Assignment 2 DMG

In [4]:
```
from google.colab import files
uploaded = files.upload()
```

Choose Files No file chosen Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving links.csv to links (1).csv
Saving movies.csv to movies (1).csv
Saving ratings.csv to ratings (1).csv
Saving tags.csv to tags (1).csv
```

In [74]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

%matplotlib inline
sns.set(color_codes=True)

import io

df_m = pd.read_csv(io.BytesIO(uploaded['movies.csv']))
df_l = pd.read_csv(io.BytesIO(uploaded['links.csv']))
df_r = pd.read_csv(io.BytesIO(uploaded['ratings.csv']))
df_t = pd.read_csv(io.BytesIO(uploaded['tags.csv']))
```

In [75]:
```
id_to_title = dict()
for index, x in df_m.iterrows():
  id_to_title[x['movieId']] = x['title']

title_to_id = dict()
for index, x in df_m.iterrows():
  title_to_id[x['title']] = x['movieId']

id_to_genre = dict()
for index, x in df_m.iterrows():
  id_to_genre[x['movieId']] = x['genres']
```

In [76]:
```
df_m
```

Out[76]:

	movieId	title	genres
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy
1	2	Jumanji (1995)	Adventure|Children|Fantasy
2	3	Grumpier Old Men (1995)	Comedy|Romance
3	4	Waiting to Exhale (1995)	Comedy|Drama|Romance
4	5	Father of the Bride Part II (1995)	Comedy
...	...	...	...
9737	193581	Black Butler: Book of the Atlantic (2017)	Action|Animation|Comedy|Fantasy
9738	193583	No Game No Life: Zero (2017)	Animation|Comedy|Fantasy
9739	193585	Flint (2017)	Drama
9740	193587	Bungo Stray Dogs: Dead Apple (2018)	Action|Animation
9741	193609	Andrew Dice Clay: Dice Rules (1991)	Comedy

9742 rows × 3 columns

In [77]:
```
df_l
```

Out[77]:

	movieId	imdbId	tmdbId
0	1	114709	862.0
1	2	113497	8844.0
2	3	113228	15602.0
3	4	114885	31357.0
4	5	113041	11862.0
...	...	...	...

	movieId	imdbId	tmdbId
9737	193581	5476944	432131.0
9738	193583	5914996	445030.0
9739	193585	6397426	479308.0
9740	193587	8391976	483455.0
9741	193609	101726	37891.0

9742 rows × 3 columns

In [78]:
```
df_r
```

Out[78]:

	userId	movieId	rating	timestamp
0	1	1	4.0	964982703
1	1	3	4.0	964981247
2	1	6	4.0	964982224
3	1	47	5.0	964983815
4	1	50	5.0	964982931
...	...	...	...	...
100831	610	166534	4.0	1493848402
100832	610	168248	5.0	1493850091
100833	610	168250	5.0	1494273047
100834	610	168252	5.0	1493846352
100835	610	170875	3.0	1493846415

100836 rows × 4 columns

In [79]:
```
df_t
```

Out[79]:

	userId	movieId	tag	timestamp
0	2	60756	funny	1445714994
1	2	60756	Highly quotable	1445714996
2	2	60756	will ferrell	1445714992
3	2	89774	Boxing story	1445715207
4	2	89774	MMA	1445715200
...	...	...	...	...
3678	606	7382	for katie	1171234019
3679	606	7936	austere	1173392334
3680	610	3265	gun fu	1493843984
3681	610	3265	heroic bloodshed	1493843978
3682	610	168248	Heroic Bloodshed	1493844270

3683 rows × 4 columns

Question 1

Counting of NaN values per column

In [80]:

```
print('\n- movies.csv -')
print(df_m.isnull().sum(axis=0))
print('\n- ratings.csv -')
print(df_r.isnull().sum(axis=0))
print('\n- tags.csv -')
print(df_t.isnull().sum(axis=0))
print('\n- links.csv -')
print(df_l.isnull().sum(axis=0))
```

```
- movies.csv -
movieId    0
title      0
```

```
genres     0
dtype: int64

- ratings.csv -
userId       0
movieId      0
rating       0
timestamp    0
dtype: int64

- tags.csv -
userId       0
movieId      0
tag          0
timestamp    0
dtype: int64

- links.csv -
movieId    0
imdbId     0
tmdbId     8
dtype: int64
```

Details of each dataset

In [81]:

```
print('\n- movies.csv -')
df_m.info()
print('\n- ratings.csv -')
df_r.info()
print('\n- tags.csv -')
df_t.info()
print('\n- links.csv -')
df_l.info()
```

```
- movies.csv -
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9742 entries, 0 to 9741
Data columns (total 3 columns):
 #   Column   Non-Null Count  Dtype 
---  ------   --------------  ----- 
 0   movieId  9742 non-null   int64 
 1   title    9742 non-null   object
 2   genres   9742 non-null   object
dtypes: int64(1), object(2)
memory usage: 228.5+ KB
```

```
- ratings.csv -
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100836 entries, 0 to 100835
Data columns (total 4 columns):
 #   Column     Non-Null Count   Dtype  
---  ------     --------------   -----  
 0   userId     100836 non-null  int64  
 1   movieId    100836 non-null  int64  
 2   rating     100836 non-null  float64
 3   timestamp  100836 non-null  int64  
dtypes: float64(1), int64(3)
memory usage: 3.1 MB

- tags.csv -
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3683 entries, 0 to 3682
Data columns (total 4 columns):
 #   Column     Non-Null Count  Dtype 
---  ------     --------------  ----- 
 0   userId     3683 non-null   int64 
 1   movieId    3683 non-null   int64 
 2   tag        3683 non-null   object
 3   timestamp  3683 non-null   int64 
dtypes: int64(3), object(1)
memory usage: 115.2+ KB

- links.csv -
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9742 entries, 0 to 9741
Data columns (total 3 columns):
 #   Column   Non-Null Count  Dtype  
---  ------   --------------  -----  
 0   movieId  9742 non-null   int64  
 1   imdbId   9742 non-null   int64  
 2   tmdbId   9734 non-null   float64
dtypes: float64(1), int64(2)
memory usage: 228.5 KB
```

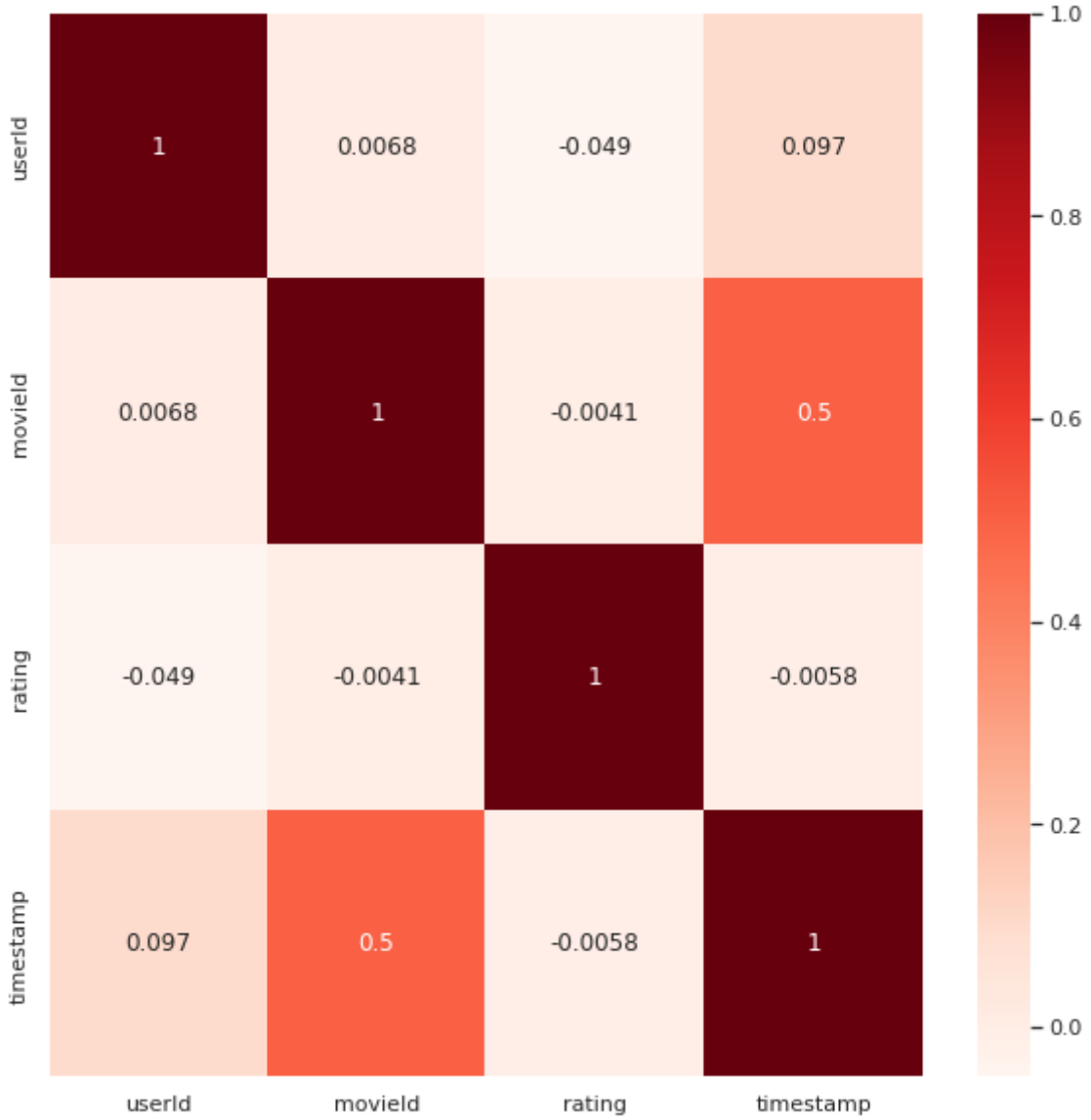
Plotting correlation matrix

In [82]:

```
plt.figure(figsize=(10,10))
sns.heatmap(df_r.corr(), cbar=True, annot=True, cmap='Reds')
```

Out[82]:

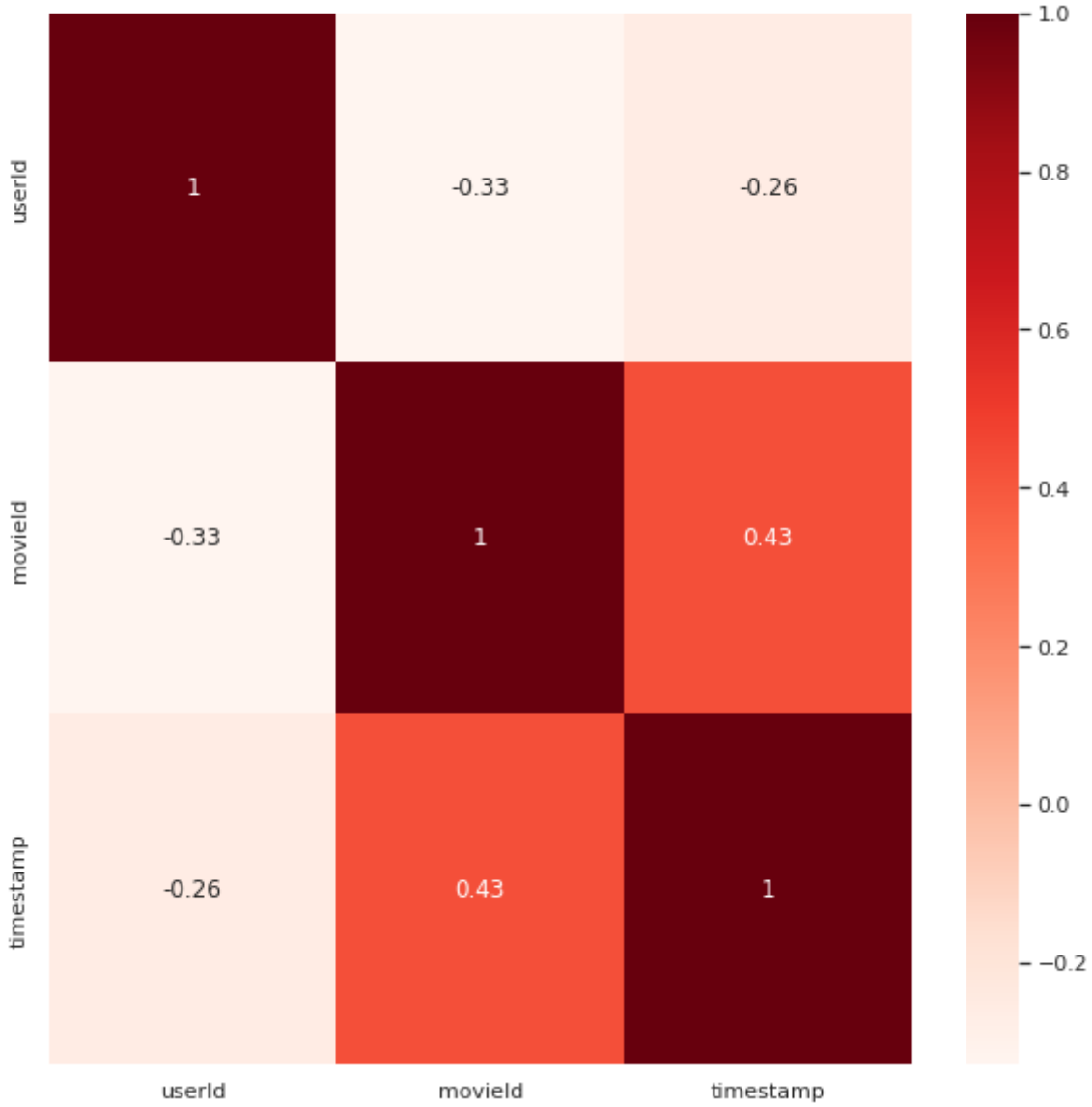
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe18515f050>
```



In [83]:

```
plt.figure(figsize=(10,10))
sns.heatmap(df_t.corr(), cbar=True, annot=True, cmap='Reds')
```

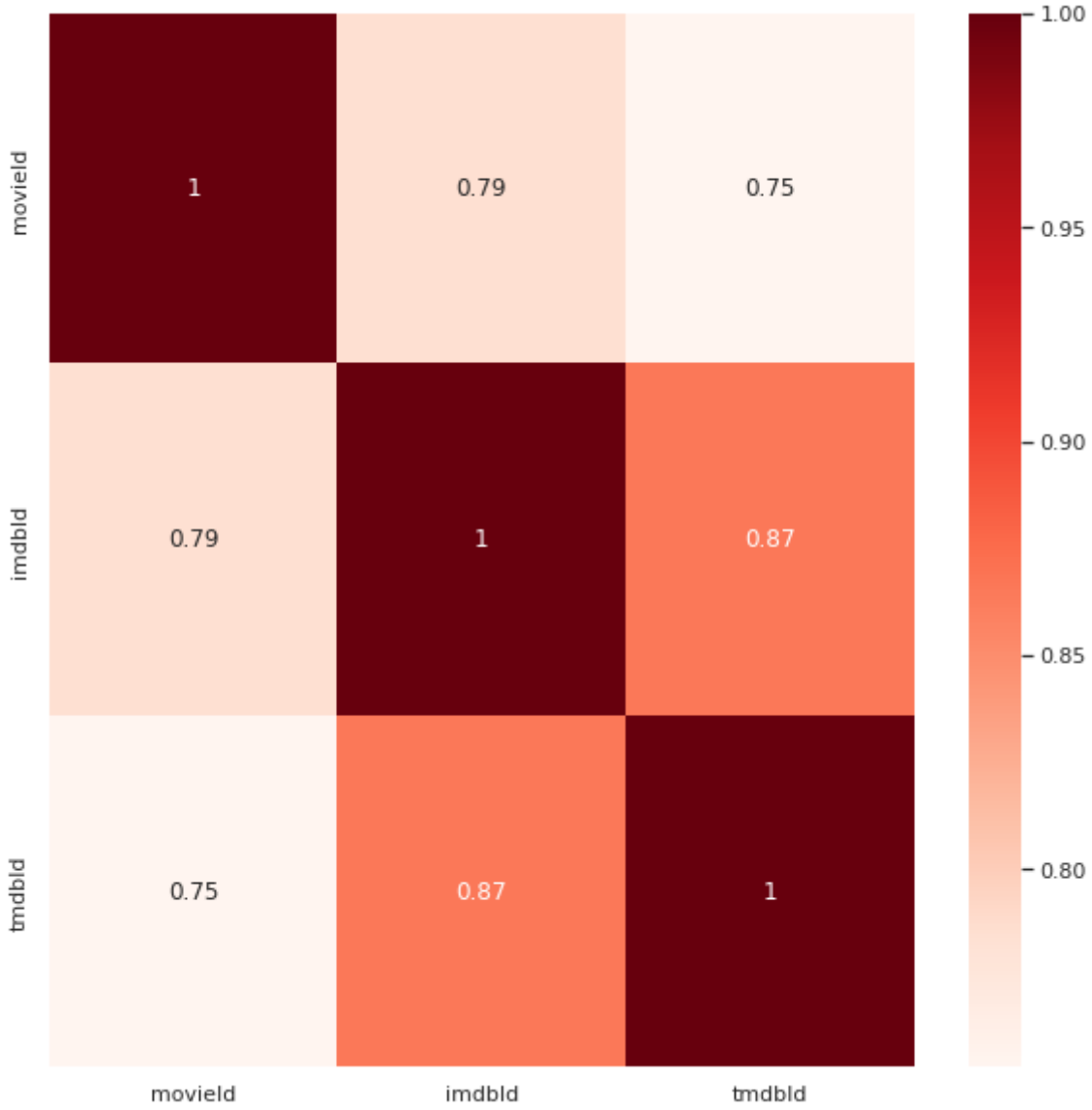
Out[83]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe18cc58310>



In [84]:

```
plt.figure(figsize=(10,10))
sns.heatmap(df_1.corr(), cbar=True, annot=True, cmap='Reds')
```

Out[84]: <matplotlib.axes._subplots.AxesSubplot at 0x7fe184ce3d10>



Frequency distribution of ratings

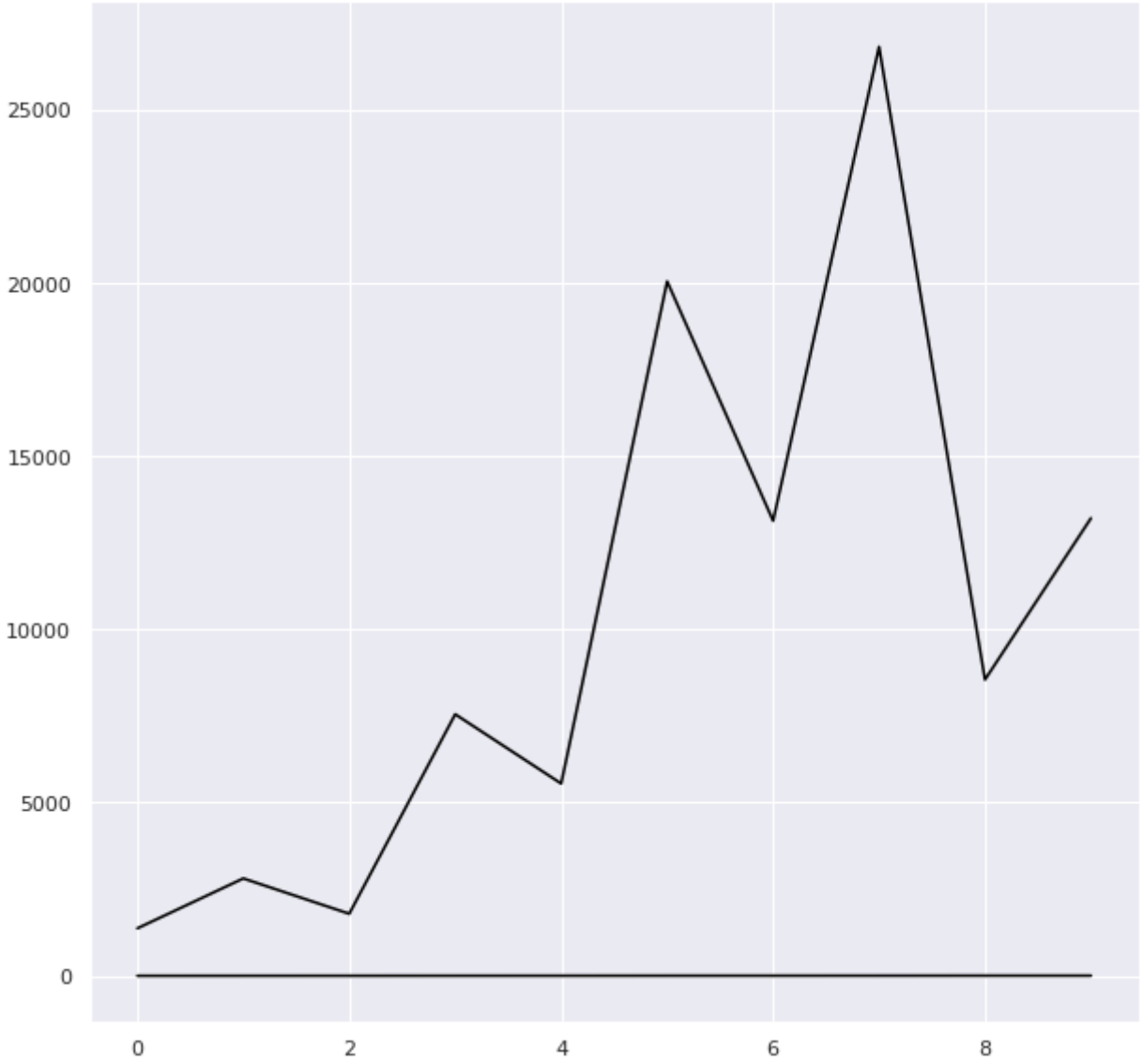
In [85]:

```
rating_dist = df_r['rating'].value_counts()
rating_dist
```

Out[85]:
```
4.0    26818
3.0    20047
5.0    13211
3.5    13136
4.5     8551
2.0     7551
2.5     5550
1.0     2811
1.5     1791
0.5     1370
Name: rating, dtype: int64
```

In [86]:
```
rating_val = [(0.5, 1370), (1.0, 2811), (1.5, 1791), (2.0, 7551), (2.5, 5550), (3.0, 20047), (3.5, 13136), (4.0, 26818), (4.5, 855
plt.figure(figsize=(10, 10))
plt.plot(rating_val, 'black')
```

Out[86]:
```
[<matplotlib.lines.Line2D at 0x7fe1a0830790>,
 <matplotlib.lines.Line2D at 0x7fe1a0830990>]
```



Frequency distribution of tags

In [87]:
```
print(df_t['tag'].value_counts())
```

```
In Netflix queue     131
atmospheric           36
```

```
superhero             24
thought-provoking     24
Disney                23
                     ...
rabbi                  1
tedious                1
awkward                1
masculinity            1
MMA                    1
Name: tag, Length: 1589, dtype: int64
```

Distribution of movies by genres

In [88]:

```
freq_temp = dict()
for index, row in df_m.iterrows():
    curr = row['genres'].split('|')
    for vals in curr:
      if vals not in freq_temp:
        freq_temp[vals] = 1
      else:
        freq_temp[vals] += 1

for genre, cnt in freq_temp.items():
  print(genre, cnt)
```

```
Adventure 1263
Animation 611
Children 664
Comedy 3756
Fantasy 779
Romance 1596
Drama 4361
Action 1828
Crime 1199
Thriller 1894
Horror 978
Mystery 573
Sci-Fi 980
War 382
Musical 334
Documentary 440
IMAX 158
Western 167
Film-Noir 87
(no genres listed) 34
```

Average rating of movie given by users

In [89]:
```
trend = df_r.groupby('movieId')
trend = trend['rating'].mean()
trend = trend.reset_index()
trend = trend.sort_values('rating', ascending=False)
trend
```

Out[89]:

	movieId	rating
7638	88448	5.0
8089	100556	5.0
9065	143031	5.0
9076	143511	5.0
9078	143559	5.0
...	...	...
9253	157172	0.5
7536	85334	0.5
6486	53453	0.5
5200	8494	0.5
7145	71810	0.5

9724 rows × 2 columns

Question 2

In [ ]:
```
df_r.drop(columns=['timestamp'],inplace=True)

merge_list = df_r.groupby(by = ["userId"])["movieId"].apply(list).reset_index()
merge_list = merge_list['movieId'].tolist()
```

In [91]:
```
pd.get_dummies
from mlxtend.preprocessing import TransactionEncoder
te = TransactionEncoder()
te_ary = te.fit(merge_list).transform(merge_list)
data = pd.DataFrame(te_ary, columns=te.columns_)
#data
```

In [ ]:
```
!pip install mlxtend --upgrade
```

Performing fpgrowth

In [93]:
```
from mlxtend.frequent_patterns import fpgrowth
%time
fpgrowth_frequent_itemsets = fpgrowth(data, min_support=0.1, use_colnames=True)
fpgrowth_frequent_itemsets.head()
fpgrowth_frequent_itemsets['itemsets'].apply(lambda x: len(x)).value_counts()
```

```
CPU times: user 4 µs, sys: 0 ns, total: 4 µs
Wall time: 9.06 µs
```

Out[93]:
```
4     38160
5     33837
3     21556
6     16419
2      5061
7      4365
8       607
1       328
9        35
10        1
Name: itemsets, dtype: int64
```

In [94]:
```
fpgrowth_frequent_itemsets['length'] = fpgrowth_frequent_itemsets['itemsets'].apply(lambda x: len(x))
fpgrowth_frequent_itemsets
```

Out[94]:

	support	itemsets	length
0	0.539344	(356)	1
1	0.503279	(296)	1

	support	itemsets	length
2	0.457377	(593)	1
3	0.455738	(2571)	1
4	0.411475	(260)	1
...	...	...	...
120364	0.101639	(1393, 780)	2
120365	0.106557	(1393, 260)	2
120366	0.104918	(593, 1393)	2
120367	0.114754	(1393, 356)	2
120368	0.103279	(1393, 1210)	2

120369 rows × 3 columns

In [95]:
```
fpgrowth_frequent_itemsets[(fpgrowth_frequent_itemsets['length'] > 2)]
```

Out[95]:

	support	itemsets	length
330	0.293443	(296, 356, 318)	3
334	0.268852	(296, 593, 356)	3
335	0.254098	(593, 356, 318)	3
336	0.221311	(296, 593, 356, 318)	4
337	0.270492	(296, 593, 318)	3
...	...	...	...
120352	0.108197	(1210, 1387, 1196)	3
120353	0.106557	(1210, 1196, 1387, 260)	4
120354	0.100000	(480, 1387, 260)	3
120362	0.103279	(8874, 2571, 2959)	3

	support	itemsets	length
120363	0.100000	(8874, 2571, 356)	3

114980 rows × 3 columns

Forming association Rules

In [96]:
```
from mlxtend.frequent_patterns import association_rules
rules = association_rules(fpgrowth_frequent_itemsets,metric="lift",min_threshold=0.1)
```

In [97]:
```
rules = rules.sort_values('lift', ascending=False)
rules
```

Out[97]:

	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
3316685	(2571, 1196, 7438)	(1210, 6874, 2959)	0.111475	0.108197	0.100000	0.897059	8.290998	0.087939	8.663232
3316704	(1210, 6874, 2959)	(2571, 1196, 7438)	0.108197	0.111475	0.100000	0.924242	8.290998	0.087939	11.728525
3316591	(1196, 7438)	(6874, 1210, 2959)	0.114754	0.108197	0.100000	0.871429	8.054113	0.087584	6.936248
3316679	(1210, 6874, 2571, 2959)	(1196, 7438)	0.108197	0.114754	0.100000	0.924242	8.054113	0.087584	11.685246
3316582	(6874, 1210, 2959)	(1196, 7438)	0.108197	0.114754	0.100000	0.924242	8.054113	0.087584	11.685246
...	...	...	...	...	...	...	...	...	...
2448244	(4993)	(150)	0.324590	0.329508	0.104918	0.323232	0.980954	-0.002037	0.990727
474655	(2959)	(592)	0.357377	0.309836	0.108197	0.302752	0.977137	-0.002532	0.989840
474654	(592)	(2959)	0.309836	0.357377	0.108197	0.349206	0.977137	-0.002532	0.987445
1044807	(590)	(2571)	0.268852	0.455738	0.113115	0.420732	0.923188	-0.009411	0.939569
1044806	(2571)	(590)	0.455738	0.268852	0.113115	0.248201	0.923188	-0.009411	0.972531

3429826 rows × 9 columns

Merging average rating column with movies dataframe

In [98]:
```
df_inner = pd.merge(df_m, trend, on='movieId', how='inner')
df_inner = df_inner.sort_values('rating', ascending=False)
df_inner
```

Out[98]:

	movieId	title	genres	rating
7638	88448	Paper Birds (Pájaros de papel) (2010)	Comedy|Drama	5.0
8089	100556	Act of Killing, The (2012)	Documentary	5.0
9065	143031	Jump In! (2007)	Comedy|Drama|Romance	5.0
9076	143511	Human (2015)	Documentary	5.0
9078	143559	L.A. Slasher (2015)	Comedy|Crime|Fantasy	5.0
...	...	...	...	...
9253	157172	Wizards of the Lost Kingdom II (1989)	Action|Fantasy	0.5
7536	85334	Hard Ticket to Hawaii (1987)	Action|Comedy	0.5
6486	53453	Starcrash (a.k.a. Star Crash) (1978)	Action|Adventure|Fantasy|Sci-Fi	0.5
5200	8494	Cincinnati Kid, The (1965)	Drama	0.5
7145	71810	Legionnaire (1998)	Action|Adventure|Drama|War	0.5

9724 rows × 4 columns

Function to recommend the movies

In [112...]
```
def solve(input):
  sett = set()

  for index, x in rules.iterrows():
    if(x['antecedents'] == input):
      for y in x['consequents']:
        if(len(sett) == 4):
            return sett
        sett.add(y)
        if(len(sett) == 4):
```

```
        return sett

  if(len(input) == 1):
    for x in input:
      str = id_to_genre[x]
      cnt = 0
      for ch in str:
        if ch == '|':
          cnt += 1
      if cnt > 3:
        for index, curr in df_inner.iterrows():
            if curr['movieId'] != x and curr['genres'] == str:
              if(len(sett) == 4):
                return sett
              sett.add(curr['movieId'])
              if(len(sett) == 4):
                return sett


for index, x in rules.iterrows():
  if(x['antecedents'] < input):
    for y in x['consequents']:
      if(len(sett) == 4):
        return sett
      sett.add(y)
      if(len(sett) == 4):
        return sett

freq = dict()
for x in input:
  for index, row in df_m.iterrows():
    if(row['movieId'] == x):
      curr = row['genres'].split('|')
      for vals in curr:
        if vals not in freq:
          freq[vals] = 1
        else:
          freq[vals] += 1

freq = sorted(freq.items(), key=lambda x: x[1], reverse=True)

for movie, cnt in freq:
  if(len(sett) == 4):
    return sett
```

```
    for index, x in df_inner.iterrows():
      if movie in x['genres']:
        if len(sett) == 4:
          return sett
        sett.add(x['movieId'])
        if len(sett) == 4:
          return sett

  for index, x in rules.iterrows():
    if(x['antecedents'] > input):
      for y in x['consequents']:
        if(len(sett) == 4):
          return sett
        sett.add(y)
        if(len(sett) == 4):
          return sett

  return sett
```

NOTE

- Performed recommendations on hard-coded values
- Will work

In [113…

```
arr = list()
arr.append(frozenset({1}))
arr.append(frozenset({5, 720, 1196}))
arr.append(frozenset({1, 1210}))

import csv
with open('output.csv', 'w', newline='') as file:
  writer = csv.writer(file)
  writer.writerow(["movies", "recommendation"])
  for input in arr:
    print('The given input is:\n')
    input_str = ""
    for x in input:
      input_str += str(id_to_title[x]) + ', '
      print(id_to_title[x])
```

```
    output = solve(input)

    print('\nThe recommended movies are:\n')
    final_str = ""
    for x in output:
      final_str += id_to_title[x] + ', '
      print(id_to_title[x])

    writer.writerow([input_str, final_str])

    print('\n\n')
```

```
The given input is:

Toy Story (1995)

The recommended movies are:

Emperor's New Groove, The (2000)
Toy Story 2 (1999)
Asterix and the Vikings (Astérix et les Vikings) (2006)
Monsters, Inc. (2001)



The given input is:

Wallace & Gromit: The Best of Aardman Animation (1996)
Star Wars: Episode V - The Empire Strikes Back (1980)
Father of the Bride Part II (1995)

The recommended movies are:

Jurassic Park (1993)
Toy Story (1995)
Independence Day (a.k.a. ID4) (1996)
Terminator, The (1984)



The given input is:

Toy Story (1995)
Star Wars: Episode VI - Return of the Jedi (1983)

The recommended movies are:
```

```
Jurassic Park (1993)
Pulp Fiction (1994)
Indiana Jones and the Last Crusade (1989)
Star Wars: Episode V - The Empire Strikes Back (1980)
```

In [101…

```
from mlxtend.frequent_patterns import fpmax
max_freq_itset=fpmax(data, min_support=0.1, use_colnames=True)

max_freq_itset
```

Out[101…

	support	itemsets
0	0.100000	(3527)
1	0.100000	(51255)
2	0.100000	(30793)
3	0.100000	(2321)
4	0.100000	(3253)
...	...	...
32764	0.109836	(356, 296, 2571, 110, 593, 318)
32765	0.100000	(480, 356, 260, 2571, 593, 318)
32766	0.103279	(480, 356, 296, 2571, 593, 318)
32767	0.104918	(480, 260, 296, 2571, 593, 318)
32768	0.108197	(480, 260, 356, 296, 593, 318)

32769 rows × 2 columns

In [104…

```
max_freq_itset = max_freq_itset.sort_values('itemsets')
import graphviz
from graphviz import Digraph, Graph
```

```
g = Graph('parent')

count=0
maxlength=0
for x in max_freq_itset['itemsets']:
  maxlength=max(maxlength, len(x))

lis=[None]*maxlength
count0=[0]*maxlength
first=[-1]*maxlength

for i in range(maxlength):
  lis[i]=Graph()
  lis[i].attr(rank='same')

for x in max_freq_itset['itemsets']:
  if(count0[len(x)-1]<10):
    lis[len(x)-1].node(str(count), str(x))
    if(count0[len(x)-1]==0):
      first[len(x)-1]=count
    count0[len(x)-1]=count0[len(x)-1]+1
  count=count+1

abc=0
prev=first[0]
while(prev==-1):
  abc=abc+1

for i in range(1, maxlength-1):
  if not first[i]==-1:
    g.edge(str(prev),str(first[i]),style='invis')
    prev=first[i]

for i in range(maxlength-1):
  g.subgraph(lis[i])

print(g.source)

g.render(filename='g1.dot')
```

```
graph parent {
        0 -- 1270 [style=invis]
        1270 -- 127 [style=invis]
        127 -- 2 [style=invis]
```

```
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4 -- 1 [style=invis]
1 -- 6 [style=invis]
6 -- 159 [style=invis]
159 -- 3437 [style=invis]
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        21780 [label="frozenset({1407})"]
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        21786 [label="frozenset({89745})"]
        21787 [label="frozenset({520})"]
}
{
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        1271 [label="frozenset({590, 1270})"]
        2679 [label="frozenset({377, 7153})"]
        2680 [label="frozenset({5952, 377})"]
        3480 [label="frozenset({3578, 150})"]
        4503 [label="frozenset({588, 1214})"]
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        4715 [label="frozenset({2571, 595})"]
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}
{
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        163 [label="frozenset({608, 4993, 4306})"]
        164 [label="frozenset({608, 4306, 5952})"]
        165 [label="frozenset({4306, 356, 150})"]
        166 [label="frozenset({4306, 2571, 150})"]
        167 [label="frozenset({1, 4306, 150})"]
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}
{
        rank=same
        2 [label="frozenset({1, 356, 589, 1580})"]
```

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        3 [label="frozenset({2571, 1580, 589, 318})"]
        14 [label="frozenset({1, 780, 1580, 589})"]
        32 [label="frozenset({296, 2028, 589, 1580})"]
        45 [label="frozenset({356, 1580, 589, 2028})"]
        46 [label="frozenset({296, 2762, 1580, 780})"]
        49 [label="frozenset({1580, 356, 589, 1270})"]
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        81 [label="frozenset({2858, 2571, 1580, 318})"]
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}
{
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        8 [label="frozenset({2762, 2571, 2028, 1580, 1210})"]
        9 [label="frozenset({356, 296, 2762, 2571, 1580})"]
        10 [label="frozenset({356, 260, 296, 2762, 1580})"]
        12 [label="frozenset({296, 2762, 2571, 2028, 1580})"]
        15 [label="frozenset({296, 2762, 2571, 1580, 1210})"]
        16 [label="frozenset({356, 2762, 2571, 1580, 589})"]
        18 [label="frozenset({296, 2762, 2571, 1580, 589})"]
        19 [label="frozenset({260, 296, 2762, 1580, 589})"]
        20 [label="frozenset({2762, 2571, 2028, 589, 1580})"]
}
{
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        1 [label="frozenset({1, 260, 1196, 589, 1580, 1210})"]
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        7 [label="frozenset({260, 2762, 1196, 1580, 2028, 1210})"]
        11 [label="frozenset({260, 296, 2762, 2571, 1196, 1580})"]
        13 [label="frozenset({260, 296, 2762, 1196, 1580, 1210})"]
        25 [label="frozenset({2762, 2571, 1196, 780, 1580, 1210})"]
        27 [label="frozenset({260, 2762, 2571, 780, 589, 1580})"]
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        34 [label="frozenset({480, 356, 260, 780, 589, 1580})"]
        38 [label="frozenset({480, 260, 1196, 589, 1580, 2028})"]
}
{
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        17 [label="frozenset({356, 260, 2762, 1196, 589, 1580, 1210})"]
        26 [label="frozenset({260, 2762, 1196, 589, 780, 1580, 1210})"]
        29 [label="frozenset({260, 2762, 2571, 1196, 589, 1580, 1210})"]
        30 [label="frozenset({480, 260, 1196, 589, 1580, 1270, 1210})"]
        31 [label="frozenset({356, 260, 2571, 1196, 589, 1580, 1210})"]
        33 [label="frozenset({356, 260, 1196, 780, 589, 1580, 1210})"]
        35 [label="frozenset({480, 356, 260, 1196, 589, 1580, 1210})"]
        42 [label="frozenset({260, 2571, 1196, 1580, 589, 2028, 1210})"]
```

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        }
        {
                rank=same
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                173 [label="frozenset({480, 260, 356, 2571, 1196, 780, 1580, 1210})"]
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                684 [label="frozenset({5952, 260, 2571, 1196, 2959, 7153, 4306, 1210})"]
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                2288 [label="frozenset({480, 260, 356, 2571, 1196, 2959, 1270, 1210})"]
        }
        {
                rank=same
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                3729 [label="frozenset({4993, 260, 356, 296, 2571, 1196, 2959, 3578, 1210})"]
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                11318 [label="frozenset({480, 260, 356, 296, 2571, 1196, 780, 589, 1210})"]
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        }
}
```

Out[104… `'g1.dot.pdf'`