IM-UH 1511 **Introduction to Digital Humanities**

HOMEWORK 7b

Best Korean Movies in IMDb: Co-Directorship and Co-Actorship Networks

25 points totally

In [1]:

```
import pandas as pd
import numpy as np
import networkx as nx
import pygraphviz
from networkx.drawing.nx_agraph import graphviz_layout
from networkx.drawing.nx_agraph import to_agraph
import matplotlib.pyplot as plt
import matplotlib as mpl
from pylab import hist
import random
from collections import Counter
import operator
import itertools
from wordcloud import WordCloud
import warnings
warnings.filterwarnings("ignore", category=RuntimeWarning)
warnings.filterwarnings("ignore", category=UserWarning)
warnings.simplefilter('ignore')
```

In [2]:

```
df = pd.read_csv('Random100KoreanFilms.csv', encoding="utf-8")
print(len(df))
df.sort_values(by="YEAR").head(28)
```

```
920
```

Out[2]:

	Unnamed: 0	YEAR	TITLE	DIRECTOR	ACTOR	GENRE
728	728	1998	Christmas in August	Jin-ho Hur	Suk-kyu Han	Drama
735	735	1998	Christmas in August	Jin-ho Hur	Ji-hye Oh	Romance
734	734	1998	Christmas in August	Jin-ho Hur	Ji-hye Oh	Drama
733	733	1998	Christmas in August	Jin-ho Hur	Goo Shin	Romance
732	732	1998	Christmas in August	Jin-ho Hur	Goo Shin	Drama
730	730	1998	Christmas in August	Jin-ho Hur	Eun-ha Shim	Drama
729	729	1998	Christmas in August	Jin-ho Hur	Suk-kyu Han	Romance
731	731	1998	Christmas in August	Jin-ho Hur	Eun-ha Shim	Romance
217	217	1999	Memento Mori	Tae-yong Kim	Yeong-jin Lee	Drama
361	361	1999	Memento Mori	Kyu-dong Min	Yeong-jin Lee	Drama
360	360	1999	Memento Mori	Kyu-dong Min	Yeong-jin Lee	Romance
359	359	1999	Memento Mori	Kyu-dong Min	Yeong-jin Lee	Horror
358	358	1999	Memento Mori	Kyu-dong Min	Park Yejin	Drama
357	357	1999	Memento Mori	Kyu-dong Min	Park Yejin	Romance
356	356	1999	Memento Mori	Kyu-dong Min	Park Yejin	Horror
355	355	1999	Memento Mori	Kyu-dong Min	Gyu-ri Kim	Drama
354	354	1999	Memento Mori	Kyu-dong Min	Gyu-ri Kim	Romance
353	353	1999	Memento Mori	Kyu-dong Min	Gyu-ri Kim	Horror
210	210	1999	Memento Mori	Tae-yong Kim	Gyu-ri Kim	Romance
211	211	1999	Memento Mori	Tae-yong Kim	Gyu-ri Kim	Drama
212	212	1999	Memento Mori	Tae-yong Kim	Park Yejin	Horror
213	213	1999	Memento Mori	Tae-yong Kim	Park Yejin	Romance
362	362	1999	Memento Mori	Kyu-dong Min	Jong-hak Baek	Horror
214	214	1999	Memento Mori	Tae-yong Kim	Park Yejin	Drama
215	215	1999	Memento Mori	Tae-yong Kim	Yeong-jin Lee	Horror
220	220	1999	Memento Mori	Tae-yong Kim	Jong-hak Baek	Drama
219	219	1999	Memento Mori	Tae-yong Kim	Jong-hak Baek	Romance
218	218	1999	Memento Mori	Tae-yong Kim	Jong-hak Baek	Horror

I. The Bipartite Graph of Titles vs. Actors

In [3]:

```
meds=[]
for i in range(len(df)):
    a=df.iloc[i]['TITLE']
    b=df.iloc[i]['ACTOR']
    c=df.iloc[i]['YEAR']
    meds.append((a,b,c))
meds=list(set(meds))
print("Number of multi-edges: %i" %len(meds))
# print "%i nonunique (%i unique)" %(len(meds),len(set(meds)))
```

```
Number of multi-edges: 393
```

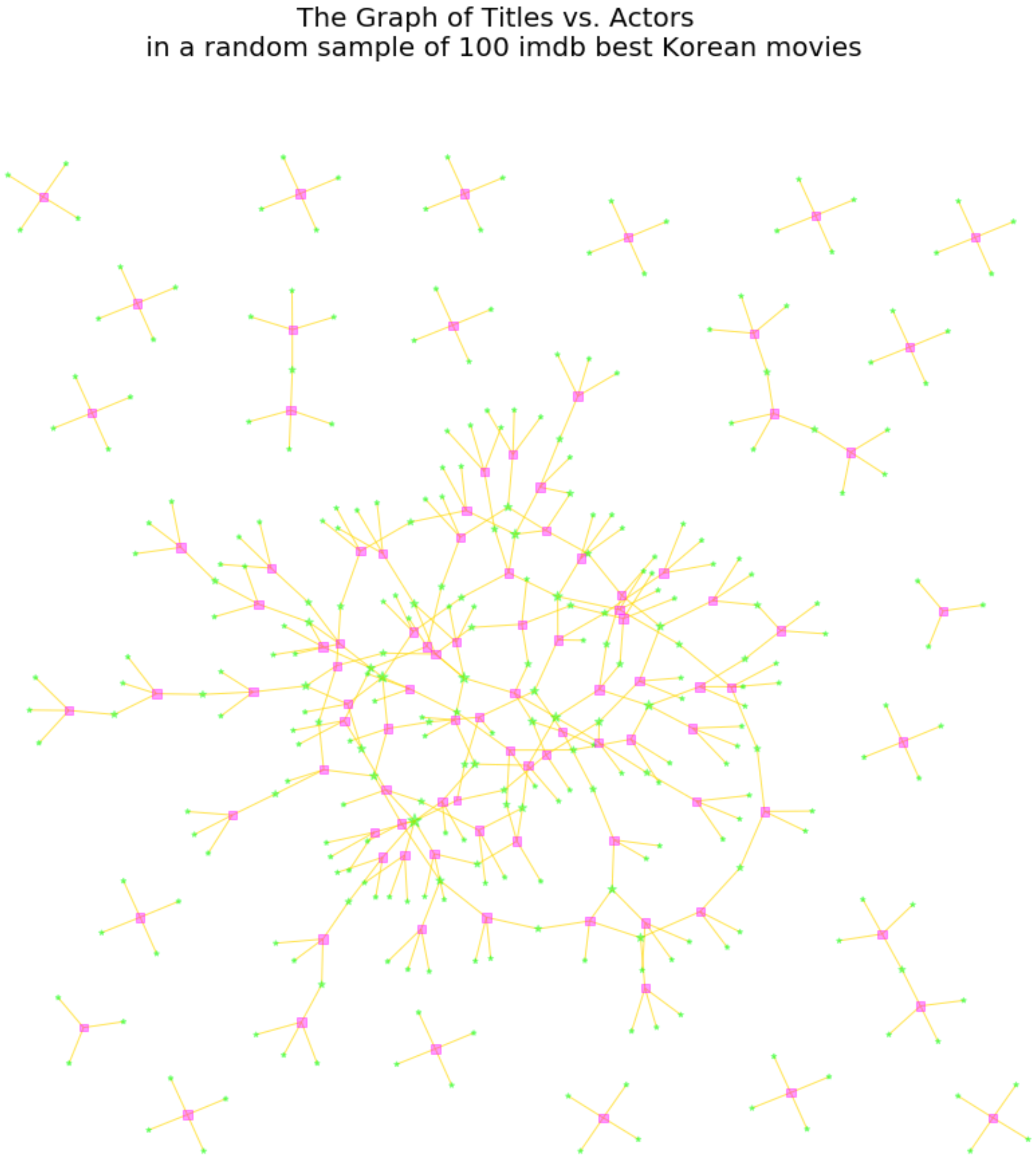
In [4]:

```
H=nx.Graph()
for k in meds:
    H.add_edge(k[0],k[1],year=k[2])
print(len(H),len(H.edges()))
ftitles=[i for i in H.nodes() if i in df.TITLE.tolist()]
factors=[i for i in H.nodes() if i in df.ACTOR.tolist()]
nt=len(ftitles)
na=len(factors)
print("The %i nodes of this graph are:" %len(H.nodes()))
print("%i titles and %i actors" %(nt,na))
if nx.is_bipartite(H)==True:
    print("This graph is bipartite")
else:
    print("This graph is not bipartite")
ncc=nx.number_connected_components(H)
if nx.is_connected(H)==True:
    print("This graph is connected")
else:
    print("This graph is not connected and has", ncc, "connected components
Gl = sorted(nx.connected_component_subgraphs(H), key = len, reverse=True)
Gc=H.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes and %i edges" %(len(Gc.nodes()), len(Gc.edges())))
ftitlesc=[n for n in Gc.nodes() if n in ftitles]
factorsc=[n for n in Gc.nodes() if n in factors]
ntc=len(ftitlesc)
nac=len(factorsc)
print("The %i nodes of the largest connected component are:" %len(Gc.nodes(
print("%i titles and %i actors" %(ntc,nac))
```

```
(390, 393)
The 390 nodes of this graph are:
99 titles and 291 actors
This graph is bipartite
('This graph is not connected and has', 23, 'connected components')
The largest connected component has:
266 nodes and 291 edges
The 266 nodes of the largest connected component are:
73 titles and 193 actors
```

In [5]:

```
pos=graphviz_layout(H)

labels={}
for i in H.nodes():
    labels[i]=""

node_size1=[10*H.degree(n) for n in ftitles]
node_size2=[15*H.degree(n) for n in factors]

fig = plt.figure(figsize=(15,15))
nx.draw_networkx_nodes(H,pos=pos,nodelist=factors,node_shape="*",node_color
nx.draw_networkx_nodes(H,pos=pos,nodelist=ftitles,node_shape="s",node_color
nx.draw_networkx_edges(H,pos=pos,edge_color='gold',alpha=0.7);
nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Graph of Titles vs. Actors \n in a random sample of 100 imdb best
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
# yoffset = {}
# y_off = -30 #0.05  # offset on the y axis
# for k, v in pos.items():
#     yoffset[k] = (v[0], v[1]+y_off)
# nx.draw_networkx_labels(H, yoffset,labels=labels,font_size=10);
plt.show()
```


The Graph of Titles vs. Actors
in a random sample of 100 imdb best Korean movies

I.1 The Co-Actorship Network of Actors Starring in Common Titles

In [6]:

```
fay_d={}
for e in H.edges(data=True):
    if e[0] in ftitles:
        fay_d[e[0]]=(list(H.neighbors(e[0])),e[2]['year'])
    if e[1] in ftitles:
        fay_d[e[1]]=(list(H.neighbors(e[1])),e[2]['year'])
# fay_d
```

In [7]:

```
aeds=[]
for k,v in fay_d.items():
    for j in itertools.combinations(v[0],2):
        aeds.append((j[0],j[1],v[1]))
print(len(aeds),len(set(aeds)))
# aeds
```

```
(585, 585)
```

In [8]:

```
maeds=[]
for k,v in Counter(aeds).items():
    maeds.append((k[0],k[1],(v,k[2])))
print(len(maeds), len(set(maeds)))
# maeds
```

```
(585, 585)
```

In [9]:

```
Ga=nx.MultiGraph()
Ga.add_weighted_edges_from(maeds)
```

In [10]:

```
edge_width=[w['weight'] for u,v,w in Ga.edges(data=True)]
edge_width=[w for w in edge_width]
edge_width=[e[0] for e in edge_width]
set(edge_width)
Counter(edge_width)
```

Out[10]:

```
Counter({1: 585})
```

In [11]:

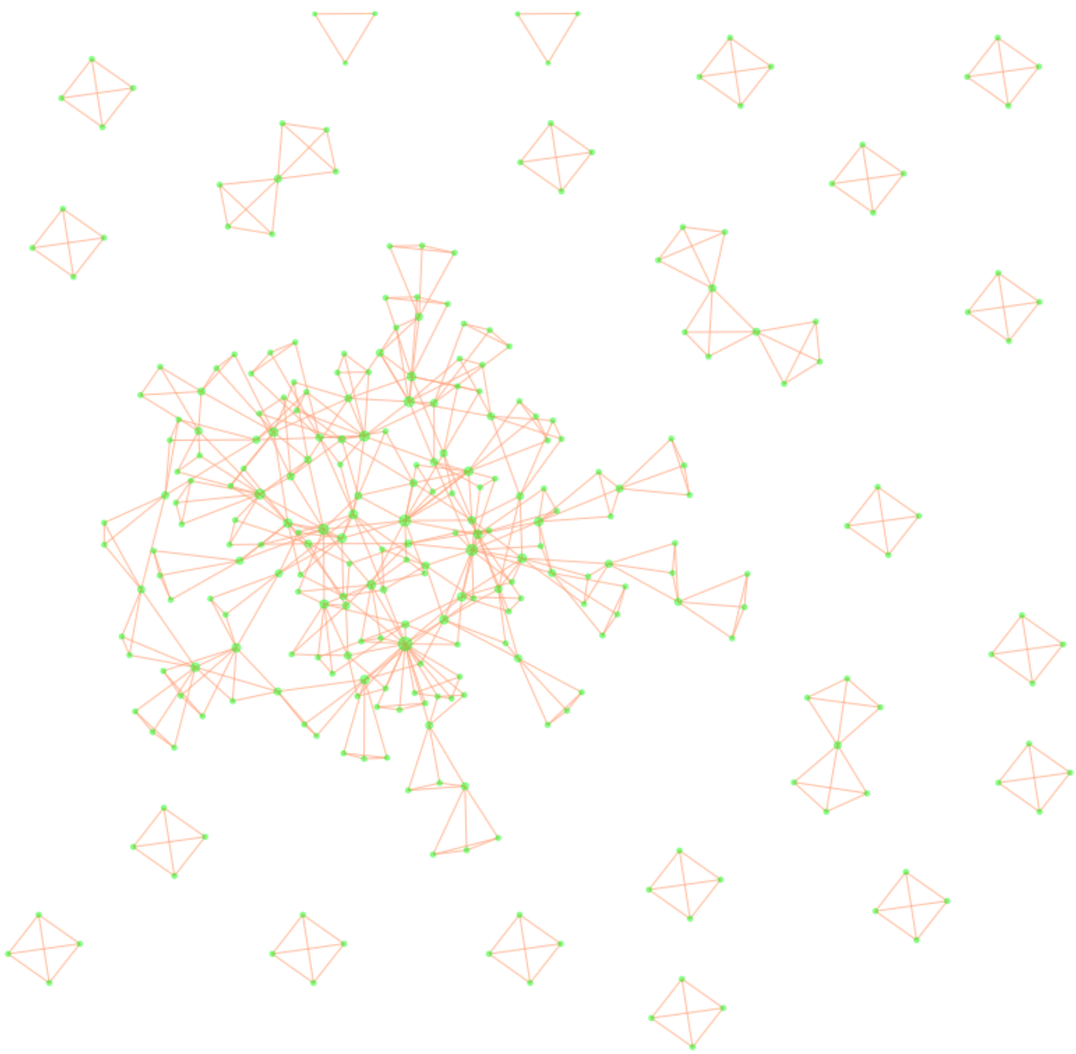
```
print("The co-actorship (by titles) multigraph has:")
print("%i nodes (actors) and %i edges (co-actorships by titles), i.e., pair

if Ga.is_multigraph()==True:
    print("The co-actorship (by titles) graph is a multigraph")
else:
    print("The co-actorship (by titles) graph is a simple graph")
if nx.is_weighted(Ga)==True:
    print("The co-actorship (by titles) graph is a weighted graph")
else:
    print("The co-actorship (by titles) graph is an unweighted graph")

ncc=nx.number_connected_components(Ga)
if nx.is_connected(Ga)==True:
    print("The co-actorship (by titles) graph is connected")
else:
    print("The co-actorship (by titles) graph is not connected and has", nc
Gl = sorted(nx.connected_component_subgraphs(Ga), key = len, reverse=True)
Gac=Ga.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes (actors) and %i edges (co-actorships by titles)" %(len(Gac.
```

```
The co-actorship (by titles) multigraph has:
291 nodes (actors) and 585 edges (co-actorships by titles), i.e., pairs o
f actors starring in the same film)
The co-actorship (by titles) graph is a multigraph
The co-actorship (by titles) graph is a weighted graph
('The co-actorship (by titles) graph is not connected and has', 23, 'conn
ected components')
The largest connected component has:
193 nodes (actors) and 435 edges (co-actorships by titles)
```

In [12]:

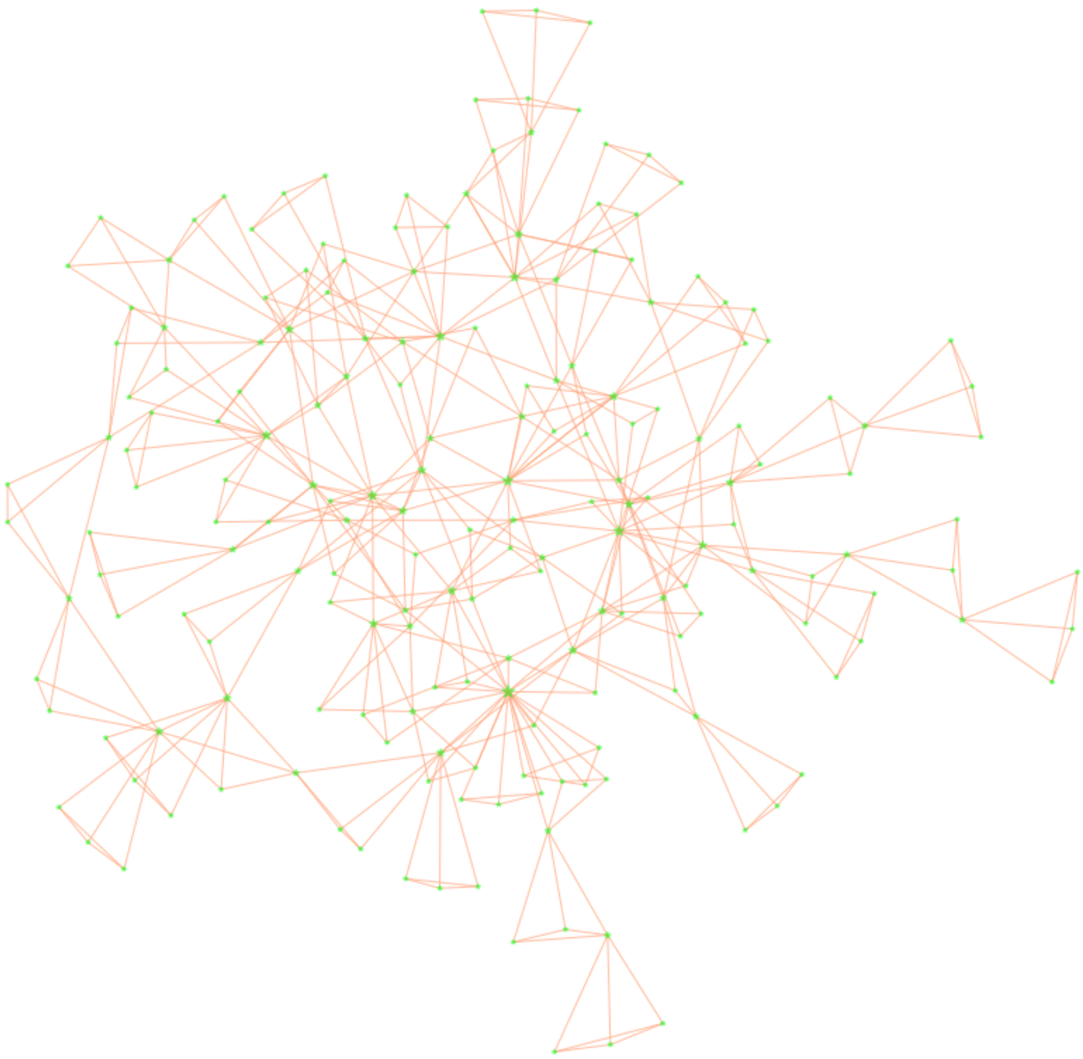
```
pos=graphviz_layout(Ga)

labels={}
for i in Ga.nodes():
    labels[i]=""

node_size2=[4*Ga.degree(n) for n in Ga.nodes()]

fig = plt.figure(figsize=(15,15))
nx.draw_networkx_nodes(Ga,pos=pos,node_color='lime',node_size=node_size2,fo
nx.draw_networkx_edges(Ga,pos=pos,edge_width=edge_width,edge_color='lightsa
nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Actorship (by titles) Graph \n in a random sample of 100 imdb b
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
# yoffset = {}
# y_off = -30 #0.05  # offset on the y axis
# for k, v in pos.items():
#     yoffset[k] = (v[0], v[1]+y_off)
# font_size=10
# nx.draw_networkx_labels(Ga, yoffset,labels=labels);
plt.show()
```

The Co-Actorship (by titles) Graph
in a random sample of 100 imdb best Korean movies



In [13]:

```
pos=graphviz_layout(Gac)

labels={}
for i in Gac.nodes():
    labels[i]=""

node_size2=[4*Gac.degree(n) for n in Gac.nodes()]

fig = plt.figure(figsize=(15,15))
nx.draw_networkx_nodes(Gac,pos=pos,node_shape="*",node_color='lime',node_si
nx.draw_networkx_edges(Gac,pos=pos,edge_width=edge_width,edge_color='lights
nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Largest Connected Component of the Co-Actorship (by titles) Graph
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
# yoffset = {}
# y_off = -7 #0.05  # offset on the y axis
# for k, v in pos.items():
#     yoffset[k] = (v[0], v[1]+y_off)
# nx.draw_networkx_labels(Gac, yoffset,labels=labels,font_size=10);
plt.show()
```



The Largest Connected Component of the Co-Actorship (by titles) Graph
in a random sample of 100 imdb best Korean movies

II. The Bipartite Graph of Directors vs. Actors

```
In [14]: emmeds=[]
         for i in range(len(df)):
             a=df.iloc[i]['DIRECTOR']
             b=df.iloc[i]['ACTOR']
             c=df.iloc[i]['YEAR']
             emmeds.append((a,b,c))
         emmeds=list(set(emmeds))
         print("Number of multi-edges: %i" %len(emmeds))
         # print("%i nonunique (%i unique)" %(len(meds),len(set(meds))))
```

```
Number of multi-edges: 397
```

In [15]:

```
Hem=nx.Graph()
for k in emmeds:
    Hem.add_edge(k[0],k[1],year=k[2])
print(len(Hem),len(Hem.edges()))
fdirectors=[i for i in Hem.nodes() if i in df.DIRECTOR.tolist()]
factors=[i for i in Hem.nodes() if i in df.ACTOR.tolist()]
nd=len(fdirectors)
na=len(factors)
print("The %i nodes of this graph are:" %len(Hem.nodes()))
print("%i directors and %i actors" %(nd,na))
if nx.is_bipartite(Hem)==True:
    print("This graph is bipartite")
else:
    print("This graph is not bipartite")
ncc=nx.number_connected_components(Hem)
if nx.is_connected(Hem)==True:
    print("This graph is connected")
else:
    print("This graph is not connected and has", ncc, "connected components
Geml = sorted(nx.connected_component_subgraphs(Hem), key = len, reverse=Tru
Gemc=Hem.subgraph(Geml[0])
# print('The largest connected component has:')
# print("%i nodes and %i edges" %(len(Gmc.nodes()), len(Gmc.edges())))
fdirecotrsc=[n for n in Gemc.nodes() if n in fdirectors]
factorsc=[n for n in Gemc.nodes() if n in factors]
ndc=len(fdirecotrsc)
nac=len(factorsc)
print("The %i nodes of the largest connected component are:" %len(Gemc.node
print("%i directors and %i actors" %(ndc,nac))
len(Gemc.edges())
```

```
(367, 389)
The 367 nodes of this graph are:
76 directors and 291 actors
This graph is bipartite
('This graph is not connected and has', 13, 'connected components')
The 293 nodes of the largest connected component are:
61 directors and 232 actors
```

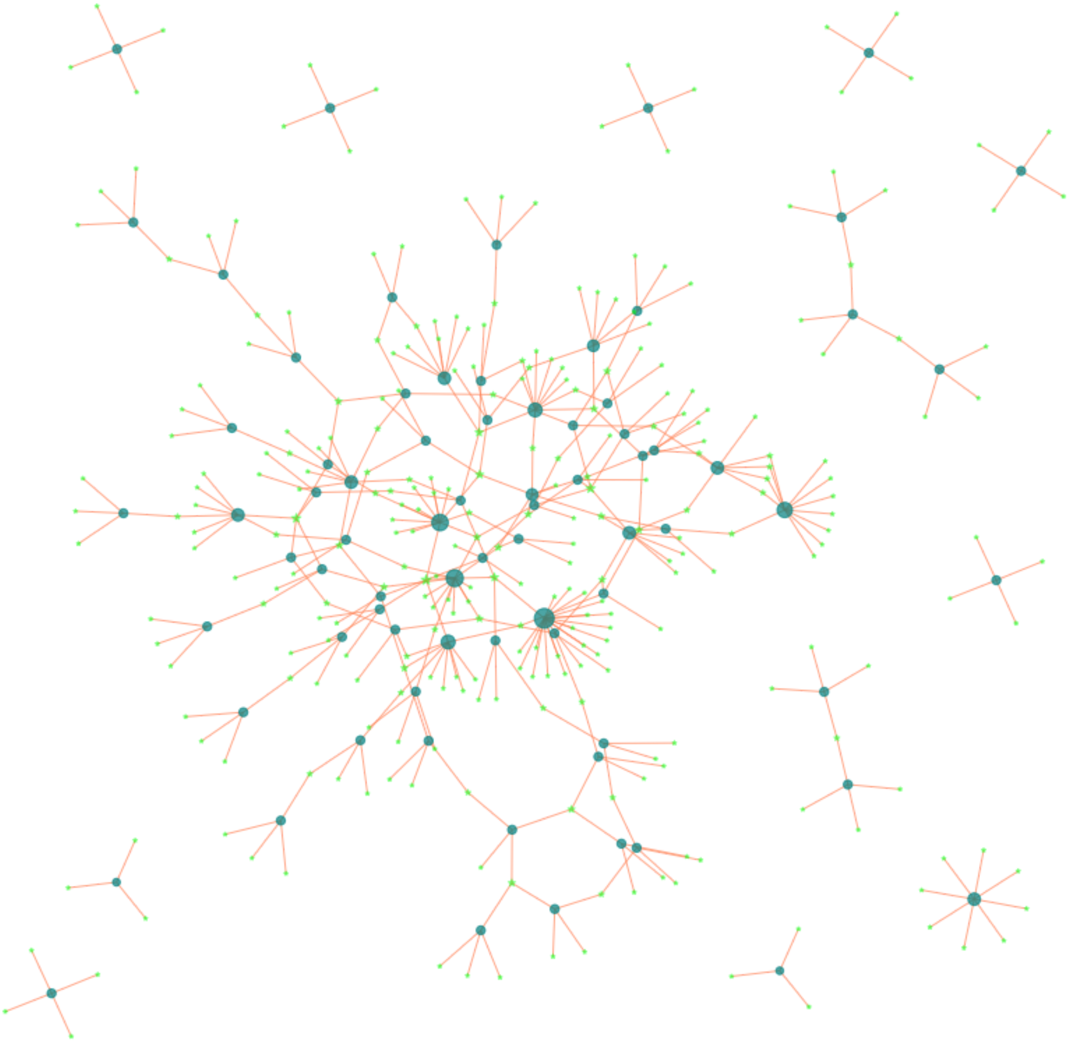
Out[15]:

```
327
```

In [16]:

```
pos=graphviz_layout(Hem)

labels={}
for i in Hem.nodes():
    labels[i]=""

node_size1=[10*Hem.degree(n) for n in fdirectors]
node_size2=[10*Hem.degree(n) for n in factors]

fig = plt.figure(figsize=(15,15))
nx.draw_networkx_nodes(Hem,pos=pos,nodelist=fdirectors,node_color='teal',no
nx.draw_networkx_nodes(Hem,pos=pos,nodelist=factors,node_shape="*",node_col
nx.draw_networkx_edges(Hem,pos=pos,edge_color='coral',alpha=0.7);
nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Graph of Directors vs. Actors \n in a random sample of 100 imdb be
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
# yoffset = {}
# y_off = -20 #0.05  # offset on the y axis
# for k, v in pos.items():
#     yoffset[k] = (v[0], v[1]+y_off)
# nx.draw_networkx_labels(Hem, yoffset,labels=labels,font_size=10);
plt.show()
```

The Graph of Directors vs. Actors
in a random sample of 100 imdb best Korean movies



II.1 The Co-Directorship Network of Directors with Common Actors

In [17]:
```
fay_d3={}
for e in Hem.edges(data=True):
    if e[0] in factors:
        fay_d3[e[0]]=(list(Hem.neighbors(e[0])),e[2]['year'])
    if e[1] in factors:
        fay_d3[e[1]]=(list(Hem.neighbors(e[1])),e[2]['year'])
# fay_d3
```

In [18]:
```
kmmaeds=[]
for k,v in fay_d3.items():
    for j in itertools.combinations(v[0],2):
        kmmaeds.append((j[0],j[1],v[1]))
print(len(kmmaeds),len(set(kmmaeds)))
# kmmaeds
```

```
(144, 141)
```

In [19]:
```
kmmaeds1=[]
for k,v in Counter(kmmaeds).items():
    kmmaeds1.append((k[0],k[1],(v,k[2])))
print(len(kmmaeds1), len(set(kmmaeds1)))
# kmmaeds1
```

```
(141, 141)
```

In [20]:
```
Gkmm=nx.MultiGraph()
Gkmm.add_weighted_edges_from(kmmaeds1)
# Gkmm.edges(data=True)
```

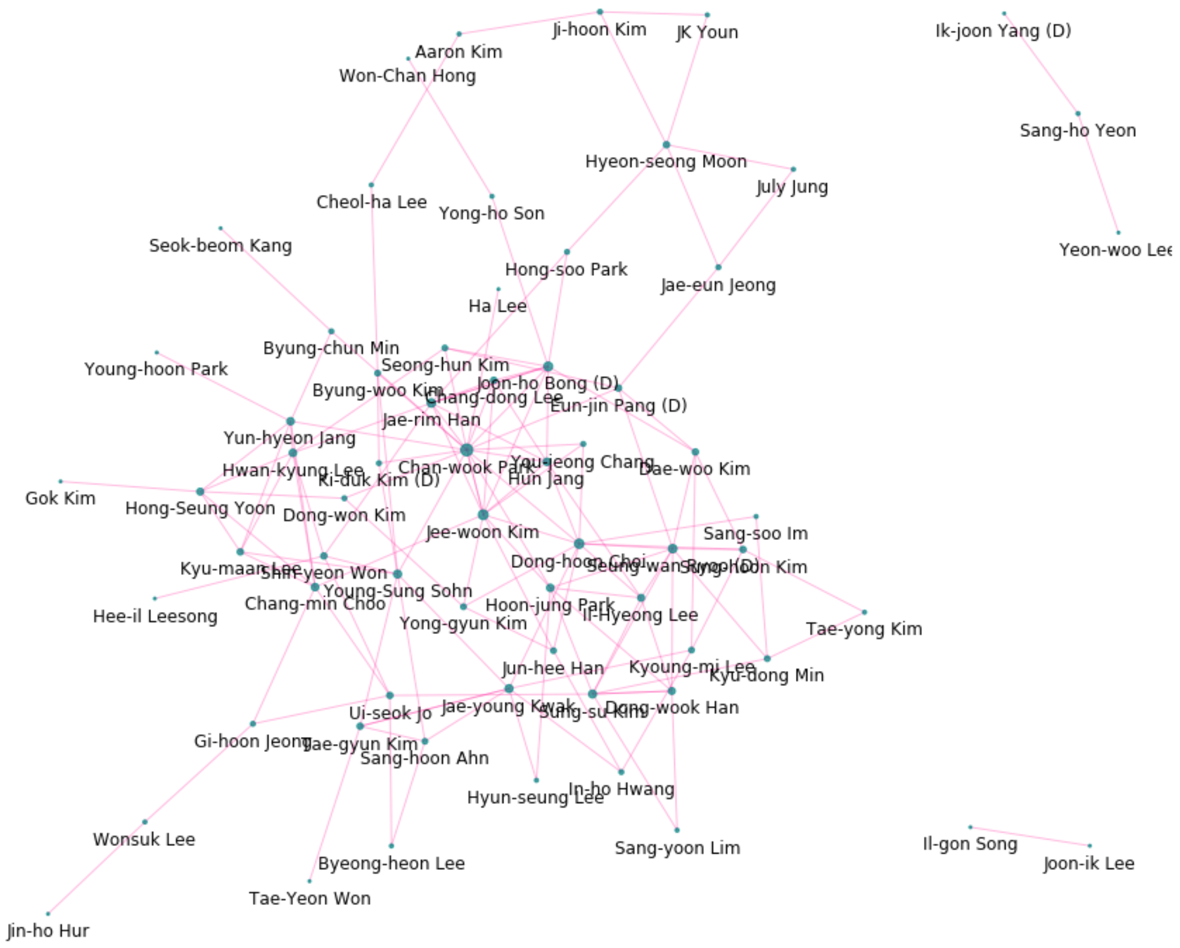
In [21]:
```
print("The co-directorship multigraph has:")
print("%i nodes (directors) and %i edges (i.e., pairs of directors with com

if Gkmm.is_multigraph()==True:
    print("The co-directorship graph is a multigraph")
else:
    print("The co-directorship graph is a simple graph")
if nx.is_weighted(Gkmm)==True:
    print("The co-directorship graph is a weighted graph")
else:
    print("The co-directorship graph is an unweighted graph")

ncc=nx.number_connected_components(Gkmm)
if nx.is_connected(Gkmm)==True:
    print("The co-directorship graph is connected")
else:
    print("The co-directorship graph is not connected and has", ncc, "conne
Gkmml = sorted(nx.connected_component_subgraphs(Gkmm), key = len, reverse=T
Gkmmc=Gkmm.subgraph(Gkmml[0])
print('The largest connected component has:')
print("%i nodes (directors) and %i edges (i.e., pairs of directors with com
```

```
The co-directorship multigraph has:
66 nodes (directors) and 141 edges (i.e., pairs of directors with common
actors)
The co-directorship graph is a multigraph
The co-directorship graph is a weighted graph
('The co-directorship graph is not connected and has', 3, 'connected comp
onents')
The largest connected component has:
61 nodes (directors) and 138 edges (i.e., pairs of directors with common
actors)
```

In [22]:

```
pos=graphviz_layout(Gkmm)

labels={}
for i in Gkmm.nodes():
    labels[i]=i #""

node_size2=[4*Gkmm.degree(n) for n in Gkmm.nodes()]

fig = plt.figure(figsize=(15,13))
nx.draw_networkx_nodes(Gkmm,pos=pos,node_color='teal',node_size=node_size2,
nx.draw_networkx_edges(Gkmm,pos=pos,edge_width=edge_width,edge_color='deepp
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Directorship (by actors) Graph \n in a random sample of 100 imd
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -10 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
font_size=8
nx.draw_networkx_labels(Gkmm, yoffset,labels=labels);
plt.show()
```

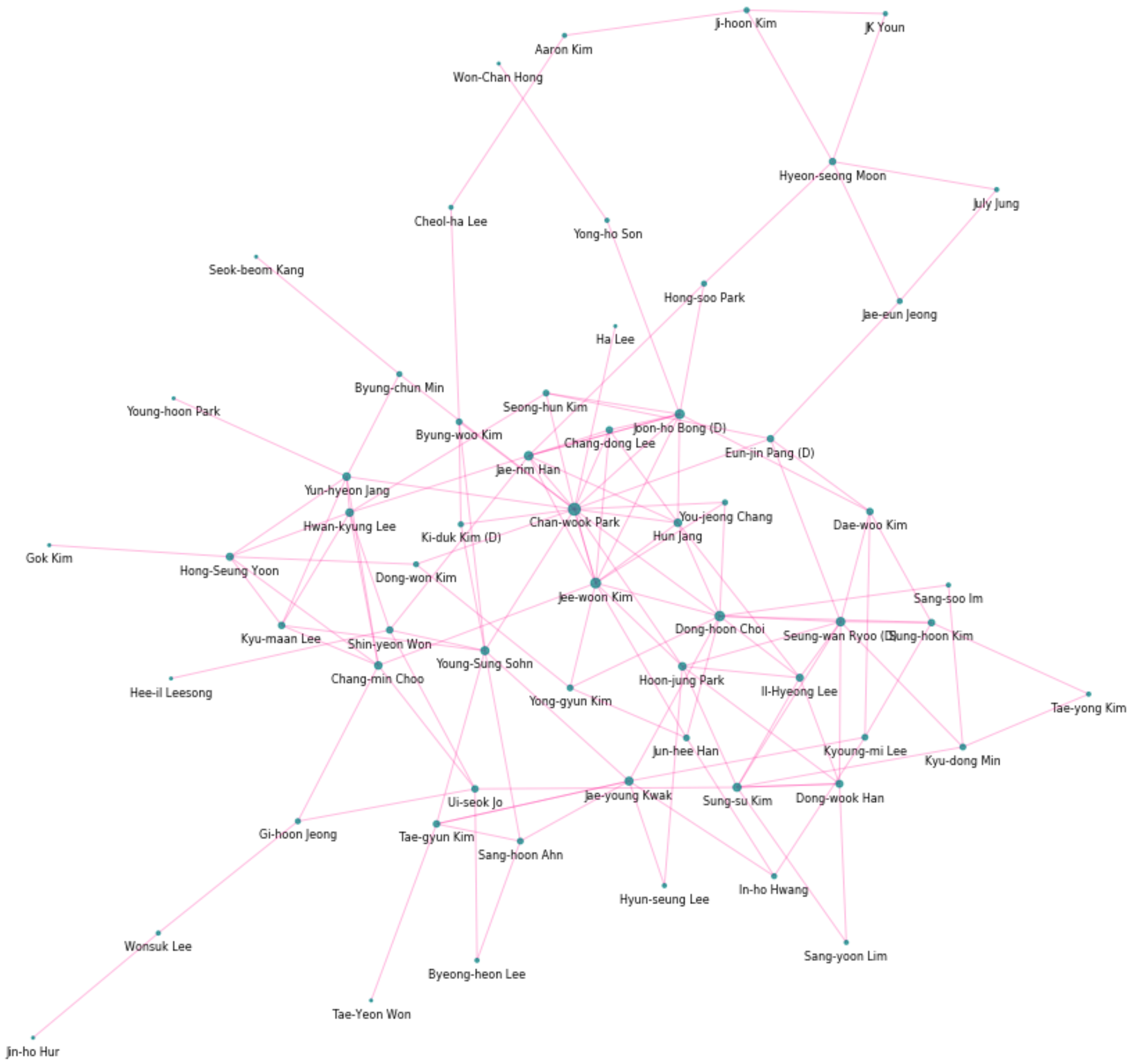
The Co-Directorship (by actors) Graph
in a random sample of 100 imdb best Korean movies



In [23]:

```
pos=graphviz_layout(Gkmmc)

labels={}
for i in Gkmmc.nodes():
    labels[i]=i #""

node_size2=[4*Gkmmc.degree(n) for n in Gkmmc.nodes()]

fig = plt.figure(figsize=(15,15))
nx.draw_networkx_nodes(Gkmmc,pos=pos,node_color='teal',node_size=node_size2
nx.draw_networkx_edges(Gkmmc,pos=pos,edge_width=edge_width,edge_color='deep
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Largest Connected Component of the Co-Directorship (by actors) Gra
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -7 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Gkmmc, yoffset,labels=labels,font_size=8);
plt.show()
```

The Largest Connected Component of the Co-Directorship (by actors) Graph
in a random sample of 100 imdb best Korean movies



III. Longitudinal Co-Actorship Networks

In [24]:

```
slots=[range(1997,2000),range(2000,2004),range(2004,2008),range(2008,2012),
       range(2012,2016),range(2016,2020)]
sslots=["1997-99","2000-03","2004-07","2008-11","2012-15","2016-19"]
periods={}
tuy=zip(sslots,slots)
GG={}
GG={}
for t in tuy:
    bin=[]
    for year in t[1]:
        for e in Ga.edges(data=True):
            if year==int(e[2]['weight'][1]):
                bin.append((e[0],e[1],(e[2]['weight'][0],e[2]['weight'][1])
    g=nx.MultiGraph()
    g.add_weighted_edges_from(bin)
    GG[t[0]]=g
s=0
for k,v in GG.items():
    s+=len(v.edges())
    print(k,len(v),len(v.edges()))
print(len(Ga.edges()),s)
```

```
('2000-03', 38, 60)
('2008-11', 76, 123)
('2016-19', 44, 69)
('2004-07', 72, 114)
('1997-99', 8, 12)
('2012-15', 121, 207)
(585, 585)
```

In [25]:

```
yl=[]
for e in GG['2012-15'].edges(data=True):
    yl.append(e[2]['weight'][1])
yl=sorted(set(yl))
yl
```

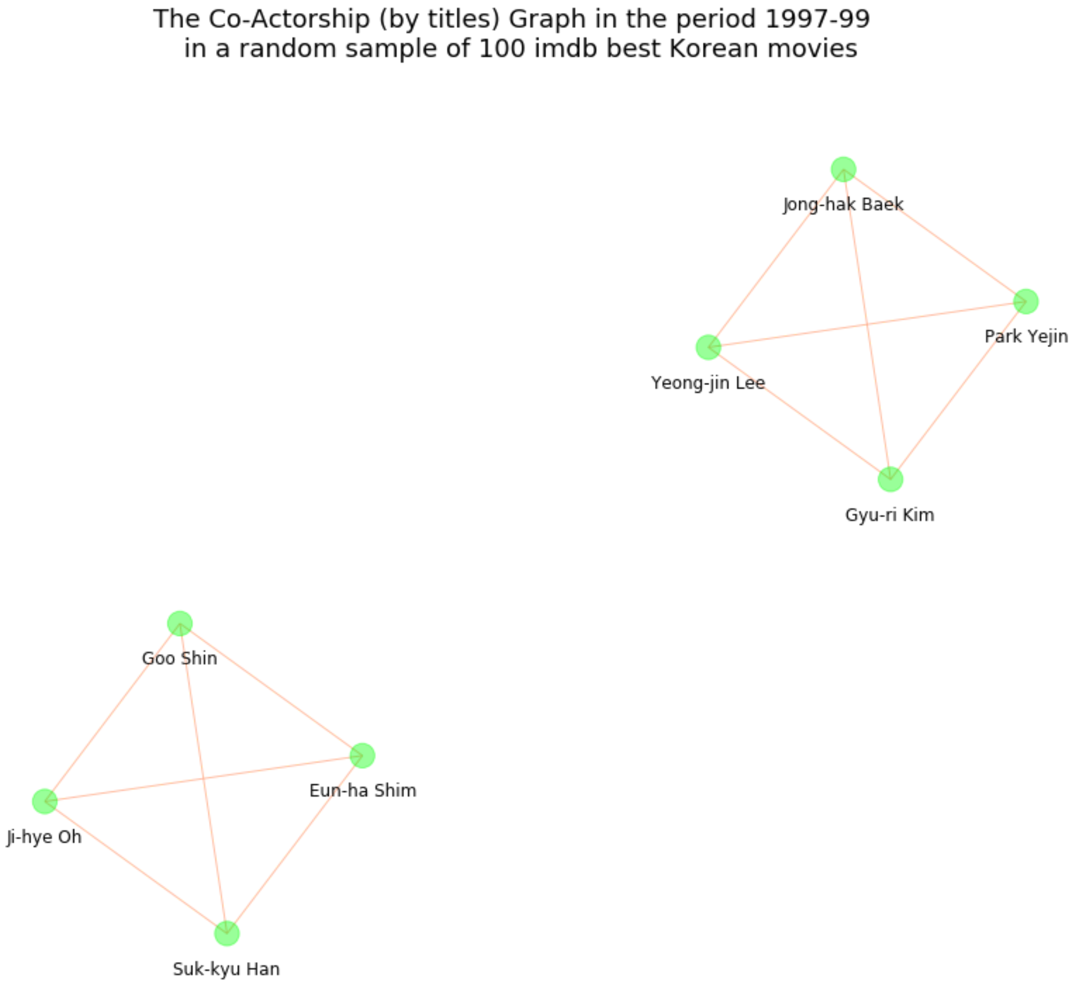
Out[25]:

```
[2012, 2013, 2014, 2015]
```

In [26]:

```
p=sslots[0]
Ga1=GG[p]

edge_width=[w['weight'] for u,v,w in Ga1.edges(data=True)]
edge_width=[w for w in edge_width]
edge_width=[e[0] for e in edge_width]

print("The co-actorship (by titles) multigraph in the period %s has:" %p)
print("%i nodes (actors) and %i edges (co-actorships by titles), i.e., pair

if Ga1.is_multigraph()==True:
    print("The co-actorship (by titles) graph in the period %s is a multigr
else:
    print("The co-actorship (by titles) graph in the period %s is a simple
if nx.is_weighted(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is a weighte
else:
    print("The co-actorship (by titles) graph in the period %s is an unweig

ncc=nx.number_connected_components(Ga1)
if nx.is_connected(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is connected
else:
    print("The co-actorship (by titles) graph in the period %s is not conne
Gl = sorted(nx.connected_component_subgraphs(Ga1), key = len, reverse=True)
Ga1c=Ga1.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes (actors) and %i edges (co-actorships by titles)" %(len(Ga1c

pos=graphviz_layout(Ga1)

labels={}
for n in Ga1.nodes():
    labels[n]=n

node_size2=[100*Ga1.degree(n) for n in Ga1.nodes()]

fig = plt.figure(figsize=(15,12))
nx.draw_networkx_nodes(Ga1,pos=pos,node_color='lime',node_size=node_size2,f
nx.draw_networkx_edges(Ga1,pos=pos,edge_width=edge_width,edge_color='lights
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Actorship (by titles) Graph in the period %s \n in a random sam
fig.suptitle(sst,x=0.5, y=.95, fontsize=18);
plt.axis('off');
yoffset = {}
y_off = -10 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Ga1, yoffset,labels=labels,font_size=12);
plt.margins(x=0.1, y=0.1);
plt.show()
```

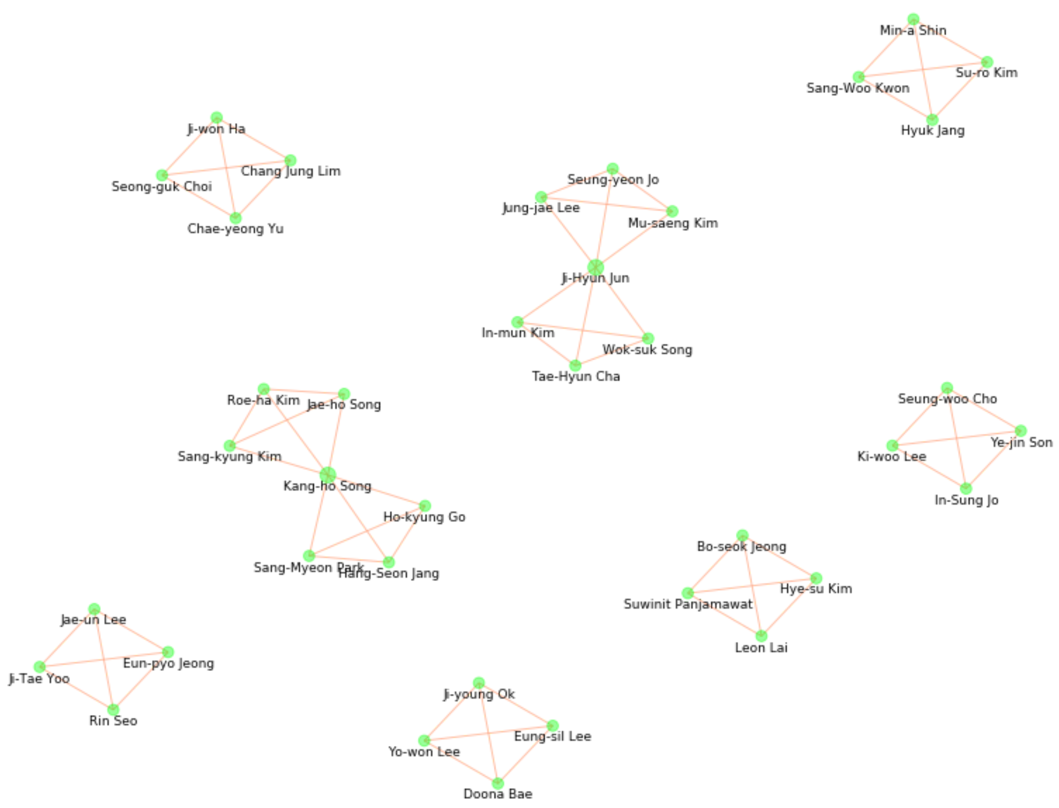
```
The co-actorship (by titles) multigraph in the period 1997-99 has:
8 nodes (actors) and 12 edges (co-actorships by titles), i.e., pairs of a
ctors starring in the same film)
The co-actorship (by titles) graph in the period 1997-99 is a multigraph
The co-actorship (by titles) graph in the period 1997-99 is a weighted gr
aph
The co-actorship (by titles) graph in the period 1997-99 is not connected
and it has 2 connected components
The largest connected component has:
4 nodes (actors) and 6 edges (co-actorships by titles)
```


The Co-Actorship (by titles) Graph in the period 1997-99
in a random sample of 100 imdb best Korean movies
Jong-hak Baek
Park Yejin
Yeong-jin Lee
Gyu-ri Kim
Goo Shin
Eun-ha Shim
Ji-hye Oh
Suk-kyu Han

In [27]:

```
p=sslots[1]
Ga1=GG[p]

edge_width=[w['weight'] for u,v,w in Ga1.edges(data=True)]
edge_width=[w for w in edge_width]
edge_width=[e[0] for e in edge_width]

print("The co-actorship (by titles) multigraph in the period %s has:" %p)
print("%i nodes (actors) and %i edges (co-actorships by titles), i.e., pair

if Ga1.is_multigraph()==True:
    print("The co-actorship (by titles) graph in the period %s is a multigr
else:
    print("The co-actorship (by titles) graph in the period %s is a simple
if nx.is_weighted(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is a weighte
else:
    print("The co-actorship (by titles) graph in the period %s is an unweig

ncc=nx.number_connected_components(Ga1)
if nx.is_connected(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is connected
else:
    print("The co-actorship (by titles) graph in the period %s is not conne
Gl = sorted(nx.connected_component_subgraphs(Ga1), key = len, reverse=True)
Ga1c=Ga1.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes (actors) and %i edges (co-actorships by titles)" %(len(Ga1c
pos=graphviz_layout(Ga1)

labels={}
for n in Ga1.nodes():
    labels[n]=n

node_size2=[20*Ga1.degree(n) for n in Ga1.nodes()]

fig = plt.figure(figsize=(15,12))
nx.draw_networkx_nodes(Ga1,pos=pos,node_color='lime',node_size=node_size2,f
nx.draw_networkx_edges(Ga1,pos=pos,edge_width=edge_width,edge_color='lights
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Actorship (by titles) Graph in the period %s \n in a random sam

fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -10 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Ga1, yoffset,labels=labels,font_size=9);
plt.margins(x=0.1, y=0.1);
plt.show()
```

```
The co-actorship (by titles) multigraph in the period 2000-03 has:
38 nodes (actors) and 60 edges (co-actorships by titles), i.e., pairs of
actors starring in the same film)
The co-actorship (by titles) graph in the period 2000-03 is a multigraph
The co-actorship (by titles) graph in the period 2000-03 is a weighted gr
aph
The co-actorship (by titles) graph in the period 2000-03 is not connected
and it has 8 connected components
The largest connected component has:
7 nodes (actors) and 12 edges (co-actorships by titles)
```



The Co-Actorship (by titles) Graph in the period 2000-03
in a random sample of 100 imdb best Korean movies

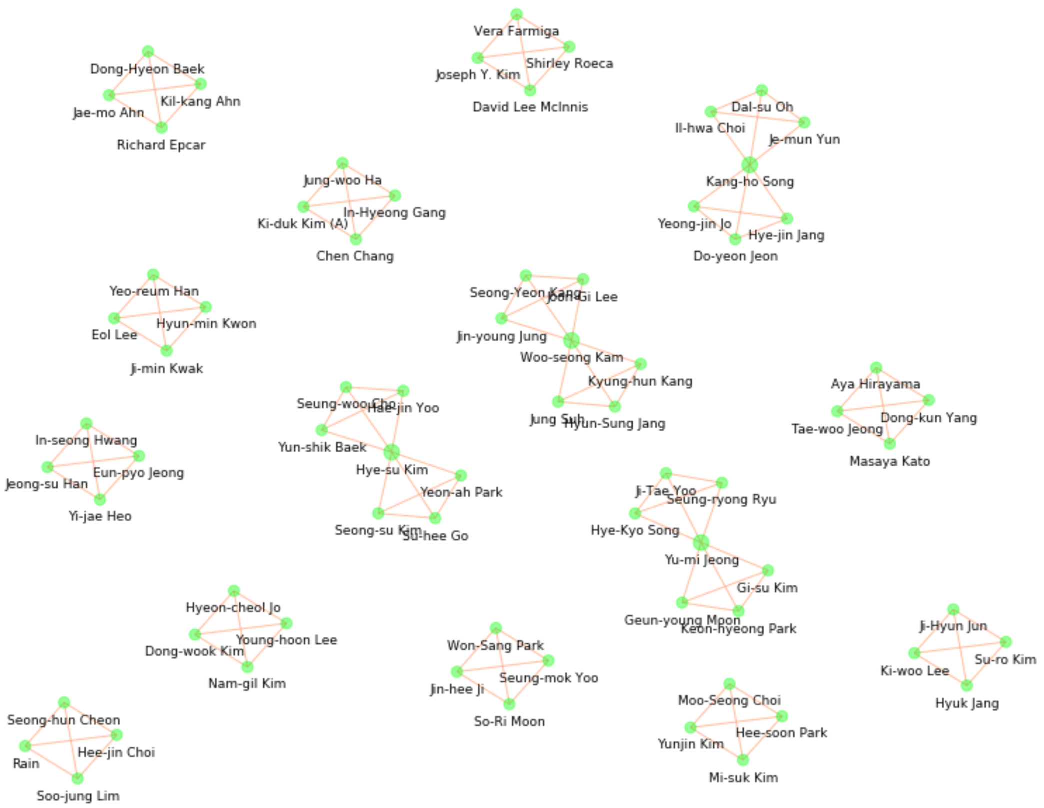
In [28]:

```
p=sslots[2]
Ga1=GG[p]

edge_width=[w['weight'] for u,v,w in Ga1.edges(data=True)]
edge_width=[w for w in edge_width]
edge_width=[e[0] for e in edge_width]

print("The co-actorship (by titles) multigraph in the period %s has:" %p)
print("%i nodes (actors) and %i edges (co-actorships by titles), i.e., pair

if Ga1.is_multigraph()==True:
    print("The co-actorship (by titles) graph in the period %s is a multigr
else:
    print("The co-actorship (by titles) graph in the period %s is a simple
if nx.is_weighted(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is a weighte
else:
    print("The co-actorship (by titles) graph in the period %s is an unweig

ncc=nx.number_connected_components(Ga1)
if nx.is_connected(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is connected
else:
    print("The co-actorship (by titles) graph in the period %s is not conne
Gl = sorted(nx.connected_component_subgraphs(Ga1), key = len, reverse=True)
Ga1c=Ga1.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes (actors) and %i edges (co-actorships by titles)" %(len(Ga1c
pos=graphviz_layout(Ga1)

labels={}
for n in Ga1.nodes():
    labels[n]=n

node_size2=[20*Ga1.degree(n) for n in Ga1.nodes()]

fig = plt.figure(figsize=(15,12))
nx.draw_networkx_nodes(Ga1,pos=pos,node_color='lime',node_size=node_size2,f
nx.draw_networkx_edges(Ga1,pos=pos,edge_width=edge_width,edge_color='lights
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Actorship (by titles) Graph in the period %s \n in a random sam
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -20 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Ga1, yoffset,labels=labels,font_size=9);
plt.margins(x=0.1, y=0.1);
plt.show()
```

```
The co-actorship (by titles) multigraph in the period 2004-07 has:
72 nodes (actors) and 114 edges (co-actorships by titles), i.e., pairs of
actors starring in the same film)
The co-actorship (by titles) graph in the period 2004-07 is a multigraph
The co-actorship (by titles) graph in the period 2004-07 is a weighted gr
```

```
aph
The co-actorship (by titles) graph in the period 2004-07 is not connected
and it has 15 connected components
The largest connected component has:
7 nodes (actors) and 12 edges (co-actorships by titles)
```

The Co-Actorship (by titles) Graph in the period 2004-07
in a random sample of 100 imdb best Korean movies

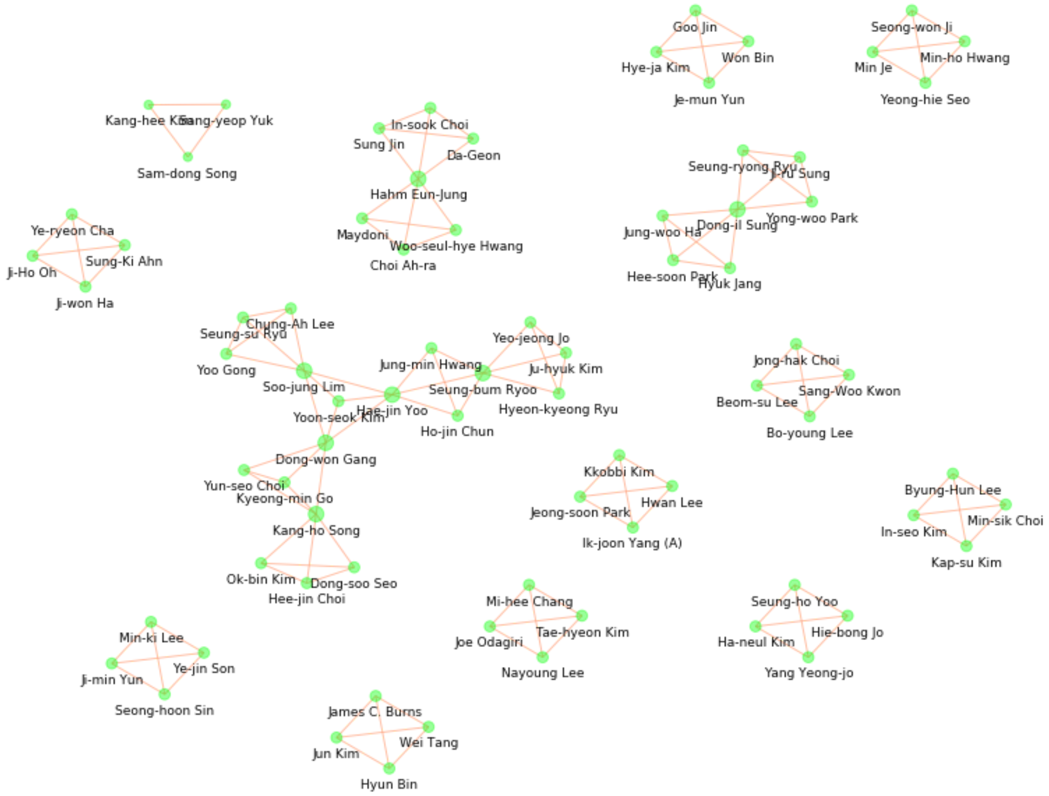


In [29]:

```
p=sslots[3]
Ga1=GG[p]

edge_width=[w['weight'] for u,v,w in Ga1.edges(data=True)]
edge_width=[w for w in edge_width]
edge_width=[e[0] for e in edge_width]

print("The co-actorship (by titles) multigraph in the period %s has:" %p)
print("%i nodes (actors) and %i edges (co-actorships by titles), i.e., pair

if Ga1.is_multigraph()==True:
    print("The co-actorship (by titles) graph in the period %s is a multigr
else:
    print("The co-actorship (by titles) graph in the period %s is a simple 
if nx.is_weighted(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is a weighte
else:
    print("The co-actorship (by titles) graph in the period %s is an unweig

ncc=nx.number_connected_components(Ga1)
if nx.is_connected(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is connected
else:
    print("The co-actorship (by titles) graph in the period %s is not conne
Gl = sorted(nx.connected_component_subgraphs(Ga1), key = len, reverse=True)
Ga1c=Ga1.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes (actors) and %i edges (co-actorships by titles)" %(len(Ga1c

pos=graphviz_layout(Ga1)

labels={}
for n in Ga1.nodes():
    labels[n]=n

node_size2=[20*Ga1.degree(n) for n in Ga1.nodes()]

fig = plt.figure(figsize=(15,12))
nx.draw_networkx_nodes(Ga1,pos=pos,node_color='lime',node_size=node_size2,f
nx.draw_networkx_edges(Ga1,pos=pos,edge_width=edge_width,edge_color='lights
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Actorship (by titles) Graph in the period %s \n in a random sam
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -20 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Ga1, yoffset,labels=labels,font_size=9);
plt.margins(x=0.1, y=0.1);
plt.show()
```

```
The co-actorship (by titles) multigraph in the period 2008-11 has:
76 nodes (actors) and 123 edges (co-actorships by titles), i.e., pairs of
actors starring in the same film)
The co-actorship (by titles) graph in the period 2008-11 is a multigraph
The co-actorship (by titles) graph in the period 2008-11 is a weighted gr
aph
The co-actorship (by titles) graph in the period 2008-11 is not connected
and it has 14 connected components
The largest connected component has:
19 nodes (actors) and 36 edges (co-actorships by titles)
```

The Co-Actorship (by titles) Graph in the period 2008-11
in a random sample of 100 imdb best Korean movies



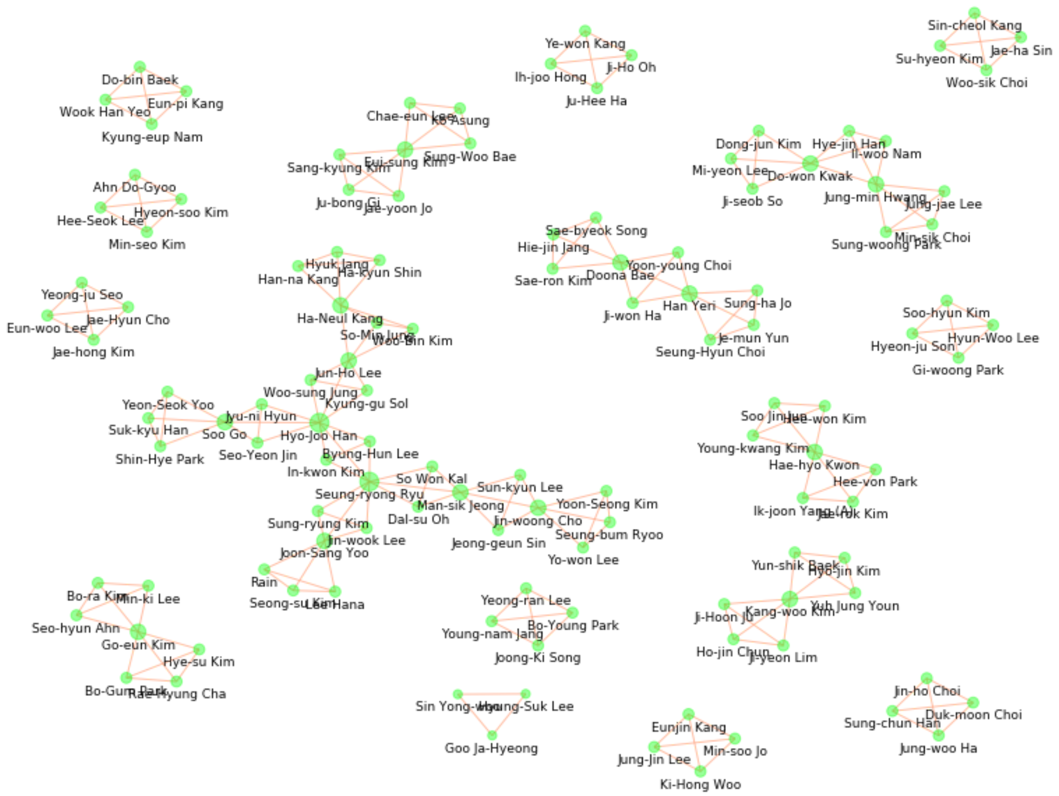
In [30]:

```
p=sslots[4]
Ga1=GG[p]

edge_width=[w['weight'] for u,v,w in Ga1.edges(data=True)]
edge_width=[w for w in edge_width]
edge_width=[e[0] for e in edge_width]

print("The co-actorship (by titles) multigraph in the period %s has:" %p)
print("%i nodes (actors) and %i edges (co-actorships by titles), i.e., pair

if Ga1.is_multigraph()==True:
    print("The co-actorship (by titles) graph in the period %s is a multigr
else:
    print("The co-actorship (by titles) graph in the period %s is a simple 
if nx.is_weighted(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is a weighte
else:
    print("The co-actorship (by titles) graph in the period %s is an unweig

ncc=nx.number_connected_components(Ga1)
if nx.is_connected(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is connected
else:
    print("The co-actorship (by titles) graph in the period %s is not conne
Gl = sorted(nx.connected_component_subgraphs(Ga1), key = len, reverse=True)
Ga1c=Ga1.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes (actors) and %i edges (co-actorships by titles)" %(len(Ga1c
pos=graphviz_layout(Ga1)

labels={}
for n in Ga1.nodes():
    labels[n]=n

node_size2=[20*Ga1.degree(n) for n in Ga1.nodes()]

fig = plt.figure(figsize=(15,12))
nx.draw_networkx_nodes(Ga1,pos=pos,node_color='lime',node_size=node_size2,f
nx.draw_networkx_edges(Ga1,pos=pos,edge_width=edge_width,edge_color='lights
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Actorship (by titles) Graph in the period %s \n in a random sam
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -20 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Ga1, yoffset,labels=labels,font_size=9);
plt.margins(x=0.1, y=0.1);
plt.show()
```

```
The co-actorship (by titles) multigraph in the period 2012-15 has:
121 nodes (actors) and 207 edges (co-actorships by titles), i.e., pairs o
f actors starring in the same film)
The co-actorship (by titles) graph in the period 2012-15 is a multigraph
The co-actorship (by titles) graph in the period 2012-15 is a weighted gr
```

```
aph
The co-actorship (by titles) graph in the period 2012-15 is not connected
and it has 17 connected components
The largest connected component has:
34 nodes (actors) and 66 edges (co-actorships by titles)
```

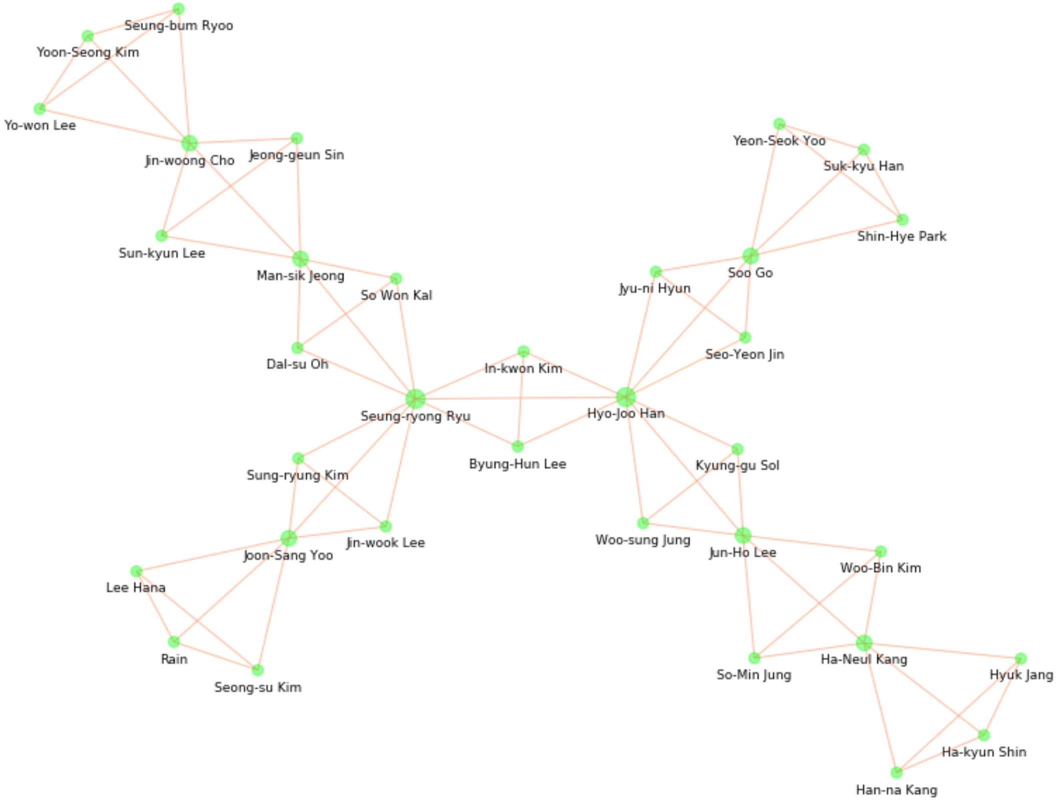
The Co-Actorship (by titles) Graph in the period 2012-15
in a random sample of 100 imdb best Korean movies



In [31]:

```
pos=graphviz_layout(Ga1c)

labels={}
for n in Ga1c.nodes():
    labels[n]=n

node_size2=[20*Ga1c.degree(n) for n in Ga1c.nodes()]

fig = plt.figure(figsize=(15,12))
nx.draw_networkx_nodes(Ga1c,pos=pos,node_color='lime',node_size=node_size2,
nx.draw_networkx_edges(Ga1c,pos=pos,edge_width=edge_width,edge_color='light
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The largest connected component of the \n Co-Actorship (by titles) Gra
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -10 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Ga1c, yoffset,labels=labels,font_size=9);
plt.margins(x=0.1, y=0.1);
plt.show()
```

The largest connected component of the
Co-Actorship (by titles) Graph in the period 2012-15
in a random sample of 100 imdb best Korean movies



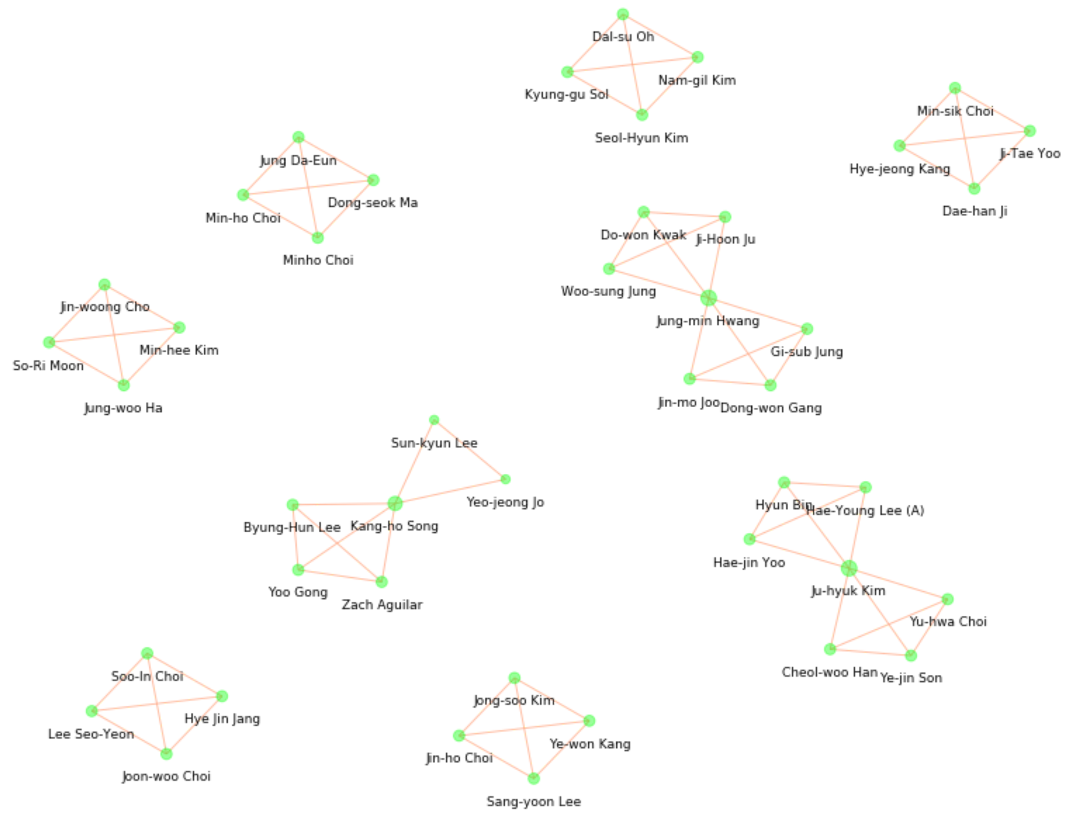
In [32]:

```
p=sslots[5]
Ga1=GG[p]

edge_width=[w['weight'] for u,v,w in Ga1.edges(data=True)]
edge_width=[w for w in edge_width]
edge_width=[e[0] for e in edge_width]

print("The co-actorship (by titles) multigraph in the period %s has:" %p)
print("%i nodes (actors) and %i edges (co-actorships by titles), i.e., pair

if Ga1.is_multigraph()==True:
    print("The co-actorship (by titles) graph in the period %s is a multigr
else:
    print("The co-actorship (by titles) graph in the period %s is a simple 
if nx.is_weighted(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is a weighte
else:
    print("The co-actorship (by titles) graph in the period %s is an unweig

ncc=nx.number_connected_components(Ga1)
if nx.is_connected(Ga1)==True:
    print("The co-actorship (by titles) graph in the period %s is connected
else:
    print("The co-actorship (by titles) graph in the period %s is not conne
Gl = sorted(nx.connected_component_subgraphs(Ga1), key = len, reverse=True)
Ga1c=Ga1.subgraph(Gl[0])
print('The largest connected component has:')
print("%i nodes (actors) and %i edges (co-actorships by titles)" %(len(Ga1c
pos=graphviz_layout(Ga1)

labels={}
for n in Ga1.nodes():
    labels[n]=n

node_size2=[20*Ga1.degree(n) for n in Ga1.nodes()]

fig = plt.figure(figsize=(15,12))
nx.draw_networkx_nodes(Ga1,pos=pos,node_color='lime',node_size=node_size2,f
nx.draw_networkx_edges(Ga1,pos=pos,edge_width=edge_width,edge_color='lights
# nx.draw_networkx_labels(H,pos=pos,labels=labels,font_size=15);
sst="The Co-Actorship (by titles) Graph in the period %s \n in a random sam
fig.suptitle(sst,x=0.5, y=.95, fontsize=20);
plt.axis('off');
yoffset = {}
y_off = -20 #0.05  # offset on the y axis
for k, v in pos.items():
    yoffset[k] = (v[0], v[1]+y_off)
nx.draw_networkx_labels(Ga1, yoffset,labels=labels,font_size=9);
plt.margins(x=0.1, y=0.1);
plt.show()
```

```
The co-actorship (by titles) multigraph in the period 2016-19 has:
44 nodes (actors) and 69 edges (co-actorships by titles), i.e., pairs of
actors starring in the same film)
The co-actorship (by titles) graph in the period 2016-19 is a multigraph
The co-actorship (by titles) graph in the period 2016-19 is a weighted gr
aph
```

```
The co-actorship (by titles) graph in the period 2016-19 is not connected
and it has 9 connected components
The largest connected component has:
7 nodes (actors) and 12 edges (co-actorships by titles)
```

The Co-Actorship (by titles) Graph in the period 2016-19
in a random sample of 100the top 300 imdb best Korean movies



```
In [ ]:
```