# Programming Project II, Second Report

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## 1 Abstract

As stated in the prior report, social networks have revolutionized the way we communicate. Seeing as social *networks* are a real-life representation of a graph, we would like to more closely examine them. Particularly, we would like to test

- Degree Distribution
- Shortest Path Distribution
- Graph Diameter
- Closeness Centrality
- Betweenness Centrality Distribution
- Community Detection

This report will showcase our results — more specifically, we would like to discuss, in detail, our implementation and experiments. Also, we will list any relevant, interesting results we obtain.

## 2 Implementation

Our implementation is as follows, from a higher level:

1. Get and parse graph input.
    - Because our data was given in the form of a `csv`, we decided to just pipe that input directly to a `vector<string>`.
    - We then pass said `vector<string>` to a function that parses using C++ string functions.
    - We pipe the parsed data to a data structure of `map<int, vector<pair<int, double>>>`
        - The `int` is the key for retrieval of the `vector`

- The `vector<pair<int, double>>` stores a `vector` of the edges, in pairs — where the pair `<int, double>` are proportional to the target vertex and weight.

2. Move on to calculating the out degree of the vertexes.
   - Initialize a `map` of `<int, int>` for unweighted and `<int, double>` for unweighted.
   - For both weighted and unweighted simply use the source as the `key`.
   - For unweighted, use the `size()` method of the vector class to determine the out degree[1].
   - For weighted, sum the `second` property of the `pair`s in the `vector` — note that the second property of `pair` is the weight. This gives a total weight.
3. Move to calculating the in degree of the vertexes.
   - This is done almost the same way, except there is a weight `map`.
   - Iterate over the entirety of our data structure[2], and store where the target vertex points to in all the edges in the weight `map`.
4. Calculate shortest path via the Floyd-Warshall algorithm.
   - Initialize an adjacency matrix — a `vector<vector<int>>`
     - Default all values to infinity — in our case, 999999.
   - Copy over data from our `map` to said adjacency matrix.
     - If unweighted and an edge exists, default to 1.
   - If requested an undirected shortest path, make the graph indirected.
     - This is done by making a mirror image of the adjacency matrix $A$, by setting $\forall i, j \in A, A_{i,j} = A_{j,i}$. Just copying over the diagonal.
   - Run the Floyd-Warshall algorithm, with triple C-Style `for` loops.

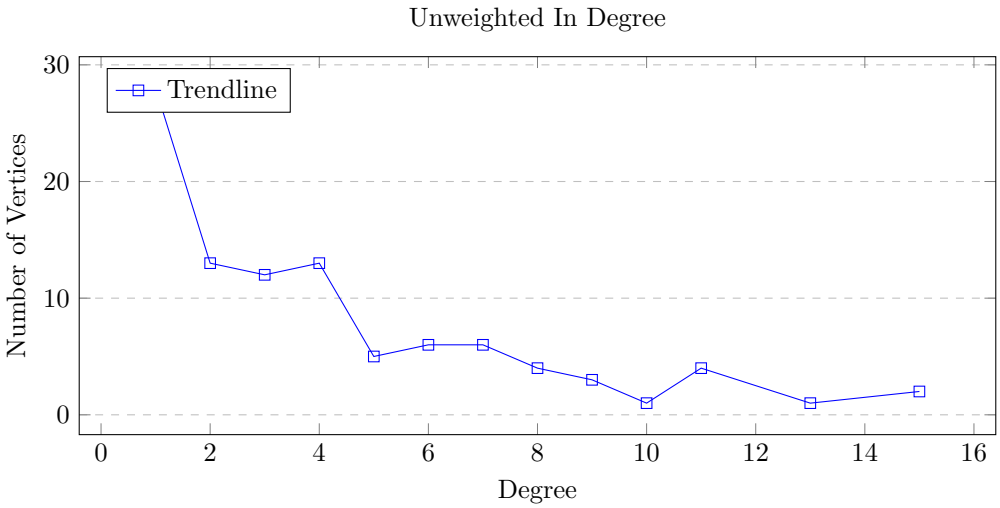
[1] Remember, the key return the a `vector` of pairs. The number of pairs are directly proportional the out degree.

[2] An adjacency map of sorts, `map<int, vector<pair<int, double>>>`.

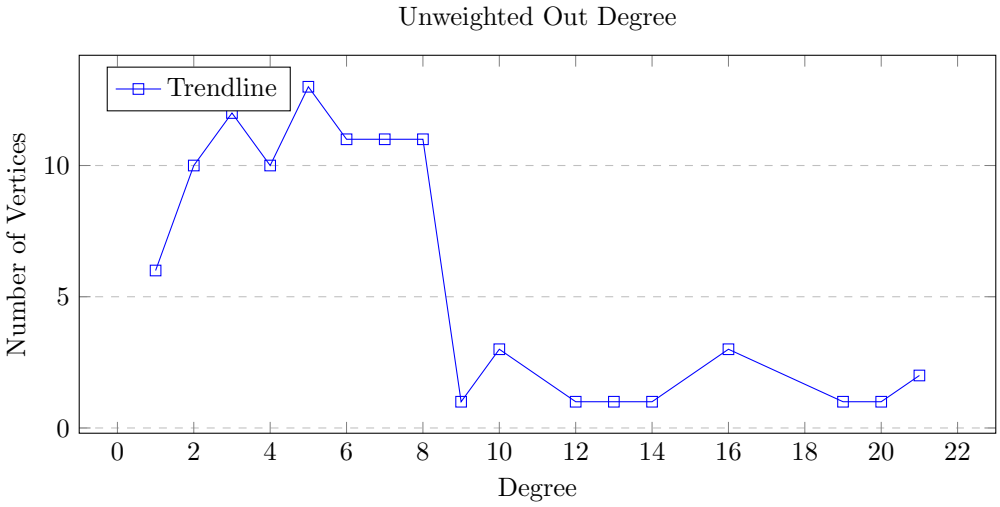
# 3 Experiments

## 3.1 Degree Distribution

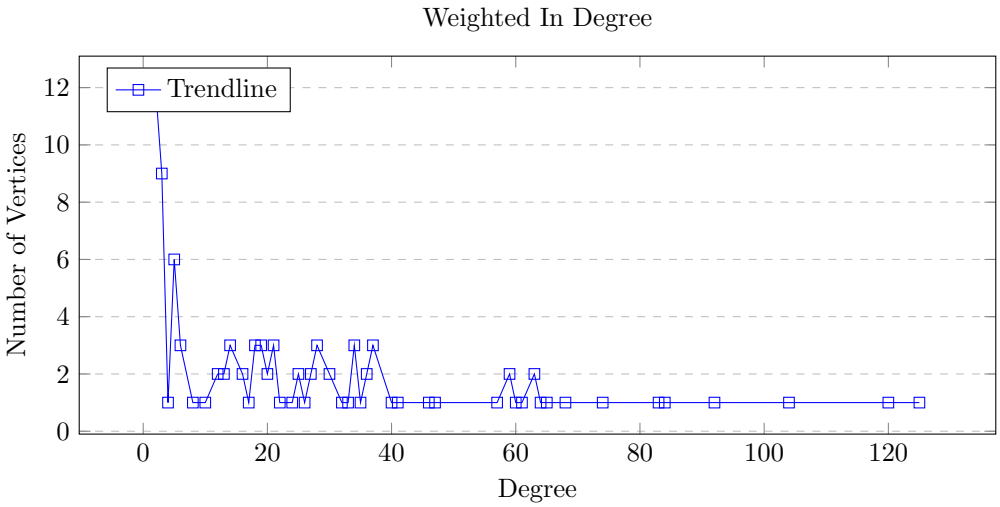
### 3.1.1 Unweighted In Degree



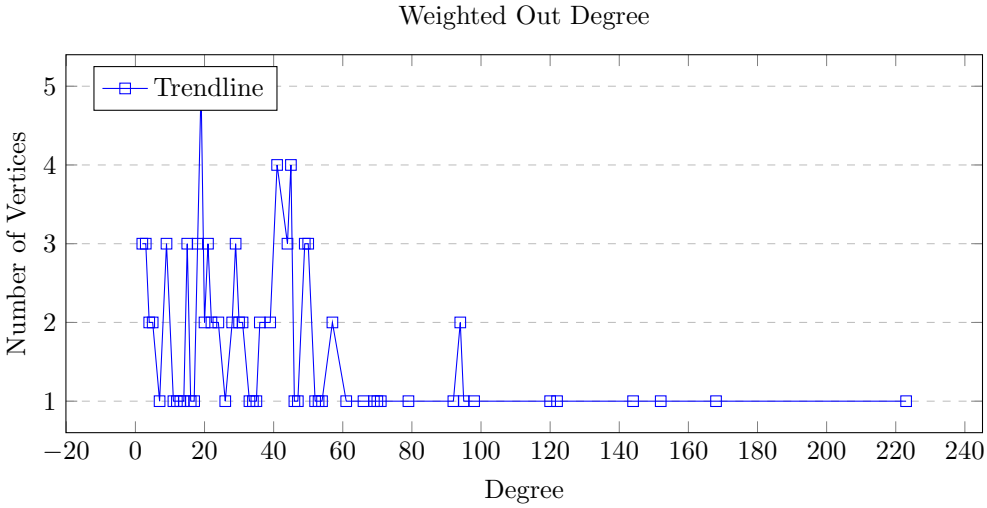

### 3.1.2 Unweighted Out Degree



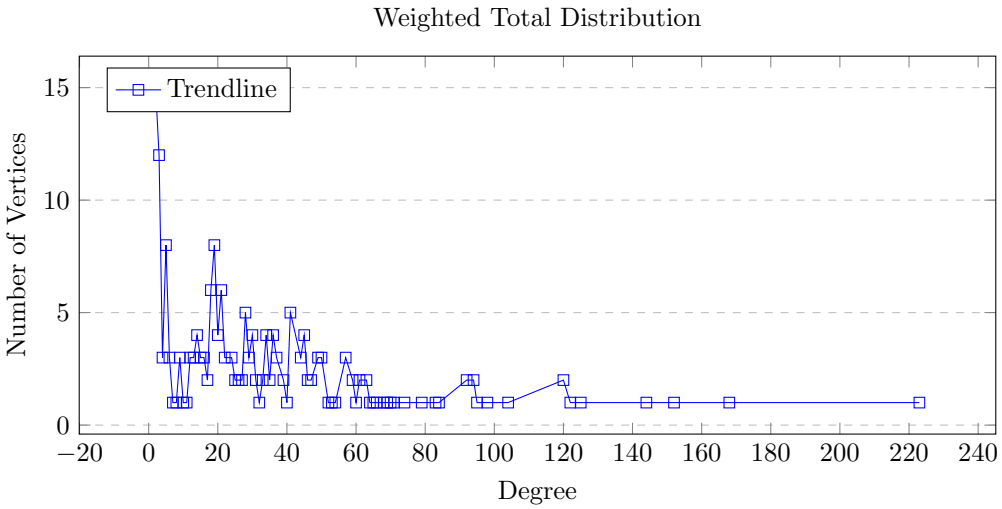
### 3.1.3 Weighted In Degree



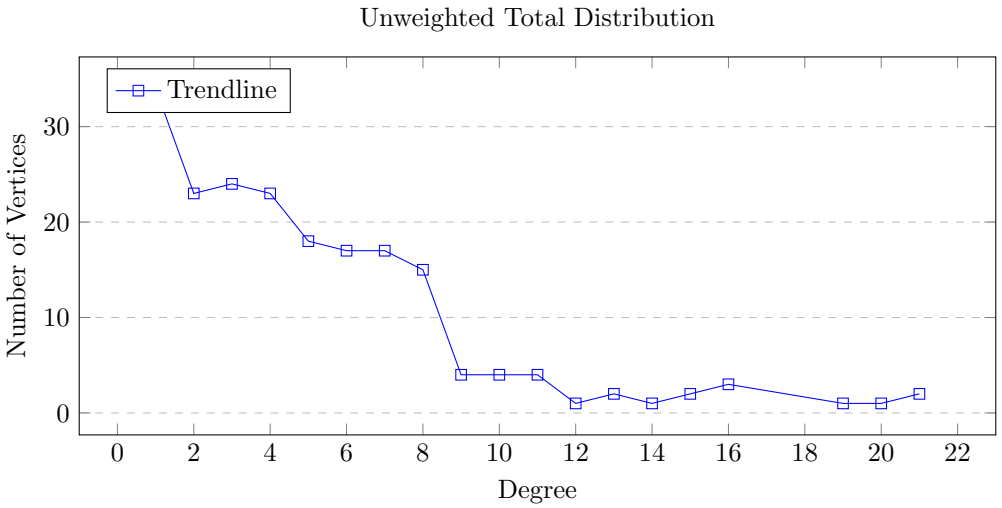

### 3.1.4 Weighted Out Degree



### 3.1.5 Weighted Total Distribution



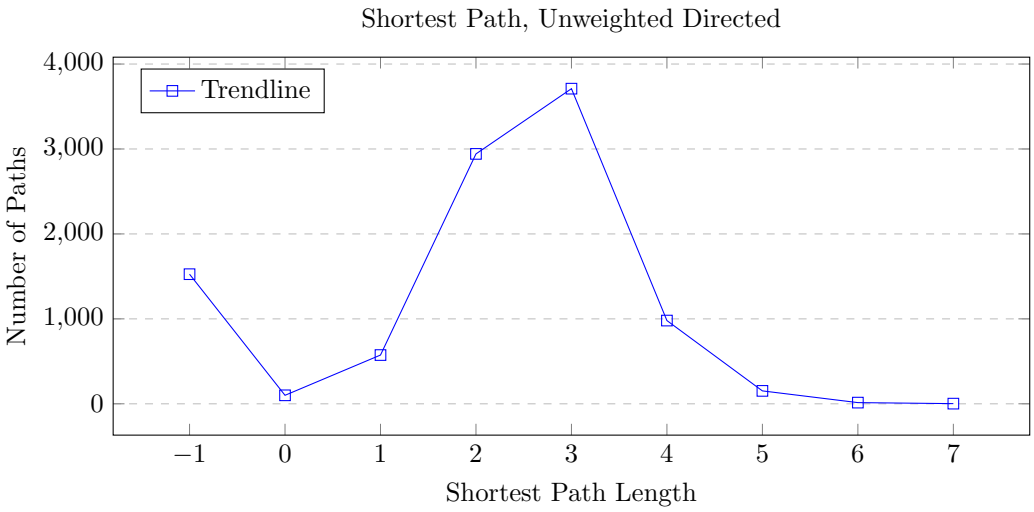

### 3.1.6 Unweighted Total Distribution



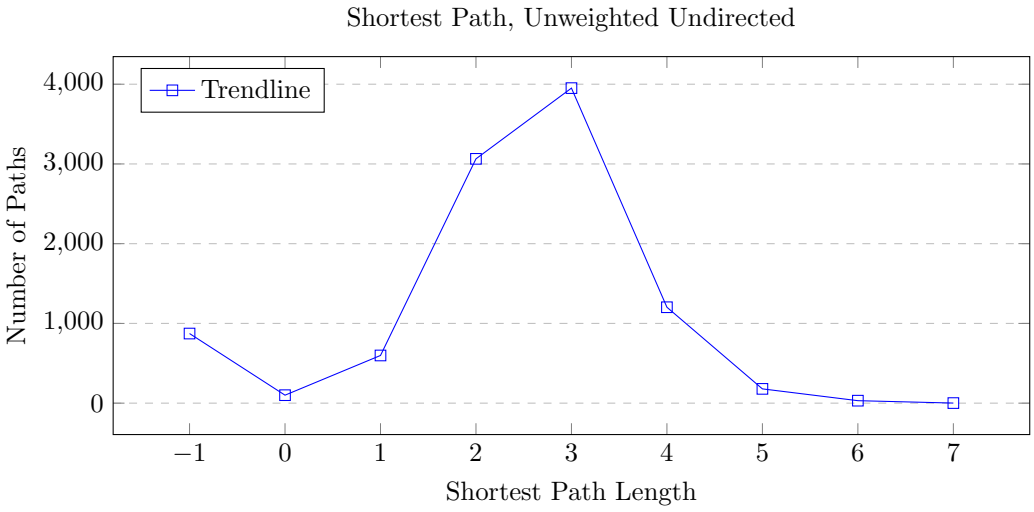

## 3.2 Shortest Path

Please not that $-1$ corresponds to a path between two vertices not existing.

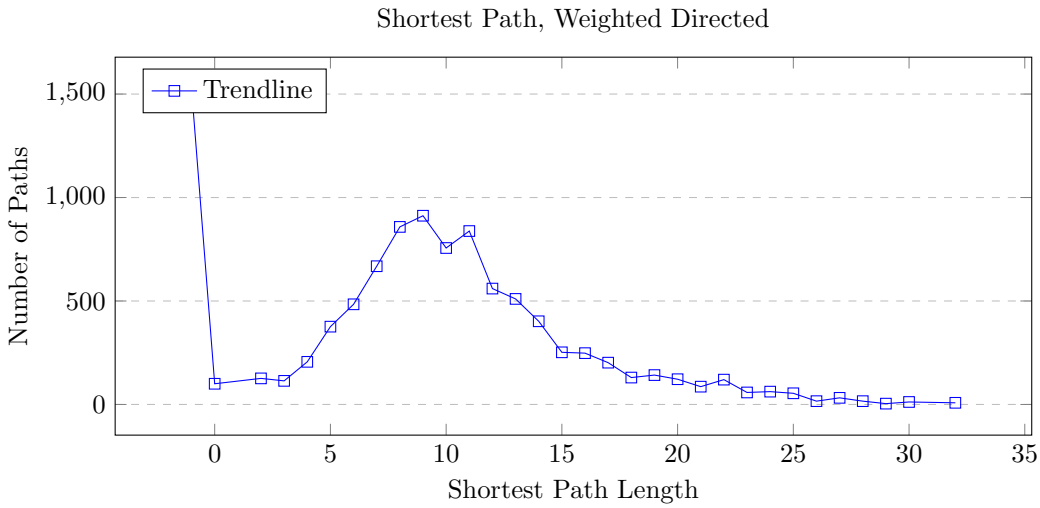
### 3.3 Shortest Path, Unweighted Directed



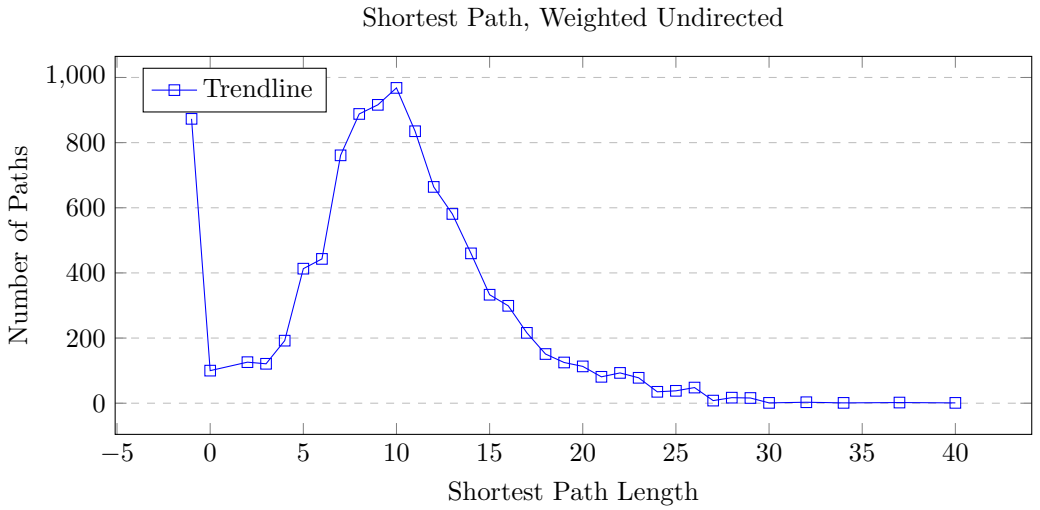

### 3.4 Shortest Path, Unweighted Undirected



### 3.5 Shortest Path, Weighted Directed




### 3.6 Shortest Path, Weighted Undirected




## 4 Team Roles

- Illya Starikov
  - Project Manager

  - Implementation
    - Weight Distribution
    - Shortest Path
- Timothy Ott
  - Report Writeup
  - Implementation
    - Closeness Centrality
    - Community Detection
- Claire Trebing
  - Report Writeup
  - Implementation
    - Unweighted/Weighted Graph Diameter
    - Betweenness Centrality Distribution

# 5 Conclusions