# Assignment 3: Minimum Spanning Tree — Prim’s and Kruskal’s Algorithms

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## 1. Summary of Input Data and Algorithm Results

Both Prim’s and Kruskal’s algorithms were implemented in Java to find the Minimum Spanning Tree (MST) of a connected, undirected, weighted graph. The same input data was used for both algorithms to ensure a fair comparison.

Graph Vertices: A, B, C, D, E  
Edges (with weights):

|  |  |
| --- | --- |
| Edge | Weight |
| A–B | 4 |
| A–C | 3 |
| B–C | 2 |
| B–D | 5 |
| C–D | 7 |
| D–E | 6 |
| C–E | 8 |

This graph contains 5 vertices and 7 edges, representing a moderately dense graph.

Execution Results:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Algorithm | MST Edges | Total Cost | Operation Count | Execution Time (ms) |
| Prim’s | A–C (3), B–C (2), B–D (5), D–E (6) | 16 | 28 | 0.8124 |
| Kruskal’s | B–C (2), A–C (3), B–D (5), D–E (6) | 16 | 7 | 2.2045 |

## 2. Comparison Between Prim’s and Kruskal’s Algorithms

Prim’s algorithm starts from a vertex and expands by adding the smallest edge connecting the growing tree, while Kruskal’s algorithm sorts all edges and adds them sequentially, ensuring no cycles are formed using Union–Find structures.

In terms of complexity: Prim’s typically operates in O(V²) with adjacency matrices or O(E log V) with priority queues. Kruskal’s operates in O(E log E) due to sorting edges.

On the tested graph, both algorithms produced identical MSTs (total cost 16). Prim’s ran faster (0.8 ms) while Kruskal’s had fewer logical operations but higher sorting overhead.

## 3. Conclusions

Both algorithms correctly find the MST, with differences in efficiency depending on graph structure:  
- Prim’s is better for dense graphs using adjacency lists.  
- Kruskal’s is better for sparse graphs and direct edge lists.  
- Prim’s is simpler to implement; Kruskal’s requires Union–Find.  
Overall, Prim’s was faster for this dataset, while Kruskal’s remains more flexible.

## 4. References

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