Assignment Report on Graph Theory Concept implementation using networkx Libraries in Python

February 2, 2022

Problem statement: Download any Social Network Data from http://snap.stanford.edu/data/index.html. Try to download data set with at least 2000 nodes and possibly less than 10000 nodes. Measure the following:

1. Node Count, Edge Count, Average Degree
2. Degree distribution
3. No of Triangles
4. Diameter
5. No of components
6. Size of largest connected components
7. Clustering Coefficient

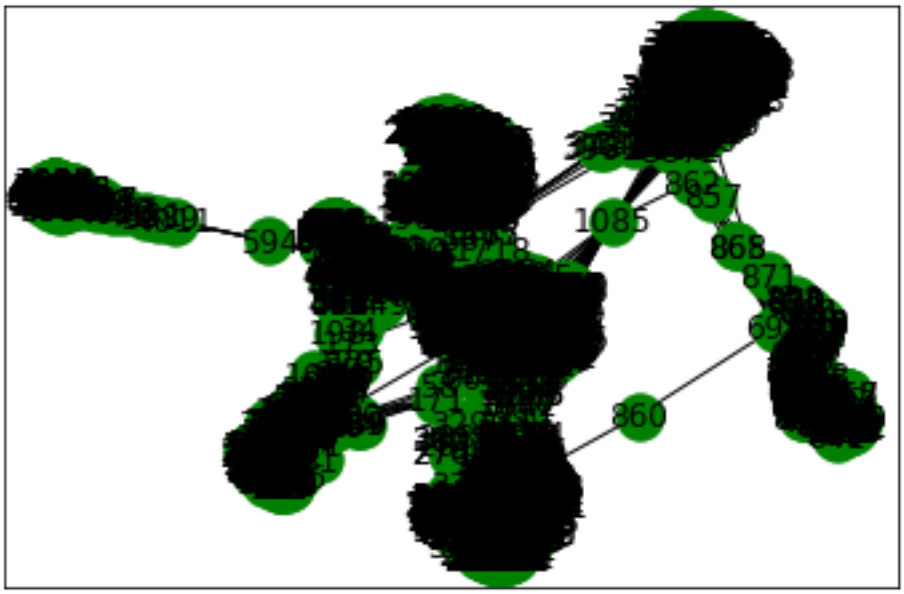
Please submit two files: 1. the full code in python script (convert the notebook into python file), 2. pdf generated from the jupyter notebook/output

[1]:
```
# basic information about graph
import networkx as nx
import matplotlib.pyplot as plt

G =nx.read_edgelist("facebook_combined.txt")
print(nx.info(G))
```

```
Name:
Type: Graph
Number of nodes: 4039
Number of edges: 88234
Average degree:  43.6910
```

[2]:
```
#Drawing a graph with all nodes
nx.draw_networkx(G, with_labels = True, node_color ='green')
```



[17]:
```
# 1. Node Count, Edge Count, Average Degree
print("Number of nodes is:",nx.number_of_nodes(G))
print("Number of edges is:",nx.number_of_edges(G))

n=nx.number_of_nodes(G)
deg = 0
for x in G.nodes():
      deg = deg + G.degree(x)
avg = deg/n
print("Average Degree:",)
```

```
Number of nodes is: 4039
Number of edges is: 88234
Average Degree: 43.69101262688784
```

Definitions for calculation of above measure: 1. Node count: Total number of nodes. 2. Edges count: Total number of edges. 3. Average Degree: The average degree of an undirected graph is used to measure the number of edges compared to the number of nodes. To do this we simply divide the summation of all nodes' degree by the total number of nodes.

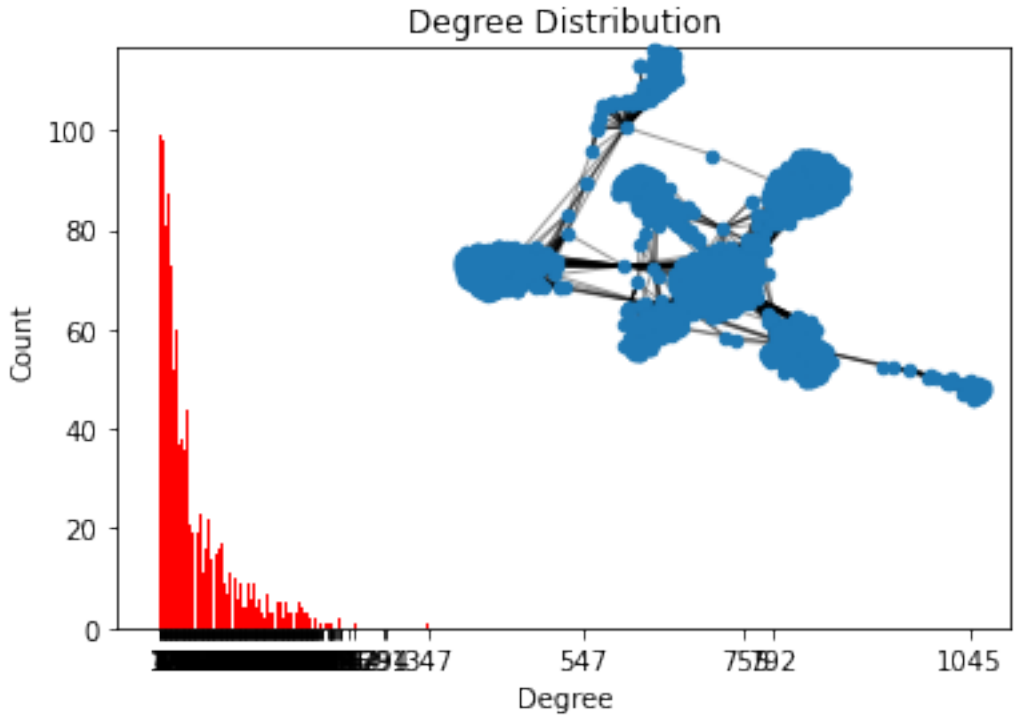
[18]:
```
# 2. Degree Distribution using histogram plot
import collections

degree_sequence = sorted([d for n, d in G.degree()], reverse=True)  # degree␣
 ↪sequence
degreeCount = collections.Counter(degree_sequence)
deg, cnt = zip(*degreeCount.items())
```

```
fig, ax = plt.subplots()
plt.bar(deg, cnt, width=0.90, color="r")

plt.title("Degree Distribution")
plt.ylabel("Count")
plt.xlabel("Degree")
ax.set_xticks([d + 0.4 for d in deg])
ax.set_xticklabels(deg)

# draw graph in inset
plt.axes([0.4, 0.4, 0.5, 0.5])
Gcc = G.subgraph(sorted(nx.connected_components(G), key=len, reverse=True)[0])
pos = nx.spring_layout(G)
plt.axis("off")
nx.draw_networkx_nodes(G, pos, node_size=20)
nx.draw_networkx_edges(G, pos, alpha=0.4)
plt.show()
```



Degree Distribution: It is a tool for analyzing a network by plotting of the number of nodes having a particular degree

[5]:
```
# 3. number of triangle
print("Number of triangle is:",len(nx.triangles(G)))
```

```
Number of triangle is: 4039
```

Number of triangle: triangle has three vertices and it is counted for every vertex, we need to divide result by 3.

[6]:
```
# 4. Diameter
print("Diameter is:",nx.diameter(G, e=None))
```

```
Diameter is: 8
```

Diameter: The diameter of a graph is the maximum eccentricity of any vertex in the graph. That is, it is the greatest distance between any pair of vertices. To find the diameter of a graph, first find the shortest path between each pair of vertices. The greatest length of any of these paths is the diameter of the graph

[20]:
```
# 5. number of connected component

print("Number of connected components:",nx.number_connected_components(G))

# print(nx.is_strongly_connected(G))  Not implemented for undirected graphs
# print(nx.is_weakly_connected(G))    Not implemented for undirected graphs
```

```
Number of connected components: 1
```

Connected Component: Connected component of an undirected graph is a subgraph in which any two vertices are connected to each other by paths, and which is connected to no additional vertices in the supergraph

[22]:
```
# 6. Size of largest connected components. here is only one connected component␣
 ↪of node 4039 nodes so largest size is 4039
largest_cc = max(nx.connected_components(G), key=len)
print("Size of largest connected components:",len(largest_cc))
```

```
Size of largest connected components: 4039
```

[23]:
```
# 7. cluster coiefficient is the average clustring
print("Clustering Coefficient:",nx.average_clustering(G))
```

```
Clustering Coefficient: 0.6055467186200876
```

Clustering Coefficient: a clustering coefficient is a measure of the degree to which nodes in a graph tend to cluster together.

[9]:
```
#Some other properties that I have practiced
print("Number of nodes is:",nx.number_of_nodes(G))
print("Number of edges is:",nx.number_of_edges(G))
print("Number of isolates is:",nx.number_of_isolates(G))
print("Number of selfloop is:",nx.number_of_selfloops(G))
print("Diameter is:",nx.diameter(G, e=None))
print("Number of triangle is:",len(nx.triangles(G)))
```

```
print("Diameter: ", nx.diameter(G))
print("Radius: ", nx.radius(G))
print("Center: ", list(nx.center(G)))
print("Eccentricity: ", len(nx.eccentricity(G)))
print("Preiphery: ",len( list(nx.periphery(G))) )
# returns True or False whether Graph is connected
print(nx.is_connected(G))

# returns number of different connected components
print(nx.number_connected_components(G))

# returns list of nodes in different connected components
print(list(nx.connected_components(G)))

# returns number of nodes to be removed
# so that Graph becomes disconnected
print(nx.node_connectivity(G))

# returns number of edges to be removed
# so that Graph becomes disconnected
print(nx.edge_connectivity(G))
```

```
Number of nodes is: 4039
Number of edges is: 88234
Number of isolates is: 0
Number of selfloop is: 0
Diameter is: 8
Number of triangle is: 4039
Diameter:  8
Radius:  4
Center:  ['567']
Eccentricity:  4039
Preiphery:  197
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'1309', '2166', '1062', '2725', '1218', '1171'}]
1
1
```
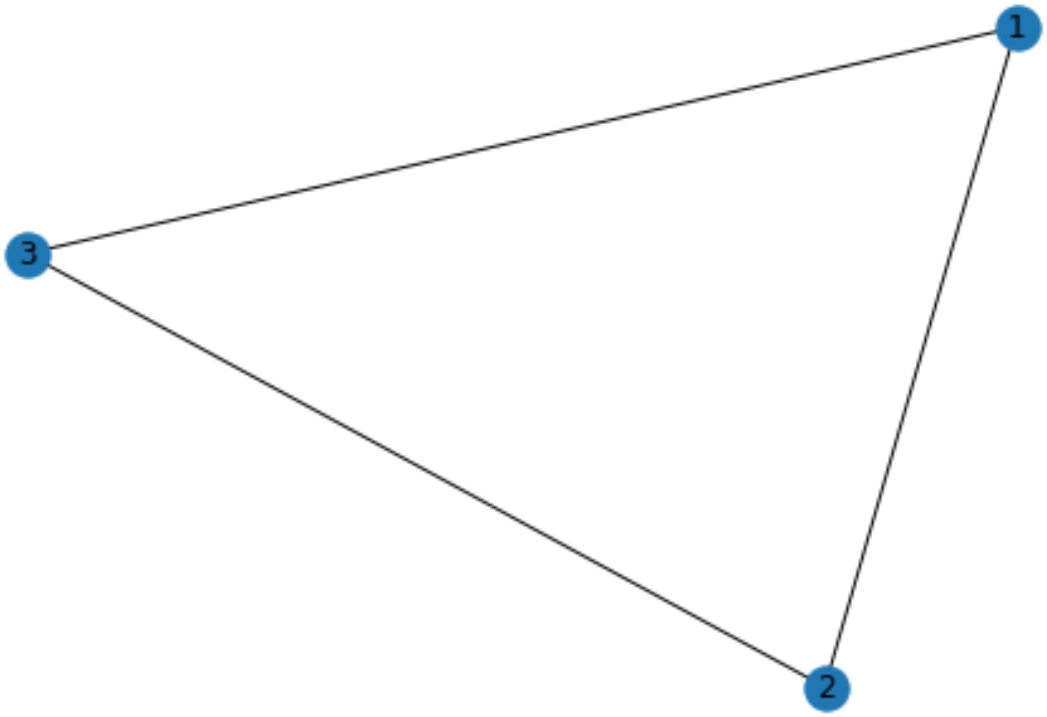

1 Some practice code with other example

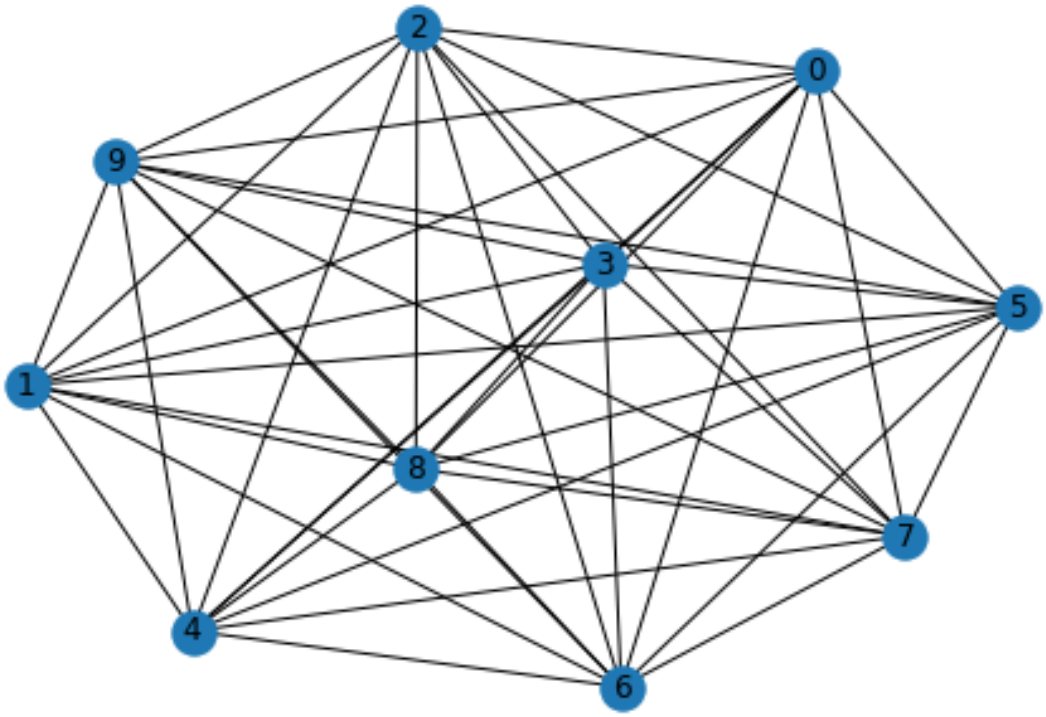
[24]:
```
#for manually creation of graph
import networkx
G =networkx.Graph()
G.add_node(1)
G.add_node(2)
G.add_node(3)
print("number of nodes:",G.number_of_nodes())
print("Details of nodes:",G.nodes())
G.add_edge(1,2)
G.add_edge(1,3)
G.add_edge(2,3)
print("Number of edges:",G.number_of_edges())
print("Details of edges:" ,G.edges())
networkx.draw(G, with_labels=1)
print("Degree:" ,G.degree(2))
```

```
number of nodes: 3
Details of nodes: [1, 2, 3]
Number of edges: 3
Details of edges: [(1, 2), (1, 3), (2, 3)]
Degree: 2
```



[25]:
```
#Example of complete graph
Z= networkx.complete_graph(10)
networkx.draw(Z, with_labels=1)
Z.nodes
Z.edges
# 1.node count
len(Z)
#2. edge count
Z.number_of_edges()
# 3. average Degree
Z.degree()
Z.degree(0)
```

[25]: 9



[27]:
```
from copy import deepcopy
import networkx as nx
from networkx.classes.coreviews import AdjacencyView
from networkx.classes.reportviews import NodeView, EdgeView, DegreeView
from networkx.exception import NetworkXError
import networkx.convert as convert

import matplotlib
import networkx as nx
g = nx.read_edgelist("Wiki-Vote.txt",nodetype=int ,edgetype=int)

# check if the data has been read properly or not.
print(nx.info(g))
g.number_of_nodes()
print(nx.number_connected_components(g))
print("average clustering:",nx.average_clustering(g))

#conversion from underected to directed graph
h = g.to_directed()
print("conversion from underected to directed graph:",nx.info(h))

i = h.to_undirected()
print("direced to undirected conversion:",nx.info(i))
```

```
Name:
Type: Graph
Number of nodes: 7115
Number of edges: 100762
Average degree:  28.3238
24
average clustering: 0.14089784589308738
conversion from underected to directed graph: Name:
Type: DiGraph
Number of nodes: 7115
Number of edges: 201524
Average in degree:  28.3238
Average out degree:  28.3238
direced to undirected conversion: Name:
Type: Graph
Number of nodes: 7115
Number of edges: 100762
Average degree:  28.3238
```

2 Thankyou

[ ]: