CSC4202 **DESIGN AND ANALYSIS OF ALGORITHM**

AMBULANCE DISPATCH TEAM

GROUP 3

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INTRODUCTION

Problem Statement

The challenge is to select the optimal route using a consistent, pre-mapped road network that minimizes total travel distance, especially in environments where real-time traffic data is unavailable.

Without a shortest-distance algorithm in place, ambulances may take longer routes unnecessarily, increasing response times and putting patients' lives at greater risk.

Objectives

To implement a shortest-distance routing system using a consistent, pre-mapped road network.

To reduce response time by avoiding unnecessary delays caused by suboptimal routing decisions.

Importance for Finding The Solution

1. Reduces Critical Response Time
   - To minimize the travel distance of the ambulance to reach the patient and transport them to the hospital.
   - Increase the chance of survival of time-sensitive emergencies (cardiac arrest or accident) and also reduce long-term complications.

2. Reduce The Algorithm Running Time
   - Choosing the best algorithm is crucial to find shortest path for the ambulance.
   - Ensure all incidents are covered efficiently without unnecessary delay caused by algorithm.

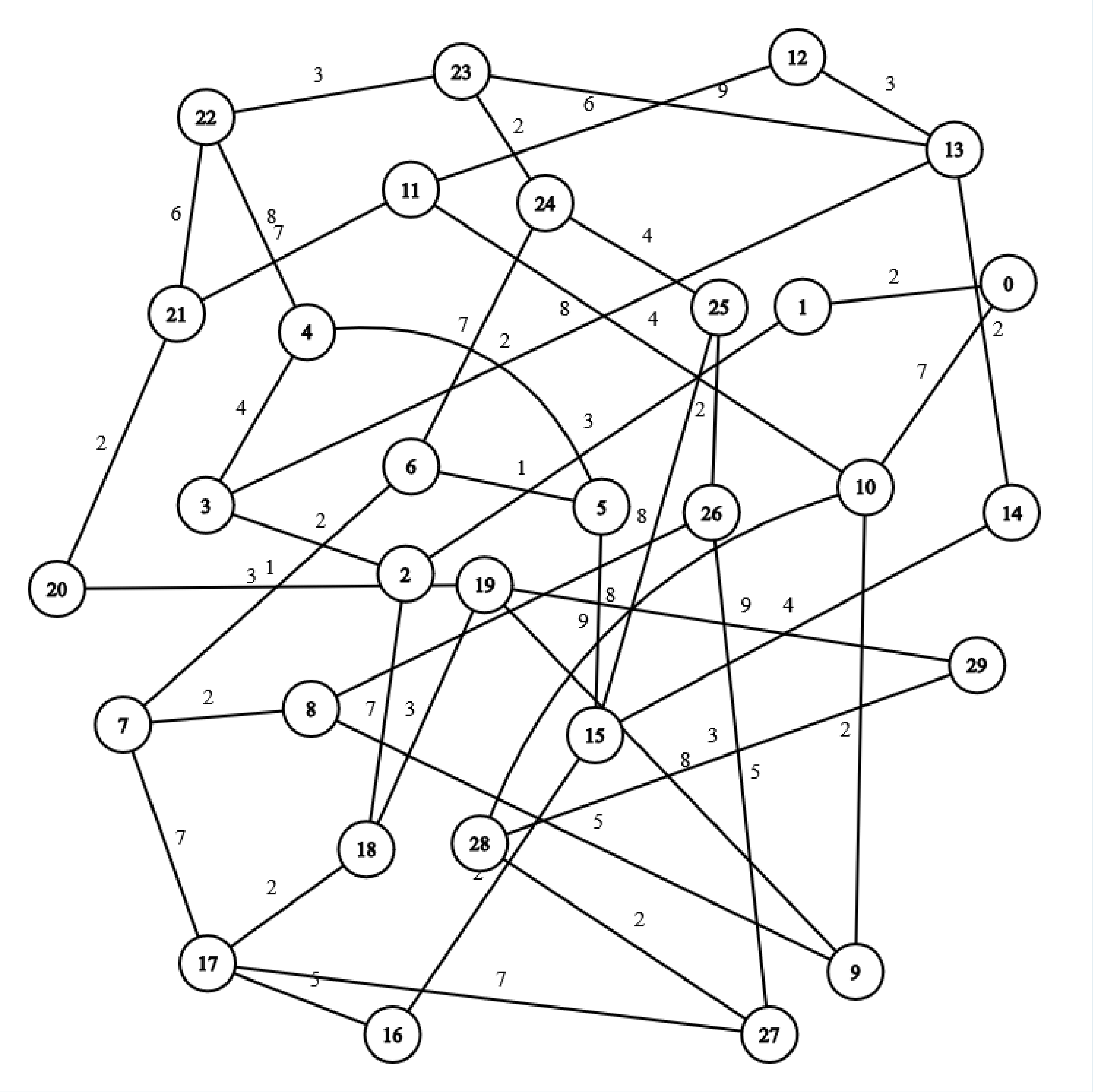
Comparison Of Brute Force and Dijkstra (Theoretically)

REFERENCE
V=Number of Nodes
E=Number of Edges

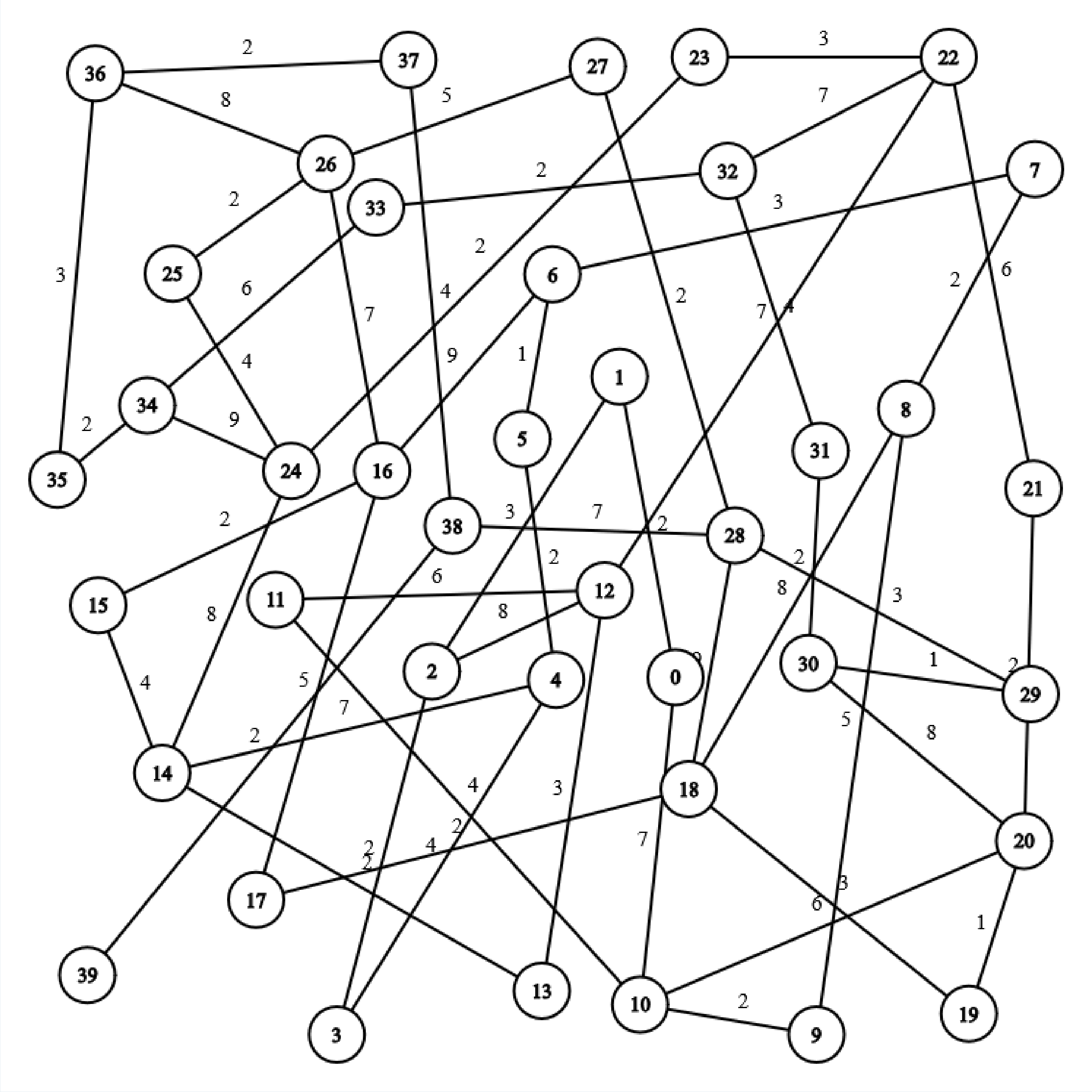
Dijkstra		Brute Force
Greedy algorithm that uses min heap priority	Approach	Combanitorial exhaustive search, typically using recursion
Has a time complexity of O((V + E) log V) with binary heap	Time Complexity	Worst-case tme complxity O(V!)
High scalability due to its quasi-linear behaviour	Scalability	Poor scalability due exponential behaviour.
Highly reliable with non-negative edge weight.	Practicality	it is impractical due to its non-polynomial runtime.

Node Map

vertices = 30

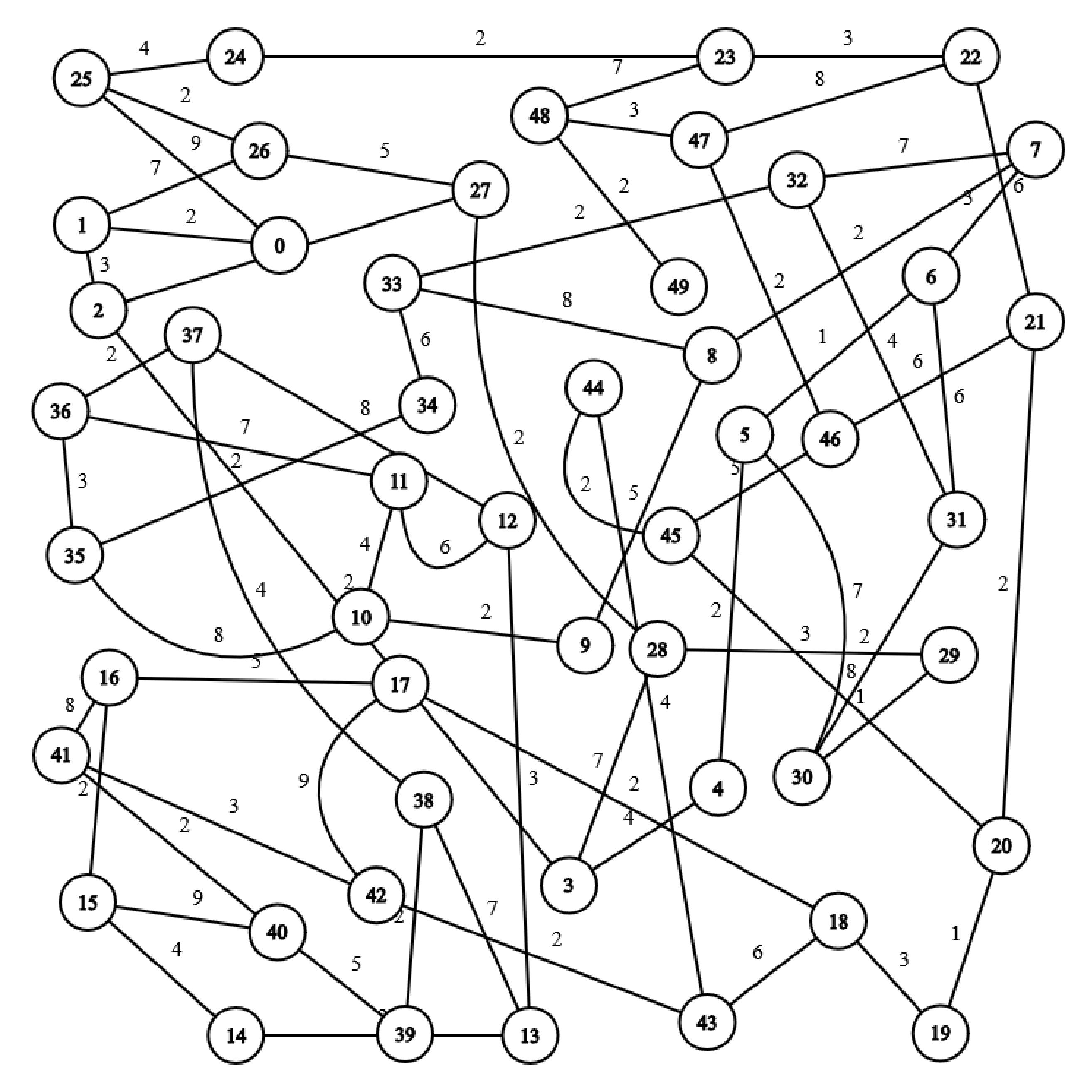


vertices = 40

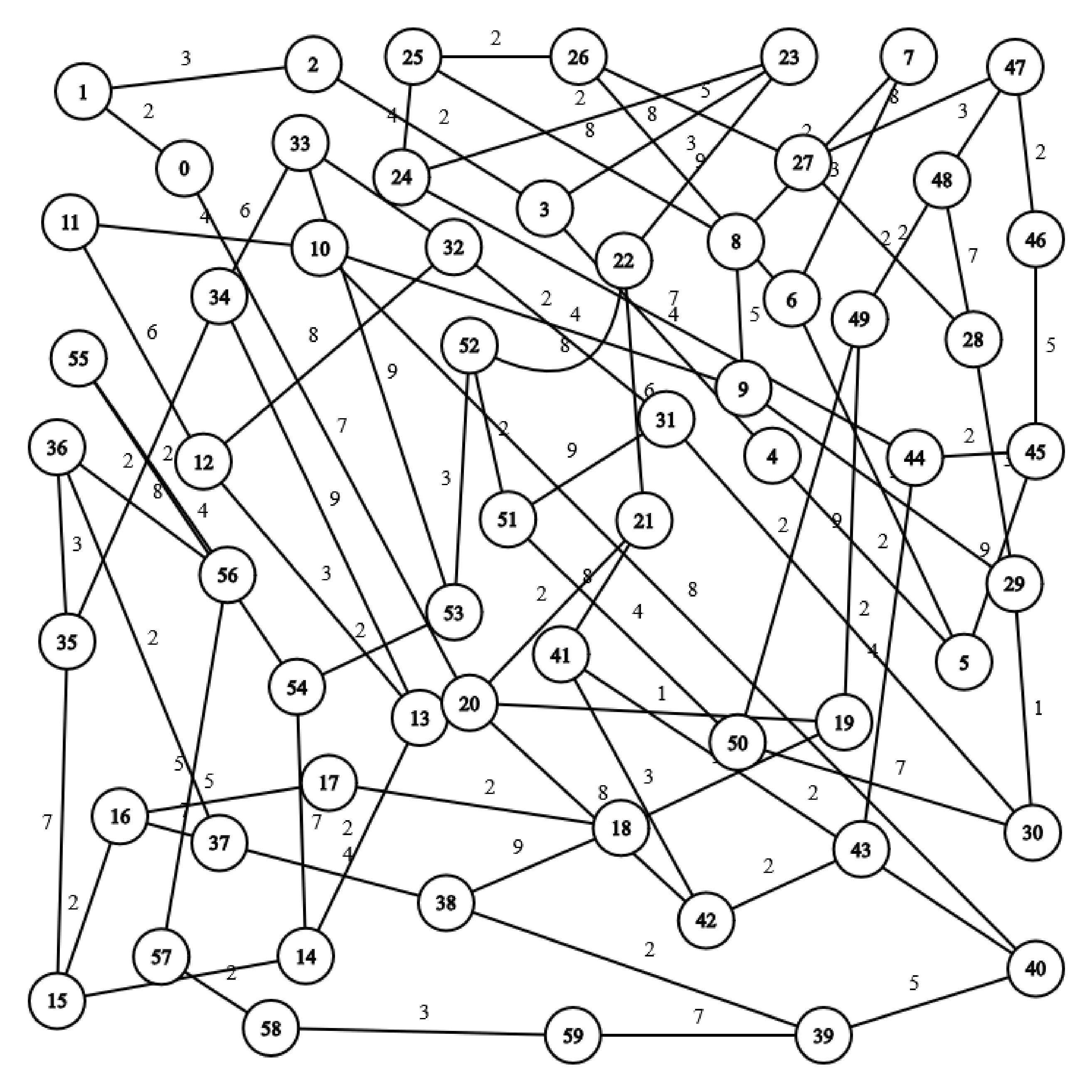


Node Map

vertices = 50



vertices = 60



Sample Output from Coding

vertices = 30

```
Enter source node (0-29): 0
Enter destination node (0-29): 29

[ Dijkstra ]
Shortest distance = 18
Path: [0, 10, 28, 29]
Elapsed time: 2635 microsecs

[ Brute Force ]
Shortest distance = 18
Path: [0, 10, 28, 29]
Elapsed time: 7777 microsecs
```

vertices = 40

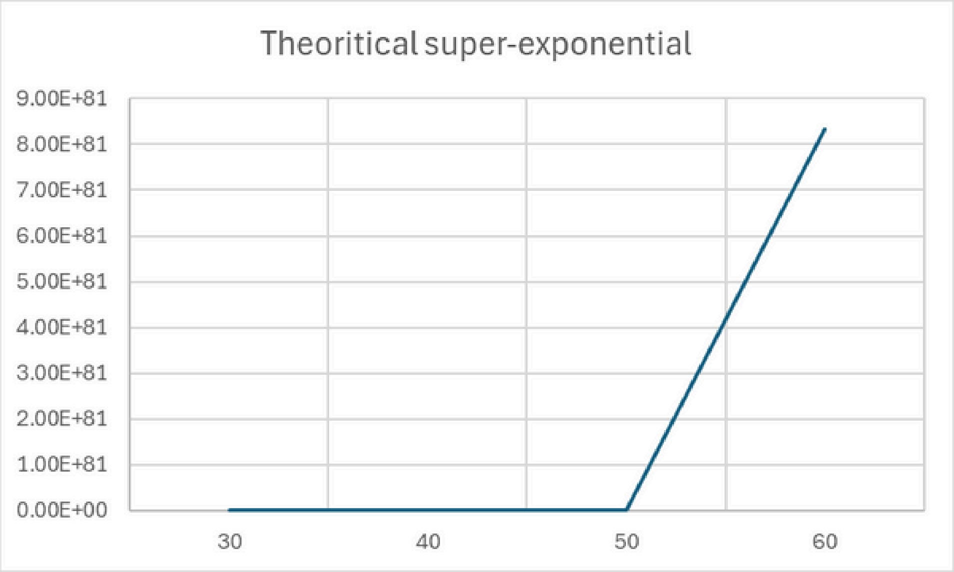
```
Enter source node (0-39): 0
Enter destination node (0-39): 39

[ Dijkstra ]
Shortest distance = 34
Path: [0, 10, 20, 30, 29, 28, 38, 39]
Elapsed time: 2788 microsecs

[ Brute Force ]
Shortest distance = 34
Path: [0, 10, 20, 30, 29, 28, 38, 39]
Elapsed time: 11064 microsecs
```

vertices = 50

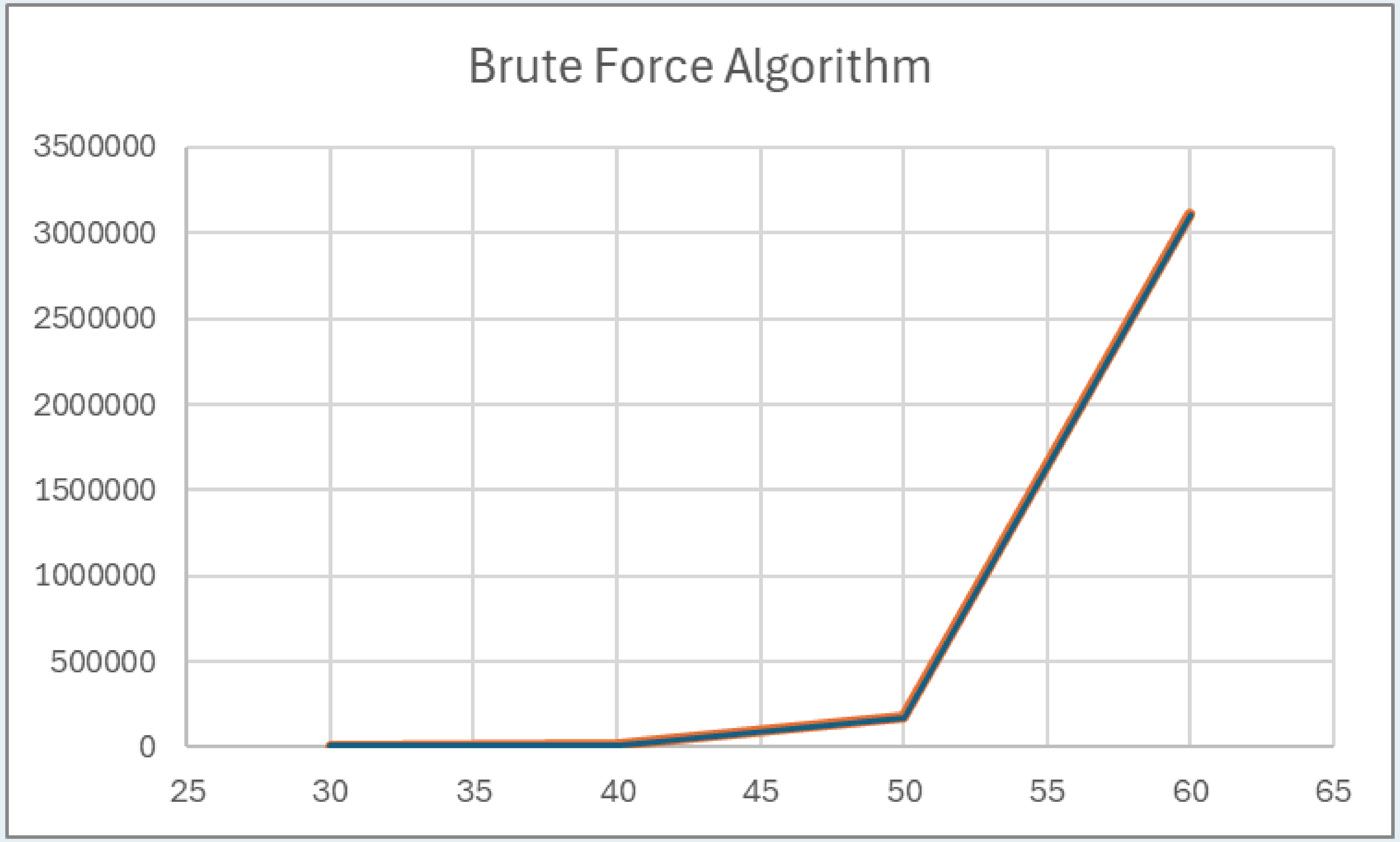
```
Enter source node (0-49): 0
Enter destination node (0-49): 49

[ Dijkstra ]
Shortest distance = 24
Path: [0, 25, 24, 23, 48, 49]
Elapsed time: 2888 microsecs

[ Brute Force ]
Shortest distance = 24
Path: [0, 25, 24, 23, 48, 49]
Elapsed time: 171752 microsecs
```

vertices = 60

```
Enter source node (0-59): 0
Enter destination node (0-59): 59

[ Dijkstra ]
Shortest distance = 29
Path: [0, 20, 19, 18, 38, 39, 59]
Elapsed time: 3099 microsecs

[ Brute Force ]
Shortest distance = 29
Path: [0, 20, 19, 18, 38, 39, 59]
Elapsed time: 3158153 microsecs
```



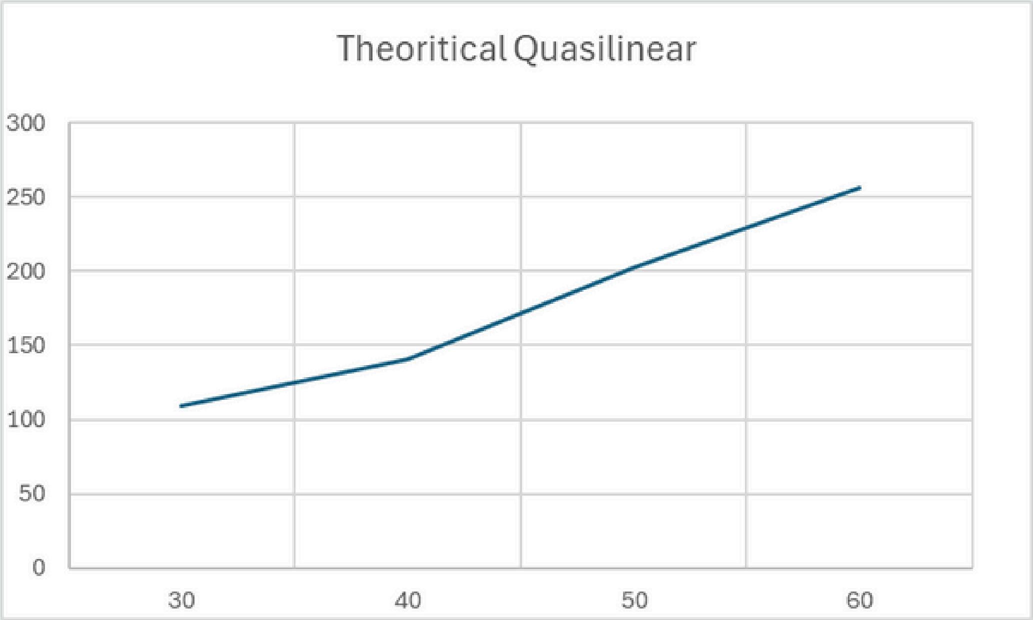
Brute Force Algorithm graph



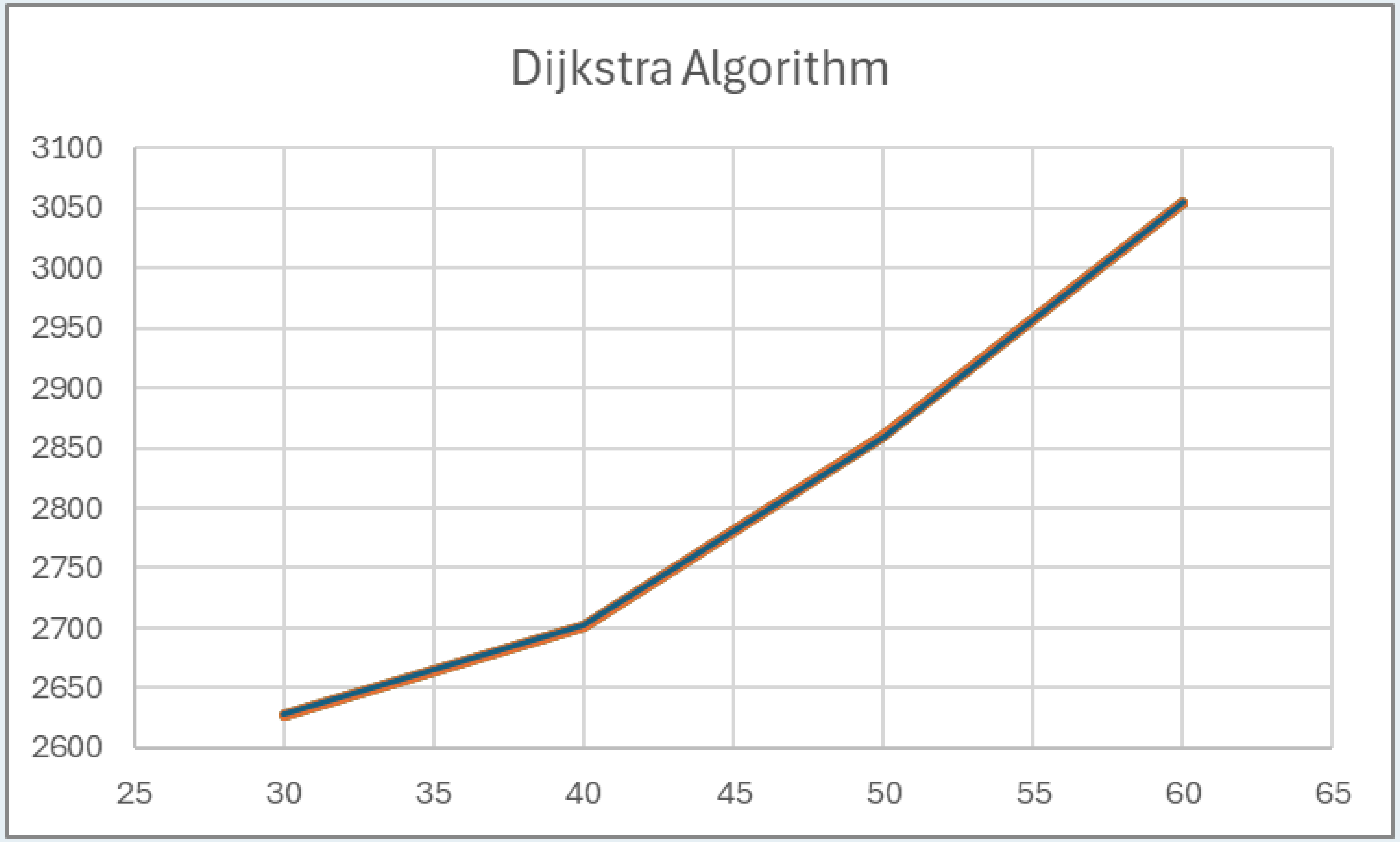
Vertices Size	Elapsed Time (microseconds)
30	8128
40	11163
50	177162
60	3108688

Time Complexity

V !



Dijkstra Algorithm Graph

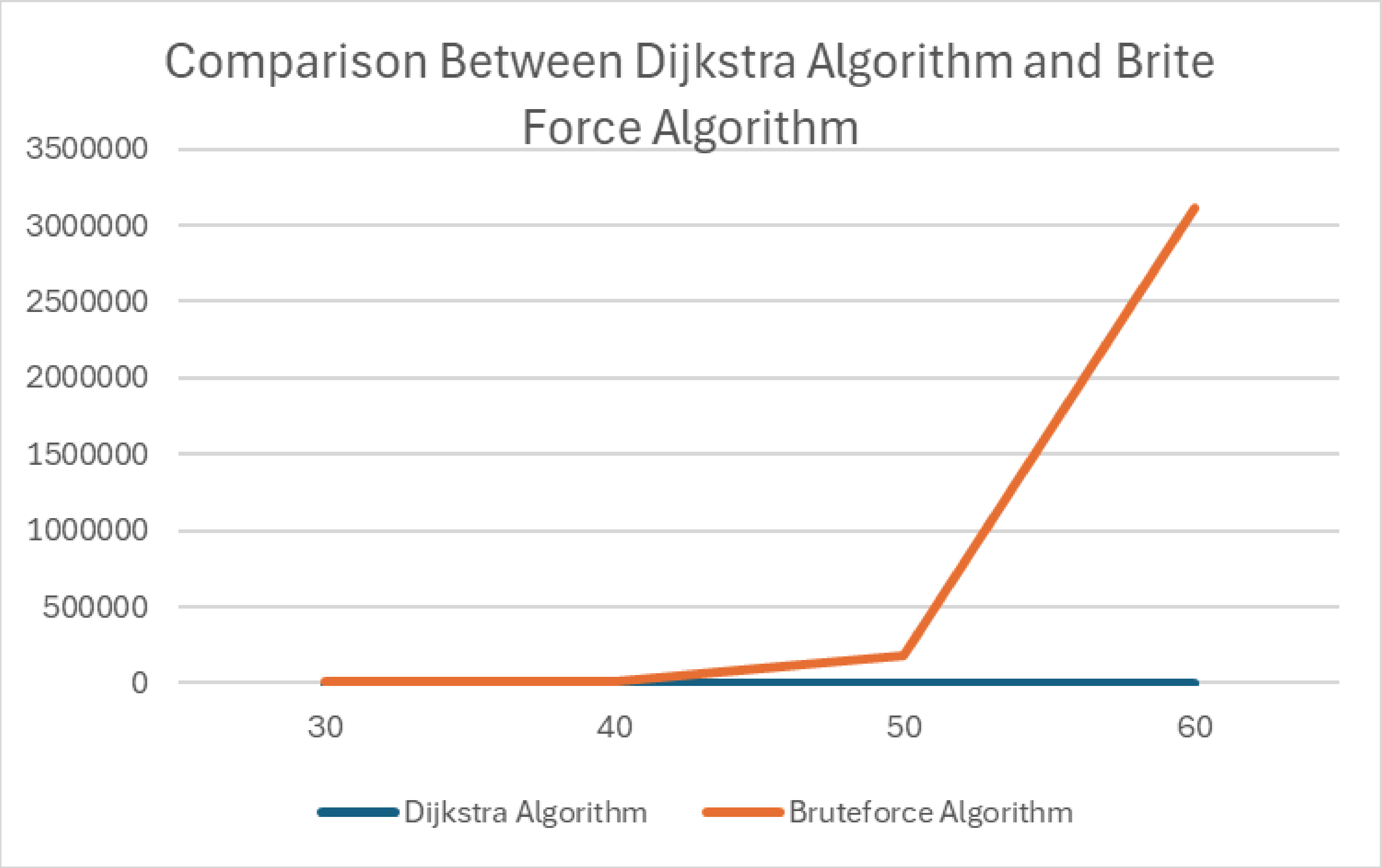


Vertices Size	Elapsed Time (microseconds)
30	2628
40	2702
50	2859
60	3055

Time Complexity

$(V + E) \operatorname{Log} V$

Comparison

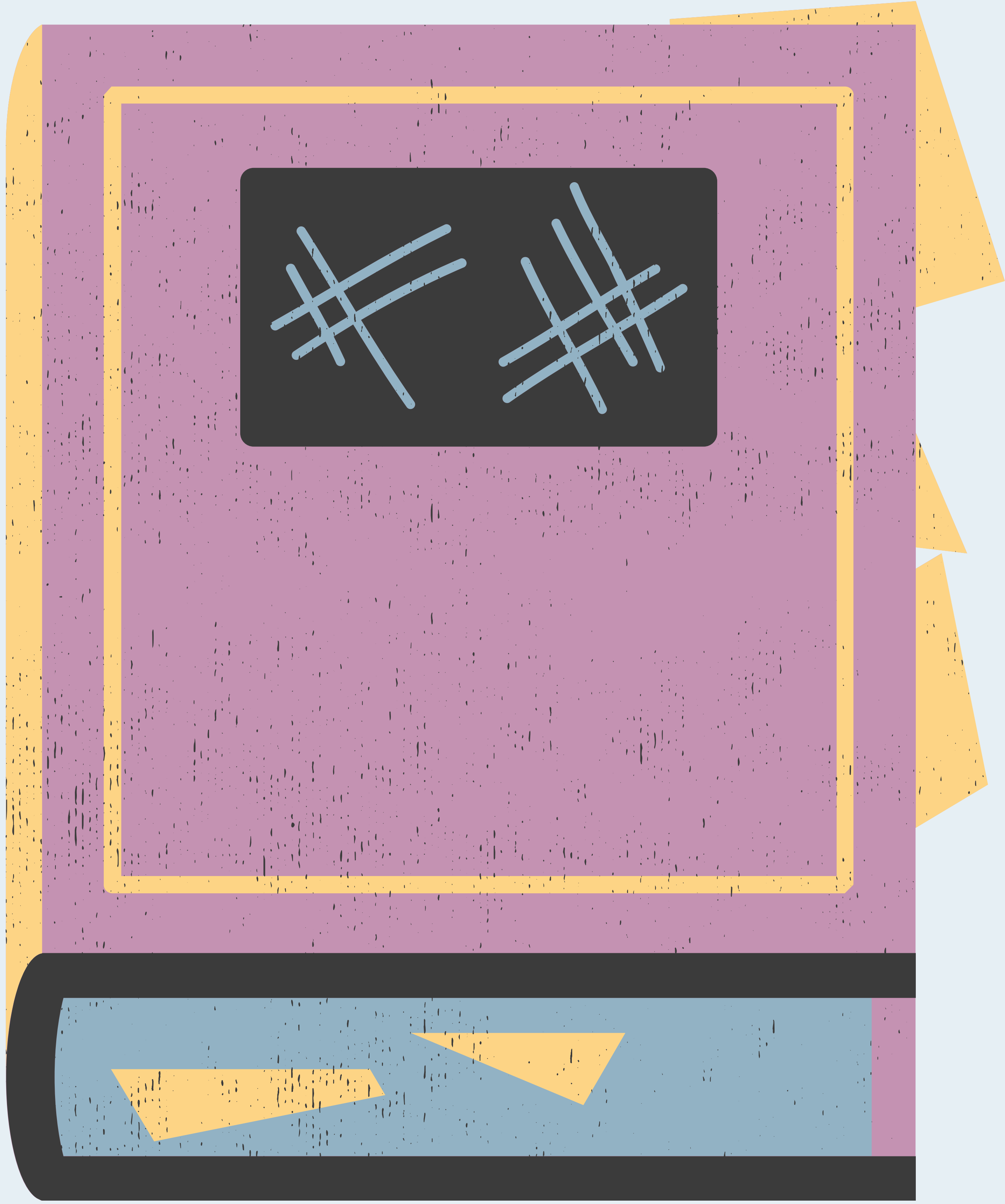


It's very difficult to compare these two algorithms on the same graph because

the brute force algorithm grows super-exponentially; values to increase extremely fast

Dijkstra's algorithm is quasilinear; scales much more slowly

Due to the brute force algorithm's huge values, the dijkstra growth looks almost flat by comparison. In reality, it is increasing too just at a much slower rate that's hard to see on the same graph



Conclusion

- *The brute force algorithm grows super-exponentially, causing values to increase extremely fast as input size increases.*
- *Dijkstra's algorithm grows quasilinear, making it significantly more efficient and scalable.*
- *This visual gap highlights the vast efficiency difference between the two approaches.*
- *Dijkstra's algorithm is far more practical for larger problem sizes, offering consistent performance and lower computational cost.*

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THANK YOU

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