Riley Payung

CDS 292

04/30/2020

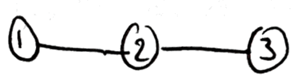
Assignment 10

Imports

In [71]:

```
import matplotlib.pyplot as plt
import networkx as netx
import numpy as np
```

Question 2



Paths:

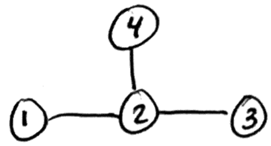
```
1,2: 1 <-> 2

1,3: 1 <-> 3

2,3: 2 <-> 3
```

$b_1=2$ | $b_2=3$ | $b_3=2$

cont on next page.



Paths:

```
1,2: 1 <-> 2

1,3: 1 <-> 2 <-> 3

1,4: 1 <-> 2 <-> 4

2,3: 2 <-> 3

2,4: 2 <-> 4

3,4: 3 <-> 2 <-> 4
```

b_1=3 | b_2=6 | b_3=3 | b_4=3

Everything increases by 1 except for b_2, which doubles in size.

Question 3

$b_2 = 5 - 1 + (2 - 1)\ (5 - 2) = 4 + 1\ 3 = 4 + 3 = 7$

Question 4

$b_5 = - 1 + (5 * 10) - 5^2 = -1 + 50 - 25 = -1 + 25 = 24$

Question 5

Let us say that the ns are the follwing:

$n_1 = 4$

$n_2 = 4$

$n_3 = 4$

$n_4 = 4$

Therefore n = 16 + 1 = 17.

In [53]:

```
n = 17;
b = [];

for i in range(1,n):
    b.append(-1 + (i * n) - (i**2))
```

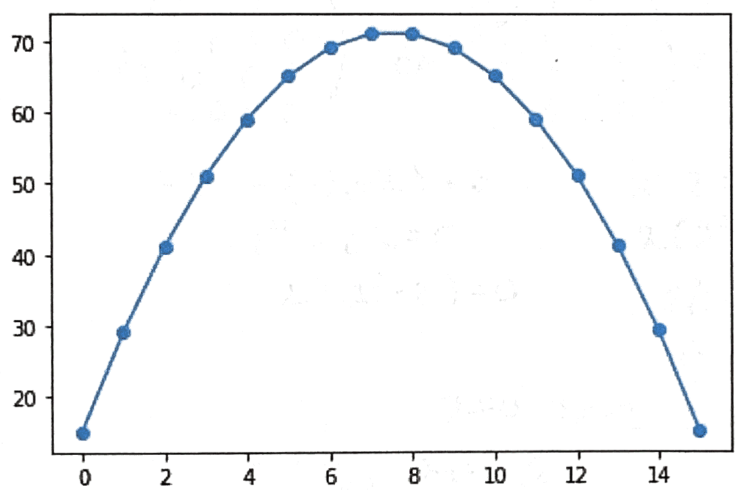
In [60]:

```
print(b)
```

```
[15, 29, 41, 51, 59, 65, 69, 71, 71, 69, 65, 59, 51, 41, 29, 15]
```

In [74]:

```
plt.plot(b, marker='o')
plt.show()
```



Question 6

$b_1 = -1 + 5 - 1 = 3$

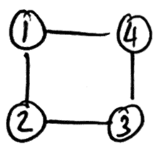
$b_2 = -1 + 2 * 5 - 4 = -1 + 10 - 4 = 5$

$b_3 = -1 + 3 * 5 - 9 = -1 + 15 - 9 = 5$

$b_4 = -1 + 4 * 5 - 16 = -1 + 20 - 16 = 3$

$b_5 = -1 + 5 * 5 - 25 = -1 + 25 - 25 = -1$

Question 9



Paths:

```
1,2: 1 <-> 2

1,3: 1 <-> 2 <-> 3, 1 <-> 4 <-> 3

1,4: 1 <-> 4

2,3: 2 <-> 3

2,4: 2 <-> 3 <-> 4, 2 <-> 1 <-> 4

3,4: 3 <-> 4
```

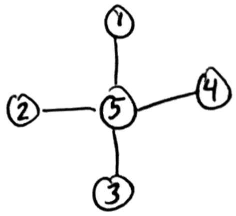
$b_1=5$ | $b_2=5$ | $b_3=5$ | $b_4=5$

Question 10

$b_i = n + 1$

Question 11

Lets assume a star network of n = 5 for the following:



Paths: 1,2: 1 <-> 2 1,3: 1 <-> 2 <-> 3, 1 <-> 4 <-> 3 1,4: 1 <-> 4 2,3: 2 <-> 3 2,4: 2 <-> 3 <-> 4, 2 <-> 1 <-> 4 3,4: 3 <-> 4

b_1=4 | b_2=4 | b_3=4 | b_4=4 | $b_{5(HUB)}$=10

Considering 5 is our b_{hub}, if we do the calculation with the equation:

$5 \choose 2$ $= \frac{5!}{2!(3!)} = \frac{120}{12} = 10$

$$\binom{5}{2} = \frac{5!}{2!(3!)} = \frac{120}{12} = 10$$

We prove that the equation is the model for the hub centrality.

which is the same as:

$5 - 1 + $$4 \choose 2$ $= 4 + 6 = 10 <=> 10 =$ $5\choose 2$

$$5 - 1 + \binom{4}{2} = 4 + 6 = 10 \Leftrightarrow 10 = \binom{5}{2}$$

Question 12

$$A = \begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix} \quad \det\begin{pmatrix} -\lambda & 1 & 1 & 1 \\ 1 & -\lambda & 1 & 0 \\ 1 & 1 & -\lambda & 0 \\ 1 & 0 & 0 & -\lambda \end{pmatrix} = 0$$

$$-\lambda^4 - (-\lambda - \lambda) = 0 \qquad -\lambda^3 - 2 = 0$$

$$-\lambda^4 + 2\lambda = 0 \qquad -\lambda(\lambda^2) = 2$$

$$-\lambda(\lambda^3 - 2) = 0$$

$$\lambda^2 = 2$$

$$\lambda = 0 \quad \lambda = -2 \quad \lambda = \pm\sqrt{2}$$

$$x_1 = 0 \quad x_3 = -\sqrt{2}$$

$$x_2 = -2 \quad x_4 = 2 + 2\sqrt{2}$$

biggest is $\sqrt{2}\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \end{pmatrix}\begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{pmatrix}$

$$0x_1 + x_2 + x_3 + x_4 = \sqrt{2}$$

$$x_1 + x_3 = -\sqrt{2}$$

$$x_1 + x_2 = -2$$

$$x_1 = 0$$

Question 14

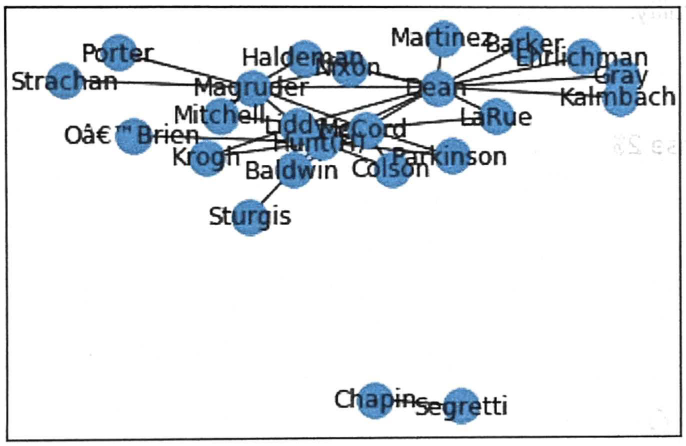
In [5]:

```
# Load watergate network:
WG = netx.Graph();

watergateFile = open('watergate-testimony-links.dat','r');
for line in watergateFile:
    cLine = line.strip();
    items = cLine.split();
    WG.add_edge(items[0],items[1]);
```

In [16]:

```
netx.draw_networkx(WG)
plt.show()
```



In [46]:

```
def BC1 (G , o ) :
    A =[ o ]
    V =[]
    l =0
    p ={}
    m ={}
    z ={}
    p [ o ]=[]
    m [ o ]=1
    z [ l ]=[ o ]
    while len( A ) >0:
        # print Len(A)
        l = l +1
        nA =[]
        for i in A :
            for j in G . neighbors ( i ) :
                if ( j not in V ) and ( j not in A ) :
                    if j not in nA :
                        nA . append ( j )
                        z [ l ]= z . get (l ,[])
                        z [ l ]. append ( j )
                    p [ j ]= p . get (j ,[])
                    p [ j ]. append ( i )
                    m [ j ]= m . get (j ,0)
                    m [ j ]= m [ j ]+ m [ i ]
            V . append ( i )
        A = nA
    lf =l -1
    b ={}
    for i in G . nodes () :
        b [ i ]=0
    for l in range ( lf ,0 , -1) :
        for i in z [ l ]:
            b [ i ]= b [ i ]+ m [ i ]
            for j in p [ i ]:
                b [ j ]= b [ j ]+ m [ j ]* b [ i ]/ m [ i ]

    return ( b )
```

In [47]:

```
def BC ( G ) :
    B ={}
    for i in G . nodes () :
        B [ i ]=0
    for o in G . nodes () :
        b = BC1 (G , o )
        for i in b . keys () :
            B [ i ]= B [ i ]+ b [ i ]
    for i in G . nodes () :
        B [ i ]= B [ i ]/2
    return ( B )
```

In [48]:

```
G = BC(WG);
```

In [51]:

```
G
```

Out[51]:

```
{'Baldwin': 93.0,
 'Hunt(H)': 110.0,
 'Liddy': 79.0,
 'McCord': 117.0,
 'Sturgis': 47.0,
 'Dean': 208.0,
 'Barker': 29.0,
 'Ehrlichman': 29.0,
 'Gray': 29.0,
 'Haldeman': 38.0,
 'Kalmbach': 29.0,
 'LaRue': 30.0,
 'Martinez': 29.0,
 'Nixon': 38.0,
 'Colson': 35.0,
 'Oâ€™Brien': 28.0,
 'Parkinson': 35.0,
 'Krogh': 39.0,
 'Magruder': 110.0,
 'Mitchell': 30.0,
 'Porter': 28.0,
 'Strachan': 28.0,
 'Segretti': 1.0,
 'Chapin': 1.0}
```

Dean has the highest centrality, at 208.0

In [ ]:

```

```