Graph Mining with Python

Overview of Python

- **NetworkX** is a Python package for creating and manipulating graphs and networks
  - http://networkx.github.io/
- Main features
  - Python language data structures for graphs, digraphs, and multigraphs
  - Nodes can be anything (e.g., text, images, XML records)
  - Edges can hold arbitrary data (e.g. weights, time-series)
  - Generators for classic graphs, random graphs, and synthetic networks
  - Standard graph algorithms
  - Network structure and analysis measures
  - Open source
  - Well tested: more than 1800 unit tests, >90% code coverage
  - Additional benefits from Python: fast prototyping, easy to teach, multiplatform

Creating Undirected Graphs

```
>>>import networkx as nx
```

Import library

```
>>> G = nx.Graph()
```

Create a new undirected graph

```
>>> G.add_node("Jim")
>>> G.add_node("Jenny")
>>> G.add_node("David")
>>> G.add_edge("Jim", "David")
>>> G.add_edge("Jenny", "David")
```

Add new nodes and edges

```
>>> print G.number_of_nodes()
>>> print G.number_of_edges()
>>> print G.nodes()
>>> print G.edges()
```

Print the basic characteristics of the graph

```
>>> print G.degree("Jim")
>>> print G.degree()
```

Compute the degree of a specific node or of all the nodes in the graph

Creating Directed Graphs

test.txt

```
a b
b c
b d
c d
```

Suppose that you have a graph stored in a text file in the **edge list** format: node pairs, one edge per line

```
>>> G = nx.read_edge_list("test.txt")
----
Syntax:
>>> G = nx.read_adjlist("adjlist.txt", comments='#',
delimiter=' ', nodetype=int)
Especially for character type nodes:
G1=nx.read_edgelist("test.txt", comments='#', delimiter='  ',
nodetype=None, create_using=nx.Graph())
```

Add a new edge between nodes **a** and **c** of G and save the new graph into the "edgelist.txt" file

```
>>> G.add_edge(a,c)
>>> nx.write_edgelist (G, "edgelist.txt", delimiter=' ')
```

Loading/Writing Graphs from/to File

```
>>> G = nx.DiGraph()
```

Create a new directed graph

```
>>> G.add_edges_from([("A","B"), ("C","A")])
```

Add nodes and edges edges

```
>>> print G.in_degree()
>>> print G.out_degree()
```

Print the in-degree and out-degree of the nodes

```
>>> print G.neighbors("A")
>>> print G.neighbors("B")
```

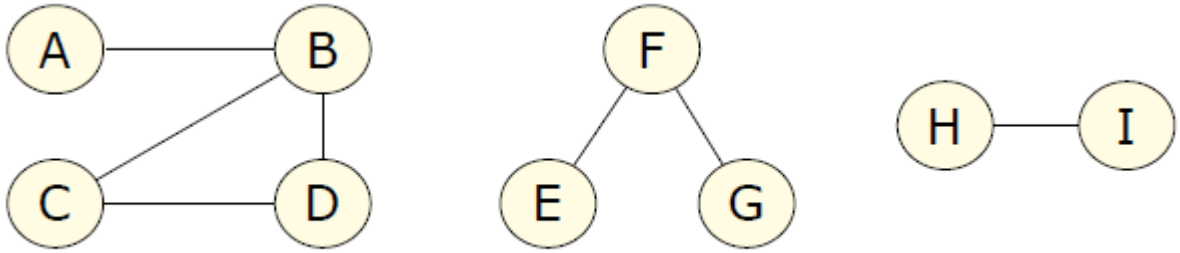
Print the neighborhood nodes of A and B

```
>>> print G.degree("Jim")
>>> print G.degree()
```

Convert the directed graph to undirected and print the neighbours of B

Graph Connectivity

- A graph is connected if there is a path between every pair of nodes in the graph
- A connected component is a subset of the nodes where
  - A path exists between every pair in the subset



Example graph with 3 connected components

Connectivity in NetworkX

Define the graph

```
G = nx.Graph()
G.add_edges_from([("a","b"),("b","c"),("b","d"),("c","d")])
G.add_edges_from([("e","f"),("f","g"),("h","i")])
```

Examine if the graph is connected and if not, find the number of con. components

```
>>> print nx.is_connected(G)

>>> print nx.number_connected_components(G)
```

Find all connected components and print their nodes

```
>>> comps = nx.connected_component_subgraphs(G)
>>> print comps[0].nodes()
>>> print comps[0].nodes()
>>> print comps[2].nodes()
```

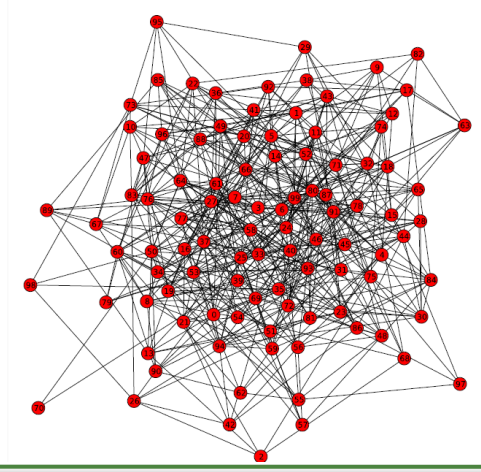
Network Visualization

- NetworkX uses the Matplotlib module for some simple network visualizations

Create a random graph based on the Erdos-Renyi model and visualize it

```
import networkx as nx
import matplotlib.pyplot as plt

G = nx.erdos_renyi_graph(100,0.11)
plt.figure(figsize =(10 ,10))
nx.draw(G)
plt.show()
```



More examples of graph visualization at:
http://networkx.github.io/documentation/latest/gallery.html