Project - Network Properties

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0.1 1) Degree Distribution

For the graphs provided to you, test and report which graphs are scalefree, namely whose degree distribution follows a power law , at least asymptotically. That is, the fraction P(k) of nodes in the network having k connections to other nodes goes for large values of k as

$$P(k) \sim k^{(-\gamma)}$$

where is a parameter whose value is typically in the range 2 < < 3, although occasionally it may lie outside these bounds.

```
In [2]: import glob
        import pandas as pd
        import numpy as np
        from IPython.display import display, HTML

        files = glob.glob('degree-outputs/*')

        result = {
            'filename': [],
            'alpha': [],
            'scalefree': []
        }

        for f in files:
            name = f.split('/')[1]
            result['filename'].append(name)

            df = pd.read_csv(f)
            # Show DF for the random generated graphs
            if len(name.split('.')) == 2:
                print(name)
                display(df)

            count = list(df['count'])
            degree = list(df['degree'])
```

```
            total_nodes = sum(count)
            fraction = [float(c)/total_nodes for c in count]
            slope, intercept = np.polyfit(np.log(degree), np.log(fraction), 1)

            result['alpha'].append(abs(slope))
            result['scalefree'].append('True' if abs(slope) > 1 and abs(slope) < 3.5 else 'Fals

        df = pd.DataFrame(data=result)
        display(df)
```

gnm2.csv

	Unnamed: 0	degree	count
0	0	200	36
1	1	201	41
2	2	202	42
3	3	203	31
4	4	204	29
5	5	205	30
6	6	206	21
7	7	207	22
8	8	208	26
9	9	209	21
10	10	210	15
11	11	211	24
12	12	212	29
13	13	213	21
14	14	214	12
15	15	215	10
16	16	216	13
17	17	217	14
18	18	218	9
19	19	219	10
20	20	220	8
21	21	221	9
22	22	222	11
23	23	223	8
24	24	224	4
25	25	225	2
26	26	226	2
27	27	227	3
28	28	228	1
29	29	229	3
..	...	...	...
40	40	166	1
41	41	170	2
42	42	172	4

43	43	173	3
44	44	174	5
45	45	175	6
46	46	176	2
47	47	177	4
48	48	178	3
49	49	179	4
50	50	180	12
51	51	181	9
52	52	182	13
53	53	183	12
54	54	184	20
55	55	185	12
56	56	186	18
57	57	187	17
58	58	188	25
59	59	189	26
60	60	190	16
61	61	191	25
62	62	192	33
63	63	193	30
64	64	194	27
65	65	195	29
66	66	196	37
67	67	197	30
68	68	198	30
69	69	199	19

[70 rows x 3 columns]

gnm1.csv

	Unnamed: 0	degree	count
0	0	12	3
1	1	13	2
2	2	14	5
3	3	15	4
4	4	16	7
5	5	17	8
6	6	18	10
7	7	19	5
8	8	20	10
9	9	21	10
10	10	22	12
11	11	23	6
12	12	24	4

13	13	25	6
14	14	26	3
15	15	27	1
16	16	29	2
17	17	31	1
18	18	33	1

gnp2.csv

	Unnamed: 0	degree	count
0	0	6	1
1	1	7	2
2	2	8	2
3	3	9	5
4	4	10	7
5	5	11	19
6	6	12	48
7	7	13	60
8	8	14	73
9	9	15	101
10	10	16	130
11	11	17	151
12	12	18	170
13	13	19	173
14	14	20	180
15	15	21	170
16	16	22	151
17	17	23	124
18	18	24	109
19	19	25	94
20	20	26	70
21	21	27	57
22	22	28	32
23	23	29	25
24	24	30	19
25	25	31	11
26	26	32	8
27	27	33	3
28	28	34	1
29	29	35	1
30	30	36	3

gnp1.csv

	Unnamed: 0	degree	count

```
0           0       1      4
1           1       2     12
2           2       3     15
3           3       4     12
4           4       5     18
5           5       6     19
6           6       7     11
7           7       8      5
8           8       9      4
```

```
                 filename     alpha scalefree
0     dblp.graph.large.csv  2.671850      True
1     dblp.graph.small.csv  1.141093      True
2                 gnm2.csv  0.864608     False
3                 gnm1.csv  1.093619      True
4  youtube.graph.small.csv  2.604728      True
5   amazon.graph.large.csv  2.548099      True
6                 gnp2.csv  0.448687     False
7                 gnp1.csv  0.063797     False
8  youtube.graph.large.csv  1.733190      True
9   amazon.graph.small.csv  1.678353      True
```

Answer the following questions: 1. Generate a few random graphs. You can do this using networkx's random graph generators or GTGraph . Do the random graphs you tested appear to be scalefree?

filename	alpha	scalefree
gnm2.csv	0.864608	False
gnm1.csv	1.093619	True
gnp2.csv	0.448687	False
gnp1.csv	0.063797	False

2. Do the Stanford graphs provided to you appear to be scalefree?

filename	alpha	scalefree
dblp.graph.large.csv	2.671850	True
dblp.graph.small.csv	1.141093	True
youtube.graph.small.csv	2.604728	True
amazon.graph.large.csv	2.548099	True
youtube.graph.large.csv	1.733190	True
9amazon.graph.small.csv	1.678353	True

0.2 2 - Centrality

Answer the following questions about the graph:

1. Rank the nodes from highest to lowest closeness centrality.

```
In [25]: df = pd.read_csv('closeness.csv')
         df
```

```
Out[25]:    Unnamed: 0 id  closeness
         0           0  F   0.071429
         1           1  C   0.071429
         2           2  H   0.066667
         3           3  D   0.066667
         4           4  B   0.058824
         5           5  E   0.058824
         6           6  A   0.055556
         7           7  G   0.055556
         8           8  I   0.047619
         9           9  J   0.034483
```

2. Suppose we had some centralized data that would sit on one machine but would be shared with all computers on the network. Which two machines would be the best candidates to hold this data based on other machines having few hops to access this data?

   - Ans : F and C as they have the most degree of closeness amongst all other computers

0.3 3 - Articulation

Answer the following questions: 1. In this example, which members should have been targeted to best disrupt communication in the organization?

```
In [27]: df = pd.read_csv('graphframe_false.csv')
         display(df)
```

```
   Unnamed: 0                      id  articulation
0           0            Mohamed Atta             1
1           1          Usman Bandukra             1
2           2       Mamoun Darkazanli             1
3           3  Essid Sami Ben Khemais             1
4           4           Djamal Beghal             1
5           5           Nawaf Alhazmi             1
6           6             Raed Hijazi             1
```

The above members should be targetted to best disrupt the organization