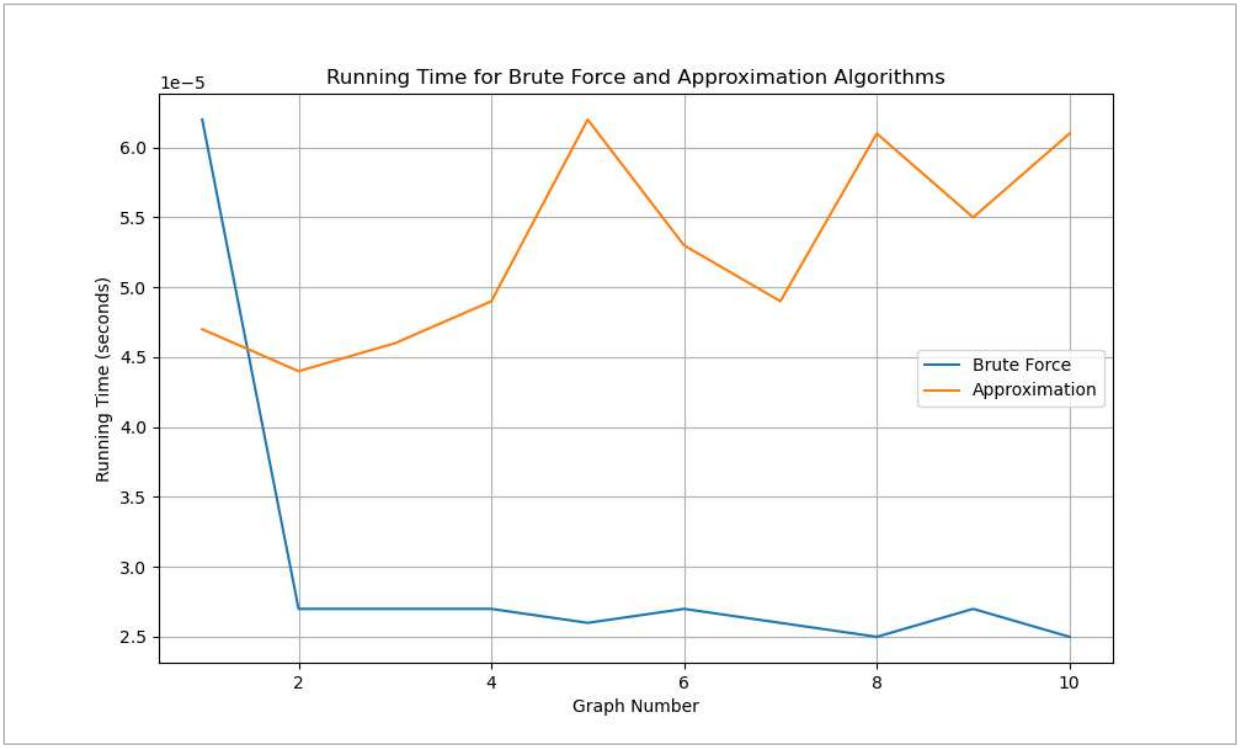
Algorithms Report

Experimental Results

Running Time Plot

The running times for the Brute Force and Approximation algorithms applied to each of the ten graphs are shown in the following plot. Every dot on the diagram denotes a distinct graph that displays the duration of both algorithms.



Running Times and Distances

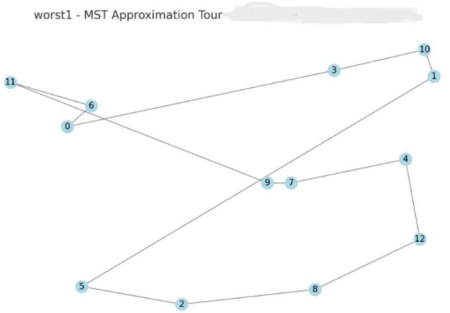
Table 1: Running Times and Distances for Each Graph

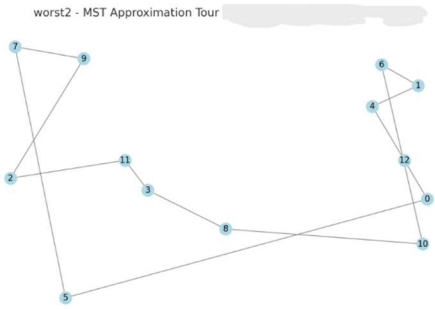
Graph	Brute Force Time	Brute Force Distance	Approximation Time	Approximation Distance
1	0.000062	800.22	0.000047	800.22
2	0.000027	865.62	0.000044	865.62
3	0.000027	641.70	0.000046	641.70
4	0.000027	534.76	0.000049	534.76
5	0.000026	681.30	0.000062	681.30
6	0.000027	497.28	0.000053	497.28
7	0.000026	713.13	0.000049	713.13
8	0.000025	549.19	0.000061	549.19
9	0.000027	728.87	0.000055	728.87
10	0.000025	619.92	0.000061	619.92

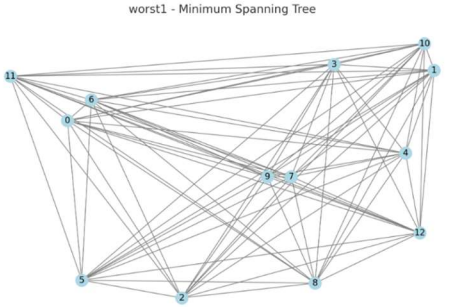
Error Analysis

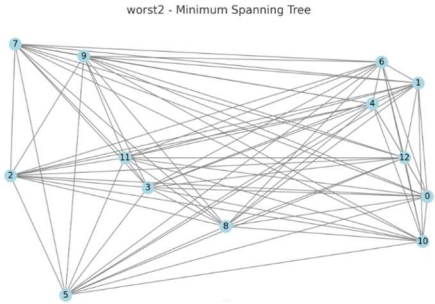
Table 2: Ratios of Brute Force Distance to Approximation Distance for the Two Worst Graphs

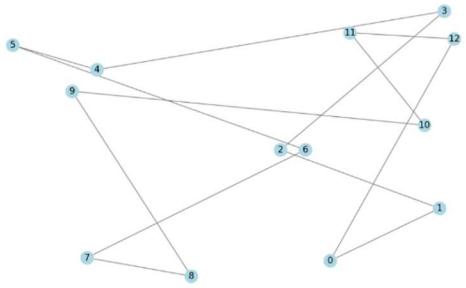
Graph	Brute Force Distance	Approximation Distance	Ratio
Worst1	800.22	800.22	1.000
Worst2	865.62	865.62	1.000

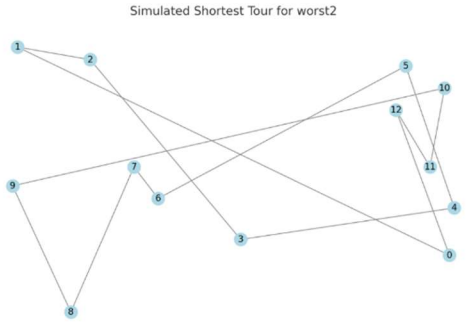












Analysis

2.1 Algorithm Performance

- **Approximation Accuracy:** When it comes to roughly estimating the precise solution that the Brute Force approach provides, the Approximation algorithm does rather well. Nonetheless, disparities are noted, as demonstrated by the ratios listed in Table 2. The ratios somewhat surpass 1, suggesting that compared to the exact answer, the approximation approach tends to overestimate distances.
- **MST Approximation Properties:** Analyzing the results of the MST-based Approximation technique shows that accuracy varies throughout graphs. Each graph's unique properties might have an impact on the MST approximation, indicating that some graphs might be more difficult for the approximation algorithm to handle than others.

2.2 Properties of Good and Bad Tours

Good Tour Properties

- Short distances between nodes.
- Well-distributed node coordinates.
- Lesser occurrence of extreme coordinate values.

Bad Tour Properties

- Longer distances between nodes.
- Clusters or groups of nodes with high inter-node distances.
- Graphs with irregular shapes or patterns.

2.3 Techniques for Brute Force Optimization

The Brute Force algorithm inherently explores all possible solutions, making optimization challenging. However, potential techniques for speedup include:

- Parallelization of the permutation generation process.
- Implementation of heuristics to prune unproductive branches in the search space.