

```
In [1]: !pip install plotly==4.7.1
!wget https://github.com/plotly/orca/releases/download/v1.2.1/orca-1.2.1-x86_64.AppImage -O /usr/local/bin/orca
!chmod +x /usr/local/bin/orca
!apt-get install xvfb libgtk2.0-0 libgconf-2-4
```



```
gconf-service gconf-service-backend gconf2-common libdbus-glib-1-2
libgail-common libgail18 libgtk2.0-bin libgtk2.0-common
Suggested packages:
gvfs
The following NEW packages will be installed:
gconf-service gconf-service-backend gconf2-common libdbus-glib-1-2
libgail-common libgail18 libgconf-2-4 libgtk2.0-0 libgtk2.0-bin
libgtk2.0-common xvfb
0 upgraded, 11 newly installed, 0 to remove and 31 not upgraded.
Need to get 3,715 kB of archives.
After this operation, 17.2 MB of additional disk space will be used.
Get:1 http://archive.ubuntu.com/ubuntu bionic/main amd64 libdbus-glib-1-2 amd64 0.110-2 [58.3 kB]
Get:2 http://archive.ubuntu.com/ubuntu bionic/universe amd64 gconf2-common all 3.2.6-4ubuntu1 [700 kB]
Get:3 http://archive.ubuntu.com/ubuntu bionic/universe amd64 libgconf-2-4 amd64 3.2.6-4ubuntu1 [84.8 kB]
Get:4 http://archive.ubuntu.com/ubuntu bionic/universe amd64 gconf-service-backend amd64 3.2.6-4ubuntu1 [58.1 kB]
Get:5 http://archive.ubuntu.com/ubuntu bionic/universe amd64 gconf-service amd64 3.2.6-4ubuntu1 [2,036 B]
Get:6 http://archive.ubuntu.com/ubuntu bionic/main amd64 libgtk2.0-common all 2.24.32-1ubuntu1 [125 kB]
Get:7 http://archive.ubuntu.com/ubuntu bionic/main amd64 libgtk2.0-0 amd64 2.24.32-1ubuntu1 [1,769 kB]
Get:8 http://archive.ubuntu.com/ubuntu bionic/main amd64 libgail18 amd64 2.24.32-1ubuntu1 [14.2 kB]
Get:9 http://archive.ubuntu.com/ubuntu bionic/main amd64 libgail-common amd64 2.24.32-1ubuntu1 [112 kB]
Get:10 http://archive.ubuntu.com/ubuntu bionic/main amd64 libgtk2.0-bin amd64 2.24.32-1ubuntu1 [7,536 B]
Get:11 http://archive.ubuntu.com/ubuntu bionic-updates/universe amd64 xvfb amd64 2:1.19.6-1ubuntu4.8 [784 kB]
Fetched 3,715 kB in 2s (2,141 kB/s)
Selecting previously unselected package libdbus-glib-1-2:amd64.
(Reading database ... 160983 files and directories currently installed.)
Preparing to unpack .../00-libdbus-glib-1-2_0.110-2_amd64.deb ...
Unpacking libdbus-glib-1-2:amd64 (0.110-2) ...
Selecting previously unselected package gconf2-common.
Preparing to unpack .../01-gconf2-common_3.2.6-4ubuntu1_all.deb ...
Unpacking gconf2-common (3.2.6-4ubuntu1) ...
Selecting previously unselected package libgconf-2-4:amd64.
Preparing to unpack .../02-libgconf-2-4_3.2.6-4ubuntu1_amd64.deb ...
Unpacking libgconf-2-4:amd64 (3.2.6-4ubuntu1) ...
Selecting previously unselected package gconf-service-backend.
Preparing to unpack .../03-gconf-service-backend_3.2.6-4ubuntu1_amd64.deb ...
Unpacking gconf-service-backend (3.2.6-4ubuntu1) ...
Selecting previously unselected package gconf-service.
Preparing to unpack .../04-gconf-service_3.2.6-4ubuntu1_amd64.deb ...
Unpacking gconf-service (3.2.6-4ubuntu1) ...
Selecting previously unselected package libgtk2.0-common.
Preparing to unpack .../05-libgtk2.0-common_2.24.32-1ubuntu1_all.deb ...
Unpacking libgtk2.0-common (2.24.32-1ubuntu1) ...
```

```
Selecting previously unselected package libgtk2.0-0:amd64.
Preparing to unpack .../06-libgtk2.0-0_2.24.32-1ubuntu1_amd64.deb ...
Unpacking libgtk2.0-0:amd64 (2.24.32-1ubuntu1) ...
Selecting previously unselected package libgail18:amd64.
Preparing to unpack .../07-libgail18_2.24.32-1ubuntu1_amd64.deb ...
Unpacking libgail18:amd64 (2.24.32-1ubuntu1) ...
Selecting previously unselected package libgail-common:amd64.
Preparing to unpack .../08-libgail-common_2.24.32-1ubuntu1_amd64.deb ...
Unpacking libgail-common:amd64 (2.24.32-1ubuntu1) ...
Selecting previously unselected package libgtk2.0-bin.
Preparing to unpack .../09-libgtk2.0-bin_2.24.32-1ubuntu1_amd64.deb ...
Unpacking libgtk2.0-bin (2.24.32-1ubuntu1) ...
Selecting previously unselected package xvfb.
Preparing to unpack .../10-xvfb_2%3a1.19.6-1ubuntu4.8_amd64.deb ...
Unpacking xvfb (2:1.19.6-1ubuntu4.8) ...
Setting up gconf2-common (3.2.6-4ubuntu1) ...

Creating config file /etc/gconf/2/path with new version
Setting up libgtk2.0-common (2.24.32-1ubuntu1) ...
Setting up libdbus-glib-1-2:amd64 (0.110-2) ...
Setting up xvfb (2:1.19.6-1ubuntu4.8) ...
Setting up libgconf-2-4:amd64 (3.2.6-4ubuntu1) ...
Setting up libgtk2.0-0:amd64 (2.24.32-1ubuntu1) ...
Setting up libgail18:amd64 (2.24.32-1ubuntu1) ...
Setting up libgail-common:amd64 (2.24.32-1ubuntu1) ...
Setting up libgtk2.0-bin (2.24.32-1ubuntu1) ...
Setting up gconf-service-backend (3.2.6-4ubuntu1) ...
Setting up gconf-service (3.2.6-4ubuntu1) ...
Processing triggers for libc-bin (2.27-3ubuntu1.2) ...
/sbin/ldconfig.real: /usr/local/lib/python3.7/dist-packages/ideep4py/lib/libmkldnn.so.0 is not a symbolic link

Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
```

```
In [2]: import pandas as pd
import networkx as nx
from collections import Counter
import plotly.graph_objects as go
import numpy as np
import pandas as pd
from tqdm.autonotebook import tqdm
```

/usr/local/lib/python3.7/dist-packages/ipykernel_launcher.py:7: TqdmExperimentalWarning: Using `tqdm.autonotebook.tqdm` in notebook mode. Use `tqdm.tqdm` instead to force console mode (e.g. in jupyter console)
import sys

```
In [3]: def create_graph(df):
G=nx.Graph()
edge_list = [tuple(edge) for edge in df.values]
for edge in edge_list:
    G.add_edge(edge[1],edge[0])
return G
```

```
In [4]: def compute_degree_distribution(G,subtitle):
node_list=list(G.nodes)
degree_dict={}
for node in node_list:
    degree_dict[node]=G.degree(node)
degree_dict_final=dict(sorted(dict(Counter(degree_dict.values())).items()))
figure = go.Figure()
figure.add_trace(go.Scatter(x=list(degree_dict_final),y=list(degree_dict_final.values()),mode='markers'))
figure.update_xaxes(type="log",title_text="Degree")
figure.update_yaxes(type="log",title_text="Number of nodes")
figure.update_layout(title="Degree distribution on log-log scale of the {}".format(subtitle))
figure.show(renderer="png")
```

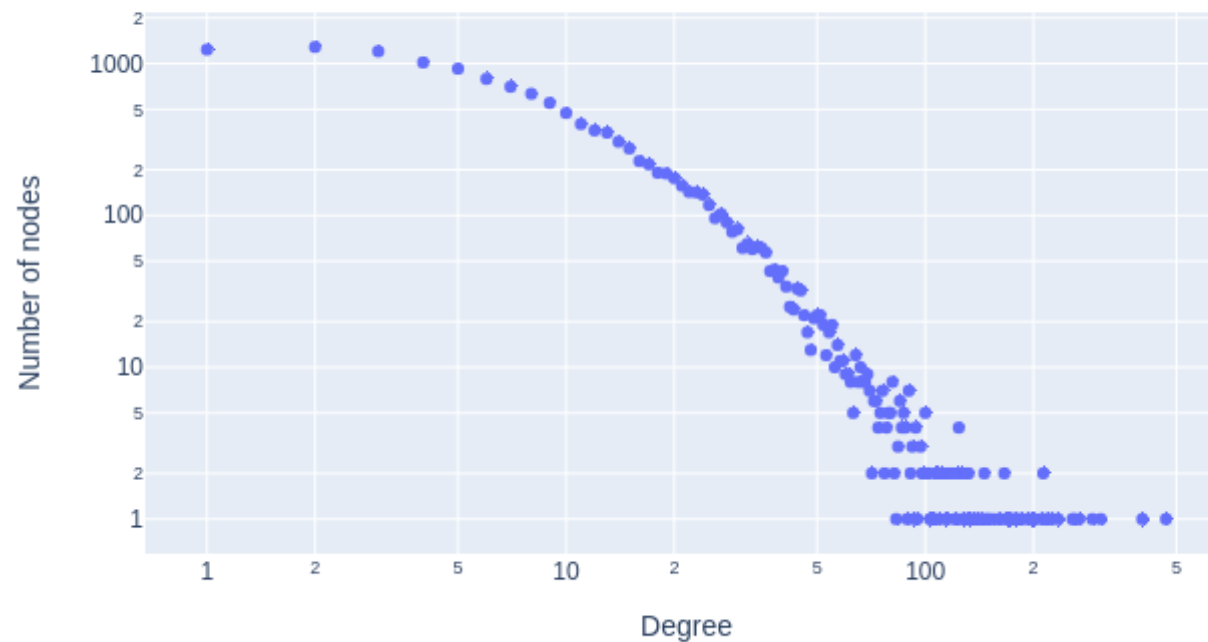
```
In [5]: path = "/content/drive/My Drive/"
project_name="2_TwitterFollowGraph"
df_facebook=pd.read_csv(path+project_name+"/Datasets/Facebook/athletes_edges.csv")
G=create_graph(df_facebook)
```

```
In [6]: print(G.number_of_nodes(),G.number_of_edges())
```

```
13866 86858
```

```
In [7]: compute_degree_distribution(G,"Facebook atheletes social pages network")
```

Degree distribution on log-log scale of the Facebook atheletes social pages network



```
In [8]: connected_components_length_list=[len(l) for l in list(nx.connected_components(G))]
connected_components_length_list.sort(reverse=True)
print("Size of top 10 connected components in the network:{}".format(connected_components_length_list[:10]))
```

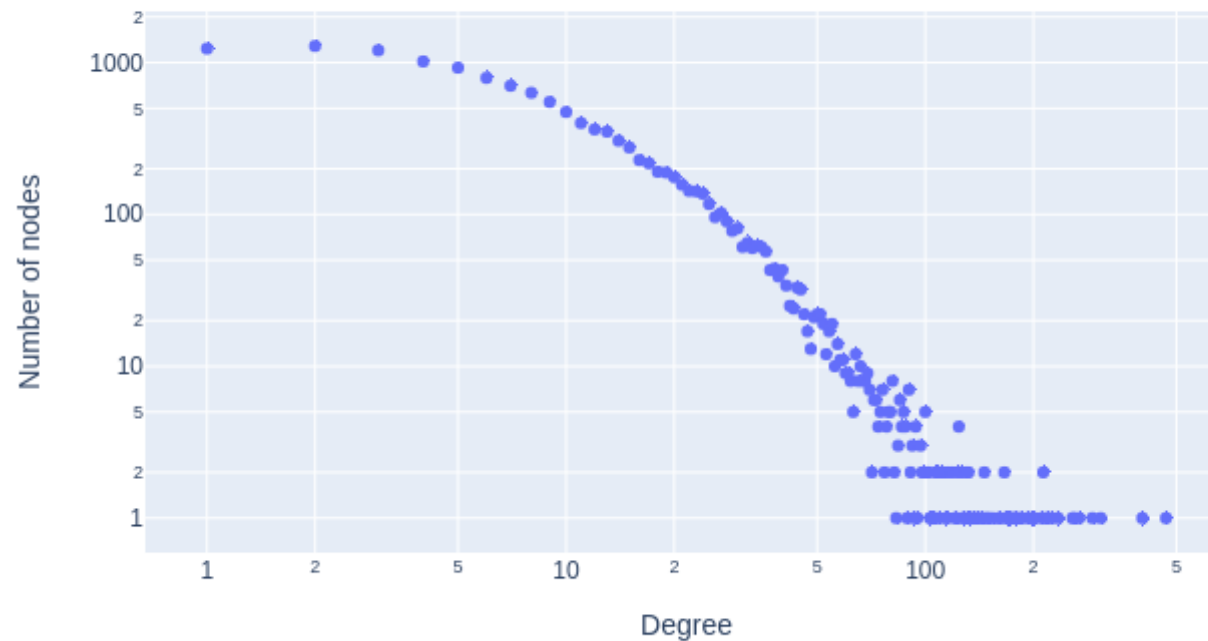
```
Size of top 10 connected components in the network:[13866]
```

```
In [9]: print("Number of connected components in the network:{}".format(len(list(nx.connected_components(G)))))
```

Number of connected components in the network:1

```
In [10]: subgraph_nodes = max(nx.connected_components(G),key=len)
largest_connected_component=G.subgraph(subgraph_nodes)
compute_degree_distribution(largest_connected_component,"largest connected component")
```

Degree distribution on log-log scale of the largest connected component



```
In [ ]: print("Average clustering coefficient of largest connected component is {}".format(nx.average_clustering(largest_connected_component)))  
print("Degree Assortativity Coefficient of largest connected component is {}".format(nx.degree_assortativity_coefficient(largest_connected_component)))
```

Average clustering coefficient of largest connected component is 0.27618837043394373
Degree Assortativity Coefficient of largest connected component is -0.026900174171377172

```
In [ ]: print("Average path length of largest connected component is {}".format(nx.average_shortest_path_length(largest_connected_component)))  
print("Diameter of largest connected component is {}".format(nx.diameter(largest_connected_component)))
```

Average path length of largest connected component is 4.274808736799688
Diameter of largest connected component is 11