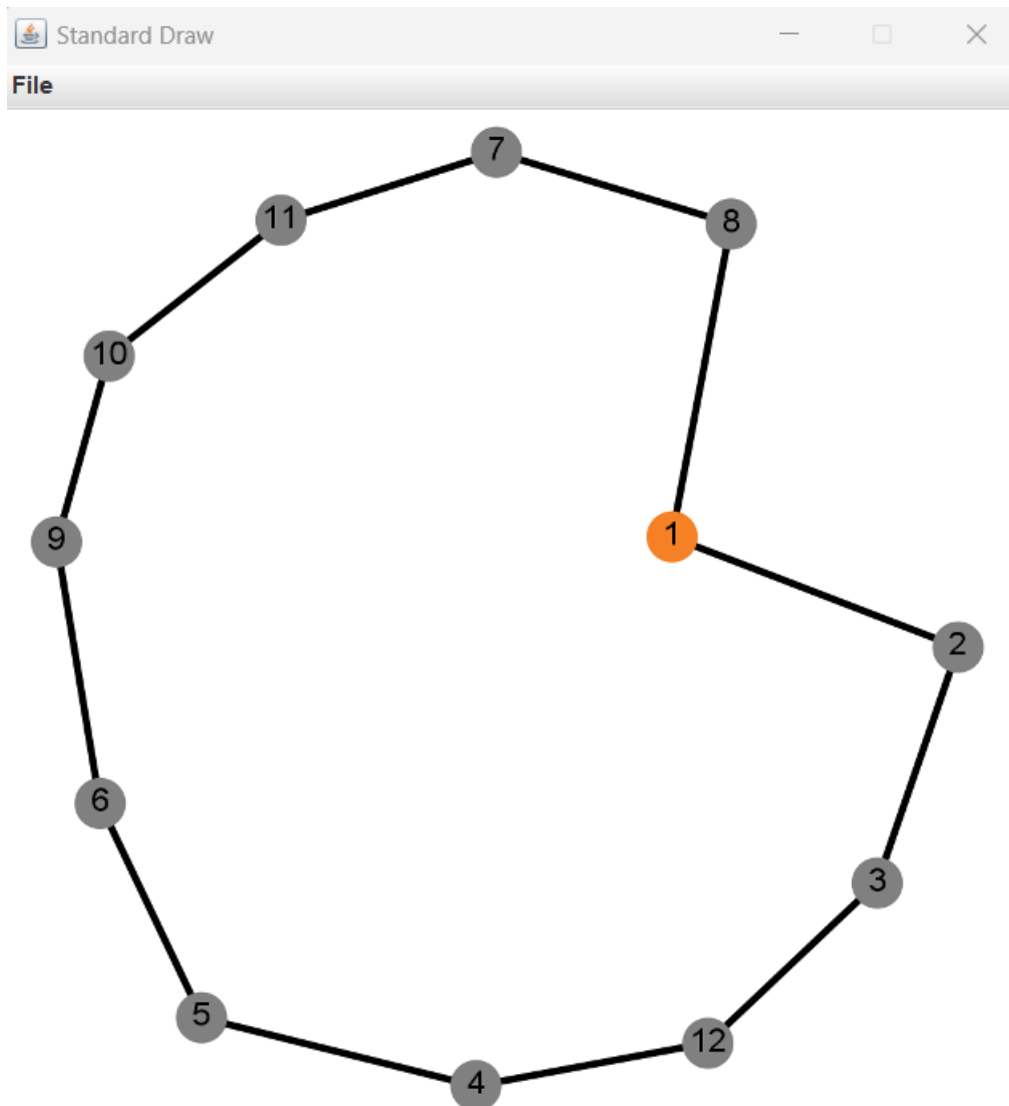
Ant Colony Optimization

Iteration count (N) = 100, Ant count per iteration (M) = 100, Degradation factor = 0.9, Alpha = 0.7, Beta = 1.6, Initial pheromone intensity = 0.1, and Q value = 0.0001


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
Method: Ant Colony Optimization
Shortest Distance: 1.79529
Shortest Path: [1, 2, 3, 5, 6, 7, 10, 11, 8, 9, 4, 1]
Time it takes to find the shortest path: 0.16 seconds.
```
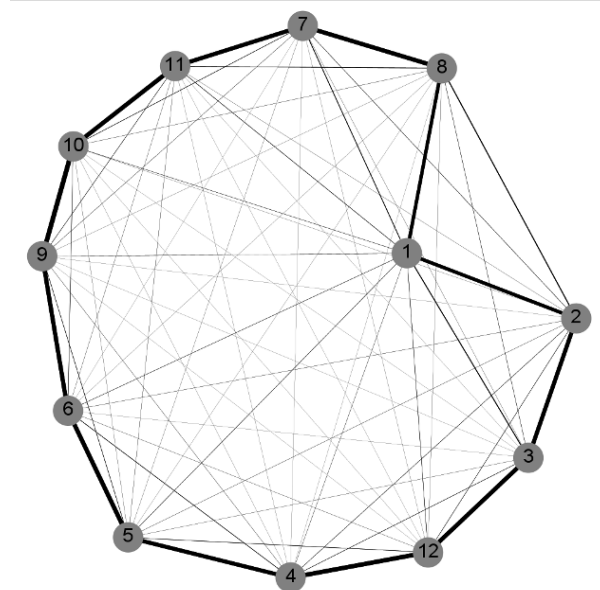
Input02

Brute Force Method

"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
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: 1.41 seconds.

Ant Colony Optimization

Iteration count (N) = 100, Ant count per iteration (M) = 100, Degradation factor = 0.9, Alpha = 0.7, Beta = 1.6, Initial pheromone intensity = 0.1, and Q value = 0.0001


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
Method: Ant Colony Optimization
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: 0.19 seconds.
```
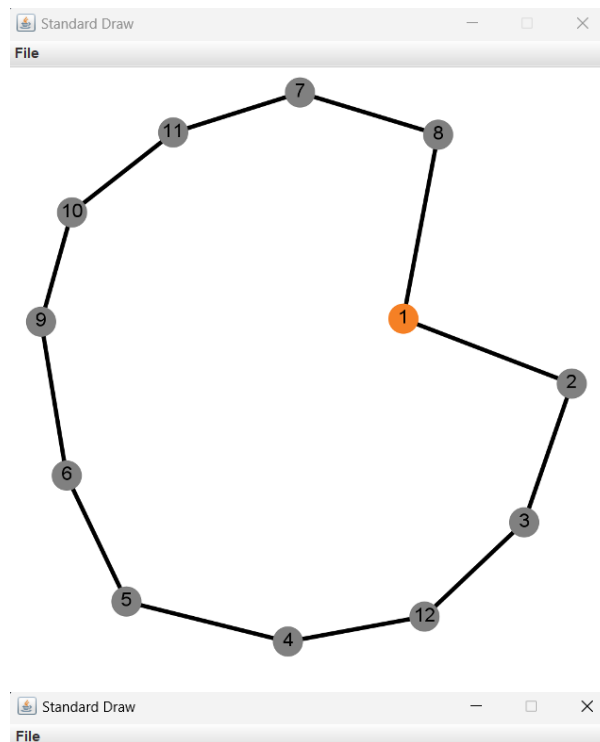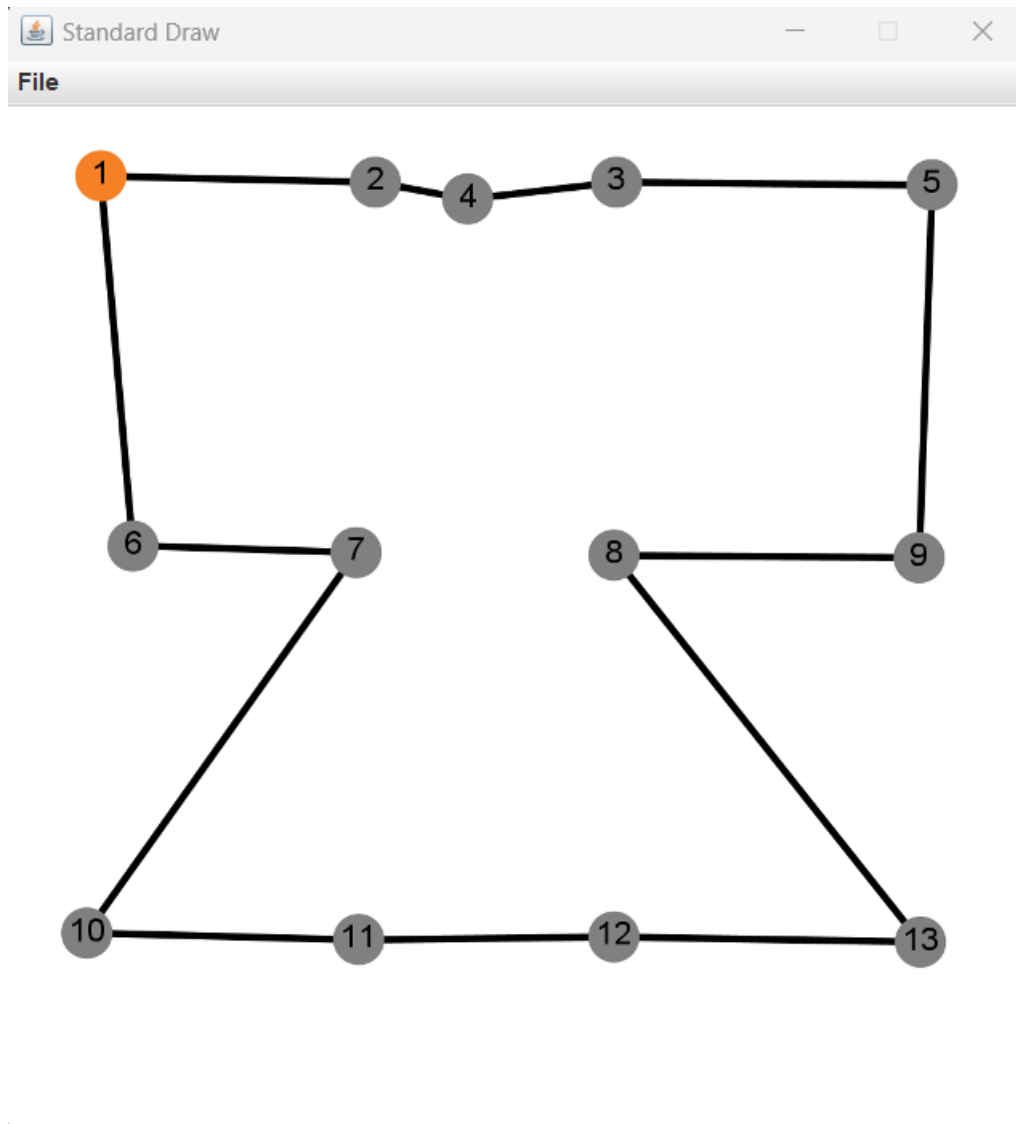
Input03

Brute Force Method


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
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: 17.71 seconds.
```

Ant Colony Optimization

Iteration count (N) = 100, Ant count per iteration (M) = 100, Degradation factor = 0.9, Alpha = 0.7, Beta = 1.5, Initial pheromone intensity = 0.1, and Q value = 0.0001


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
Method: Ant Colony Optimization
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: 0.22 seconds.
```
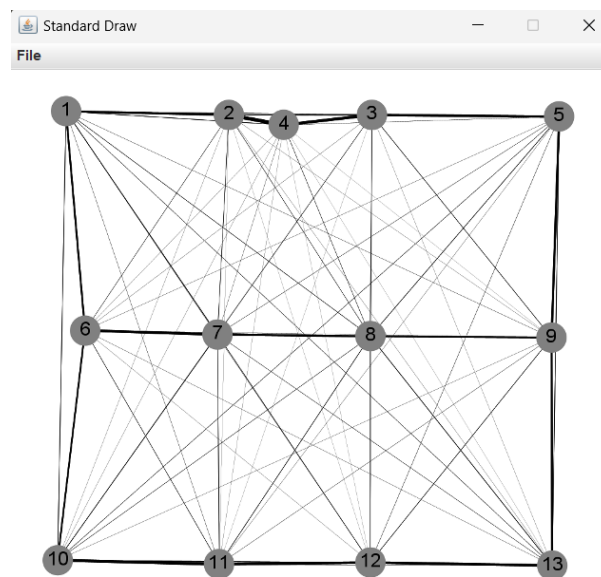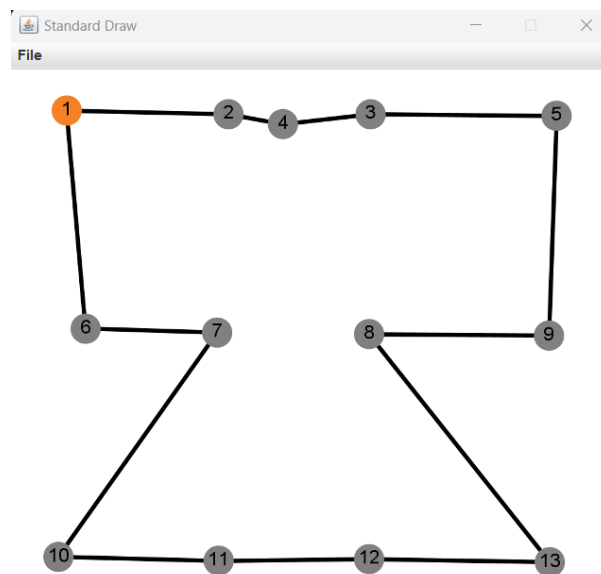
Input04

Brute Force Method


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
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: 244.90 seconds.
```
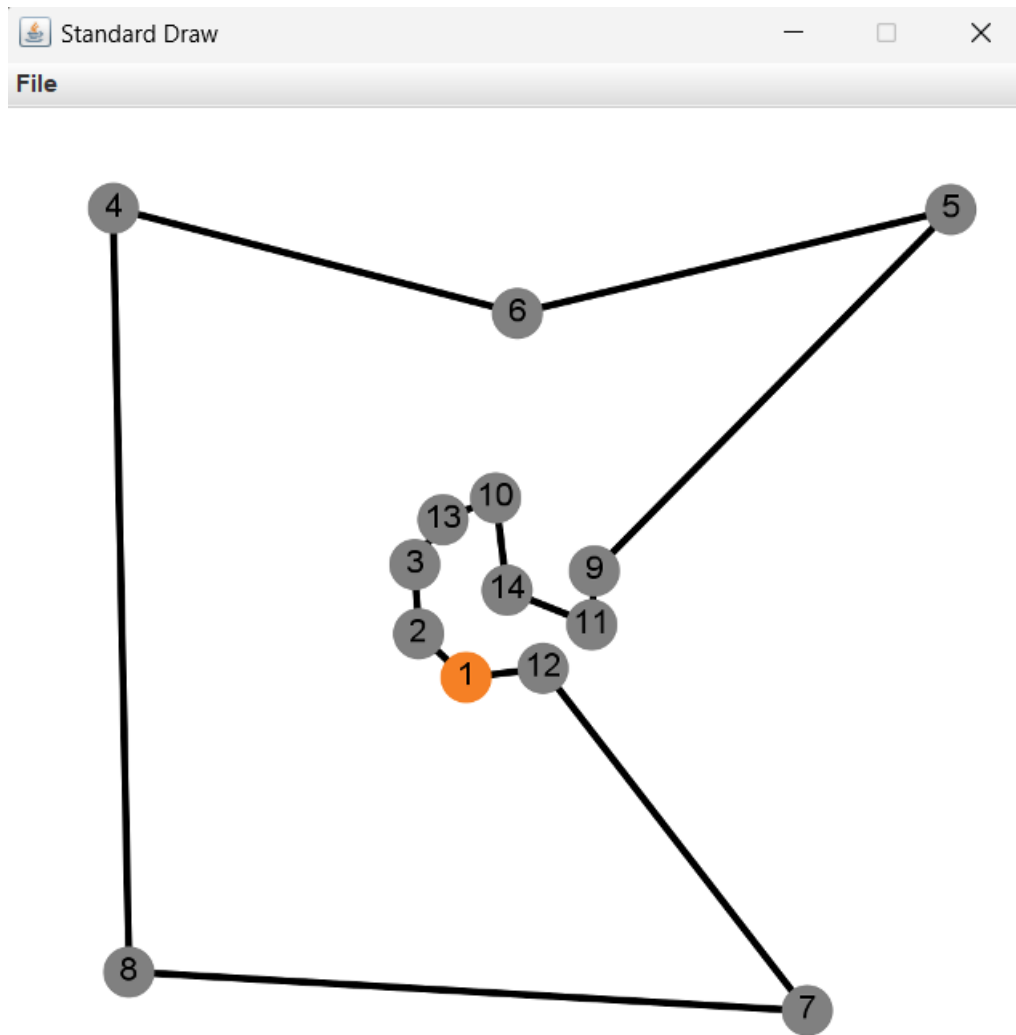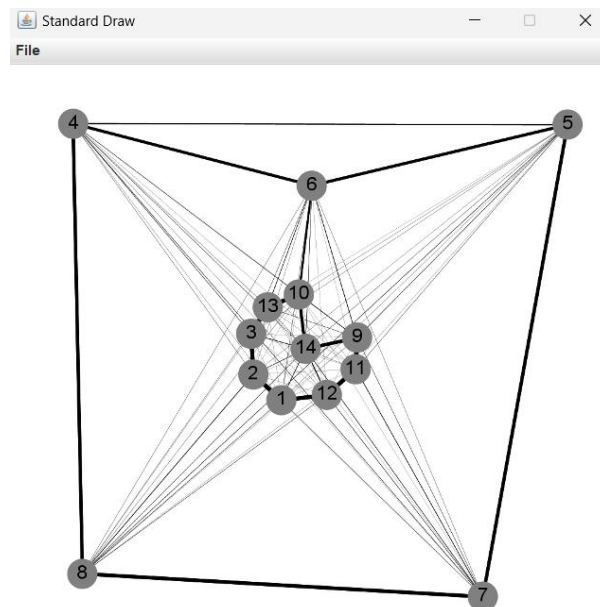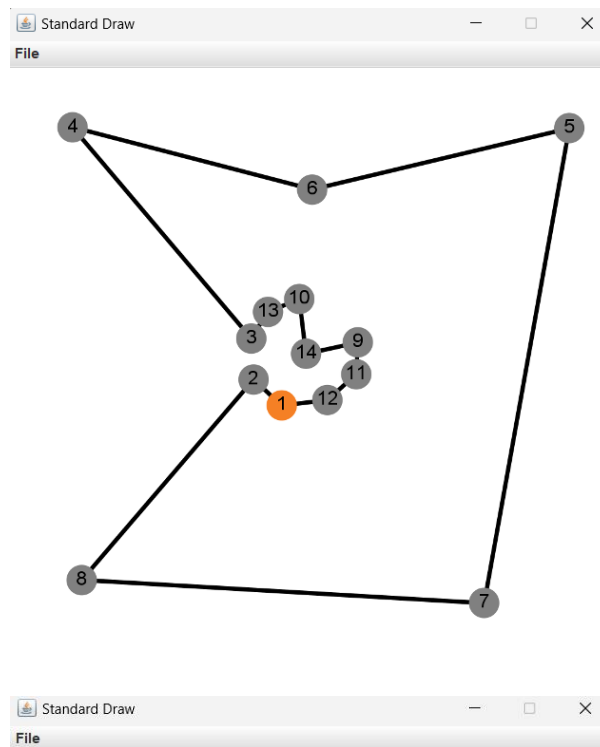
Ant Colony Optimization

Iteration count (N) = 100, Ant count per iteration (M) = 100, Degradation factor = 0.9, Alpha = 1.05, Beta = 1.4, Initial pheromone intensity = 0.1, and Q value = 0.0001
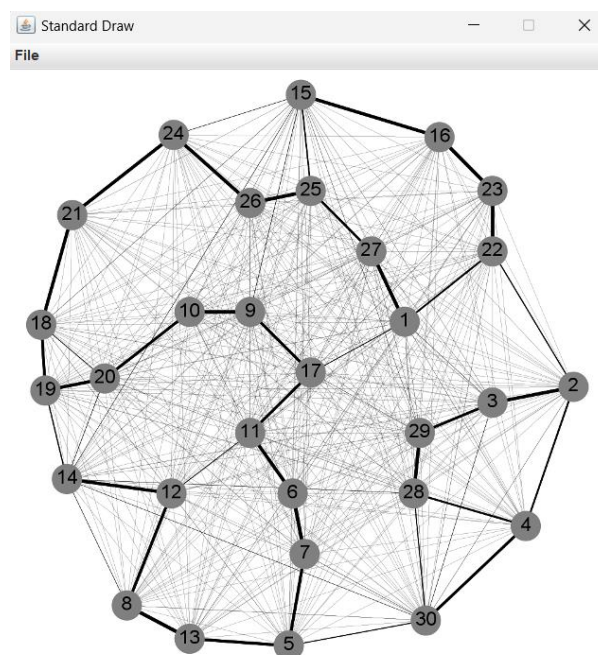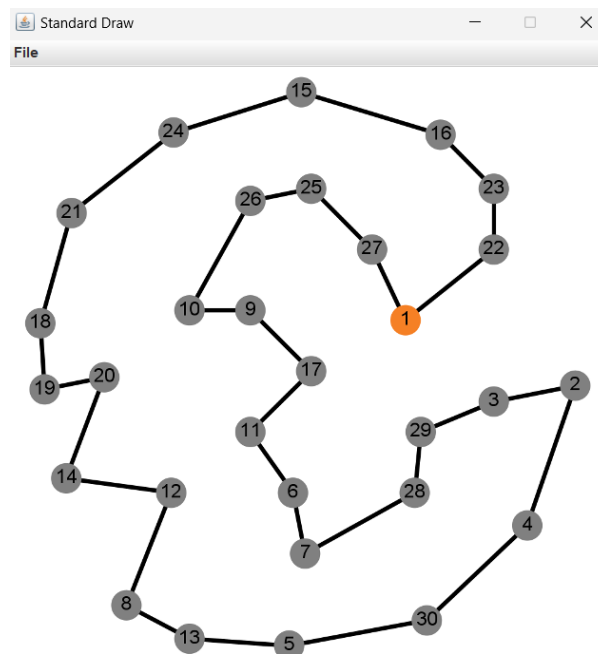


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA
Method: Ant Colony Optimization
Shortest Distance: 3.72629
Shortest Path: [1, 2, 8, 7, 5, 6, 4, 3, 13, 10, 14, 9, 11, 12, 1]
Time it takes to find the shortest path: 0.26 seconds.
```

Input05

Ant Colony Optimization

Iteration count (N) = 100, Ant count per iteration (M) = 100, Degradation factor = 0.9, Alpha = 1.0, Beta = 2.5, Initial pheromone intensity = 0.1, and Q value = 0.0001


```
"C:\Program Files\Java\jdk-21\bin\java.exe" "-javaagent:C:\Program Files\JetBrains\IntelliJ IDEA Community Edition 2023.3.4\lib\idea_r
Method: Ant Colony Optimization
Shortest Distance: 4.77101
Shortest Path: [1, 22, 23, 16, 15, 24, 21, 18, 19, 20, 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: 1.28 seconds.
```
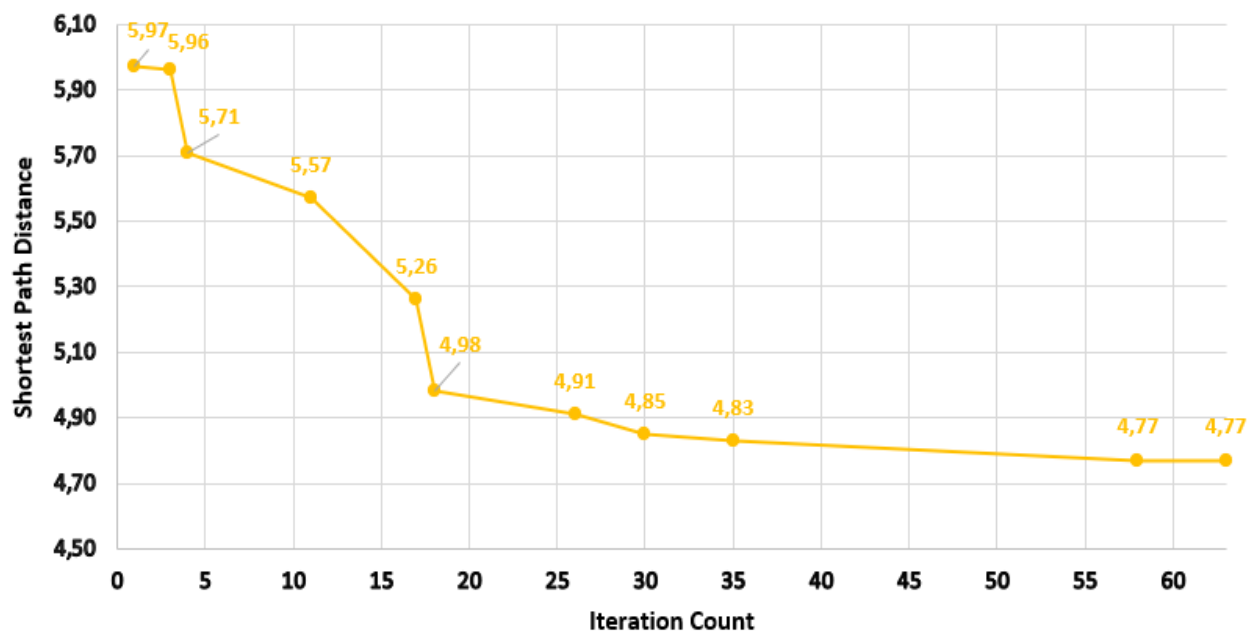
There is no output for brute force method since it takes very long to compute.

Table 1. Comparison of methods.

Input File	Number of Houses + Migros	Brute-Force Time (seconds)	Ant Colony Time (seconds)	Speed Up Factor
Input 01	11	0,12 (Distance: 1,79529)	0,16 (Distance: 1,79529)	0,75 times slower
Input 02	12	1,41 (Distance: 2,93588)	0,19 (Distance: 2,93588)	7,42 times faster
Input 03	13	17,71 (Distance: 3,80292)	0,22 (Distance: 3,80292)	80,50 times faster
Input 04	14	244,90 (Distance: 3.71091)	0,26 (Distance: 3,72629)	941,92 times faster
Input 05	30	Too long to compute	1,28 (Distance: 4.77101)	A lot faster

Table 1.

Best Distance VS. Iteration Graph

References:

https://www.youtube.com/watch?v=u7bQomIlcJw

https://en.wikipedia.org/wiki/Ant_colony_optimization_algorithms

https://www.geeksforgeeks.org/introduction-to-ant-colony-optimization/

https://www.upperinc.com/glossary/route-optimization/ant-colony-optimization/

Advantages and Disadvantages of Ant Colony Optimization Method

Advantages:

- It is very fast.
- The algorithm is capable of finding solutions that are very close to the optimal solutions even in complex problem environments.
- It can be used to explore the environment. Therefore, it can discover lots of different routes that are close to the shortest route.
- This method can be used in dynamic environments because the algorithm can respond to changes in the environment by adapting the pheromone levels on roads.

Disadvantages:

- Algorithm's success relies on the hyperparameters. If the hyperparameters are not tuned well, the algorithm leads to wrong solutions.
- It may struggle with finding the optimal solution when there is more than one nearly optimal solutions.
- Although it can adapt changes in the problem environment, the algorithm may have difficulties in responding to drastic changes due to its reliance on pheromone levels and possibilities.