CS141 – Intermediate Algorithms and Data Structures Assignment 2 – All Pairs Shortest Path

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Abstract

1 Introduction

- We are given a file that contains different vertices and their weights to other vertices. Given this information, we want to find the weight of each point to any other points on the graph if possible and also the path that costs the least.

- To do so, we will be utilizing two different algorithms, Bellman-Ford and Floyd Warshall.

- Bellman-Ford and Floyd Warshall are both superior to Djykstra's since they can account for negative weights. Floyd Warshall is better than Bellman-Ford since Bellman-Ford can not account for negative cycles.

- We are using both algorithms to compare their runtimes given the same sets of data.

2 Bellman-Ford

- Bellman-Ford algorithm is an algorithm used for finding the best path that requires the least weight that can account for negative weights. This algorithm requires a source point to be set to 0.

- We are using Bellman-Ford because although it can't deal with negative cycles, it can still detect it. Also we use Bellman-Ford when we only want to deal with one point.

- We wrapped the Bellman-Ford algorithm within a giant for loop. Each index would represent a source point within the given data.

- Before, Runtime is $O(|V||E|)$. Our adaptation is $O(|V|^3|E|)$

3 Floyd-Warshall

- Floyd Warshall is a 3-Dimensional algorithm as opposed to Bellman-Ford

- It can handle situations that Bellman-Ford can not and also when we want distance between all points.

- This algorithm can deal with negative cycles and isn't restricted to needing a source point to calculate.

- The runtime is $O(|V|^3)$

4 Results

- Although they both are capable of finding all shortest path pairs, Floyd Warshall algorithm is more suitable as it is an all pairs shortest path algorithm vs a single source shortest path algorithm.

- The theoretical run-time of Bellman-Ford is faster since it only needs to find from source point compared to Floyd Warshall's all points.

- In our actual run-times, Floyd Warshall outperformed Bellman-Ford due to the modificications

Benchmarks	Bellman-Ford		Floyd-Warshall	
	$O(.)$	Actual	$O(.)$	Actual
input1.txt	$O(|V|^3|E|)$	0.00013907253742218018	$O(|V|^3)$	6.523728370666504e-05

done to Bellman Ford so that it can output same results as Floyd Warshall.

5   Conclusions

- The hardest part of this assignment was understanding how to implement Bellman-Ford and the pseudo-code.

- I learned the difference between the two algorithms and how each has their own way of arriving at the same solution.

- Bellman-Ford can be used in a GPS for finding the shortest distance from one place to another. Floyd Warshall can be used as more of an information gathering algorithm for finding cheapest flights from every place to every other place.