In [1]:
```
import networkx as nx
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import operator
```

Reading the dataset

In [2]:
```
actor_edges = pd.read_csv('actor_edges2.csv')
actors_key = pd.read_csv('actors_key.csv')
```

Creating the network using the edge list

Since each edge is the link between every pairs of actors, the network is undirected

In [3]:
```
G = nx.from_pandas_edgelist(actor_edges, 'from', 'to', 'weight', create_using = nx.Graph
```

Question a

Betweenness Centrality

In [4]:
```
d = dict(nx.betweenness_centrality(G, weight = 'weight'))
between_centrality_ranked = sorted(d.items(), key = operator.itemgetter(1), reverse = Tr
for i in range(5):
    print("Actor with the top {} betweeness centrality is actor {}, with the correspondin
```

```
Actor with the top 0 betweeness centrality is actor 4, with the corresponding betweenness
centrality equal to 0.08.
Actor with the top 1 betweeness centrality is actor 47, with the corresponding betweennes
s centrality equal to 0.07.
Actor with the top 2 betweeness centrality is actor 27, with the corresponding betweennes
s centrality equal to 0.07.
Actor with the top 3 betweeness centrality is actor 10, with the corresponding betweennes
s centrality equal to 0.06.
Actor with the top 4 betweeness centrality is actor 13, with the corresponding betweennes
s centrality equal to 0.05.
```

Closeness Centrality

In [21]:
```
d = dict(nx.closeness_centrality(G))
closeness_centrality_ranked = sorted(d.items(), key = operator.itemgetter(1), reverse = 
for i in range(5):
    print("Actor with the top {} closeness centrality is actor {}, with the corresponding
```

```
Actor with the top 0 closeness centrality is actor 28, with the corresponding closeness c
entrality equal to 0.67.
Actor with the top 1 closeness centrality is actor 4, with the corresponding closeness ce
ntrality equal to 0.67.
Actor with the top 2 closeness centrality is actor 1, with the corresponding closeness ce
ntrality equal to 0.65.
Actor with the top 3 closeness centrality is actor 5, with the corresponding closeness ce
ntrality equal to 0.65.
Actor with the top 4 closeness centrality is actor 27, with the corresponding closeness c
entrality equal to 0.65.
```

The 5 actors with the largest betweenness centrality does not necessarily have to be the same as the 5 actors with the largest closeness centrality.

While both the criteria analyze the centrality of the network, the actor with the highest betweeness centrality is someone who is on the shortest path linking other actors, and the actor with the highest closeness centrality is someone who directly collaborates with other actors.

For example, we could assume three actors, A,B,C, collorbated once in a movie, while A has collorbated many time with Group 1, and B has collorbated many time with Group 2. Actors in Group 1 have never collorbated with actors in Group 2 before. B might have high betweenness centrality since B links Group 1 and Group 2, but B might have a low closeness centrality.

Question b

While there are many algorithms to detect the communicities within a network, for this question I used Girvan-Newman method, which finds and removes the edge with the highest betweeness repeatly.

1. Define the function to find the edge with the highest betweenness centrality

In [6]:
```
def find_the_edge_with_highest_betweenness_centrality(G):
    d = dict(nx.edge_betweenness_centrality(G, weight = 'weight'))
    between_centrality_ranked = sorted(d.items(), key = operator.itemgetter(1), reverse =
    return between_centrality_ranked[0][0]
```

1. Create a copy of the original network

In [7]:
```
C = G.copy()
```

1. Split the network by removing the edge with the highest betweenness. By constantly trying, I found that until I divided the network into 29 cummunities, the netowrk is composed of 1 giant cummunities and multiple cummunities which have only 1 or 2 actors.

In [8]:
```
while nx.number_connected_components(C) < 29 : # Dividing the network into 4 communities
    removed_edge = find_the_edge_with_highest_betweenness_centrality(C)
    C.remove_edge(removed_edge[0], removed_edge[1])
communities = list(nx.connected_components(C))
```

1. Define the largest and second largest communities

In [9]:
```
larest_community = communities[0]
second_larest_community = communities[1]
```

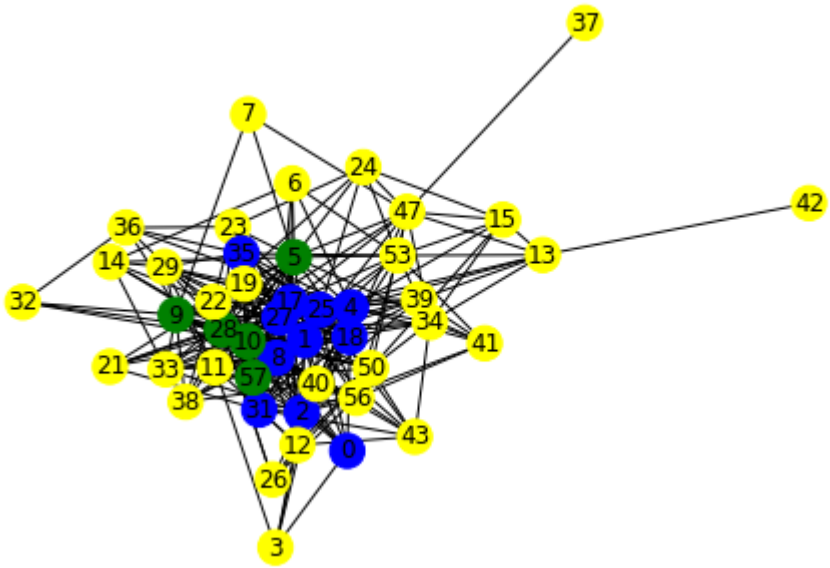
1. Define the color for the nodes in the largest cummunity, the nodes in the second largest communities, and other nodes

In [10]:
```
color_map = []
for node in G:
    if node in larest_community:
        color_map.append('blue')
    elif node in second_larest_community:
        color_map.append('green')
```

```
    else:
        color_map.append('yellow')
```

1. Draw the nodes with the corresponding communities

In [11]:
```
nx.draw(G, node_color=color_map, with_labels=True)
```



Question c

From the result of question b, if we use Girvan-Newman method to split the network, then the largest communitiy is composed of actors 0, 1, 2, 4, 8, 17, 18, 25, 27, 31, 35, and the second largest communities is composed of actor 5, 9, 10, 28, 57, while other actors form other small communities.

The table below is the information for those actor in the largest cummunity

In [19]:
```
actors_key[actors_key['id'].isin(larest_community)]
```

Out[19]:

	id	name	movies_95_04	main_genre	genres
1774	17	Sz�kely B., Mikl�s	21	Drama	Comedy:1,Crime:3,Drama:7,Family:1,Music:1,Musi...
2001	25	Bezer�dy, Zolt�n	20	Drama	Comedy:5,Drama:6,NULL:4,Romance:2,Short:2,War:1
3278	4	Rajhona, �d�m	20	Drama	Action:1,Adventure:2,Animation:1,Comedy:2,Crim...
4129	2	K�llai, Ferenc	15	Drama	Action:1,Comedy:4,Crime:1,Drama:4,Family:1,NUL...
4439	35	Pog�ny, Judit	12	Drama	Adventure:1,Comedy:2,Crime:2,Drama:4,Musical:1...
6480	1	Reviczky, G�bor	17	Comedy	Comedy:7,Crime:2,Fantasy:1,Musical:1,NULL:2,Ro...
6703	27	G�sp�r, S�ndor	18	Comedy	Comedy:6,Crime:1,Drama:4,NULL:5,Romance:1,Short:1

	id	name	movies_95_04	main_genre	genres
8795	31	Eperjes, K�roly	14	Drama	Adventure:1,Comedy:2,Crime:1,Drama:6,NULL:4
9431	0	Tordy, G�za	10	Comedy	Adventure:1,Animation:1,Comedy:2,Family:1,NULL...
13209	18	Kiss, Jen� (II)	13	Drama	Action:1,Comedy:3,Drama:3,Family:1,Mystery:1,N...
16017	8	Dengyel, Iv�n	16	Drama	Animation:1,Comedy:1,Crime:1,Drama:6,Mystery:1...

The table below is the information for those actor in the second largest cummunity

In [18]:
```
actors_key[actors_key['id'].isin(second_larest_community)]
```

Out[18]:

	id	name	movies_95_04	main_genre	genres
6024	5	Csuja, Imre	26	Drama	Action:2,Animation:1,Comedy:4,Drama:7,Fantasy:...
6189	10	Cserna, Antal	19	Drama	Adventure:1,Animation:1,Comedy:2,Drama:5,Fanta...
9837	9	Galk�, Bal�zs	17	Drama	Animation:1,Comedy:2,Drama:3,Music:1,NULL:6,Ro...
10700	28	Mucsi, Zolt�n	31	Comedy	Action:1,Adventure:1,Comedy:6,Crime:2,Drama:5,...
15756	57	Nagy-K�l�zy, Eszter	16	Drama	Comedy:2,Drama:5,Music:1,NULL:5,Romance:2,Short:1

From the two tables above, it appears that the main genres of actors in both communities are Drama and Comedy, therefore, they have collaborated more than other actors do. Also, it appears that the average number of movies made by actors in the largest community is less than that in the second largest community. So naturally, the actors in the largest community collaborated less than the actors in the second largest community.

In conclusion, the communities are split regarding to the main genre and the number of movies made during 1995 and 2004.