Import modules to handle dataframes, plotting, graphing centrality, and shortest path

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import networkx as nx
import matplotlib.colors as mcolors
```

Load movie data into dataframes, and drop unwanted rows

In [2]:
```
local_file = 'watchlist.txt'
header_field = ['tconst']
watchlist_info = pd.read_csv(local_file, names=header_field)
watchlist = []
watchlist = watchlist_info['tconst'].tolist() # refactor this to load direct to list, don't need a df
```

In [3]:
```
local_file = 'movie_info.csv'
movie_info = pd.read_csv(local_file, sep='\t')
```

In [4]:
```
movie_info = movie_info[movie_info['tconst'].isin(watchlist) == True]  # drop movies not on/by Hallmark
```

In [5]:
```
local_file = 'cast_crew_info.csv'
cast_crew_info = pd.read_csv(local_file, sep='\t')
```

In [6]:
```
actorlist = cast_crew_info['nconst'].tolist()  # all the Hallmark actors
actorlist = list(set(actorlist))
```

In [7]:
```
cast_crew_info = cast_crew_info[cast_crew_info['nconst'].isin(actorlist) == True]  # drop people not in
```

In [8]:
```
#local_file = 'movie_crew.csv'  # may be able to use for ML, but not yet
#movie_crew = pd.read_csv(local_file, sep='\t')
```

In [9]:
```
#movie_crew = movie_crew[movie_crew['tconst'].isin(watchlist) == True]  # drop people not associated w/t
```

In [10]:
```
local_file = 'movie_cast_crew.csv'
movie_cast_crew = pd.read_csv(local_file, sep='\t')
```

In [11]:
```
movie_cast_crew = movie_cast_crew[movie_cast_crew['tconst'].isin(watchlist) == True]  # drop non-Hallmar
```

In [12]:
```
unwantedValues = ['composer', 'cinematographer', 'editor', 'production_designer',
                  'self']  # leave sactor, actress, writer, producer, director categories
```

In [13]:
```
movie_cast_crew = movie_cast_crew[movie_cast_crew['category'].isin(unwantedValues) == False]
# keep actor, actress rows
```

In [14]:
```
movielist = movie_cast_crew['tconst'].tolist()  # all the Hallmark movies
movielist = list(set(movielist))
```

Create lookup dictionaries for all four tables

In [15]:
```
df = movie_cast_crew.groupby('nconst')['tconst'].apply(list).reset_index(name="movieList")
```

In [16]:
```
nm_tt = dict(zip(df.nconst, df.movieList))  # list of movies each actor starred in
```

In [17]:
```
df = movie_cast_crew.groupby('tconst')['nconst'].apply(list).reset_index(name="actorList")
```

In [18]:
```
tt_nm = dict(zip(df.tconst, df.actorList))  # list for dictionary lookup of actors in a movie
```

In [19]:
```
df = cast_crew_info  # source of ID no, full name, birth year, death year, etc.
```

In [20]:
```
nm_name = dict(zip(df.nconst, df.primaryName))  # create a lookup dictionary
```

In [21]:
```
df = movie_info  # includes title, release year, runtime, ratings, num votes
```

In [22]:
```
tt_title = dict(zip(df.tconst, df.primaryTitle)) # create lookup table
```

In [23]:
```
title_tt = dict(zip(df.primaryTitle, df.tconst))  # create a dictionary mapping movie titles to codes
```

In [24]:
```
tt_rating = dict(zip(df.tconst, df.averageRating)) # create lookup table
```

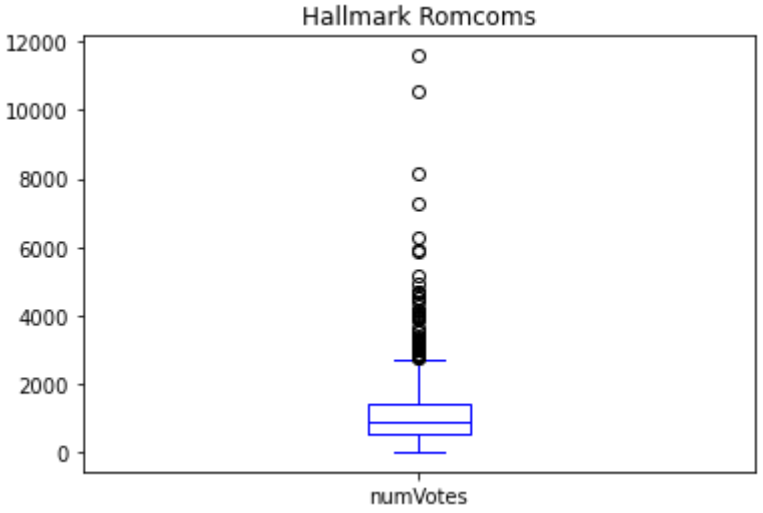
In [25]:
```
title_rating = dict(zip(df.primaryTitle, df.averageRating)) # create lookup table
```

Analyze movie data using basic visualizations

In [26]:
```
%matplotlib inline
```

In [27]:
```
df = movie_info  #let's start with the movie database
```

In [28]:
```
df.numVotes.plot(kind='box', title='Hallmark Romcoms', color='b');  #older, more popular probably get mo
```



In [29]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1141 entries, 0 to 1140
Data columns (total 8 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   tconst          1141 non-null   object 
 1   titleType       1141 non-null   object 
 2   primaryTitle    1141 non-null   object 
 3   startYear       1141 non-null   object 
 4   runtimeMinutes  1141 non-null   int64  
 5   genres          1141 non-null   object 
 6   averageRating   1141 non-null   float64
 7   numVotes        1141 non-null   int64  
dtypes: float64(1), int64(2), object(5)
memory usage: 80.2+ KB
```

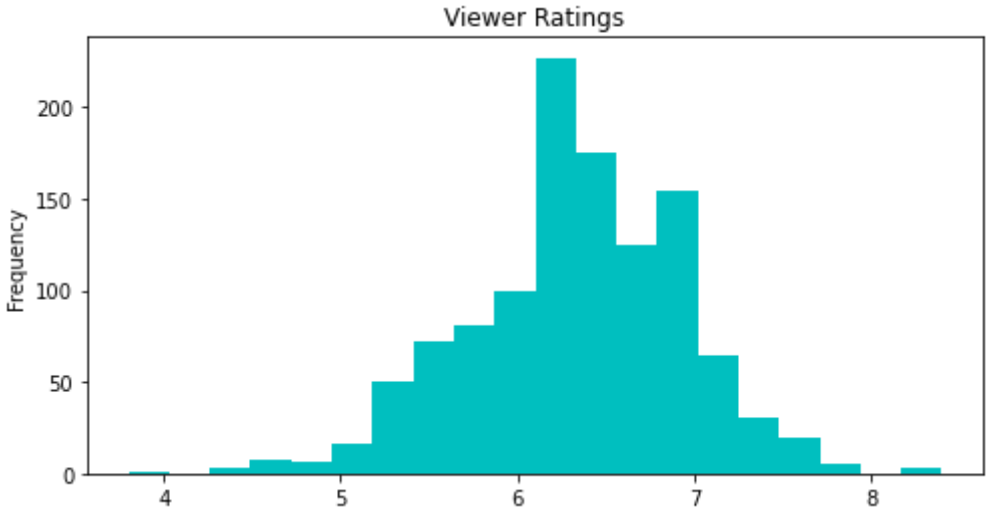
In [30]:
```
df['startYear'] = pd.to_numeric(df['startYear'], errors='coerce') #convert to float
df['startYear'] = df['startYear'].astype("Int64") #then back to integer (refactor later)
```

In [31]:
```
df.info()  #that's better!
```

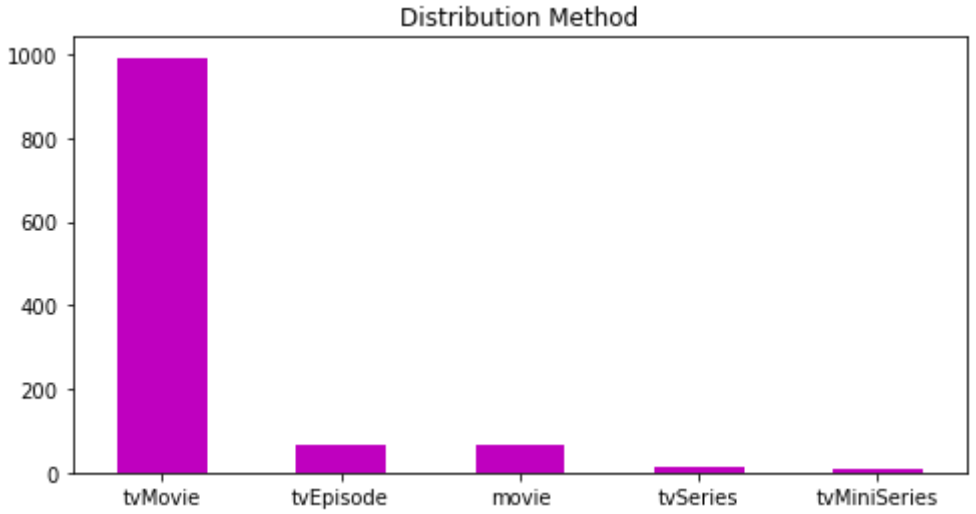
```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1141 entries, 0 to 1140
Data columns (total 8 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   tconst          1141 non-null   object 
 1   titleType       1141 non-null   object 
 2   primaryTitle    1141 non-null   object 
 3   startYear       1136 non-null   Int64  
 4   runtimeMinutes  1141 non-null   int64  
 5   genres          1141 non-null   object 
 6   averageRating   1141 non-null   float64
 7   numVotes        1141 non-null   int64  
dtypes: Int64(1), float64(1), int64(2), object(4)
memory usage: 81.3+ KB
```

In [32]:
```
plt.rcParams["figure.figsize"] = (8,4)
```

In [33]:
```
df.averageRating.plot(kind='hist',
                      title='Viewer Ratings',
                      color='c',
                      bins=20);  # most people rate movies between 5 and 7, mostly in 6 range
```



In [34]:
```
df.titleType.value_counts().plot(kind='bar',
                                 rot=0,
                                 title='Distribution Method',
                                 color='m');  # could probably drop lowest categories - should be more t
```

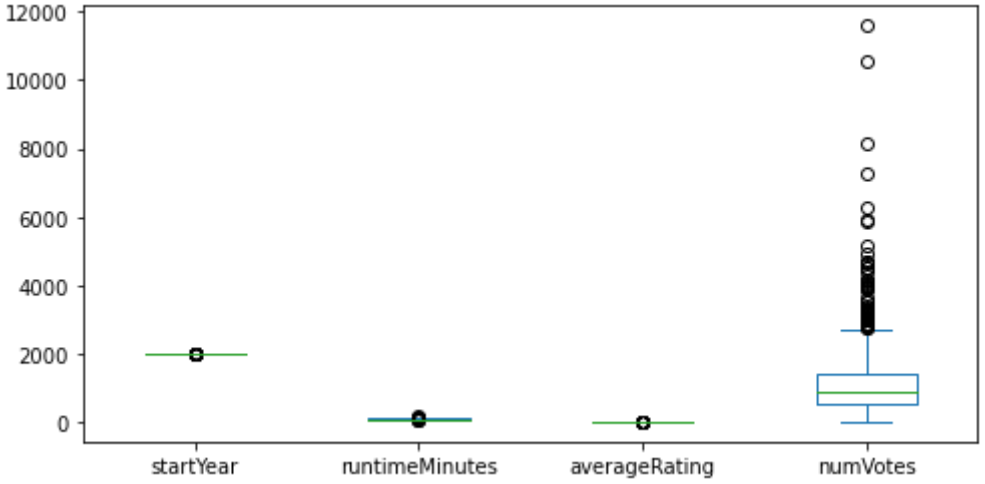


In [35]:
```
df.groupby(['titleType']).agg({ 'numVotes': 'mean', 'averageRating': 'mean', 'runtimeMinutes': 'median'
```

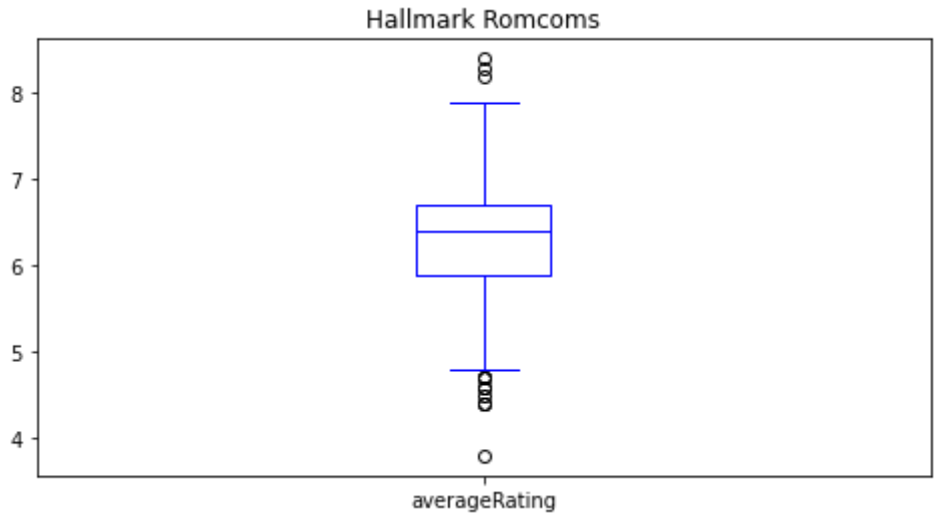
Out[35]:

titleType	numVotes	averageRating	runtimeMinutes
movie	770.234375	5.795312	88.0
tvEpisode	753.545455	6.862121	84.0
tvMiniSeries	281.428571	7.285714	80.0
tvMovie	1150.806452	6.304335	85.0
tvSeries	833.750000	7.450000	80.0

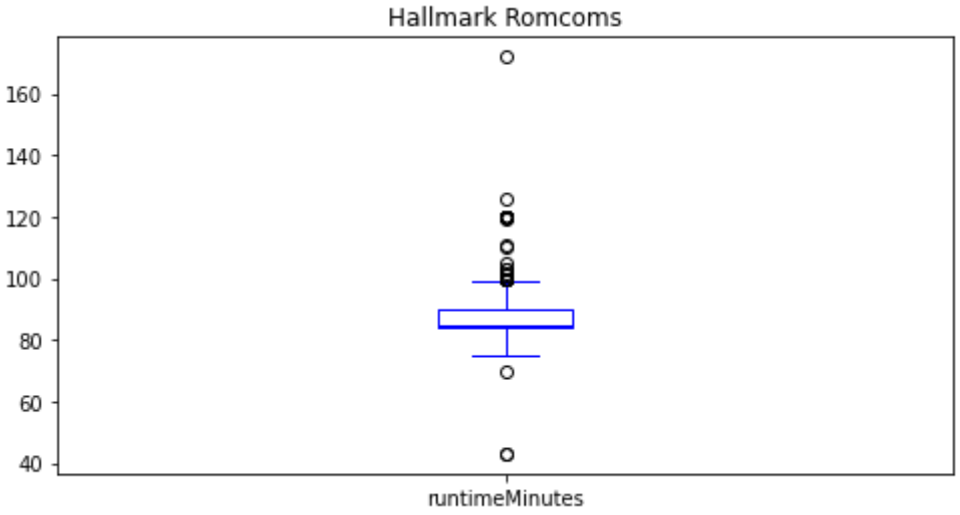
In [36]:
```
df.plot(kind='box');
```



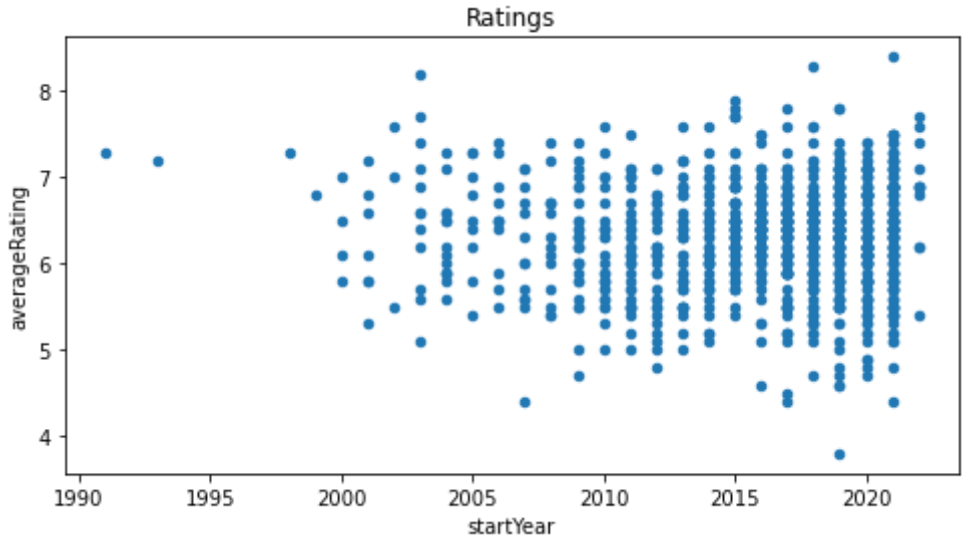
In [37]:
```
df.averageRating.plot(kind='box', title='Hallmark Romcoms', color='b');  # mirrors what we saw in bar gr
```



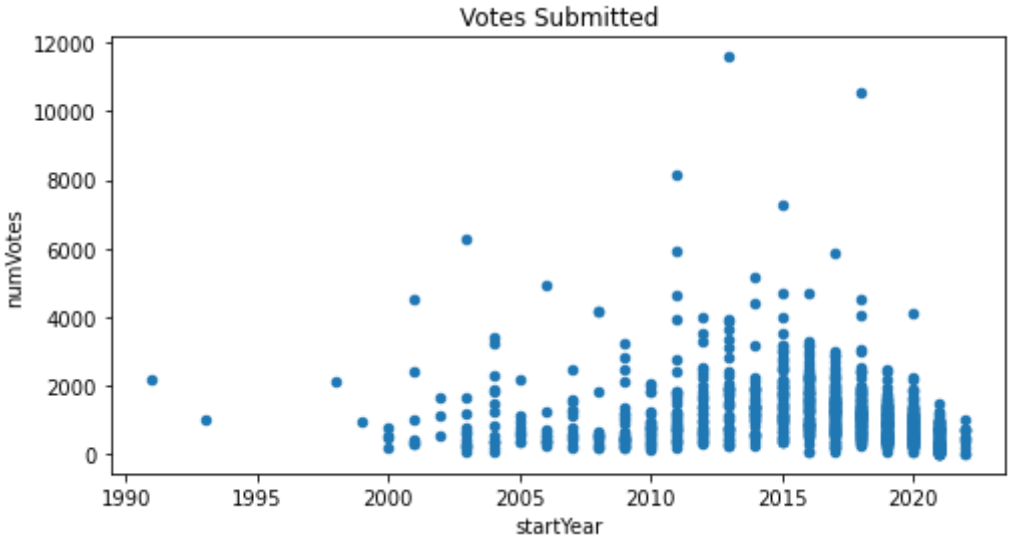
In [38]:
```
df.runtimeMinutes.plot(kind='box', title='Hallmark Romcoms', color='b');
```



In [39]:
```
df.plot.scatter(x='startYear', y='averageRating', title="Ratings");  # social media influence? COVID?
```



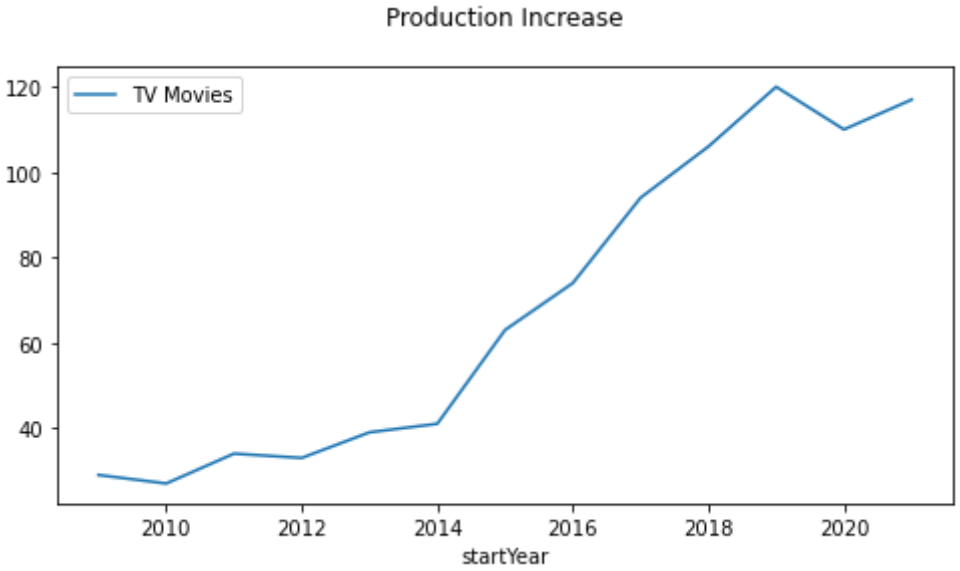
In [40]:
```
df.plot.scatter(x='startYear', y='numVotes', title="Votes Submitted"); # less votes, more movies?
```



In [41]:
```
annual_volume = pd.crosstab(df.startYear, df.titleType)[-14:-1]  # number of movies produced annually ir
```

In [42]:
```
annual_volume.tvMovie.plot(kind='line')
annual_volume.index.names = ['Year']  # change the index for graph
plt.legend(['TV Movies'])
plt.title('Production Increase\n')
```

Out[42]:
```
Text(0.5, 1.0, 'Production Increase\n')
```



In [43]:
```
pd.crosstab(df.startYear, df.titleType)[-14:-1]
```

Out[43]:

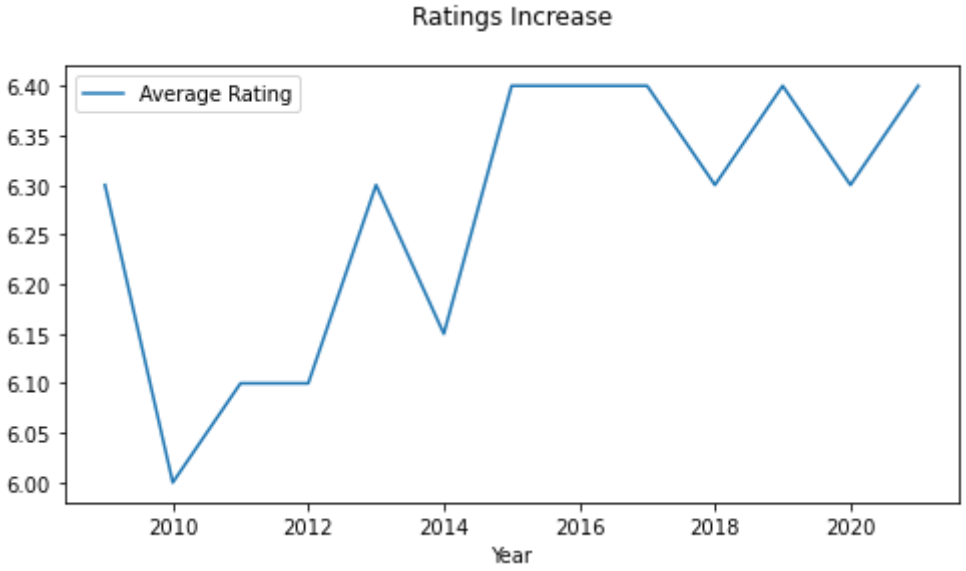
titleType	movie	tvEpisode	tvMiniSeries	tvMovie	tvSeries
startYear					
2009	0	0	0	29	0
2010	0	0	0	27	0
2011	1	0	0	34	0
2012	0	0	0	33	0
2013	0	1	0	39	1
2014	0	1	0	41	0
2015	2	5	2	63	1
2016	6	7	0	74	1
2017	9	8	3	94	0
2018	5	7	0	106	1
2019	15	20	2	120	3
2020	15	9	0	110	2
2021	11	7	0	117	1

In [44]:
```
annual_ratings = df.groupby(['startYear']).agg({ 'averageRating': 'median'})[-14:-1]   # recent annual p
annual_ratings.columns = ["Avg Rating"]  # change the name for graph
annual_ratings.index.names = ['Year']  # change the index for graph
annual_ratings
```

Out[44]:

Year	Avg Rating
2009	6.30
2010	6.00
2011	6.10
2012	6.10
2013	6.30
2014	6.15
2015	6.40
2016	6.40
2017	6.40
2018	6.30
2019	6.40
2020	6.30
2021	6.40

In [45]:
```
annual_ratings.plot(kind='line')
plt.legend(['Average Rating'])
plt.title('Ratings Increase\n');
```



Graph network plot and determine centrality

In [46]:
```
titles = watchlist
```

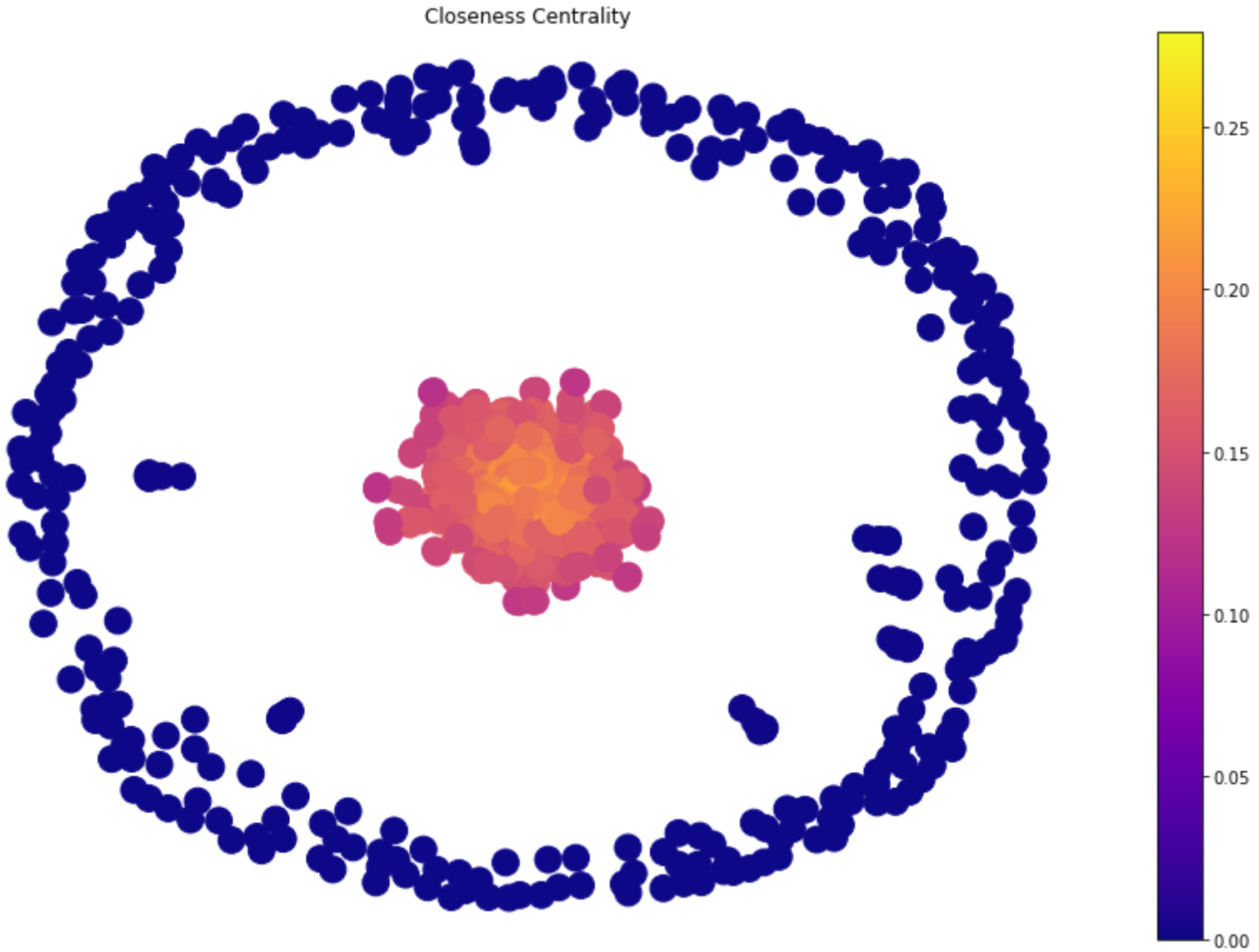
In [47]:
```
G = nx.Graph()  # prototype for logic in main project module
edge_attribute_dict = {}
for name_ID, titles in nm_tt.items():
    G.add_node(name_ID)  # save people as nodes
    for title in titles:
        for name_ID2, titles2 in nm_tt.items():
            if (title in titles2) and (titles2 != titles):
                G.add_edge(name_ID, name_ID2)  # save movies as edges
                name_ID_tuple = tuple(sorted((name_ID, name_ID2)))
                if name_ID_tuple not in edge_attribute_dict:
                    edge_attribute_dict[name_ID_tuple] = 1
                else:
                    edge_attribute_dict[name_ID_tuple] += 1 # keep count of movies both starred in, for
```

In [48]:
```
for k,v in edge_attribute_dict.items():  # calculate centrality with weighted edges of more movies costa
    edge_attribute_dict[k] = {'weight':v}
```

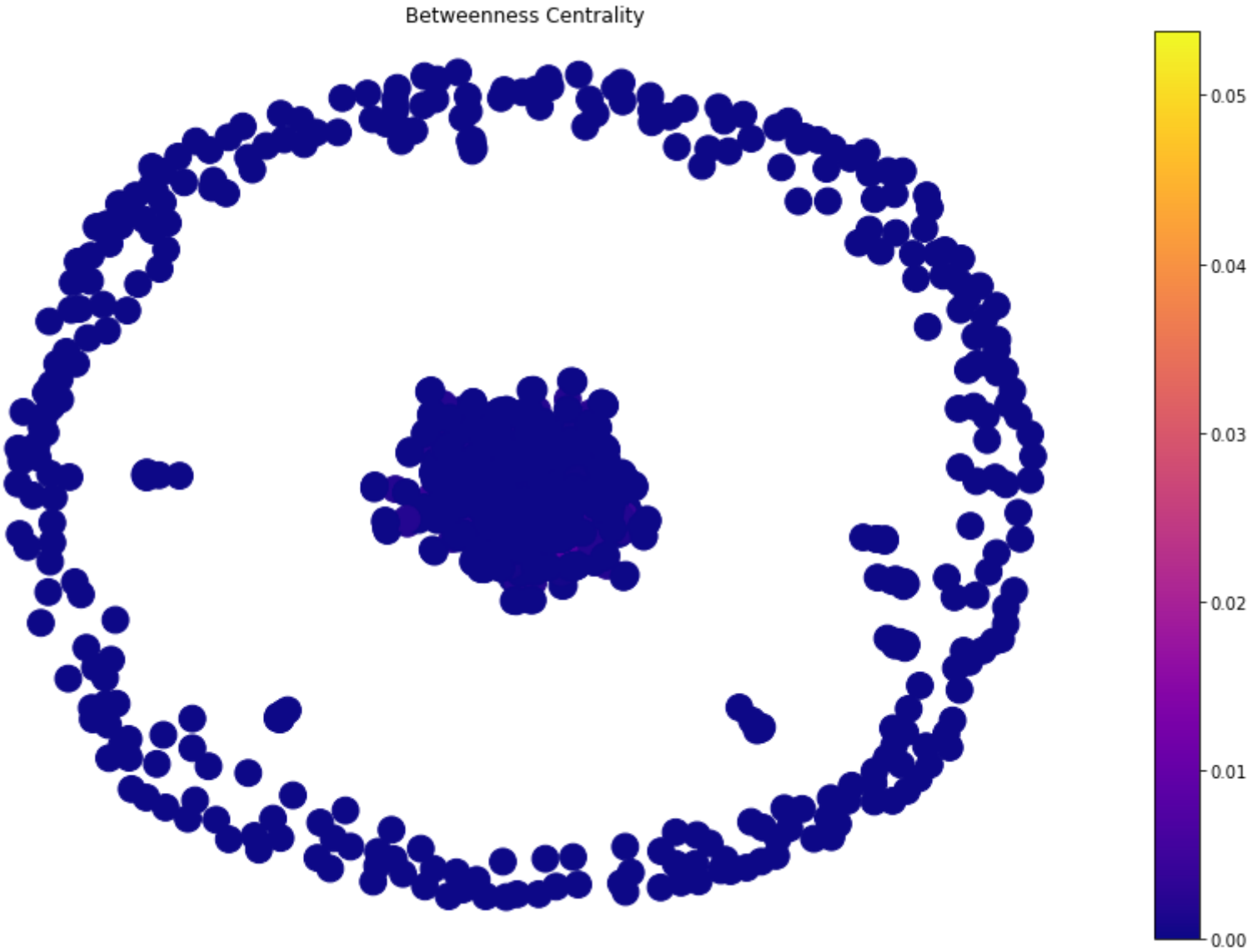
In [49]:
```
import matplotlib.colors as mcolors   # courtesy of aksakalli.github.io
pos = nx.spring_layout(G, seed=675)
def draw(G, pos, measures, measure_name):  # use this function for nicer looking color graphs below
    nodes = nx.draw_networkx_nodes(G, pos, node_size=250, cmap=plt.cm.plasma,
                                   node_color=list(measures.values()),
                                   nodelist=measures.keys())  # removed color line, caused errors
    # labels = nx.draw_networkx_labels(G, pos)
    edges = nx.draw_networkx_edges(G, pos)
    plt.title(measure_name)
    plt.colorbar(nodes)
    plt.axis('off')
    plt.show()
```

In [50]:
```
plt.rcParams["figure.figsize"] = (15, 10)  # make these three graphs a little larger for analysis
```

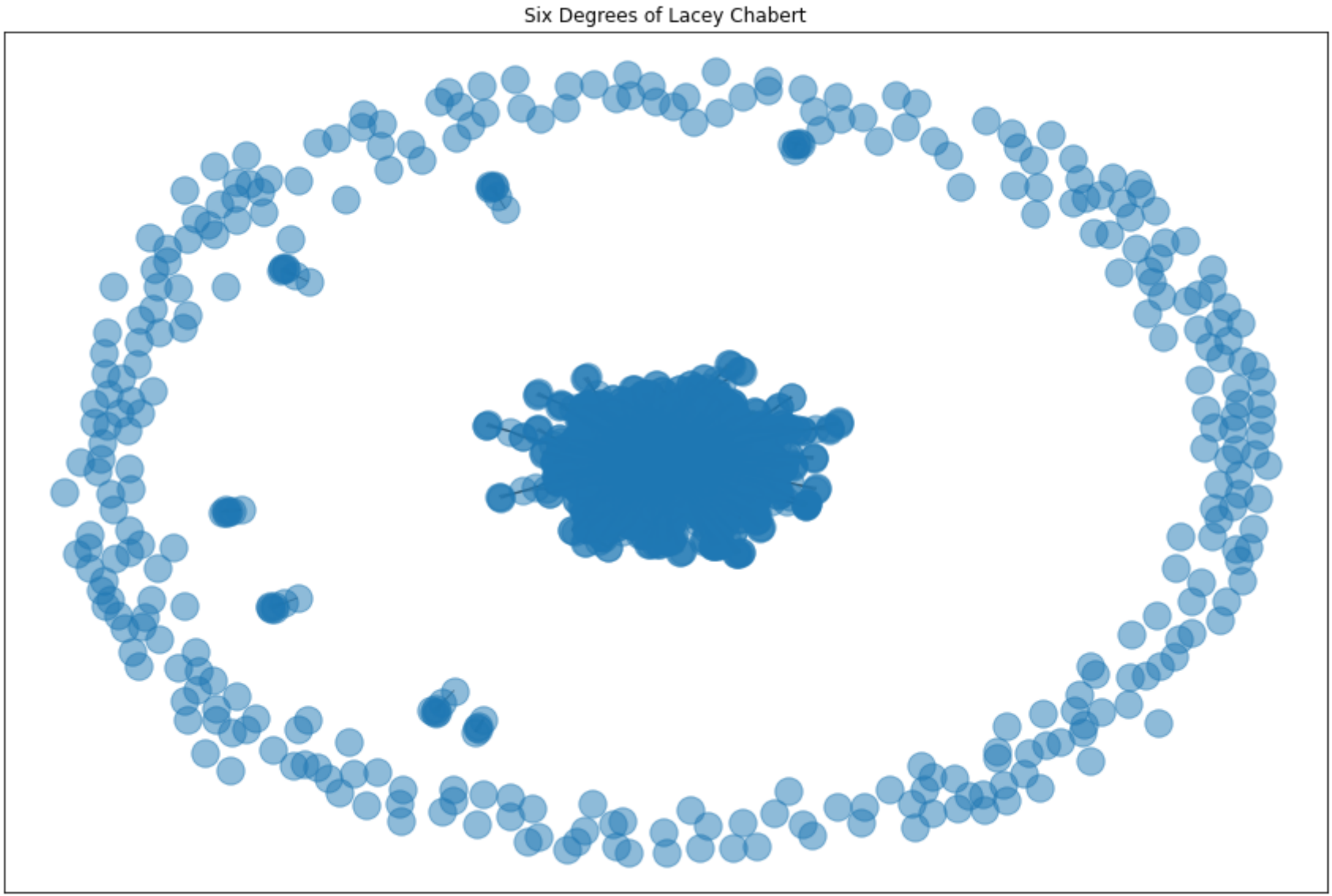
In [51]:
```
draw(G, pos, nx.closeness_centrality(G), 'Closeness Centrality')  # uses draw function coded above
```



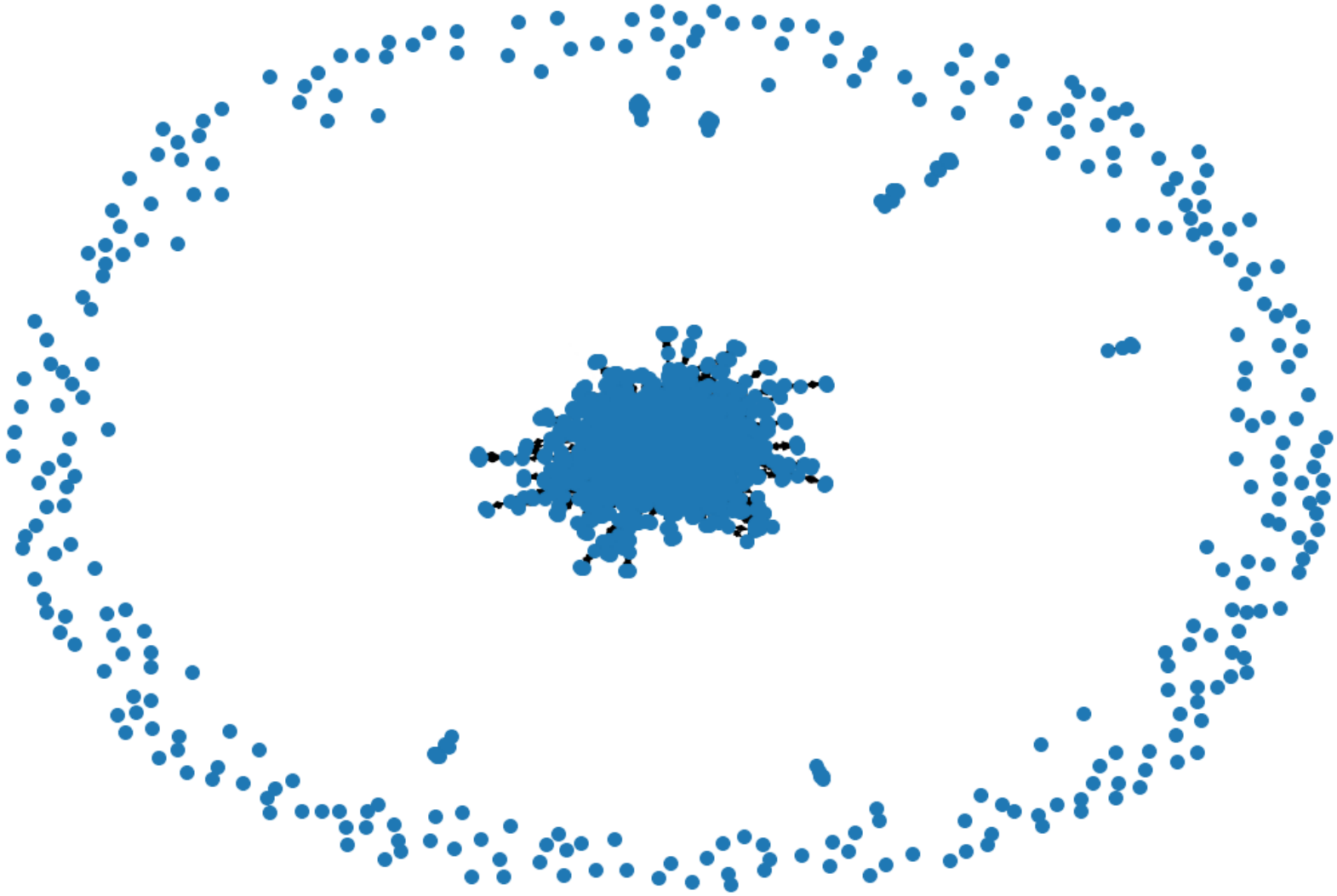
In [52]:
```
draw(G, pos, nx.betweenness_centrality(G), 'Betweenness Centrality')  # similar results, main cluster ar
```



In [53]:
```
#color_map = [n[1]['color'] for n in G.nodes(data=True)]  # plot with an alpha value for strength of cer
labels = {n:n for n in G.nodes()}
plt.title('Six Degrees of Lacey Chabert')
nx.draw_networkx(G, alpha=0.5, labels=labels, with_labels=False)
#nx.draw_networkx(G, node_color=color_map, alpha=0.5, labels=labels, with_labels=False)
```



In [54]:
```
nx.draw_spring(G.to_directed(), node_size=100)  # some fringe people only acted in 1 movie in the list
```



In [55]:
```
between_ity = nx.betweenness_centrality(G)  # comfirms general results of main prgoject, few variations
[(nm_name[x], between_ity[x]) for x in sorted(between_ity, key=between_ity.get, reverse=True)[:10]]
```

Out[55]:
```
[('Lacey Chabert', 0.05378388747600292),
 ('Andrew W. Walker', 0.039791565438469595),
 ('Cindy Busby', 0.03142992282708718),
 ('Candace Cameron Bure', 0.03101284389823941),
 ('Danica McKellar', 0.029818411144530352),
 ('Trevor Donovan', 0.027440188481101538),
 ('Jen Lilley', 0.02567108387900853),
 ('Alison Sweeney', 0.023808686187877195),
 ('Corey Sevier', 0.023466145149259893),
 ('Stephen Huszar', 0.022368595798011343)]
```

In [56]:
```
close_ity = nx.closeness_centrality(G)  # not as useful without removing titles from list
[(nm_name[x], close_ity[x]) for x in sorted(close_ity, key=close_ity.get, reverse=True)[:10]]
```

Out[56]:
```
[('Lacey Chabert', 0.27908807591534335),
 ('Andrew W. Walker', 0.2735418778047684),
 ('Barbara Niven', 0.26662547072143034),
 ('Danica McKellar', 0.26544796974665585),
 ('Candace Cameron Bure', 0.26393267835026835),
 ('Christopher Russell', 0.26152111073082424),
 ('Niall Matter', 0.26046339137498675),
 ('Autumn Reeser', 0.26038816729083514),
 ('Alison Sweeney', 0.26031298664487273),
 ('Jen Lilley', 0.25956356103196104)]
```

In [57]:
```
G1 = nx.Graph()  # this approach uses actors and movies as nodes, for better SP and Degree Separation lo
names = {}
for n, star in enumerate(movie_cast_crew.nconst.unique()):
    name = nm_name[star]
    names[star] = name
    G1.add_node(name)
for n, movie in enumerate(movie_cast_crew.tconst.unique()):
    name = tt_title[movie]
    names[movie] = name
    G1.add_node(name)
for row in movie_cast_crew.index:
    star = movie_cast_crew['nconst'][row]
    s_name = names[star]
    movie = movie_cast_crew['tconst'][row]
    m_name = names[movie]
    G1.add_edge(s_name, m_name)
sp = nx.all_pairs_shortest_path(G1)  # saerved as SP source in main module of project, exported as pickl
```

In [58]:
```
lacey1 = nx.single_source_shortest_path(G1, 'Lacey Chabert', cutoff=7) # can map specific distances (not
```

In [59]:
```
path = nx.single_source_shortest_path(G1, 'Lacey Chabert')  # map of all Degrees of Separation from Lace
```

In [60]:
```
path['Autumn Reeser']  # has Autumn ever starred with Lacey? Yep, in "The Wedding Veil"
```

Out[60]:
```
['Lacey Chabert', 'The Wedding Veil', 'Autumn Reeser']
```

In [61]:
```
path['Cindy Busby']  # what about Cindy? She starred in Wedding March w/Tyler, who was in Winter in Vail
```

Out[61]:
```
['Lacey Chabert',
 'Winter in Vail',
 'Tyler Hynes',
 "Wedding March 5: My Boyfriend's Back",
 'Cindy Busby']
```

In [62]:
```
movie_cast_crew.head()  # could refactor and keep director, cinematographer, and writer in results
```

Out[62]:

	tconst	nconst	category
0	tt0102842	nm0000335	actress
1	tt0102842	nm0000686	actor
2	tt0102842	nm0709634	actress
3	tt0102842	nm0825555	actress
4	tt0108159	nm0000335	actress

In [63]:
```
cast_crew_info.head()  # mean age of actors/actresses could be a feature for analysis
```

Out[63]:

	nconst	primaryName	birthYear	deathYear
0	nm0000137	Bo Derek	1956	\N
1	nm0000145	Sherilyn Fenn	1965	\N
2	nm0000157	Linda Hamilton	1956	\N
3	nm0000162	Anne Heche	1969	\N
4	nm0000176	Nastassja Kinski	1961	\N

In [64]:
```
movie_info.head()  # genres could be an feature for research later, as well as a seasonal feature (Chris
```

Out[64]:

	tconst	titleType	primaryTitle	startYear	runtimeMinutes	genres	averageRating	numVotes
0	tt0102842	tvMovie	Sarah, Plain and Tall	1991	98	Drama,Family,Romance	7.3	2155
1	tt0108159	tvMovie	Skylark	1993	95	Drama	7.2	1010
2	tt0140340	tvMovie	The Love Letter	1998	99	Fantasy,Romance	7.3	2090
3	tt0184799	tvMovie	Ordinary Miracles	2005	85	Drama	6.4	530
4	tt0192573	tvMovie	Sarah, Plain & Tall: Winter's End	1999	95	Drama	6.8	954

In [65]:
```
movie_info.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 1141 entries, 0 to 1140
Data columns (total 8 columns):
 #   Column          Non-Null Count  Dtype  
---  ------          --------------  -----  
 0   tconst          1141 non-null   object 
 1   titleType       1141 non-null   object 
 2   primaryTitle    1141 non-null   object 
 3   startYear       1136 non-null   Int64  
 4   runtimeMinutes  1141 non-null   int64  
 5   genres          1141 non-null   object 
 6   averageRating   1141 non-null   float64
 7   numVotes        1141 non-null   int64  
dtypes: Int64(1), float64(1), int64(2), object(4)
memory usage: 81.3+ KB
```

In [66]:
```
cast_crew_info.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 2463 entries, 0 to 2462
Data columns (total 4 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   nconst       2463 non-null   object
 1   primaryName  2463 non-null   object
 2   birthYear    2463 non-null   object
 3   deathYear    2463 non-null   object
dtypes: object(4)
memory usage: 96.2+ KB
```

In [67]:
```
movie_cast_crew.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 4702 entries, 0 to 4701
Data columns (total 3 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   tconst    4702 non-null   object
 1   nconst    4702 non-null   object
 2   category  4702 non-null   object
dtypes: object(3)
memory usage: 276.0+ KB
```

Actor analysis -- who starred in the most movies?

In [68]:
```
nm_tt #let's peek at the database structure
```

```
 'nm0000287': ['tt2288568', 'tt4882698', 'tt6295106'],
 'nm0000304': ['tt0363827'],
 'nm0000308': ['tt0402260', 'tt0950740', 'tt1297854'],
 'nm0000310': ['tt10768456',
  'tt11686340',
  'tt13178100',
  'tt1672621',
  'tt6619330',
  'tt8783262'],
 'nm0000327': ['tt10344956',
  'tt11439610',
  'tt11585200',
  'tt11686354',
  'tt13169850',
  'tt14113198',
  'tt14477372',
  'tt1492820',
  'tt15943556',
  'tt16287754',
```

In [69]:
```
actorlist[:3]  # let's verify we still have a list of Hallmark actors by code
```

Out[69]:
```
['nm0339797', 'nm0569787', 'nm0001337']
```

In [70]:
```
name_count = {}  # create a dictionary to store the sorted movie count by actor
for actor in actorlist:
    name_count[nm_name[actor]] = len(nm_tt[actor])  # count movies for each actor, store in dictionary
sorted_dict = sorted([(value, key)
 for (key, value) in name_count.items()])  # sort the dictionary
df = pd.DataFrame(sorted_dict, columns =["Movies", "Actor"])  # rename the columns for display
df = df.sort_values(by='Movies', ascending=False) # reverse sort the movie count so we can grab top 10
df[:10]  # Sure enough, data confirms Lacey Chabert is the Queen of RomComs at Hallmark!
```

Out[70]:

	Movies	Actor
2462	30	Lacey Chabert
2461	20	Andrew W. Walker
2460	19	Brennan Elliott
2459	18	Cindy Busby
2458	17	Jill Wagner
2457	17	Candace Cameron Bure
2456	16	Lori Loughlin
2455	16	Danica McKellar
2454	16	Barbara Niven
2452	15	Kellie Martin

In [71]:
```
df.describe()  # let's see how top 10 compare to the pack (spoiler alert... Kellie is 99.6 percentile)
```

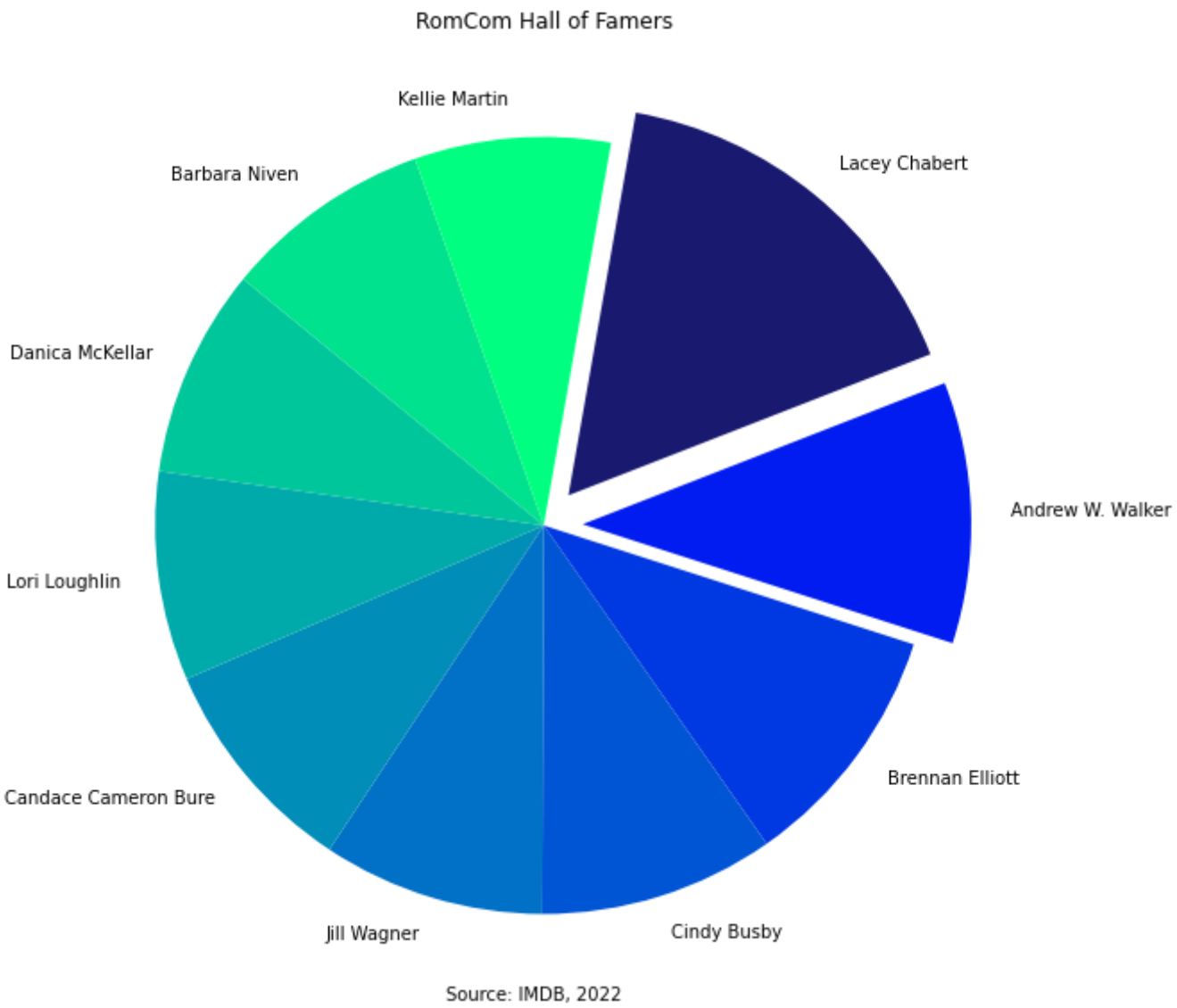
Out[71]:

	Movies
count	2463.000000
mean	1.909054
std	2.176384
min	1.000000
25%	1.000000
50%	1.000000
75%	2.000000
max	30.000000

In [72]:
```
print(df['Movies'].quantile(q=0.990), df['Movies'].quantile(q=0.993), df['Movies'].quantile(q=0.996))
```

```
12.0 13.0 15.0
```

In [73]:
```
top_10 = df[:10]
values = list(top_10['Movies'])  # let's chart the Top 10 on a pie chart, based on # movies starred in
labels = list(top_10['Actor'])
plt.title('RomCom Hall of Famers')
plt.annotate(r'Source: IMDB, 2022', xy=(.4, .01), xycoords='axes fraction')  # throw in a source attribu
colors = ['#191970','#001CF0','#0038E2','#0055D4','#0071C6','#008DB8',\
          '#00AAAA','#00C69C','#00E28E','#00FF80']  # use a blue-green spectrum for the wheel
explode = (.1, .1, 0, 0, 0, 0, 0, 0, 0, 0)  # callout the two two, female and male
plt.pie(values, labels=labels, explode=explode, colors=colors, counterclock=False, shadow=False, startar
plt.show()
```


RomCom Hall of Famers
Kellie Martin
Lacey Chabert
Barbara Niven
Danica McKellar
Andrew W. Walker
Lori Loughlin
Brennan Elliott
Candace Cameron Bure
Jill Wagner
Cindy Busby
Source: IMDB, 2022

In [ ]: