CUNY MSDS DATA620 - Web Analytics

Week 3 - Part 2 | Network Analysis - Davis Southern Club Women

Team1 : Ramnivas Singh, Deepak Sharma, Tage Singh

Description

Davis Southern Club Women dataset is used ths assignment for 2-node network analysis. These data were collected by Davis et al in the 1930s. They represent observed attendance at 14 social events by 18 Southern women. The result is a person-by-event matrix: cell (i,j) is 1 if person i attended social event j, and 0 otherwise.

1.Brief Description: http://vlado.fmf.uni-lj.si/pub/networks/data/ucinet/ucidata.htm#davis. [For more background information, see also:http://rpackages.ianhowson.com/cran/latentnet/man/davis.html]. Small "musty" datasets like that from this 1941 study have proven very valuable in testing and comparing new network algorithms.

2.Dataset: http://vlado.fmf.uni-lj.si/pub/networks/data/Ucinet/davis.dat

3.Python code to create dataset: https://networkx.readthedocs.io/en/stable/examples/algorithms/davis_club.html

In [1]:
```
import pandas as pd
import networkx as nx
import matplotlib.pyplot as plt
import math
import scipy as sp
from prettytable import PrettyTable
import networkx.algorithms.bipartite as bipartite
```

Load graph object of davis southern women data set.

In [2]:
```
G = nx.davis_southern_women_graph() # Returns Davis Southern women social network.
print(nx.info(G))
```

```
Name:
Type: Graph
Number of nodes: 32
Number of edges: 89
Average degree:   5.5625
```

In [3]:
```
print(bipartite.is_bipartite(G))
```

```
True
```

Create two separate nodes from this data sets a. Women,who attended the events b. Events, attended by the women

In [4]:
```
# Separates the two sets of nodes into 'women' and the other 'clubs'
women = G.graph['top']
clubs = G.graph['bottom']
```

In [5]:
```
print(len(women))
print(women)
```

```
18
['Evelyn Jefferson', 'Laura Mandeville', 'Theresa Anderson', 'Brenda Rogers', 'Charlotte McDowd', 'Frances Anderson', 'El
eanor Nye', 'Pearl Oglethorpe', 'Ruth DeSand', 'Verne Sanderson', 'Myra Liddel', 'Katherina Rogers', 'Sylvia Avondale',
'Nora Fayette', 'Helen Lloyd', 'Dorothy Murchison', 'Olivia Carleton', 'Flora Price']
```

In [6]:
```
print(len(clubs))
print(clubs)
```

```
14
['E1', 'E2', 'E3', 'E4', 'E5', 'E6', 'E7', 'E8', 'E9', 'E10', 'E11', 'E12', 'E13', 'E14']
```

Generate adjacency list format from graph G

In [7]:
```
for line in nx.generate_adjlist(G):
    print(line)
```

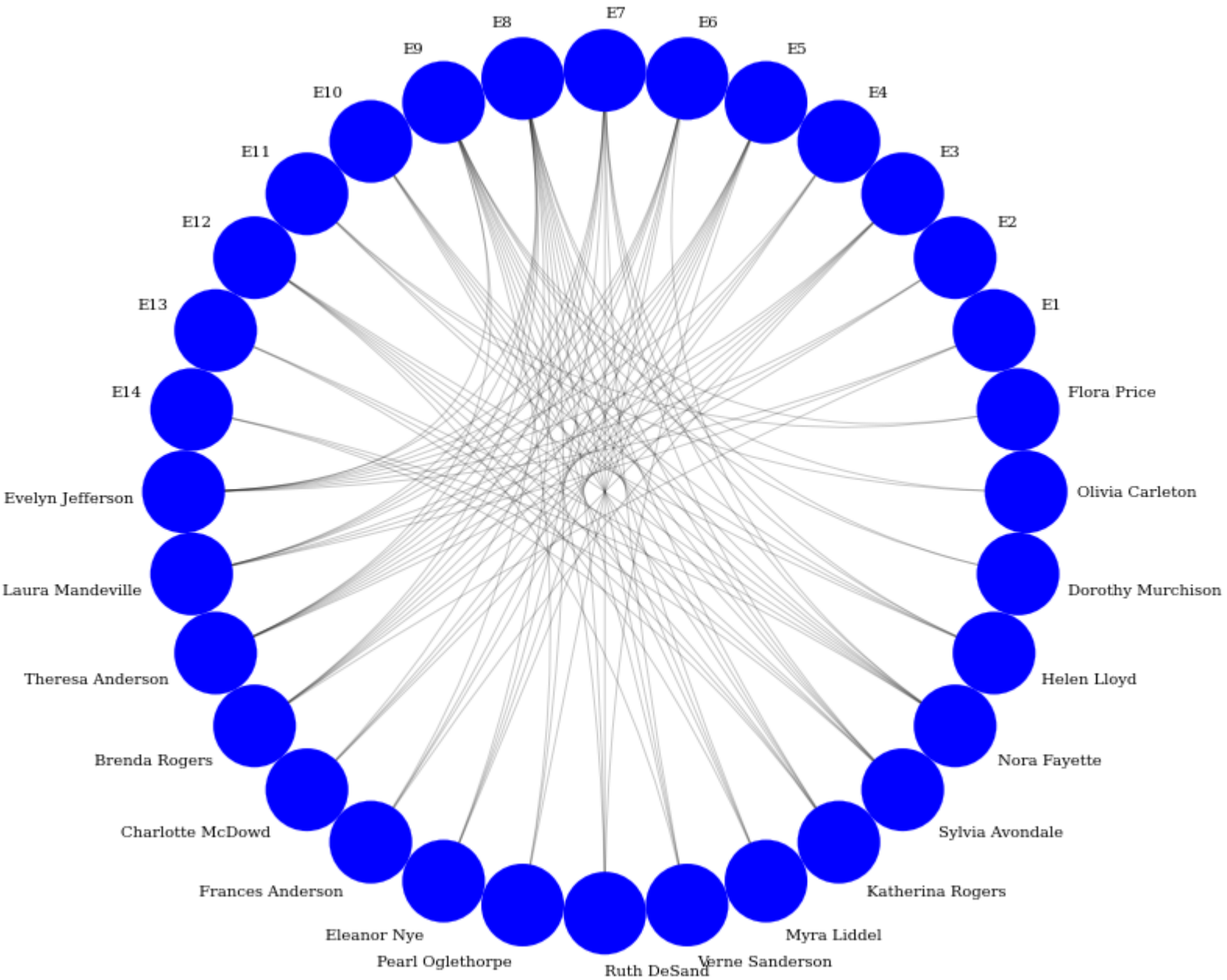
```
Evelyn Jefferson E1 E2 E3 E4 E5 E6 E8 E9
Laura Mandeville E1 E2 E3 E5 E6 E7 E8
Theresa Anderson E2 E3 E4 E5 E6 E7 E8 E9
Brenda Rogers E1 E3 E4 E5 E6 E7 E8
Charlotte McDowd E3 E4 E5 E7
Frances Anderson E3 E5 E6 E8
Eleanor Nye E5 E6 E7 E8
Pearl Oglethorpe E6 E8 E9
```

```
Ruth DeSand E5 E7 E8 E9
Verne Sanderson E7 E8 E9 E12
Myra Liddel E8 E9 E10 E12
Katherina Rogers E8 E9 E10 E12 E13 E14
Sylvia Avondale E7 E8 E9 E10 E12 E13 E14
Nora Fayette E6 E7 E9 E10 E11 E12 E13 E14
Helen Lloyd E7 E8 E10 E11 E12
Dorothy Murchison E8 E9
Olivia Carleton E9 E11
Flora Price E9 E11
E1
E2
E3
E4
E5
E6
E7
E8
E9
E10
E11
E12
E13
E14
```

Draw aplot to show network relation between each node. Women and events are considered as separate nodes and used together in this plot.

In [8]:

```
from nxviz.plots import CircosPlot
c = CircosPlot(G, figsize=(12, 12),node_labels=True)
c.draw()
```



Create a bipartite projected graph onto women nodes

In [9]:
```
# Bipartite graph onto women nodes
```

```
W = bipartite.projected_graph(G, women)
print('')
print("#Friends, Member")
for w in women:
    print('%d %s' % (W.degree(w),w))
```

```
#Friends, Member
17 Evelyn Jefferson
15 Laura Mandeville
17 Theresa Anderson
15 Brenda Rogers
11 Charlotte McDowd
15 Frances Anderson
15 Eleanor Nye
16 Pearl Oglethorpe
17 Ruth DeSand
17 Verne Sanderson
16 Myra Liddel
16 Katherina Rogers
17 Sylvia Avondale
17 Nora Fayette
17 Helen Lloyd
16 Dorothy Murchison
12 Olivia Carleton
12 Flora Price
```

Project bipartite graph onto women nodes keeping number of co-occurence. The degree computed is weighted and counts the total number of shared contacts

In [10]:

```
W = bipartite.weighted_projected_graph(G, women)
print('')
print("#Friend meetings, Member")
for w in women:
    print('%d %s' % (W.degree(w,weight='weight'),w))
```

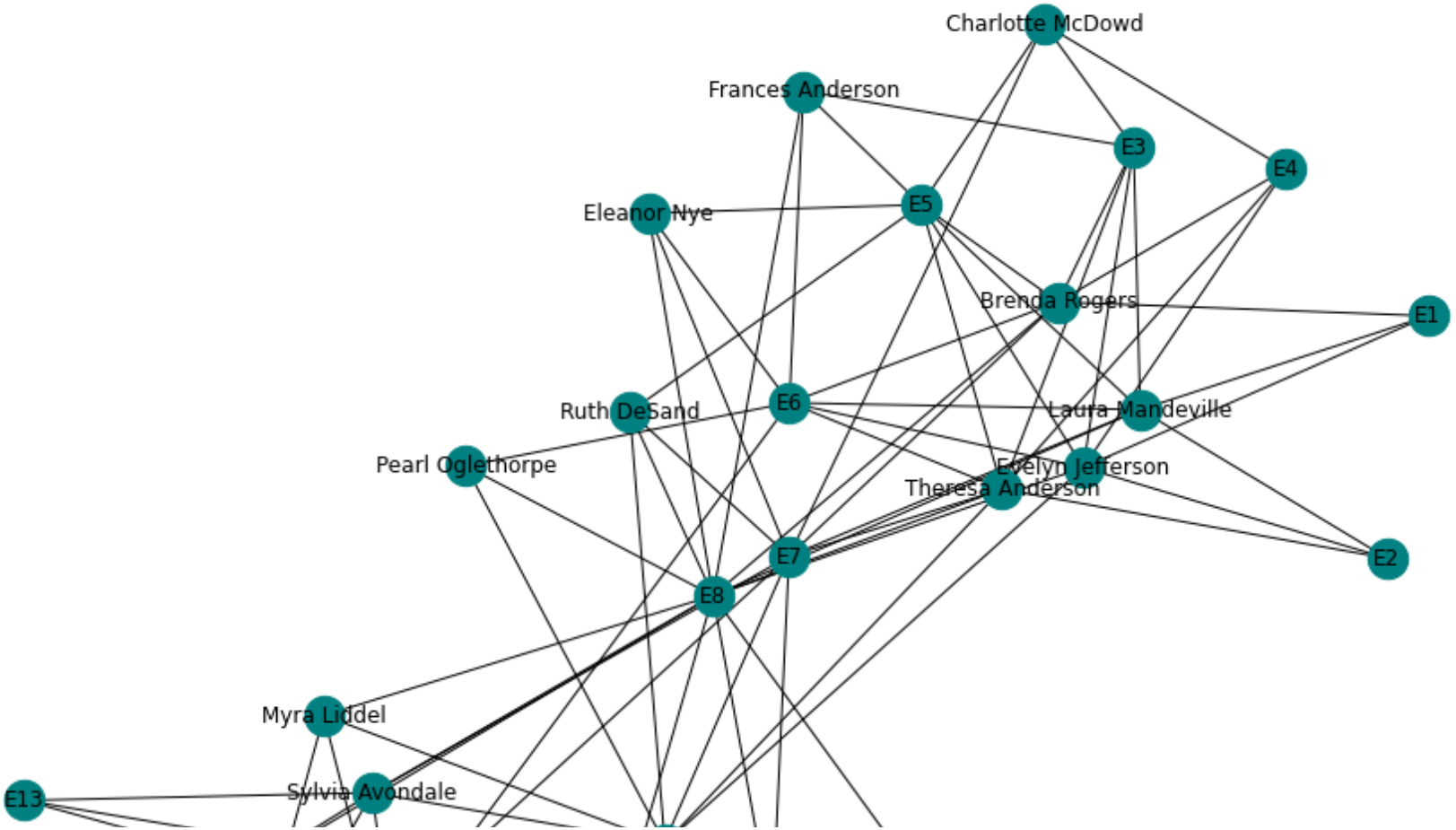
```
#Friend meetings, Member
50 Evelyn Jefferson
45 Laura Mandeville
57 Theresa Anderson
46 Brenda Rogers
24 Charlotte McDowd
32 Frances Anderson
36 Eleanor Nye
31 Pearl Oglethorpe
40 Ruth DeSand
38 Verne Sanderson
33 Myra Liddel
```

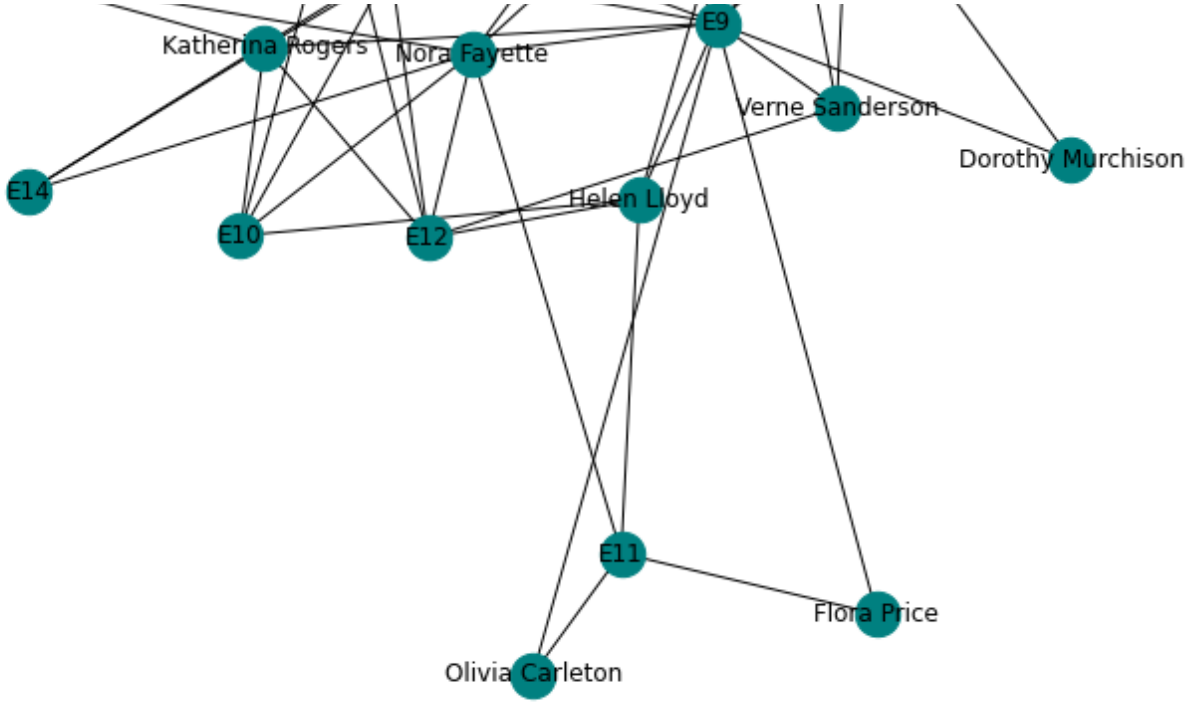
```
37 Katherina Rogers
46 Sylvia Avondale
43 Nora Fayette
34 Helen Lloyd
24 Dorothy Murchison
14 Olivia Carleton
14 Flora Price
```

Draw the bipartite graph of women and clubs nodes. This graph shows, how many social events (clubs) are attended by an indiviual women. Also this graph shows how many women attended a perticullr social event

In [11]:

```
plt.figure(3,figsize=(12,12))
nx.draw(G, pos=nx.fruchterman_reingold_layout(G), node_color='teal', with_labels=True, node_size = 500)
plt.show()
```





Generate weighted projection of G onto one of its node sets for social events.

In [12]:
```
clubs_wt_proj_graph = bipartite.weighted_projected_graph(G, clubs)
print(nx.info(clubs_wt_proj_graph))
```

```
Name:
Type: Graph
Number of nodes: 14
Number of edges: 66
Average degree:   9.4286
```

Compute the clustering coefficient for social event nodes.

In [13]:
```
clubs_cluster= pd.DataFrame(zip(nx.clustering(clubs_wt_proj_graph).keys(),
                                nx.clustering(clubs_wt_proj_graph).values())).sort_values(by = [1],
                                                                                          axis=0,ascending=True)
# Print Club Cluster
print(clubs_cluster)
```

```
    0         1
```

```
5    E6  0.679487
6    E7  0.679487
7    E8  0.679487
8    E9  0.679487
0    E1  1.000000
1    E2  1.000000
2    E3  1.000000
3    E4  1.000000
4    E5  1.000000
9   E10  1.000000
10  E11  1.000000
11  E12  1.000000
12  E13  1.000000
13  E14  1.000000
```

Generate weighted projection of G onto one of its node sets for women who attended the events.

In [14]:
```
women_wt_proj_graph  = bipartite.weighted_projected_graph(G, women)
print(nx.info(women_wt_proj_graph))
```

```
Name:
Type: Graph
Number of nodes: 18
Number of edges: 139
Average degree:  15.4444
```

Compute the clustering coefficient for women nodes.

In [15]:
```
women_cluster = pd.DataFrame(zip(nx.clustering(women_wt_proj_graph).keys(),
                                 nx.clustering(women_wt_proj_graph).values())).sort_values(by = [1],
                                                                                           axis=0, ascending=False)

# Print Women Cluster
print(women_cluster)
```

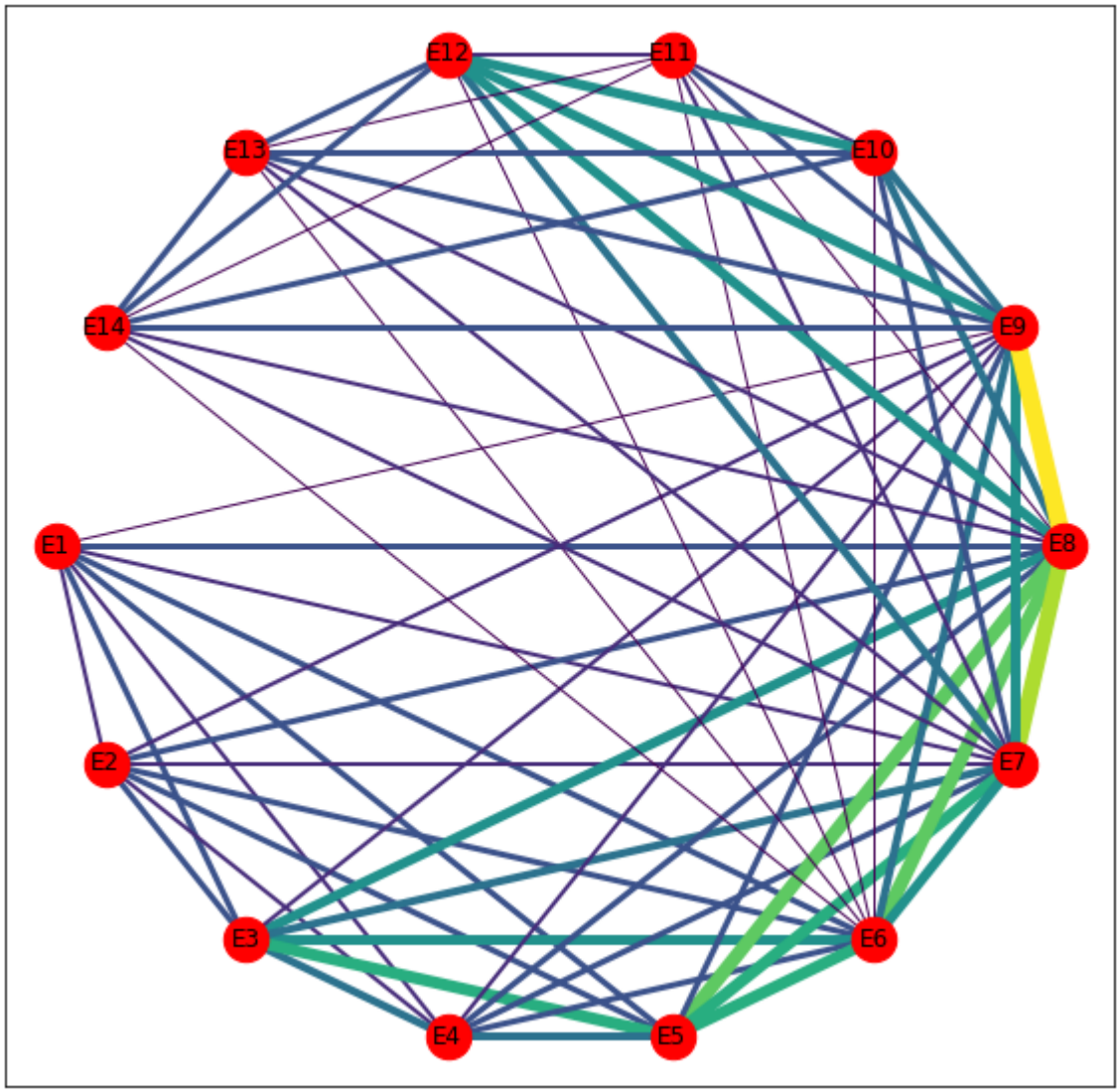
```
                   0         1
17       Flora Price  1.000000
16    Olivia Carleton  1.000000
4    Charlotte McDowd  1.000000
3       Brenda Rogers  0.961905
5    Frances Anderson  0.961905
6         Eleanor Nye  0.961905
1    Laura Mandeville  0.961905
7    Pearl Oglethorpe  0.933333
15  Dorothy Murchison  0.933333
10        Myra Liddel  0.933333
11   Katherina Rogers  0.933333
13       Nora Fayette  0.897059
```

```
14        Helen Lloyd  0.897059
0    Evelyn Jefferson  0.897059
12    Sylvia Avondale  0.897059
8         Ruth DeSand  0.897059
2    Theresa Anderson  0.897059
9     Verne Sanderson  0.897059
```

Draw the weighted projected network graph of club nodes.

In [16]:

```
plt.figure(figsize=(10,10))
club_network = bipartite.weighted_projected_graph(G, clubs, ratio=False)
weights = [edata['weight'] for f,t,edata in club_network.edges(data=True)]
clubplot = nx.draw_networkx(club_network,pos=nx.shell_layout(club_network),
                            width=weights, node_color ='red',edge_color=weights, node_size=500)
```



Generate project bipartite graph onto women nodes

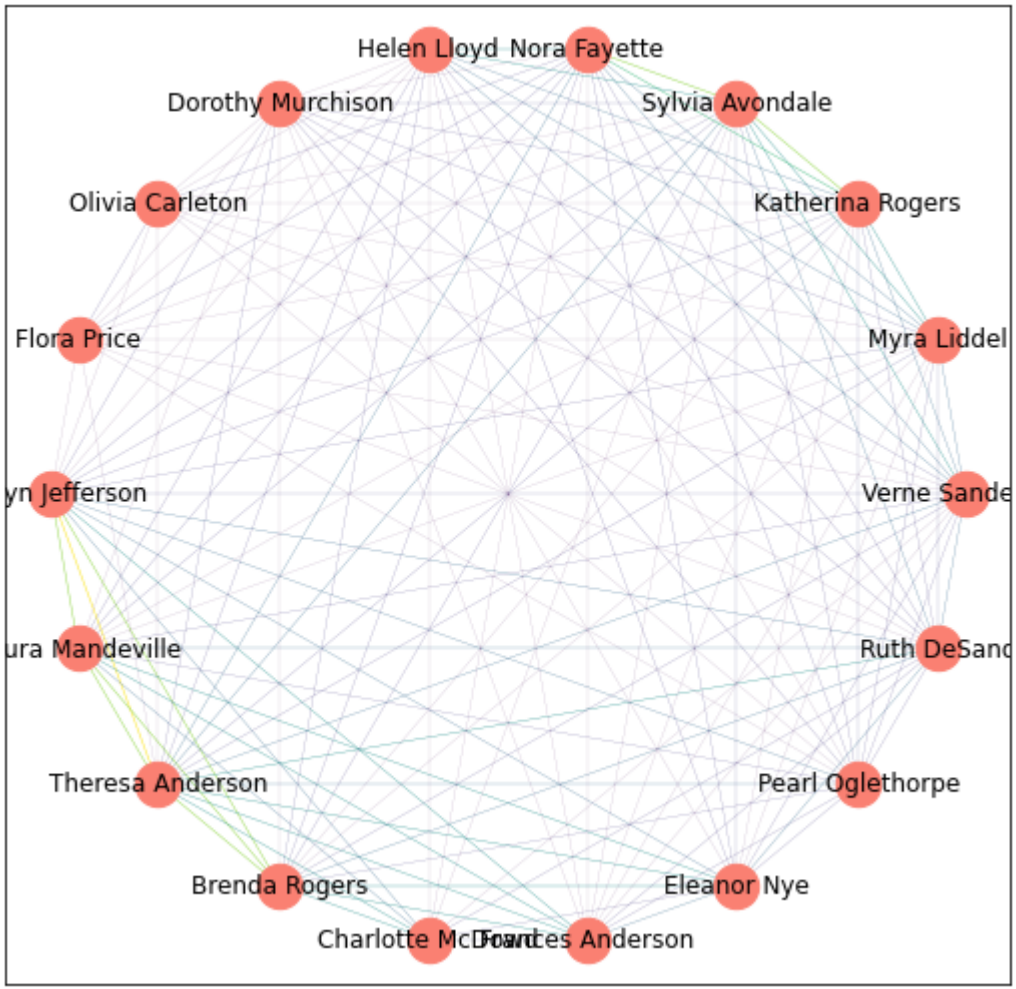
In [17]:
```
women_projected_graph = bipartite.projected_graph(G, women)
women_cluster  = pd.DataFrame(list(women_projected_graph.degree()),
                              columns=["Member","#Friends"]).sort_values('#Friends', ascending=False)
print(women_cluster)
```

```
              Member  #Friends
0    Evelyn Jefferson        17
```

8	Ruth DeSand	17
14	Helen Lloyd	17
13	Nora Fayette	17
12	Sylvia Avondale	17
9	Verne Sanderson	17
2	Theresa Anderson	17
7	Pearl Oglethorpe	16
10	Myra Liddel	16
11	Katherina Rogers	16
15	Dorothy Murchison	16
6	Eleanor Nye	15
5	Frances Anderson	15
1	Laura Mandeville	15
3	Brenda Rogers	15
16	Olivia Carleton	12
17	Flora Price	12
4	Charlotte McDowd	11

Draw weighted projected network graph of women nodes.

In [18]:
```
plt.figure(figsize=(9,9))
women_network = bipartite.weighted_projected_graph(G, women, ratio=True)
weights = [edata['weight'] for f,t,edata in women_network.edges(data=True)]
women_plot = nx.draw_networkx(women_network,pos=nx.shell_layout(women_network),
                              width=weights, node_color ='salmon',edge_color=weights, node_size=500)
```



Function to search each node in the graph for a given width

In [19]:
```
def progressive_widening_search(G, source, value, condition, initial_width=1):
    if condition(source):
        return source
    log_m = math.ceil(math.log2(len(G)))
    for i in range(log_m):
        width = initial_width * pow(2, i)
        for u, v in nx.bfs_beam_edges(G, source, value, width):
            if condition(v):
                return v
    raise nx.NodeNotFound("no node satisfied the termination condition")
```

Lets generate Centrality for Graph G

In [20]:

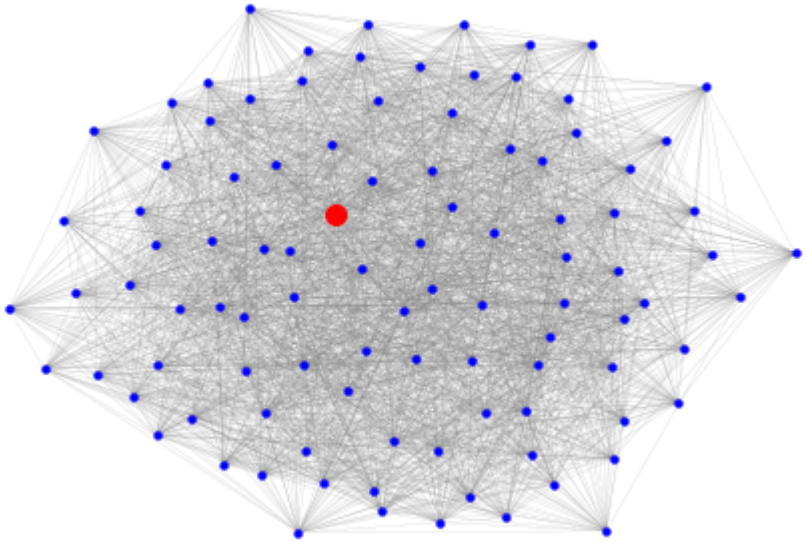
```
G = nx.gnp_random_graph(100, 0.5)
centrality = nx.eigenvector_centrality(G)
avg_centrality = sum(centrality.values()) / len(G)

def has_high_centrality(v):
    return centrality[v] >= avg_centrality
source = 0
value = centrality.get
condition = has_high_centrality

found_node = progressive_widening_search(G, source, value, condition)
c = centrality[found_node]
print(f"Found node {found_node} with centrality {c}")

# Draw graph
pos = nx.spring_layout(G)
options = {
    "node_color": "blue",
    "node_size": 20,
    "edge_color": "grey",
    "linewidths": 0,
    "width": 0.1,
}
nx.draw(G, pos, **options)
# Draw node with high centrality as large and red
nx.draw_networkx_nodes(G, pos, nodelist=[found_node], node_size=100, node_color="r")
plt.show()
```

```
Found node 66 with centrality 0.12664400266150413
```

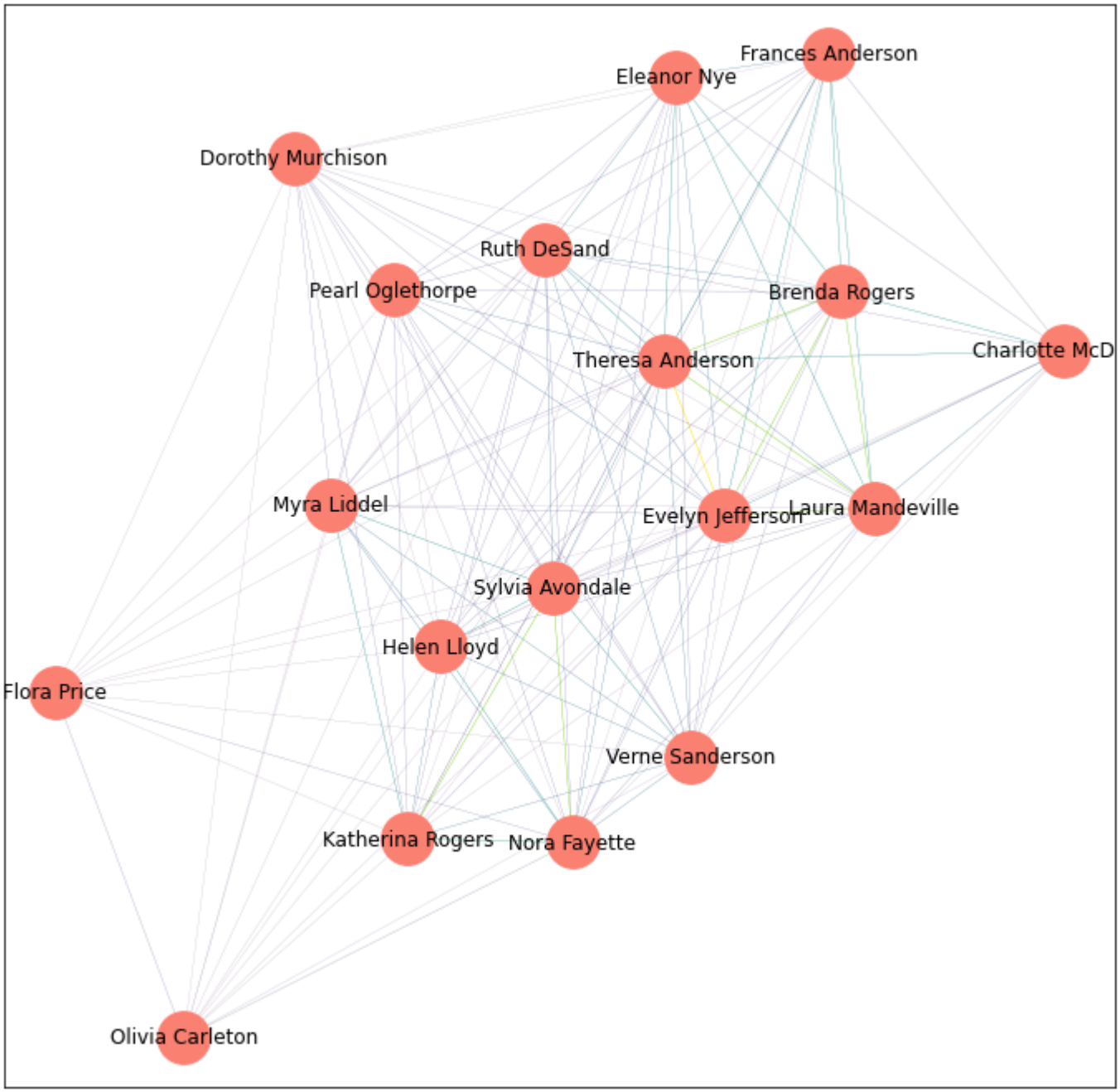


Function to generate the table for a given graph (women nodes or club nodes). This table displays Degree, Degree Centrality, Betweenness, Closeness, Eigenvector for provided grap objects

In [21]:
```
def PrintTable(graph):
    degree = nx.degree(graph)
    degree_centrality = nx.degree_centrality(graph)
    betweenness_centrality = nx.betweenness_centrality(graph)
    closeness_centrality = nx.closeness_centrality(graph)
    eigenvector_centrality = nx.eigenvector_centrality_numpy(graph)
    table = [[name,degree[name], round(degree_centrality[name],3), round(betweenness_centrality[name],3),
              round(closeness_centrality[name],3), round(eigenvector_centrality[name],3)] for name in graph.nodes()]
    table = sorted(table,key = lambda x: -x[2])
    printTable = PrettyTable(['Subject','Degree','Degree Centrality','Betweenness','Closeness','Eigenvector'])
    for i in range(0, len(table)):
        printTable.add_row(table[i])
    return printTable
```

Draw a weighted projected network graph of women nodes along with the weight as weighted factor

In [22]:
```
weights = [edata['weight'] for f,t,edata in women_network.edges(data=True)]
plt.figure(figsize = (12,12))
nx.draw_networkx(women_network, width=weights, node_color ='salmon',edge_color=weights, node_size=1000)
```



Create table with degree, degree centrality, closeness centrality, betweenness centrality and eigenvecture centrality for women nodes

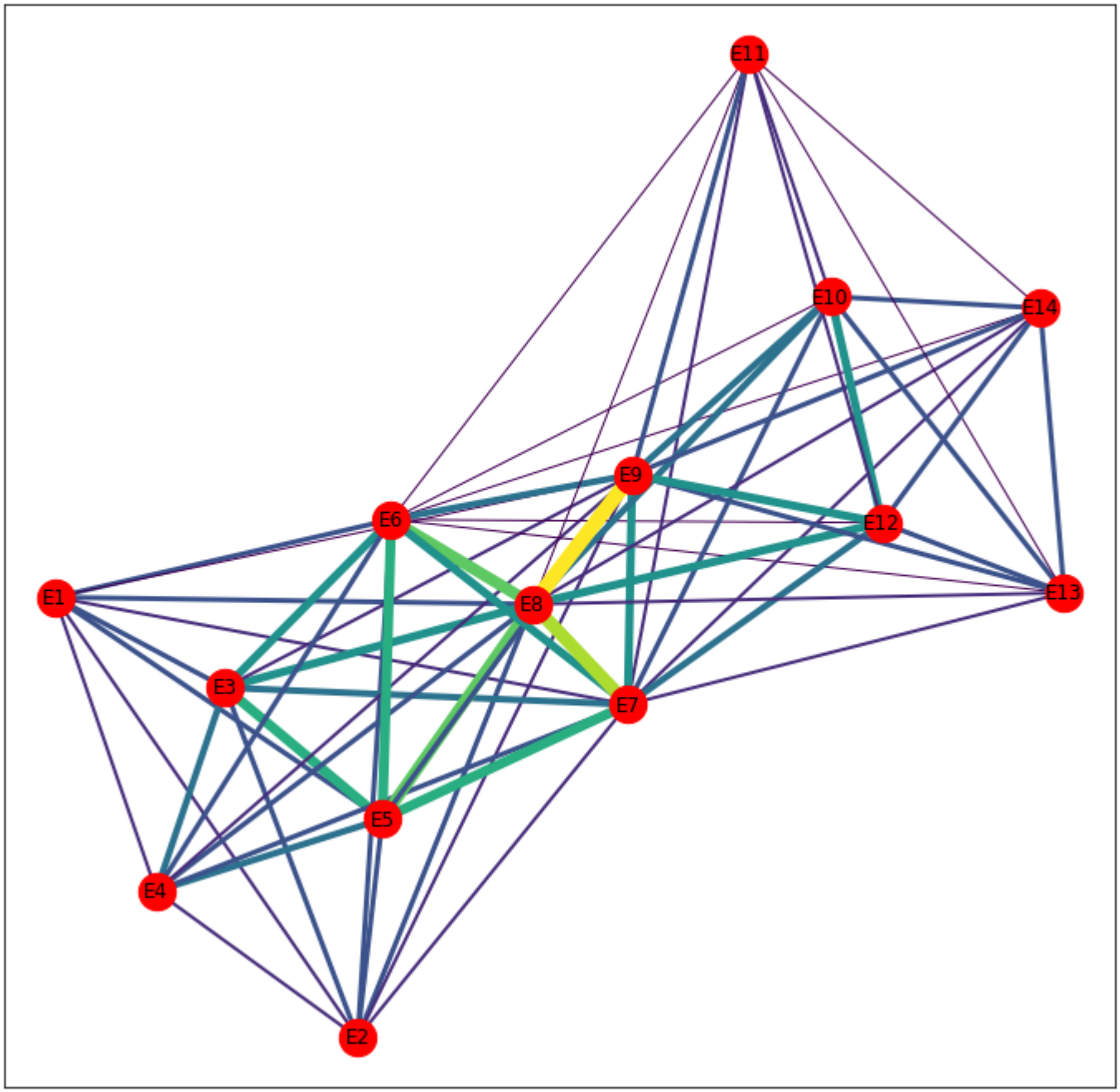
In [23]:
```
print((PrintTable(women_wt_proj_graph)))
```

Subject	Degree	Degree Centrality	Betweenness	Closeness	Eigenvector
Evelyn Jefferson	17	1.0	0.01	1.0	0.254
Theresa Anderson	17	1.0	0.01	1.0	0.254
Ruth DeSand	17	1.0	0.01	1.0	0.254
Verne Sanderson	17	1.0	0.01	1.0	0.254
Sylvia Avondale	17	1.0	0.01	1.0	0.254
Nora Fayette	17	1.0	0.01	1.0	0.254
Helen Lloyd	17	1.0	0.01	1.0	0.254
Pearl Oglethorpe	16	0.941	0.005	0.944	0.243
Myra Liddel	16	0.941	0.005	0.944	0.243
Katherina Rogers	16	0.941	0.005	0.944	0.243
Dorothy Murchison	16	0.941	0.005	0.944	0.243
Laura Mandeville	15	0.882	0.003	0.895	0.231
Brenda Rogers	15	0.882	0.003	0.895	0.231
Frances Anderson	15	0.882	0.003	0.895	0.231
Eleanor Nye	15	0.882	0.003	0.895	0.231
Olivia Carleton	12	0.706	0.0	0.773	0.188
Flora Price	12	0.706	0.0	0.773	0.188
Charlotte McDowd	11	0.647	0.0	0.739	0.173

Draw a weighted projected network graph of social event nodes along with the weight as weighted factor

In [24]:

```
weights = [edata['weight'] for f,t,edata in club_network.edges(data=True)]
plt.figure(figsize = (12,12))
nx.draw_networkx(club_network, width=weights, node_color ='red',edge_color=weights, node_size=500)
```



Create table with degree, degree centrality, closeness centrality, betweenness centrality and eigenvecture centrality for social event nodes

In [25]:
```
print((PrintTable(clubs_wt_proj_graph)))
```

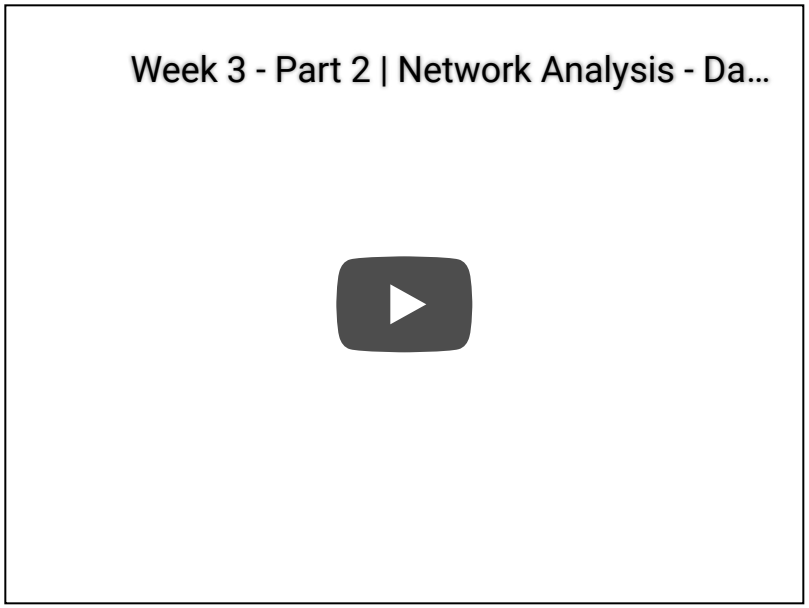
Subject	Degree	Degree Centrality	Betweenness	Closeness	Eigenvector
E6	13	1.0	0.08	1.0	0.339
E7	13	1.0	0.08	1.0	0.339
E8	13	1.0	0.08	1.0	0.339
E9	13	1.0	0.08	1.0	0.339
E1	8	0.615	0.0	0.722	0.232
E2	8	0.615	0.0	0.722	0.232
E3	8	0.615	0.0	0.722	0.232
E4	8	0.615	0.0	0.722	0.232
E5	8	0.615	0.0	0.722	0.232
E10	8	0.615	0.0	0.722	0.232
E11	8	0.615	0.0	0.722	0.232
E12	8	0.615	0.0	0.722	0.232
E13	8	0.615	0.0	0.722	0.232
E14	8	0.615	0.0	0.722	0.232

Conclusions

By looking at the adjancency matrix, we found various patterns. looking at each member and how many friends they have versus how many meetings they attend that have friends. Events E7, E8, E9 have very large attendance when compared to the others. There's a few strong sub networks between (Laura, Brenda, Theresa, Evelyn) and (Sylvia, Helen, Katherine, Nora). We found this graph a well connected closed network with high degree of variation on social events and women nodes.

In [26]:
```
from IPython.display import YouTubeVideo
YouTubeVideo('h9mojGTCpGI')
```

Out[26]:



References

Breiger R. (1974). The duality of persons and groups. Social Forces, 53, 181-190.

Davis, A et al. (1941). Deep South. Chicago: University of Chicago Pre

Robert A. Hanneman (Department of Sociology, University of California, Riverside) Social network data