Project: Investigate a Dataset (The Movie Database - TMDb)

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Introduction

I have selected TMDB Movie dataset which contains over 10,000 movies including user rating, authors, budget and revenue. In the following I will descirbe my understnding about columns of the table.

- `id` - Unique id of each movie
- `imdb_id` - Unique ID to access the movie from IMDB (https://www.imdb.com/title/tt0369610/ (https://www.imdb.com/title/tt0369610/))
- `popularity` - Popularity range from 0 to 33.
- `budget` - Estimated budget in dollars (precise to extracted date)
- `revenue` - Revenue in dollars (precise to extracted date)
- `original_title` - Title of the movie
- `cast` - Top actors/actresses/cast
- `homepage` - web home page address
- `director` - director name
- `tagline` - short text like search keyword
- `keywords` - movie keywords, need to split by |
- `overview` - Short description/storyline
- `runtime` - duration of the movie
- `genres` - genres need to split by |
- `production_companies` - productioners, need to split by |
- `release_date` - Released date
- `vote_count` - integer
- `vote_average` - average vote
- `budget_adj, revenue_adj` - The final two columns ending with “_adj” show the budget and revenue of the associated movie in terms of 2010 dollars

Questions I am going to ask and find.

- Which genres are most popular from year to year?
- What kinds of properties are associated with movies that have high revenues?
- Which movies made the most profit, yearly?

In [1]:
```
import pandas as pd # CSV reader pandas library
import matplotlib.pyplot as plt # Matplotlib for styling
import seaborn as sns # Seaborn data visualization library
import matplotlib.pyplot as plt # Matplotlib for styling
import matplotlib.ticker as ticker #tick locators and formatters
import numpy as np # Numpy library
#to draw the graphs inline
%matplotlib inline
pd.options.mode.chained_assignment = None
```

Data Wrangling

General Properties

In [2]:
```
### Importing city_list.csv file into city_lists file object
df = pd.read_csv('./dataset/tmdb-movies.csv')
df.head(3)
```

Out[2]:

	id	imdb_id	popularity	budget	revenue	original_title	cast	
0	135397	tt0369610	32.985763	150000000	1513528810	Jurassic World	Chris Pratt|Bryce Dallas Howard|Irrfan Khan|Vi...	
1	76341	tt1392190	28.419936	150000000	378436354	Mad Max: Fury Road	Tom Hardy|Charlize Theron|Hugh Keays-Byrne|Nic...	
2	262500	tt2908446	13.112507	110000000	295238201	Insurgent	Shailene Woodley|Theo James|Kate Winslet|Ansel...	http://www.the

3 rows × 21 columns

In [3]:

```
# printing columns
print('Columns : ', df.columns)

# To print the size of the table
print('Size of the table: ', df.shape)

# To determine the range of pupularity in the dataset
max_popularity =  df['popularity'].max()
min_popularity =  df['popularity'].min()
print('Min value in popularity: ', '{0:.6f}'.format(max_popularity))
print('Max value in popularity: ', '{0:.6f}'.format(min_popularity))
```

```
Columns :  Index(['id', 'imdb_id', 'popularity', 'budget', 'revenue', 'or
iginal_title',
       'cast', 'homepage', 'director', 'tagline', 'keywords', 'overview',
       'runtime', 'genres', 'production_companies', 'release_date',
       'vote_count', 'vote_average', 'release_year', 'budget_adj',
       'revenue_adj'],
      dtype='object')
Size of the table:  (10866, 21)
Min value in popularity:  32.985763
Max value in popularity:  0.000065
```

In [4]:

```
# to determine, if release_year have missing value
null_data_release_year = df[df['release_year'].isnull()]
null_data_release_year.head(3)
```

Out[4]:

id	imdb_id	popularity	budget	revenue	original_title	cast	homepage	director	tagline	...	ove

0 rows × 21 columns

In [5]:

```
# to determine, if release_year have missing value
null_data_genres = df[df['genres'].isnull()]
# null_data_genres.shape
null_data_genres.head(2)
```

Out[5]:

	id	imdb_id	popularity	budget	revenue	original_title	cast	homepage
424	363869	tt4835298	0.244648	0	0	Belli di papÃ	Diego Abatantuono|Matilde Gioli|Andrea Pisani|...	NaN
620	361043	tt5022680	0.129696	0	0	All Hallows' Eve 2	NaN	NaN

2 rows × 21 columns

Data Cleaning (Dropping, unique, merging, grouping, duplicate

values)

To answer Q1(Question - 1), I decided to transform given dataframe to `df_q1` which will be comfortable to draw barplot. The answer of the question 1 can be found in `release_year` and `genres`. Therefore, I did some cleaning process as following to above mentioned columns.

In [6]:

```
# to select non-null genres with release_year for Question 1 (Q1)
df_q1 = df.dropna(subset=['genres'])[['release_year','genres']]

# To determine the non-null values lengh
print('Lenght of Q1 dataset : ', len(df_q1))
df_q1.head(4)
```

```
Lenght of Q1 dataset :  10843
```

Out[6]:

	release_year	genres
0	2015	Action|Adventure|Science Fiction|Thriller
1	2015	Action|Adventure|Science Fiction|Thriller
2	2015	Adventure|Science Fiction|Thriller
3	2015	Action|Adventure|Science Fiction|Fantasy

In [7]:

```
# Finding the unique values of the year
df_q1['release_year'].unique()
```

Out[7]:

```
array([2015, 2014, 1977, 2009, 2010, 1999, 2001, 2008, 2011, 2002, 1994,
       2012, 2003, 1997, 2013, 1985, 2005, 2006, 2004, 1972, 1980, 2007,
       1979, 1984, 1983, 1995, 1992, 1981, 1996, 2000, 1982, 1998, 1989,
       1991, 1988, 1987, 1968, 1974, 1975, 1962, 1964, 1971, 1990, 1961,
       1960, 1976, 1993, 1967, 1963, 1986, 1973, 1970, 1965, 1969, 1978,
       1966])
```

In [8]:

```
# Grouping all other genres in the same year by using `|` character
df_q1['genres']= df_q1.groupby('release_year')['genres'].transform(lambda x
df_q1.head()
```

Out[8]:

	release_year	genres
0	2015	Action|Adventure|Science Fiction|Thriller|Acti...
1	2015	Action|Adventure|Science Fiction|Thriller|Acti...
2	2015	Action|Adventure|Science Fiction|Thriller|Acti...
3	2015	Action|Adventure|Science Fiction|Thriller|Acti...
4	2015	Action|Adventure|Science Fiction|Thriller|Acti...

In [9]:

```
#droping duplicate values after merging dataset of `df_q1`
df_q1 = df_q1.drop_duplicates()

# sorting values to draw barplot in ascending order
df_q1 = df_q1.sort_values(by=['release_year'])
```

In [10]:
```
# to check if release_year is sorted
df_q1.head(4)
```

Out[10]:

	release_year	genres
10141	1960	Drama|Horror|Thriller|Action|Adventure|Western...
10110	1961	Adventure|Animation|Comedy|Family|Comedy|Drama...
9849	1962	Adventure|Action|Thriller|Adventure|Drama|Hist...
10438	1963	Action|Thriller|Adventure|Animation|Family|Hor...

In [11]:
```
# to check if genres is merged correctly by manually checking original data
df_q1['genres'][10141]
```

Out[11]:
```
'Drama|Horror|Thriller|Action|Adventure|Western|Action|Drama|History|Come
dy|Drama|Romance|Comedy|Romance|Thriller|Adventure|Fantasy|Science Fictio
n|Romance|Horror|Thriller|Adventure|Family|Thriller|Music|Comedy|Crime|Ac
tion|Drama|Western|Comedy|Drama|Romance|Horror|Horror|Thriller|Drama|Crim
e|Western|Action|Western|Action|Drama|Romance|Western|Drama|Family|Thrill
er|Comedy|Action|Adventure|Drama|History|Western|Action|Drama|Foreign|His
tory|War|Drama|History|Adventure|Fantasy|Science Fiction|Drama|Comedy|Hor
ror|Science Fiction|Comedy|Family|Horror|Comedy|Romance|Horror|Action|Dra
ma|History|War'
```

In [12]:
```
# shape should be equal to df_q1['release_year'].unique() value, manually c
df_q1.shape
```

Out[12]:
```
(56, 2)
```

Exploratory Data Analysis

Research Question 1 (Which genres are most popular from year to year?)

To Explore Question 1 visually, I have to split genres by `|` character and should create columns to each genre with argument `count` values.

Function `get_genre_frequency` splits the genres and return it as `numpy.ndarray` like tuple. So, it returns `unique` - unique genre name and `counts` - counts the number of its appearance

In [13]:
```
def get_genre_frequency(genres):
    array = np.array(genres.split('|'))
    (unique, counts) = np.unique(array, return_counts=True)
    return np.asarray((unique, counts)).T
```

Function `create_each_genre_columns` . Here, I am transferring all genres values into columns which is resulted from `get_genre_frequency` function.

In [14]:

```
def create_each_genre_columns(np_genre_frequencies, df, ind):
    for unique, counts in np_genre_frequencies:
        if unique not in df.columns:
            df[unique] = 0
        df[unique][ind] = counts
    return df
```

Function `create_the_most_popular_genre_columns` is created to visualize the winner of the genres from year to year.

In [15]:

```
def create_the_most_popular_genre_columns(np_genre_frequencies, df, ind):
    df['popular_genre_count'] = df.iloc[:, 4:].max(axis=1)
    df['popular_genre_name'] = df.iloc[:, 4:].idxmax(axis=1)
    return df
```

Here I am running above 3 functions to create `df_q1` by considering index.

In [16]:

```
df_q1['popular_genre_name'] = 'UNKNOWN'
df_q1['popular_genre_count'] = 0
for ind in df_q1.index:
    np_genre_frequencies = get_genre_frequency(df_q1['genres'][ind])
    df_q1 = create_each_genre_columns(np_genre_frequencies, df_q1, ind)
    df_q1 = create_the_most_popular_genre_columns(np_genre_frequencies, df_

df_q1.head(10)
```

Out[16]:

	release_year	genres	popular_genre_name	popular_
10141	1960	Drama|Horror|Thriller|Action|Adventure|Western...	Drama	
10110	1961	Adventure|Animation|Comedy|Family|Comedy|Drama...	Drama	
9849	1962	Adventure|Action|Thriller|Adventure|Drama|Hist...	Drama	
10438	1963	Action|Thriller|Adventure|Animation|Family|Hor...	Comedy	
9881	1964	Adventure|Action|Thriller|Drama|Comedy|War|Com...	Drama	
10689	1965	Adventure|Action|Thriller|Drama|Family|Music|R...	Drama	
10820	1966	Animation|Family|Comedy|Drama|Science Fiction|...	Comedy	
10398	1967	Family|Animation|Adventure|Comedy|Drama|Romanc...	Comedy	
9719	1968	Science Fiction|Mystery|Adventure|Adventure|Sc...	Drama	
10724	1969	Adventure|Action|Thriller|History|Drama|Wester...	Drama	

10 rows × 24 columns

In [17]:

```
# if 'genres' in df_q1.columns:
#     del df_q1['genres']

# Ranaming release_year to Years for convinience
df_q1.rename(columns={'release_year': 'Years'}, inplace=True)
df_q1.head(3)
```

Out[17]:

	Years	genres	popular_genre_name	popular_genre_
10141	1960	Drama|Horror|Thriller|Action|Adventure|Western...	Drama	
10110	1961	Adventure|Animation|Comedy|Family|Comedy|Drama...	Drama	
9849	1962	Adventure|Action|Thriller|Adventure|Drama|Hist...	Drama	

3 rows × 24 columns

In [18]:

```
# This cells code has been copied from here
#[https://towardsdatascience.com/reordering-pandas-dataframe-columns-thumbs
# Aim of this function is to change the position of the columns
def movecol(df, cols_to_move=[], ref_col='', place='After'):

    cols = df.columns.tolist()
    if place == 'After':
        seg1 = cols[:list(cols).index(ref_col) + 1]
        seg2 = cols_to_move
    if place == 'Before':
        seg1 = cols[:list(cols).index(ref_col)]
        seg2 = cols_to_move + [ref_col]

    seg1 = [i for i in seg1 if i not in seg2]
    seg3 = [i for i in cols if i not in seg1 + seg2]

    return(df[seg1 + seg2 + seg3])
```

In [19]:

```
# I am changing position of `Years` column with `popular_genre_count` colum
df_q1 = movecol(df_q1,
                cols_to_move=['popular_genre_count','Years'],
                ref_col='popular_genre_name',
                place='After')
df_q1.head(3)
```

Out[19]:

	genres	popular_genre_name	popular_genre_count
10141	Drama|Horror|Thriller|Action|Adventure|Western...	Drama	13
10110	Adventure|Animation|Comedy|Family|Comedy|Drama...	Drama	16
9849	Adventure|Action|Thriller|Adventure|Drama|Hist...	Drama	21

3 rows × 24 columns

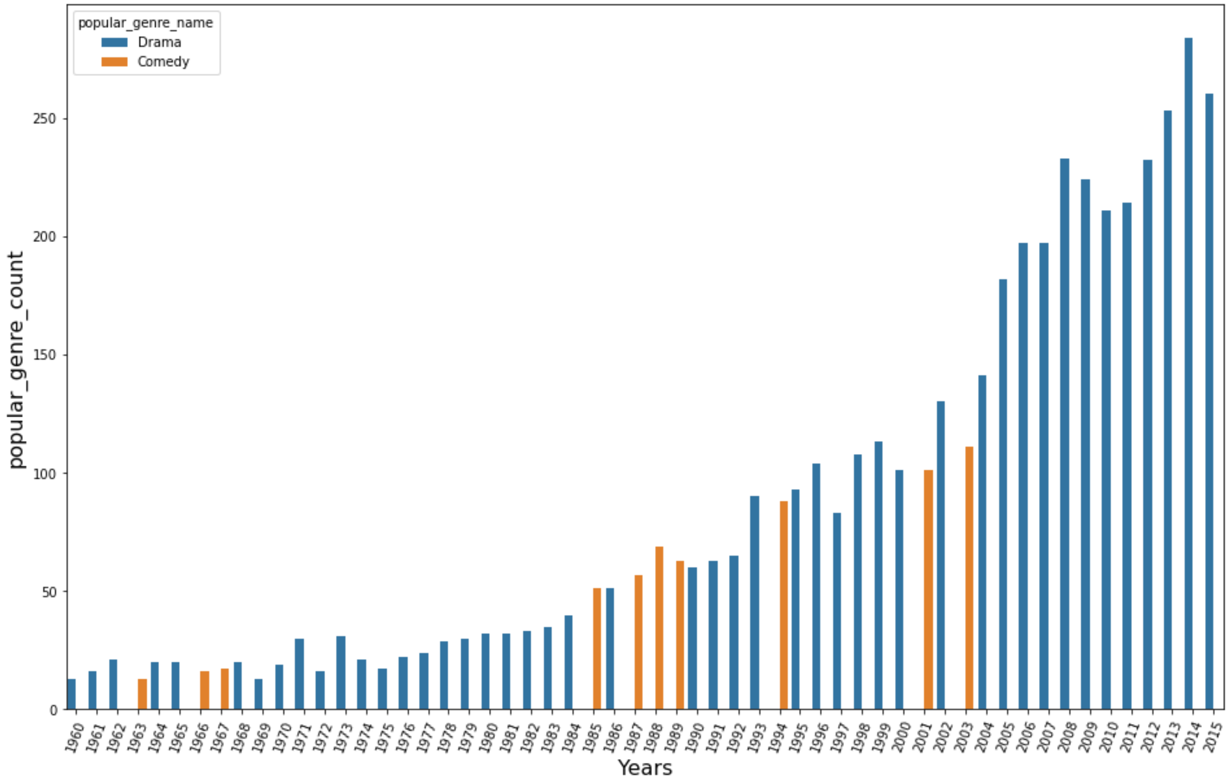
In [20]:
```
# to count number of unique genre movies in the dataset, manually
df_q1.columns
```

Out[20]:
```
Index(['genres', 'popular_genre_name', 'popular_genre_count', 'Years',
       'Action', 'Adventure', 'Comedy', 'Crime', 'Drama', 'Family', 'Fant
asy',
       'Foreign', 'History', 'Horror', 'Music', 'Romance', 'Science Ficti
on',
       'Thriller', 'War', 'Western', 'Animation', 'Mystery', 'TV Movie',
       'Documentary'],
      dtype='object')
```

Answer to Q1 (Question 1).

It is obvious that `Drama` genres movies is the most popular from the below bar plot. However, rarely we can see `comedy` genre movies can beat the `Drama` genre movies.

In [21]:
```
# Here I am using `Years`, `popular_genre_count` and `popular_genre_name` c
fig, ax1 = plt.subplots(figsize=(16, 10))
# ax1.set_title(title, fontsize=16)
ax1.set_xlabel('Years', fontsize=16)
ax1.set_ylabel('Count', fontsize=16)
ax1 = sns.barplot(x='Years', y='popular_genre_count', hue='popular_genre_na
plt.xticks(rotation=70)
plt.show()
sns.despine(fig)
```



To explore all other genres, I decided to draw bar plot by slicing the `df_q1` dataframe within 15 years

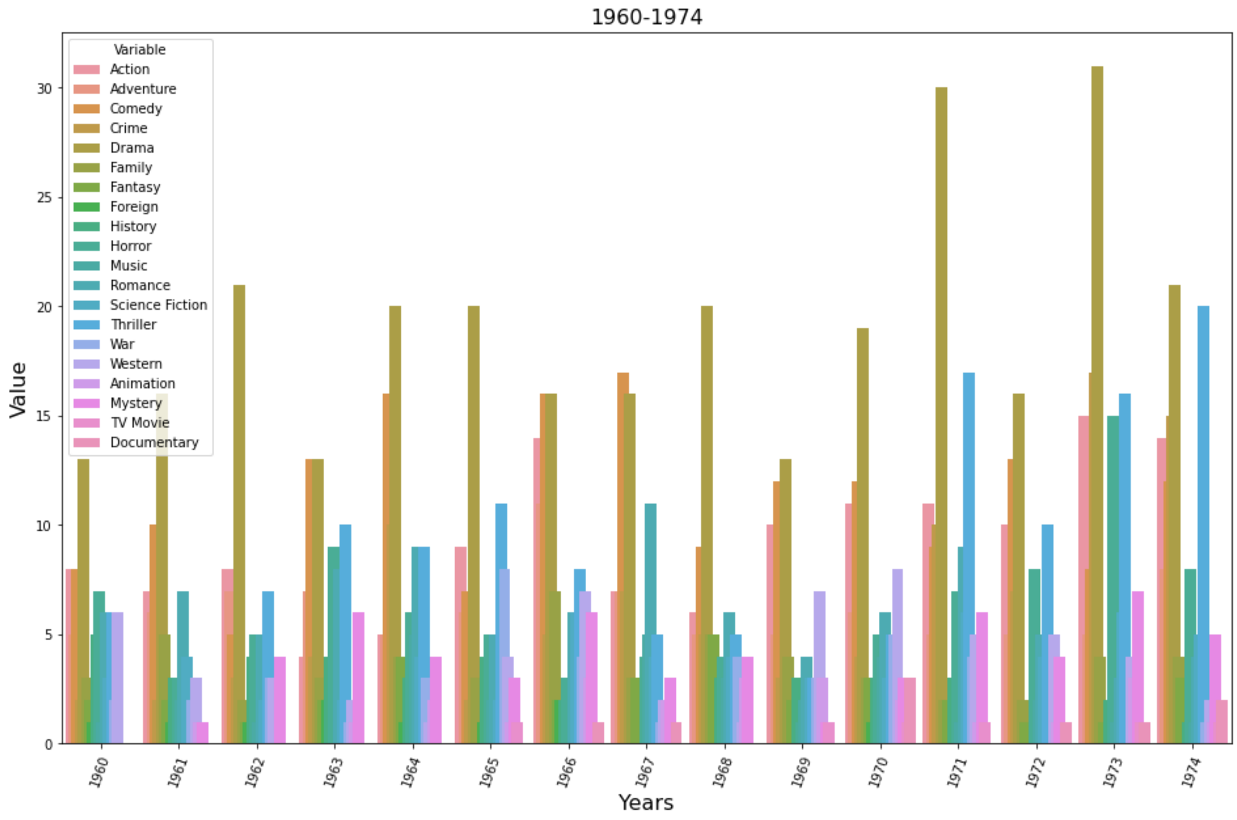
In [22]:

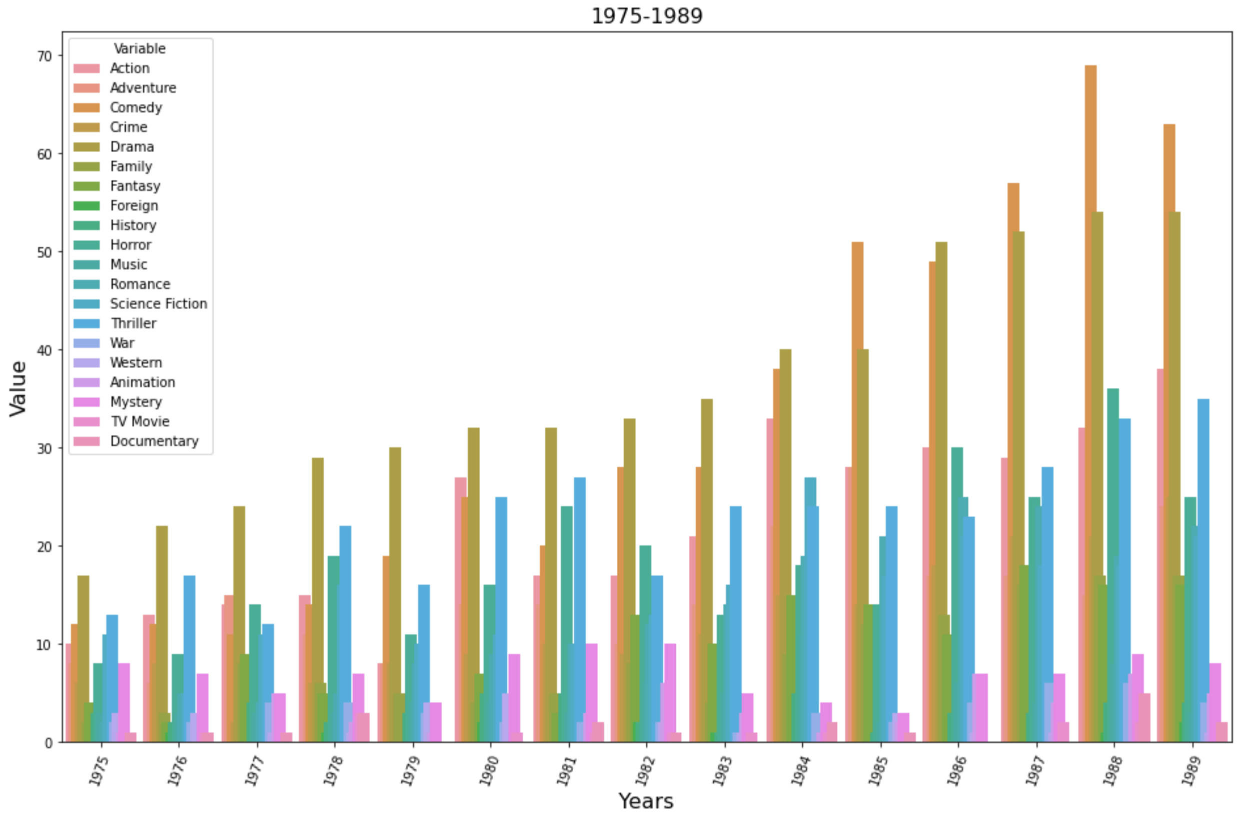
```
# to change the width of barplot
def change_width(ax, new_value) :
        for patch in ax.patches :
            current_width = patch.get_width()
            diff = current_width - new_value

            # change the bar width
            patch.set_width(new_value)

            # I recenter the bar
            patch.set_x(patch.get_x() + diff * .5)
```

In [23]:

```
# to draw the bar plot by grouping them yearly
def draw_bar_plot(title, df):
    df1 = df.iloc[:, 2:]
    fig, ax1 = plt.subplots(figsize=(16, 10))
    ax1.set_title(title, fontsize=16)
    ax1.set_xlabel('Years', fontsize=16)
    ax1.set_ylabel('Count', fontsize=16)
    tidy = df1.melt(id_vars='Years').rename(columns=str.title)
    ax1 = sns.barplot(x='Years', y='Value', hue='Variable', data=tidy)
    plt.xticks(rotation=70)
    change_width(ax1, .15)
    plt.show()
    sns.despine(fig)
```

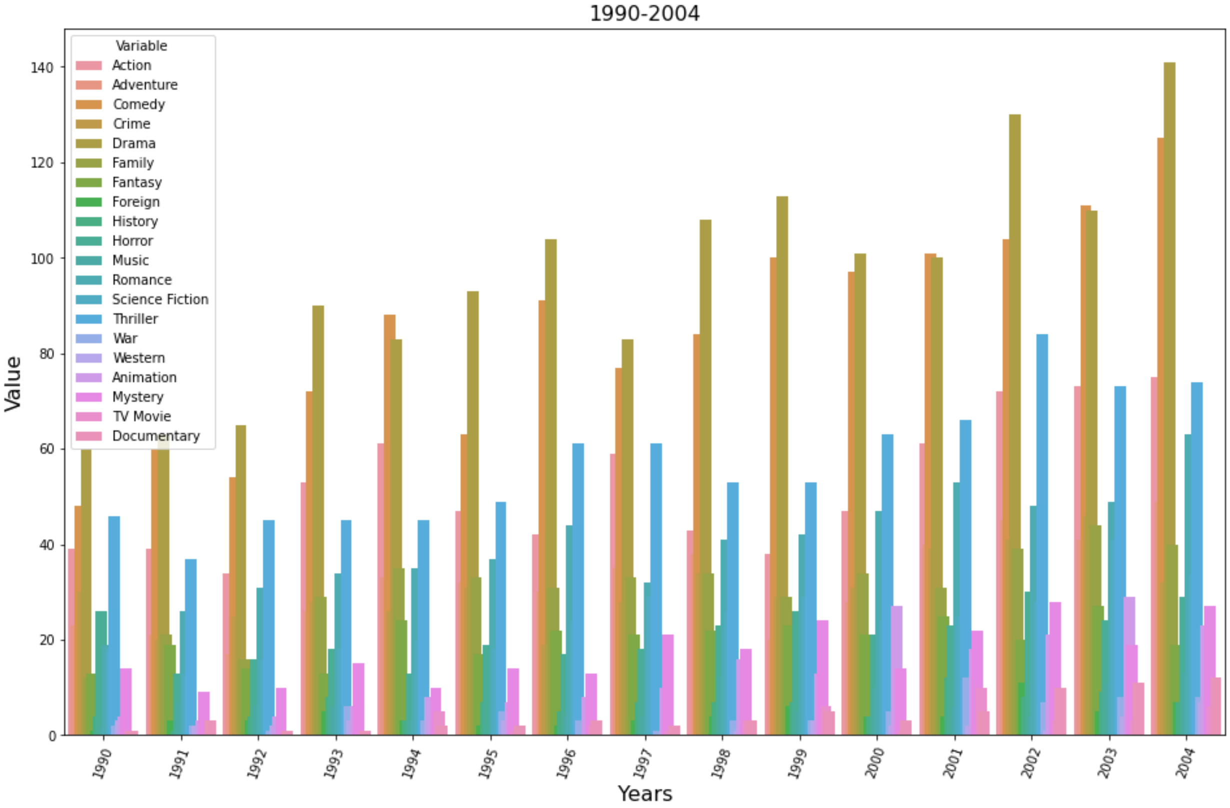
In [24]:
```
# Bar Plot of all Genres from 1960 to 1989
df_q1_1 = df_q1.iloc[:15, 1:]
draw_bar_plot('1960-1974', df_q1_1)

df_q1_2 = df_q1.iloc[15:30,1:]
draw_bar_plot('1975-1989', df_q1_2)
```

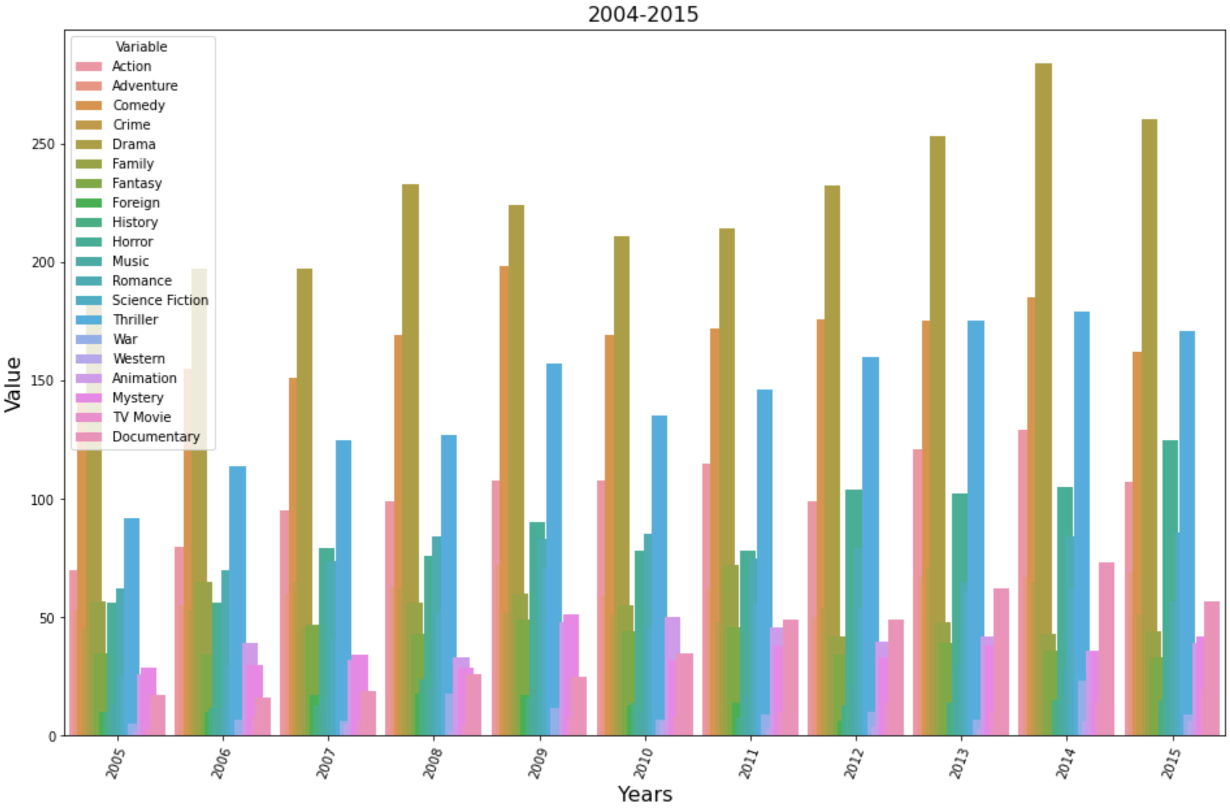




In [25]:

```
# Bar Plot of all Genres from 1989 to 2015
df_q1_3 = df_q1.iloc[30:45,1:]
draw_bar_plot('1990-2004', df_q1_3)

df_q1_4 = df_q1.iloc[45:56,1:]
draw_bar_plot('2004-2015', df_q1_4)
```





Research Question 2 (Q2.What kinds of properties are associated with movies that have high revenues?)

To answer the question following posts' idea is partially used [https://towardsdatascience.com/correlation-is-simple-with-seaborn-and-pandas-28c28e92701e (https://towardsdatascience.com/correlation-is-simple-with-seaborn-and-pandas-28c28e92701e)](https://towardsdatascience.com/correlation-is-simple-with-seaborn-and-pandas-28c28e92701e). None of code is copied!

In [26]:
```
# to see the highest revenue value
df_q2 = df.sort_values(by ='revenue', ascending=False)
df_q2.head(2)
```

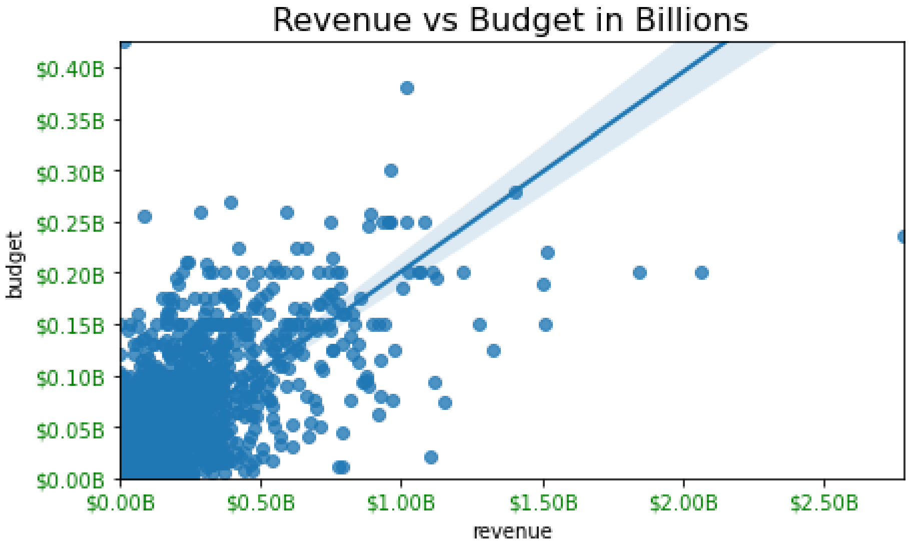
Out[26]:

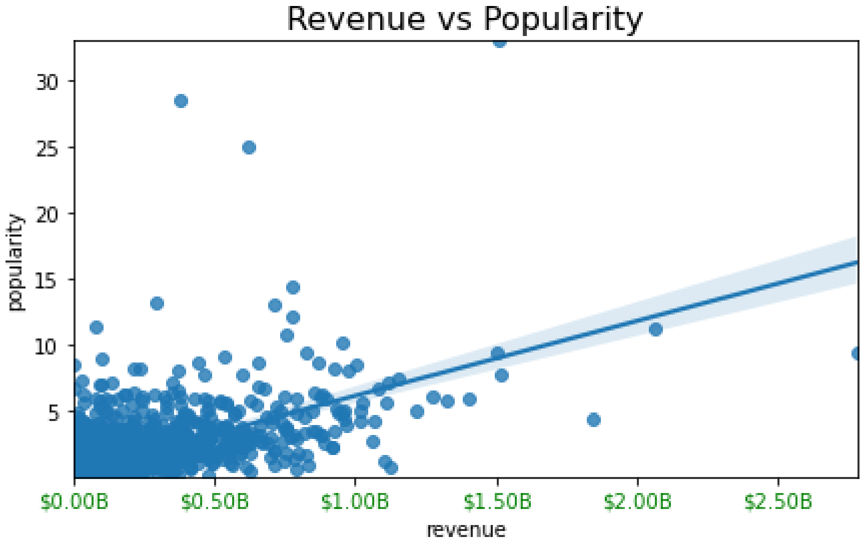
	id	imdb_id	popularity	budget	revenue	original_title	cast	
1386	19995	tt0499549	9.432768	237000000	2781505847	Avatar	Sam Worthington|Zoe Saldana|Sigourney Weaver|S...	h
3	140607	tt2488496	11.173104	200000000	2068178225	Star Wars: The Force Awakens	Harrison Ford|Mark Hamill|Carrie Fisher|Adam D...	http://w

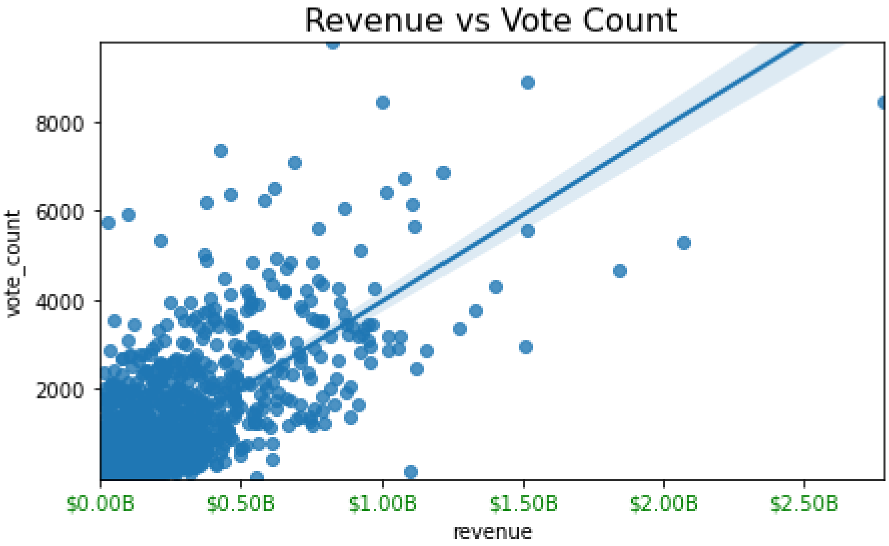
2 rows × 21 columns

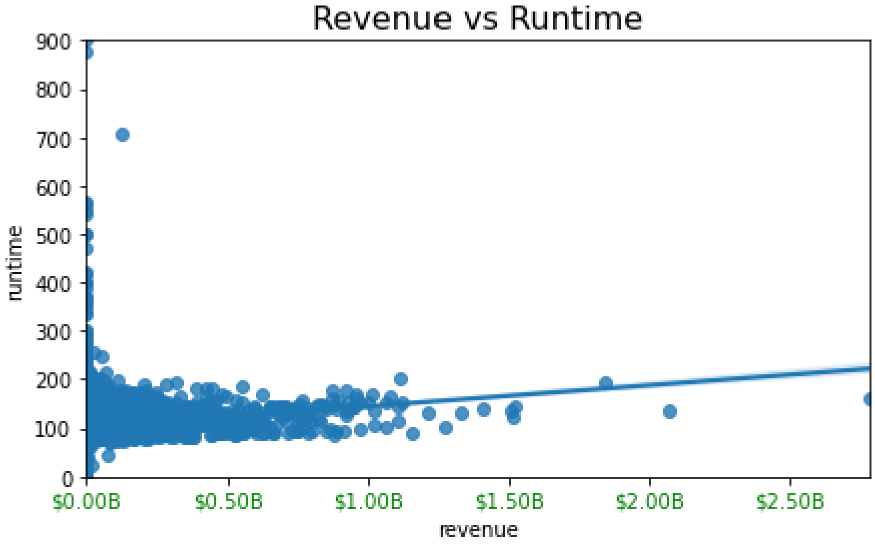
In [27]:
```
def plot_correlation(xPlot, YPlot, df, title, isCurrency):
    fig, ax1 = plt.subplots(figsize=(7, 4))
    ax1 = sns.regplot(x=xPlot, y=YPlot, data=df);
    ax1.set_title(title, fontsize=16)
    ax1.set(xlim = (min(df[xPlot]),max(df[xPlot])))
    ax1.set(ylim = (min(df[YPlot]),max(df[YPlot])))

    xlabels = ['${:,.2f}'.format(x) + 'B' for x in ax1.get_xticks()/1000000
    ticks_loc = ax1.get_xticks().tolist()
    ax1.xaxis.set_major_locator(ticker.FixedLocator(ticks_loc))
    ax1.set_xticklabels(xlabels)
    ax1.xaxis.set_tick_params(which='major', labelcolor='green')

    if isCurrency:
        ylabels = ['${:,.2f}'.format(x) + 'B' for x in ax1.get_yticks()/100
        ticks_loc = ax1.get_yticks().tolist()
        ax1.yaxis.set_major_locator(ticker.FixedLocator(ticks_loc))
        ax1.set_yticklabels(ylabels)
        ax1.yaxis.set_tick_params(which='major', labelcolor='green',
                                  labelleft=True, labelright=False)

    plt.show()
```

```
In [28]: plot_correlation('revenue', 'budget', df_q2, 'Revenue vs Budget in Billions
         plot_correlation('revenue', 'popularity', df_q2, 'Revenue vs Popularity', F
         plot_correlation('revenue', 'vote_count', df_q2, 'Revenue vs Vote Count', F
         plot_correlation('revenue', 'runtime', df_q2, 'Revenue vs Runtime', False);
```









In [29]:

```
correlations = df_q2.corr()
```

In [30]:

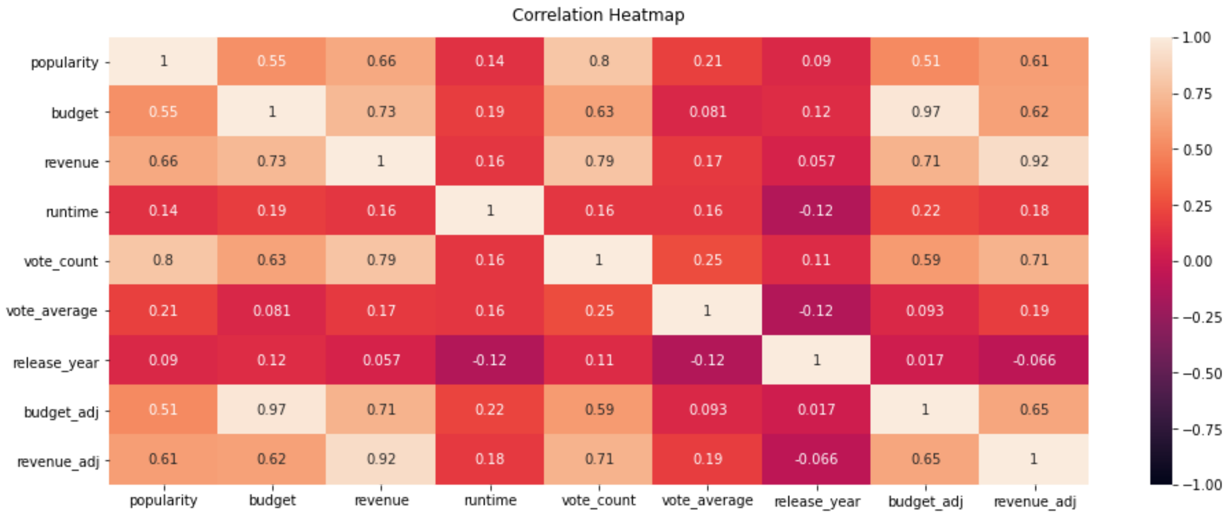
```
correlations.iloc[1:, 1:]
```

Out[30]:

	popularity	budget	revenue	runtime	vote_count	vote_average	release_year	bu
popularity	1.000000	0.545472	0.663358	0.139033	0.800828	0.209511	0.089801	
budget	0.545472	1.000000	0.734901	0.191283	0.632702	0.081014	0.115931	
revenue	0.663358	0.734901	1.000000	0.162838	0.791175	0.172564	0.057048	
runtime	0.139033	0.191283	0.162838	1.000000	0.163278	0.156835	-0.117204	
vote_count	0.800828	0.632702	0.791175	0.163278	1.000000	0.253823	0.107948	
vote_average	0.209511	0.081014	0.172564	0.156835	0.253823	1.000000	-0.117632	
release_year	0.089801	0.115931	0.057048	-0.117204	0.107948	-0.117632	1.000000	
budget_adj	0.513550	0.968963	0.706427	0.221114	0.587051	0.093039	0.016793	
revenue_adj	0.609083	0.622505	0.919110	0.175676	0.707942	0.193085	-0.066256	

In [31]:

```
# Code idea is copied from [https://medium.com/@szabo.bibor/how-to-create-a
plt.figure(figsize=(16, 6))
heatmap = sns.heatmap(correlations.iloc[1:, 1:], vmin=-1, vmax=1, annot=Tru
heatmap.set_title('Correlation Heatmap', fontdict={'fontsize':12}, pad=12);
plt.show()
```



Research Question 3 (Q3. Which movies made the most profit, yearly?)

In [32]:

```
df_q3 = pd.DataFrame()
df_q3['profit'] = df['revenue'] - df['budget']
df_q3['year'] = df['release_year']
df_q3['movie_name'] = df['original_title']
df_q3.head()
```

Out[32]:

	profit	year	movie_name
0	1363528810	2015	Jurassic World
1	228436354	2015	Mad Max: Fury Road
2	185238201	2015	Insurgent
3	1868178225	2015	Star Wars: The Force Awakens
4	1316249360	2015	Furious 7

In [33]:

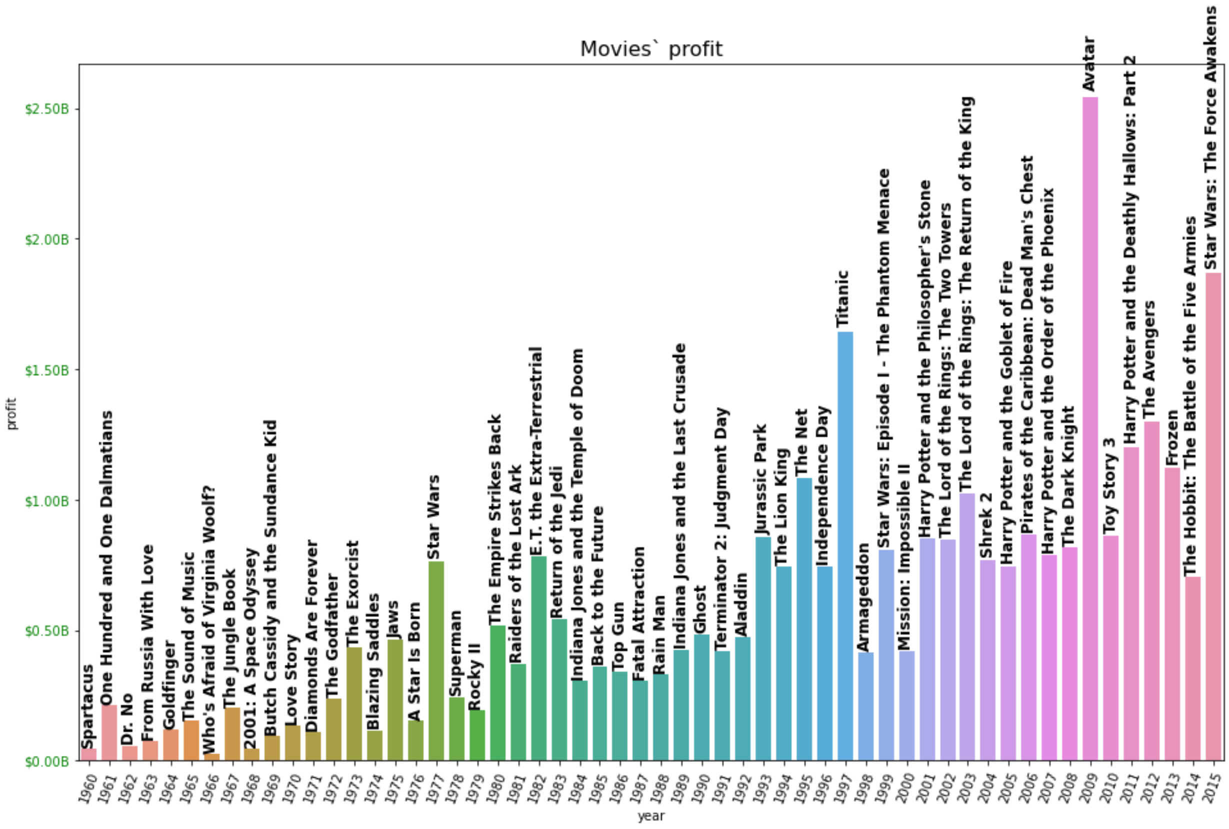
```
# df_q3 = df_q3.groupby(['year'], sort=True)['profit'].max()
idxs = df_q3.groupby(['year'], sort=False)['profit'].transform(max) == df_q
df_q3 = df_q3[idxs]
df_q3 = df_q3.sort_values(by='year', ascending=True, na_position='first')
df_q3 = df_q3.reset_index()
df_q3.head(5)
```

Out[33]:

	index	profit	year	movie_name
0	10143	48000000	1960	Spartacus
1	10110	211880014	1961	One Hundred and One Dalmatians
2	9849	58500000	1962	Dr. No
3	10438	76398765	1963	From Russia With Love
4	9881	121400000	1964	Goldfinger

In [34]:

```
fig, ax1 = plt.subplots(figsize=(16, 10))
ax1.set_title('Movies` profit', fontsize=16)
ax1 = sns.barplot(x='year', y='profit', data=df_q3)
plt.xticks(rotation=70)

ylabels = ['${:,.2f}'.format(x) + 'B' for x in ax1.get_yticks()/1000000000]
ticks_loc = ax1.get_yticks().tolist()
ax1.yaxis.set_major_locator(ticker.FixedLocator(ticks_loc))
ax1.set_yticklabels(ylabels)
ax1.yaxis.set_tick_params(which='major', labelcolor='green',
                          labelleft=True, labelright=False)

change_width(ax1, .75)

def autolabel(rects):
    for i in range(0, len(rects)):
        height = rects[i].get_height()
        ax1.text(rects[i].get_x() + rects[i].get_width() / 2.,
                1.01 * height,
                df_q3.iloc[i]['movie_name'],
                ha='center', va='bottom', rotation=90, color='black', fontd

autolabel(ax1.patches)
plt.show()
```



Conclusions

Following summarizations I get from three research questions above

- `Drama` genre movies is the most popular from the below bar plot. However, rarely we can see comedy genre movies can beat the Drama genre movies. `Comedy` genre movies is the second most popular movie genre.
- Overall, there `20` unique genre movies in the dataset
- Correaltions beetwen revenue and other tables are as following:
  - Correlation beetwen `revenue` and `vote_count` is the highest `val = (0.79)`;
  - The second and third highest corresponds to `budget(0.73)` and `popularity``(0.66)`, respectively;
  - It seems from the given dataset, `runtime(0.16)` and `vote_average(0.17)` properties doesn't associated with revenue.
- `Avatar` movive made the most profit, followed by `Star Wars: The Force Awakens` and `Titanic`

30 July, 06:56. Made by Sanatbek Matlatipov