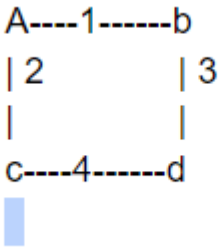
Que2 : How would redefine the notion of ‘degree’ and ‘clustering coefficient’ for a weighted network to account for the edge weights?

Taken data set is directed and weighted. So what I did is I make it undirected and if 2 differnt nodes are connected with 2 different direction then I assign both of them with same weighted edge so by this degree of all the edges are same. As weight of the edges are conscider as a degree of node which connects it. This is how degree is defined as new.

example: a , b ,c ,d are 4 nodes so, here degree of a is 1+3 that is 4 which is weight sum of addjacent edges. likwise all have degree like that.



Loaded the weighted directed graph and make it undirected by assigning same weights to bidirection of two nodes.

In [1]:
```
import pandas as pd
data = pd.read_csv('/content/que3.txt', sep=',') #data loaded
```

In [2]:
```
data.columns=["SOURCE", "TARGET", "RATING", "TIME"] #all the columns of the da
ta
```

In [3]:
```
data#here data contains negtive weights
```

Out[3]:

	SOURCE	TARGET	RATING	TIME
0	430	1	10	1376539200
1	3134	1	10	1369713600
2	3026	1	10	1350014400
3	3010	1	10	1347854400
4	804	1	10	1337572800
...	...	...	...	...
24180	7604	7601	10	1364270400
24181	7601	7604	10	1364270400
24182	7604	7602	10	1364270400
24183	7602	7604	10	1364270400
24184	7604	7603	-10	1364270400

24185 rows × 4 columns

In [4]:
```
data=data.drop(["TIME"],axis=1) #drop the time column because it is not requir
ed
```

RATING columns is the weight of the nodes

In [5]:
```
for i in range(len(data['RATING'])):
  data['RATING'][i]=abs(data['RATING'][i])
```

In [6]:
```
data
```

Out[6]:

	SOURCE	TARGET	RATING
0	430	1	10
1	3134	1	10
2	3026	1	10
3	3010	1	10
4	804	1	10
...	...	...	...
24180	7604	7601	10
24181	7601	7604	10
24182	7604	7602	10
24183	7602	7604	10
24184	7604	7603	10

24185 rows × 3 columns

In [7]:
```
df = pd.DataFrame({'SOURCE': list(data['SOURCE']),
                   'TARGET': list(data['TARGET']),
                   'RATING': list(data['RATING'])})
```

In [8]:
```
compression_opts = dict(method='zip',
                        archive_name='out.csv')
df.to_csv('que3_data.csv', index=False)
```

In [9]:
```
n=set(data['SOURCE']).union(set(data['TARGET']))
print("total number of nodes in the graph is :",len(n))
```

```
total number of nodes in the graph is : 3782
```

In [10]:
```
adjancency_matrix= [[0 for i in range(max(n)+1)] for j in range(max(n)+1)] #ad
jancency matric for the graph
```

In [11]:
```
edge_list={}
for i in range(0,max(n)+1):
  edge_list[i]=[]
for i in range(0,len(data)):#initialise the adjancecncy matrix its value will
 be the weights of the graph
  if(data["SOURCE"][i]!=data["TARGET"][i]):   # dont assign the values if ther
e is loop because we dont want any loop in graph
    adjancency_matrix[data["SOURCE"][i]][data["TARGET"][i]]=abs(data["RATING"]
[i])  #assign weights values in the graph
    adjancency_matrix[data["TARGET"][i]][data["SOURCE"][i]]=abs(data["RATING"]
[i] ) #and make the graph undirected
    edge_list[data["SOURCE"][i]].append(data["TARGET"][i])   #here make the ed
ge list assign all the adjncent nodes to here in the edge list
    edge_list[data["TARGET"][i]].append(data["SOURCE"][i])
```

In [12]:
```
weighted_degree={}  #weighted degree is calculated here
weighted_degree_sum={}  #wighted sum of all the degree is caluclated here
for i in range(len(adjancency_matrix)):
  weighted_degree[i]=[]       #initialise with empty list
  weighted_degree_sum[i]=0     #intilaise sum with zero
  for j in range(len(adjancency_matrix[i])):
    if adjancency_matrix[i][j]>0:     #conceider the nodes adjncent only if th
e adjacency matrix value id greater then 0 as all the weights are assigned as
 positive here
      weighted_degree[i].append(adjancency_matrix[i][j])
  weighted_degree_sum[i]=sum(weighted_degree[i])
```

In [13]:
```
weighted_degree_frequncy={}  #frquncy fo all the weighted degree are counted h
ere
for key,value in weighted_degree_sum.items():
  if value not in weighted_degree_frequncy.keys():
    weighted_degree_frequncy[value]=0
    weighted_degree_frequncy[value]+=1
  else:
    weighted_degree_frequncy[value]+=1
# weighted_degree_frequncy
```

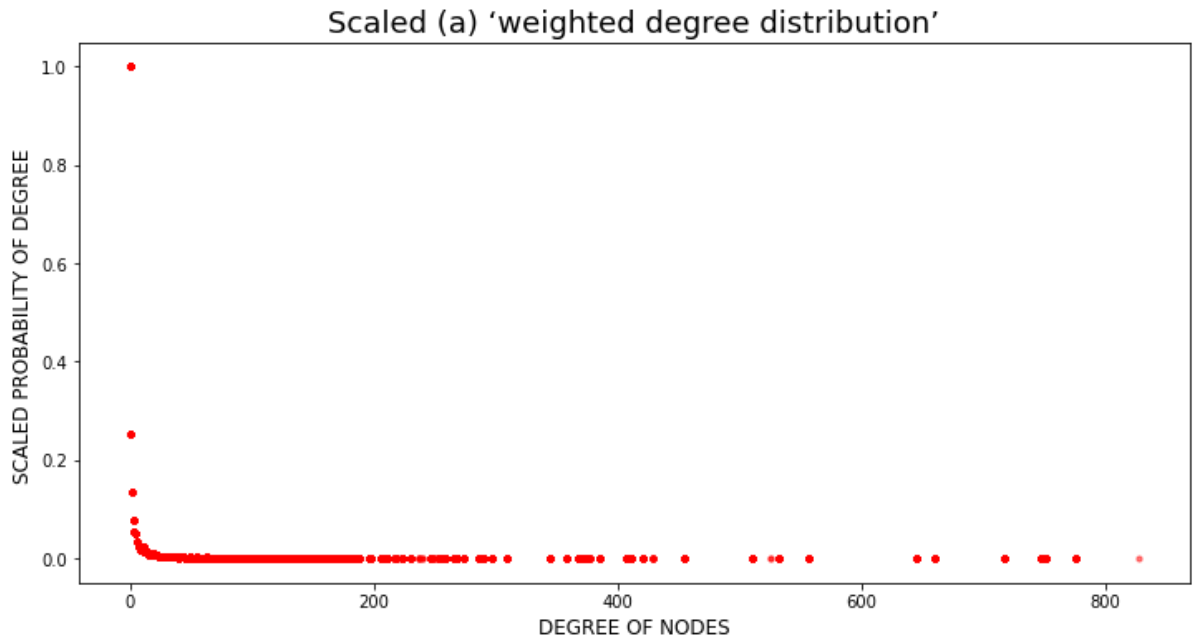
In [22]:
```
kmax=max(list(weighted_degree_frequncy.values()))#max degree of weighted frequ
ncy
```

(a) ‘weighted degree distribution’

In [23]:
```
import matplotlib.pyplot as plt
import numpy as np
fg, ax = plt.subplots(figsize =(12, 6))
x_axis=[]
y_axis=[]

for key,value in  weighted_degree_frequncy.items():
    x_axis.append(key)
    y_axis.append(value/kmax)
    ax.scatter(x_axis,y_axis,s=np.pi*3.2,c=("red"), alpha=0.5)

plt.xlabel("DEGREE OF NODES", fontsize=12)
plt.ylabel("SCALED PROBABILITY OF DEGREE ", fontsize=12)
plt.title("Scaled (a) ‘weighted degree distribution’",fontsize=18)
plt.show()
```

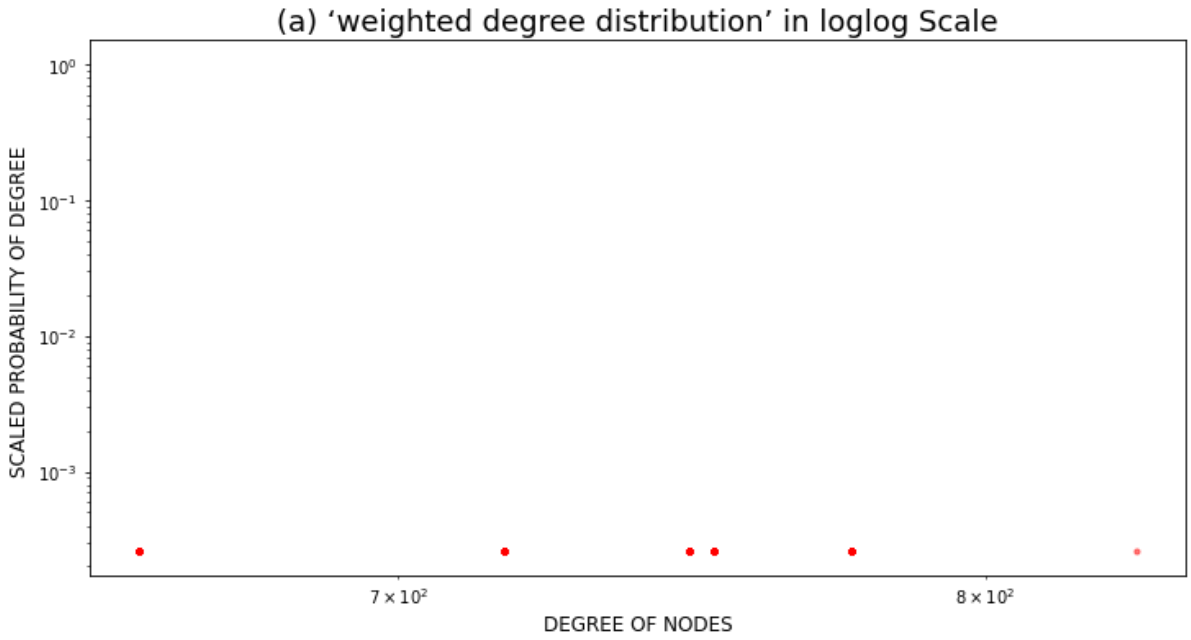


In [24]:
```
  #Loglog Scaled Degree Distribution

import matplotlib.pyplot as plt
import numpy as np
fg, ax = plt.subplots(figsize =(12, 6))
x_axis=[]
y_axis=[]
for key,value in  weighted_degree_frequncy.items():
  x_axis.append(key)
  y_axis.append((value/kmax))
  ax.scatter(x_axis,y_axis,s=np.pi*3.2,c=("red"), alpha=0.5)
  plt.yscale('log')
  plt.xscale('log')

plt.xlabel("DEGREE OF NODES", fontsize=12)
plt.ylabel("SCALED PROBABILITY OF DEGREE ", fontsize=12)
plt.title("(a) 'weighted degree distribution' in loglog Scale",fontsize=18)
plt.show()
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:14: UserWarning:
Data has no positive values, and therefore cannot be log-scaled.
```



(b)cluster coefficient values:

It is defined as new fomula where li is the total sum of weight of edges of all nodes which are adjcent to node i and connected to one another, and weighted_degree_sum(i) is the weighted sum of all the connected edges of node i:

cluster_coefficient[i]=(2*li)/(weighted_degree_sum[i]*(weighted_degree_sum[i]-1))

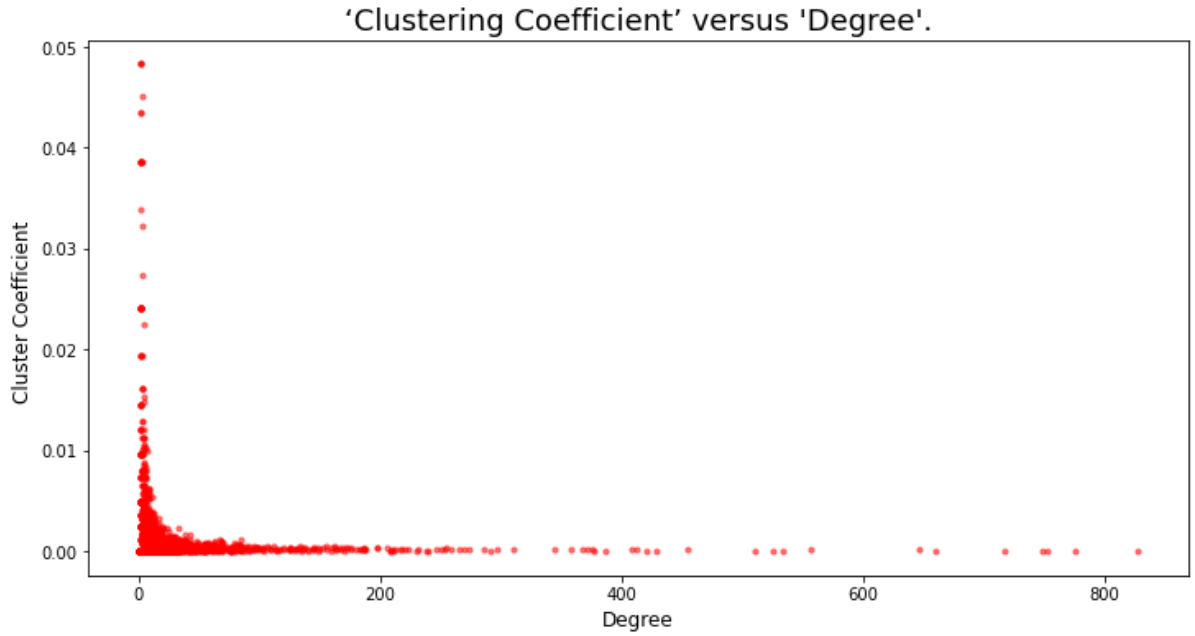
In [17]:
```
cluster_coefficient={} #cluster coefficent is taken out for each nodes of the
 graph
for i in range(0,len(adjancency_matrix)):
  li=0
  for j in range(0,len(edge_list[i])):
    for k in range(j+1,len(edge_list[i])):
        li+=adjancency_matrix[edge_list[i][j]][edge_list[i][k]]
  if li!=0:
    cluster_coefficient[i]=(2*li)/(weighted_degree_sum[i]*(weighted_degree_sum
[i]-1))
  else:
    cluster_coefficient[i]=0
```

In [18]:
```
cluster_coefficient = dict(sorted(cluster_coefficient.items(), key=lambda x: x
[0]))
weighted_degree_sum= dict(sorted(weighted_degree_sum.items(), key=lambda x: x[
0]))
```

following is the scalled graph

In [25]:
```
import matplotlib.pyplot as plt
import numpy as np
fg, ax = plt.subplots(figsize =(12, 6))
x_axis=list(weighted_degree_sum.values())
y_axis=list(cluster_coefficient.values())
for i in range(0,len(x_axis)):
  y_axis[i]=y_axis[i]/max(list(weighted_degree_sum.values()))
ax.scatter(x_axis,y_axis,s=np.pi*3.2,c=("red"), alpha=0.5)

plt.xlabel("Degree", fontsize=12)
plt.ylabel("Cluster Coefficient ", fontsize=12)
plt.title("‘Clustering Coefficient’ versus 'Degree'.",fontsize=18)
plt.show()
```



In [19]: