Project CZ1115 - Group 8

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Problem:

When making a movie, there are some factors that the producer can control, such as how much money they invest, director of the movie, genres of the movies, casts of the movie, etc. We call them **pre-elements**.
The producer should always want their movies to be successful. The measurements for these sucessful are some outcome such as revenue of the movies, popularity of the movie, rating of the movie, etc. We call them **post-elements**. In these elements, revenue is a element that the producer usually care the most.
Our problem:

> Can the producer predict the success of the movie before it is released? Does investing more money mean generating more revenue?
> After releasing the film, with the response from viewers, will it help improve the prediction performance?
> Bonus for customer: building recommendation system base on content

1. Import libraries

In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sb
import matplotlib.pyplot as plt
from sklearn.datasets import make_regression
from sklearn.model_selection import train_test_split
from sklearn.feature_selection import mutual_info_regression
import numpy as np
from scipy import stats
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics.pairwise import cosine_similarity
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error
from sklearn.preprocessing import MinMaxScaler
from sklearn.svm import LinearSVR
from sklearn.pipeline import make_pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.datasets import make_regression
from sklearn.linear_model import RidgeCV
```

2. Import two datasets

In [2]:
```
credits = pd.read_csv("credits.csv")
credits.head()
```

Out[2]:

	movie_id	title	cast	crew
0	19995	Avatar	[{"cast_id": 242, "character": "Jake Sully", "...	[{"credit_id": "52fe48009251416c750aca23", "de...
1	285	Pirates of the Caribbean: At World's End	[{"cast_id": 4, "character": "Captain Jack Spa...	[{"credit_id": "52fe4232c3a36847f800b579", "de...
2	206647	Spectre	[{"cast_id": 1, "character": "James Bond", "cr...	[{"credit_id": "54805967c3a36829b5002c41", "de...
3	49026	The Dark Knight Rises	[{"cast_id": 2, "character": "Bruce Wayne / Ba...	[{"credit_id": "52fe4781c3a36847f81398c3", "de...
4	49529	John Carter	[{"cast_id": 5, "character": "John Carter", "c...	[{"credit_id": "52fe479ac3a36847f813eaa3", "de...

In [3]:
```
1 credits.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4803 entries, 0 to 4802
Data columns (total 4 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   movie_id  4803 non-null   int64 
 1   title     4803 non-null   object
 2   cast      4803 non-null   object
 3   crew      4803 non-null   object
dtypes: int64(1), object(3)
memory usage: 150.2+ KB
```

In [4]:
```
1 print("Number of records:", len(credits['movie_id']))
```

```
Number of records: 4803
```

Summary:

movie_id - int: id of the movie
title - string: title of the movie
cast - string: json data of information of cast in the movie
crew - string: json data of information of cast in the movie
There are 4803 records

In [5]:
```
1 movies = pd.read_csv("movies.csv")
2 movies.head()
```

Out[5]:

	budget	genres	homepage	id	keywords	original_language	original_title	
0	237000000	[{"id": 28, "name": "Action"}, {"id": 12, "nam...	http://www.avatarmovie.com/	19995	[{"id": 1463, "name": "culture clash"}, {"id":...	en	Avatar	
1	300000000	[{"id": 12, "name": "Adventure"}, {"id": 14, "...	http://disney.go.com/disneypictures/pirates/	285	[{"id": 270, "name": "ocean"}, {"id": 726, "na...	en	Pirates of the Caribbean: At World's End	
2	245000000	[{"id": 28, "name": "Action"},	http://www.sonypictures.com/movies/spectre/	206647	[{"id": 470, "name": "spy"},	en	Spectre	

In [6]:
```
1 movies.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4803 entries, 0 to 4802
Data columns (total 20 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   budget                4803 non-null   int64  
 1   genres                4803 non-null   object 
 2   homepage              1712 non-null   object 
 3   id                    4803 non-null   int64  
 4   keywords              4803 non-null   object 
 5   original_language     4803 non-null   object 
 6   original_title        4803 non-null   object 
 7   overview              4800 non-null   object 
 8   popularity            4803 non-null   float64
 9   production_companies  4803 non-null   object 
 10  production_countries  4803 non-null   object 
 11  release_date          4802 non-null   object 
 12  revenue               4803 non-null   int64  
 13  runtime               4801 non-null   float64
 14  spoken_languages      4803 non-null   object 
 15  status                4803 non-null   object 
 16  tagline               3959 non-null   object 
 17  title                 4803 non-null   object 
 18  vote_average          4803 non-null   float64
 19  vote_count            4803 non-null   int64  
dtypes: float64(3), int64(4), object(13)
memory usage: 750.6+ KB
```

In [7]:
```
1 print("Number of records:", len(movies['title']))
```

```
Number of records: 4803
```

Summary:

Budget - int: budget of the company
genres - string json data: show genres of the movie
homapage - string: link to the homepage
id - string: id of the movie
keywords - string json data: show keywords of the data
original_language - string: show the language of the movie
original_title - string: original title of the movie
overview - string: overview of the movie
popularity - float: popularity rate of the movie
production_companies - string json data: name of production company
production_countries - string json data: name of production countries
release_date - string: date of release
revenue - int: revenue of the movie
runtime - float: runtime of the movie
spoken_languages - string json data: list of spoken language
status - string: status of the movie (ex. released)
tagline - string: tagline of the movie
vote_average - float: average of vote grade
vote_count - int: number of vote

3. Data extraction, curation, preparation and cleaning

3.1. Data extraction

Check the number of missing value in this dataset

In [8]:
```
for item in credits:
    print("Number of missing value in ", item, ": ", credits[item].isna().sum())
```

```
Number of missing value in  movie_id :  0
Number of missing value in  title :  0
Number of missing value in  cast :  0
Number of missing value in  crew :  0
```

We can see that the **credits** table has no missing value

Extract columns from credits table

In [9]:
```
#Extract the columns of the credits table
movie_id = credits['movie_id']
title = credits['title']
cast = credits['cast']
crew = credits['crew']
```

Then we take a closer look to what data is on each column

In [10]:
```
movie_id[0]
```

Out[10]:
```
19995
```

In [11]:
```
title[0]
```

Out[11]:
```
'Avatar'
```

In [12]:
```
# This line is to display the dictionary of cast
cast[0]
```

Out[12]:
```
'[{"cast_id": 242, "character": "Jake Sully", "credit_id": "5602a8a7c3a3685532001c9a", "gender":
2, "id": 65731, "name": "Sam Worthington", "order": 0}, {"cast_id": 3, "character": "Neytiri", "c
redit_id": "52fe48009251416c750ac9cb", "gender": 1, "id": 8691, "name": "Zoe Saldana", "order":
1}, {"cast_id": 25, "character": "Dr. Grace Augustine", "credit_id": "52fe48009251416c750aca39",
"gender": 1, "id": 10205, "name": "Sigourney Weaver", "order": 2}, {"cast_id": 4, "character": "C
ol. Quaritch", "credit_id": "52fe48009251416c750ac9cf", "gender": 2, "id": 32747, "name": "Stephe
n Lang", "order": 3}, {"cast_id": 5, "character": "Trudy Chacon", "credit_id": "52fe48009251416c7
50ac9d3", "gender": 1, "id": 17647, "name": "Michelle Rodriguez", "order": 4}, {"cast_id": 8, "ch
aracter": "Selfridge", "credit_id": "52fe48009251416c750ac9e1", "gender": 2, "id": 1771, "name":
"Giovanni Ribisi", "order": 5}, {"cast_id": 7, "character": "Norm Spellman", "credit_id": "52fe48
009251416c750ac9dd", "gender": 2, "id": 59231, "name": "Joel David Moore", "order": 6}, {"cast_i
d": 9, "character": "Moat", "credit_id": "52fe48009251416c750ac9e5", "gender": 1, "id": 30485, "n
ame": "CCH Pounder", "order": 7}, {"cast_id": 11, "character": "Eytukan", "credit_id": "52fe48009
251416c750ac9ed", "gender": 2, "id": 15853, "name": "Wes Studi", "order": 8}, {"cast_id": 10, "ch
aracter": "Tsu\'Tey", "credit_id": "52fe48009251416c750ac9e9", "gender": 2, "id": 10964, "name":
"Laz Alonso", "order": 9}, {"cast_id": 12, "character": "Dr. Max Patel", "credit_id": "52fe480092
51416c750ac9f1", "gender": 2, "id": 95697, "name": "Dileep Rao", "order": 10}, {"cast_id": 13, "c
haracter": "Lyle Wainfleet", "credit_id": "52fe48009251416c750ac9f5", "gender": 2, "id": 98215,
"name": "Matt Gerald", "order": 11}, {"cast_id": 32, "character": "Private Fike", "credit_id": "5
```

In [13]:
```
#This line is to display the dictionary of crew
crew[0]
```

Out[13]:

```
'[{"credit_id": "52fe48009251416c750aca23", "department": "Editing", "gender": 0, "id": 1721, "jo
b": "Editor", "name": "Stephen E. Rivkin"}, {"credit_id": "539c47ecc3a36810e3001f87", "departmen
t": "Art", "gender": 2, "id": 496, "job": "Production Design", "name": "Rick Carter"}, {"credit_i
d": "54491c89c3a3680fb4001cf7", "department": "Sound", "gender": 0, "id": 900, "job": "Sound Desi
gner", "name": "Christopher Boyes"}, {"credit_id": "54491cb70e0a267480001bd0", "department": "Sou
nd", "gender": 0, "id": 900, "job": "Supervising Sound Editor", "name": "Christopher Boyes"}, {"c
redit_id": "539c4a4cc3a36810c9002101", "department": "Production", "gender": 1, "id": 1262, "jo
b": "Casting", "name": "Mali Finn"}, {"credit_id": "5544ee3b925141499f0008fc", "department": "Sou
nd", "gender": 2, "id": 1729, "job": "Original Music Composer", "name": "James Horner"}, {"credit
_id": "52fe48009251416c750ac9c3", "department": "Directing", "gender": 2, "id": 2710, "job": "Dir
ector", "name": "James Cameron"}, {"credit_id": "52fe48009251416c750ac9d9", "department": "Writin
g", "gender": 2, "id": 2710, "job": "Writer", "name": "James Cameron"}, {"credit_id": "52fe480092
51416c750aca17", "department": "Editing", "gender": 2, "id": 2710, "job": "Editor", "name": "Jame
s Cameron"}, {"credit_id": "52fe48009251416c750aca29", "department": "Production", "gender": 2,
"id": 2710, "job": "Producer", "name": "James Cameron"}, {"credit_id": "52fe48009251416c750aca3
f", "department": "Writing", "gender": 2, "id": 2710, "job": "Screenplay", "name": "James Camero
n"}, {"credit_id": "539c4987c3a36810ba0021a4", "department": "Art", "gender": 2, "id": 7236, "jo
b": "Art Direction", "name": "Andrew Menzies"}, {"credit_id": "549598c3c3a3686ae9004383", "depart
ment": "Visual Effects", "gender": 0, "id": 6690, "job": "Visual Effects Producer", "name": "Jill
```


We can see that the cast and crew columns are very complicated string-based dictionaires with many keys for each record. Most of them are string. Therefore, we will proceed to extract the number of cast and crew in each movie as num_cast and num_crew columns as potential features to predict revenue. Also, I will extract the name of 3 first casts and the director of the movies as another feature called **name_cast** and **director** that I will need to use when building recommdation system. Also, I will lower case the charactor and remove all space for the recommendation part later.

Extract from cast column

In [14]:
```
num_cast = []
name_cast = []
for i in range(len(cast)):
    temp = eval(cast[i]) #Convert the sting-based dictionaries to list of real dictionaries
    num_cast.append(len(temp)) # Append the number of cast to the list
    temp_name = []
    count = 0
    for ca in temp:
        if count<3:
            count = count+1
            temp_name.append(str.lower(ca['name'].replace(" ","")))
    name_cast.append(temp_name)
print("Length of num_cast column", len(num_cast))
print("Length of name_cast column", len(name_cast))
print("List of 3 cast names in the first movie:", name_cast[0])
```

```
Length of num_cast column 4803
Length of name_cast column 4803
List of 3 cast names in the first movie: ['samworthington', 'zoesaldana', 'sigourneyweaver']
```

We do the similar extraction with crew

In [15]:
```
num_crew = []
director = []
for i in range(len(crew)):
    temp = eval(crew[i]) #Convert the sting-based dictionaries to list of real dictionaries
    num_crew.append(len(temp)) # Append the number of cast to the list
    flag = 0
    for cr in temp:
        if cr['job'] == 'Director':
            director.append(str.lower(cr['name'].replace(" ","")))
            flag = 1
    if flag == 0:
        director.append("")
```

In [16]:
```
print("Length of num_crew column:", len(num_crew))
print("Director of the first movie:", director[0])
```

```
Length of num_crew column: 4803
Director of the first movie: jamescameron
```

Summary:

From the ***credits*** dataset, we have 6 variales:
- movie_id
- title
- num_cast: Used for regression model
- num_crew: Used for regression model
- name_cast: Used for recommendation system
- director: Used for recommendation system
with totally 4803 record.

Extract the data from movie dataset

Check the missing value and fill with some value

In [17]:
```
for item in movies:
    missing = movies[item].isna().sum()
    print("Number of missing value in ", item, ": ", movies[item].isna().sum())
```

```
Number of missing value in  budget :  0
Number of missing value in  genres :  0
Number of missing value in  homepage :  3091
Number of missing value in  id :  0
Number of missing value in  keywords :  0
Number of missing value in  original_language :  0
Number of missing value in  original_title :  0
Number of missing value in  overview :  3
Number of missing value in  popularity :  0
Number of missing value in  production_companies :  0
Number of missing value in  production_countries :  0
Number of missing value in  release_date :  1
Number of missing value in  revenue :  0
Number of missing value in  runtime :  2
Number of missing value in  spoken_languages :  0
Number of missing value in  status :  0
Number of missing value in  tagline :  844
Number of missing value in  title :  0
Number of missing value in  vote_average :  0
Number of missing value in  vote_count :  0
```

Here, we observe some missing values in some variables. We replace these missing value with some default value.

In [18]:
```
movies['homepage'] = movies['homepage'].fillna('')
movies['overview'] = movies['overview'].fillna('')
movies['release_date'] = movies['release_date'].fillna('')
movies['tagline'] = movies['tagline'].fillna('')
movies['runtime'] = movies['runtime'].fillna(0)
```

Extract the columns of the table

In [19]:
```
budget = movies['budget']
genres = movies['genres']
# homepage: I ignore this variable
# id: I have the id from the credit dataset already
keywords = movies['keywords']
original_language = movies['original_language']
original_title = movies['original_title']
popularity = movies['popularity']
production_companies = movies['production_companies']
production_countries = movies['production_countries']
release_day = movies['release_date']
revenue = movies['revenue']
runtime = movies['runtime']
spoken_languages = movies['spoken_languages']
status = movies['status']
tagline = movies['tagline']
# title: already from the credit dataset
vote_average = movies['vote_average']
vote_count = movies['vote_count']
```

Count the number of genres and the list of genres for each movies

In this part, I extract the number of genres, as a possible features for predicting revenue. Also, I extract 3 first genres, lower case them and remove space for recommendation later.

In [20]:
```
num_genres = []
name_genres = []
for i in range(len(genres)):
    temp = eval(genres[i])
    num_genres.append(len(temp))
    temp_name = []
    count = 0
    for ge in temp:
        if count<3:
            count = count+1
            temp_name.append(str.lower(ge['name'].replace(" ","")))
    name_genres.append(temp_name)
print(num_genres[0])
print(name_genres[0])
```

```
4
['action', 'adventure', 'fantasy']
```

In [21]:
```
genres_list = set()
for na in name_genres:
    for n in na:
        genres_list.add(n)
genres_list = list(genres_list)
genres_list
```

Out[21]:
```
['crime',
 'drama',
 'documentary',
 'thriller',
 'foreign',
 'music',
 'adventure',
 'comedy',
 'tvmovie',
 'family',
 'horror',
 'mystery',
 'romance',
 'animation',
 'history',
 'sciencefiction',
 'action',
 'fantasy',
 'war',
 'western']
```

Transform this categorical variable in to one-hot encoding

In [22]:
```
genres_d = pd.DataFrame()
for genres in genres_list:
    temp = []
    for i in range(len(name_genres)):
        temp.append(1 if genres in name_genres[i] else 0)
    genres_d[genres] = pd.Series(temp).values
    movies[genres] = pd.Series(temp).values
```

In [23]:
```
genres_d.head()
```

Out[23]:

	crime	drama	documentary	thriller	foreign	music	adventure	comedy	tvmovie	family	horror	mystery	romance	ani
0	0	0	0	0	0	0	1	0	0	0	0	0	0	
1	0	0	0	0	0	0	1	0	0	0	0	0	0	
2	1	0	0	0	0	0	1	0	0	0	0	0	0	
3	1	1	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	1	0	0	0	0	0	0	

In [24]:
```
movies.head()
```

Out[24]:

	budget	genres	homepage	id	keywords	original_language	original_title	ove
0	237000000	[{"id": 28, "name": "Action"}, {"id": 12, "nam...	http://www.avatarmovie.com/	19995	[{"id": 1463, "name": "culture clash"}, {"id":...	en	Avatar	cen para Ma
1	300000000	[{"id": 12, "name": "Adventure"}, {"id": 14, "...	http://disney.go.com/disneypictures/pirates/	285	[{"id": 270, "name": "ocean"}, {"id": 726, "na...	en	Pirates of the Caribbean: At World's End	C Bark be
2	245000000	[{"id": 28, "name": "Action"}, {"id": 12, "nam...	http://www.sonypictures.com/movies/spectre/	206647	[{"id": 470, "name": "spy"}, {"id": 818, "name...	en	Spectre	A me E senc
3	250000000	[{"id": 28, "name": "Action"}, {"id": 80, "nam...	http://www.thedarkknightrises.com/	49026	[{"id": 849, "name": "dc comics"}, {"id": 853,...	en	The Dark Knight Rises	Foll the of D At H
4	260000000	[{"id": 28, "name": "Action"}, {"id": 12, "nam...	http://movies.disney.com/john-carter	49529	[{"id": 818, "name": "based on novel"}, {"id":...	en	John Carter	Cart f n

5 rows × 40 columns

Extract the keywords

In [25]:
```
num_keywords = []
name_keywords = []
for i in range(len(keywords)):
    temp = eval(keywords[i])
    num_keywords.append(len(temp))
    temp_name = []
    count = 0
    for ke in temp:
        if count<3:
            count = count+1
            temp_name.append(str.lower(ke['name'].replace(" ","")))
    name_keywords.append(temp_name)
print(num_keywords[0])
print(name_keywords[0])
```

```
21
['cultureclash', 'future', 'spacewar']
```

Convert all features to dataframe

In [26]:
```
num_cast_d = pd.DataFrame(num_cast)
num_crew_d = pd.DataFrame(num_crew)
budget_d = pd.DataFrame(budget)
num_genres_d = pd.DataFrame(num_genres)
num_keywords_d = pd.DataFrame(num_keywords)
popularity_d = pd.DataFrame(popularity)
runtime_d = pd.DataFrame(runtime)
vote_average_d = pd.DataFrame(vote_average)
vote_count_d = pd.DataFrame(vote_count)
revenue_d = pd.DataFrame(revenue)

```

3.2. Normalize the distribution of the varibales by using log scale and remove outliers

In [27]:
```
data_o = pd.concat([revenue_d, budget_d, num_cast_d, num_crew_d, genres_d, popularity_d, vote_cou
data_o.columns = ['revenue', 'budget', 'num_cast', 'num_crew', 'sciencefiction','action','western
data_o.shape
```

Out[27]: (4803, 27)

In [28]:
```
data_o.loc[:, ['revenue', 'budget', 'popularity', 'vote_count', 'vote_average']].skew()
```

Out[28]:
```
revenue         4.444716
budget          2.437211
popularity      9.721416
vote_count      3.824069
vote_average   -1.959710
dtype: float64
```

In [29]:
```
data_o.loc[:, ['revenue', 'budget', 'popularity', 'vote_count', 'vote_average']].kurt()
```

Out[29]:
```
revenue          33.123630
budget            7.658060
popularity      191.995820
vote_count       19.913946
vote_average      7.792363
dtype: float64
```

In [30]:

```python
f, axes = plt.subplots(5, 3, figsize=(18, 12))

count = 0
for var in data_o.loc[:, ['revenue', 'budget', 'popularity', 'vote_count', 'vote_average']]:
    sb.boxplot(data_o[var], orient = "h", ax = axes[count,0])
    sb.histplot(data_o[var], ax = axes[count,1])
    sb.violinplot(data_o[var], orient = "h", ax = axes[count,2])
    count += 1
```

```
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
```

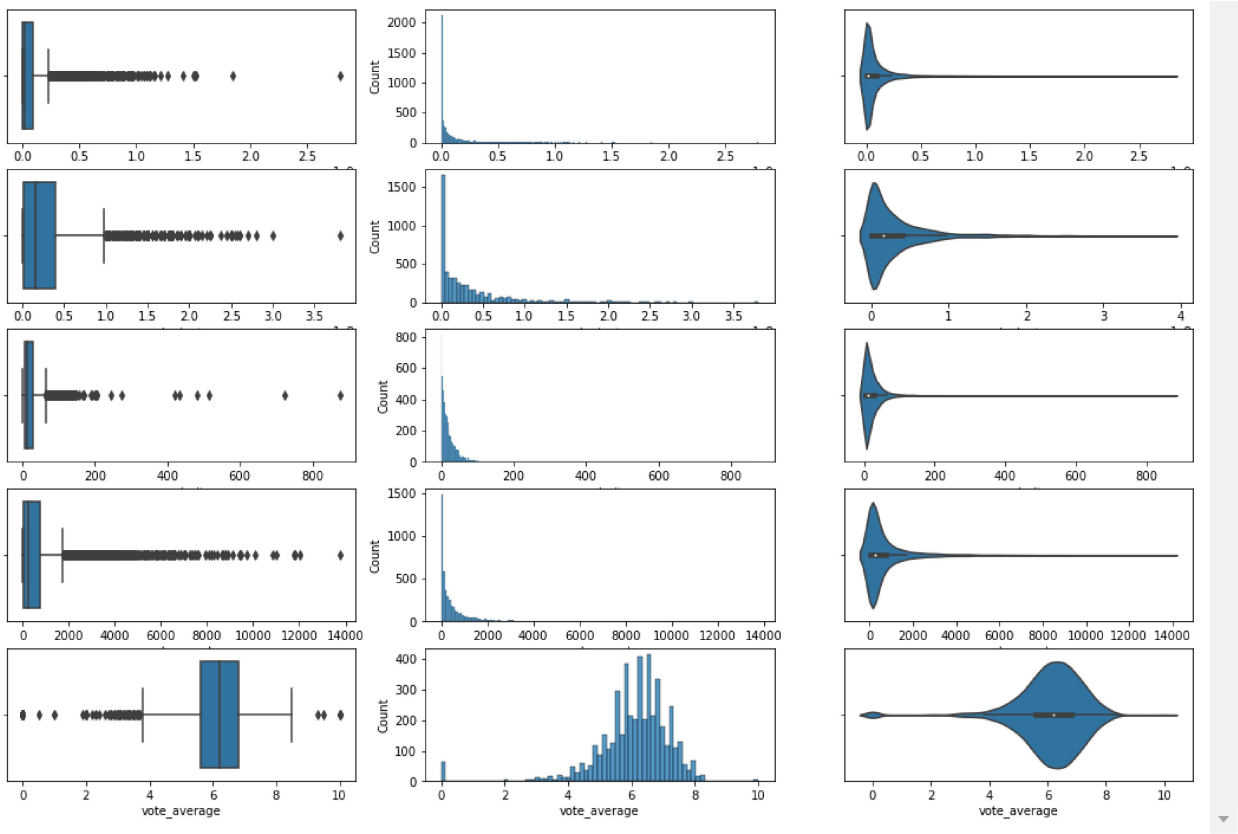

We can see that the distribution of this data is very skewed to the left. Therefore, we proceed to some normalization and cut the outlier to make it more uniform.

In [31]:
```
data_process = data_o
data_process.shape
```

Out[31]: (4803, 27)

We remove all records with '0' value, as when we transform to log scale, and log(0) will go to -infinity.

In [32]:
```
data_process = data_process[data_process['budget'] > 0]
data_process = data_process[data_process['revenue'] > 0]
data_process = data_process[data_process['vote_count'] > 0]
data_process = data_process[data_process['popularity'] > 0]
data_process.shape
```

Out[32]: (3227, 27)

Transform the dataset into log scale to make it more uniform

In [33]:
```
budget_log = pd.DataFrame(np.log(data_process['budget']))
revenue_log = pd.DataFrame(np.log(data_process['revenue']))
popularity_log = pd.DataFrame(np.log(data_process['popularity']))
vote_count_log = pd.DataFrame(np.log(data_process['vote_count']))
```

In [34]:
```
data_log = pd.concat([budget_log, revenue_log, num_cast_d, num_crew_d, genres_d, popularity_log,
data_log.columns = ['budget', 'revenue', 'num_cast', 'num_crew', 'sciencefiction','action','weste
data_log.shape
```

Out[34]: (3227, 27)

Here, we use a function called ***zscore*** from stats in scipy. The function of this function is to to measure the distance of the point to mean over the standard deviation. If more than 3 times or the point lies out of 3 standard deviation, we cut that record.

In [35]:

```
data_log = data_log[(np.abs(stats.zscore(data_log['budget'])) < 3)]
data_log = data_log[(np.abs(stats.zscore(data_log['revenue'])) < 3)]
data_log = data_log[(np.abs(stats.zscore(data_log['popularity'])) < 3)]
data_log = data_log[(np.abs(stats.zscore(data_log['vote_count'])) < 3)]
data_log.shape
```

Out[35]: (3098, 27)

In [36]:

```python
f, axes = plt.subplots(5, 3, figsize=(18, 12))

count = 0
for var in data_o.loc[:, ['revenue', 'budget', 'popularity', 'vote_count', 'vote_average']]:
    sb.boxplot(data_log[var], orient = "h", ax = axes[count,0])
    sb.histplot(data_log[var], ax = axes[count,1])
    sb.violinplot(data_log[var], orient = "h", ax = axes[count,2])
    count += 1
```

```
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
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  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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  warnings.warn(
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`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
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  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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  warnings.warn(
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ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
```
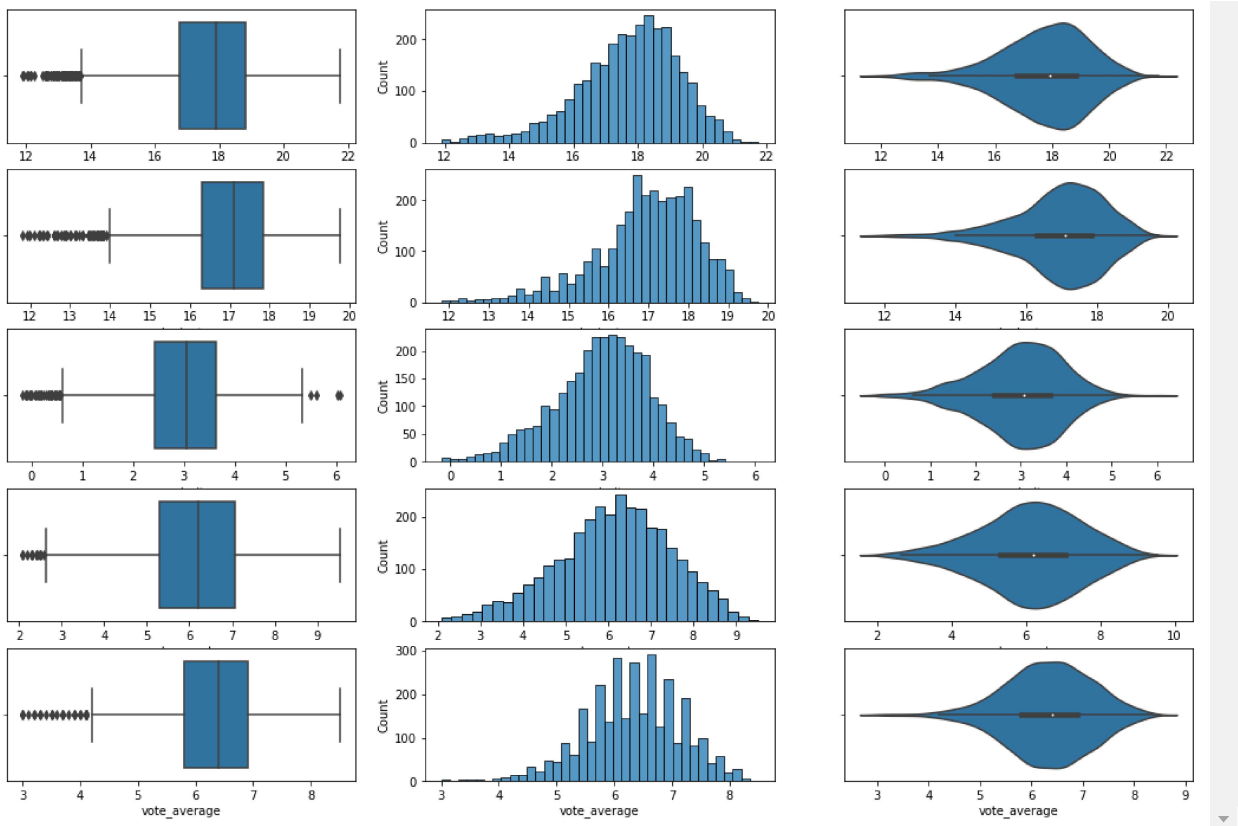



In [37]:
```
1 data_log.loc[:, ['revenue', 'budget', 'popularity', 'vote_count', 'vote_average']].skew()
```

Out[37]:
```
revenue         -0.677596
budget          -0.840173
popularity      -0.413783
vote_count      -0.286842
vote_average    -0.358957
dtype: float64
```

In [38]:
```
1 data_log.loc[:, ['revenue', 'budget', 'popularity', 'vote_count', 'vote_average']].kurt()
```

Out[38]:
```
revenue          0.572837
budget           0.890514
popularity       0.192931
vote_count      -0.185193
vote_average     0.332166
dtype: float64
```

Now, our data is more uniform and less skewed. :)

4. Exploratory data analysis/visualization to gather relevant insights

In [39]:
```
1 data_log.describe()
```

Out[39]:

	budget	revenue	num_cast	num_crew	sciencefiction	action	western	comedy	mystery
count	3098.000000	3098.000000	3098.000000	3098.000000	3098.000000	3098.000000	3098.000000	3098.000000	3098.0
mean	16.949055	17.714582	26.576501	34.863460	0.145255	0.432214	0.009038	0.224015	0.0
std	1.273891	1.576674	21.665511	35.371232	0.352415	0.495464	0.094654	0.417000	0.0
min	11.805632	11.894112	0.000000	1.000000	0.000000	0.000000	0.000000	0.000000	0.0
25%	16.300417	16.782571	15.000000	12.000000	0.000000	0.000000	0.000000	0.000000	0.0
50%	17.111347	17.909855	20.000000	21.000000	0.000000	0.000000	0.000000	0.000000	0.0
75%	17.854137	18.832300	31.000000	45.000000	0.000000	1.000000	0.000000	0.000000	0.0
max	19.755682	21.748578	224.000000	435.000000	1.000000	1.000000	1.000000	1.000000	0.0

8 rows × 27 columns

In [40]:
```
data_log[['budget','revenue', 'num_cast', 'num_crew', 'popularity', 'vote_count', 'vote_average']
```

Out[40]:

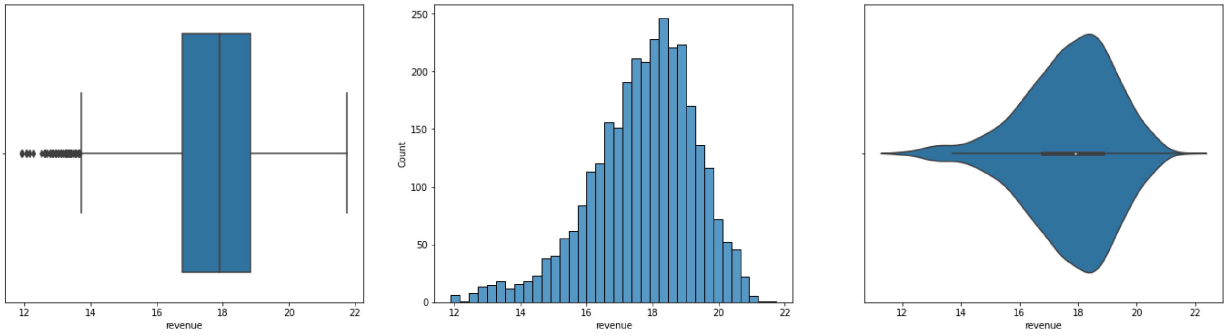
	budget	revenue	num_cast	num_crew	popularity	vote_count	vote_average
count	3098.000000	3098.000000	3098.000000	3098.000000	3098.000000	3098.000000	3098.000000
mean	16.949055	17.714582	26.576501	34.863460	2.986412	6.131337	6.325339
std	1.273891	1.576674	21.665511	35.371232	0.931786	1.344940	0.844225
min	11.805632	11.894112	0.000000	1.000000	-0.179585	2.079442	3.000000
25%	16.300417	16.782571	15.000000	12.000000	2.420102	5.299564	5.800000
50%	17.111347	17.909855	20.000000	21.000000	3.055700	6.210600	6.400000
75%	17.854137	18.832300	31.000000	45.000000	3.640710	7.075809	6.900000
max	19.755682	21.748578	224.000000	435.000000	6.073686	9.528940	8.500000

Revenue

In [41]:
```
f, axes = plt.subplots(1, 3, figsize =(24, 6))
sb.boxplot(data_log['revenue'], orient = "h", ax = axes[0])
sb.histplot(data_log['revenue'], ax = axes[1])
sb.violinplot(data_log['revenue'], orient = "h", ax = axes[2])
```

```
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

Out[41]: <AxesSubplot:xlabel='revenue'>



4.1. Pre-elements uni-varite analysis

Now, we have 4 pre-elements:

budget
num_cast
num_crew
genres: 20 genres are used as 20 different features

Budget, num_cast, num_crew

In [42]:

```python
# Draw the distributions of all Predictors
f, axes = plt.subplots(3, 3, figsize=(18, 12))

count = 0
for var in ['budget', 'num_cast', 'num_crew']:
    sb.boxplot(data_log[var], orient = "h", ax = axes[count,0])
    sb.histplot(data_log[var], ax = axes[count,1])
    sb.violinplot(data_log[var], orient = "h", ax = axes[count,2])
    count += 1
```

```
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
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  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
```
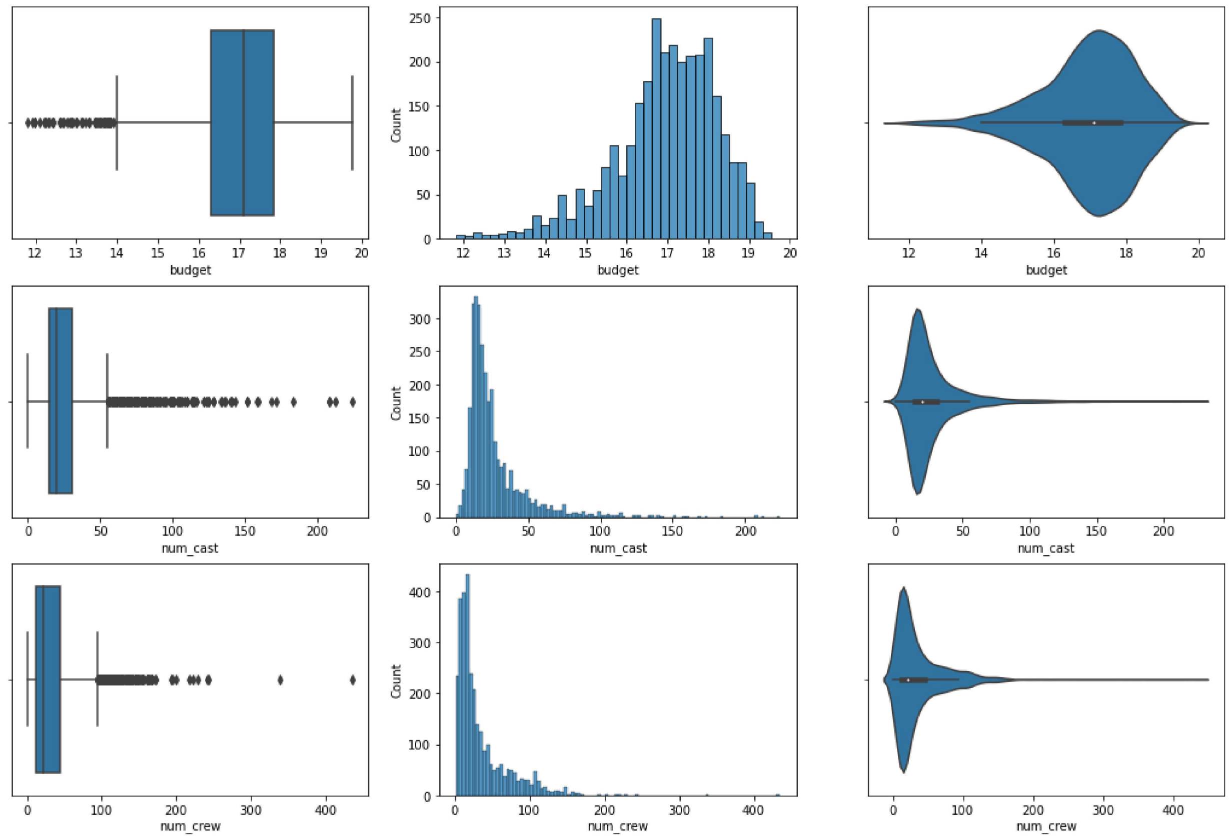



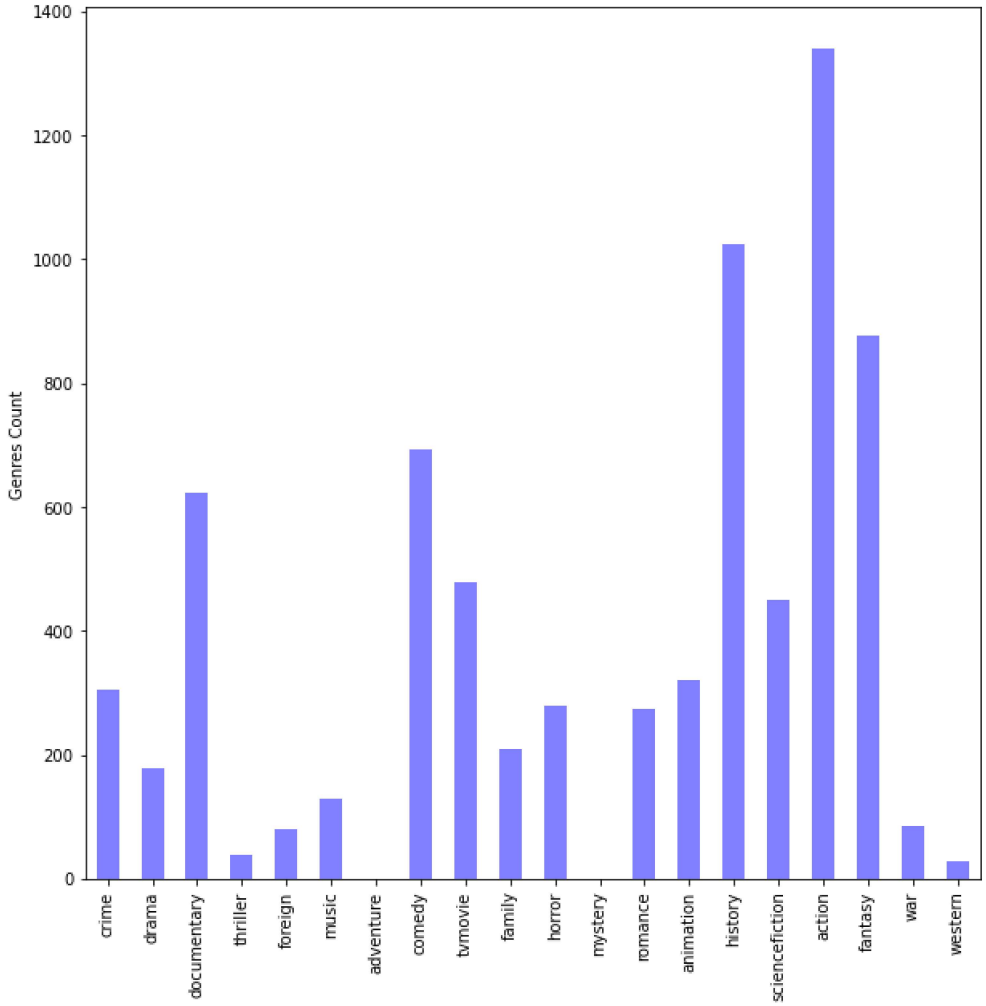
Genres

In [43]:
```
num_genres = data_log[genres_list].sum(axis = 0)
num_genres
```

Out[43]:
```
crime              304
drama              177
documentary        622
thriller            39
foreign             80
music              128
adventure            0
comedy             694
tvmovie            477
family             210
horror             278
mystery              0
romance            274
animation          321
history           1025
sciencefiction     450
action            1339
fantasy            877
war                 84
western             28
dtype: int64
```

In [44]:
```
plt.subplots(figsize=(10, 10))
num_genres.plot.bar(align='center', alpha=0.5, color='blue')
#y_pos = np.arange(num_genres)
#plt.xticks(y_pos, name_genres)
plt.ylabel('Genres Count')
```

Out[44]: Text(0, 0.5, 'Genres Count')



4.2. Post elements uni-variate analysis

We have 3 post elements:

popularity
vote_count
vote_average

In [45]:

```python
f, axes = plt.subplots(3, 3, figsize=(18, 12))

count = 0
for var in ['popularity', 'vote_count', 'vote_average']:
    sb.boxplot(data_log[var], orient = "h", ax = axes[count,0])
    sb.histplot(data_log[var], ax = axes[count,1])
    sb.violinplot(data_log[var], orient = "h", ax = axes[count,2])
    count += 1
```

```
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
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  warnings.warn(
C:\Users\root\anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the followi
ng variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data
`, and passing other arguments without an explicit keyword will result in an error or misinterpretat
ion.
  warnings.warn(
```
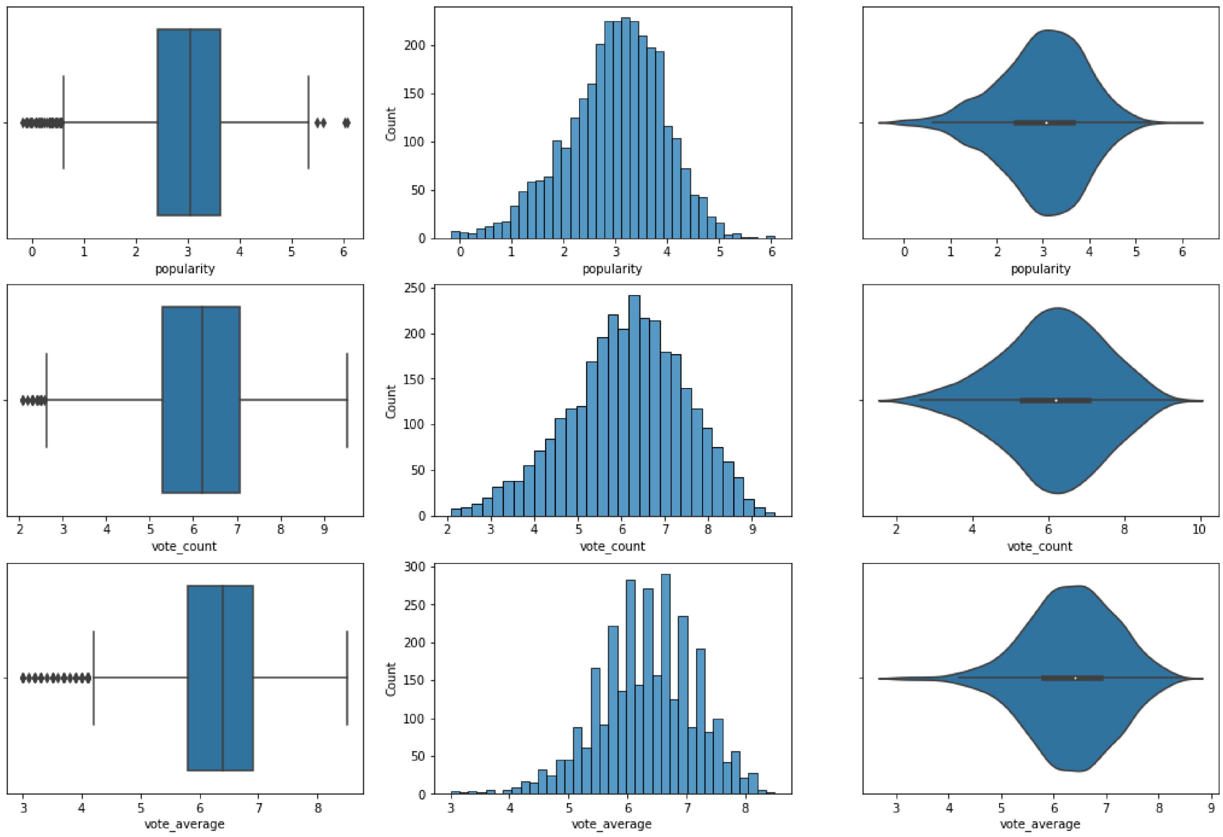



5.2. Multi-variate exploratory

In [46]:
```
correlation = data_log.corr()['revenue'][:]
correlation.sort_values()
```

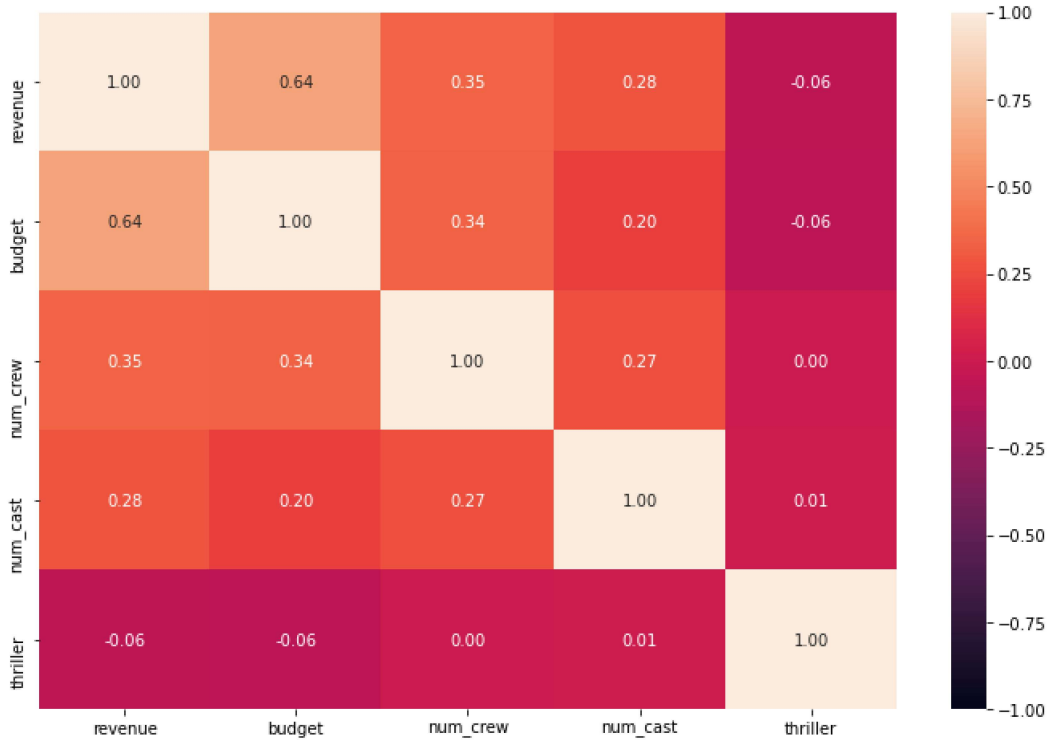
Out[46]:
```
action           -0.199666
western          -0.084818
tvmovie          -0.073575
crime            -0.062023
thriller         -0.061680
sciencefiction   -0.059444
music            -0.036693
war              -0.028161
history          -0.019405
family           -0.017789
foreign          -0.011921
comedy            0.013221
animation         0.070776
vote_average      0.125916
horror            0.148400
romance           0.163918
drama             0.164734
fantasy           0.165788
documentary       0.251319
num_cast          0.282160
num_crew          0.349847
budget            0.638766
popularity        0.652001
vote_count        0.707789
revenue           1.000000
mystery                NaN
adventure              NaN
Name: revenue, dtype: float64
```

we can see that some pre-elements that has a higher correlation to revenue is **budget, num_crew, num_cast, thriller**

In [47]:
```
data_F = pd.DataFrame(data_log[['revenue', 'budget', 'num_crew', 'num_cast', 'thriller']])
```

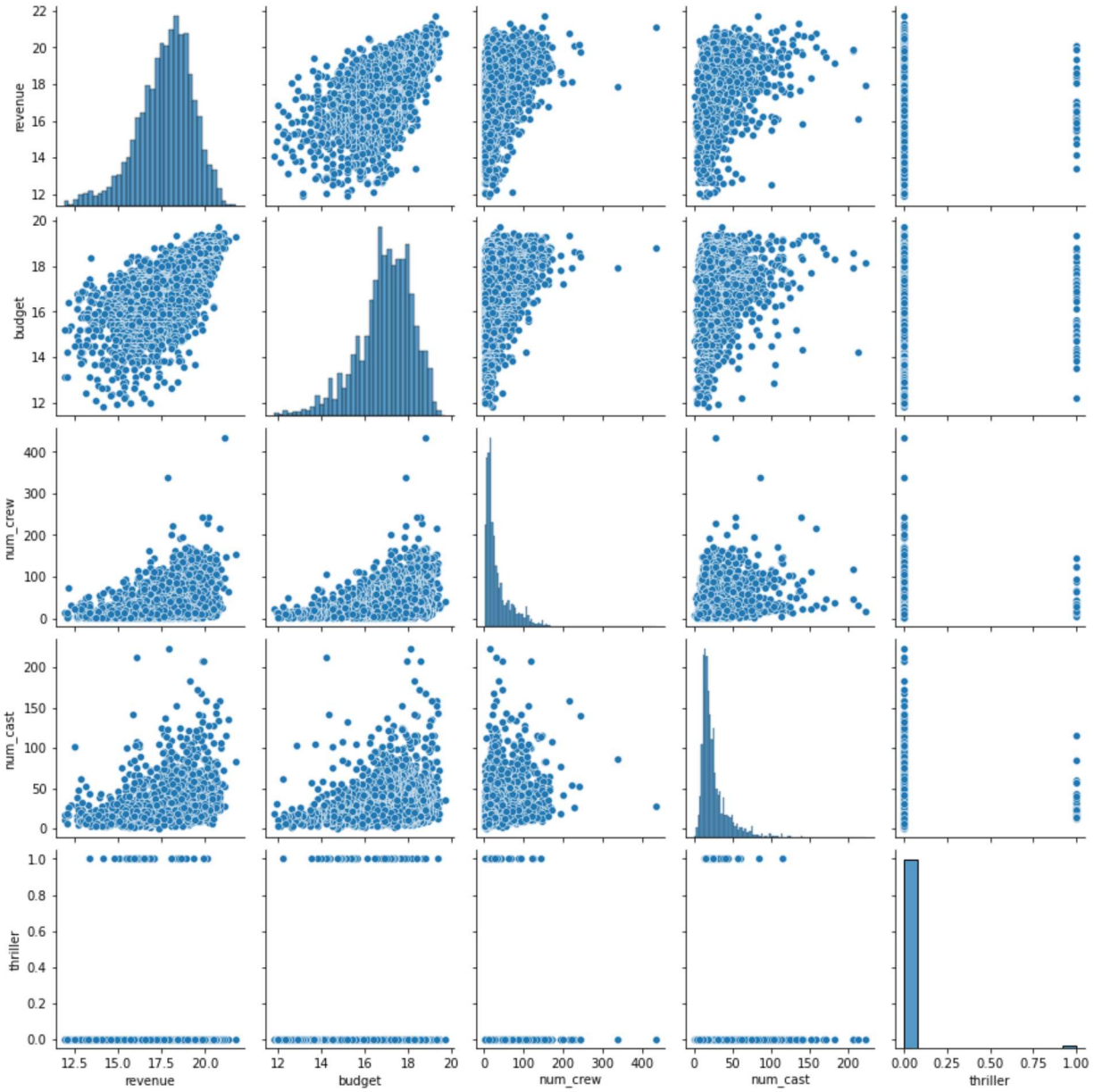
In [48]:
```
1 f = plt.figure(figsize=(12, 8))
2 sb.heatmap(data_F.corr(), vmin = -1, vmax = 1, annot = True, fmt = ".2f")
```

Out[48]: <AxesSubplot:>



In [49]:
```
1 sb.pairplot(data = data_F)
```

Out[49]: <seaborn.axisgrid.PairGrid at 0x254478f4c10>

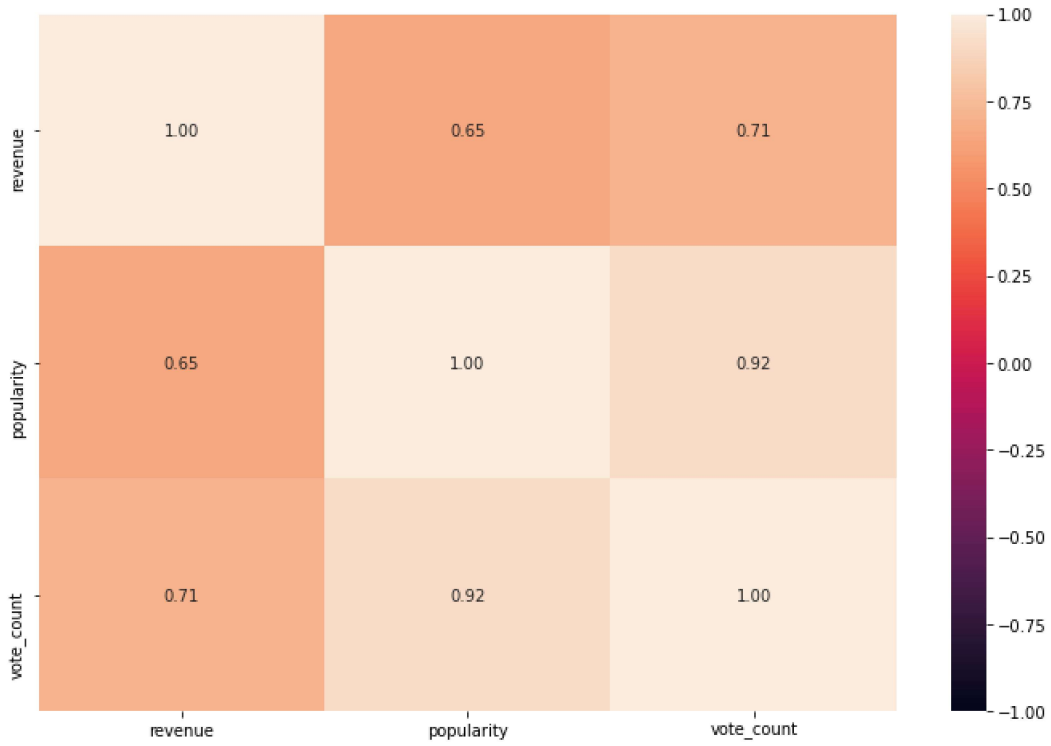


From the correlation matrix, there are some post-elements that have high correlation such as **popularity, vote_count**

In [50]:
```
1 data_P = pd.DataFrame(data_log[['revenue', 'popularity', 'vote_count']])
```

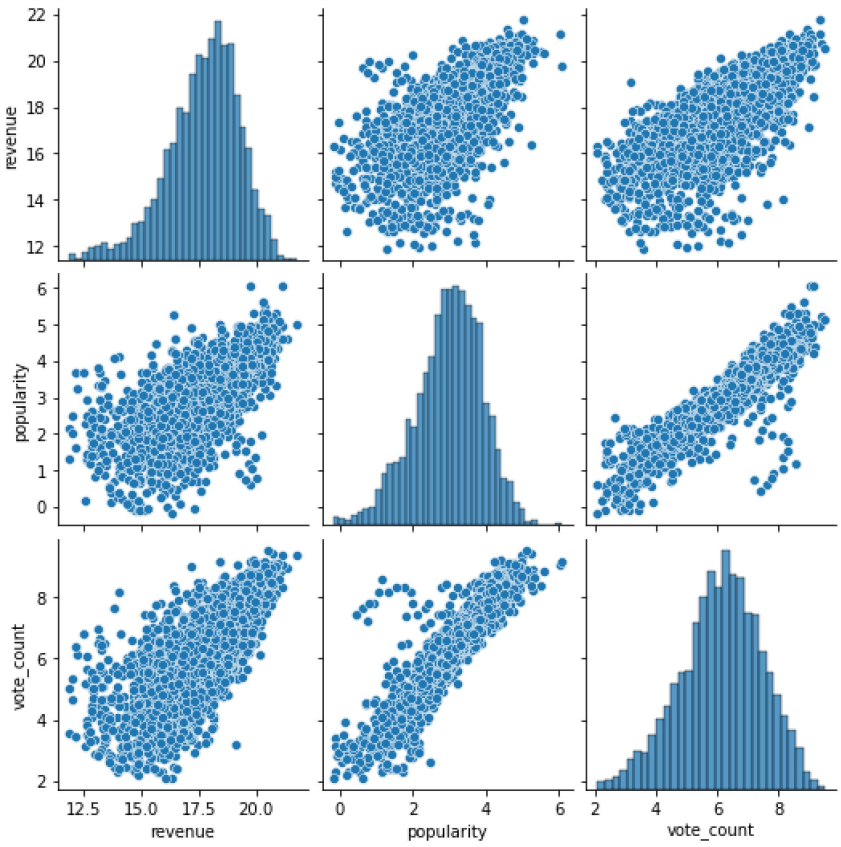
In [51]:
```
f = plt.figure(figsize=(12, 8))
sb.heatmap(data_P.corr(), vmin = -1, vmax = 1, annot = True, fmt = ".2f")
```

Out[51]: <AxesSubplot:>



In [52]:
```
sb.pairplot(data = data_P)
```

Out[52]: <seaborn.axisgrid.PairGrid at 0x2543f37bcd0>



5. Building regression models:

Some note on data

data_F: preprocessed pre-elements data frame
data_P: preprocessed post-elements data frame
data_log: all elements

Model 1: Linear regression model with budget using LinearRegression

Budget is the variable that has highest correlation to revenue that the producer can control. The budget is the money they have to give out, while the revenue is the money they receive. Now, let's build a model to predict revenue base on budget only to see if we can predict the revenue based on what we give out.

In [53]:
```
#data_train = data_log.drop(['revenue'], axis = 1)
data_train = pd.DataFrame(data_log['budget'])
data_test = pd.DataFrame(data_log['revenue'])
```

In [54]:
```
X_train, X_test, y_train, y_test = train_test_split(data_train, data_test, test_size = 0.25)
print("Shape of train set:", X_train.shape, y_train.shape)
print("Shape of test set:", X_test.shape, y_test.shape)
```

```
Shape of train set: (2323, 1) (2323, 1)
Shape of test set: (775, 1) (775, 1)
```

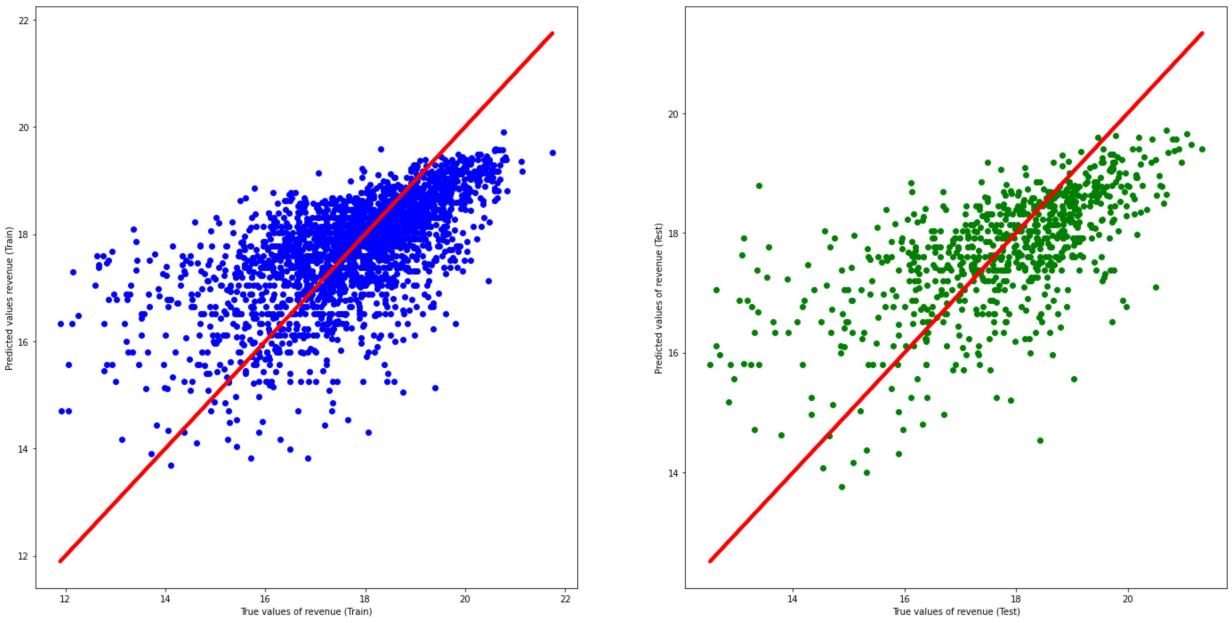
In [55]:
```
linreg = LinearRegression()
linreg.fit(X_train, y_train)
```

Out[55]:
```
LinearRegression()
```

In [56]:
```
print('Intercept of Regression \t: b = ', linreg.intercept_)
print('Coefficients of Regression \t: a = ', linreg.coef_)
print()
```

```
Intercept of Regression         : b =  [4.4497735]
Coefficients of Regression      : a =  [[0.782124]]
```

In [57]:
```
y_train_pred = linreg.predict(X_train)
y_test_pred = linreg.predict(X_test)

f, axes = plt.subplots(1, 2, figsize=(24, 12))
axes[0].scatter(y_train, y_train_pred, color = "blue")
axes[0].plot(y_train, y_train, 'r-', linewidth = 4)
axes[0].set_xlabel("True values of revenue (Train)")
axes[0].set_ylabel("Predicted values revenue (Train)")
axes[1].scatter(y_test, y_test_pred, color = "green")
axes[1].plot(y_test, y_test, 'r-', linewidth = 4)
axes[1].set_xlabel("True values of revenue (Test)")
axes[1].set_ylabel("Predicted values of revenue (Test)")
plt.show()
```



In [58]:
```
# Check the Goodness of Fit (on Train Data)
print("Goodness of Fit of Model \tTrain Dataset")
print("Explained Variance (R^2) \t:", linreg.score(X_train, y_train))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_train, y_train_pred))
print()

# Check the Goodness of Fit (on Test Data)
print("Goodness of Fit of Model \tTest Dataset")
print("Explained Variance (R^2) \t:", linreg.score(X_test, y_test))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_test, y_test_pred))
print()
```

```
Goodness of Fit of Model        Train Dataset
Explained Variance (R^2)        : 0.4096668368154598
Mean Squared Error (MSE)        : 1.4282726055070838

Goodness of Fit of Model        Test Dataset
Explained Variance (R^2)        : 0.40327400002177083
Mean Squared Error (MSE)        : 1.600323788695773
```

Some insights from budget

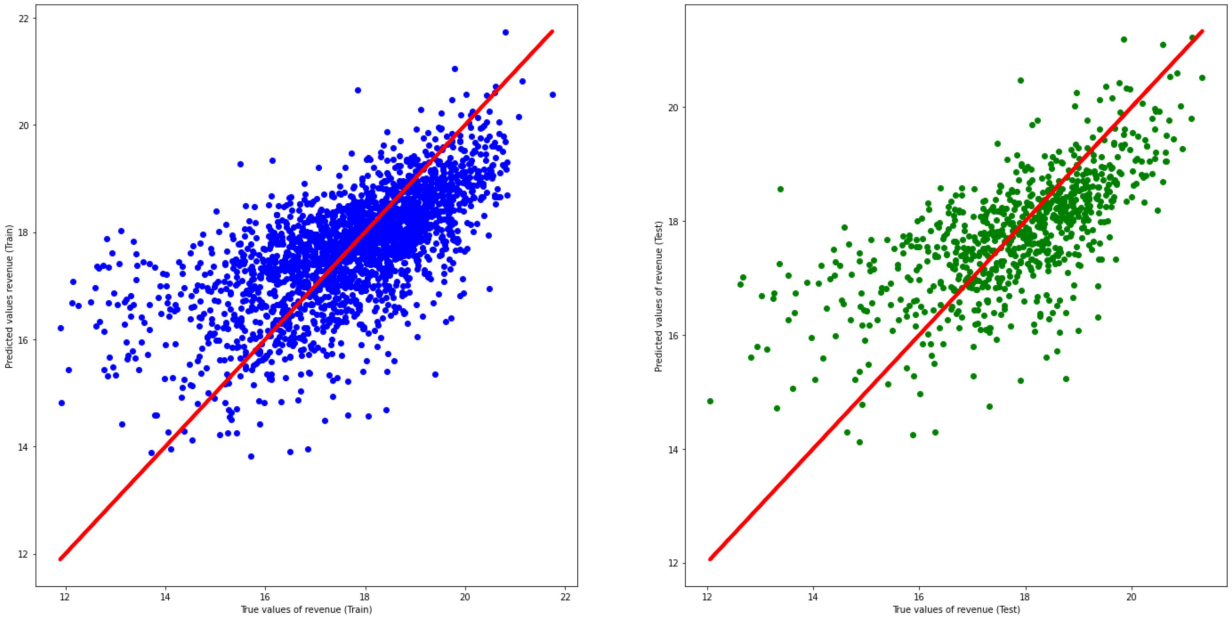
We can see that the performance is quite poor with low score. There are some correlation between budget and revenue but not very hgih. There is a trend in the data pattern, which means increase budget can also contribute to increase the revenue, but the formular (model) base on budget is not enough to predict the upcoming revenue.
The producer, in this case, can not just base on budget to predict there success. There should also be other factors that affect the revenue as well.
Let's build a model with other pre-elements to see if there is any improvement.

Model 2: Regression model base on pre_elements that producer can control using LinearRegression

In [59]:

```
data_train = data_F.drop(['revenue'], axis = 1)
data_test = pd.DataFrame(data_F['revenue'])
X_train, X_test, y_train, y_test = train_test_split(data_train, data_test, test_size = 0.25)
print("Shape of train set:", X_train.shape, y_train.shape)
print("Shape of test set:", X_test.shape, y_test.shape)
linreg = LinearRegression()
linreg.fit(X_train, y_train)
print('Intercept of Regression \t: b = ', linreg.intercept_)
print('Coefficients of Regression \t: a = ', linreg.coef_)
print()
y_train_pred = linreg.predict(X_train)
y_test_pred = linreg.predict(X_test)

f, axes = plt.subplots(1, 2, figsize=(24, 12))
axes[0].scatter(y_train, y_train_pred, color = "blue")
axes[0].plot(y_train, y_train, 'r-', linewidth = 4)
axes[0].set_xlabel("True values of revenue (Train)")
axes[0].set_ylabel("Predicted values revenue (Train)")
axes[1].scatter(y_test, y_test_pred, color = "green")
axes[1].plot(y_test, y_test, 'r-', linewidth = 4)
axes[1].set_xlabel("True values of revenue (Test)")
axes[1].set_ylabel("Predicted values of revenue (Test)")
plt.show()
# Check the Goodness of Fit (on Train Data)
print("Goodness of Fit of Model \tTrain Dataset")
print("Explained Variance (R^2) \t:", linreg.score(X_train, y_train))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_train, y_train_pred))
print()

# Check the Goodness of Fit (on Test Data)
print("Goodness of Fit of Model \tTest Dataset")
print("Explained Variance (R^2) \t:", linreg.score(X_test, y_test))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_test, y_test_pred))
print()
```

```
Shape of train set: (2323, 4) (2323, 1)
Shape of test set: (775, 4) (775, 1)
Intercept of Regression         : b =  [5.39114776]
Coefficients of Regression      : a =  [[ 0.69961979  0.00548081  0.01031847 -0.33180234]]
```




```
Goodness of Fit of Model        Train Dataset
Explained Variance (R^2)        : 0.44147649461839167
Mean Squared Error (MSE)        : 1.395209717561367

Goodness of Fit of Model        Test Dataset
Explained Variance (R^2)        : 0.45527915849956324
Mean Squared Error (MSE)        : 1.328996278203477
```

Now, we can see that the performance seems to be improved, but not very significant. There is a formular (model) to predict revenue but there performance is not very high. Therefore, before release, it is hard for the company to predicts the revenue.

Let's take a look again at the correlation matrix with other post-elements factor as well.

In [60]:
```
1 correlation = data_log.corr()['revenue'][:]
2 correlation.sort_values()
```

Out[60]:
```
action           -0.199666
western          -0.084818
tvmovie          -0.073575
crime            -0.062023
thriller         -0.061680
sciencefiction   -0.059444
music            -0.036693
war              -0.028161
history          -0.019405
family           -0.017789
foreign          -0.011921
comedy            0.013221
animation         0.070776
vote_average      0.125916
horror            0.148400
romance           0.163918
drama             0.164734
fantasy           0.165788
documentary       0.251319
num_cast          0.282160
num_crew          0.349847
budget            0.638766
popularity        0.652001
vote_count        0.707789
revenue           1.000000
mystery                NaN
adventure              NaN
Name: revenue, dtype: float64
```

We can see that, the correlation is higher on some post-elements, such as popularity, vote_count. Therefore, it seems to be easier to use post elements to predict the revenue of the movie by some post-elements.

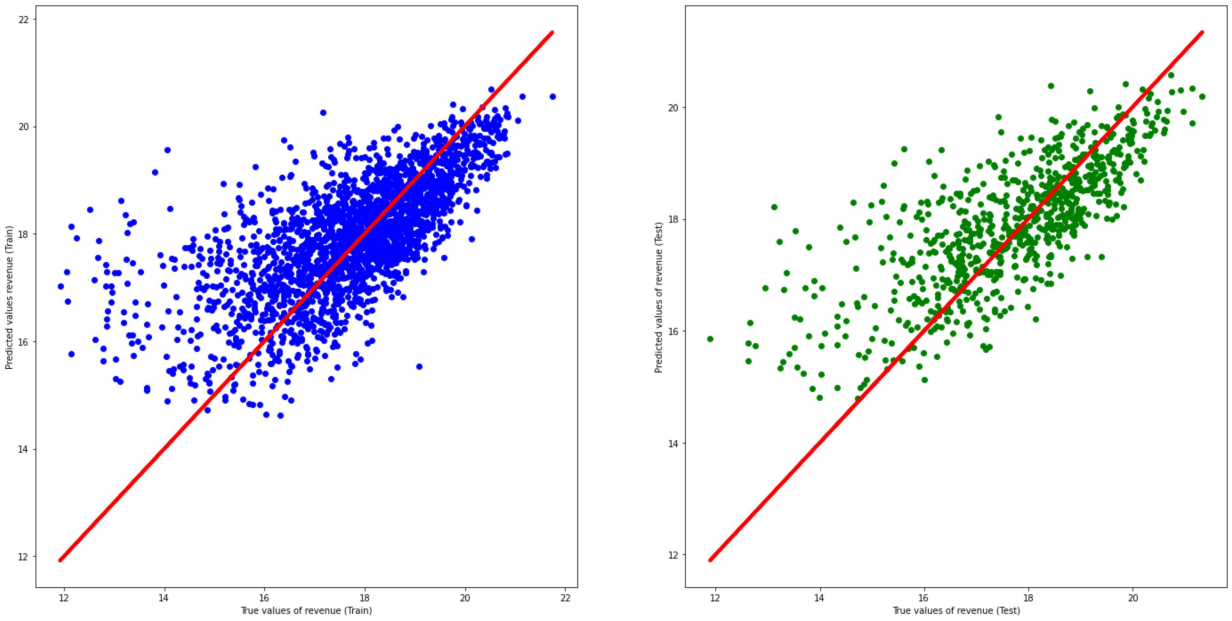
Model 3: Regression model base on post-elements by using LinearSVR

In [61]:

```
data_train = data_P.drop(['revenue'], axis = 1)
data_test = pd.DataFrame(data_P['revenue'])
X_train, X_test, y_train, y_test = train_test_split(data_train, data_test, test_size = 0.25)
print("Shape of train set:", X_train.shape, y_train.shape)
print("Shape of test set:", X_test.shape, y_test.shape)
svr = make_pipeline(StandardScaler(), LinearSVR(random_state=0, tol=1e-5))
svr.fit(X_train, y_train)
print('Intercept of Regression \t: b = ', svr.named_steps['linearsvr'].intercept_)
print('Coefficients of Regression \t: a = ', svr.named_steps['linearsvr'].coef_)
print()
y_train_pred = svr.predict(X_train)
y_test_pred = svr.predict(X_test)

f, axes = plt.subplots(1, 2, figsize=(24, 12))
axes[0].scatter(y_train, y_train_pred, color = "blue")
axes[0].plot(y_train, y_train, 'r-', linewidth = 4)
axes[0].set_xlabel("True values of revenue (Train)")
axes[0].set_ylabel("Predicted values revenue (Train)")
axes[1].scatter(y_test, y_test_pred, color = "green")
axes[1].plot(y_test, y_test, 'r-', linewidth = 4)
axes[1].set_xlabel("True values of revenue (Test)")
axes[1].set_ylabel("Predicted values of revenue (Test)")
plt.show()
# Check the Goodness of Fit (on Train Data)
print("Goodness of Fit of Model \tTrain Dataset")
print("Explained Variance (R^2) \t:", svr.score(X_train, y_train))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_train, y_train_pred))
print()

# Check the Goodness of Fit (on Test Data)
print("Goodness of Fit of Model \tTest Dataset")
print("Explained Variance (R^2) \t:", svr.score(X_test, y_test))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_test, y_test_pred))
print()
```

```
Shape of train set: (2323, 2) (2323, 1)
Shape of test set: (775, 2) (775, 1)
Intercept of Regression         : b =  [17.93556815]
Coefficients of Regression      : a =  [0.02247106 1.05928884]
```

```
C:\Users\root\anaconda3\lib\site-packages\sklearn\utils\validation.py:72: DataConversionWarning: A c
olumn-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,
), for example using ravel().
  return f(**kwargs)
```




```
Goodness of Fit of Model        Train Dataset
Explained Variance (R^2)        : 0.46200269148511974
Mean Squared Error (MSE)        : 1.3023762074670202

Goodness of Fit of Model        Test Dataset
Explained Variance (R^2)        : 0.5390775802470897
```

```
Mean Squared Error (MSE)        : 1.230658041523028
```

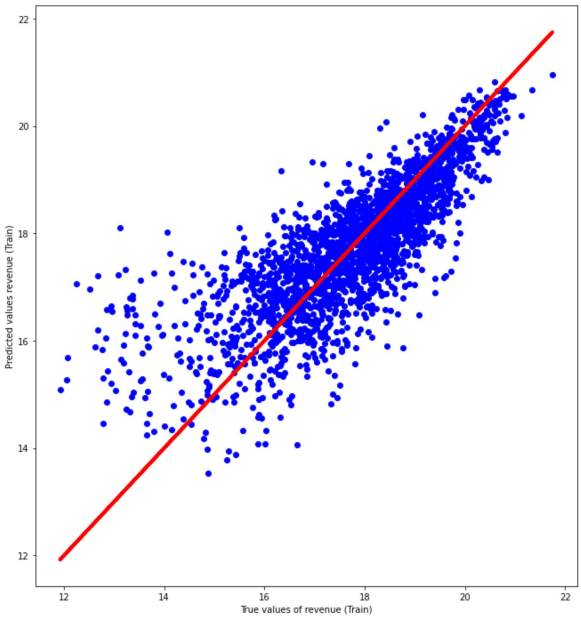
The performance seems to be improved. Now, let's see if we know all the pre-elements and post-elements if the performance can be improved

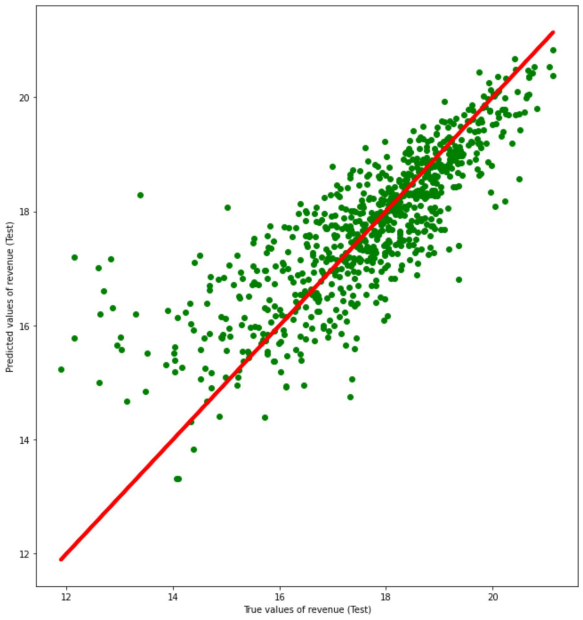
Model 4: Predicting revenue base on both pre and post elements by using RidgeCV

In [62]:

```
data_train = data_log.drop(['revenue'], axis = 1)
data_test = pd.DataFrame(data_log['revenue'])
X_train, X_test, y_train, y_test = train_test_split(data_train, data_test, test_size = 0.25)
print("Shape of train set:", X_train.shape, y_train.shape)
print("Shape of test set:", X_test.shape, y_test.shape)

linreg = RidgeCV(alphas=np.arange(70,100,0.1), fit_intercept=True)
linreg.fit(X_train, y_train)
print('Intercept of Regression \t: b = ', linreg.intercept_)
print('Coefficients of Regression \t: a = ', linreg.coef_)
print()
y_train_pred = linreg.predict(X_train)
y_test_pred = linreg.predict(X_test)

f, axes = plt.subplots(1, 2, figsize=(24, 12))
axes[0].scatter(y_train, y_train_pred, color = "blue")
axes[0].plot(y_train, y_train, 'r-', linewidth = 4)
axes[0].set_xlabel("True values of revenue (Train)")
axes[0].set_ylabel("Predicted values revenue (Train)")
axes[1].scatter(y_test, y_test_pred, color = "green")
axes[1].plot(y_test, y_test, 'r-', linewidth = 4)
axes[1].set_xlabel("True values of revenue (Test)")
axes[1].set_ylabel("Predicted values of revenue (Test)")
plt.show()
# Check the Goodness of Fit (on Train Data)
print("Goodness of Fit of Model \tTrain Dataset")
print("Explained Variance (R^2) \t:", linreg.score(X_train, y_train))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_train, y_train_pred))
print()

# Check the Goodness of Fit (on Test Data)
print("Goodness of Fit of Model \tTest Dataset")
print("Explained Variance (R^2) \t:", linreg.score(X_test, y_test))
print("Mean Squared Error (MSE) \t:", mean_squared_error(y_test, y_test_pred))
print()
```

```
Shape of train set: (2323, 26) (2323, 1)
Shape of test set: (775, 26) (775, 1)
Intercept of Regression         : b =  [5.77795412]
Coefficients of Regression      : a =  [[ 4.90410754e-01  1.96207029e-03  1.06875389e-04 -1.78004593
e-01
  -1.45227629e-01  5.74732338e-02 -6.57726952e-02  0.00000000e+00
   1.73534599e-01  7.73777175e-02  7.48319120e-02  0.00000000e+00
   1.93107834e-01  7.73011131e-02 -8.58356604e-02  1.23562923e-01
   4.72540924e-03  4.46284800e-02 -2.56244122e-01 -3.58431123e-02
  -1.04908662e-01 -5.81105743e-02 -8.42095437e-02  4.79582907e-02
   5.71783966e-01  5.65687207e-04]]
```






```
Goodness of Fit of Model        Train Dataset
Explained Variance (R^2)        : 0.6430965210783375
Mean Squared Error (MSE)        : 0.8658470252771964
```

```
Goodness of Fit of Model        Test Dataset
Explained Variance (R^2)        : 0.6703596057929615
Mean Squared Error (MSE)        : 0.8761040044530093
```

We can see that, now, the performance of the model is much enhanced.

7. Bonus: recommendation system base on content

Summary of the variables used:

- director: A list of director in each movie
- name_cast: A list of list of cast in each movie
- name_keywords: The list of list of keywords in each movie
- name_genres: The list of list of genres in each movie

We use director, cast, genres and keywords to build the recommendation system. With each variables, we choose only the first 3 elements (except for director as it has only one element)

In [63]:
```
combine = []
for item in zip(name_keywords, name_genres, director, name_cast):
    temp = ''
    for i in range(4):
        if i == 2:
            if temp != '':
                temp = temp + ' ' + item[2]
            else:
                temp = temp + item[2]
        else:
            for c in item[i]:
                if temp != '':
                    temp = temp + ' ' + c
                else:
                    temp = temp + c
    combine.append(temp)
    count = count+1
```

In [64]:
```
combine = pd.DataFrame(combine)
data_re = pd.concat([title, combine], axis = 1).reindex(title.index)
data_re.columns = ['title', 'combine']
data_re
```

Out[64]:

	title	combine
0	Avatar	cultureclash future spacewar action adventure ...
1	Pirates of the Caribbean: At World's End	ocean drugabuse exoticisland adventure fantasy...
2	Spectre	spy basedonnovel secretagent action adventure ...
3	The Dark Knight Rises	dccomics crimefighter terrorist action crime d...
4	John Carter	basedonnovel mars medallion action adventure s...
...	...	...
4798	El Mariachi	unitedstates–mexicobarrier legs arms action cr...
4799	Newlyweds	comedy romance davidhand edwardburns kerrybish...
4800	Signed, Sealed, Delivered	date loveatfirstsight narration comedy drama r...
4801	Shanghai Calling	samuelarmstrong danielhenney elizacoupe billpa...
4802	My Date with Drew	obsession camcorder crush documentary williamr...

4803 rows × 2 columns

We build a recommendation system based on the content. The input is the title of a film and we will recommend some films that are similar to the film, base on the combine variable

In [65]:
```
cv = CountVectorizer(stop_words = 'english')
count_matrix = cv.fit_transform(data_re['combine'])
cosine_sim = cosine_similarity(count_matrix, count_matrix)
```

In [66]:
```
data_re = data_re.reset_index()
indices = pd.Series(data_re.index, index=data_re['title'])
```

In [67]:
```
def get_recommendations(title, cosine_sim=cosine_sim):
    idx = indices[title]
    sim_scores = list(enumerate(cosine_sim[idx]))
    sim_scores = sorted(sim_scores, key=lambda x: x[1], reverse=True)
    sim_scores = sim_scores[1:11]
    movie_indices = [i[0] for i in sim_scores]
    return data_re['title'].iloc[movie_indices]
```

In [68]:
```
get_recommendations('Avatar', cosine_sim)
```

Out[68]:
```
206                         Clash of the Titans
71        The Mummy: Tomb of the Dragon Emperor
786                          The Monkey King 2
103                The Sorcerer's Apprentice
131                                   G-Force
215      Fantastic 4: Rise of the Silver Surfer
466                           The Time Machine
715                          The Scorpion King
1      Pirates of the Caribbean: At World's End
5                                  Spider-Man 3
Name: title, dtype: object
```

In [69]:
```
get_recommendations('Batman Begins', cosine_sim)
```

Out[69]:
```
3          The Dark Knight Rises
65               The Dark Knight
4638    Amidst the Devil's Wings
982                Run All Night
3603           Lone Wolf McQuade
1742              Brick Mansions
1986                      Faster
3326              Black November
1503                      Takers
303                     Catwoman
Name: title, dtype: object
```

In [70]:
```
get_recommendations('Romeo Is Bleeding', cosine_sim)
```

Out[70]:
```
4638    Amidst the Devil's Wings
2154                Street Kings
3          The Dark Knight Rises
4408              Jimmy and Judy
1986                      Faster
3326              Black November
1503                      Takers
747               Gangster Squad
1253                Kiss of Death
1278                   The Gunman
Name: title, dtype: object
```

So with every movie as input, the program will calculate the similarity score with other movies and finds the 10 most similar movies with the input movie to be the input.

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In [ ]:
```
1
```