FINAL REPORT

Introduction

The objective of the project was to scrawl the data using the twitter API configuration details provided by twitter and then visualizing the data of followers of the main user and then visualizing the data of the followers of the followers using the packages provided in the assignment. Then calculating network measures such as degree distribution and plotting the values in a histogram

Libraries and Tools:

Networkx: NetworkX is a Python package for the creation, manipulation, and study of the structure, dynamics, and functions of complex networks.

Tweepy: It is an open-source python package which gives us the access to the API for python. Tweepy is a automation process and used for creating twitter bots with the benefits of data encoding and decoding.

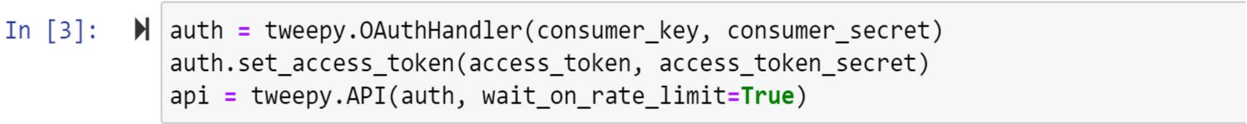
I. Data Collection:

STEP-1: Scrawling the data from social media platform Twitter using the API credentials provided in the twitter developer account

```
In [2]:  consumer_key = 'a3cHbvaD1blmD0bZOtbtxLpdT'
         consumer_secret = '92ohZ0aHDcByGUmP2UNh72mfJip015w03ghwwIZCdduuRFTJoD'
         access_token = '3282685604-D91tVrNjvZG0xjg2uMDbqLm08TOSSuDFu8oBMlm'
         access_token_secret = '4A4kPx2i57LZOTgE137VXsXlszZWggz56hWzEP9iDYlhH'
```

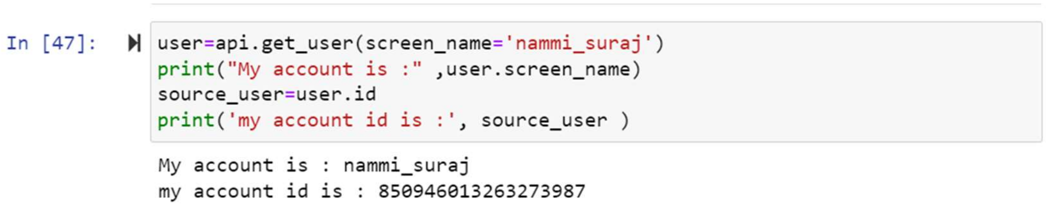
After giving API Instructions we must give authentication to twitter for allowing us to access the data from twitter as mentioned in the code snippet below.

Before the authentication we need to get the elevated access from twitter for elevated access we need to follow the instructions mentioned in the assignment



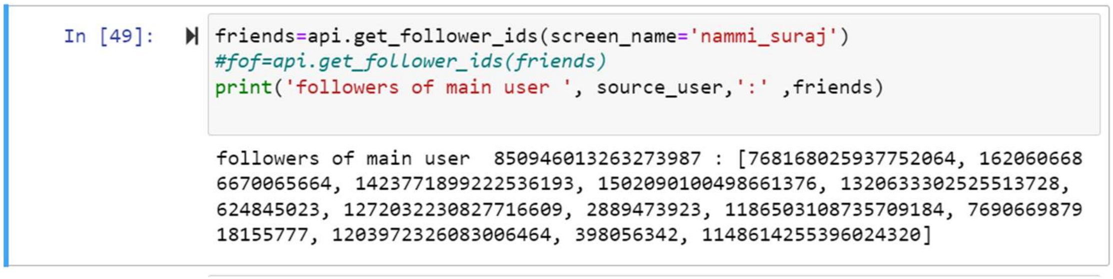
```
In [3]:  auth = tweepy.OAuthHandler(consumer_key, consumer_secret)
         auth.set_access_token(access_token, access_token_secret)
         api = tweepy.API(auth, wait_on_rate_limit=True)
```

After getting access to twitter we printed the screen name of the main user as mentioned below in the code snippet where the screen name is printed in the output



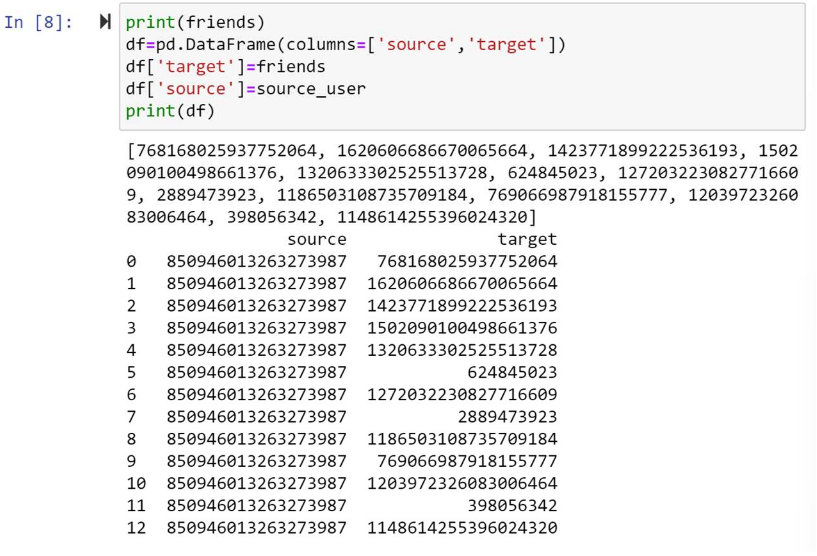
```
In [47]:  user=api.get_user(screen_name='nammi_suraj')
          print("My account is :" ,user.screen_name)
          source_user=user.id
          print('my account id is :', source_user )

          My account is : nammi_suraj
          my account id is : 850946013263273987
```

The process of authentication and API configuration is followed by the extraction of the followers of the main users.



```
In [49]:  friends=api.get_follower_ids(screen_name='nammi_suraj')
          #fof=api.get_follower_ids(friends)
          print('followers of main user ', source_user,':' ,friends)

          followers of main user  850946013263273987 : [768168025937752064, 162060668
          6670065664, 1423771899222536193, 1502090100498661376, 1320633302525513728,
          624845023, 1272032230827716609, 2889473923, 1186503108735709184, 7690669879
          18155777, 1203972326083006464, 398056342, 1148614255396024320]
```

In the Above screenshot after the execution, we have extracted the followers of the main user **nammi_suraj** where the followers are printed in the output with their unique id's.Then we have inserted the followers of the main user into a data frame where source i.e., the main user and each target i.e., the followers of the main user are printed in the snippet provided below with the output.

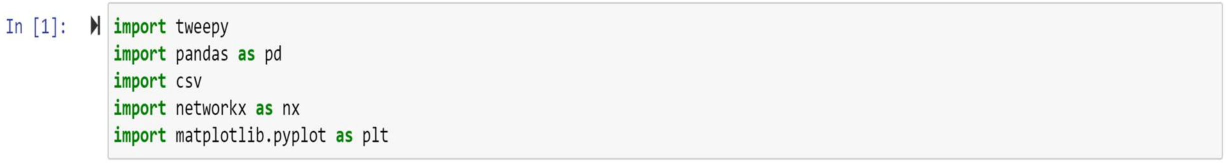


```
In [8]:  print(friends)
         df=pd.DataFrame(columns=['source','target'])
         df['target']=friends
         df['source']=source_user
         print(df)

         [768168025937752064, 1620606686670065664, 1423771899222536193, 1502
         090100498661376, 1320633302525513728, 624845023, 127203223082771660
         9, 2889473923, 1186503108735709184, 769066987918155777, 12039723260
         83006464, 398056342, 1148614255396024320]
                         source               target
         0   850946013263273987   768168025937752064
         1   850946013263273987  1620606686670065664
         2   850946013263273987  1423771899222536193
         3   850946013263273987  1502090100498661376
         4   850946013263273987  1320633302525513728
         5   850946013263273987            624845023
         6   850946013263273987  1272032230827716609
         7   850946013263273987           2889473923
         8   850946013263273987  1186503108735709184
         9   850946013263273987   769066987918155777
         10  850946013263273987  1203972326083006464
         11  850946013263273987            398056342
         12  850946013263273987  1148614255396024320
```

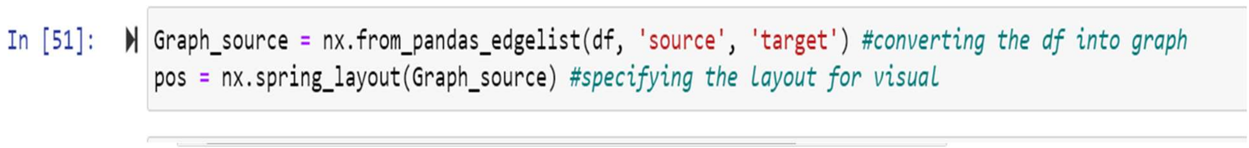
II. Data Visualization:

Step 2: Now that we have fetched the data, visualization of the data is the next step where in the given list of packages to visualize we have used the **networkx** graph visualization package.

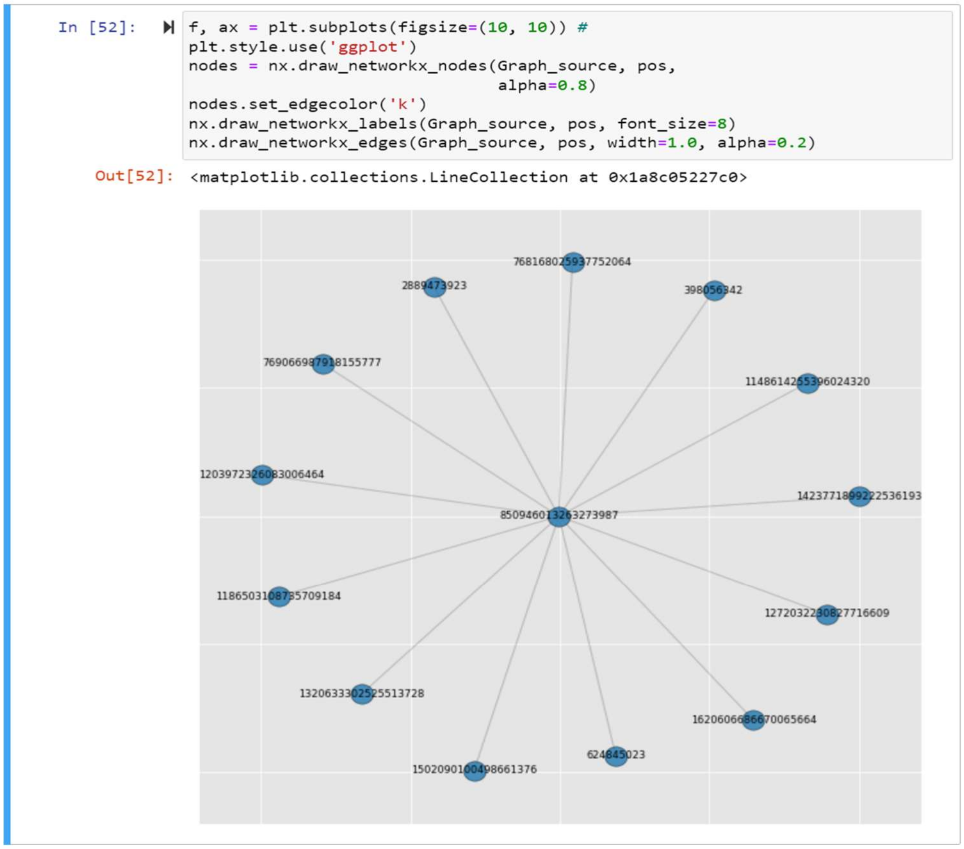
In the process of visualization the data frame which we have created previously, to convert the data frame into a graph we have imported libraries from the **networkx** documentation and imported various packages that were required to execute the visualization.



```
In [1]:  import tweepy
         import pandas as pd
         import csv
         import networkx as nx
         import matplotlib.pyplot as plt
```



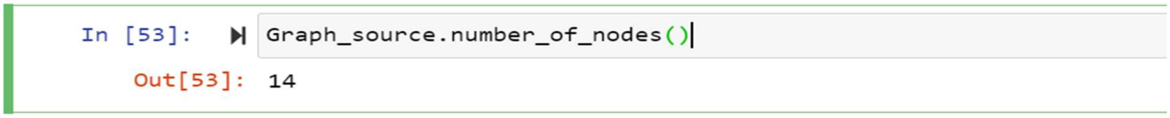
```
In [51]:  Graph_source = nx.from_pandas_edgelist(df, 'source', 'target') #converting the df into graph
           pos = nx.spring_layout(Graph_source) #specifying the layout for visual
```



```
In [52]:  f, ax = plt.subplots(figsize=(10, 10)) #
           plt.style.use('ggplot')
           nodes = nx.draw_networkx_nodes(Graph_source, pos,
                                          alpha=0.8)
           nodes.set_edgecolor('k')
           nx.draw_networkx_labels(Graph_source, pos, font_size=8)
           nx.draw_networkx_edges(Graph_source, pos, width=1.0, alpha=0.2)

Out[52]:  <matplotlib.collections.LineCollection at 0x1a8c05227c0>
```

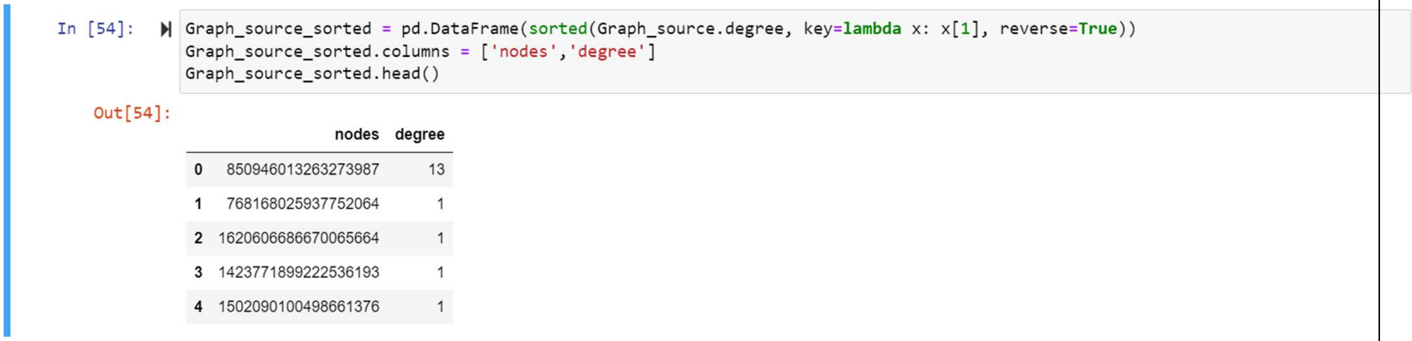
In this visualization we have plotted the main user and their followers here the central node represents the unique id of the main user and the other node are the followers of the main user, the blue dots represents the node and the line represents the edges where relation is formed between the user and the follower.

The next step was to calculate the number of nodes using the number of nodes mentioned in the networkx number of nodes documentation as mentioned below



```
In [53]:    Graph_source.number_of_nodes()

Out[53]:    14
```

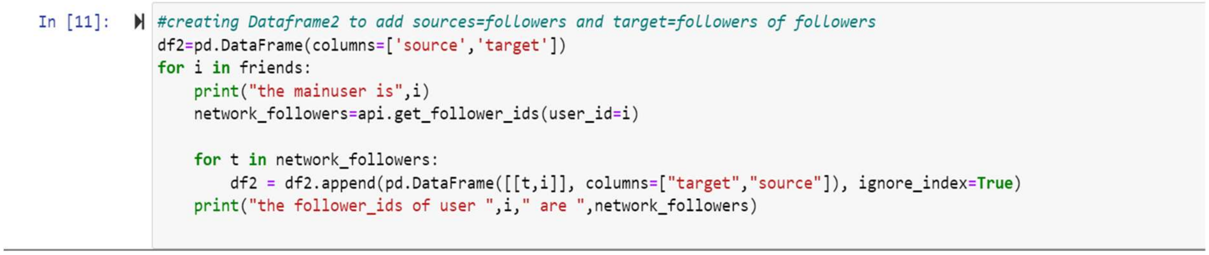
Here we have calculated degree for all the corresponding follower nodes.



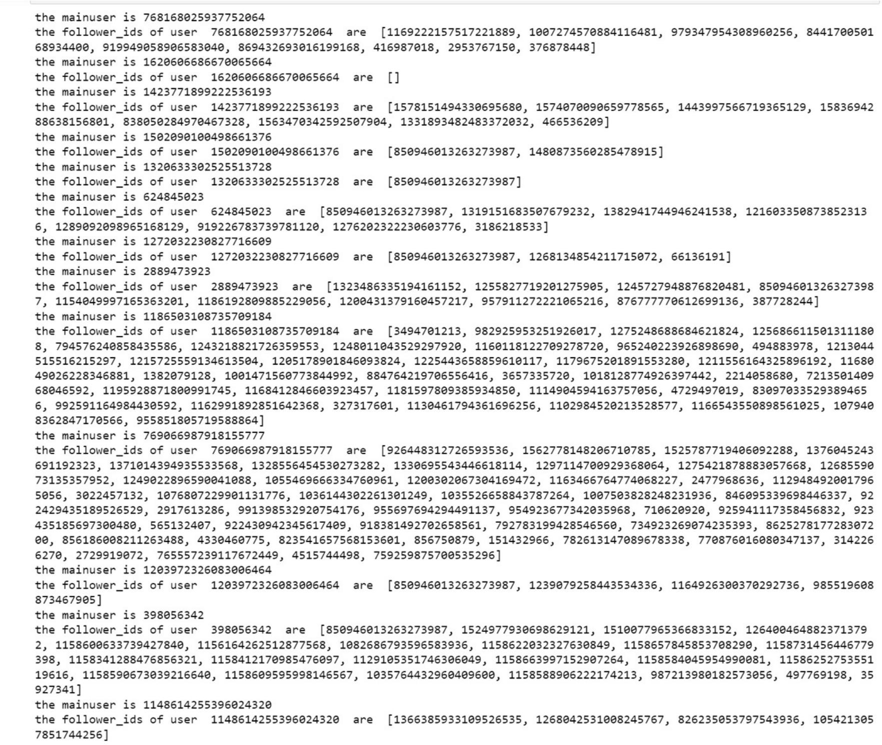
```
In [54]:    Graph_source_sorted = pd.DataFrame(sorted(Graph_source.degree, key=lambda x: x[1], reverse=True))
            Graph_source_sorted.columns = ['nodes','degree']
            Graph_source_sorted.head()

Out[54]:
```

	nodes	degree
0	850946013263273987	13
1	768168025937752064	1
2	1620606686670065664	1
3	1423771899222536193	1
4	1502090100498661376	1

The next step is to create another data frame for the followers of the source i.e., the main user and the followers of the followers where the output of the visualization will be the nodes of the main user and the nodes of the follower of followers. There will be sub nodes to the followers of the main user where sub nodes describe the followers of followers.



```
In [11]:    #creating Dataframe2 to add sources=followers and target=followers of followers
            df2=pd.DataFrame(columns=['source','target'])
            for i in friends:
                print("the mainuser is",i)
                network_followers=api.get_follower_ids(user_id=i)

                for t in network_followers:
                    df2 = df2.append(pd.DataFrame([[t,i]], columns=["target","source"]), ignore_index=True)
                print("the follower_ids of user ",i," are ",network_followers)
```

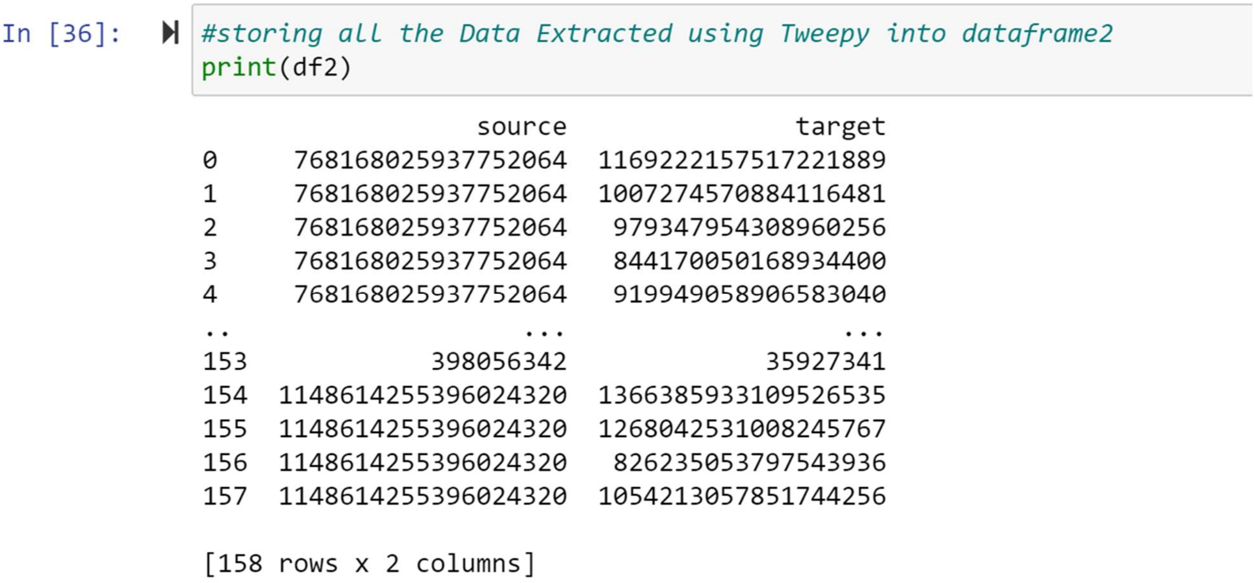


```
the mainuser is 768168025937752064
the follower_ids of user  768168025937752064  are  [1169222157517221889, 1007274570884116481, 979347954308960256, 8441700501
68934400, 919949058906583040, 869432693016199168, 416987018, 2953767150, 376878448]
the mainuser is 1620606686670065664
the follower_ids of user  1620606686670065664  are  []
the mainuser is 1423771899222536193
the follower_ids of user  1423771899222536193  are  [1578151494330695680, 1574070090659778565, 1443997566719365129, 15836942
88638156801, 838050284970467328, 1563470342592507904, 1331893482483372032, 466536209]
the mainuser is 1502090100498661376
the follower_ids of user  1502090100498661376  are  [850946013263273987, 1480873560285478915]
the mainuser is 1320633302525513728
the follower_ids of user  1320633302525513728  are  [850946013263273987]
the mainuser is 624845023
the follower_ids of user  624845023  are  [850946013263273987, 1319151683507679232, 1382941744946241538, 121603350873852313
6, 1289092098965168129, 919226783739781120, 1276202322230603776, 3186218533]
the mainuser is 1272032230827716609
the follower_ids of user  1272032230827716609  are  [850946013263273987, 1268134854211715072, 66136191]
the mainuser is 2889473923
the follower_ids of user  2889473923  are  [1323486335194161152, 1255827719201275905, 1245727948876820481, 85094601326327398
7, 1154049997165363201, 1186192809885229056, 1200431379160457217, 957911272221065216, 876777770612699136, 387728244]
the mainuser is 1186503108735709184
the follower_ids of user  1186503108735709184  are  [3494701213, 982925953251926017, 1275248688684621824, 125686611501311180
8, 794576240858435586, 1243218821726359553, 1248011043529297920, 1160118122709278720, 965240223926898690, 494883978, 1213044
515516215297, 1215725559134613504, 1205178901846093824, 1225443658859610117, 1179675201891553280, 1211556164325896192, 11680
49026228346881, 1382079128, 1001471560773844992, 884764219706556416, 3657335720, 1018128774926397442, 2214058680, 7213501409
68046592, 1195928871800991745, 1168412846603923457, 1181597809385934850, 1114904594163757056, 4729497019, 83097033529389465
6, 992591164984430592, 1162991892851642368, 327317601, 1130461794361696256, 1102984520213528577, 1166543550898561025, 107940
8362847170566, 955851805719588864]
the mainuser is 769066987918155777
the follower_ids of user  769066987918155777  are  [926448312726593536, 1562778148206710785, 1525787719406092288, 1376045243
691192323, 1371014394935533568, 1328556454530273282, 1330695543446618114, 1297114700929368064, 1275421878883057668, 12685590
73135357952, 1249022896590041088, 1055469666334760961, 1200302067304169472, 1163466764774068227, 2477968636, 112948492001796
5056, 3022457132, 1076807229901131776, 1036144302261301249, 1035526658843787264, 1007503828248231936, 846095339698446337, 92
2429435189526529, 2917613286, 991398532920754176, 955697694294491137, 954923677342035968, 710620920, 925941117358456832, 923
435185697300480, 565132407, 922430942345617409, 918381492702658561, 792783199428546560, 734923269074235393, 862527817728307200, 856186008211263488, 4330460775, 823541657568153601, 856750879, 151432966, 782613147089678338, 770876016080347137, 314226
6270, 2729919072, 765557239117672449, 4515744498, 759259875700535296]
the mainuser is 1203972326083006464
the follower_ids of user  1203972326083006464  are  [850946013263273987, 1239079258443534336, 1164926300370292736, 985519608
873467905]
the mainuser is 398056342
the follower_ids of user  398056342  are  [850946013263273987, 1524977930698629121, 1510077965366833152, 126400464882371379
2, 1158600633739427840, 1156164262512877568, 1082686793596583936, 1158622032327630849, 1158657845853708290, 1158731456446779
398, 1158341288476856321, 1158412170985476097, 1129105351746306049, 1158663997152907264, 1158584045954990081, 11586252753551
19616, 1158590673039216640, 1158609595998146567, 1035764432960409600, 1158588906222174213, 987213980182573056, 497769198, 35
927341]
the mainuser is 1148614255396024320
the follower_ids of user  1148614255396024320  are  [1366385933109526535, 1268042531008245767, 826235053797543936, 105421305
7851744256]
```

After the followers of the followers data is extracted then we have sorted the data in the data frame df2 to store the data of each followers of the followers.

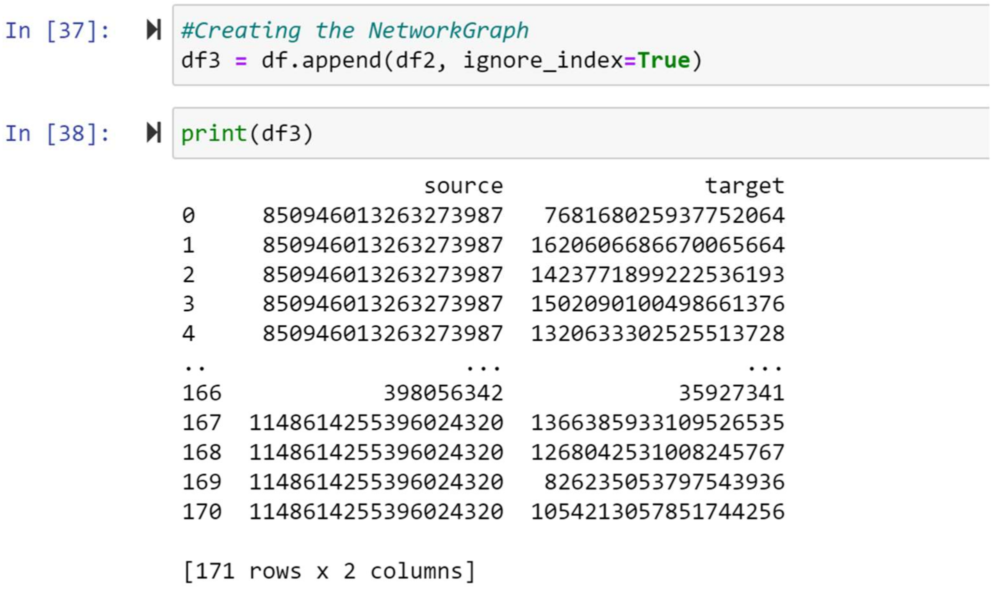
In the data frame the list will be generated in such a way that each followers of the main user will have their own followers and their own unique id’s.

After the storing of values in a data frame there are 158 rows and 2 columns



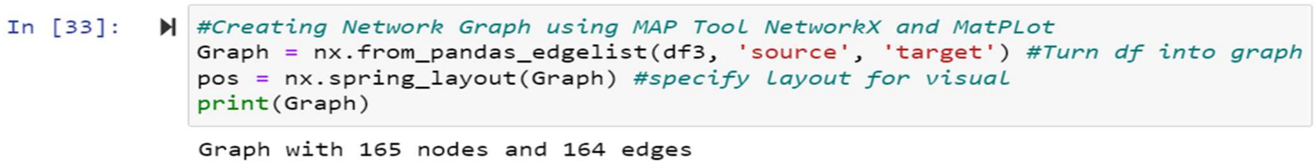
```
In [36]:  #storing all the Data Extracted using Tweepy into dataframe2
          print(df2)

                         source               target
          0     768168025937752064  1169222157517221889
          1     768168025937752064  1007274570884116481
          2     768168025937752064   979347954308960256
          3     768168025937752064   844170050168934400
          4     768168025937752064   919949058906583040
          ..                   ...                  ...
          153            398056342             35927341
          154  1148614255396024320  1366385933109526535
          155  1148614255396024320  1268042531008245767
          156  1148614255396024320   826235053797543936
          157  1148614255396024320  1054213057851744256

          [158 rows x 2 columns]
```

Creating a network graph of the followers of the followers

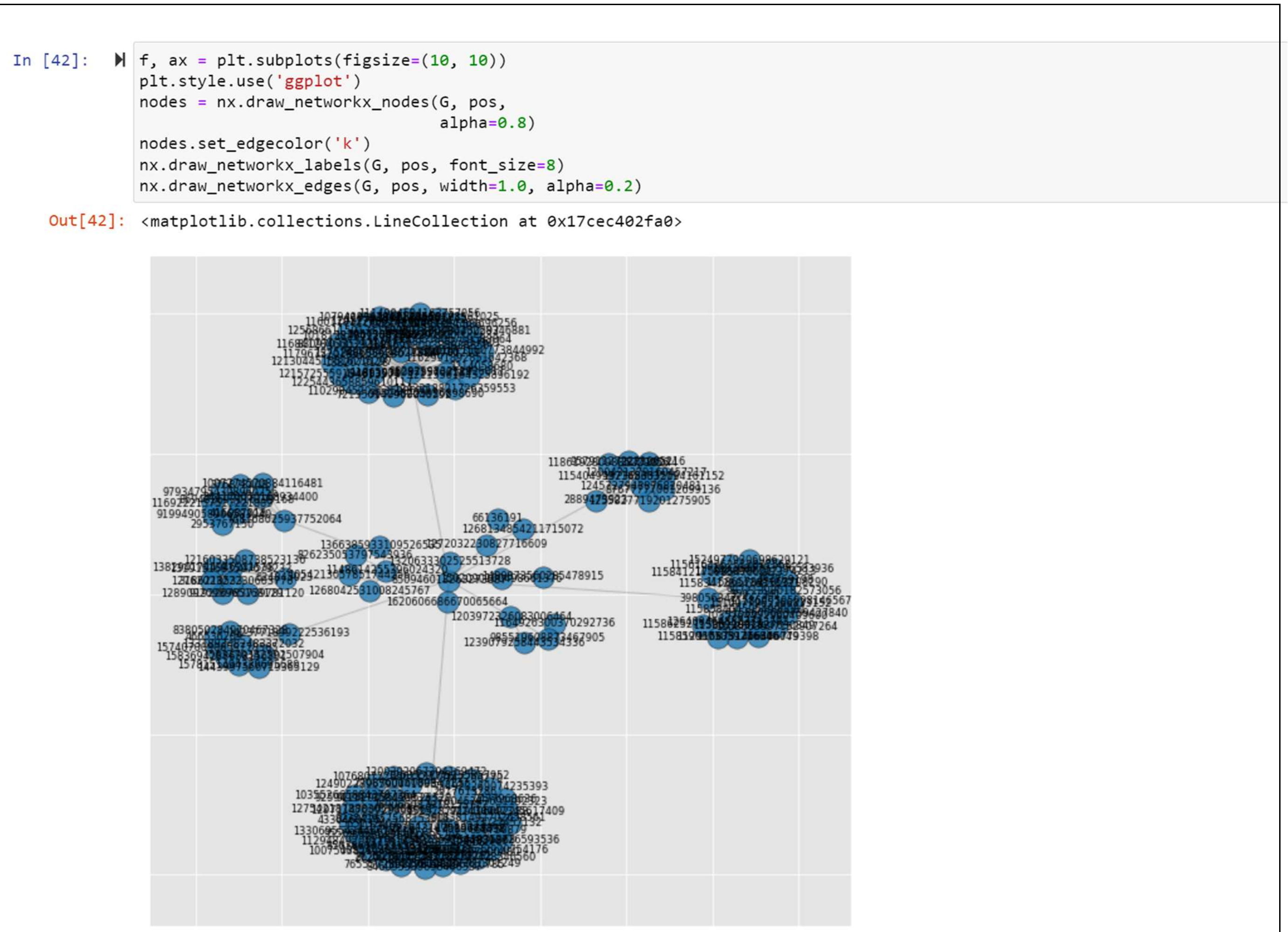


```
In [37]:  #Creating the NetworkGraph
           df3 = df.append(df2, ignore_index=True)

In [38]:  print(df3)

                         source               target
           0     850946013263273987   768168025937752064
           1     850946013263273987  1620606686670065664
           2     850946013263273987  1423771899222536193
           3     850946013263273987  1502090100498661376
           4     850946013263273987  1320633302525513728
           ..                   ...                  ...
           166            398056342             35927341
           167  1148614255396024320  1366385933109526535
           168  1148614255396024320  1268042531008245767
           169  1148614255396024320   826235053797543936
           170  1148614255396024320  1054213057851744256

           [171 rows x 2 columns]
```

Then visualizing the data of the Follower we have imported the network graph tools and repeated the same process as earlier mentioned in the visualization of the followers of the main user.



```
In [33]:  #Creating Network Graph using MAP Tool NetworkX and MatPLot
           Graph = nx.from_pandas_edgelist(df3, 'source', 'target') #Turn df into graph
           pos = nx.spring_layout(Graph) #specify layout for visual
           print(Graph)

           Graph with 165 nodes and 164 edges
```



In [42]:

```
f, ax = plt.subplots(figsize=(10, 10))
plt.style.use('ggplot')
nodes = nx.draw_networkx_nodes(G, pos,
                               alpha=0.8)
nodes.set_edgecolor('k')
nx.draw_networkx_labels(G, pos, font_size=8)
nx.draw_networkx_edges(G, pos, width=1.0, alpha=0.2)
```

Out[42]:

```
<matplotlib.collections.LineCollection at 0x17cec402fa0>
```

In the visualization graph of the Followers of the followers we can clearly observe that the node of the main user has each sub-nodes with their unique id’s.

III. NETWORK MEASURES

STEP-3: Calculating the network measures such as degree distribution, closeness and betweenness.

First let us understand what is network measures, Basically network is a representation of group or relationship between the objects. A network is a structure consisting of nodes and edges where edges are the relationship between the nodes and edges.

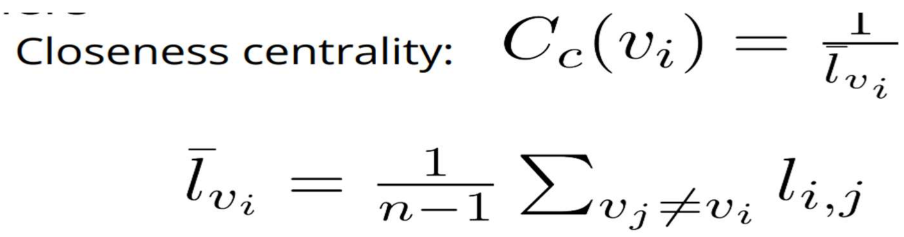
DEGREE DISTRIBUTION: It is defined as the number of edges that the node has to other nodes and if the graph is directed then it is pointing in a single direction from a node to other node.

Formula for degree distribution is given as:

$$C_d(v_i) = d_i$$

CLOSENESS: closeness is defined as the information sharing between one node to other node as it measures the shortest path from main node N to all other nodes in the network.

FORMULA:



Closeness centrality: $C_c(v_i) = \frac{1}{\bar{l}_{v_i}}$

$$\bar{l}_{v_i} = \frac{1}{n-1} \sum_{v_j \neq v_i} l_{i,j}$$

BETWEENNESS: Betweenness is defined to discover the amount of influence a node in the network is having on the passing of information in a network. It is used to find the nodes which acts as a bridge from one node to another in a network.

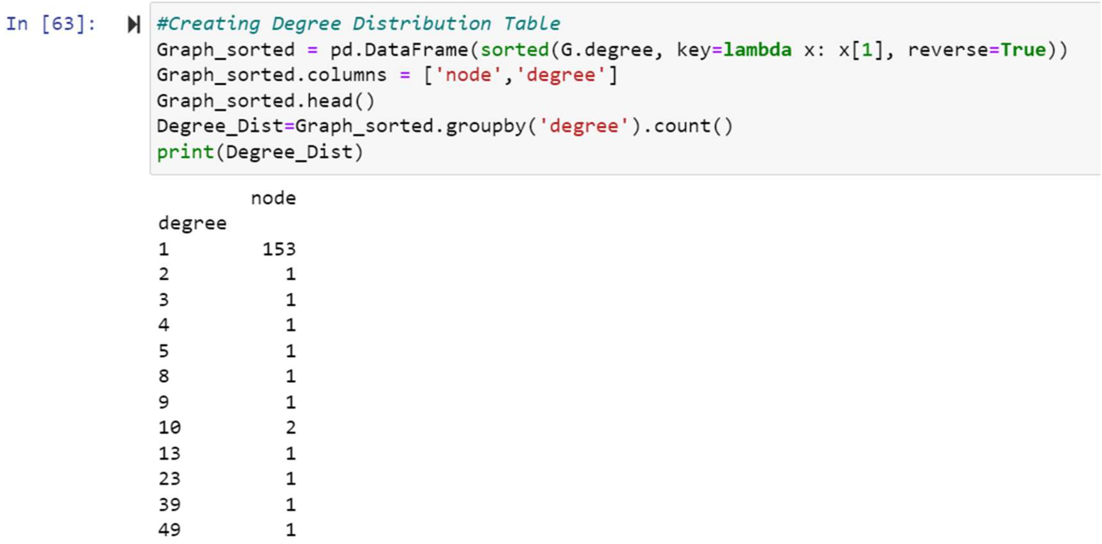
Formula:

$$C_b(v_i) = \sum_{s \neq t \neq v_i} \frac{\sigma_{st}(v_i)}{\sigma_{st}}$$

σ_{st} The number of shortest paths from vertex s to t – *a.k.a.* information pathways

$\sigma_{st}(v_i)$ The number of **shortest paths** from s to t that pass through v_i

In the below code snippet we have created a degree distribution table by sorting the data into a data frame

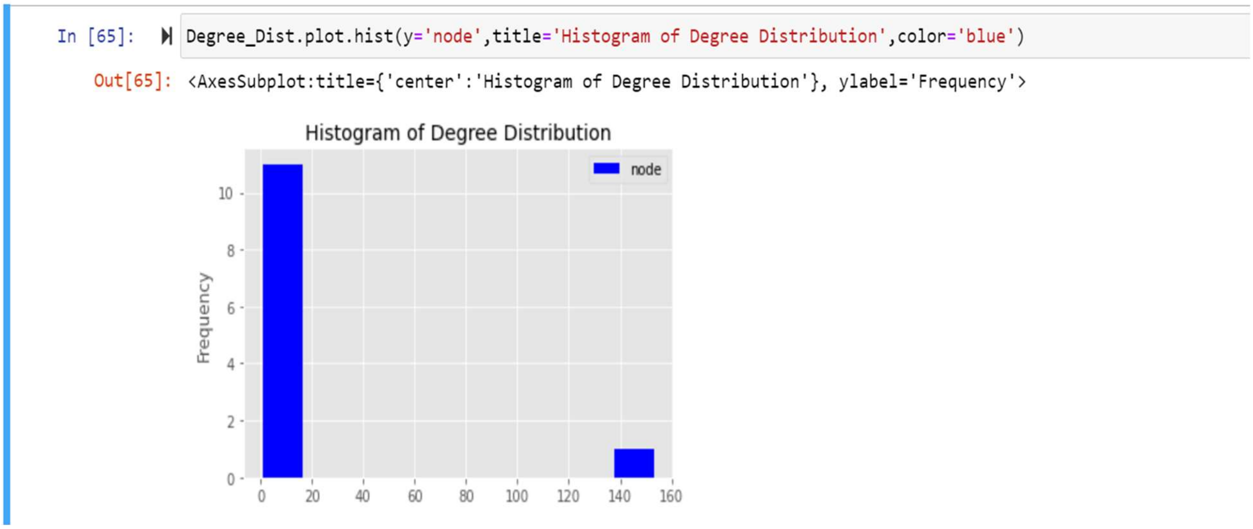


In [63]:

```
#Creating Degree Distribution Table
Graph_sorted = pd.DataFrame(sorted(G.degree, key=lambda x: x[1], reverse=True))
Graph_sorted.columns = ['node','degree']
Graph_sorted.head()
Degree_Dist=Graph_sorted.groupby('degree').count()
print(Degree_Dist)
```

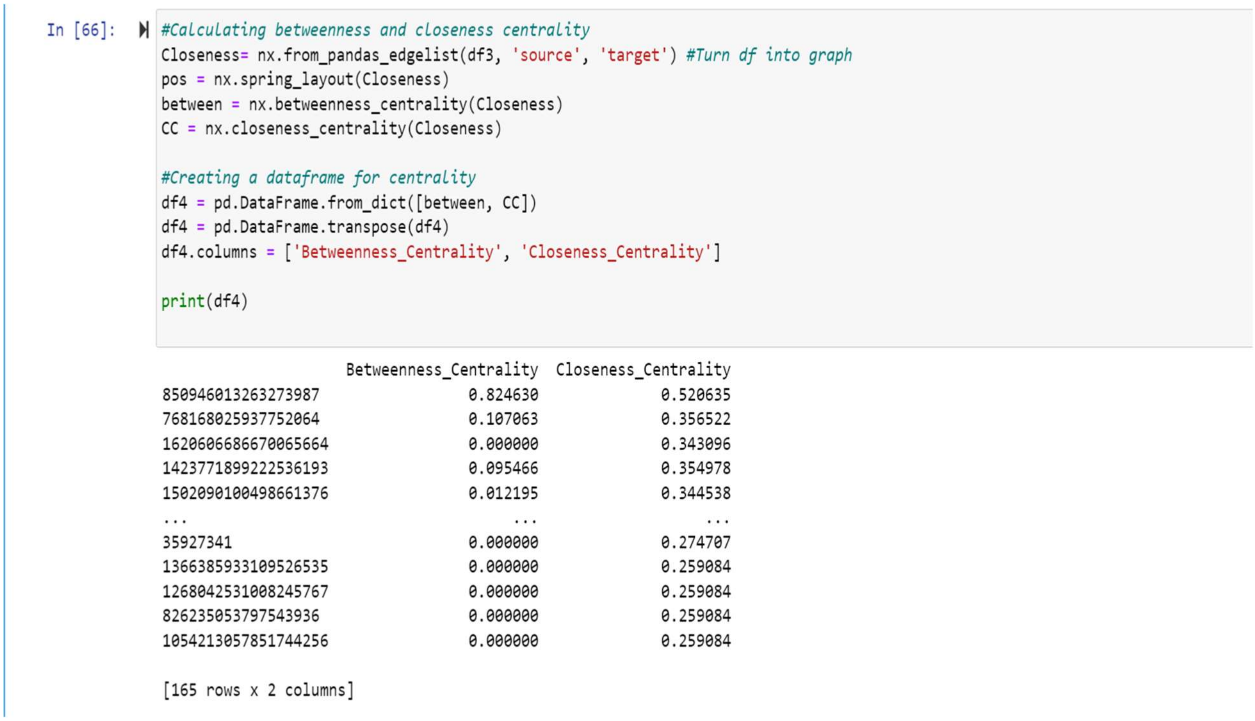
```
        node
degree      
1        153
2          1
3          1
4          1
5          1
8          1
9          1
10         2
13         1
23         1
39         1
49         1
```

Then plotting the data in a data frame into a histogram where the there will be a representation between the node and the frequency in the mentioned code snippet below.



```
In [65]:  Degree_Dist.plot.hist(y='node',title='Histogram of Degree Distribution',color='blue')

Out[65]: <AxesSubplot:title={'center':'Histogram of Degree Distribution'}, ylabel='Frequency'>
```

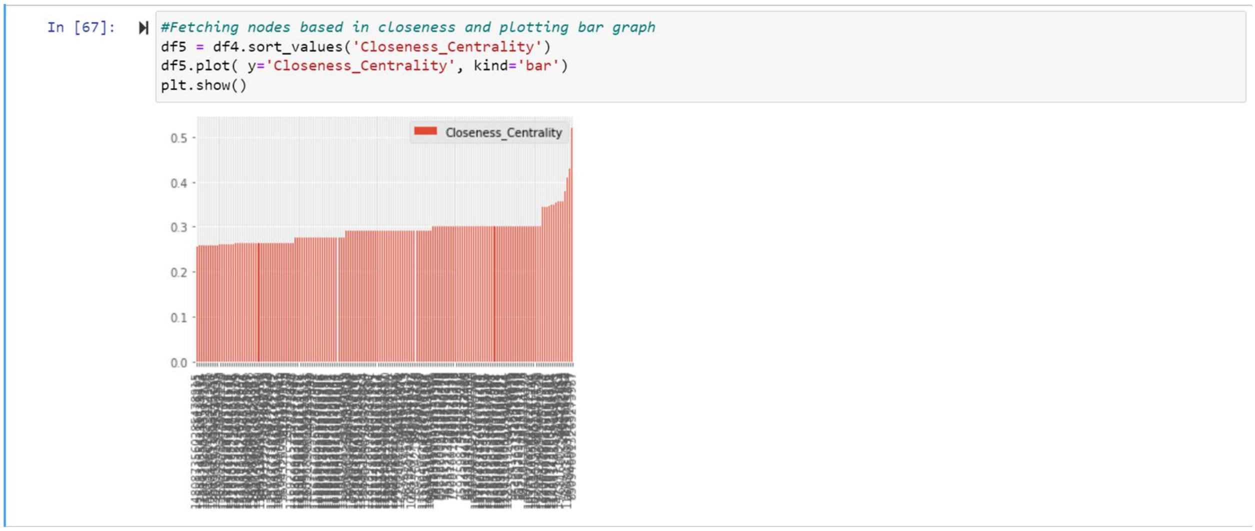
The calculation of the betweenness and the closeness centrality of the data is mentioned in below snippet.



```
In [66]:  #Calculating betweenness and closeness centrality
          Closeness= nx.from_pandas_edgelist(df3, 'source', 'target') #Turn df into graph
          pos = nx.spring_layout(Closeness)
          between = nx.betweenness_centrality(Closeness)
          CC = nx.closeness_centrality(Closeness)

          #Creating a dataframe for centrality
          df4 = pd.DataFrame.from_dict([between, CC])
          df4 = pd.DataFrame.transpose(df4)
          df4.columns = ['Betweenness_Centrality', 'Closeness_Centrality']

          print(df4)
```

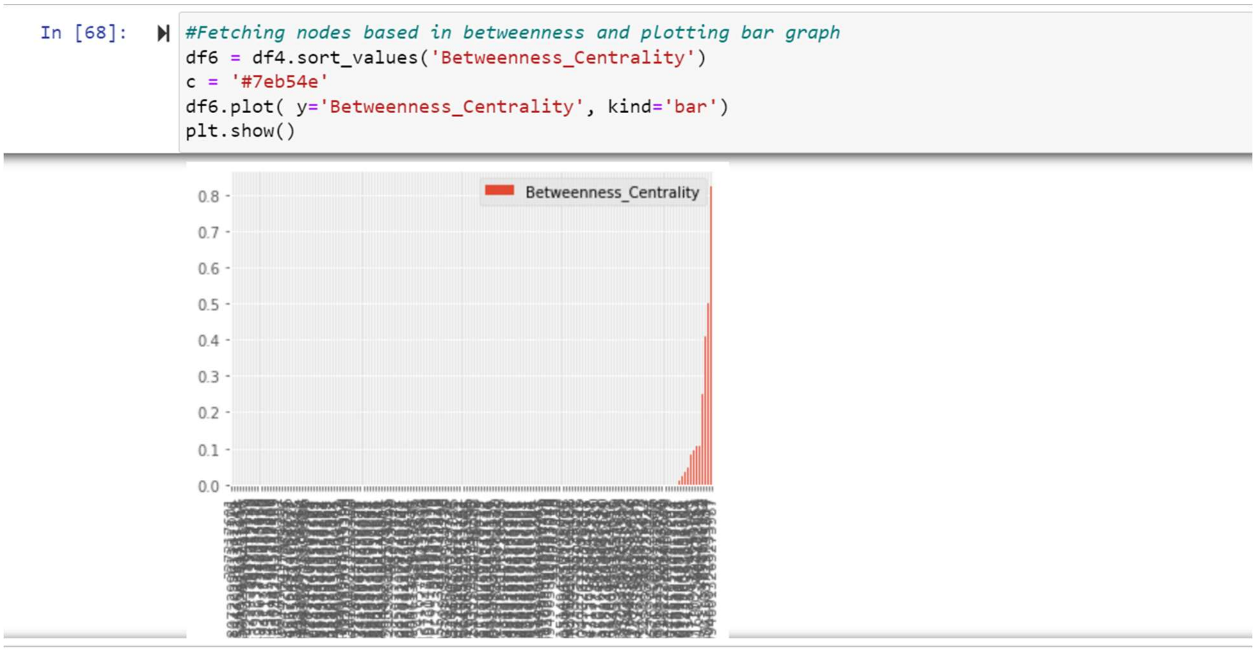
```
                     Betweenness_Centrality  Closeness_Centrality
850946013263273987                 0.824630              0.520635
768168025937752064                 0.107063              0.356522
1620606686670065664                0.000000              0.343096
1423771899222536193                0.095466              0.354978
1502090100498661376                0.012195              0.344538
...                                     ...                   ...
35927341                           0.000000              0.274707
1366385933109526535                0.000000              0.259084
1268042531008245767                0.000000              0.259084
826235053797543936                 0.000000              0.259084
1054213057851744256                0.000000              0.259084

[165 rows x 2 columns]
```

Plotting of the closeness centrality in a bar graph



```
In [67]:  #Fetching nodes based in closeness and plotting bar graph
          df5 = df4.sort_values('Closeness_Centrality')
          df5.plot( y='Closeness_Centrality', kind='bar')
          plt.show()
```

Plotting of the betweenness centrality in a bar graph



```
In [68]:  #Fetching nodes based in betweenness and plotting bar graph
          df6 = df4.sort_values('Betweenness_Centrality')
          c = '#7eb54e'
          df6.plot( y='Betweenness_Centrality', kind='bar')
          plt.show()
```

Modularity

In [30]:

```
#Calculating the modularity and plotting the network graph
Mod_Grp = max((Graph.subgraph(c) for c in nx.connected_components(Graph)), key=len)

partition = community.best_partition(Mod_Grp)
modularity = community.modularity(partition, Mod_Grp)
print('Modularity:', modularity)

colors = [partition[n] for n in Mod_Grp.nodes()]
my_colors = plt.cm.summer
pos = nx.spring_layout(Mod_Grp, seed=10396950)
nx.draw_networkx_nodes(Mod_Grp, pos, node_color=colors, cmap = my_colors,  node_size=10)
nx.draw_networkx_edges(Mod_Grp, pos, alpha=0.5)

plt.show()
```

```
Modularity: 0.7643515764425937
```