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CDS 292

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Assignment 10

Imports

In [1]:

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

Question 8

In [2]:

```
# 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 [3]:

```
tris = netx.triangles(WG)
print(tris)
# Person involved in the most number of triangles:
max(tris)
```

```
{'Baldwin': 3, 'Hunt(H)': 8, 'Liddy': 8, 'McCord': 11, 'Sturgis': 0, 'Dean':
8, 'Barker': 0, 'Ehrlichman': 0, 'Gray': 0, 'Haldeman': 1, 'Kalmbach': 0, 'La
Rue': 1, 'Martinez': 0, 'Nixon': 1, 'Colson': 1, 'Oâ€™Brien': 0, 'Parkinson':
1, 'Krogh': 1, 'Magruder': 6, 'Mitchell': 1, 'Porter': 0, 'Strachan': 0, 'Seg
retti': 0, 'Chapin': 0}
```

Out[3]:

```
'Sturgis'
```

In [4]:

```
A = netx.adjacency_matrix(WG);
A2 = A*A;
A3 = A*A*A;

vshape = [];
tris = [];
```

In [5]:

```
for i in range(len(A2.toarray())):
    for j in range(len(A2.toarray())):
        if (j == i + 1):
            vshape.append(A2[i,j]);
```

In [6]:

```
for i in range(len(A3.toarray())):
    for j in range(len(A3.toarray())):
        if (i == j):
            tris.append(A3[i,j]);
```

In [7]:

```
totalV = sum(vshape);
totalT = sum(tris);
cluster = (1/2) * (totalT / totalV);
cluster
```

Out[7]:

2.04

In [8]:

```
localcluster = {};
for i in WG.nodes():
    degree = WG.degree(i);
    if (not ((degree - 1) == 0)):
        clustercoeff = totalT / (degree * (degree-1));
        localcluster[i] = clustercoeff;
```

In [9]:

```
m = 1000;
p = None;
for i,j in zip(localcluster.keys(),localcluster.values()):
    if (m > int(j)):
        m = int(j);
        p = i;
```

In [10]:

```
# person with the greatest clustering. (lowest clustering coefficient, meaning high degre
e)
print(p)
```

```
Dean
```

Question 9

In [11]:

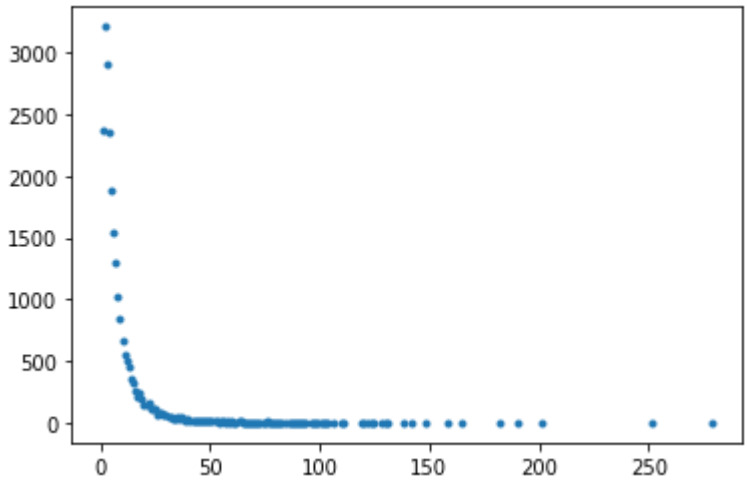
```
# Load coauthor network
CO = netx.Graph();

coauthorFile = open('coauthor.txt','r');
for line in coauthorFile:
    cLine = line.strip();
    items = cLine.split();
    CO.add_edge(items[0],items[1]);
```

In [12]:

```
degrees = [];
for i in CO.nodes():
    degree = CO.degree(i);
    degrees.append(degree);

degreehist = {};
for i in degrees:
    if i in degreehist.keys():
        degreehist[i] += 1;
    else:
        degreehist[i] = 1;
```

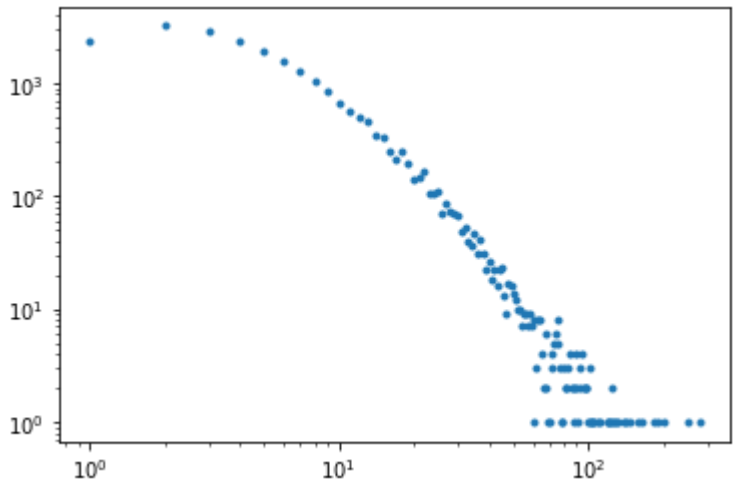
In [13]:

```
plt.plot(list(degreehist.keys()),list(degreehist.values()), marker='.', linewidth=0.0);
plt.show();
```



In [14]:

```
plt.plot(list(degreehist.keys()),list(degreehist.values()), marker='.', linewidth=0.0);
plt.xscale('log');
plt.yscale('log');
plt.show();
```



Question 11

In [15]:

```
def GetTriangles(G):
    t ={} # Count of triangles per node
    for node in G.nodes():
        t [node]=0 # Initialize triangle count
        neighs = list(G.neighbors(node))
        k = G.degree(node) # Length of neighs
        for c1 in range(k):
            i = neighs[c1]
            for c2 in range(c1+1,k):
                j = neighs[c2]
                if G.has_edge(i,j):
                    t[node]= t[node]+1;
    return t;
```

In [16]:

```
tris = GetTriangles(CO);
```

In [17]:

```
def factorial(n):
    res = 1;
    for i in range(n,1,-1):
        res *= n;
    return res;

def choose(a,b):
    return (factorial(a) / (factorial(b) * factorial(a-b)));
```

In [18]:

```
ci = [];
for i in CO.nodes():
    degree = CO.degree(i);
    if not(degree == 0):
        ci.append(tris[i] / (choose(degree,2)));
```

In [19]:

```
n = len(ci);
avg = sum(ci) / n;
avg
```

Out[19]:

```
0.30287085709054734
```

It does not match

Question 12

In [20]:

```
avgk = 2 * len(CO.edges()) / len(CO.nodes());
avgk = round(avgk);

avgT = round((avgk * (avgk-1)) / 2 * 0.63);
print(avgT)
n = len(CO.nodes());
m = len(CO.edges());
density = m / (n * (n-1) / 2);
print(density)
```

```
18
0.00034923119987489135
```

Question 14

It says that there are approx 2540 global triangles per node, so we can say that there are about:

In [21]:

```
n * 2540
```

Out[21]:

```
58757820
```

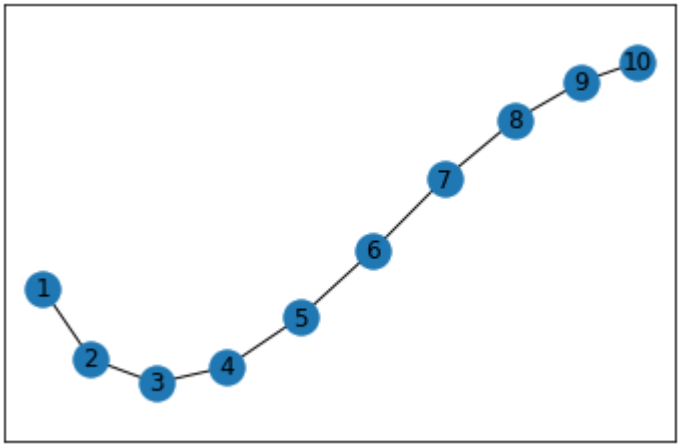
58,757,820 global triangles in the network.

Question 16

In [35]:

```
# Line Network of 10 Nodes:
Line = netx.Graph();
N=10;
for i in range(1,N):
    if (i + 1 <= N):
        Line.add_edge(i, i+1);

print(Line.edges())
netx.draw_networkx(Line)
plt.show()
```

```
[(1, 2), (2, 3), (3, 4), (4, 5), (5, 6), (6, 7), (7, 8), (8, 9), (9, 10)]
```



In [23]:

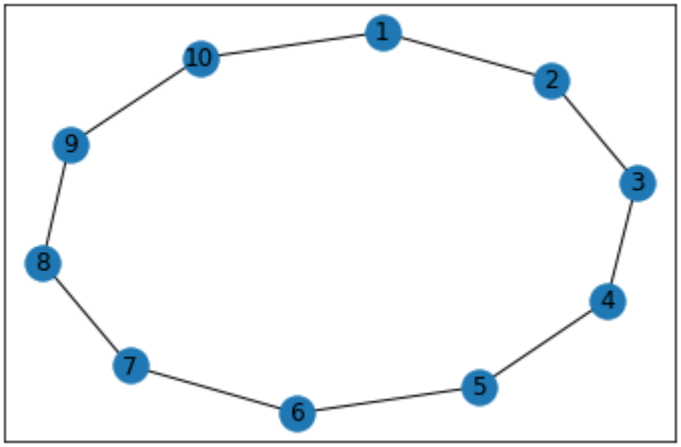
```
# Calculate the number of V-Shapes:

vshapes = 0;

for i in Line.nodes():
    degree = Line.degree(i);
    vshapes += choose(degree,2);
print(vshapes)
```

```
9.0
```

In [24]:

```
# Ring Network of 10 Nodes:
Ring = netx.Graph();
N=10;
for i in range(1,N):
    if (i + 1 <= N):
        Ring.add_edge(i, i+1);
Ring.add_edge(1,10);
print(Ring.edges())
netx.draw_networkx(Ring)
plt.show()
```

```
[(1, 2), (1, 10), (2, 3), (3, 4), (4, 5), (5, 6), (6, 7), (7, 8), (8, 9), (9,
10)]
```



In [25]:

```
# Calculate the number of V-Shapes:

vshapes = 0;

for i in Ring.nodes():
    degree = Ring.degree(i);
    vshapes += choose(degree,2);
print(vshapes)
```

```
10.0
```

They are nearly the same because a ring network is just a line network with a link from the last node to the first node, allowing for an additional v-shape in the network.

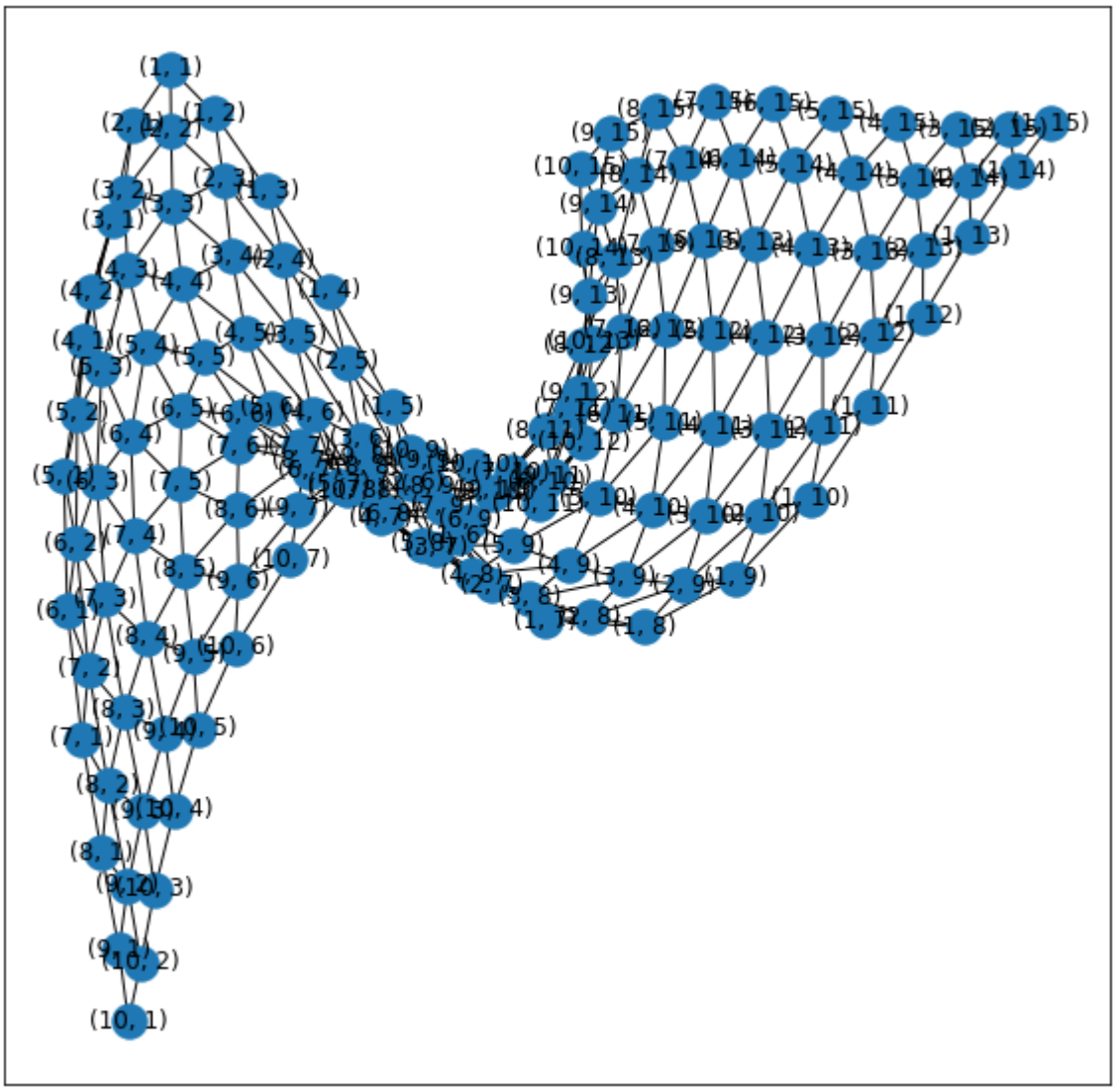
Question 17

In [26]:

```
u = 10;
v = 15;

lattice = netx.Graph();

for i in range(1,u):
    for j in range(1,v):
        lattice.add_edge((i,j),(i+1,j+1)); # diagonals.
        lattice.add_edge((i,j),(i,j+1)); # horizontals
        lattice.add_edge((i,j),(i+1,j)); # verticals
for i in range(1,u):
    lattice.add_edge((i,v),(i+1,v));
for i in range(1,v):
    lattice.add_edge((u,i),(u,i+1));
```

In [27]:

```
plt.figure(figsize=(10,10))
netx.draw_networkx(lattice)
plt.show()
```



In [28]:

```
A = netx.adjacency_matrix(lattice)
```

In [29]:

```
A2 = A*A
vshape = [];
```

In [30]:

```
for i in range(len(A2.toarray())):
    for j in range(len(A2.toarray())):
        if (j == i + 1):
            vshape.append(A2[i,j]);
```

In [31]:

```
sum(vshape)
```

Out[31]:

```
259
```

There are 259 local v-shapes in the lattice network.

In [32]:

```
A3 = A*A*A
tris = [];
```

In [33]:

```
for i in range(len(A3.toarray())):
    tris.append(A3[i,i]);
```

In [34]:

```
sum(tris)/2
```

Out[34]:

```
756.0
```

There are 756 local triangles in the lattice network.