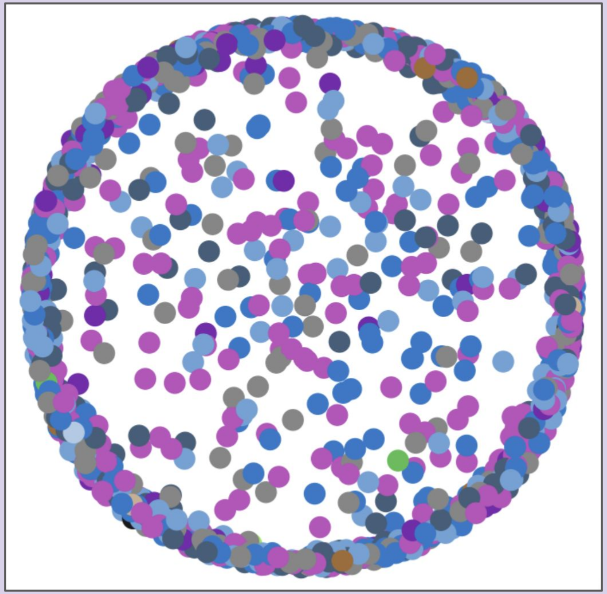


# CS 176 Final Project

Group Name: Youtube Analysts

Group Members: Shreya Raj and Erica Xue

# Introduction

- Using **NetworkX** to analyze and visualize large-scale communities in highly extensive datasets
  - Uncovering patterns and connections within a social network
  - Implementing sampling, community detection, and visualization
    - Goal: to understand the network’s cohesiveness and structure
- Tools:
  - NetworkX, Matplotlib, Google Colab, Pandas
- Technologies:
  - Python, Network Analysis Algorithms, Graph Theory

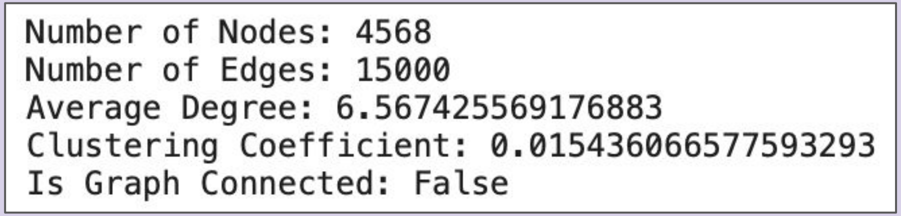
# Problem Description

- Large-scale network analysis overview
  - Degree distributions, clustering coefficient, average degree, node connectedness
  - Centrality algorithms (Degree, Betweenness, and Closeness)
  - Community detection algorithms (Louvain and Girvan-Newman)
  - Visualizations of communities and the overall network
- Challenges
  - Too large of a dataset
    - Random sampling to find optimal subset of the data
  - Clear, interpretable visualizations
    - Experimenting with different layouts and hyperparameters

# Dataset Description

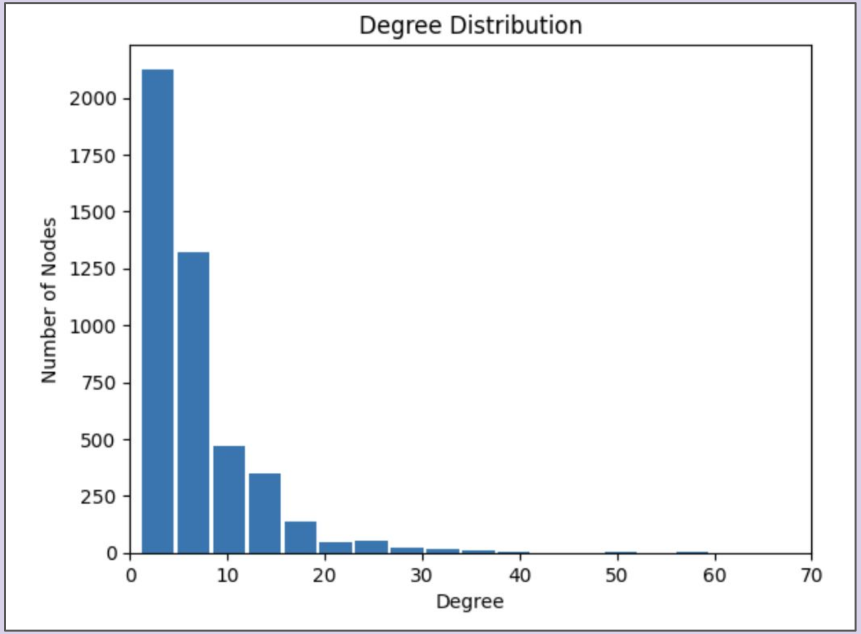
- YouTube Social Network Dataset
  - Type: Undirected Graph
  - Nodes: 1,134,890 (users)
  - Edges: 2,987,624 (friendship connections)
  - Diameter: 20 (the shortest path connecting the two furthest apart users is a distance of 20 friendship connections)
  - Communities: 8,385 communities
- Sampling nodes with highest degrees
  - Creating subgraph with 15,000 edges for analysis

# Analysis and Results



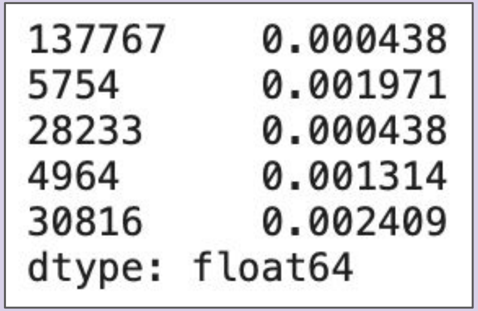
```
Number of Nodes: 4568
Number of Edges: 15000
Average Degree: 6.567425569176883
Clustering Coefficient: 0.015436066577593293
Is Graph Connected: False
```

- Sampled graph results:
- Number of bridges: 577
- Number of articulation points: 469
- Maximum diameter of connected component: 14
- Degree distribution histogram:
  - Power-law degree distribution



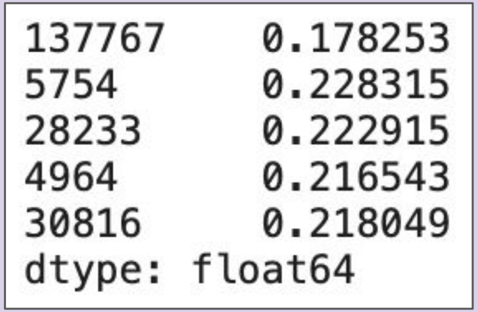
# Analysis and Results

Degree centrality



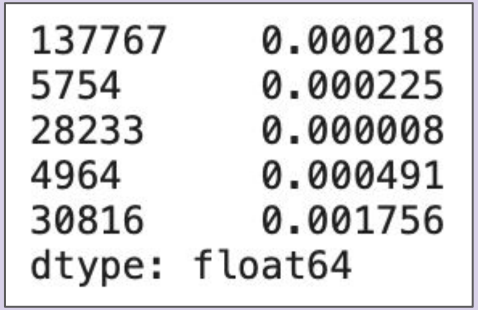
```
137767     0.000438
5754       0.001971
28233      0.000438
4964       0.001314
30816      0.002409
dtype: float64
```

Connectedness centrality



```
137767     0.178253
5754       0.228315
28233      0.222915
4964       0.216543
30816      0.218049
dtype: float64
```

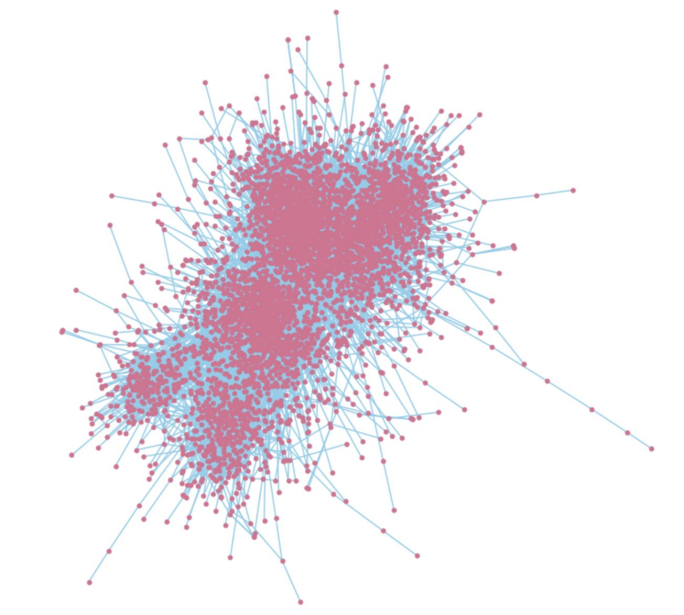
Betweenness centrality



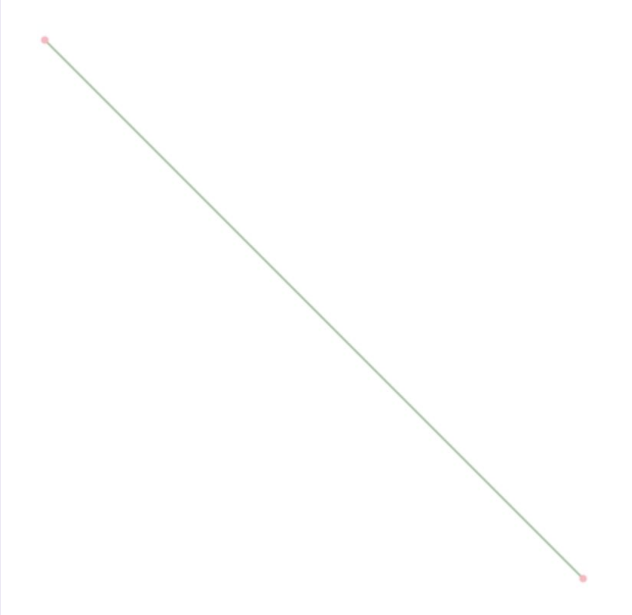
```
137767     0.000218
5754       0.000225
28233      0.000008
4964       0.000491
30816      0.001756
dtype: float64
```

# Analysis and Results

- Largest Connected Component



- Second Largest Connected Component

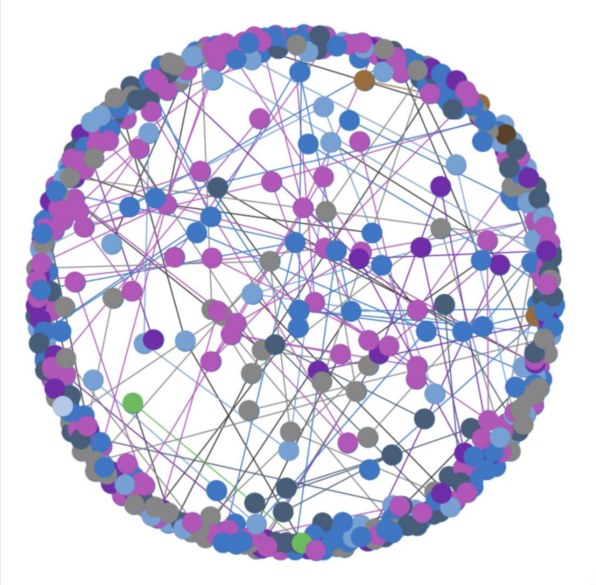


# Analysis and Results- Louvain algorithm

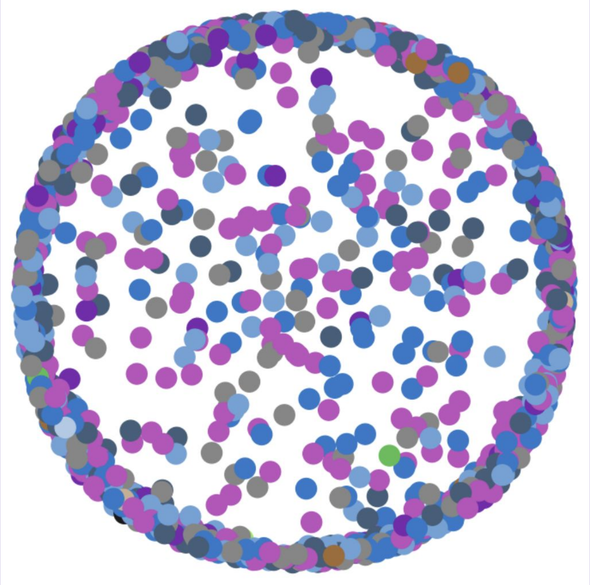
Number of communities: 24

Modularity score:  0.603

500 nodes with edges

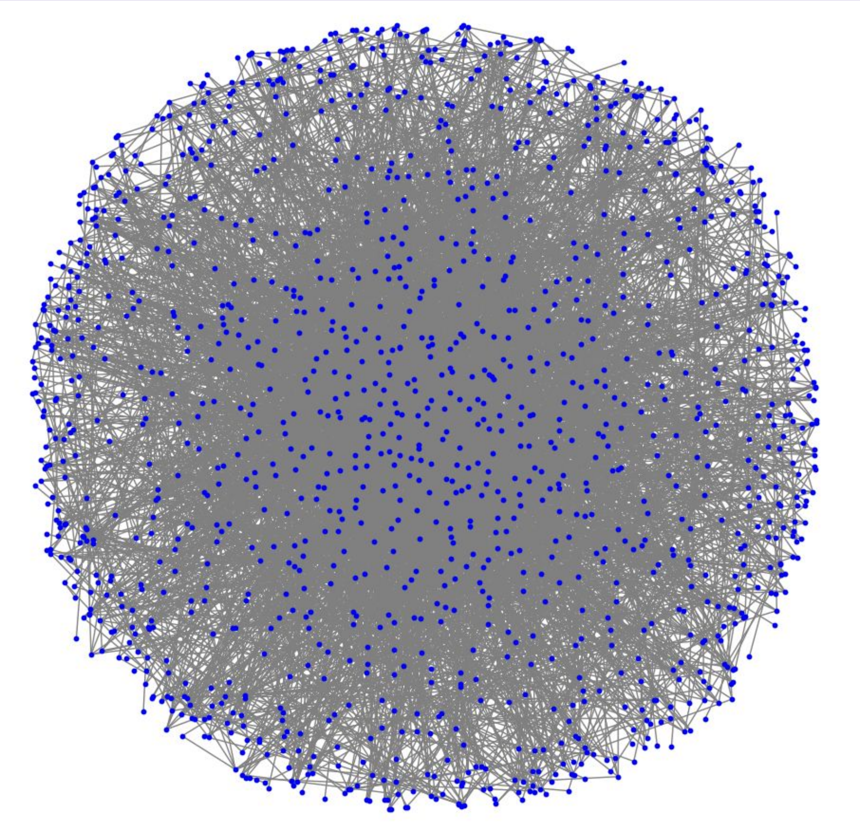


1250 nodes without edges



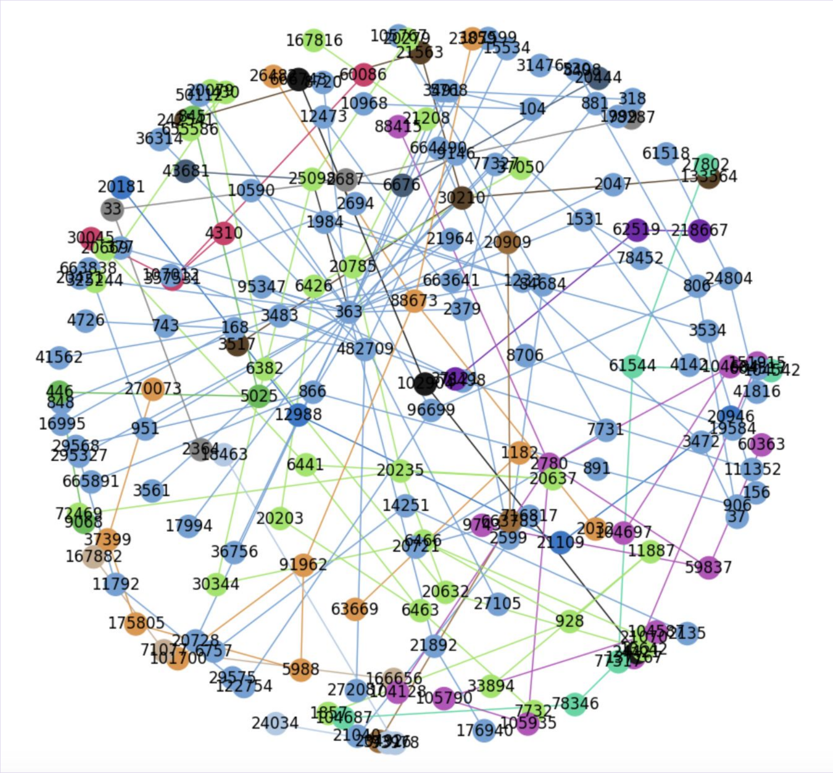
# Analysis and Results- Louvain algorithm

- Largest community by node count
  - 1326 nodes



# Analysis and Results- Girvan-Newman

Top 20 Communities Based on Girvan-Newman



## First Round

Number of communities: 318

Modularity score: 0.874

## Second Round

Number of communities: 319

Modularity score: 0.896

# Conclusion

- Sampling of the entire dataset allowed for more effective analysis and visualization
- Low clustering coefficient
  - Nodes are more randomly connected, nodes of a node do not have edges between them
- The degree distribution histogram supports the power-law degree distribution
- Louvain Algorithm identified a strong community structure with a modularity score of 0.603
  - Girvan Newman Algorithm produced an average modularity score of 0.885
    - Bridges and articulation points are very important components that ensure the network is connected
- Overall, Youtube Social Network has a decently strong community structure

# Future Work

- Integrate Gephi for advanced graph visualization
- Implement a Machine learning algorithm to handle a larger quantity of nodes
- Explore maximum influence
- Utilize the results for a recommendation system

# Thank You!