flow_network_analysis

May 31, 2017

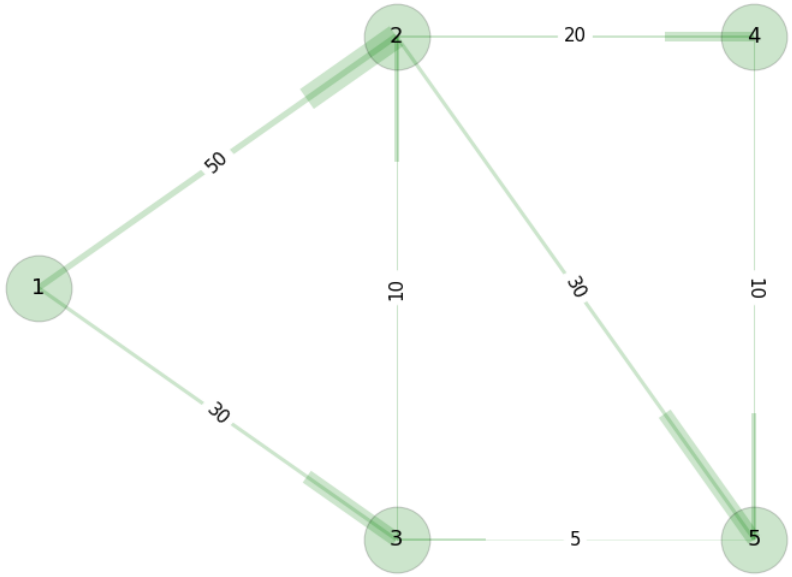
```
In [1]: %matplotlib inline
        from flownetwork import flownetwork as fn
        import networkx as nx
        import matplotlib.pyplot as plt
        import numpy as np

        print fn.__version__
```

```
$version = 0.0.0.8$
```

1 Example

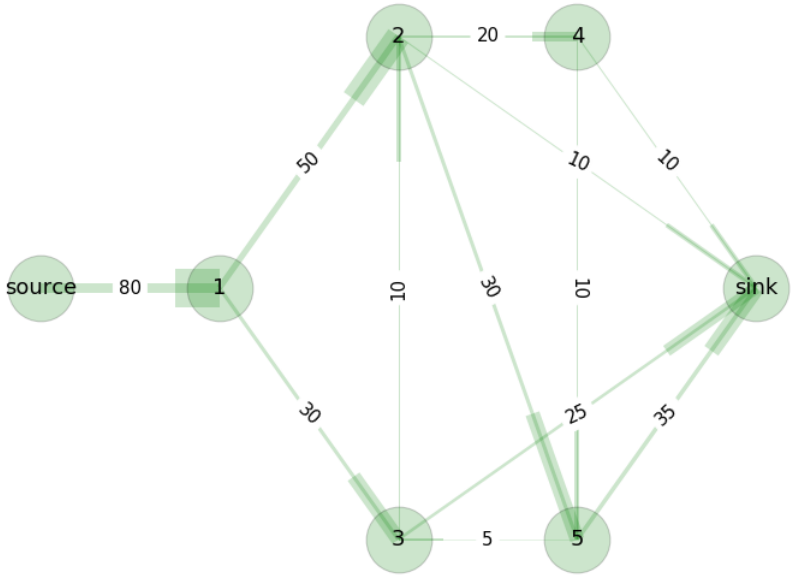
```
In [11]: G = nx.DiGraph()
         G.add_edge(1, 2, weight = 50)
         G.add_edge(1, 3, weight = 30)
         G.add_edge(3, 2, weight = 10)
         G.add_edge(2, 4, weight = 20)
         G.add_edge(2, 5, weight = 30)
         G.add_edge(5, 3, weight = 5)
         G.add_edge(4, 5, weight = 10)
```

```
In [12]: fig = plt.figure(figsize=(16, 10),facecolor='white')
         pos={1: np.array([ 0.2,  0.5]),
          2: np.array([ 0.4,  0.8]),
          3: np.array([ 0.4,  0.2 ]),
          4: np.array([ 0.6,  0.8]),
          5: np.array([ 0.6,  0.2])}

         width=[float(d['weight']*.1) for (u,v,d) in G.edges(data=True)]
         edge_labels=dict([((u,v,),d['weight']) for u,v,d in G.edges(data=True)])
         nx.draw_networkx_edge_labels(G,pos,edge_labels=edge_labels, font_size = 15,alpha = .5)
         nx.draw(G, pos, node_size = 3000, node_color = 'green',
                 alpha = 0.2, width = width, edge_color='green',style='solid')
         nx.draw_networkx_labels(G,pos,font_size=18)
         plt.show()
```

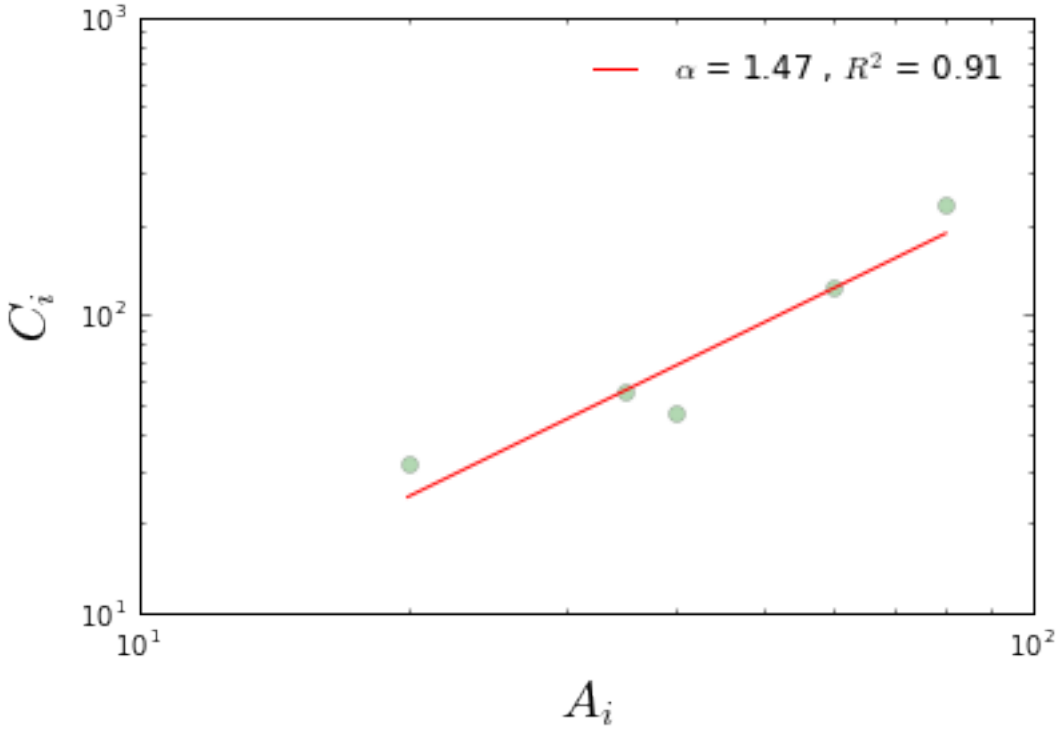



```
In [13]: H = fn.flowBalancing(G)
```

```
In [24]: fig = plt.figure(figsize=(16, 10),facecolor='white')
         pos={1: np.array([ 0.2,  0.5]),
          2: np.array([ 0.4,  0.8]),
          3: np.array([ 0.4,  0.2 ]),
          4: np.array([ 0.6,  0.8]),
          5: np.array([ 0.6,  0.2]),
          'sink': np.array([ 0.8,  0.5]),
          'source': np.array([0,  0.5])}

         width=[float(d['weight']*.1) for (u,v,d) in H.edges(data=True)]
         edge_labels=dict([((u,v,),d['weight']) for u,v,d in H.edges(data=True)])
         nx.draw_networkx_edge_labels(H,pos,edge_labels=edge_labels, font_size = 15,alpha = .5)
         nx.draw(H, pos, node_size = 3000, node_color = 'green',
                 alpha = 0.2, width = width, edge_color='green',style='solid')
         nx.draw_networkx_labels(H,pos,font_size=18)
         plt.show()
```



In [23]:
```
ai, ci = fn.getAICI(G).T
fn.alloRegressPlot(ai,ci,'g','o','$A_i$','$C_i$', loglog=True)
```



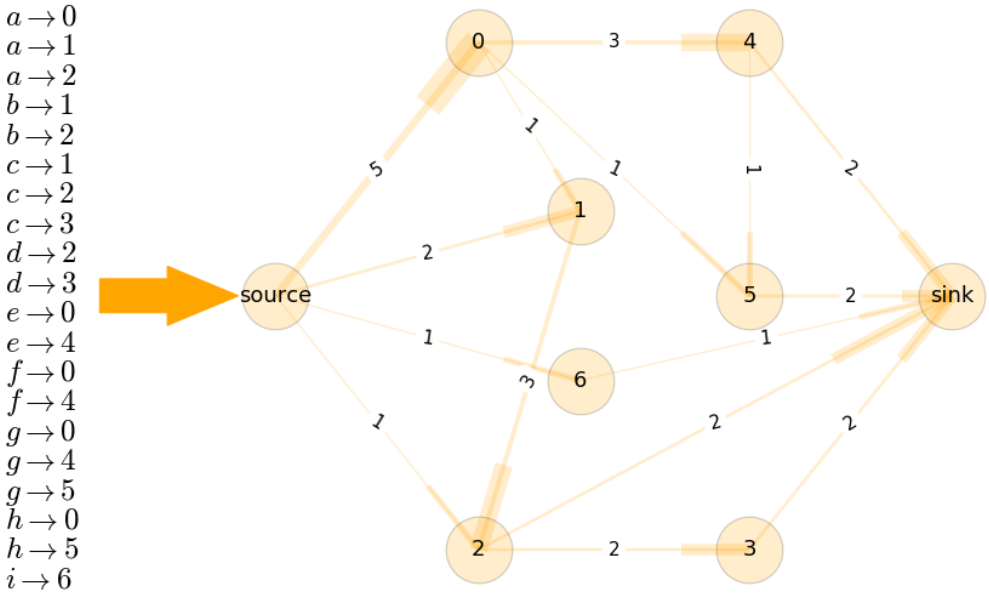
2 Demo Data

In [15]:
```
demo = fn.attention_data
demo
```

Out[15]:
```
[['a', 0],
 ['a', 1],
 ['a', 2],
 ['b', 1],
 ['b', 2],
 ['c', 1],
 ['c', 2],
 ['c', 3],
 ['d', 2],
 ['d', 3],
 ['e', 0],
 ['e', 4],
 ['f', 0],
 ['f', 4],
 ['g', 0],
 ['g', 4],
 ['g', 5],
 ['h', 0],
 ['h', 5],
 ['i', 6]]
```

In [16]:
```
gd = fn.constructFlowNetwork(demo)
```

In [17]:
```
fig = plt.figure(figsize=(16, 10),facecolor='white')
pos={0: np.array([ 0.6 ,  0.8]),
 2: np.array([ 0.6,  0.2]),
 1: np.array([ 0.75,  0.6]),
 6: np.array([ 0.75,  0.4]),
 4: np.array([ 1,  0.8]),
 5: np.array([ 1,  0.5]),
 3: np.array([ 1,  0.2 ]),
 'sink': np.array([ 1.3,  0.5]),
 'source': np.array([.3,  0.5])}
width=[float(d['weight']*1.2) for (u,v,d) in gd.edges(data=True)]
edge_labels=dict([((u,v,),d['weight']) for u,v,d in gd.edges(data=True)])
nx.draw_networkx_edge_labels(gd,pos,edge_labels=edge_labels, font_size = 15,alpha = .5)
nx.draw(gd, pos, node_size = 3000, node_color = 'orange',
        alpha = 0.2, width = width, edge_color='orange',style='solid')
nx.draw_networkx_labels(gd,pos,font_size=18)
for k,  i in enumerate(demo):
    plt.text(-.1, .82-.035*k, '$%s  \\rightarrow  %i$' % (i[0], i[1]) , fontsize = 25)
plt.arrow(.04, .5,  .1, 0, color='orange', width=0.04, head_width = .07)
plt.xlim(-.1, 1.5)
plt.show()
```



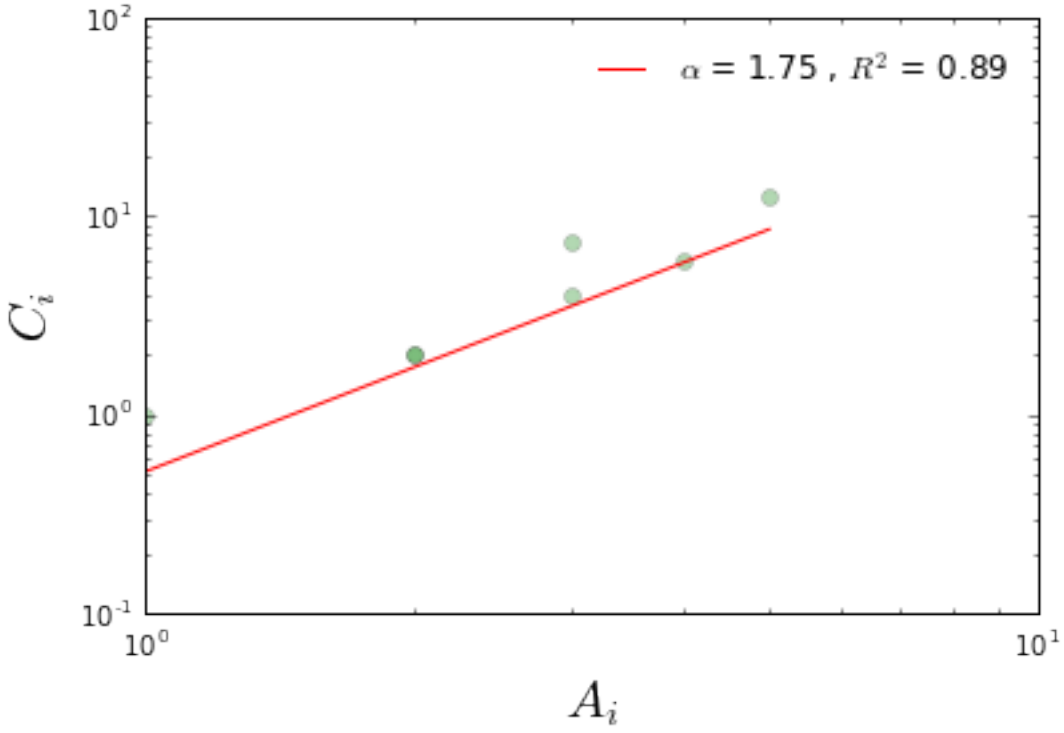

```
In [6]: nx.info(gd)

Out[6]: 'Name: \nType: DiGraph\nNumber of nodes: 9\nNumber of edges: 15\nAverage in degree:   1.6667\nAv

In [7]: gh = fn.flowBalancing(gd)
        nx.info(gh)

Out[7]: 'Name: \nType: DiGraph\nNumber of nodes: 9\nNumber of edges: 15\nAverage in degree:   1.6667\nAv

In [18]: m = fn.getFlowMatrix(gd)
         m

Out[18]: matrix([[ 0.,  1.,  0.,  0.,  3.,  1.,  0.,  0.,  0.],
                 [ 0.,  0.,  3.,  0.,  0.,  0.,  0.,  0.,  0.],
                 [ 0.,  0.,  0.,  2.,  0.,  0.,  0.,  0.,  2.],
                 [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  2.],
                 [ 0.,  0.,  0.,  0.,  0.,  1.,  0.,  0.,  2.],
                 [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  2.],
                 [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  1.],
                 [ 5.,  2.,  1.,  0.,  0.,  0.,  1.,  0.,  0.],
                 [ 0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.,  0.]])

In [19]: M = fn.getMarkovMatrix(m)
         M

Out[19]: array([[ 0.        ,  0.2       ,  0.        ,  0.        ,  0.6       ,
                  0.2       ,  0.        ,  0.        ,  0.        ],
                [ 0.        ,  0.        ,  1.        ,  0.        ,  0.        ,
                  0.        ,  0.        ,  0.        ,  0.        ],
```

```
       [ 0.        ,  0.        ,  0.        ,  0.5       ,  0.        ,
         0.        ,  0.        ,  0.        ,  0.5       ],
       [ 0.        ,  0.        ,  0.        ,  0.        ,  0.        ,
         0.        ,  0.        ,  0.        ,  1.        ],
       [ 0.        ,  0.        ,  0.        ,  0.        ,  0.        ,
         0.33333333,  0.        ,  0.        ,  0.66666667],
       [ 0.        ,  0.        ,  0.        ,  0.        ,  0.        ,
         0.        ,  0.        ,  0.        ,  1.        ],
       [ 0.        ,  0.        ,  0.        ,  0.        ,  0.        ,
         0.        ,  0.        ,  0.        ,  1.        ],
       [ 0.55555556,  0.22222222,  0.11111111,  0.        ,  0.        ,
         0.        ,  0.11111111,  0.        ,  0.        ],
       [ 0.        ,  0.        ,  0.        ,  0.        ,  0.        ,
         0.        ,  0.        ,  0.        ,  0.        ]])
```

In [21]:
```
U = fn.getUmatrix(gh)
U
```

Out[21]:
```
matrix([[ 1.        ,  0.2       ,  0.2       ,  0.1       ,  0.6       ,
          0.4       ,  0.        ],
        [ 0.        ,  1.        ,  1.        ,  0.5       ,  0.        ,
          0.        ,  0.        ],
        [ 0.        ,  0.        ,  1.        ,  0.5       ,  0.        ,
          0.        ,  0.        ],
        [ 0.        ,  0.        ,  0.        ,  1.        ,  0.        ,
          0.        ,  0.        ],
        [ 0.        ,  0.        ,  0.        ,  0.        ,  1.        ,
          0.33333333,  0.        ],
        [ 0.        ,  0.        ,  0.        ,  0.        ,  0.        ,
          1.        ,  0.        ],
        [ 0.        ,  0.        ,  0.        ,  0.        ,  0.        ,
          0.        ,  1.        ]])
```

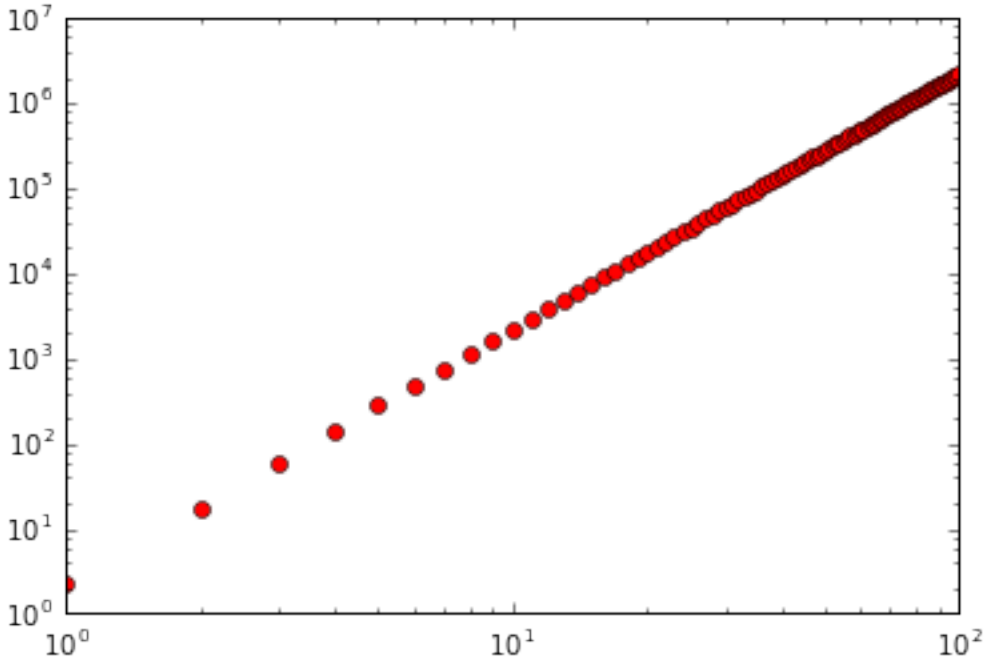
In [26]:
```
ai, ci = fn.getAICI(gh).T
fn.alloRegressPlot(ai,ci,'g','o','$A_i$','$C_i$', loglog=True)
```



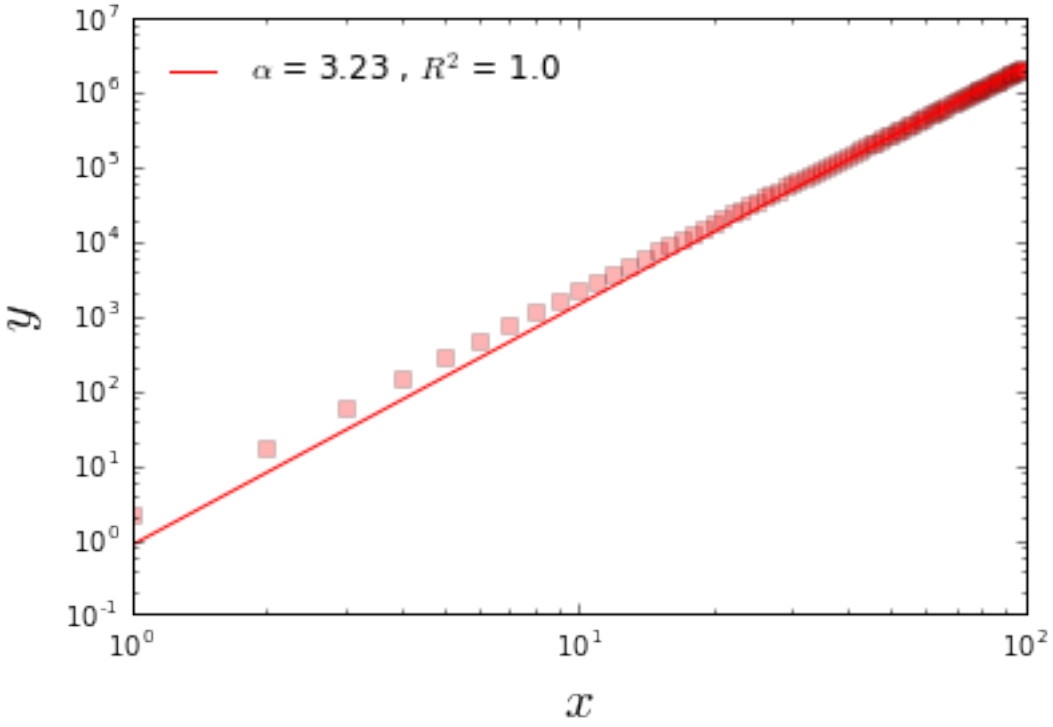

```
In [27]: fn.networkDissipate(gh)

Out[27]: defaultdict(<function flownetwork.flownetwork.<lambda>>,
                     {0: [0, 5, 5],
                      1: [0, 3, 2],
                      2: [2, 4, 1],
                      3: [2, 2, 0],
                      4: [2, 3, 0],
                      5: [2, 2, 0],
                      6: [1, 1, 1]})

In [28]: fn.flowDistanceFromSource(gd)

Out[28]: {0: 1.0,
          1: 1.333333333333333,
          2: 2.0,
          3: 3.0,
          4: 2.0,
          5: 2.5,
          6: 1.0,
          'sink': 3.2222222222222214}

In [29]: fn.averageFlowLength(gd)

Out[29]: 3.2222222222222223
```

3 Visualization

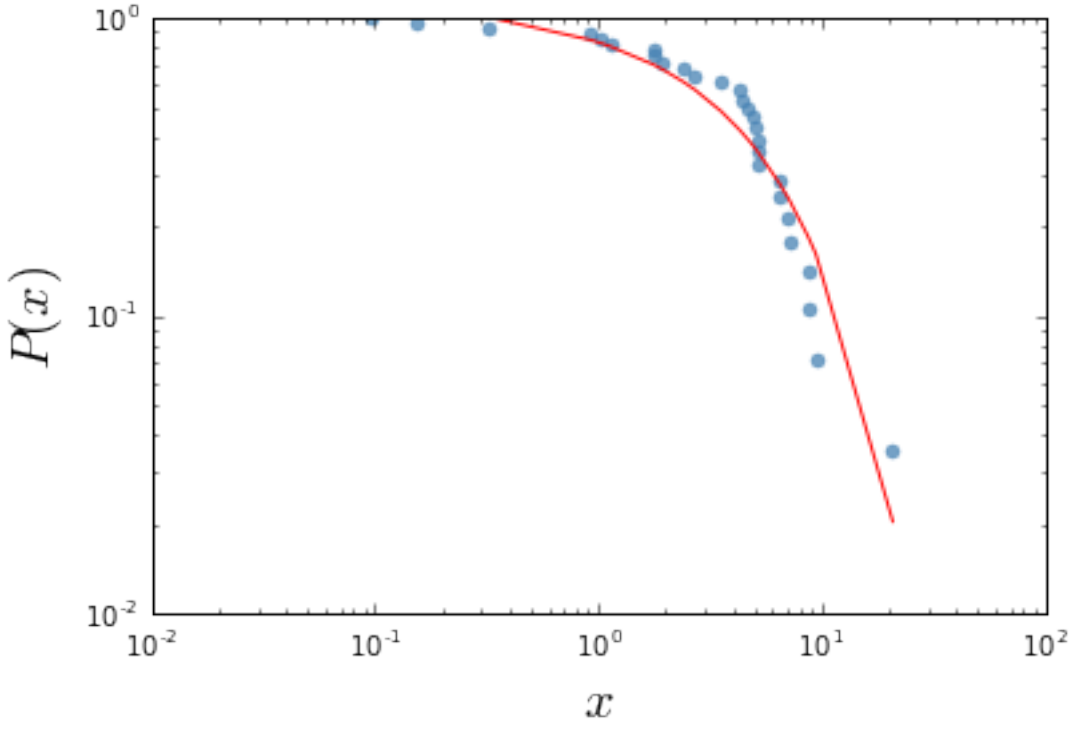
In [30]:
```
from random import random
x = np.array(range(1, 100))
y = (x+random()*x)**3

plt.plot(x, y, 'ro')
plt.xscale('log');plt.yscale('log')
plt.show()
```



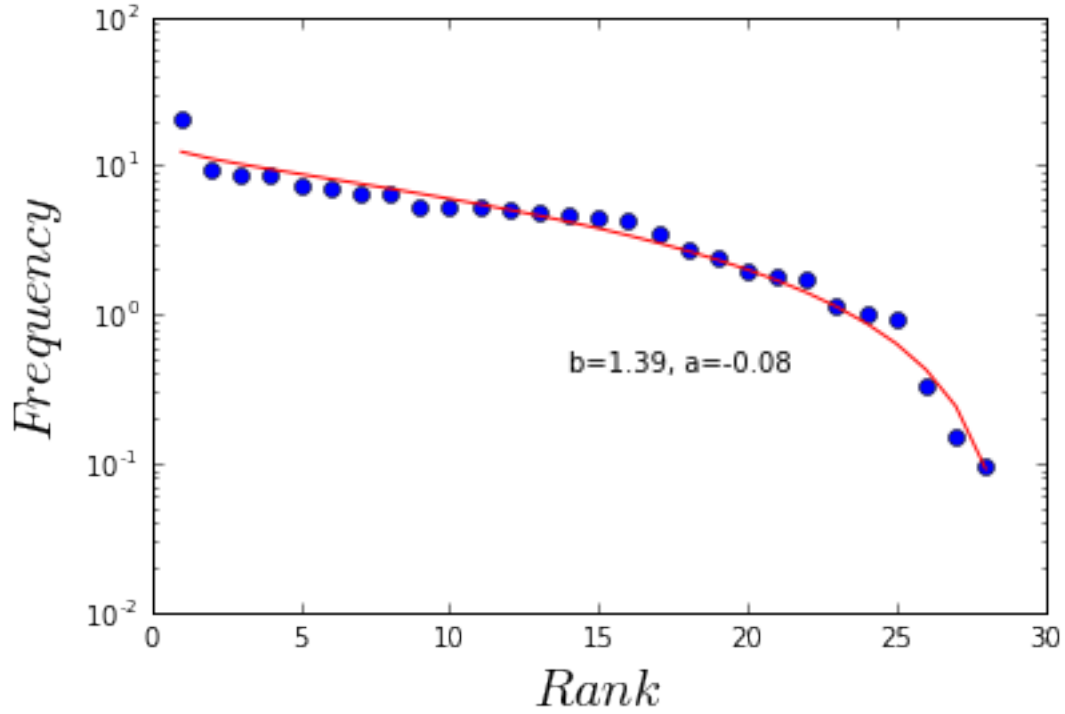
In [31]:
```
fn.alloRegressPlot(x,y,'r','s','$x$','$y$', loglog=True)
```




```
In [32]: rg = np.array([ 20.7863444 ,   9.40547933,   8.70934714,   8.62690145,
                7.16978087,   7.02575052,   6.45280959,   6.44755478,
                5.16630287,   5.16092884,   5.15618737,   5.05610068,
                4.87023561,   4.66753197,   4.41807645,   4.2635671 ,
                3.54454372,   2.7087178 ,   2.39016885,   1.9483156 ,
                1.78393238,   1.75432688,   1.12789787,   1.02098332,
                0.92653501,   0.32586582,   0.1514813 ,   0.09722761])
         fn.powerLawExponentialCutOffPlot(rg, '$x$', '$P(x)$')

Out[32]: [-0.0099301962503268171,
          -0.064764460567964449,
          -0.17705123513352666,
          0.89999847894045781]
```

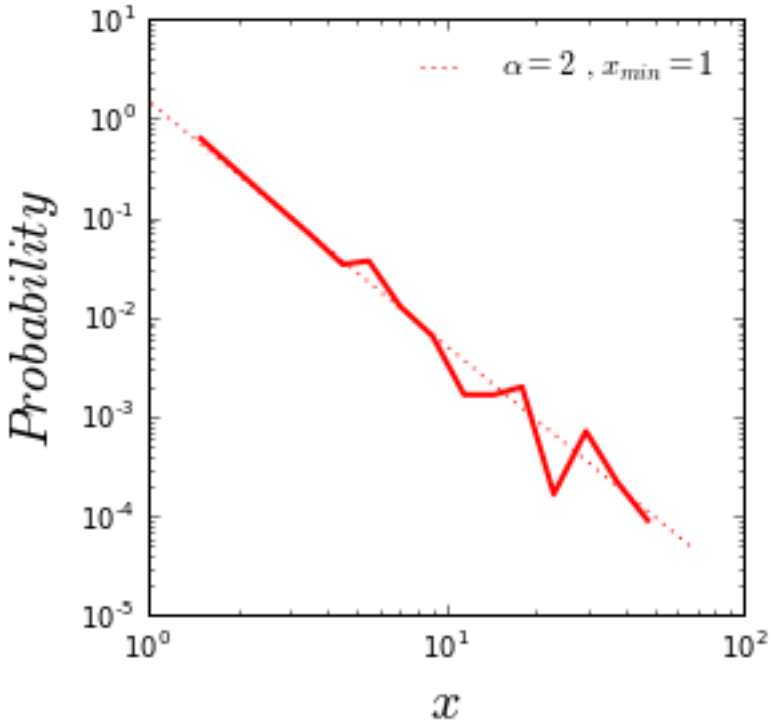


In [33]: `fn.DGBDPlot(rg)`



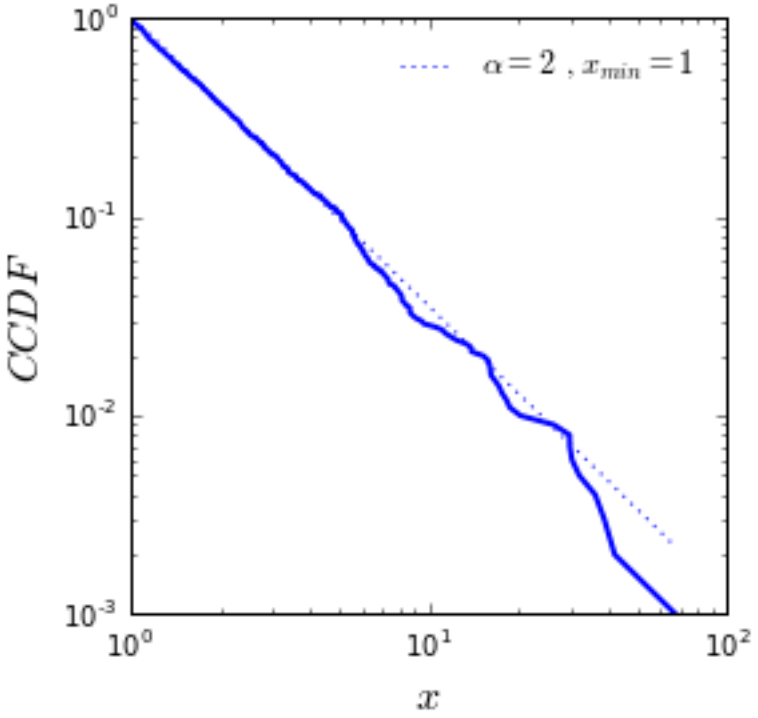
In [34]:
```
from networkx.utils import powerlaw_sequence
pl_sequence = powerlaw_sequence(1000,exponent=2.5)

fig = plt.figure(figsize=(4, 4),facecolor='white')
ax = fig.add_subplot(111)
fn.plotPowerlaw(pl_sequence,ax,'r','$x$')
```

```
Calculating best minimal value for power law fit
```

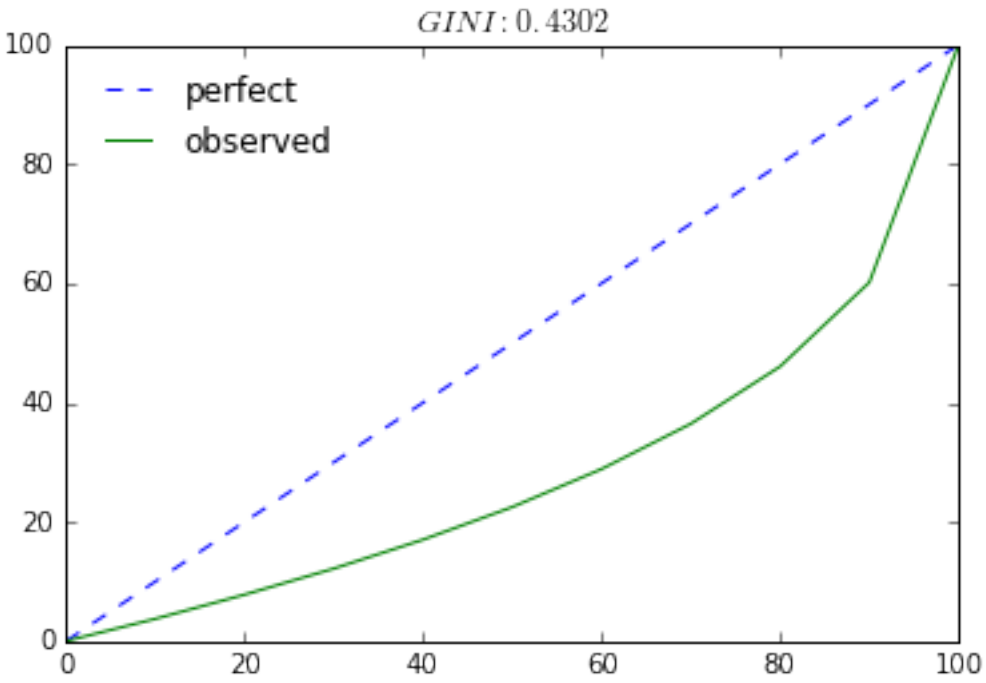


In [35]:
```
fig = plt.figure(figsize=(4, 4),facecolor='white')
ax = fig.add_subplot(111)
fn.plotCCDF(pl_sequence,ax,'b','$x$')
```

```
Calculating best minimal value for power law fit
```



In [36]:
```
bins, result, gini_val = fn.gini_coefficient(np.array(pl_sequence))

plt.plot(bins, bins, '--', label="perfect")
plt.plot(bins, result, label="observed")
plt.title("$GINI: %.4f$" %(gini_val))

plt.legend(loc = 0, frameon = False)
plt.show()
```



In [ ]: