```
from google.colab import files
files.upload()
```

Выбрать файлы Файл не выбран Upload widget is only available when the cell has been executed in the curre
this cell to enable.

```
Saving vk_edges.csv to vk_edges (1).csv
{'vk_edges.csv': b'Source,Target,Type,Id,Label,timeset,Weight\r\n227657,1687066,Directed,1,,,1'
```

```
import networkx as nx
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.cm as cm
import matplotlib.colors as mcolors
%matplotlib inline
```

```
edges = pd.read_csv("vk_edges.csv")
edges.shape
```

```
(2012, 7)
```

```
edges1 = edges.drop_duplicates()
edges1.shape
```

```
(2012, 7)
```

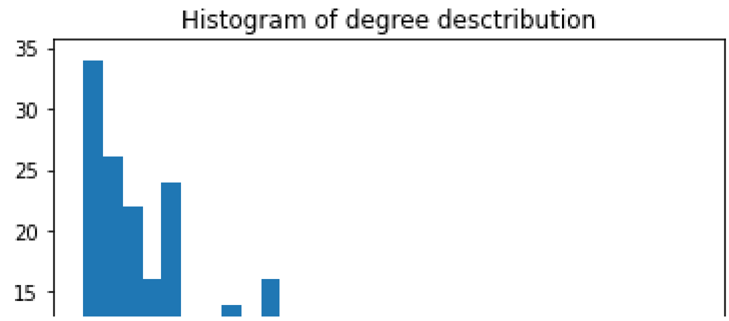
```
graph = nx.from_pandas_edgelist(edges1, 'Source', 'Target')
```

```
print("Number of nodes: {}".format(len(graph.nodes())))
print("Number of edges: {}".format(len(graph.edges())))
print("Average degree of nodes: {0:.2f}".format(len(graph.edges())/len(graph.nodes())))
print("Connected graph - {}".format(nx.is_connected(graph)))
```

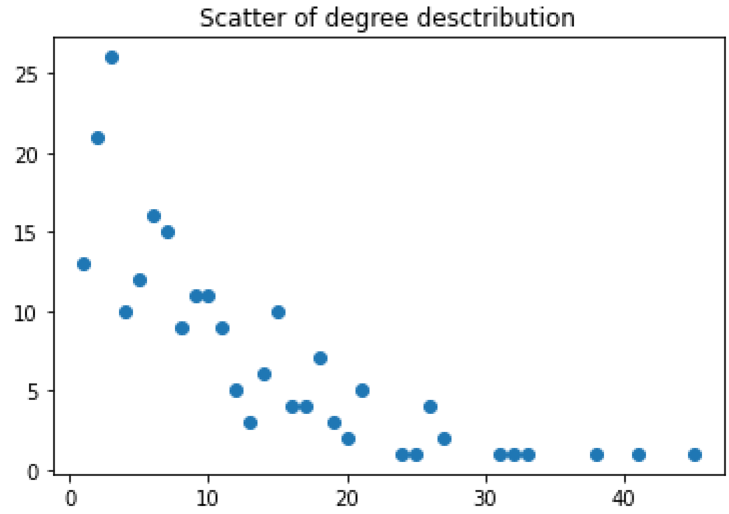
```
Number of nodes: 216
Number of edges: 1017
Average degree of nodes: 4.71
Connected graph - False
```

Стандартная статистика показывает, что средняя степень вершины довольно высока/ граф несвязный, есть вершины, не имеющие связей

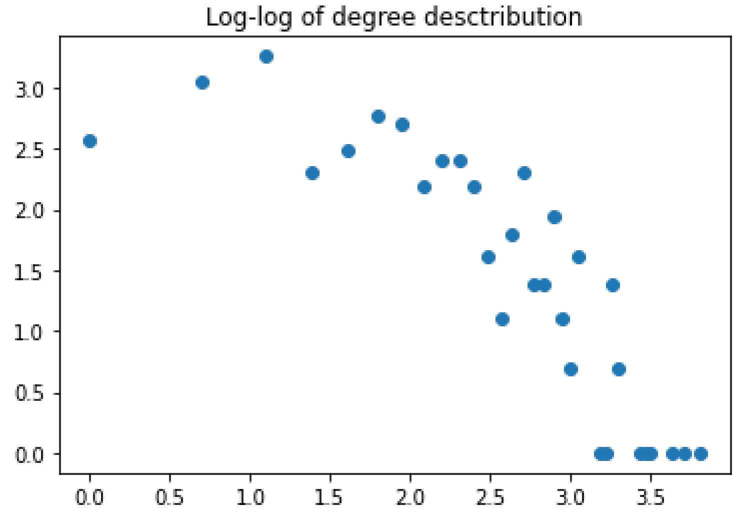
```
degree_view = nx.degree(graph)
degree_values = dict(degree_view).values()
plt.hist([i for i in list(degree_values)], bins = len(set(degree_values)))
plt.title("Histogram of degree desctribution")
plt.show()
```



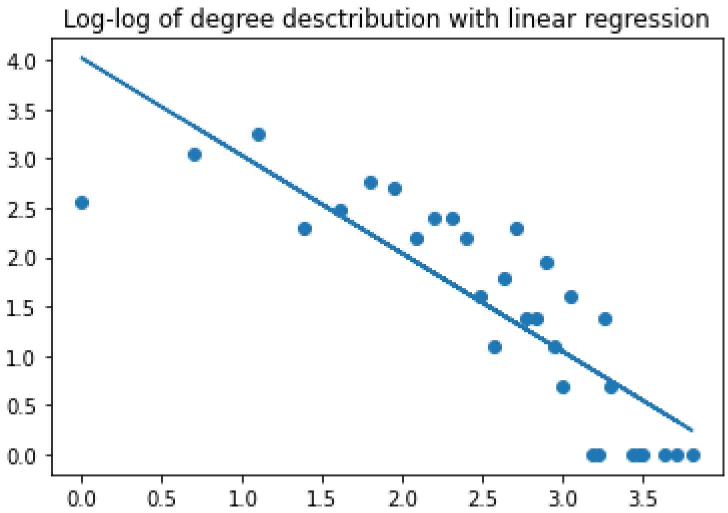
```
from collections import Counter
res = Counter(list(dict(degree_view).values()))
plt.title("Scatter of degree desctribution")
plt.scatter(res.keys(), res.values())
plt.show()
```



```
import math
plt.title("Log-log of degree desctribution")
plt.scatter([math.log(i) for i in res.keys()], [math.log(i) for i in res.values()])
plt.show()
```



```
import numpy as np
x = np.array([math.log(i) for i in res.keys()])
y = np.array([math.log(i) for i in res.values()])
m, b = np.polyfit(x, y, 1)
plt.scatter(x, y)
plt.plot(x, m*x + b)
plt.title("Log-log of degree desctribution with linear regression")
plt.show()
plt.show()
```



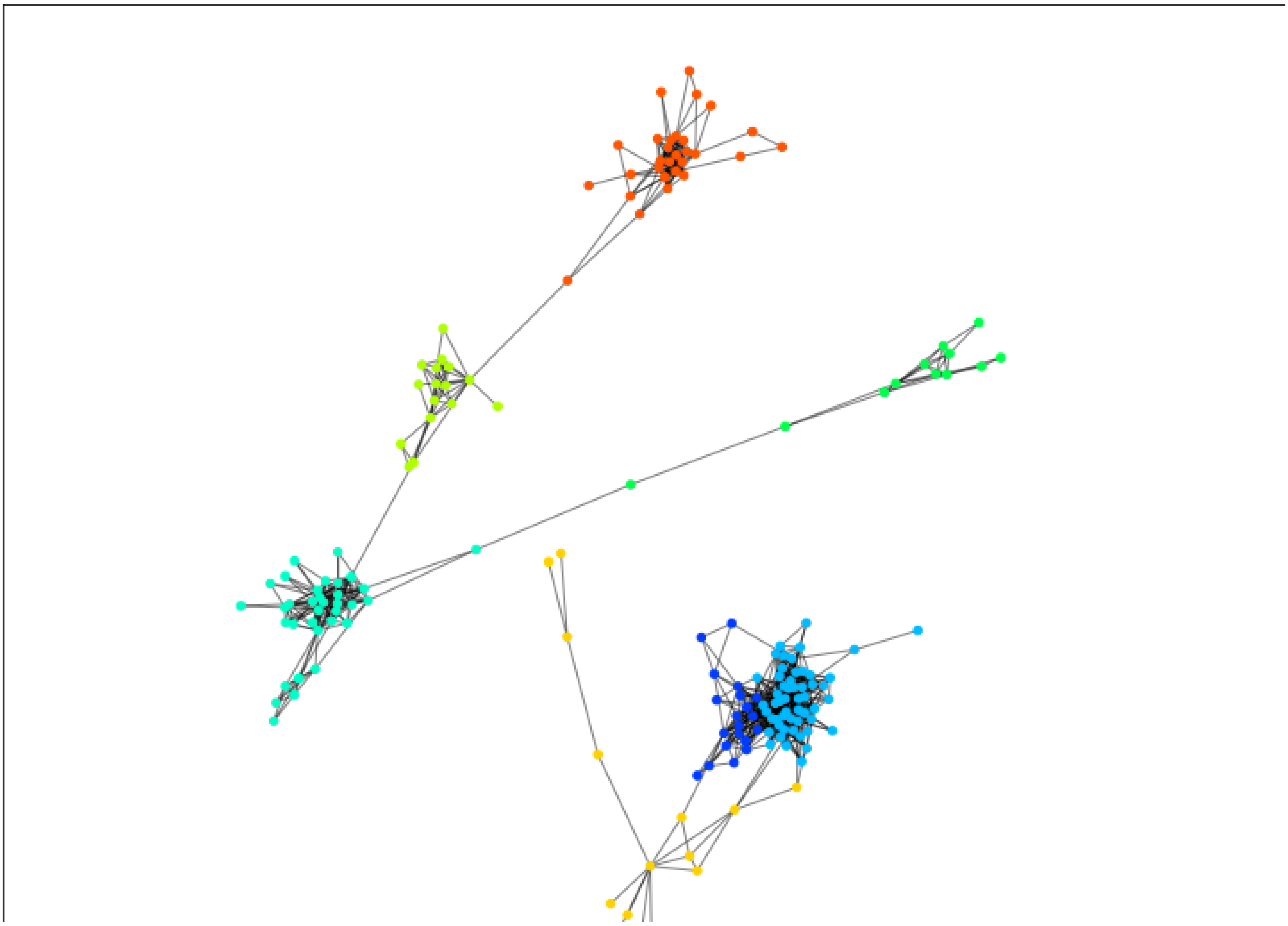
Такое "степенное распределение" (power-law distribution) характерно для реальной социальной сети

```
import community
graph_undirected = graph.to_undirected()
partition = community.best_partition(graph_undirected)
communities = set(partition.values())
communities_dict = {c: [k for k, v in partition.items() if v == c] for c in communities}
highest_degree = {k: sorted(v, key=lambda x: graph.degree(x))[-5:] for k, v in communities_dict.item
print('Количество сообществ: ', len(highest_degree))
print('Количество элементов в выделенных сообществах:', ', '.join([str(len(highest_degree[key])) for
```

```
    Количество сообществ:  12
    Количество элементов в выделенных сообществах: 5, 5, 5, 5, 5, 5, 5, 5, 5, 3, 5, 2
```

Считаем количество сообществ и количество элементов в них

```
pos = nx.spring_layout(graph)
plt.figure(figsize=(15, 15))
cmap = cm.get_cmap('gist_rainbow', max(partition.values()) + 1)
nx.draw_networkx_nodes(graph, pos, partition.keys(), node_size=20, cmap=cmap, node_color=list(partit
nx.draw_networkx_edges(graph, pos, alpha=0.5)
plt.show()
```



визаулизируем сообщества

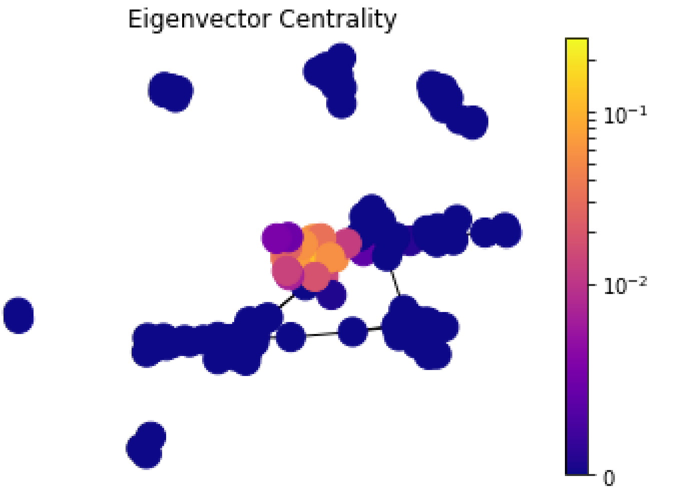
```
bw_centrality = nx.betweenness_centrality(graph, normalized=True)
bw_centrality
```

```
{227657: 0.0,
 413300: 0.04033353953154002,
 1601280: 0.03952779233373919,
 1687066: 2.8979207418677098e-05,
 1895348: 2.8979207418677098e-05,
 1990478: 0.011214953271028038,
 2058128: 0.0,
 2459486: 6.30297761356227e-05,
 2517874: 0.0,
 2583166: 0.0,
 2699093: 3.260160834601174e-05,
 2833128: 0.0,
 3363362: 0.0022381153102735366,
 3538796: 0.022326474124069243,
 3734345: 0.0,
 3848664: 4.493502102717491e-05,
 3864197: 0.011803638535870674,
 3905784: 8.69376222560313e-06,
 4217922: 0.007607041947402739,
 4311406: 0.08833630380356154,
 4422316: 0.0014774160008891595,
 4479411: 0.0,
 5325067: 1.7232278697177634e-05,
 5349199: 0.004784132769353367,
 5599901: 0.0007486831073197778,
 5751292: 0.00027519897330808,
 5938997: 0.0,
 6111900: 0.002422736045861458,
 6218698: 0.07548359052379917,
 6308154: 0.0,
 6407680: 0.005706530241957319,
 6516489: 0.000481234827195949,
 6769254: 0.017993506625485593,
 7038577: 0.023706598996689417,
 7066177: 0.007952181123230902,
 7278378: 2.5788044696977535e-05,
 7292505: 4.346881112801565e-05,
 7372677: 0.0030390399766622345,
 7383910: 0.0,
 7726541: 2.1734405564007825e-05,
 7815454: 0.006225182294483086,
 8316747: 0.00012771550698088407,
 8408976: 0.0,
 8644937: 0.04068680721582265,
 8660003: 0.0009930427948250172,
 8764390: 0.0,
 8837849: 0.031780988311754736,
 9023364: 0.002409388891675351,
 9155167: 0.006583247948168615,
 9173772: 1.4127363616605086e-05,
 9372166: 0.005727015866116062,
 9433513: 0.003868724190393392,
 9667022: 0.0014774160008891595,
 9673822: 0.0019126276896326887,
 10020082: 0.001941572397994915,
 10040536: 0.00040115502840997304,
 10360922: 0.0019234948924146925,
 11044395: 0.0017833079765268423,
 12789381: 0.0026561548125609118
```

```
def draw(G, pos, measures, measure_name):

    nodes = nx.draw_networkx_nodes(G, pos, node_size=200, cmap=plt.cm.plasma,
                                   node_color=list(measures.values()),
                                   nodelist=measures.keys())
    nodes.set_norm(mcolors.SymLogNorm(linthresh=0.01, linscale=1, base=10))
    edges = nx.draw_networkx_edges(G, pos)

    plt.title(measure_name)
    plt.colorbar(nodes)
    plt.axis('off')
    plt.show()


G = graph
pos = nx.spring_layout(G, seed=675)


draw(G, pos, nx.degree_centrality(G), 'Degree Centrality')
```

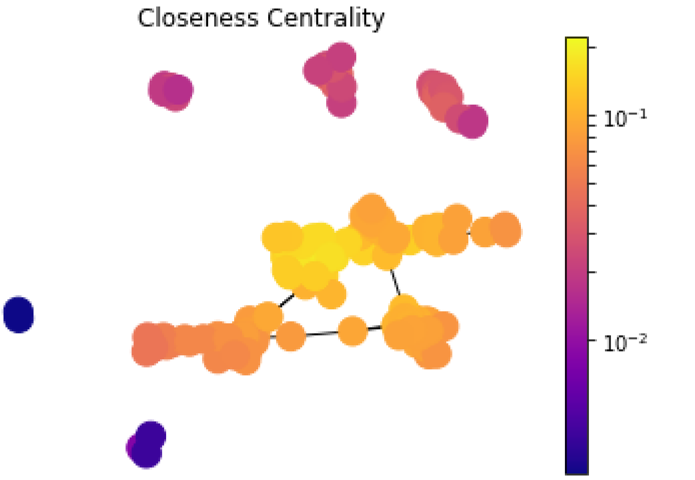
Degree Centrality

```
draw(G, pos, nx.eigenvector_centrality(G), 'Eigenvector Centrality')
```



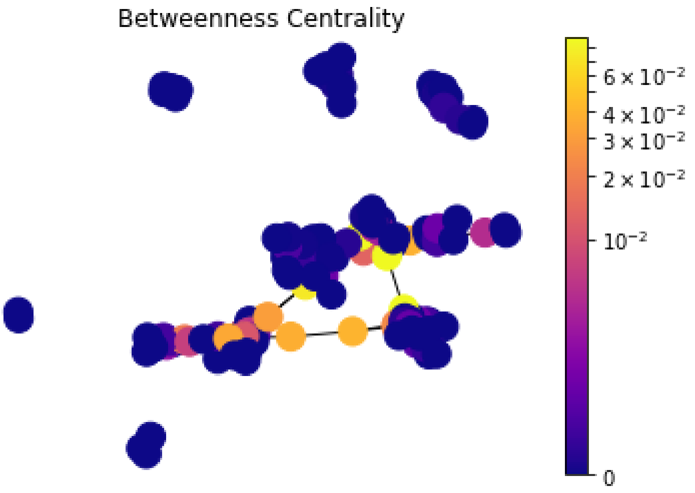
Eigenvector Centrality

```
draw(G, pos, nx.closeness_centrality(G), 'Closeness Centrality')
```



Closeness Centrality

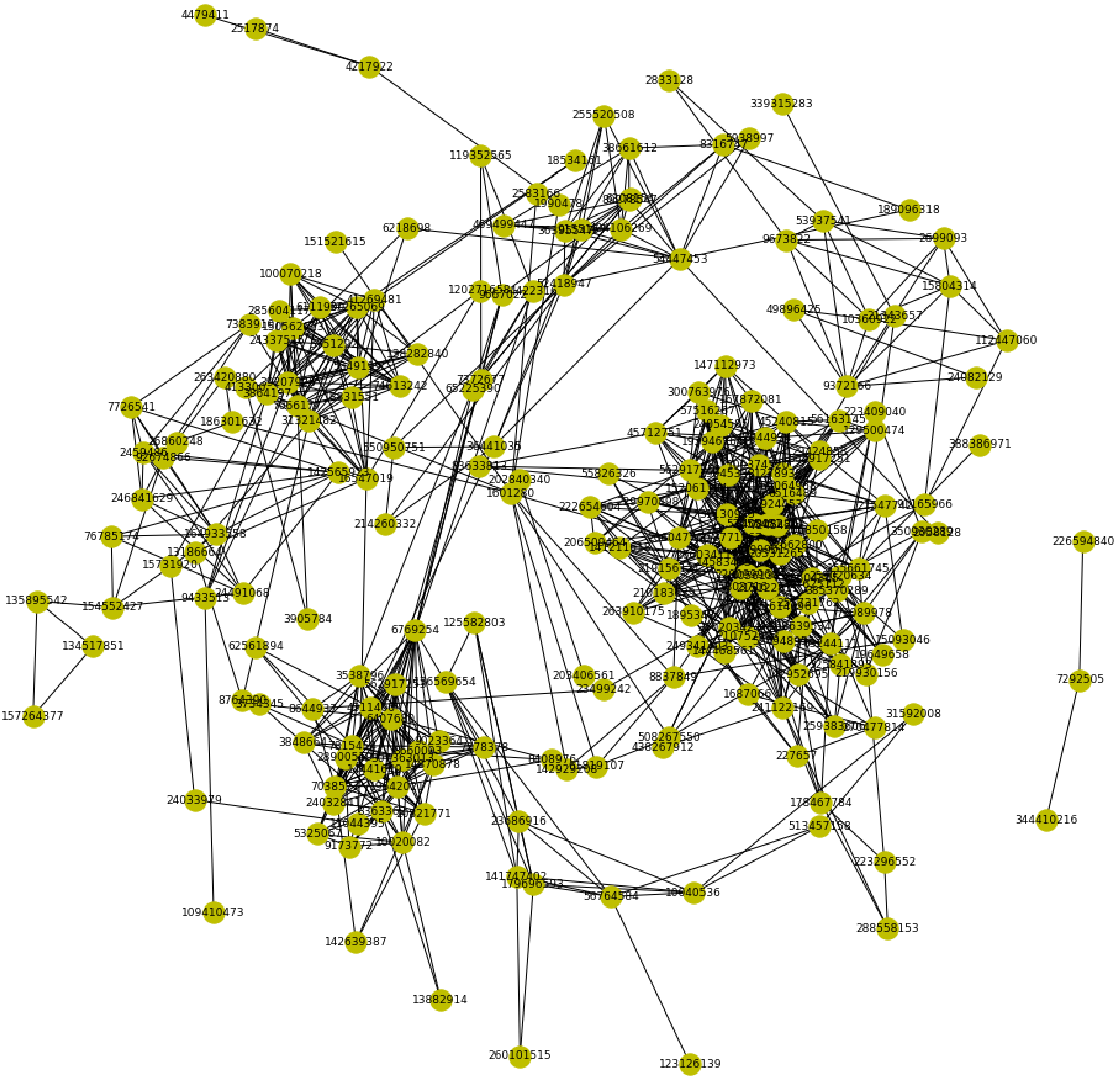
```
draw(G, pos, nx.betweenness_centrality(G), 'Betweenness Centrality')
```



Betweenness Centrality

Мне паказалось, что Eigenvector Centrality более информативен и показывает "степень важности" лишь некоторых вершин, что на самом деле "оправдывает" реальную ситуацию

```
pos = nx.spring_layout(graph, scale = 4, k=0.16, iterations=20)
plt.figure(figsize=(13, 13))
nx.draw(graph, pos, node_color='y', edge_color='black', edge_vmax = True, font_size= 9, with_labels=
```



В действительности, ярко выражено существование 3-х обществ внутри графа, что отражает три круга "реальных сообществ": школьный, студенческий и рабочий.

Спасибо за домашку, было интересно

Куски кода брал отсюда и приспосабливал под себя https://newtechaudit.ru/analiz-setej-s-ispolzovaniem-grafov/ https://aksakalli.github.io/2017/07/17/network-centrality-measures-and-their-visualization.html
https://github.com/semensorokin/SNA_2021/blob/master/week1/Loading%2BGraphs%2Bin%2BNetworkX.ipynb
https://github.com/semensorokin/SNA_2021/blob/master/week2/Marvel%20Universe%20Social%20Network.ipynb