Investigate_a_Dataset

September 15, 2020

1 Project: TMDb Movie Data Analysis

1.1 Table of Contents

Introduction

I choose **TMDb Movie Data** for this project.

There's a description of this dataset from Kaggle:

"What can we say about the success of a movie before it is released? Are there certain companies (Pixar?) that have found a consistent formula? Given that major films costing over \$100 million to produce can still flop, this question is more important than ever to the industry. Film aficionados might have different interests. Can we predict which films will be highly rated, whether or not they are a commercial success? This is a great place to start digging in to those questions, with data on the plot, cast, crew, budget, and revenues of several thousand films.

The following questions could be answered using these data: 1. Which genres are most popular from year to year?
2. How sharp is the divide between major film studios and the independents?
3. What kinds of properties are associated with movies that have high revenues?
4. Other questionswhich will arise during Data Cleaning.

Link to data:
https://www.google.com/url?q=https://d17h27t6h515a5.cloudfront.net/topher/2017/October/59dd1c4c_tmd
movies/tmdb-movies.csv&sa=D&ust=1532469042115000

```
In [1]: # Import statements for all of the packages that will be used.

        # + 'magic word' so that visualizations are plotted
        #   inline with the notebook. See this page for more:
        #   http://ipython.readthedocs.io/en/stable/interactive/magics.html

        import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        import seaborn as sns
```

```
% matplotlib inline

pd.set_option('display.max_columns', 100)
```

Data Wrangling

1.1.1 General Properties

This data set contains information about 10,000 movies collected from The Movie Database (TMDb), including user ratings and revenue.

In [2]:
```
# Load your data and print out a few lines. Perform operations to inspect data
#   types and look for instances of missing or possibly errant data.

df = pd.read_csv('tmdb-movies.csv', parse_dates=['release_date'])
# release_date is date type column, so, when load data parse_dates was used to nterpret
df.head(3)
```

Out[2]:
```
       id    imdb_id  popularity     budget     revenue      original_title  \
0  135397  tt0369610   32.985763  150000000  1513528810      Jurassic World
1   76341  tt1392190   28.419936  150000000   378436354  Mad Max: Fury Road
2  262500  tt2908446   13.112507  110000000   295238201           Insurgent

                                                cast  \
0  Chris Pratt|Bryce Dallas Howard|Irrfan Khan|Vi...
1  Tom Hardy|Charlize Theron|Hugh Keays-Byrne|Nic...
2  Shailene Woodley|Theo James|Kate Winslet|Ansel...

                                        homepage          director  \
0                  http://www.jurassicworld.com/   Colin Trevorrow
1                    http://www.madmaxmovie.com/     George Miller
2  http://www.thedivergentseries.movie/#insurgent  Robert Schwentke

                      tagline  \
0           The park is open.
1          What a Lovely Day.
2  One Choice Can Destroy You

                                           keywords  \
0  monster|dna|tyrannosaurus rex|velociraptor|island
1   future|chase|post-apocalyptic|dystopia|australia
2  based on novel|revolution|dystopia|sequel|dyst...

                                            overview  runtime  \
0  Twenty-two years after the events of Jurassic ...      124
1  An apocalyptic story set in the furthest reach...      120
2  Beatrice Prior must confront her inner demons ...      119

                                        genres  \
```

```
0  Action|Adventure|Science Fiction|Thriller
1  Action|Adventure|Science Fiction|Thriller
2         Adventure|Science Fiction|Thriller

                             production_companies release_date  vote_count  \
0  Universal Studios|Amblin Entertainment|Legenda...   2015-06-09        5562
1  Village Roadshow Pictures|Kennedy Miller Produ...   2015-05-13        6185
2  Summit Entertainment|Mandeville Films|Red Wago...   2015-03-18        2480

   vote_average  release_year    budget_adj   revenue_adj
0           6.5          2015  1.379999e+08  1.392446e+09
1           7.1          2015  1.379999e+08  3.481613e+08
2           6.3          2015  1.012000e+08  2.716190e+08
```

There are 21 columns and 10866 movies in dataset.

```
In [3]: df.shape
```

```
Out[3]: (10866, 21)
```

Some column types are correct (like popularity or director, and probably "id" column type isn't correct (should be string).

```
In [4]: df.dtypes
```

```
Out[4]: id                              int64
        imdb_id                        object
        popularity                    float64
        budget                          int64
        revenue                         int64
        original_title                 object
        cast                           object
        homepage                       object
        director                       object
        tagline                        object
        keywords                       object
        overview                       object
        runtime                         int64
        genres                         object
        production_companies           object
        release_date           datetime64[ns]
        vote_count                      int64
        vote_average                  float64
        release_year                    int64
        budget_adj                    float64
        revenue_adj                   float64
        dtype: object
```

Descriptive statistics of all numeric columns is shown below.

In [5]: df.describe()

```
Out[5]:                    id    popularity        budget       revenue       runtime  \
        count   10866.000000  10866.000000  1.086600e+04  1.086600e+04  10866.000000
        mean    66064.177434      0.646441  1.462570e+07  3.982332e+07    102.070863
        std     92130.136561      1.000185  3.091321e+07  1.170035e+08     31.381405
        min         5.000000      0.000065  0.000000e+00  0.000000e+00      0.000000
        25%     10596.250000      0.207583  0.000000e+00  0.000000e+00     90.000000
        50%     20669.000000      0.383856  0.000000e+00  0.000000e+00     99.000000
        75%     75610.000000      0.713817  1.500000e+07  2.400000e+07    111.000000
        max    417859.000000     32.985763  4.250000e+08  2.781506e+09    900.000000

                 vote_count  vote_average  release_year    budget_adj   revenue_adj
        count  10866.000000  10866.000000  10866.000000  1.086600e+04  1.086600e+04
        mean     217.389748      5.974922   2001.322658  1.755104e+07  5.136436e+07
        std      575.619058      0.935142     12.812941  3.430616e+07  1.446325e+08
        min       10.000000      1.500000   1960.000000  0.000000e+00  0.000000e+00
        25%       17.000000      5.400000   1995.000000  0.000000e+00  0.000000e+00
        50%       38.000000      6.000000   2006.000000  0.000000e+00  0.000000e+00
        75%      145.750000      6.600000   2011.000000  2.085325e+07  3.369710e+07
        max     9767.000000      9.200000   2015.000000  4.250000e+08  2.827124e+09
```

Most of columns don't have missing values. And only cast, homepage, director, and other string columns which describe movies have some missings. However, numeric columns "budget", "revenue", "runtime", "budget_adj", and "revenue_adj" have no missing data. So, zeros will be interpreted as missing data.

In [6]: df.info()

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10866 entries, 0 to 10865
Data columns (total 21 columns):
id                      10866 non-null int64
imdb_id                 10856 non-null object
popularity              10866 non-null float64
budget                  10866 non-null int64
revenue                 10866 non-null int64
original_title          10866 non-null object
cast                    10790 non-null object
homepage                2936 non-null object
director                10822 non-null object
tagline                 8042 non-null object
keywords                9373 non-null object
overview                10862 non-null object
runtime                 10866 non-null int64
genres                  10843 non-null object
production_companies    9836 non-null object
release_date            10866 non-null datetime64[ns]
vote_count              10866 non-null int64
```

```
vote_average            10866 non-null float64
release_year            10866 non-null int64
budget_adj              10866 non-null float64
revenue_adj             10866 non-null float64
dtypes: datetime64[ns](1), float64(4), int64(6), object(10)
memory usage: 1.7+ MB
```

1.1.2 Data Cleaning

From Kaggle:
Certain columns, like "cast" and "genres", contain multiple values separated by pipe (|) characters. There are some odd characters in the "cast" column. Don't worry about cleaning them. You can leave them as is.
The final two columns ending with "_adj" _show the budget and revenue of the associated movie in terms of 2010 dollars, accounting for inflation over time.
In the IMDb version it was necessary to treat values of zero in the budget field as missing. ... (It's probably a good idea to keep treating zeros as missing, with the caveat that missing budgets much more likely to have been from small budget films in the first place).

In [7]:
```
# Check are column release_year and year in relaese_date differ

df['different_years'] = df.release_date.dt.year - df.release_year
print('Columns with different years in relaese_date and release_year columns')
print(df['different_years'].sum())
df.sort_values('different_years', ascending=False).head(3)
```

```
Columns with different years in relaese_date and release_year columns
36200
```

Out[7]:
```
          id    imdb_id  popularity  budget  revenue  \
10865  22293  tt0060666    0.035919   19000        0
10155  43040  tt0054292    0.269428       0        0
10153  23439  tt0053925    0.323180  270000        0

                 original_title  \
10865  Manos: The Hands of Fate
10155         Sergeant Rutledge
10153            House of Usher

                                                    cast homepage  \
10865  Harold P. Warren|Tom Neyman|John Reynolds|Dian...      NaN
10155  Jeffrey Hunter|Woody Strode|Constance Towers|B...      NaN
10153  Vincent Price|Mark Damon|Myrna Fahey|Harry Ell...      NaN

               director                                            tagline  \
10865  Harold P. Warren         It's Shocking! It's Beyond Your Imagination!
10155         John Ford  Forget all the suspense you have ever seen! Fo...
```

```
10153     Roger Corman  Edgar Allan Poe's demonic tale of The Ungodly...

                                    keywords  \
10865  fire|gun|drive|sacrifice|flashlight
10155                  rape|court martial
10153    curse|new england|edgar allan poe

                                                overview  runtime  \
10865  A family gets lost on the road and stumbles up...       74
10155  Respected black cavalry Sergeant Brax Rutledge...      111
10153  After a long journey, Philip arrives at the Us...       79

                 genres    production_companies release_date  vote_count  \
10865            Horror               Norm-Iris   2066-11-15          15
10155     Crime|Western   John Ford Productions   2060-05-18          12
10153  Horror|Thriller  Alta Vista Productions   2060-06-21          28

       vote_average  release_year    budget_adj  revenue_adj  different_years
10865           1.5          1966  1.276423e+05          0.0              100
10155           5.2          1960  0.000000e+00          0.0              100
10153           5.9          1960  1.990701e+06          0.0              100
```

In [8]:
```python
# Create new release_date where year is replaced with release_year
df['release_date_corrected'] = pd.to_datetime(df.release_year.astype(str) + '-' + df.rel
                                              + '-' + df.release_date.dt.day.astype(str)

# Drop useless columns
df.drop(['release_year', 'release_date', 'different_years'], axis=1, inplace=True)

# Rename release_date_corrected
df.rename(columns={'release_date_corrected': 'release_date'}, inplace=True)

df.head(3)
```

Out[8]:
```
       id    imdb_id  popularity     budget     revenue      original_title  \
0  135397  tt0369610   32.985763  150000000  1513528810      Jurassic World
1   76341  tt1392190   28.419936  150000000   378436354  Mad Max: Fury Road
2  262500  tt2908446   13.112507  110000000   295238201           Insurgent

                                                cast  \
0  Chris Pratt|Bryce Dallas Howard|Irrfan Khan|Vi...
1  Tom Hardy|Charlize Theron|Hugh Keays-Byrne|Nic...
2  Shailene Woodley|Theo James|Kate Winslet|Ansel...

                                        homepage          director  \
0                  http://www.jurassicworld.com/   Colin Trevorrow
1                    http://www.madmaxmovie.com/     George Miller
2  http://www.thedivergentseries.movie/#insurgent  Robert Schwentke
```

```
                     tagline  \
0          The park is open.
1         What a Lovely Day.
2  One Choice Can Destroy You

                                           keywords  \
0  monster|dna|tyrannosaurus rex|velociraptor|island
1   future|chase|post-apocalyptic|dystopia|australia
2  based on novel|revolution|dystopia|sequel|dyst...

                                            overview  runtime  \
0  Twenty-two years after the events of Jurassic ...      124
1  An apocalyptic story set in the furthest reach...      120
2  Beatrice Prior must confront her inner demons ...      119

                                      genres  \
0  Action|Adventure|Science Fiction|Thriller
1  Action|Adventure|Science Fiction|Thriller
2         Adventure|Science Fiction|Thriller

                                production_companies  vote_count  \
0  Universal Studios|Amblin Entertainment|Legenda...        5562
1  Village Roadshow Pictures|Kennedy Miller Produ...        6185
2  Summit Entertainment|Mandeville Films|Red Wago...        2480

   vote_average    budget_adj   revenue_adj release_date
0           6.5  1.379999e+08  1.392446e+09   2015-06-09
1           7.1  1.379999e+08  3.481613e+08   2015-05-13
2           6.3  1.012000e+08  2.716190e+08   2015-03-18
```

In [9]:
```python
# Check duplicated rows

df[df.duplicated()]
```

Out[9]:
```
         id    imdb_id  popularity    budget  revenue original_title  \
2090  42194  tt0411951     0.59643  30000000   967000         TEKKEN

                                                 cast homepage  \
2090  Jon Foo|Kelly Overton|Cary-Hiroyuki Tagawa|Ian...      NaN

              director              tagline  \
2090  Dwight H. Little  Survival is no game

                                              keywords  \
2090  martial arts|dystopia|based on video game|mart...

                                              overview  runtime  \
```

```
2090  In the year of 2039, after World Wars destroy ...       92

                                          genres    production_companies  \
2090  Crime|Drama|Action|Thriller|Science Fiction  Namco|Light Song Films

      vote_count  vote_average  budget_adj  revenue_adj release_date
2090         110           5.0  30000000.0     967000.0   2010-03-20
```

In [10]:
```python
df[df.id == 42194]
```

Out[10]:
```
         id    imdb_id  popularity    budget  revenue original_title  \
2089  42194  tt0411951     0.59643  30000000   967000         TEKKEN
2090  42194  tt0411951     0.59643  30000000   967000         TEKKEN

                                                   cast homepage  \
2089  Jon Foo|Kelly Overton|Cary-Hiroyuki Tagawa|Ian...      NaN
2090  Jon Foo|Kelly Overton|Cary-Hiroyuki Tagawa|Ian...      NaN

              director              tagline  \
2089  Dwight H. Little  Survival is no game
2090  Dwight H. Little  Survival is no game

                                               keywords  \
2089  martial arts|dystopia|based on video game|mart...
2090  martial arts|dystopia|based on video game|mart...

                                               overview  runtime  \
2089  In the year of 2039, after World Wars destroy ...       92
2090  In the year of 2039, after World Wars destroy ...       92

                                           genres    production_companies  \
2089  Crime|Drama|Action|Thriller|Science Fiction  Namco|Light Song Films
2090  Crime|Drama|Action|Thriller|Science Fiction  Namco|Light Song Films

      vote_count  vote_average  budget_adj  revenue_adj release_date
2089         110           5.0  30000000.0     967000.0   2010-03-20
2090         110           5.0  30000000.0     967000.0   2010-03-20
```

From 10866 movies, "TEKKEN" is met twice. So, duplicated row will be deleted.

In [11]:
```python
df = df[~df.duplicated()]
df.shape
```

Out[11]:
```
(10865, 20)
```

In [12]:
```python
# Check which columns has only unique values, or don't include importnat information

# "id" columns is a unique identifier
print(df.id.unique().shape[0] == df.shape[0])
```

```
# imdb_id has 9 missing values and all other ids are also unique for movies
imdb_id_null = df[df.imdb_id.duplicated() & df.imdb_id.isnull()].shape[0]
print(df.imdb_id.unique().shape[0] + imdb_id_null == df.shape[0])
```

```
True
True
```

In [13]:
```
print(df[(df.budget == 0) & (df.budget_adj != 0)].shape)
print(df[(df.revenue == 0) & (df.revenue_adj != 0)].shape)

df['budget_check'] = df.budget / df.budget_adj
df['revenue_check'] = df.revenue / df.revenue_adj
df_agg = df.groupby(df.release_date.dt.year).agg({'revenue_check': ['min', 'max'], 'bud
df_agg.columns = map('_'.join, df_agg.columns)

# We don't need 'budget_check' and 'revenue_check' columns anymore
df.drop(['budget_check', 'revenue_check'], axis=1, inplace=True)

print(int((df_agg.revenue_check_max - df_agg.revenue_check_min).sum()))
print(int((df_agg.budget_check_max - df_agg.budget_check_min).sum()))
df_agg.head()
```

```
(0, 20)
(0, 20)
0
0
```

Out[13]:
```
              revenue_check_min  revenue_check_max  budget_check_min  \
release_date
1960                   0.135631           0.135631          0.135631
1961                   0.137083           0.137083          0.137083
1962                   0.138726           0.138726          0.138726
1963                   0.140446           0.140446          0.140446
1964                   0.142242           0.142242          0.142242

              budget_check_max
release_date
1960                  0.135631
1961                  0.137083
1962                  0.138726
1963                  0.140446
1964                  0.142242
```

Columns "revenue" and "budget" could be deleted since corresponding adjusted columns are calculated correctly. Moreover, it's inconvenient to compare financial indicators across years and don't take into account inflation.

There're 5068 directors in this dataset. This means, on average, one person made 2 movies.

In [14]:
```
df['director'].unique().shape
```

Out[14]:
```
(5068,)
```

In [15]:
```
directors_df = df['director'].value_counts()
directors_df.head(15)
```

Out[15]:
```
Woody Allen          45
Clint Eastwood       34
Martin Scorsese      29
Steven Spielberg     29
Ridley Scott         23
Steven Soderbergh    22
Ron Howard           22
Joel Schumacher      21
Brian De Palma       20
Tim Burton           19
Barry Levinson       19
Wes Craven           19
John Carpenter       18
Rob Reiner           18
David Cronenberg     18
Name: director, dtype: int64
```

Top-8 directors made more than 20 movies. Whether their movies are also popular or profitable than movies of the other directos? It will be disscused in Data Analysis part.

In [16]:
```
# Drop columns which won't be used in analysis

df.drop(['id', 'imdb_id', 'budget', 'revenue', 'homepage', 'tagline', 'overview'], axis
df.head(3)
```

Out[16]:
```
   popularity      original_title  \
0   32.985763      Jurassic World
1   28.419936  Mad Max: Fury Road
2   13.112507           Insurgent

                                                 cast           director  \
0  Chris Pratt|Bryce Dallas Howard|Irrfan Khan|Vi...    Colin Trevorrow
1  Tom Hardy|Charlize Theron|Hugh Keays-Byrne|Nic...      George Miller
2  Shailene Woodley|Theo James|Kate Winslet|Ansel...  Robert Schwentke

                                            keywords  runtime  \
0  monster|dna|tyrannosaurus rex|velociraptor|island      124
1   future|chase|post-apocalyptic|dystopia|australia      120
2  based on novel|revolution|dystopia|sequel|dyst...      119

                                      genres  \
0  Action|Adventure|Science Fiction|Thriller
```

```
1  Action|Adventure|Science Fiction|Thriller
2         Adventure|Science Fiction|Thriller

                                 production_companies  vote_count  \
0  Universal Studios|Amblin Entertainment|Legenda...        5562
1  Village Roadshow Pictures|Kennedy Miller Produ...        6185
2  Summit Entertainment|Mandeville Films|Red Wago...        2480

   vote_average    budget_adj   revenue_adj release_date
0           6.5  1.379999e+08  1.392446e+09   2015-06-09
1           7.1  1.379999e+08  3.481613e+08   2015-05-13
2           6.3  1.012000e+08  2.716190e+08   2015-03-18
```

Replace zeros in numeric columns without missing values with NaN. The logic was explained above.

In [17]:
```python
col_numeric = ['runtime', 'budget_adj', 'revenue_adj']

for col in col_numeric:
    df[col] = df[col].replace(0, np.nan)

df.describe()
```

Out[17]:
```
         popularity       runtime    vote_count  vote_average    budget_adj  \
count  10865.000000  10834.000000  10865.000000  10865.000000  5.169000e+03
mean       0.646446    102.363855    217.399632      5.975012  3.688907e+07
std        1.000231     30.948225    575.644627      0.935138  4.196096e+07
min        0.000065      2.000000     10.000000      1.500000  9.210911e-01
25%        0.207575     90.000000     17.000000      5.400000  8.102293e+06
50%        0.383831     99.000000     38.000000      6.000000  2.271505e+07
75%        0.713857    112.000000    146.000000      6.600000  5.008384e+07
max       32.985763    900.000000   9767.000000      9.200000  4.250000e+08

        revenue_adj
count  4.849000e+03
mean   1.151009e+08
std    1.988557e+08
min    2.370705e+00
25%    1.046585e+07
50%    4.395666e+07
75%    1.316482e+08
max    2.827124e+09
```

1.1.3 Split columns with different values in each row

Let's look at "cast", "keywords", "genres", "production_companies" columns. Values in this columns are stored as multiple values separated by pipe (|) characters.

cast

```
In [18]: crew_df = df['cast'].str.split('|').apply(pd.Series).stack().value_counts()
         print('Shape', crew_df.shape)
         crew_df[crew_df > 40].head(15)
         #crew_df.head()
```

```
Shape (19026,)
```

```
Out[18]: Robert De Niro       72
         Samuel L. Jackson    71
         Bruce Willis         62
         Nicolas Cage         61
         Michael Caine        53
         Robin Williams       51
         John Cusack          50
         Morgan Freeman       49
         John Goodman         49
         Liam Neeson          48
         Susan Sarandon       48
         Julianne Moore       47
         Alec Baldwin         47
         Gene Hackman         46
         Johnny Depp          46
         dtype: int64
```

Since, there's a lot of actresses and actors in this data, columns calles "Robert_De_Niro" and "Samuel_L_Jackson" will be added, they'll indicate wheter this super enduring men were starred in the movie or not. In future, this analysis could be extend by analysing more actors from the list above.

```
In [19]: df['Robert_De_Niro'] = np.where(df['cast'].str.contains('Robert De Niro').replace(np.na
         df['Samuel_L_Jackson'] = np.where(df['cast'].str.contains('Samuel L. Jackson').replace(

         df.drop('cast', axis=1, inplace=True)

         print('Share of movies with Robert De Niro and Samuel L. Jackson')
         print(df[['Robert_De_Niro', 'Samuel_L_Jackson']].mean())

         df.head(3)
```

```
Share of movies with Robert De Niro and Samuel L. Jackson
Robert_De_Niro      0.006627
Samuel_L_Jackson    0.006535
dtype: float64
```

```
Out[19]:    popularity      original_title          director  \
         0   32.985763      Jurassic World   Colin Trevorrow
```

```
1   28.419936  Mad Max: Fury Road     George Miller
2   13.112507           Insurgent  Robert Schwentke

                                            keywords  runtime  \
0  monster|dna|tyrannosaurus rex|velociraptor|island    124.0
1   future|chase|post-apocalyptic|dystopia|australia    120.0
2  based on novel|revolution|dystopia|sequel|dyst...    119.0

                                      genres  \
0  Action|Adventure|Science Fiction|Thriller
1  Action|Adventure|Science Fiction|Thriller
2         Adventure|Science Fiction|Thriller

                                production_companies  vote_count  \
0  Universal Studios|Amblin Entertainment|Legenda...        5562
1  Village Roadshow Pictures|Kennedy Miller Produ...        6185
2  Summit Entertainment|Mandeville Films|Red Wago...        2480

   vote_average    budget_adj   revenue_adj release_date  Robert_De_Niro  \
0           6.5  1.379999e+08  1.392446e+09   2015-06-09               0
1           7.1  1.379999e+08  3.481613e+08   2015-05-13               0
2           6.3  1.012000e+08  2.716190e+08   2015-03-18               0

   Samuel_L_Jackson
0                 0
1                 0
2                 0
```

keywords

In [20]:
```
keywords_df = df['keywords'].str.split('|').apply(pd.Series).stack().value_counts()
print('Shape', keywords_df.shape)
keywords_df.head()
```

```
Shape (7878,)
```

Out[20]:
```
woman director      413
independent film    396
based on novel      278
sex                 272
sport               216
dtype: int64
```

There're 7878 different keywords. So, only for Top-2, columns calles "woman_director" and "independent_film" will be added, they'll indicate wheter the director of movie was woman or man, and whether the movie is independent film or not. In future, this analysis could also be extend by analysing more keywords from the list above.

In [21]:
```
df['woman_director'] = np.where(df['keywords'].str.contains('woman director').replace(n
df['independent_film'] = np.where(df['keywords'].str.contains('independent film').repla

df.drop('keywords', axis=1, inplace=True)

print('Share of movies with woman director and independent films')
print(df[['woman_director', 'independent_film']].mean())

df.head(3)
```

```
Share of movies with woman director and independent films
woman_director      0.038012
independent_film    0.036539
dtype: float64
```

Out[21]:
```
   popularity      original_title           director  runtime  \
0   32.985763      Jurassic World    Colin Trevorrow    124.0
1   28.419936  Mad Max: Fury Road      George Miller    120.0
2   13.112507           Insurgent  Robert Schwentke    119.0

                                      genres  \
0  Action|Adventure|Science Fiction|Thriller
1  Action|Adventure|Science Fiction|Thriller
2         Adventure|Science Fiction|Thriller

                                production_companies  vote_count  \
0  Universal Studios|Amblin Entertainment|Legenda...        5562
1  Village Roadshow Pictures|Kennedy Miller Produ...        6185
2  Summit Entertainment|Mandeville Films|Red Wago...        2480

   vote_average    budget_adj   revenue_adj release_date  Robert_De_Niro  \
0           6.5  1.379999e+08  1.392446e+09   2015-06-09               0
1           7.1  1.379999e+08  3.481613e+08   2015-05-13               0
2           6.3  1.012000e+08  2.716190e+08   2015-03-18               0

   Samuel_L_Jackson  woman_director  independent_film
0                 0               0                 0
1                 0               0                 0
2                 0               0                 0
```

genres

In [22]:
```
genres_df = df['genres'].str.split('|').apply(pd.Series).stack().value_counts()
print('Shape', genres_df.shape)
genres_df
```

```
Shape (20,)
```

```
Out[22]: Drama              4760
         Comedy             3793
         Thriller           2907
         Action             2384
         Romance            1712
         Horror             1637
         Adventure          1471
         Crime              1354
         Family             1231
         Science Fiction    1229
         Fantasy             916
         Mystery             810
         Animation           699
         Documentary         520
         Music               408
         History             334
         War                 270
         Foreign             188
         TV Movie            167
         Western             165
         dtype: int64
```

For every genre will be created dummy variable which will indicate what genre the film belongs to.

```
In [23]: genre_unique = genres_df.index.tolist()

         for genre in genre_unique:
             df[genre] = np.where(df['genres'].str.contains(genre).replace(np.nan, False), 1, 0)

         df.drop('genres', axis=1, inplace=True)

         print('New shape', df.shape)
         df.head(3)
```

```
New shape (10865, 34)
```

```
Out[23]:    popularity      original_title          director  runtime  \
         0   32.985763      Jurassic World   Colin Trevorrow    124.0
         1   28.419936  Mad Max: Fury Road     George Miller    120.0
         2   13.112507           Insurgent  Robert Schwentke    119.0

                                          production_companies  vote_count  \
         0  Universal Studios|Amblin Entertainment|Legenda...        5562
         1  Village Roadshow Pictures|Kennedy Miller Produ...        6185
         2  Summit Entertainment|Mandeville Films|Red Wago...        2480

            vote_average    budget_adj   revenue_adj release_date  Robert_De_Niro  \
```

```
0          6.5  1.379999e+08  1.392446e+09   2015-06-09                 0
1          7.1  1.379999e+08  3.481613e+08   2015-05-13                 0
2          6.3  1.012000e+08  2.716190e+08   2015-03-18                 0

   Samuel_L_Jackson  woman_director  independent_film  Drama  Comedy  \
0                 0               0                 0      0       0
1                 0               0                 0      0       0
2                 0               0                 0      0       0

   Thriller  Action  Romance  Horror  Adventure  Crime  Family  \
0         1       1        0       0          1      0       0
1         1       1        0       0          1      0       0
2         1       0        0       0          1      0       0

   Science Fiction  Fantasy  Mystery  Animation  Documentary  Music  History  \
0                1        0        0          0            0      0        0
1                1        0        0          0            0      0        0
2                1        0        0          0            0      0        0

   War  Foreign  TV Movie  Western
0    0        0         0        0
1    0        0         0        0
2    0        0         0        0
```

production_companies

```
In [24]: production_companies_df = df['production_companies'].str.split('|').apply(pd.Series).st
         print('Shape', production_companies_df.shape)
         production_companies_df.head(10)
```

```
Shape (7879,)
```

```
Out[24]: Universal Pictures                        522
         Warner Bros.                              509
         Paramount Pictures                        431
         Twentieth Century Fox Film Corporation    282
         Columbia Pictures                         272
         New Line Cinema                           219
         Metro-Goldwyn-Mayer (MGM)                 218
         Walt Disney Pictures                      214
         Touchstone Pictures                       178
         Columbia Pictures Corporation             160
         dtype: int64
```

Top-3 production companies are used among list of 7879 different firms: * Universal Pictures
* Warner Bros.
* Paramount Pictures.

```
In [25]: df['Universal_Pictures'] = (np.where(df['production_companies'].str.contains('Universal
                                              .replace(np.nan, False), 1, 0))
         df['Warner_Bros'] = np.where(df['production_companies'].str.contains('Warner Bros.').re
         df['Paramount_Pictures'] = (np.where(df['production_companies'].str.contains('Paramount
                                              .replace(np.nan, False), 1, 0))

         df.drop('production_companies', axis=1, inplace=True)

         print('Share of movies of Universal Pictures, Warner Bros., and Paramount Pictures')
         print(df[['Universal_Pictures', 'Warner_Bros', 'Paramount_Pictures']].mean() * 100)

         df.head(3)
```

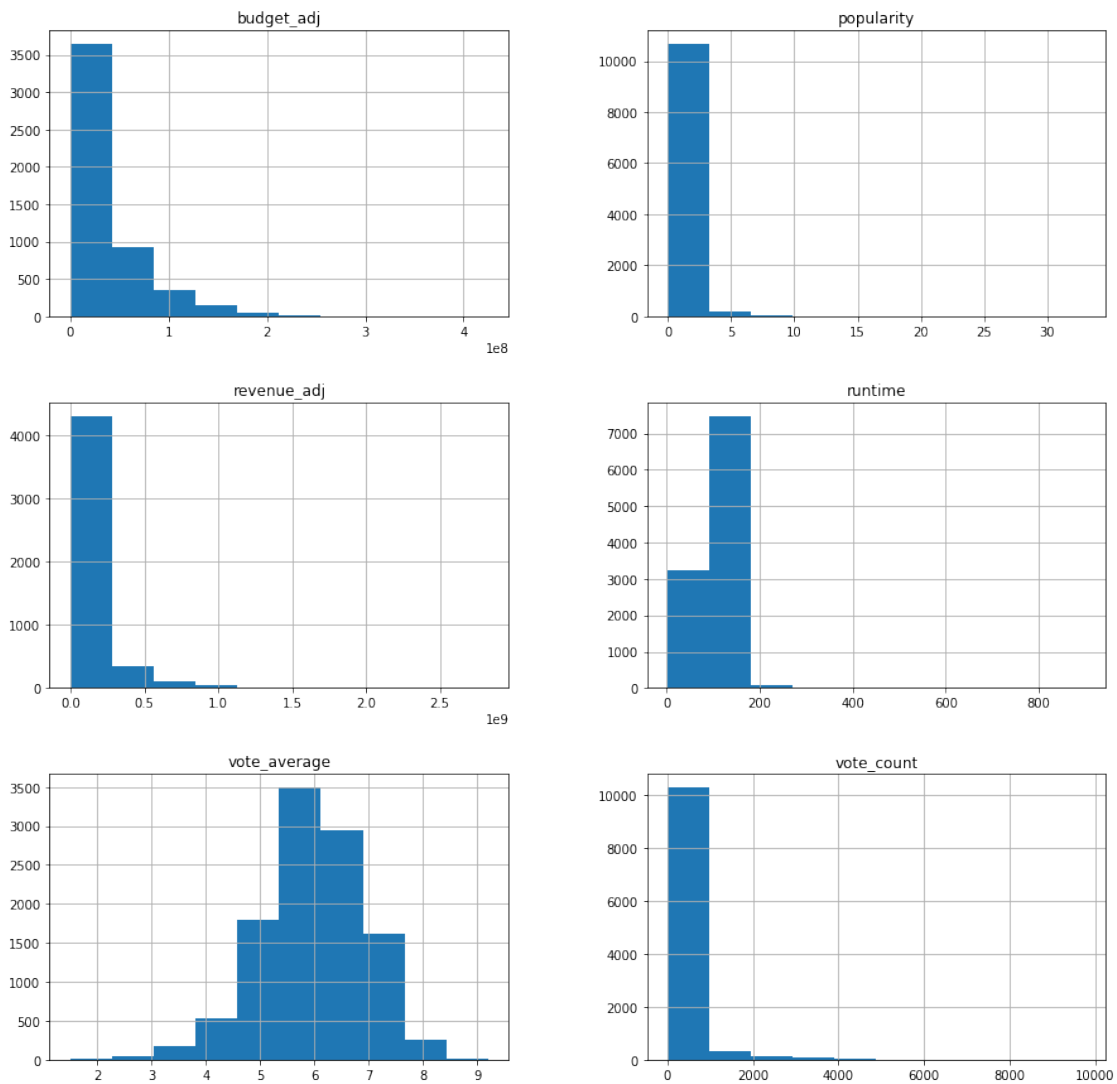
```
Share of movies of Universal Pictures, Warner Bros., and Paramount Pictures
Universal_Pictures    4.878049
Warner_Bros           5.715601
Paramount_Pictures    3.985274
dtype: float64
```

```
Out[25]:    popularity      original_title          director  runtime  vote_count  \
         0   32.985763      Jurassic World   Colin Trevorrow    124.0        5562
         1   28.419936  Mad Max: Fury Road     George Miller    120.0        6185
         2   13.112507           Insurgent  Robert Schwentke    119.0        2480

            vote_average    budget_adj   revenue_adj release_date  Robert_De_Niro  \
         0           6.5  1.379999e+08  1.392446e+09   2015-06-09               0
         1           7.1  1.379999e+08  3.481613e+08   2015-05-13               0
         2           6.3  1.012000e+08  2.716190e+08   2015-03-18               0

            Samuel_L_Jackson  woman_director  independent_film  Drama  Comedy  \
         0                 0               0                 0      0       0
         1                 0               0                 0      0       0
         2                 0               0                 0      0       0

            Thriller  Action  Romance  Horror  Adventure  Crime  Family  \
         0         1       1        0       0          1      0       0
         1         1       1        0       0          1      0       0
         2         1       0        0       0          1      0       0

            Science Fiction  Fantasy  Mystery  Animation  Documentary  Music  History  \
         0                1        0        0          0            0      0        0
         1                1        0        0          0            0      0        0
         2                1        0        0          0            0      0        0

            War  Foreign  TV Movie  Western  Universal_Pictures  Warner_Bros  \
         0    0        0         0        0                   0            0
         1    0        0         0        0                   0            0
```

```
2    0          0          0          0                     0             0

   Paramount_Pictures
0                   0
1                   0
2                   0
```

1.1.4 Visualize results

```
In [26]: df[['popularity', 'runtime', 'vote_count', 'vote_average', 'budget_adj', 'revenue_adj']
         plt.show()
```




```
In [27]: df_nulls = df.isnull().sum().sort_values(ascending=False)
```

```
print('Share of missing values')
df_nulls[df_nulls > 0] / df.shape[0]
```

```
Share of missing values
```

```
Out[27]: revenue_adj    0.553705
         budget_adj     0.524252
         director       0.004050
         runtime        0.002853
         dtype: float64
```

Missing values in "director" column isn't significant, and it's equal 0.41%. So we'll only look at non-missing data. The same could be applied to "runtime" column, and share of NaN is equal 0.29%. here we'll also look at non-missing data. More than 50% of missing values in revenues and budget will significantly distort results. Replace a half of missing values with any measure of center won't produce accurate results. So, one way is somehow impute NaN. The other way is to analyse only data with valid not-zero numbers. And some other scenarios.
In the following analyses wil be used only not-zero budgets and revenues.

```
In [28]: df = df[(df.director.notnull()) & (df.runtime.notnull())]
```

```
In [29]: print('Final shape', df.shape)
         df.head()
```

```
Final shape (10792, 36)
```

```
Out[29]:    popularity                original_title           director  runtime  \
         0   32.985763                Jurassic World    Colin Trevorrow    124.0
         1   28.419936            Mad Max: Fury Road      George Miller    120.0
         2   13.112507                     Insurgent  Robert Schwentke    119.0
         3   11.173104  Star Wars: The Force Awakens       J.J. Abrams    136.0
         4    9.335014                     Furious 7          James Wan    137.0

            vote_count  vote_average   budget_adj   revenue_adj release_date  \
         0        5562           6.5  1.379999e+08  1.392446e+09   2015-06-09
         1        6185           7.1  1.379999e+08  3.481613e+08   2015-05-13
         2        2480           6.3  1.012000e+08  2.716190e+08   2015-03-18
         3        5292           7.5  1.839999e+08  1.902723e+09   2015-12-15
         4        2947           7.3  1.747999e+08  1.385749e+09   2015-04-01

            Robert_De_Niro  Samuel_L_Jackson  woman_director  independent_film  Drama  \
         0               0                 0               0                 0      0
         1               0                 0               0                 0      0
         2               0                 0               0                 0      0
         3               0                 0               0                 0      0
         4               0                 0               0                 0      0
```

```
   Comedy  Thriller  Action  Romance  Horror  Adventure  Crime  Family  \
0       0         1       1        0       0          1      0       0
1       0         1       1        0       0          1      0       0
2       0         1       0        0       0          1      0       0
3       0         0       1        0       0          1      0       0
4       0         1       1        0       0          0      1       0

   Science Fiction  Fantasy  Mystery  Animation  Documentary  Music  History  \
0                1        0        0          0            0      0        0
1                1        0        0          0            0      0        0
2                1        0        0          0            0      0        0
3                1        1        0          0            0      0        0
4                0        0        0          0            0      0        0

   War  Foreign  TV Movie  Western  Universal_Pictures  Warner_Bros  \
0    0        0         0        0                   0            0
1    0        0         0        0                   0            0
2    0        0         0        0                   0            0
3    0        0         0        0                   0            0
4    0        0         0        0                   1            0

   Paramount_Pictures
0                   0
1                   0
2                   0
3                   0
4                   0
```

Exploratory Data Analysis
Research questions: 1. Which genres are most popular from year to year?
2. How sharp is the divide between major film studios and the independents?
3. What kinds of properties are associated with movies that have high revenues?
4. Top-8 directors made more than 20 movies. Whether their movies are also popular or profitable than movies of the other directos?

1.1.5 Research Question 1: Which genres are most popular from year to year?

```
In [30]: df.popularity.describe()
```

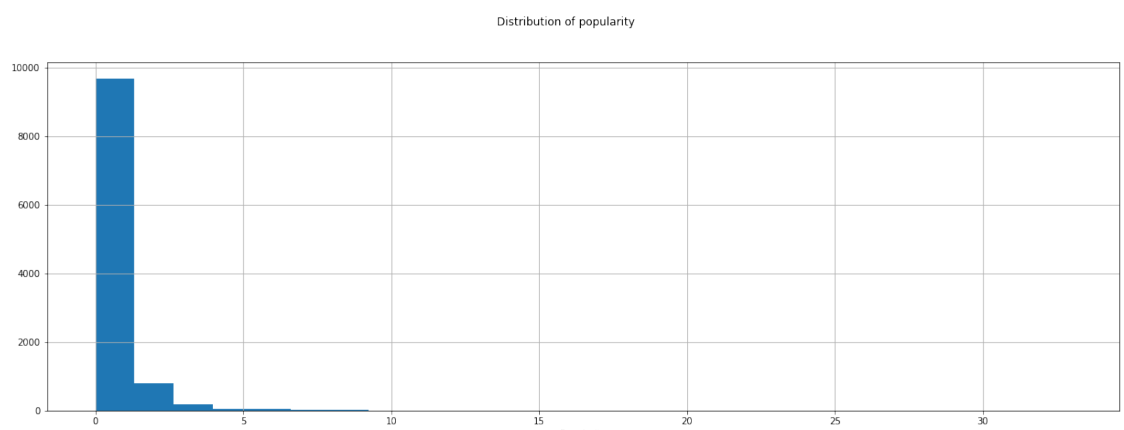
```
Out[30]: count    10792.000000
         mean         0.649765
         std          1.002611
         min          0.000188
         25%          0.209737
         50%          0.385598
         75%          0.717722
         max         32.985763
         Name: popularity, dtype: float64
```

```
In [31]: df[df.popularity == df.popularity.max()]
```

```
Out[31]:    popularity  original_title         director  runtime  vote_count  \
         0   32.985763  Jurassic World  Colin Trevorrow    124.0        5562

            vote_average    budget_adj    revenue_adj release_date  Robert_De_Niro  \
         0           6.5  1.379999e+08  1.392446e+09   2015-06-09               0

            Samuel_L_Jackson  woman_director  independent_film  Drama  Comedy  \
         0                 0               0                 0      0       0

            Thriller  Action  Romance  Horror  Adventure  Crime  Family  \
         0         1       1        0       0          1      0       0

            Science Fiction  Fantasy  Mystery  Animation  Documentary  Music  History  \
         0                1        0        0          0            0      0        0

            War  Foreign  TV Movie  Western  Universal_Pictures  Warner_Bros  \
         0    0        0         0        0                   0            0

            Paramount_Pictures
         0                   0
```

Most of the popularity ratings are less than 1. The distribution of popularity is right skewed with maximum rating 32.99 of movie "Jurassic World" (2015).

```
In [32]: df.popularity.hist(figsize=(21,7), bins=25)
         plt.xlabel('Popularity')
         plt.suptitle('Distribution of popularity')
         plt.show()
```

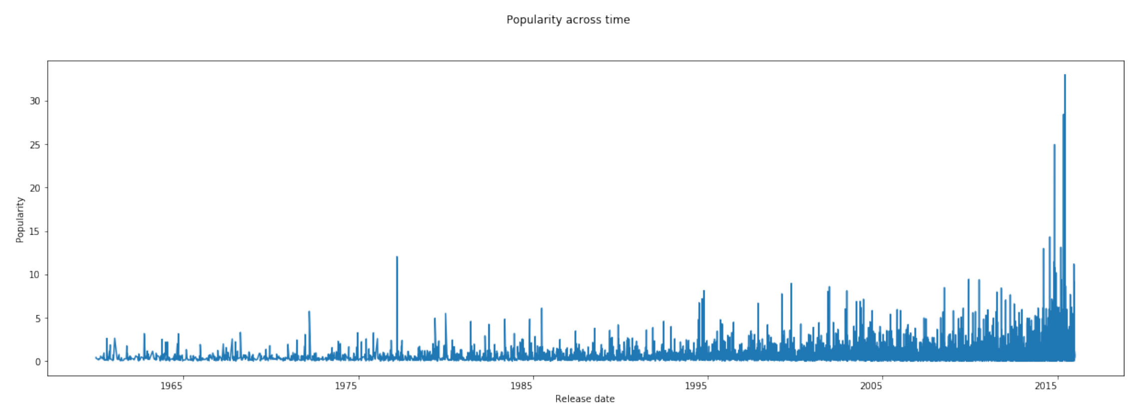


From 1960 to 2015 the number of movies increased with the corresponding increase of average opularity rate. However, some movies became popular since 20 century. For example, "The Godfather" (1972) has 5.74 popularity rate.

```
In [33]: df[(df.release_date >= '1972-01-01') & (df.release_date <= '1974-01-01')].sort_values('
                                                                              ascending=False).iloc[0, :9
```

```
Out[33]: popularity                      5.73803
         original_title             The Godfather
         director            Francis Ford Coppola
         runtime                             175
         vote_count                         3970
         vote_average                        8.3
         budget_adj                  3.12874e+07
         revenue_adj                 1.27791e+09
         release_date        1972-03-15 00:00:00
         Name: 7269, dtype: object
```

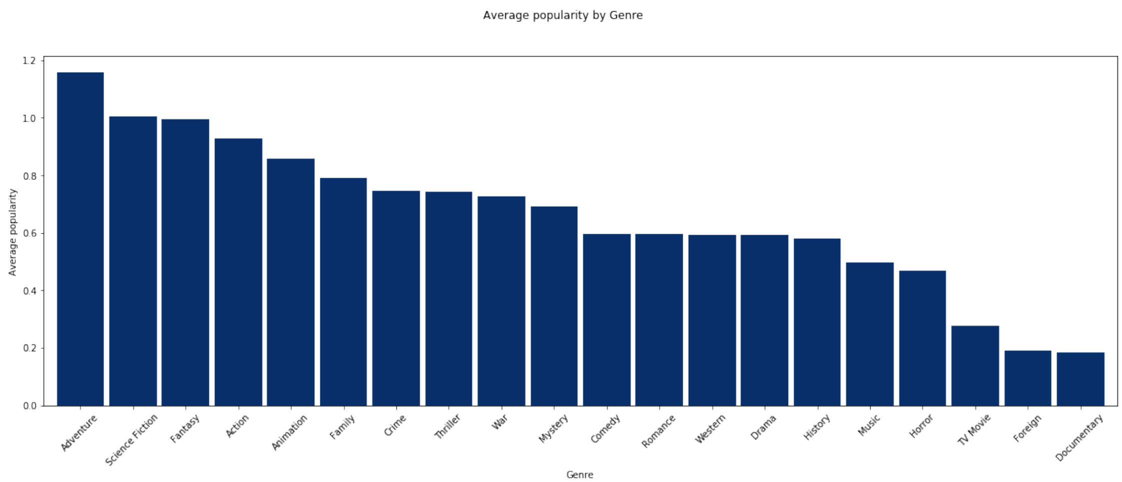
```
In [34]: fig, ax = plt.subplots(nrows=1, ncols=1, figsize=(21,7))
         df.plot(x='release_date', y='popularity', rot=0, legend=False, kind='line', ax=ax)
         plt.xlabel('Release date')
         plt.ylabel('Popularity')
         plt.suptitle('Popularity across time')
         # ax.set_yscale('log')
         plt.show()
```



Among all 10 thound movies, Adventure is the most popular genre with average popularity about 1.2.

```
In [35]: temp_lst = []
         for col in genre_unique:
             temp_lst.append(df[df[col] == 1].popularity.mean())

         popularity_by_genre = pd.DataFrame({'Genre': genre_unique, 'Mean popularity': temp_lst}
         popularity_by_genre.sort_values(by='Mean popularity', ascending=False, inplace=True)
         popularity_by_genre.plot(x='Genre', y='Mean popularity', rot=45, legend=False, kind='ba
                                  figsize=(21,7), cmap='Blues_r', width=.9)
         plt.xlabel('Genre')
```

```
plt.ylabel('Average popularity')
plt.suptitle('Average popularity by Genre')
plt.show()
```



Now, that we have average popularity separately by release date and by genres, let's look at the most popular genres over time.

```
In [36]: # Reshape dataset such that genre became one row and create popularity_by_genre dataset

         popularity_by_genre = df[df[genre_unique[0]] == 1].groupby(df.release_date.dt.year)['po
         popularity_by_genre['genre'] = genre_unique[0]
         years = df.release_date.dt.year.tolist()
         for col in genre_unique[1:]:
             temp = df[df[col] == 1].groupby(df.release_date.dt.year)['popularity'].mean().reset
             temp['genre'] = col
             popularity_by_genre = popularity_by_genre.append(temp)

         print('Genres\n', popularity_by_genre.genre.unique())
         print('Average popularity\n', popularity_by_genre.popularity.mean())
         popularity_by_genre.head()
```

```
Genres
 ['Drama' 'Comedy' 'Thriller' 'Action' 'Romance' 'Horror' 'Adventure'
 'Crime' 'Family' 'Science Fiction' 'Fantasy' 'Mystery' 'Animation'
 'Documentary' 'Music' 'History' 'War' 'Foreign' 'TV Movie' 'Western']
Average popularity
 0.586307521846
```

Out[36]:

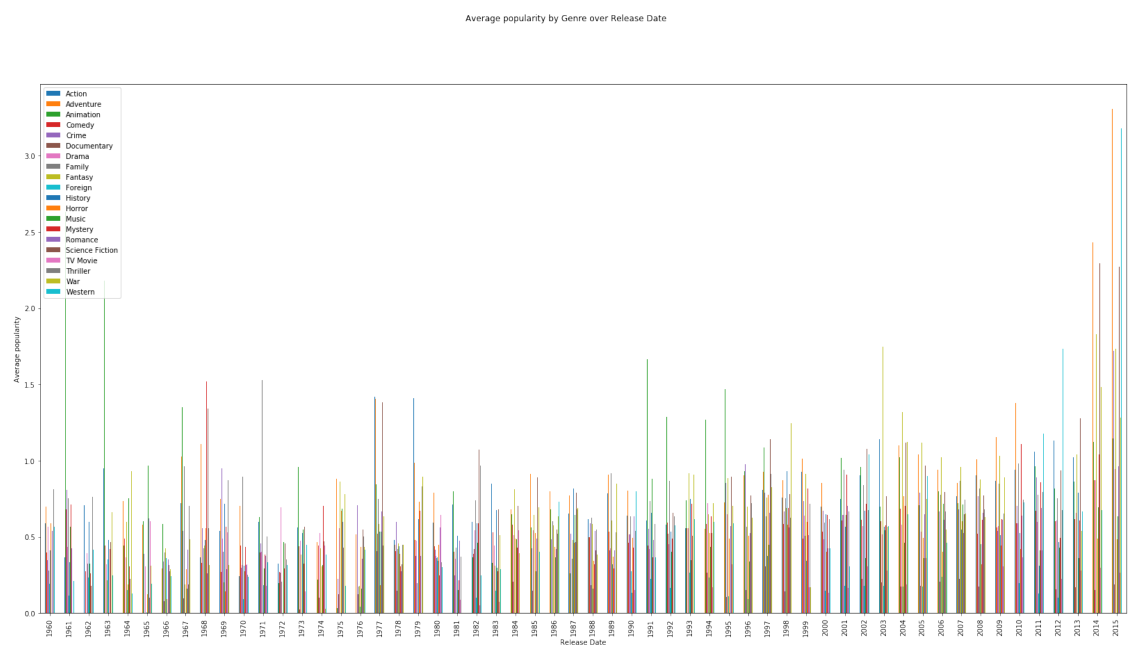
	release_date	popularity	genre
0	1960	0.566305	Drama
1	1961	0.432233	Drama

```
2           1962     0.392000   Drama
3           1963     0.322448   Drama
4           1964     0.364818   Drama
```

In [37]:
```
# Create dateset with popularity means to make visuals

df_plot = popularity_by_genre.groupby(['release_date', 'genre']).popularity.mean()
```

It's not a good idea to use all the genres for the last 55 years. Let's fix this in the following figure.

In [38]:
```
df_plot.sort_index(level='release_date', ascending=True).unstack().plot(
                kind='bar', figsize=(28,14))
plt.legend(loc='upper left')
plt.xlabel('Release Date')
plt.ylabel('Average popularity')
plt.suptitle('Average popularity by Genre over Release Date')
plt.show()
```



Get only top-5 genres from each year, so we could distinguish their popularity rates.

In [39]:
```
df_plot_top5 = df_plot.reset_index().sort_values(by=['release_date', 'genre'],
                                                  ascending=[True, False]).groupby('rele
df_plot_top5.set_index(['release_date', 'genre'], inplace=True)
df_plot_top5.head(10)
```

Out[39]:
```
                              popularity
release_date genre
```

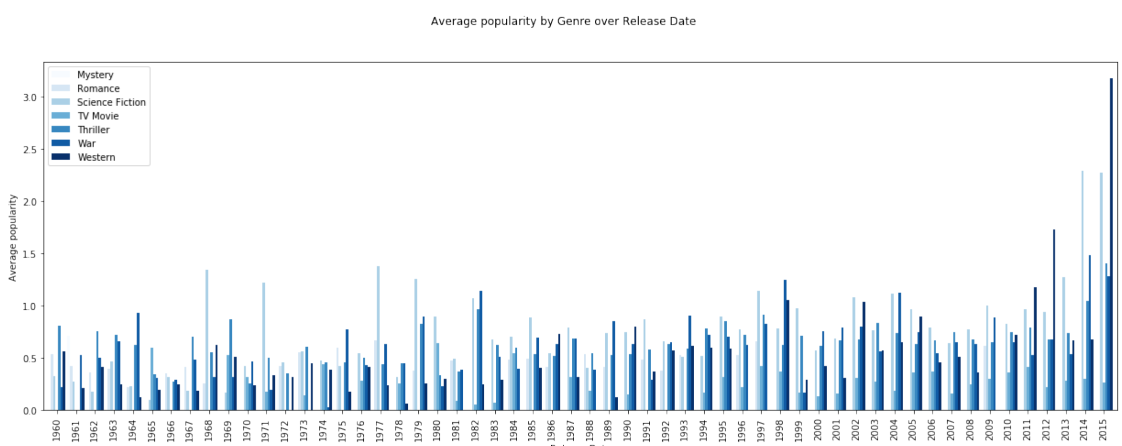
```
1960         Western            0.567759
             War                0.225863
             Thriller           0.811910
             Science Fiction    0.327905
             Romance            0.541227
1961         Western            0.210021
             War                0.531184
             Science Fiction    0.274103
             Romance            0.426036
             Mystery            0.712793
```

```
In [40]: df_plot_top5.groupby('genre').popularity.mean().sort_values()
```

```
Out[40]: genre
         TV Movie           0.285852
         Romance            0.464334
         Mystery            0.501919
         Western            0.537787
         War                0.626728
         Thriller           0.645515
         Science Fiction    0.763493
         Name: popularity, dtype: float64
```

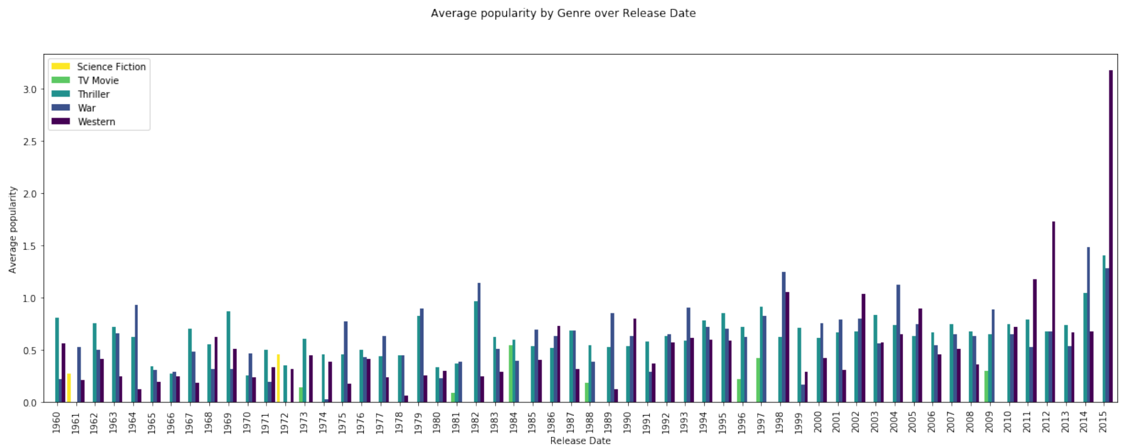
The most popular genres by popularity rate during the whole period is Science Fiction, Thriller, and Wars. Moreover, during the 20 century Romance and TV movies were also as popular as Science Fiction genre. In the 21st century Western genre has reached leading positions.

```
In [41]: df_plot_top5.sort_values(['release_date', 'popularity'], ascending=[True, False]).unsta
         plt.legend(['Western', 'War', 'Thriller', 'TV Movie', 'Science Fiction', 'Romance', 'My
                    loc='upper left')
         plt.xlabel('Release Date')
         plt.ylabel('Average popularity')
         plt.suptitle('Average popularity by Genre over Release Date')
         plt.show()
```



If we look only on top-3 genres of each year, Thriller and war genres bagin to compete for first place with each other from year to year.

```
In [42]: df_plot_top3 = df_plot.reset_index().sort_values(by=['release_date', 'genre'],
                                                         ascending=[True, False]).groupby('rele
         df_plot_top3.set_index(['release_date', 'genre'], inplace=True)

         df_plot_top3.unstack().plot(kind='bar', width=.9, figsize=(21,7), cmap='viridis_r')
         plt.legend(['Western', 'War', 'Thriller', 'TV Movie', 'Science Fiction'][::-1], loc='up
         plt.xlabel('Release Date')
         plt.ylabel('Average popularity')
         plt.suptitle('Average popularity by Genre over Release Date')
         plt.show()
```



1.1.6 Research Question 2: How sharp is the divide between major film studios and the independents?

Top-2 production companies are:
1. Universal Pictures (produced 522 movies),
2. Warner Bros. (produced 509 movies).

Let's look at difference between major film studios and the independents using this production companies data.

```
In [43]: df.groupby(['independent_film', 'Universal_Pictures']).mean()[['popularity', 'runtime',
                                                                        'budget_adj', 'revenue_ad
```

```
Out[43]:                                        popularity     runtime  vote_count  \
         independent_film Universal_Pictures
         0                0                       0.646776  102.220736  215.945171
                          1                       0.962337  108.499055  407.565217
```

```
1               0                       0.306643   98.840506   36.240506
                1                       0.327996  102.000000   23.000000

                                    vote_average    budget_adj   revenue_adj
independent_film Universal_Pictures
0               0                       5.968410  3.657895e+07  1.138762e+08
                1                       6.073535  5.267046e+07  1.660731e+08
1               0                       5.951646  9.054178e+06  5.819831e+06
                1                       5.800000  4.577416e+06           NaN
```

In [44]:
```python
pd.crosstab(df.independent_film, df.Universal_Pictures)
```

Out[44]:
```
Universal_Pictures     0    1
independent_film
0                   9867  529
1                    395    1
```

In [45]:
```python
df.groupby(['independent_film', 'Warner_Bros']).mean()[['popularity', 'runtime', 'vote_
                                                          'budget_adj', 'revenue_ad
```

Out[45]:
```
                              popularity     runtime  vote_count  \
independent_film Warner_Bros
0               0               0.638903  102.101156  210.486550
                1               1.040808  109.474960  465.922456
1               0               0.305501   98.829949   36.269036
                1               0.542260  102.500000   24.000000

                              vote_average    budget_adj   revenue_adj
independent_film Warner_Bros
0               0                 5.960949  3.546243e+07  1.125606e+08
                1                 6.176090  6.425075e+07  1.769029e+08
1               0                 5.951269  8.617312e+06  5.754943e+06
                1                 5.950000  6.792302e+07  1.432024e+07
```

In [46]:
```python
210.486550 / 36.269036, 465.922456 / 24.000000
```

Out[46]:
```
(5.803477930871942, 19.41343566666667)
```

In [47]:
```python
pd.crosstab(df.independent_film, df.Warner_Bros)
```

Out[47]:
```
Warner_Bros          0    1
independent_film
0                 9777  619
1                  394    2
```

Universal Pictures made only 1 independent film (it's about 0.19% of all movies made by the company), and Warner Bros. made 2 independent films (it's about 0.32% of all movies made by the company). In comparison, 393 movies of the other companies were independent (it's about 3.67% of all movies).
So, why major film studios don't made independent?

Popularity rates of independent movies are twice lower (0.65 vs. 0.31, or 0.96 vs. 0.33) than not-independent ones.
If we don't take into account missing data in revenue and budget columns, the result for independent movies is more than twice worse. Despite average votes for independent and not-independent movies are approximately the same (6 points), number of votes for independent movies is more then 5 times smaller (200-500 vs. 20-40).
So, producing companies don't make independent movies because revenues from them are lower, or revenues from independent movies are lower because producing comanies don't make them? It's really interesting question for the further investigation and analysis.

1.1.7 Research Question 3: What kinds of properties are associated with movies that have high revenues?

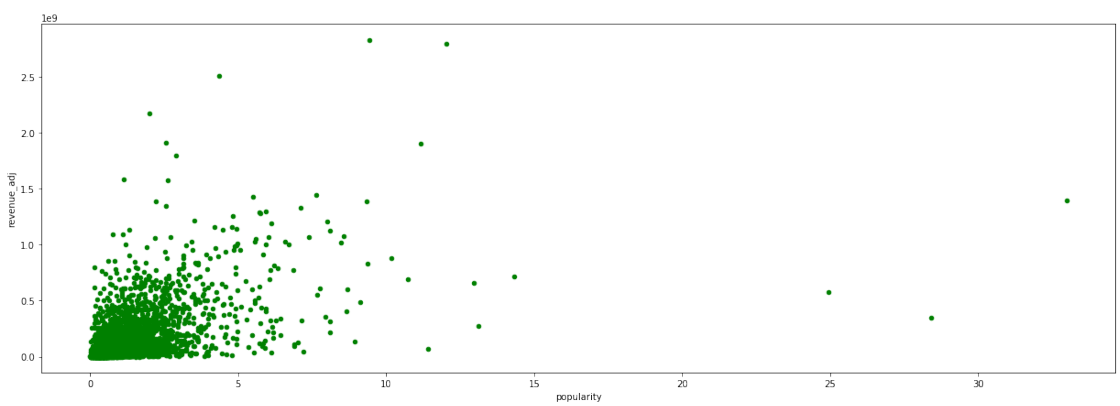
To answer this question, only numeric columns were considered.

In [48]:
```
revenue_df = df[df.revenue_adj.notnull()].sort_values(by='revenue_adj', ascending=False
revenue_df.head()
```

Out[48]:
```
       popularity original_title           director  runtime  vote_count  \
1386     9.432768         Avatar      James Cameron    162.0        8458
1329    12.037933      Star Wars       George Lucas    121.0        4428
5231     4.355219        Titanic      James Cameron    194.0        4654
10594    2.010733    The Exorcist  William Friedkin    122.0        1113
9806     2.563191           Jaws  Steven Spielberg    124.0        1415

       vote_average    budget_adj   revenue_adj release_date  Robert_De_Niro  \
1386            7.1  2.408869e+08  2.827124e+09   2009-12-10               0
1329            7.9  3.957559e+07  2.789712e+09   1977-03-20               0
5231            7.3  2.716921e+08  2.506406e+09   1997-11-18               0
10594           7.2  3.928928e+07  2.167325e+09   1973-12-26               0
9806            7.3  2.836275e+07  1.907006e+09   1975-06-18               0

       Samuel_L_Jackson  woman_director  independent_film  Drama  Comedy  \
1386                  0               0                 0      0       0
1329                  0               0                 0      0       0
5231                  0               0                 0      1       0
10594                 0               0                 0      1       0
9806                  0               0                 0      0       0

       Thriller  Action  Romance  Horror  Adventure  Crime  Family  \
1386          0       1        0       0          1      0       0
1329          0       1        0       0          1      0       0
5231          1       0        1       0          0      0       0
10594         1       0        0       1          0      0       0
9806          1       0        0       1          1      0       0

       Science Fiction  Fantasy  Mystery  Animation  Documentary  Music  \
1386                 1        1        0          0            0      0
```

```
1329                 1         0         0           0             0       0
5231                 0         0         0           0             0       0
10594                0         0         0           0             0       0
9806                 0         0         0           0             0       0

       History  War  Foreign  TV Movie  Western  Universal_Pictures  \
1386         0    0        0         0        0                   0
1329         0    0        0         0        0                   0
5231         0    0        0         0        0                   0
10594        0    0        0         0        0                   0
9806         0    0        0         0        0                   1

       Warner_Bros  Paramount_Pictures
1386             0                   0
1329             0                   0
5231             0                   1
10594            1                   0
9806             0                   0
```

In [49]:
```
revenue_df[['popularity', 'revenue_adj']].plot(kind='scatter', x='popularity', y='reven
                                               color='green')
plt.show()
```



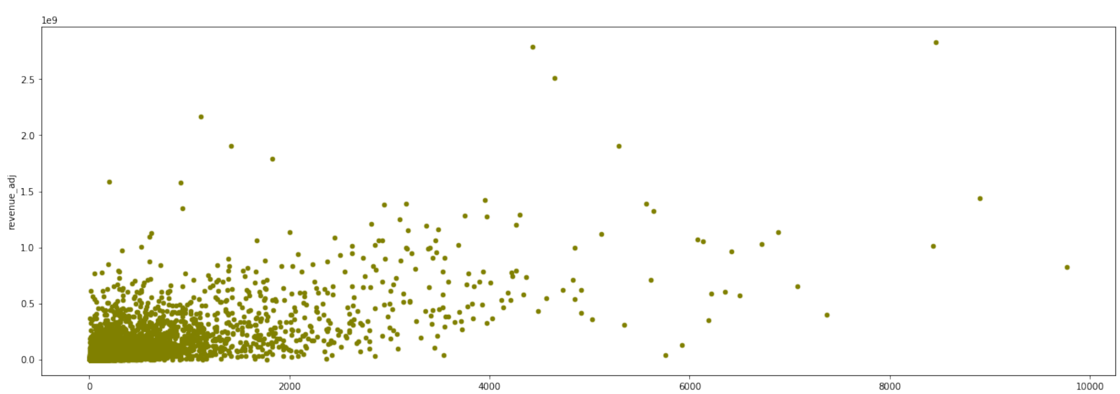
In [50]:
```
print('Average Revenue', revenue_df[revenue_df.popularity > 20].revenue_adj.mean())
revenue_df[revenue_df.popularity > 20]
```

```
Average Revenue 771099276.712
```

Out[50]:
```
     popularity      original_title           director  runtime  vote_count  \
0     32.985763      Jurassic World    Colin Trevorrow    124.0        5562
629   24.949134        Interstellar  Christopher Nolan    169.0        6498
1     28.419936  Mad Max: Fury Road      George Miller    120.0        6185
```

```
     vote_average   budget_adj   revenue_adj release_date  Robert_De_Niro  \
0             6.5  1.379999e+08  1.392446e+09   2015-06-09               0
629           8.0  1.519800e+08  5.726906e+08   2014-11-05               0
1             7.1  1.379999e+08  3.481613e+08   2015-05-13               0

     Samuel_L_Jackson  woman_director  independent_film  Drama  Comedy  \
0                   0               0                 0      0       0
629                 0               0                 0      1       0
1                   0               0                 0      0       0

     Thriller  Action  Romance  Horror  Adventure  Crime  Family  \
0           1       1        0       0          1      0       0
629         0       0        0       0          1      0       0
1           1       1        0       0          1      0       0

     Science Fiction  Fantasy  Mystery  Animation  Documentary  Music  \
0                  1        0        0          0            0      0
629                1        0        0          0            0      0
1                  1        0        0          0            0      0

     History  War  Foreign  TV Movie  Western  Universal_Pictures  \
0          0    0        0         0        0                   0
629        0    0        0         0        0                   0
1          0    0        0         0        0                   0

     Warner_Bros  Paramount_Pictures
0              0                   0
629            1                   1
1              0                   0
```

In [51]:
```python
revenue_df[['vote_count', 'revenue_adj']].plot(kind='scatter', x='vote_count', y='reven
                                                 color='olive')
plt.show()
```



```
In [52]: print('Average Revenue', revenue_df[revenue_df.vote_count > 8000].revenue_adj.mean())
         revenue_df[revenue_df.vote_count > 8000]
```

```
Average Revenue 1527637054.52
```

Out[52]:

	popularity	original_title	director	runtime	vote_count
1386	9.432768	Avatar	James Cameron	162.0	8458
4361	7.637767	The Avengers	Joss Whedon	143.0	8903
2875	8.466668	The Dark Knight	Christopher Nolan	152.0	8432
1919	9.363643	Inception	Christopher Nolan	148.0	9767

	vote_average	budget_adj	revenue_adj	release_date	Robert_De_Niro
1386	7.1	2.408869e+08	2.827124e+09	2009-12-10	0
4361	7.3	2.089437e+08	1.443191e+09	2012-04-25	0
2875	8.1	1.873655e+08	1.014733e+09	2008-07-16	0
1919	7.9	1.600000e+08	8.255000e+08	2010-07-14	0

	Samuel_L_Jackson	woman_director	independent_film	Drama	Comedy
1386	0	0	0	0	0
4361	0	0	0	0	0
2875	0	0	0	1	0
1919	0	0	0	0	0

	Thriller	Action	Romance	Horror	Adventure	Crime	Family
1386	0	1	0	0	1	0	0
4361	0	1	0	0	1	0	0
2875	1	1	0	0	0	1	0
1919	1	1	0	0	1	0	0

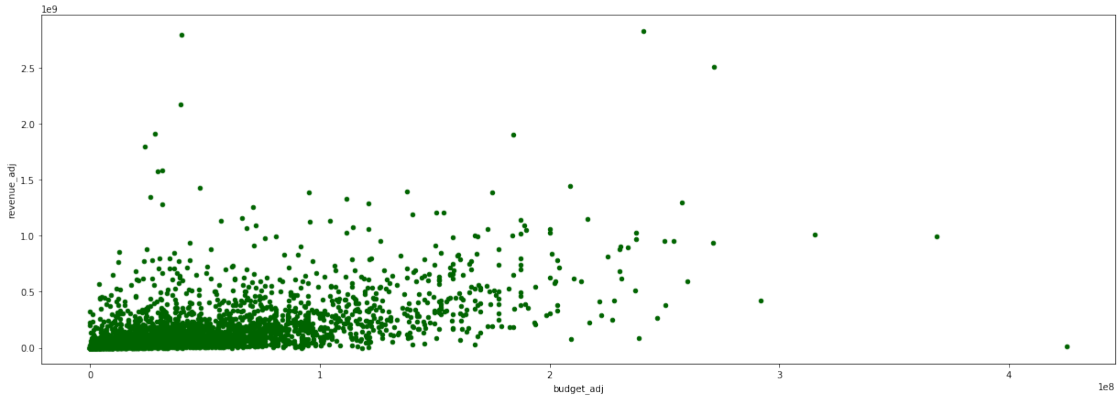
	Science Fiction	Fantasy	Mystery	Animation	Documentary	Music
1386	1	1	0	0	0	0
4361	1	0	0	0	0	0
2875	0	0	0	0	0	0
1919	1	0	1	0	0	0

	History	War	Foreign	TV Movie	Western	Universal_Pictures
1386	0	0	0	0	0	0
4361	0	0	0	0	0	0
2875	0	0	0	0	0	0
1919	0	0	0	0	0	0

	Warner_Bros	Paramount_Pictures
1386	0	0
4361	0	0
2875	1	0
1919	1	0

```
In [53]: revenue_df[['budget_adj', 'revenue_adj']].plot(kind='scatter', x='budget_adj', y='reven
```

```
                                                   color='darkgreen')
plt.show()
```




```
In [54]: print('Average Revenue', revenue_df[revenue_df.budget_adj > 300000000].revenue_adj.mean
         revenue_df[revenue_df.budget_adj > 300000000]
```

Average Revenue 670719525.753

Out[54]:

	popularity	original_title	director
7387	4.965391	Pirates of the Caribbean: At World's End	Gore Verbinski
3375	4.955130	Pirates of the Caribbean: On Stranger Tides	Rob Marshall
2244	0.250540	The Warrior's Way	Sngmoo Lee

	runtime	vote_count	vote_average	budget_adj	revenue_adj
7387	169.0	2626	6.8	3.155006e+08	1.010654e+09
3375	136.0	3180	6.3	3.683713e+08	9.904175e+08
2244	100.0	74	6.4	4.250000e+08	1.108757e+07

	release_date	Robert_De_Niro	Samuel_L_Jackson	woman_director
7387	2007-05-19	0	0	0
3375	2011-05-11	0	0	0
2244	2010-12-02	0	0	0

	independent_film	Drama	Comedy	Thriller	Action	Romance	Horror
7387	0	0	0	0	1	0	0
3375	0	0	0	0	1	0	0
2244	0	0	0	1	1	0	0

	Adventure	Crime	Family	Science Fiction	Fantasy	Mystery	Animation
7387	1	0	0	0	1	0	0
3375	1	0	0	0	1	0	0
2244	1	0	0	0	1	0	0

```
      Documentary  Music  History  War  Foreign  TV Movie  Western  \
7387            0      0        0    0        0         0        0
3375            0      0        0    0        0         0        0
2244            0      0        0    0        0         0        1

      Universal_Pictures  Warner_Bros  Paramount_Pictures
7387                   0            0                   0
3375                   0            0                   0
2244                   0            0                   0
```

The relationship between revenue and popularity, revenue and number of votes, revenue and budget is positive.
Some outliers are present in the dataset, so:
* 3 movies with the highest popularity made on average $771099276.71 (Jurassic World (2015), Interstellar (2014), Mad Max: Fury Road (2015)),
* 4 movies with the number of votes higher than 8000 gathered on average, $1527637054.52 (Avatar (2009), The Avengers (2012), The Dark Knight (2008), Inception (2010)),
* 3 movies with the highest budget made on average $670719525.753 (Pirates of the Caribbean: At World's End (2001), Pirates of the Caribbean: On Stranger Tides (2011), The Warrior's Way (2010)).

1.1.8 Research Question 4: Top-8 directors made more than 20 movies.

Whether their movies are also popular or profitable than movies of the other directos?

In [55]:
```
directors = directors_df.iloc[:8].index.tolist()
top8_directors = df[df.director.isin(directors)]
print('Shape', top8_directors.shape)
top8_directors.head()
```

```
Shape (225, 36)
```

Out[55]:
```
     popularity           original_title           director  runtime  \
7      7.667400               The Martian       Ridley Scott    141.0
33     3.648210           Bridge of Spies  Steven Spielberg    141.0
66     2.345821  In the Heart of the Sea         Ron Howard    122.0
155    1.007054            Irrational Man        Woody Allen     95.0
572    0.082569              The Audition    Martin Scorsese     16.0

     vote_count  vote_average    budget_adj   revenue_adj release_date  \
7          4572           7.6  9.935996e+07  5.477497e+08   2015-09-30
33         1638           7.1  3.679998e+07  1.496016e+08   2015-10-15
66          805           6.4  9.199996e+07  8.631506e+07   2015-11-20
155         319           6.1  1.012000e+07  2.519979e+07   2015-07-17
572          10           6.1           NaN           NaN   2015-10-27

     Robert_De_Niro  Samuel_L_Jackson  woman_director  independent_film  \
7                 0                 0               0                 0
```

```
33                0                 0                0                 0
66                0                 0                0                 0
155               0                 0                0                 0
572               1                 0                0                 0

     Drama  Comedy  Thriller  Action  Romance  Horror  Adventure  Crime  \
7        1       0         0       0        0       0          1      0
33       1       0         1       0        0       0          0      0
66       1       0         1       1        0       0          1      0
155      1       0         0       0        0       0          0      0
572      0       1         0       0        0       0          0      0

     Family  Science Fiction  Fantasy  Mystery  Animation  Documentary  Music  \
7         0                1        0        0          0            0      0
33        0                0        0        0          0            0      0
66        0                0        0        0          0            0      0
155       0                0        0        1          0            0      0
572       0                0        0        0          0            0      0

     History  War  Foreign  TV Movie  Western  Universal_Pictures  \
7          0    0        0         0        0                   0
33         0    0        0         0        0                   0
66         1    0        0         0        0                   0
155        0    0        0         0        0                   0
572        0    0        0         0        0                   0

     Warner_Bros  Paramount_Pictures
7              0                   0
33             0                   0
66             1                   0
155            0                   0
572            0                   0
```

In [56]:
```
means_ = top8_directors.groupby('director')[['popularity', 'vote_average', 'budget_adj'
                                              + genre_unique].mean().sort_values('popular
means_
```

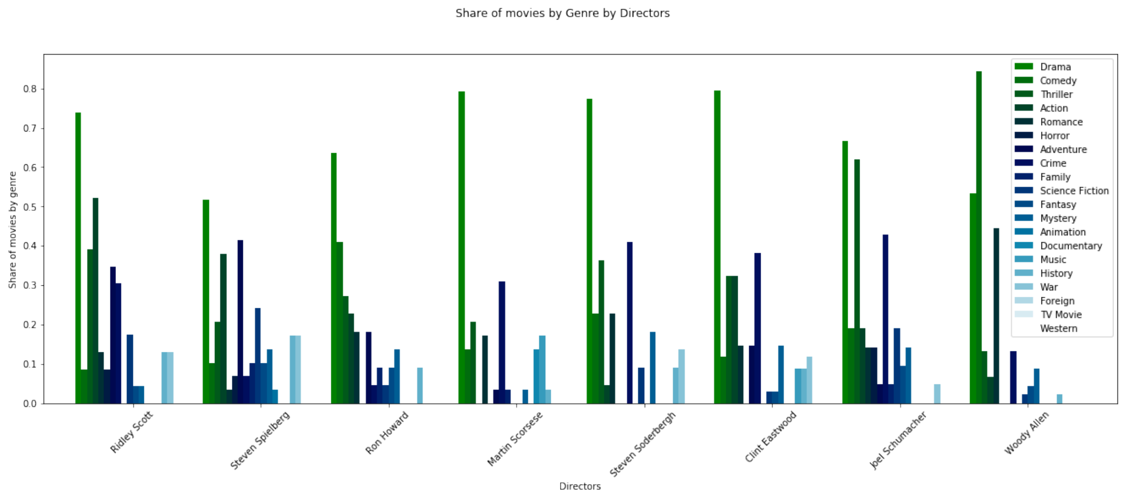
Out[56]:
```
                   popularity  vote_average    budget_adj   revenue_adj  \
director
Ridley Scott         2.009294      6.478261  7.909806e+07  1.917985e+08
Steven Spielberg     1.875138      6.824138  7.419896e+07  5.630536e+08
Ron Howard           1.295499      6.377273  8.682048e+07  2.515053e+08
Martin Scorsese      1.128548      6.958621  5.473410e+07  1.348079e+08
Steven Soderbergh    0.945138      6.172727  4.068058e+07  1.456043e+08
Clint Eastwood       0.830037      6.508824  4.264728e+07  1.407573e+08
Joel Schumacher      0.768102      5.971429  5.768043e+07  1.309330e+08
Woody Allen          0.563424      6.444444  1.848060e+07  5.882820e+07
```

```
                       Drama    Comedy  Thriller    Action   Romance    Horror  \
director
Ridley Scott        0.739130  0.086957  0.391304  0.521739  0.130435  0.086957
Steven Spielberg    0.517241  0.103448  0.206897  0.379310  0.034483  0.068966
Ron Howard          0.636364  0.409091  0.272727  0.227273  0.181818  0.000000
Martin Scorsese     0.793103  0.137931  0.206897  0.000000  0.172414  0.000000
Steven Soderbergh   0.772727  0.227273  0.363636  0.045455  0.227273  0.000000
Clint Eastwood      0.794118  0.117647  0.323529  0.323529  0.147059  0.000000
Joel Schumacher     0.666667  0.190476  0.619048  0.190476  0.142857  0.142857
Woody Allen         0.533333  0.844444  0.133333  0.066667  0.444444  0.000000

                    Adventure     Crime    Family  Science Fiction   Fantasy  \
director
Ridley Scott         0.347826  0.304348  0.000000         0.173913  0.043478
Steven Spielberg     0.413793  0.068966  0.103448         0.241379  0.103448
Ron Howard           0.181818  0.045455  0.090909         0.045455  0.090909
Martin Scorsese      0.034483  0.310345  0.034483         0.000000  0.000000
Steven Soderbergh    0.000000  0.409091  0.000000         0.090909  0.000000
Clint Eastwood       0.147059  0.382353  0.000000         0.029412  0.029412
Joel Schumacher      0.047619  0.428571  0.047619         0.190476  0.095238
Woody Allen          0.000000  0.133333  0.000000         0.022222  0.044444

                     Mystery  Animation  Documentary     Music   History  \
director
Ridley Scott        0.043478   0.000000     0.000000  0.000000  0.130435
Steven Spielberg    0.137931   0.034483     0.000000  0.000000  0.172414
Ron Howard          0.136364   0.000000     0.000000  0.000000  0.090909
Martin Scorsese     0.034483   0.000000     0.137931  0.172414  0.034483
Steven Soderbergh   0.181818   0.000000     0.000000  0.000000  0.090909
Clint Eastwood      0.147059   0.000000     0.000000  0.088235  0.088235
Joel Schumacher     0.142857   0.000000     0.000000  0.000000  0.000000
Woody Allen         0.088889   0.000000     0.000000  0.000000  0.022222

                         War  Foreign  TV Movie   Western
director
Ridley Scott        0.130435      0.0       0.0  0.000000
Steven Spielberg    0.172414      0.0       0.0  0.000000
Ron Howard          0.000000      0.0       0.0  0.090909
Martin Scorsese     0.000000      0.0       0.0  0.000000
Steven Soderbergh   0.136364      0.0       0.0  0.000000
Clint Eastwood      0.117647      0.0       0.0  0.176471
Joel Schumacher     0.047619      0.0       0.0  0.000000
Woody Allen         0.000000      0.0       0.0  0.000000
```

The most popular genres are Drama, Action, and Crime.

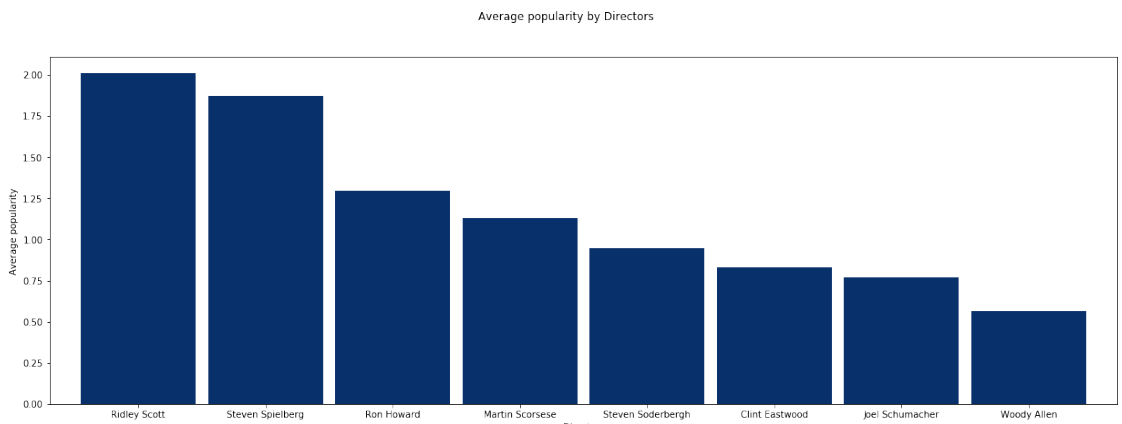
```
In [57]: means_[genre_unique].plot(kind='bar', width=.9, rot=45, figsize=(21,7), cmap='ocean')
         plt.legend(loc='best')
```

```
plt.xlabel('Directors')
plt.ylabel('Share of movies by genre')
plt.suptitle('Share of movies by Genre by Directors')
plt.show()
```

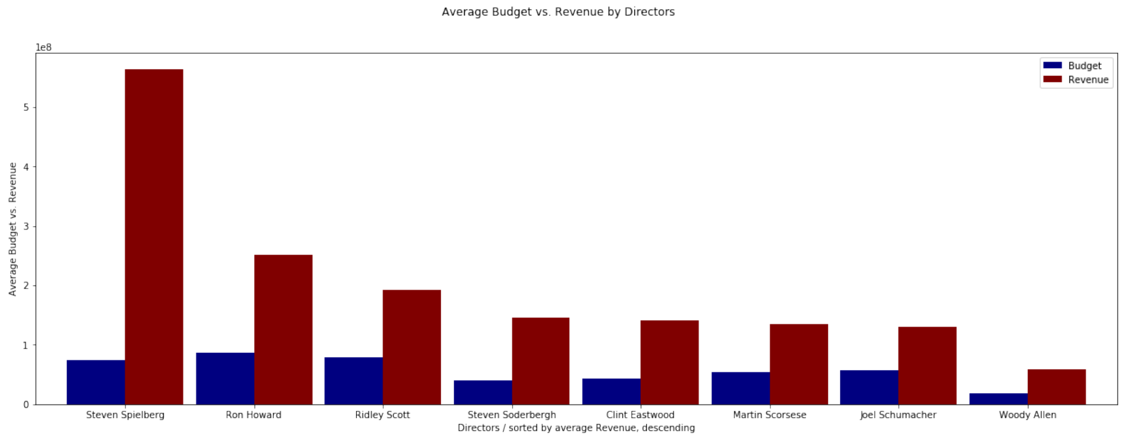


Movies of Ridley Scott have the highest average popularity rate (2.01), compared to the next Steven Spielberg's movies with average popularity rate equals 1.88.

```
In [58]: means_['popularity'].sort_values(ascending=False).plot(kind='bar', width=.9, rot=0, fig
                                                                   cmap='Blues_r', legend=False)
         plt.xlabel('Directors')
         plt.ylabel('Average popularity')
         plt.suptitle('Average popularity by Directors')
         plt.show()
```



```
In [59]: means_[['budget_adj', 'revenue_adj']].sort_values('revenue_adj', ascending=False).plot(
                                                    width=.9, rot=0, figsize=(21,7), cmap='jet')
         plt.legend(['Budget', 'Revenue'], loc='best')
         plt.xlabel('Directors / sorted by average Revenue, descending')
         plt.ylabel('Average Budget vs. Revenue')
         plt.suptitle('Average Budget vs. Revenue by Directors')
         plt.show()
```




```
In [60]: roi = ((means_['revenue_adj'] - means_['budget_adj']) / means_['budget_adj'] * 100).sor
         print('Average ROI', roi.mean())
         roi

Average ROI 246.324639484

Out[60]: director
         Steven Spielberg     658.842923
         Steven Soderbergh    257.920973
         Clint Eastwood       230.049812
         Woody Allen          218.324059
         Ron Howard           189.684298
         Martin Scorsese      146.295994
         Ridley Scott         142.481863
         Joel Schumacher      126.997194
         dtype: float64
```

Finally, average ROI of movies of directors from these group is 246%. Moreover, ROI of movies directed by Steven Spielberg equals 658%.

Conclusions

In this project TMDb Movie Data was analyzed. This dataset contains information about 10,000 movies, including user ratings and revenue.

There're 2 main parts in this Jupyter notebook:
1. Data Wrangling,
2. Exploratory Data Analysis.

First part consists of the following blocks:
* General Properties,
* Data Cleaning,
* Data visualization.

In the second part the following research questions were considered:
1. Which genres are most popular from year to year? Most of the popularity ratings are less than 1. The distribution of popularity is right skewed with maximum rating 32.99 of movie "Jurassic World" (2015).
From 1960 to 2015 the number of movies increased with the corresponding increase of average opularity rate. However, some movies became popular since 20 century. For example, "The Godfather" (1972) has 5.74 popularity rate.
Among all 10 thound movies, Adventure is the most popular genre with average popularity about 1.2.
The most popular genres by popularity rate during the whole period is Science Fiction, Thriller, and Wars. Moreover, during the 20 century Romance and TV movies were also as popular as Science Fiction genre. In the 21st century Western genre has reached leading positions.
If we look only on top-3 genres of each year, Thriller and war genres bagin to compete for first place with each other from year to year.

---

2. How sharp is the divide between major film studios and the independents?
Top-2 production companies are:
-> Universal Pictures (produced 522 movies),
-> Warner Bros. (produced 509 movies).
Universal Pictures made only 1 independent film (it's about 0.19% of all movies made by the company), and Warner Bros. made 2 independent films (it's about 0.32% of all movies made by the company). In comparison, 393 movies of the other companies were independent (it's about 3.67% of all movies).
So, why major film studios don't made independent?
Popularity rates of independent movies are twice lower (0.65 vs. 0.31, or 0.96 vs. 0.33) than not-independent ones.
If we don't take into account missing data in revenue and budget columns, the result for independent movies is more than twice worse. Despite average votes for independent and not-independent movies are approximately the same (6 points), number of votes for independent movies is more then 5 times smaller (200-500 vs. 20-40).
So, producing companies don't make independent movies because revenues from them are lower, or revenues from independent movies are lower because producing comanies don't make them? It's really interesting question for the further investigation and analysis.

---

3. What kinds of properties are associated with movies that have high revenues?
To answer this question, only numeric columns were considered.
The relationship between revenue and popularity, revenue and number of votes, revenue and budget is positive.
Some outliers are present in the dataset, so:
~ 3 movies with the highest popularity made on average \$771099276.71 (Jurassic World (2015), Interstellar (2014), Mad Max: Fury Road (2015)),

~ 4 movies with the number of votes higher than 8000 gathered on average, \$1527637054.52 (Avatar (2009), The Avengers (2012), The Dark Knight (2008), Inception (2010)),
~ 3 movies with the highest budget made on average \$670719525.753 (Pirates of the Caribbean: At World's End (2001), Pirates of the Caribbean: On Stranger Tides (2011), The Warrior's Way (2010)).

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4. Top-8 directors made more than 20 movies. Whether their movies are also popular or profitable than movies of the other directos?
Movies of Ridley Scott have the highest average popularity rate (2.01), compared to the next Steven Spielberg's movies with average popularity rate equals 1.88.
The most popular genres are Drama, Action, and Crime.
Finally, average ROI of movies of directors from these group is 246%. Moreover, ROI of movies directed by Steven Spielberg equals 658%. ___________________

```
In [61]: from subprocess import call
         call(['python', '-m', 'nbconvert', 'Investigate_a_Dataset.ipynb'])

Out[61]: 0
```