

# Assignment 3

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Here is the report belonging to pa3 for 1DT907 course from [Samuel Berg](#)

## How to run the code

Instead of being `java#` as it is on linux and mac, for windows you would need to add the `.java` after the file you want to run.

```
javac *.java
```

```
java Main1  
java Main2  
java Main3  
java Main4  
java Main5
```

## Problem 4

### Dijkstra's Algorithm

Dijkstra's Shortest Distances sample:

```
From 0 to 8729: 5.329343291714084  
From 0 to 4916: 5.580331178322289  
From 0 to 8863: 5.869060149692333  
From 0 to 6545: 5.752871187232946  
From 0 to 4: 1.549113175557646  
From 0 to 1838: 5.529777702868398  
From 0 to 8775: 5.3976037503422525  
From 0 to 1581: 5.79784568415894  
From 0 to 7099: 6.0953901166444515  
From 0 to 690: 6.189950574655911
```

Dijkstra's Time: 13.9578 ms

### Bellman-Ford Algorithm

Bellman-Ford's Shortest Distances sample:

```
From 0 to 5608: 5.020887020182483  
From 0 to 4103: 6.236187629593231  
From 0 to 470: 7.487941643279421  
From 0 to 8411: 6.062208995135986  
From 0 to 4706: 5.124226916858716  
From 0 to 2379: 7.228916440418932  
From 0 to 1044: 6.454888444866436
```

```
From 0 to 5588: 7.511343191375932
From 0 to 1112: 5.748846376855659
From 0 to 5097: 7.293874740141204

Bellman-Ford's Time: 4.6775 s
```

## Conclusion

**Note:**  $V$  = # vertices and  $E$  = # edges in the following text.

The above shown samples are from a run with 10 000 vertices and 20 000 edges. Which shows that Dijkstra's algorithm is faster than the Bellman-Ford algorithm. This holds true in all of the test cases I have provided the algorithms. The reason to Dijkstra's algorithm being faster than the Bellman-Ford algorithm is because Dijkstra's algorithm greedily selects the shortest path from the current node to all other nodes in the graph and it never revisits nodes once they have been processed. This gives Dijkstra's algorithm a time complexity of  $O((E + V) * \log V)$ . Meanwhile Bellman-Ford algorithm iterates over all edges multiple times to find the shortest path. This means it has to iterate over all edges  $V - 1$  times to gain the shortest path. This gives it the time complexity of  $O(V * E)$  in it's worst case. We can safely assume that  $O((V + E) \log V) < O(V * E)$ .

**Note:** Dijkstra's algorithm can't handle negative edge weights meanwhile Bellman-Ford can.

To explain this more theoretically this is due to Dijkstra's being a so called "greedy" algorithm and due to it's time complexity being  $O((E + V) * \log V)$ , which means it has an logarithmic increasing time complexity. Meanwhile Bellman-Ford due to being able to handle negative edge weights has a time complexity of  $O(V * E)$ . Which leads to the times mentioned in the sample outputs are reasonable for the respective algorithms.