CDS 230 Final Project Group 2
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Import Libraries

In [1]:

```
import numpy as np
import pandas as pd
import copy
import openpyxl as px
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import plotly.graph_objects as go
from plotly.offline import offline, iplot
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error, r2_score
from nltk.sentiment.vader import SentimentIntensityAnalyzer

import warnings
warnings.filterwarnings("ignore")

import nltk
nltk.download('vader_lexicon')


pd.options.display.float_format = "{:,.1f}".format
```

```
[nltk_data] Downloading package vader_lexicon to
[nltk_data]     /Users/manta/nltk_data...
[nltk_data]   Package vader_lexicon is already up-to-date!
```

Introduction of dataset and Research Question (Jungbin, Soobin)

In recent years, the film industry has undergone significant transformations. With the emergence of numerous OTT platforms including Netflix, the industry has faced substantial disruptions, including the impact of COVID-19 and the Hollywood strikes. These events, coupled with advancements in technology and shifts in consumer preferences, have led to considerable growth and changes.

This has prompted our group to ask, “What is the current state of the film industry? Is it thriving or declining?” To further explore this question, we’ve selected this dataset called “Movie Industry” which we found from a platform called Kaggle. This dataset encompassing over 4 decades of film data, analyzes the influence of key contributors in different aspects of the film industry, such as directors and actors, from box office performance to critical acceptance.

Our objective is to understand the dynamics and factors contributing to a film’s success. By examining patterns in genres, budgets, total revenue, and critic scores, we aim to identify what makes a film commercially and critically successful. This analysis will help us answer our finalized research question: “What are the factors that contribute to the success of films in the film industry?”

Read Dataset

In [56]:

```
df = pd.read_csv("movies.csv")
df.head()
```

Out[56]:

	name	rating	genre	year	released	score	votes	director	writer	star	country	budget	
0	The Shining	R	Drama	1980	June 13, 1980 (United States)	8.4	927,000.0	Stanley Kubrick	Stephen King	Jack Nicholson	United Kingdom	19,000,000.0	46,99
1	The Blue Lagoon	R	Adventure	1980	July 2, 1980 (United States)	5.8	65,000.0	Randal Kleiser	Henry De Vere Stacpoole	Brooke Shields	United States	4,500,000.0	58,85
2	Star Wars: Episode V - The Empire Strikes Back	PG	Action	1980	June 20, 1980 (United States)	8.7	1,200,000.0	Irvin Kershner	Leigh Brackett	Mark Hamill	United States	18,000,000.0	538,37
3	Airplane!	PG	Comedy	1980	July 2, 1980 (United States)	7.7	221,000.0	Jim Abrahams	Jim Abrahams	Robert Hays	United States	3,500,000.0	83,45
4	Caddyshack	R	Comedy	1980	July 25, 1980 (United States)	7.3	108,000.0	Harold Ramis	Brian Doyle-Murray	Chevy Chase	United States	6,000,000.0	39,84

Overview of Dataset

In [57]:

```
print(f"Records: {df.shape[0]}")
print(f"Features: {df.shape[1]}")
```

```
Records: 7668
Features: 15
```

In [58]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7668 entries, 0 to 7667
Data columns (total 15 columns):
 #   Column    Non-Null Count  Dtype  
---  ------    --------------  -----  
 0   name      7668 non-null   object 
 1   rating    7591 non-null   object 
 2   genre     7668 non-null   object 
 3   year      7668 non-null   int64  
 4   released  7666 non-null   object 
 5   score     7665 non-null   float64
 6   votes     7665 non-null   float64
 7   director  7668 non-null   object 
 8   writer    7665 non-null   object 
 9   star      7667 non-null   object 
 10  country   7665 non-null   object 
 11  budget    5497 non-null   float64
 12  gross     7479 non-null   float64
 13  company   7651 non-null   object 
 14  runtime   7664 non-null   float64
dtypes: float64(5), int64(1), object(9)
memory usage: 898.7+ KB
```

In [59]:

```
df.sample(10, random_state=55)
```

Out[59]:

	name	rating	genre	year	released	score	votes	director	writer	star	country	budg
3133	Bean	PG-13	Adventure	1997	November 7, 1997 (United States)	6.5	100,000.0	Mel Smith	Rowan Atkinson	Rowan Atkinson	United Kingdom	18,000,000
6747	Irrational Man	R	Comedy	2015	August 7, 2015 (United States)	6.6	60,000.0	Woody Allen	Woody Allen	Joaquin Phoenix	United States	11,000,000
1336	Monkey Shines	R	Drama	1988	July 29, 1988 (United States)	6.2	11,000.0	George A. Romero	Michael Stewart	Jason Beghe	United States	7,000,000
6343	The Heat	R	Action	2013	June 28, 2013 (United States)	6.6	165,000.0	Paul Feig	Katie Dippold	Sandra Bullock	United States	43,000,000
6846	Captain America: Civil War	PG-13	Action	2016	May 6, 2016 (United States)	7.8	694,000.0	Anthony Russo	Christopher Markus	Chris Evans	United States	250,000,000
5774	All Good Things	R	Crime	2010	December 3, 2010 (Canada)	6.3	54,000.0	Andrew Jarecki	Marcus Hinchey	Ryan Gosling	United States	Na
4699	Lord of War	R	Action	2005	September 16, 2005 (United States)	7.6	300,000.0	Andrew Niccol	Andrew Niccol	Nicolas Cage	France	50,000,000
277	The Final Option	R	Action	1982	September 16, 1983 (United States)	6.4	3,000.0	Ian Sharp	George Markstein	Lewis Collins	Switzerland	6,000,000
2395	Mr. Nanny	PG	Action	1993	October 8, 1993	3.8	8,900.0	Michael Gottlieb	Edward Rugoff	Hulk Hogan	United States	10,000,000

	name	rating	genre	year	released	score	votes	director	writer	star	country	budg
					(United States)							
7022	Sanam Teri Kasam	Not Rated	Drama	2016	February 5, 2016 (India)	7.5	11,000.0	Radhika Rao	Radhika Rao	Harshvardhan Rane	India	Na

In [60]:
```
df.dtypes
```

Out[60]:
```
name         object
rating       object
genre        object
year          int64
released     object
score       float64
votes       float64
director     object
writer       object
star         object
country      object
budget      float64
gross       float64
company      object
runtime     float64
dtype: object
```

Making Data Tidy

In [61]:
```
(df.isna().sum() / df.shape[0] * 100).sort_values(ascending=False)
```

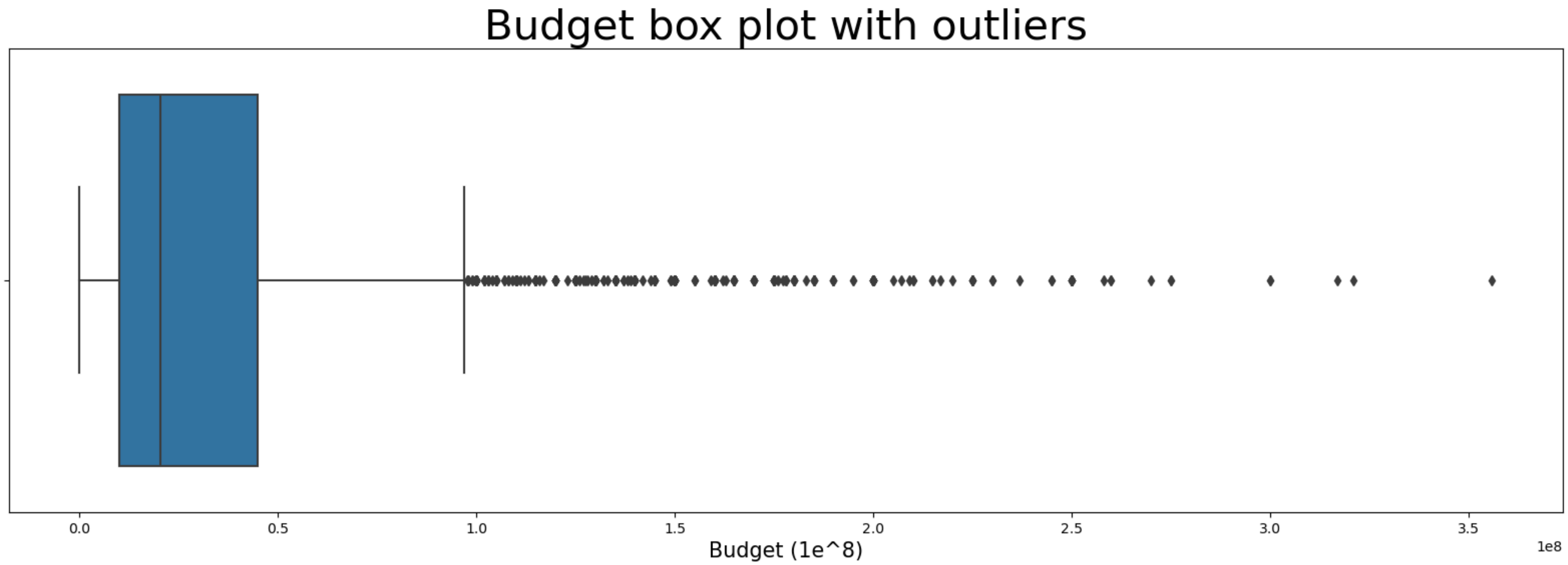
Out[61]:

```
budget      28.3
gross        2.5
rating       1.0
company      0.2
runtime      0.1
score        0.0
votes        0.0
writer       0.0
country      0.0
released     0.0
star         0.0
name         0.0
genre        0.0
year         0.0
director     0.0
dtype: float64
```

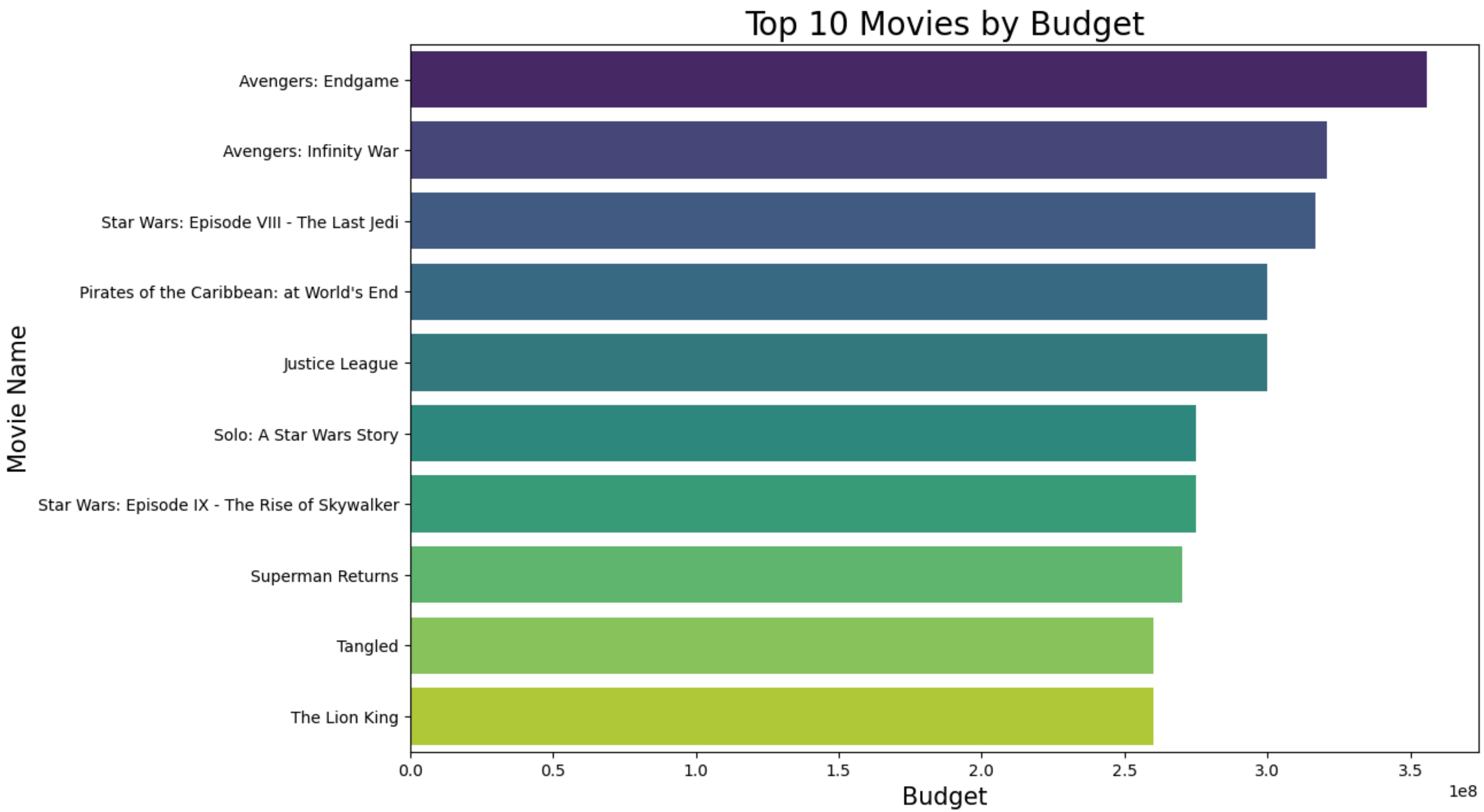
Clean ”Budget from Nan” (Geunwoo, Wonjune)

In [62]:

```python
plt.figure(figsize=(20, 6))
sns.boxplot(x=df['budget'])
plt.title('Budget box plot with outliers', fontsize=30)
plt.xlabel('Budget (1e^8)', fontsize=15)
plt.show()
```



```
In [63]: top_10_budget = df.nlargest(10, 'budget')
         plt.figure(figsize=(12, 8))
         sns.barplot(x=top_10_budget['budget'], y=top_10_budget['name'], palette="viridis")
         plt.title("Top 10 Movies by Budget", fontsize=20)
         plt.xlabel("Budget", fontsize=15)
         plt.ylabel("Movie Name", fontsize=15)
         plt.show()
```



아웃라이어들의 정체 밝히기!

In [64]:

```
df["budget"].describe()
```

```
Out[64]: count          5,497.0
         mean      35,589,876.2
         std       41,457,296.6
         min            3,000.0
         25%       10,000,000.0
         50%       20,500,000.0
         75%       45,000,000.0
         max      356,000,000.0
         Name: budget, dtype: float64
```

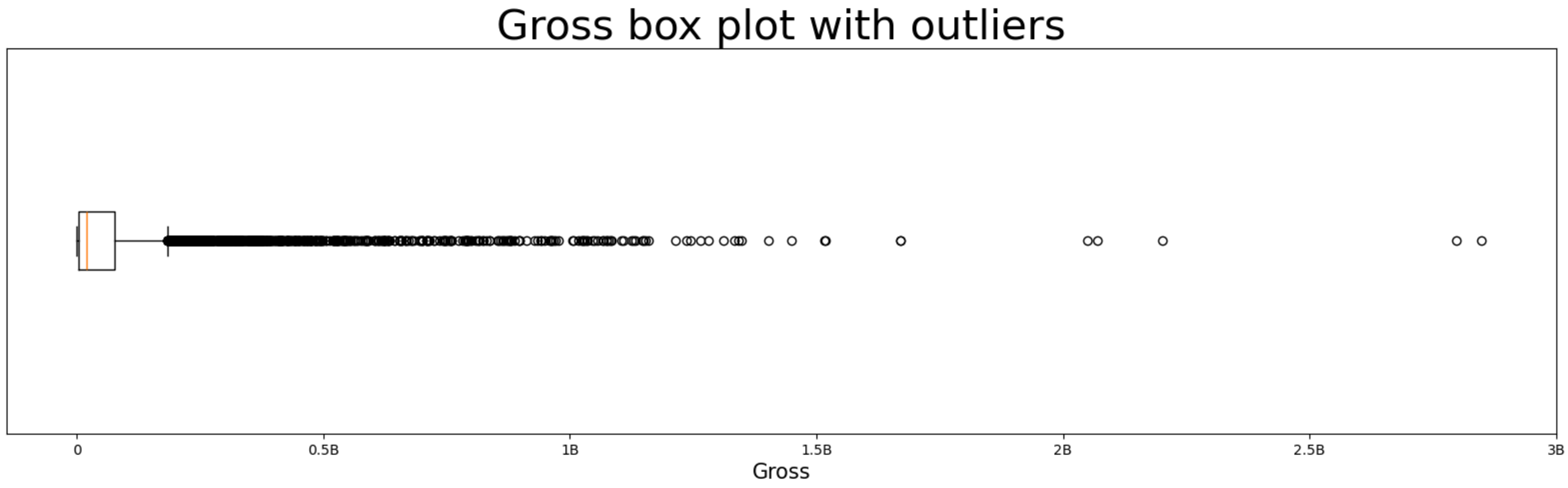
```
In [65]: print(f'Median of Budget {df["budget"].median():,.0f}')
```

```
Median of Budget 20,500,000
```

```
In [66]: df["budget"].fillna(df["budget"].median(), inplace=True)
```

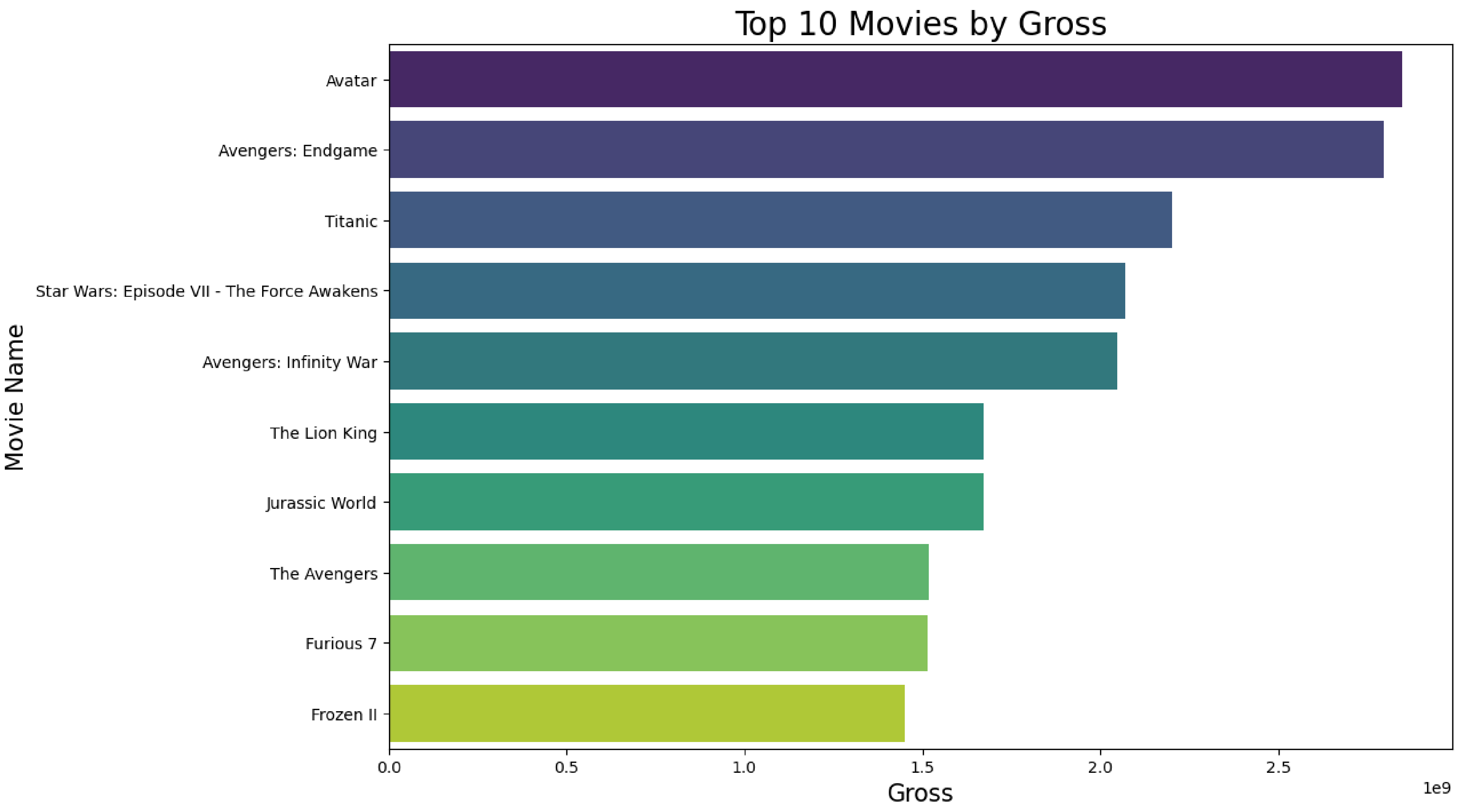
Clean ”Gross” from Nan

```
In [67]: plt.figure(figsize=(20, 5))
         plt.boxplot(df["gross"].dropna(), vert=False)
         plt.yticks([])
         plt.xticks(ticks=[0, 0.5e9, 1e9, 1.5e9, 2e9, 2.5e9, 3e9],
                    labels=['0', '0.5B', '1B', '1.5B', '2B', '2.5B', '3B'])
         plt.title('Gross box plot with outliers', fontsize=30)
         plt.xlabel('Gross', fontsize=15)
         plt.show()
```



In [68]:

```
top_10_gross = df.nlargest(10, 'gross')
plt.figure(figsize=(12, 8))
sns.barplot(x=top_10_gross['gross'], y=top_10_gross['name'], palette="viridis")
plt.title("Top 10 Movies by Gross", fontsize=20)
plt.xlabel("Gross", fontsize=15)
plt.ylabel("Movie Name", fontsize=15)
plt.show()
```



아웃라이어들 정체 밝히기!

```
In [69]: df.dropna(how= "all", subset ="gross", inplace=True)
```

```
In [70]: (df.isna().sum() / df.shape[0] * 100).sort_values(ascending=False)
```

Out[70]:

```
rating      0.7
company     0.1
writer      0.0
country     0.0
runtime     0.0
name        0.0
genre       0.0
year        0.0
released    0.0
score       0.0
votes       0.0
director    0.0
star        0.0
budget      0.0
gross       0.0
dtype: float64
```

Clean ”Rating” and ”Company” From Nan

(WonJune)

In [71]:

```
df["rating"].fillna(df["rating"].mode()[0], inplace=True)
```

In [72]:

```
df["company"].fillna(df["company"].mode()[0], inplace=True)
```

Research Each Important Column

(WonJune)

In [73]:

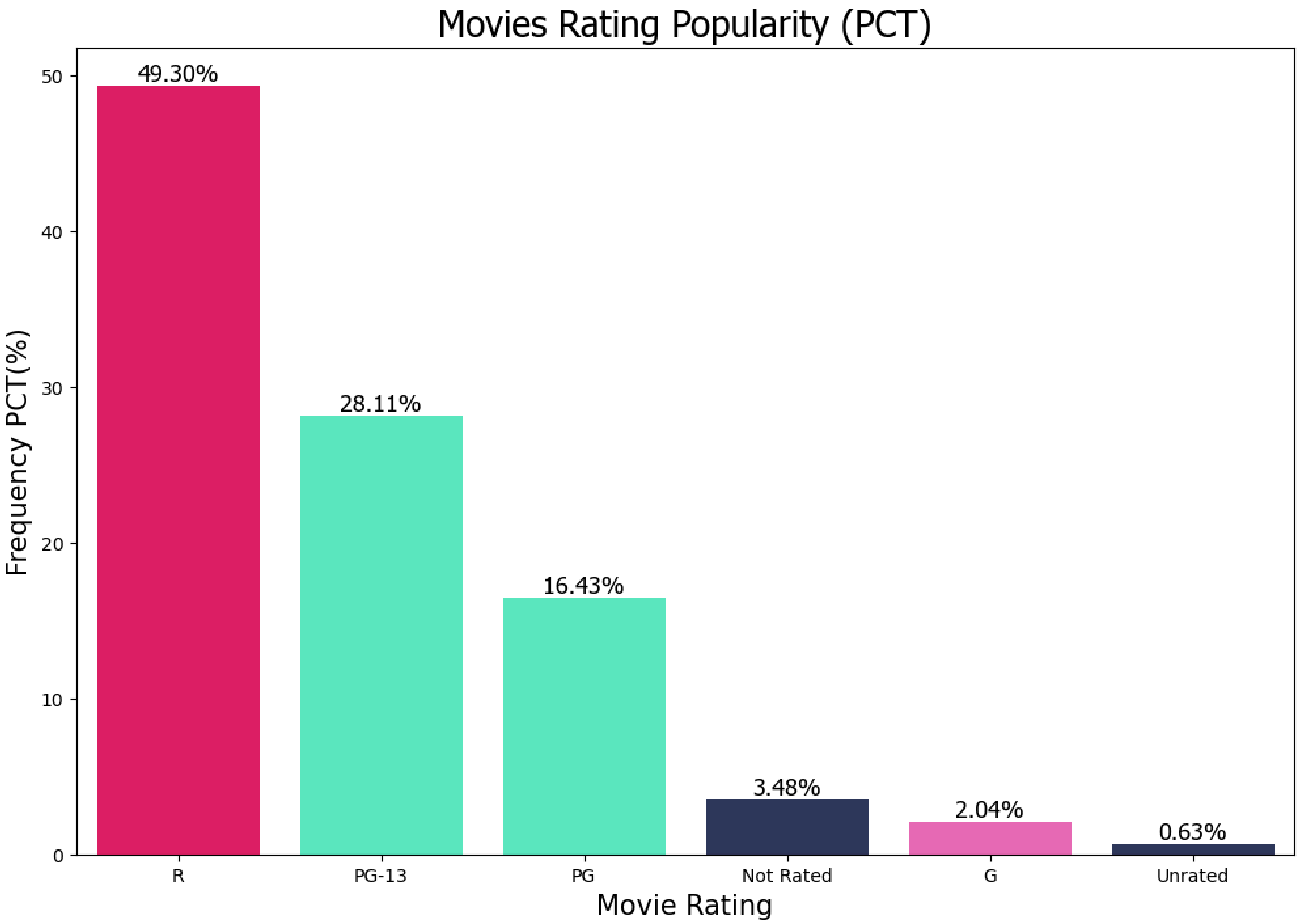
```
rating = df["rating"].value_counts()
(rating / df.shape[0] * 100).apply(lambda x: f"{x: 0.2f} %")
```

Out[73]:

```
rating
R              49.03 %
PG-13          27.96 %
PG             16.34 %
Not Rated       3.46 %
G               2.03 %
Unrated         0.63 %
NC-17           0.31 %
TV-MA           0.12 %
TV-PG           0.05 %
X               0.04 %
Approved        0.01 %
TV-14           0.01 %
Name: count, dtype: object
```

In [74]:

```
rating = rating[0:6]
rating_pct = rating / rating.sum() * 100

plt.figure(figsize=(12, 8))
bars = sns.barplot(x=rating.index, y=rating_pct, palette=["#FF0060", "#45FFCA",
                                                           "#45FFCA", "#293462",
                                                           "#FF55BB", "#293462"])
plt.title('Movies Rating Popularity (PCT)', fontsize=20, family='tahoma')
plt.xlabel('Movie Rating', fontsize=15)
plt.ylabel('Frequency PCT(%)', fontsize=15)

for i, bar in enumerate(bars.patches):
    plt.text(bar.get_x() + bar.get_width() / 2, bar.get_height(), f'{rating_pct[i]:.2f}%',
             ha='center', va='bottom', fontsize=13, family='tahoma')

plt.show()
```


Movies Rating Popularity (PCT)
Frequency PCT(%)
0
10
20
30
40
50
49.30%
28.11%
16.43%
3.48%
2.04%
0.63%
R
PG-13
PG
Not Rated
G
Unrated
Movie Rating

G 전체 관람가

PG 부모 지도하 전체관람가

PG-13 부모동반하 13세 이상 관람가

R 17세 미만 보호자동반 관람가

NC-17 17세 미만 관람불가

In [79]:

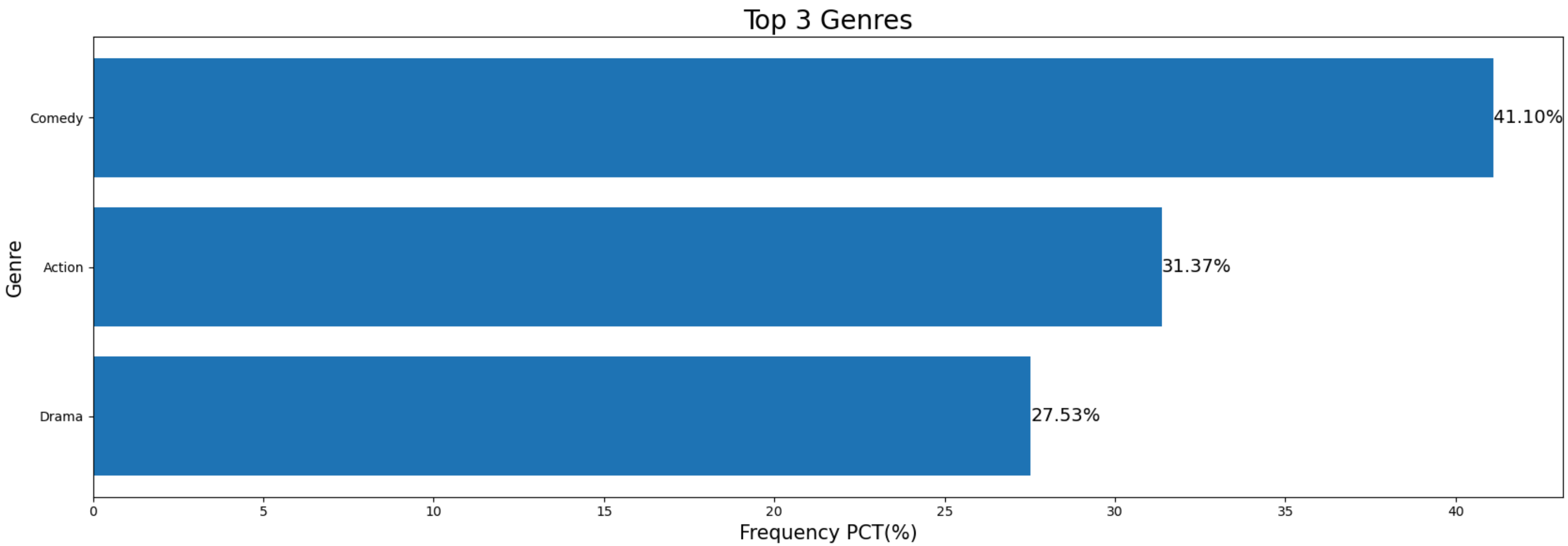
```
genre = df["genre"].value_counts()
(genre / sum(genre) * 100).apply(lambda x: f"{x:0.2f} %")
```

Out[79]:

```
genre
Comedy        29.31 %
Action        22.37 %
Drama         19.63 %
Crime          7.25 %
Biography      5.79 %
Adventure      5.62 %
Animation      4.48 %
Horror         4.10 %
Fantasy        0.57 %
Mystery        0.27 %
Thriller       0.16 %
Family         0.15 %
Romance        0.11 %
Sci-Fi         0.11 %
Western        0.04 %
Musical        0.03 %
Music          0.01 %
Sport          0.01 %
Name: count, dtype: object
```

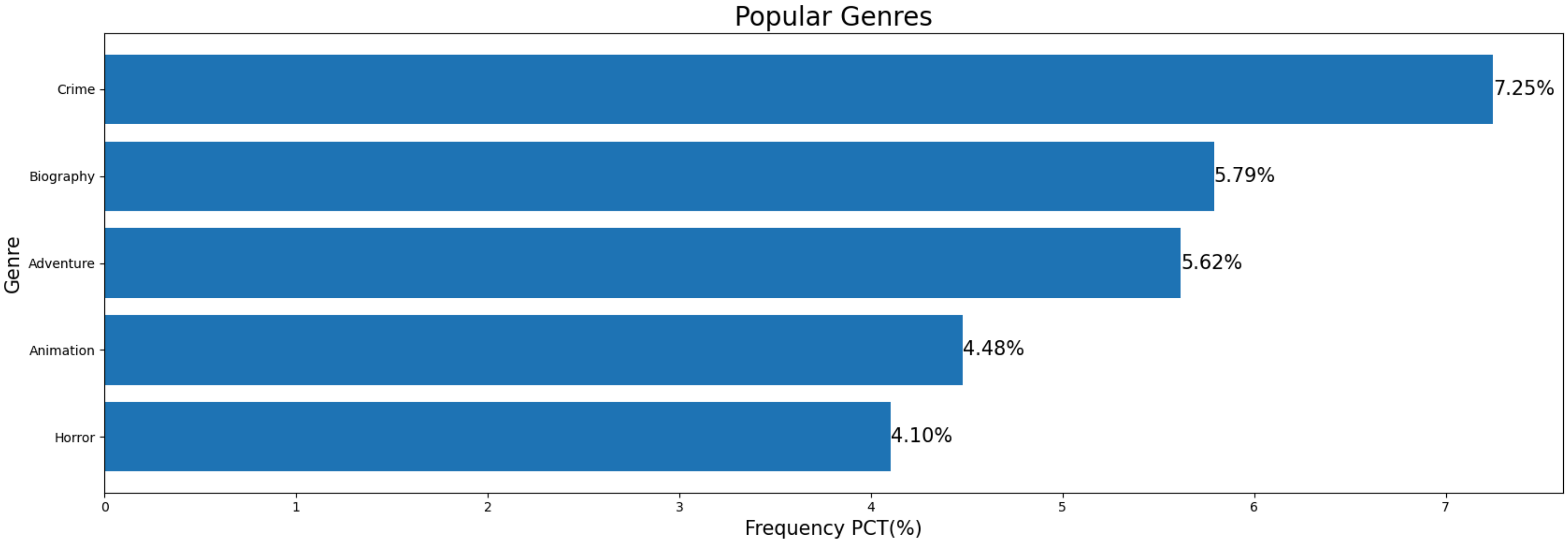
In [76]:

```
genre = genre.nlargest(3)[::-1]
count = (genre / sum(genre)) * 100
plt.figure(figsize=(17, 6))
bars = plt.barh(genre.index, count)

for bar in bars:
    width = bar.get_width()
    label_x_pos = width
    plt.text(label_x_pos, bar.get_y() + bar.get_height()/2, f"{width:0.2f}%", va='center', fontsize=14)

plt.title("Top 3 Genres", fontsize=20)
plt.xlabel("Frequency PCT(%)", fontsize=15)
plt.ylabel("Genre", fontsize=15)
plt.tight_layout()
plt.show()
```



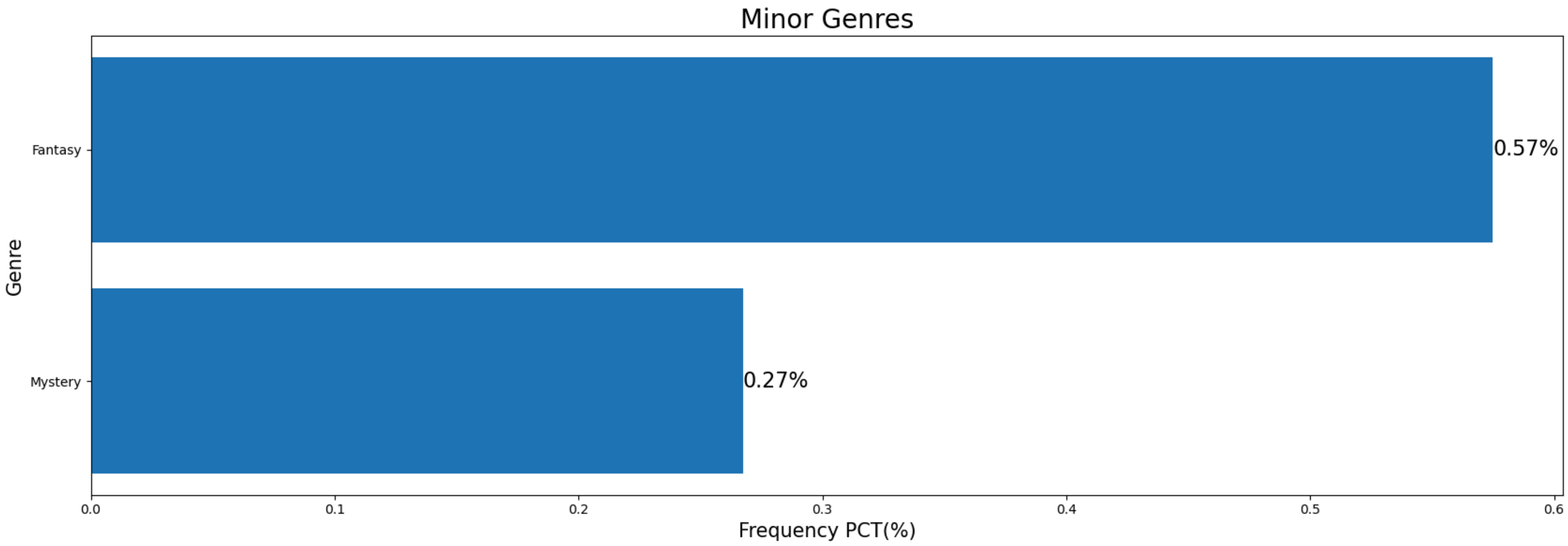
In [78]:

```
genre2 = genre.nlargest(10).iloc[3:8][::-1]
count2 = (genre2 / sum(genre)) * 100
plt.figure(figsize=(17, 6))
bars = plt.barh(genre2.index, count2)

for bar in bars:
    width = bar.get_width()
    label_x_pos = width
    plt.text(label_x_pos, bar.get_y() + bar.get_height()/2, f"{width:0.2f}%", va='center', fontsize=15)

plt.title("Popular Genres", fontsize=20)
plt.xlabel("Frequency PCT(%)", fontsize=15)
plt.ylabel("Genre", fontsize=15)
plt.tight_layout()
plt.show()
```



In [80]:

```
genre3 = genre.nlargest(10).iloc[8:][::-1]
count3 = (genre3 / sum(genre)) * 100
plt.figure(figsize=(17, 6))
bars = plt.barh(genre3.index, count3)

for bar in bars:
    width = bar.get_width()
    label_x_pos = width
    plt.text(label_x_pos, bar.get_y() + bar.get_height()/2, f"{width:0.2f}%", va='center', fontsize=16)

plt.title("Minor Genres", fontsize=20)
plt.xlabel("Frequency PCT(%)", fontsize=15)
plt.ylabel("Genre", fontsize=15)
plt.tight_layout()
plt.show()
```



In [81]:

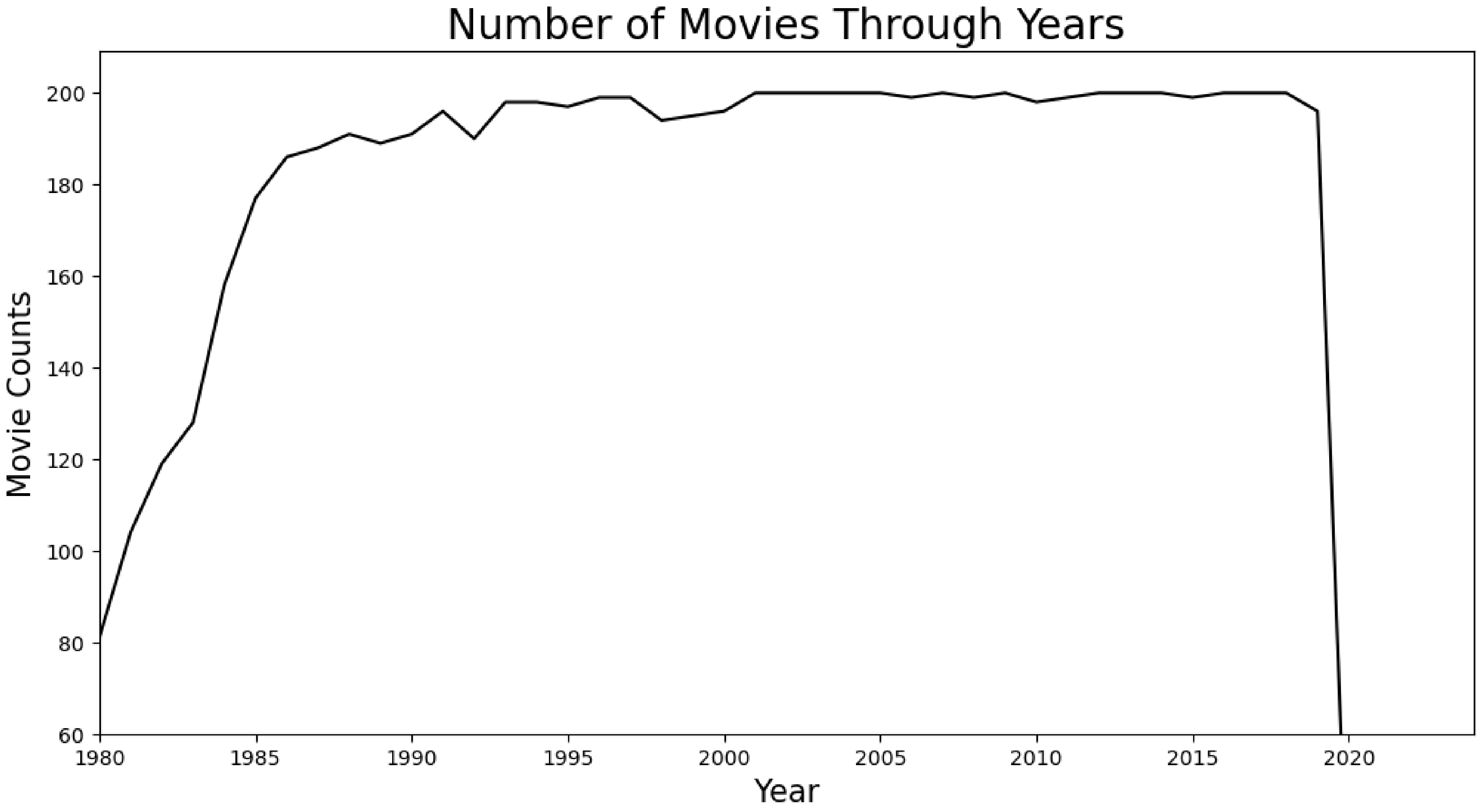
```
year = df["year"].value_counts().sort_index()
year.head(10)
```

Out[81]:

```
year
1980     81
1981    104
1982    119
1983    128
1984    158
1985    177
1986    186
1987    188
1988    191
1989    189
Name: count, dtype: int64
```

In [82]:

```
plt.figure(figsize=(12, 6))
sns.lineplot(x=year.index, y=year, color="#000000")
plt.ylim(60)
plt.xlim(1980,2024)
plt.title('Number of Movies Through Years', fontsize=20)
plt.xlabel('Year', fontsize=15)
plt.ylabel('Movie Counts', fontsize=15)
plt.show()
```



2020 년에는 코로나..

In [83]:

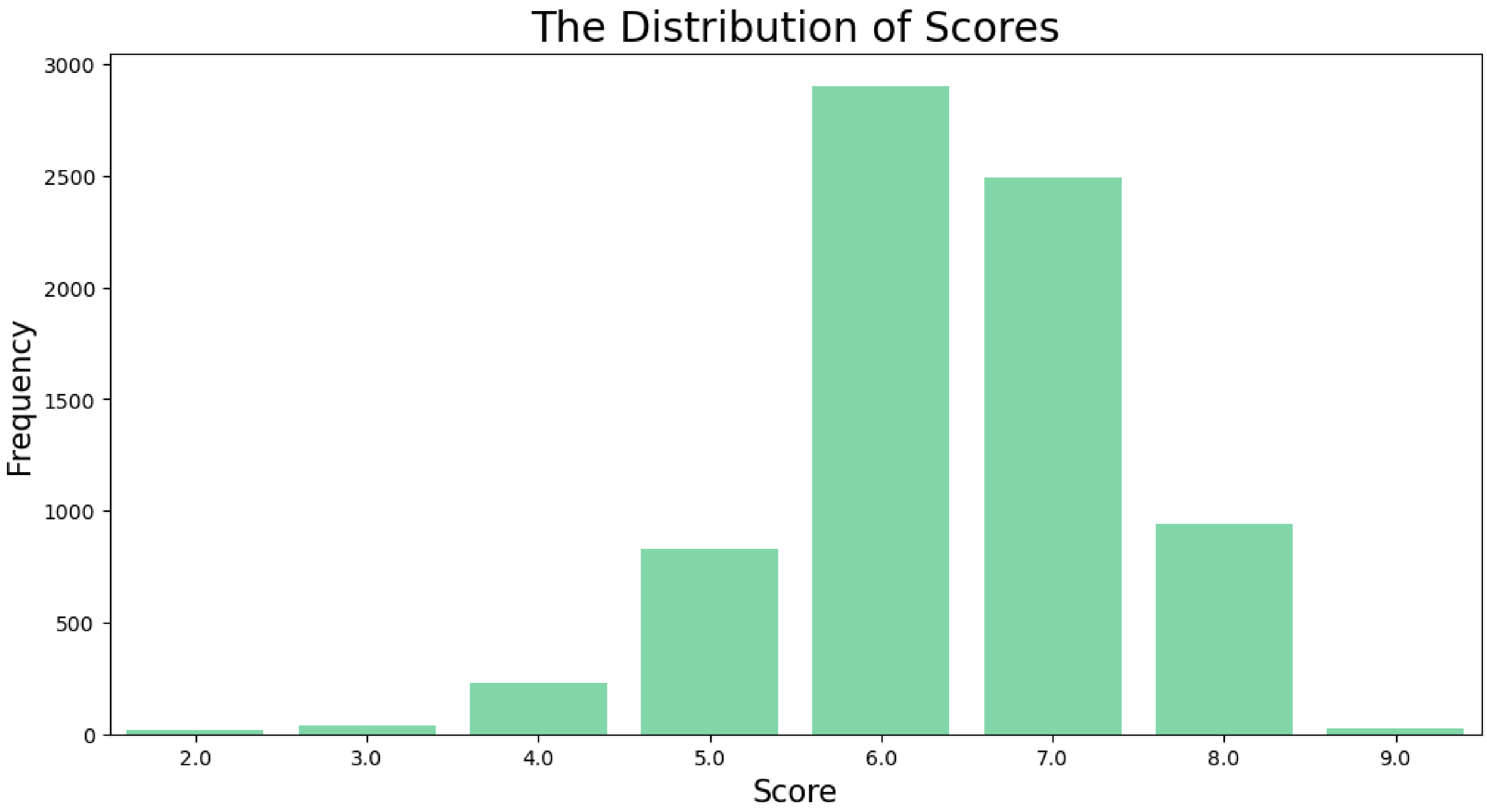
```
pd.DataFrame(df["score"].describe())
```

Out[83]:

	score
count	7,479.0
mean	6.4
std	1.0
min	1.9
25%	5.8
50%	6.5
75%	7.1
max	9.3

In [84]:

```
score_counts = df['score'].round().value_counts().sort_index()
plt.figure(figsize=(12, 6))
sns.barplot(x=score_counts.index, y=score_counts.values, color="#73EAA8")
plt.title("The Distribution of Scores", fontsize=20)
plt.xlabel("Score", fontsize=15)
plt.ylabel("Frequency", fontsize=15)
plt.show()
```



In [85]:

```
mean_value = df['score'].mean()
median_value = df['score'].median()

print(f'mean value of score is : {mean_value:,.1f}')
print(f'median value of score is : {median_value:,.1f}')
```

```
mean value of score is : 6.4
median value of score is : 6.5
```

In [86]:

```
print(f"The Skew of The Score Data: {df['score'].skew(): 0.2f}")
```

```
The Skew of The Score Data: -0.61
```

In [87]:

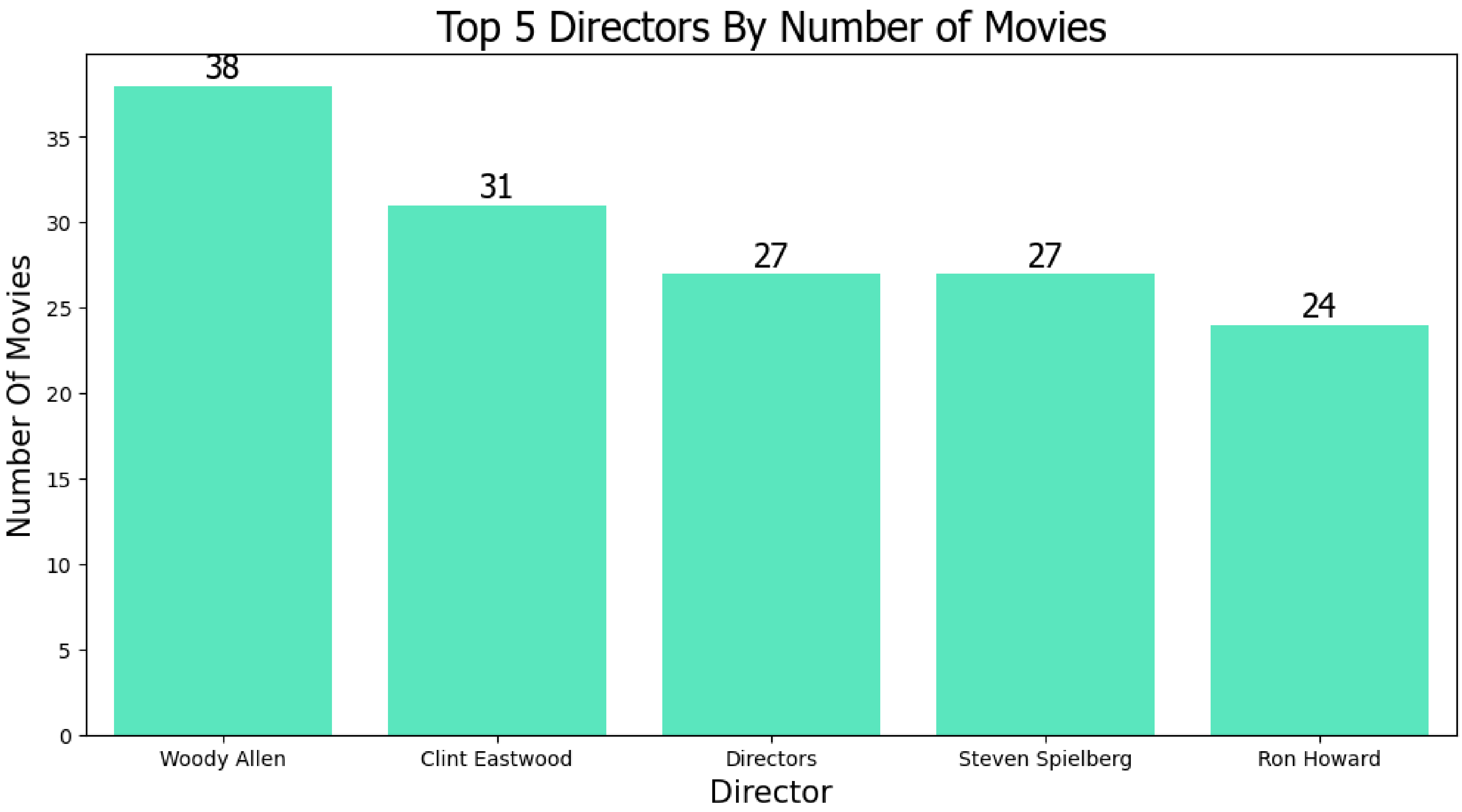
```python
director = df["director"].value_counts()
director.head(10)
```

Out[87]:

```
director
Woody Allen           38
Clint Eastwood        31
Directors             27
Steven Spielberg      27
Ron Howard            24
Ridley Scott          23
Steven Soderbergh     23
Joel Schumacher       22
Barry Levinson        20
Martin Scorsese       19
Name: count, dtype: int64
```

In [88]:

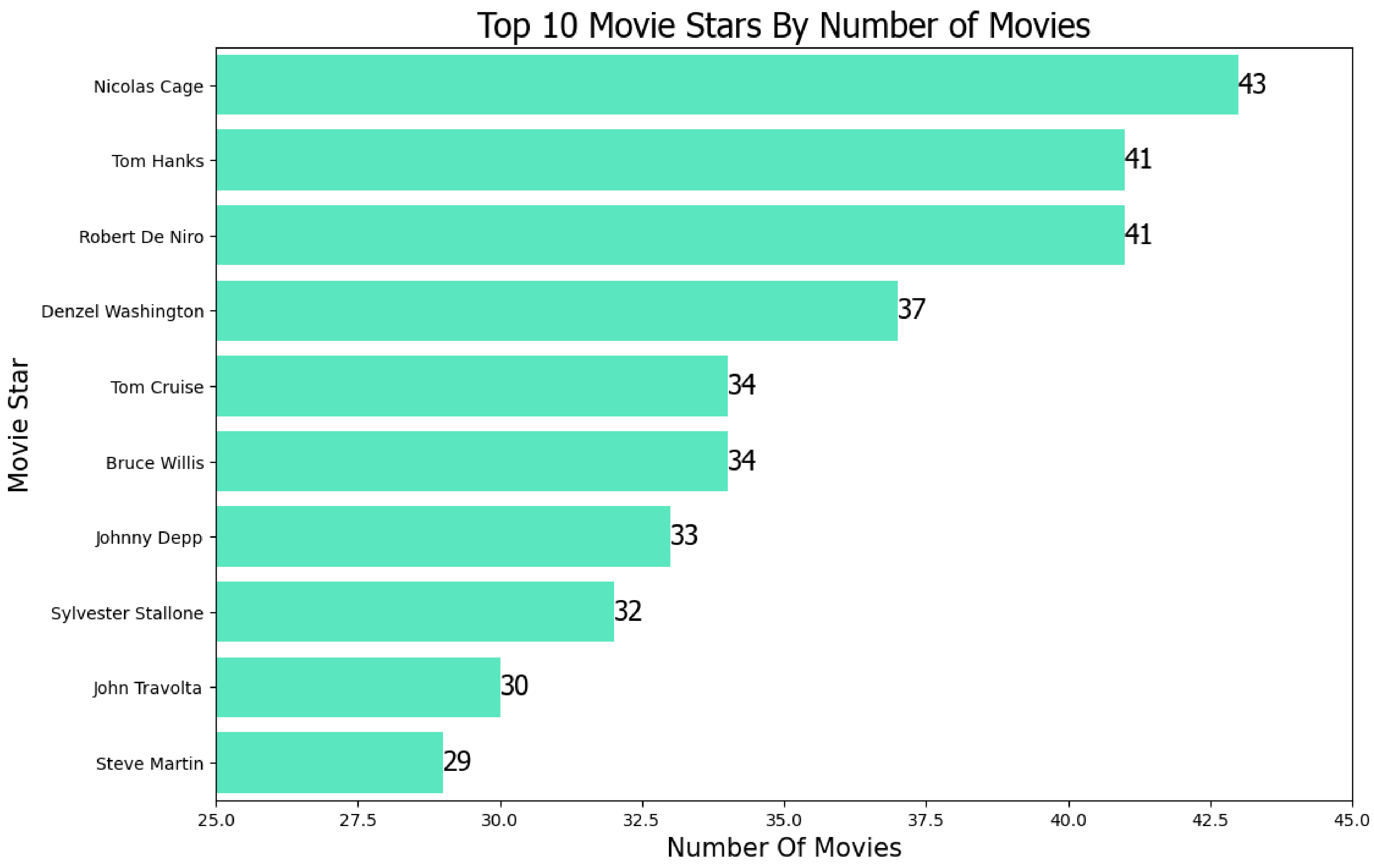
```python
top_5_directors = director.nlargest(5)

plt.figure(figsize=(12, 6))
sns.barplot(x=top_5_directors.index, y=top_5_directors.values, palette=["#45FFCA"])
plt.title('Top 5 Directors By Number of Movies', fontsize=20, family='tahoma')
plt.xlabel('Director', fontsize=15)
plt.ylabel('Number Of Movies', fontsize=15)
for index, value in enumerate(top_5_directors.values):
    plt.text(index, value, str(value), ha='center', va='bottom', fontsize=16, family='tahoma')
plt.show()
```



```
In [89]: movie_star = df["star"].value_counts()
         movie_star.head(10)
```

```
Out[89]: star
         Nicolas Cage          43
         Tom Hanks             41
         Robert De Niro        41
         Denzel Washington     37
         Tom Cruise            34
         Bruce Willis          34
         Johnny Depp           33
         Sylvester Stallone    32
         John Travolta         30
         Steve Martin          29
         Name: count, dtype: int64
```

```
In [90]: top_10_movie_stars = movie_star.nlargest(10)

         plt.figure(figsize=(12, 8))
         sns.barplot(y=top_10_movie_stars.index, x=top_10_movie_stars.values, palette=["#45FFCA"])
         plt.xlim(25, 45)
         plt.title('Top 10 Movie Stars By Number of Movies', fontsize=20, family='tahoma')
         plt.xlabel('Number Of Movies', fontsize=15)
         plt.ylabel('Movie Star', fontsize=15)
         for index, value in enumerate(top_10_movie_stars.values):
             plt.text(value, index, str(value), ha='left', va='center', fontsize=16, family='tahoma')
         plt.show()
```



top 10 여자, 남자 무비 스타

top 10 여자, 남자 감독

In [91]:

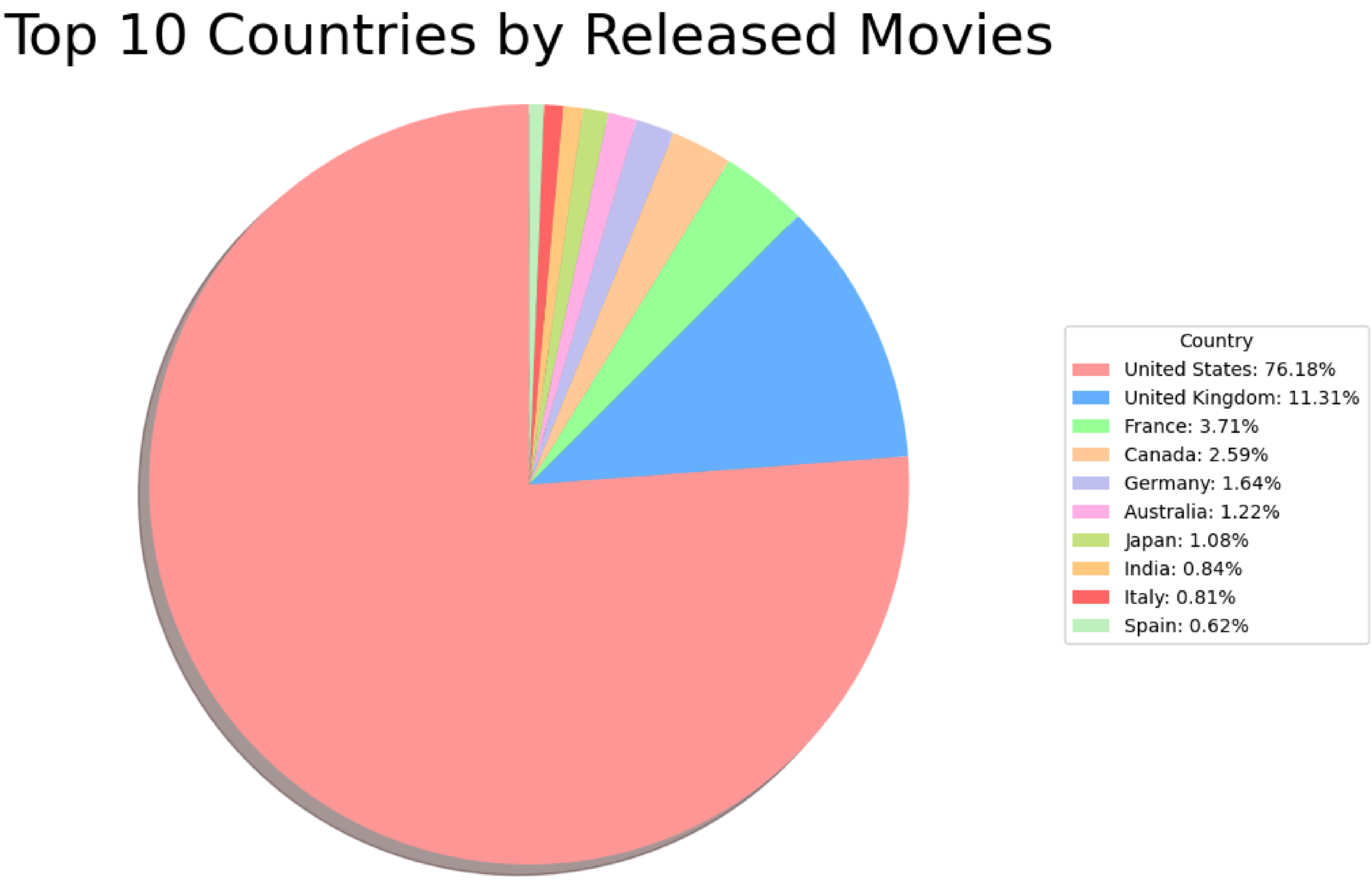
```
country = df["country"].value_counts()
country.nlargest(10)
```

Out[91]:

```
country
United States     5377
United Kingdom     798
France             262
Canada             183
Germany            116
Australia           86
Japan               76
India               59
Italy               57
Spain               44
Name: count, dtype: int64
```

In [92]:

```
country = df["country"].value_counts().nlargest(10)
custom_colors = ['#ff9999','#66b3ff','#99ff99','#ffcc99','#c2c2f0','#ffb3e6',
                 '#c4e17f','#ffcc80','#ff6666','#c2f0c2']

plt.figure(figsize=(10, 8))
wedges, texts = plt.pie(country, startangle=90, colors=custom_colors, shadow=True)
plt.title('Top 10 Countries by Released Movies', fontsize=30)
plt.axis('equal')
plt.legend(wedges, [f'{label}: {value:.2f}%' for label, value in zip(country.index, country*100/country.sum())],
           title="Country", loc="center left", bbox_to_anchor=(1, 0, 0.5, 1))
plt.style.use('default')
plt.show()
```


Top 10 Countries by Released Movies
Country
United States: 76.18%
United Kingdom: 11.31%
France: 3.71%
Canada: 2.59%
Germany: 1.64%
Australia: 1.22%
Japan: 1.08%
India: 0.84%
Italy: 0.81%
Spain: 0.62%

Top 5 Rated Movies

In [93]:

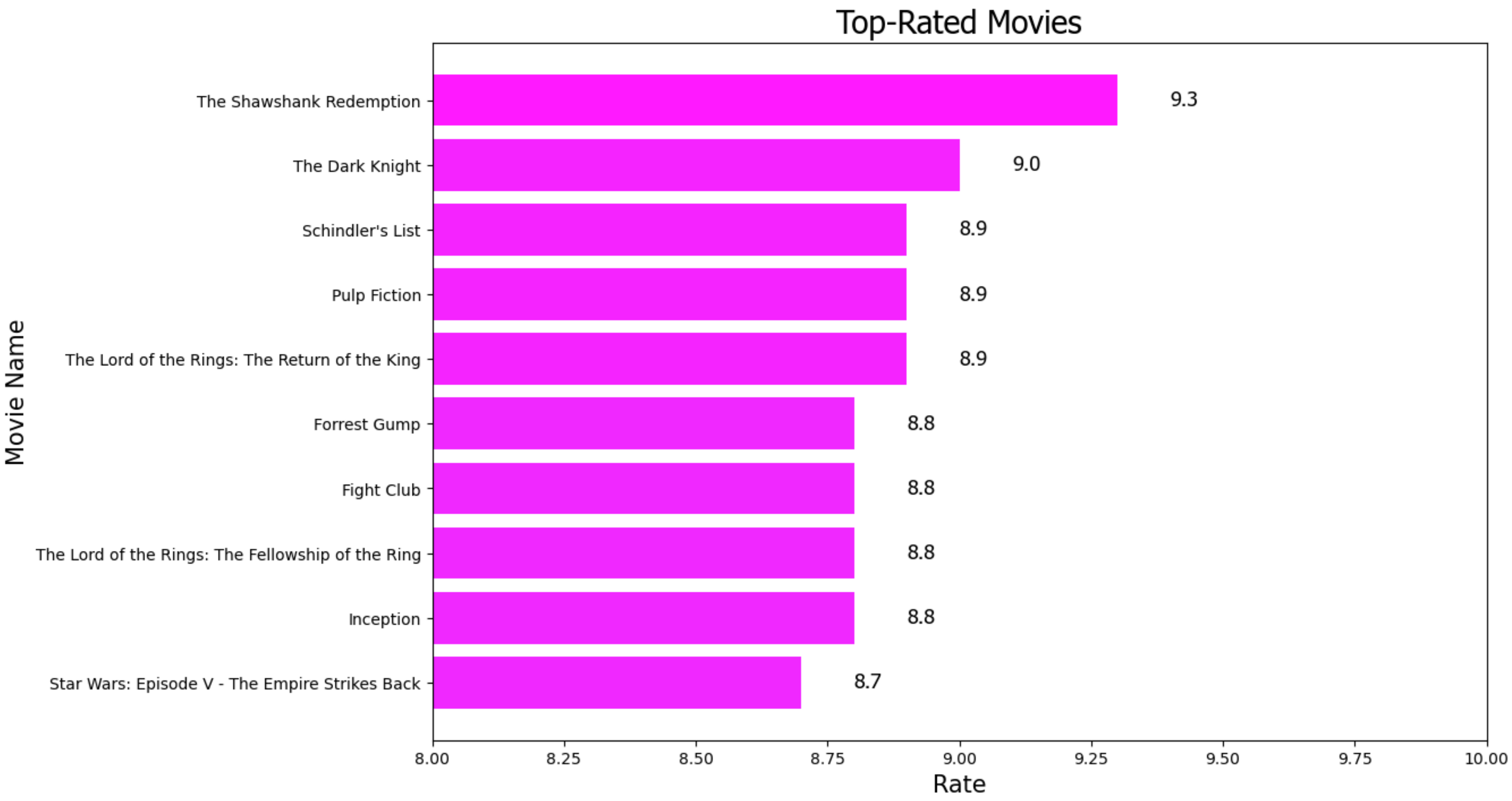
```
filt = df["score"].nlargest(10)
top_rated_movie = df.loc[filt.index, ["name", "score"]]
top_rated_movie.reset_index(drop=True)
```

Out[93]:

	name	score
0	The Shawshank Redemption	9.3
1	The Dark Knight	9.0
2	Schindler's List	8.9
3	Pulp Fiction	8.9
4	The Lord of the Rings: The Return of the King	8.9
5	Forrest Gump	8.8
6	Fight Club	8.8
7	The Lord of the Rings: The Fellowship of the Ring	8.8
8	Inception	8.8
9	Star Wars: Episode V - The Empire Strikes Back	8.7

In [94]:

```
top_rated_movie = top_rated_movie[::-1]
plt.figure(figsize=(12, 8))
bars = plt.barh(
    y=top_rated_movie['name'],
    width=top_rated_movie['score'],
    color=plt.cm.cool(top_rated_movie['score'] / top_rated_movie['score'].max()),
    alpha=0.89
)
plt.xlim(8, 10)
plt.title('Top-Rated Movies', fontsize=20, family='tahoma')
plt.xlabel('Rate', fontsize=15)
plt.ylabel('Movie Name', fontsize=15)
for i in range(len(top_rated_movie)):
    plt.text(top_rated_movie['score'].iloc[i] + 0.1, i,
             f'{top_rated_movie["score"].iloc[i]}', fontsize=13, family='tahoma', va='center')
sm = plt.cm.ScalarMappable(cmap='cool', norm=plt.Normalize(vmin=top_rated_movie['score'].min(),
                                                           vmax=top_rated_movie['score'].max()))
sm.set_array([])
plt.show()
```

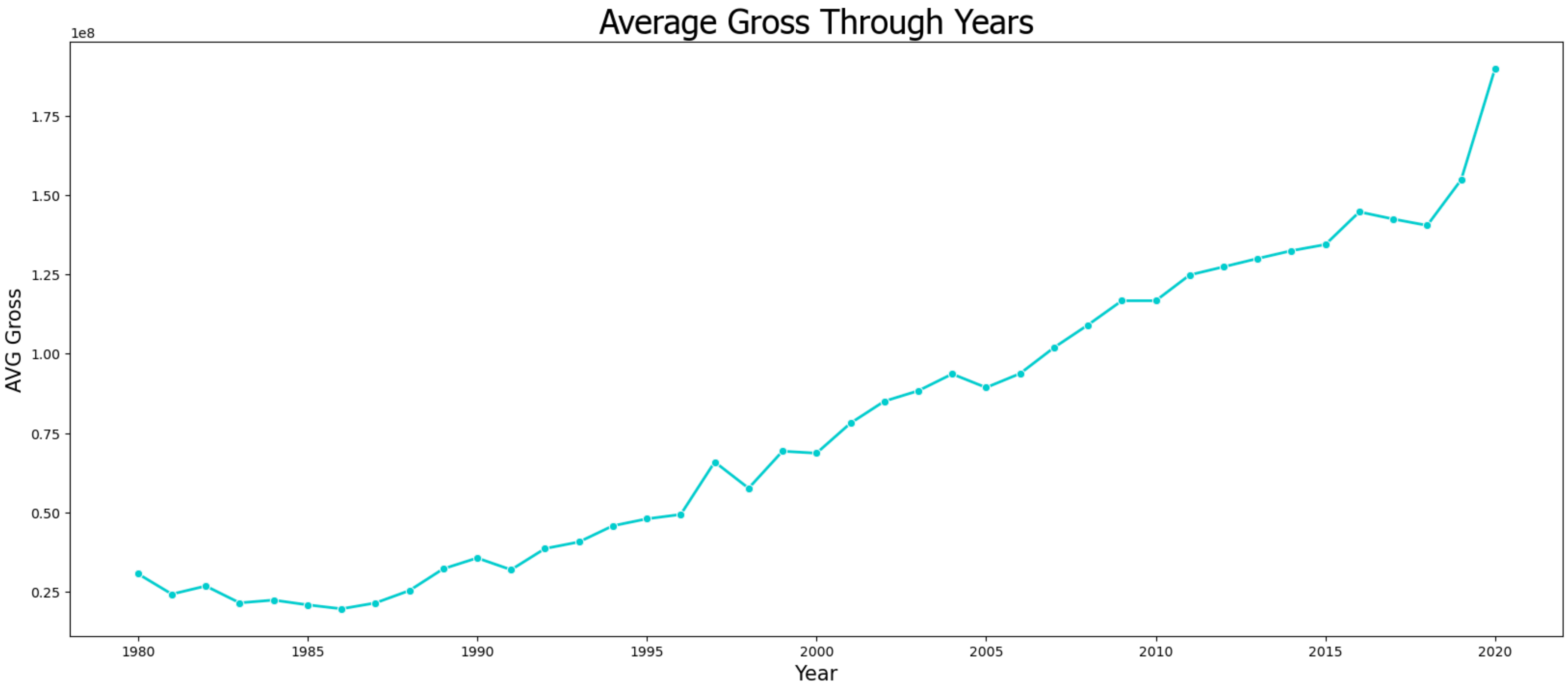


Each year, average gross revenue

In [95]:
```
gross_per_year = df.groupby("year")["gross"].mean()
gross_per_year.head(5)
```

Out[95]:
```
year
1980   30,662,555.1
1981   24,231,393.2
1982   26,786,390.9
1983   21,484,411.1
1984   22,361,343.0
Name: gross, dtype: float64
```

In [96]:
```
plt.figure(figsize=(20, 8))
sns.lineplot(x=gross_per_year.index, y=gross_per_year, color="#00CED1", marker='o', linewidth=2)
plt.title('Average Gross Through Years', fontsize=25, family='tahoma')
plt.xlabel('Year', fontsize=15)
plt.ylabel('AVG Gross', fontsize=15)
plt.show()
```



변곡점에 무슨 일이 있었는지 추가하기..?

Top 10 Company by Gross Revenue (Hyeyeon)

In [97]:

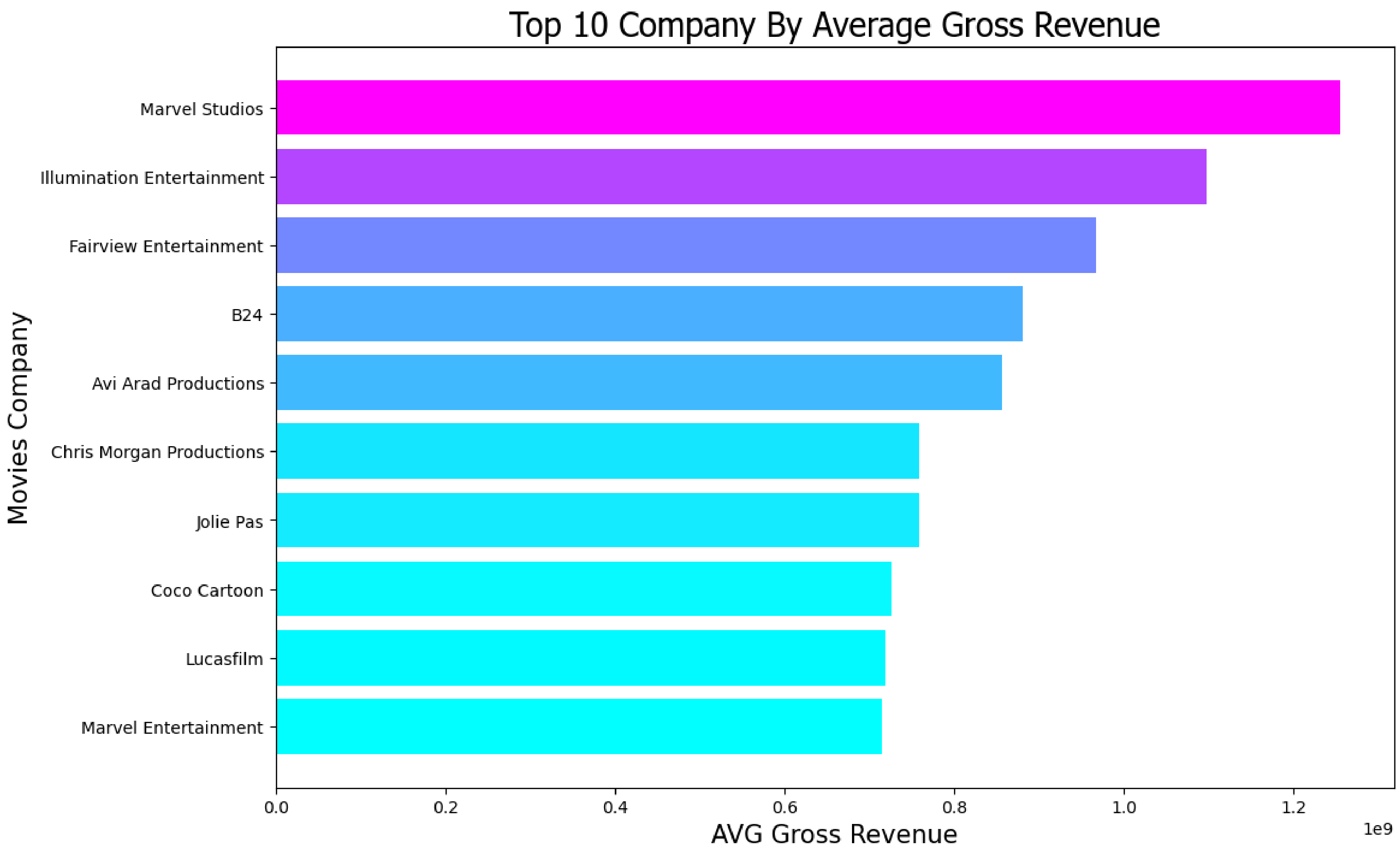
```
gross_via_comapny = df.groupby("company")["gross"].mean().sort_values(ascending=False)
gross_via_comapny = gross_via_comapny.head(10)
pd.DataFrame(gross_via_comapny)
```

Out[97]:

	gross
company	
Marvel Studios	1,255,466,034.2
Illumination Entertainment	1,097,122,396.5
Fairview Entertainment	966,554,929.0
B24	880,681,519.0
Avi Arad Productions	856,085,151.0
Chris Morgan Productions	759,056,935.0
Jolie Pas	758,411,779.0
Coco Cartoon	726,264,074.0
Lucasfilm	718,535,219.2
Marvel Entertainment	714,421,503.0

In [98]:

```
top_10_companies = gross_via_comapny.nlargest(10)[::-1]
norm = plt.Normalize(top_10_companies.min(), top_10_companies.max())
colors = plt.cm.cool(norm(top_10_companies.values))

plt.figure(figsize=(12, 8))
bars = plt.barh(top_10_companies.index, top_10_companies.values, color=colors)

plt.title('Top 10 Company By Average Gross Revenue', fontsize=20, family='tahoma')
plt.xlabel('AVG Gross Revenue', fontsize=15)
plt.ylabel('Movies Company', fontsize=15)
plt.show()
```



Top 3 Genres in each year (Juheon)

In [99]:

```python
filt = (df["year"] >= 2010) & (df["year"] <= 2019)
dff = df[filt].copy()
```

In [100…

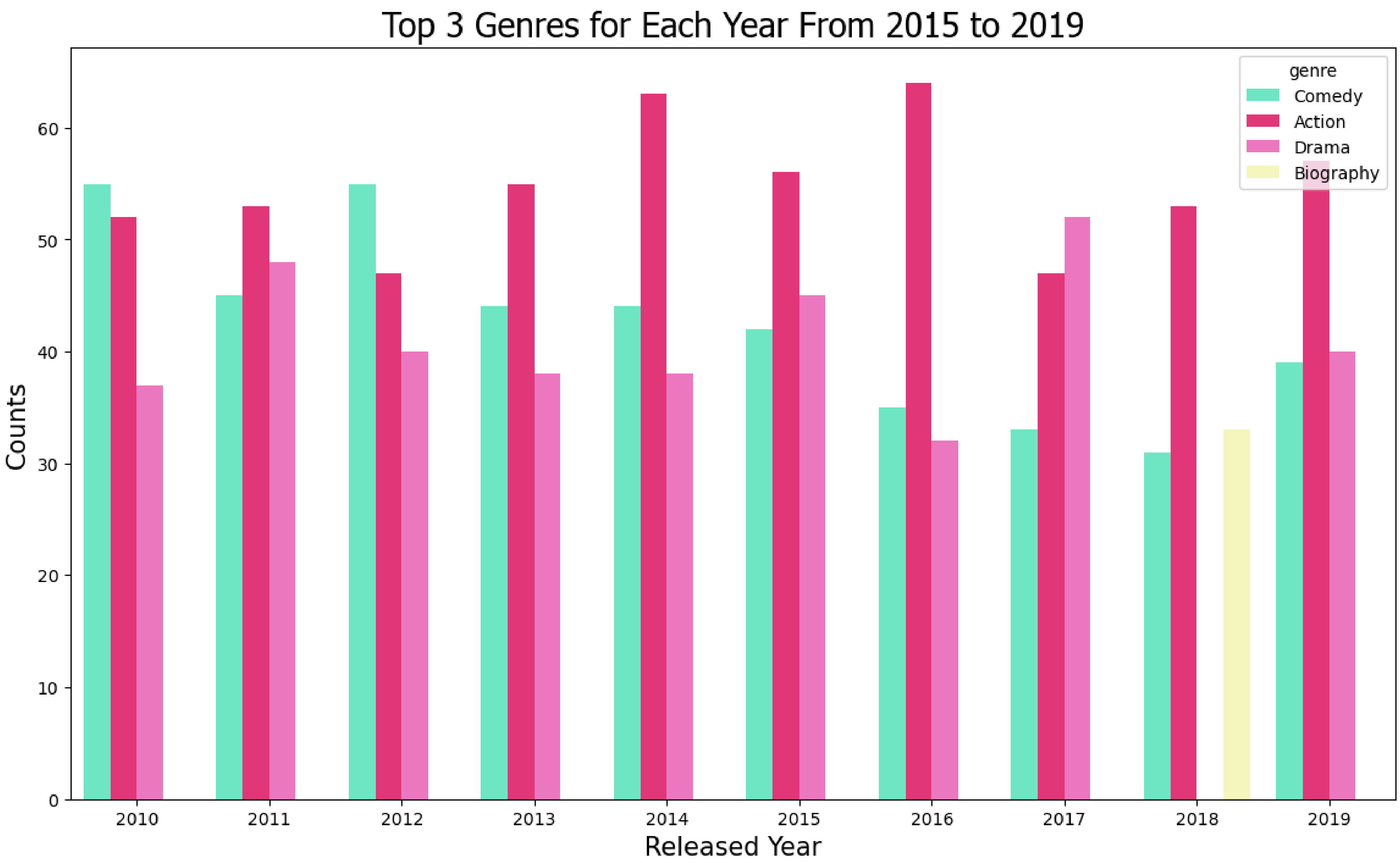
```python
year_vs_genre = dff.groupby("year", as_index=False)["genre"].value_counts()
filt = year_vs_genre.groupby("year")["count"].nlargest(3).droplevel(0).index

year_vs_genre = year_vs_genre.iloc[filt]
year_vs_genre["year"] = year_vs_genre["year"].astype(str)
year_vs_genre.head(10)
```

Out[100…

	year	genre	count
0	2010	Comedy	55
1	2010	Action	52
2	2010	Drama	37
10	2011	Action	53
11	2011	Drama	48
12	2011	Comedy	45
22	2012	Comedy	55
23	2012	Action	47
24	2012	Drama	40
31	2013	Action	55

In [101…

```python
plt.figure(figsize=(14, 8))
sns.barplot(data=year_vs_genre, x='year', y='count', hue='genre',
            palette=["#45FFCA","#FF0060","#FF55BB", "#FFFDAF"], alpha=0.89)
plt.title('Top 3 Genres for Each Year From 2015 to 2019', fontsize=20, family='tahoma')
plt.xlabel('Released Year', fontsize=15)
plt.ylabel('Counts', fontsize=15)
plt.show()
```



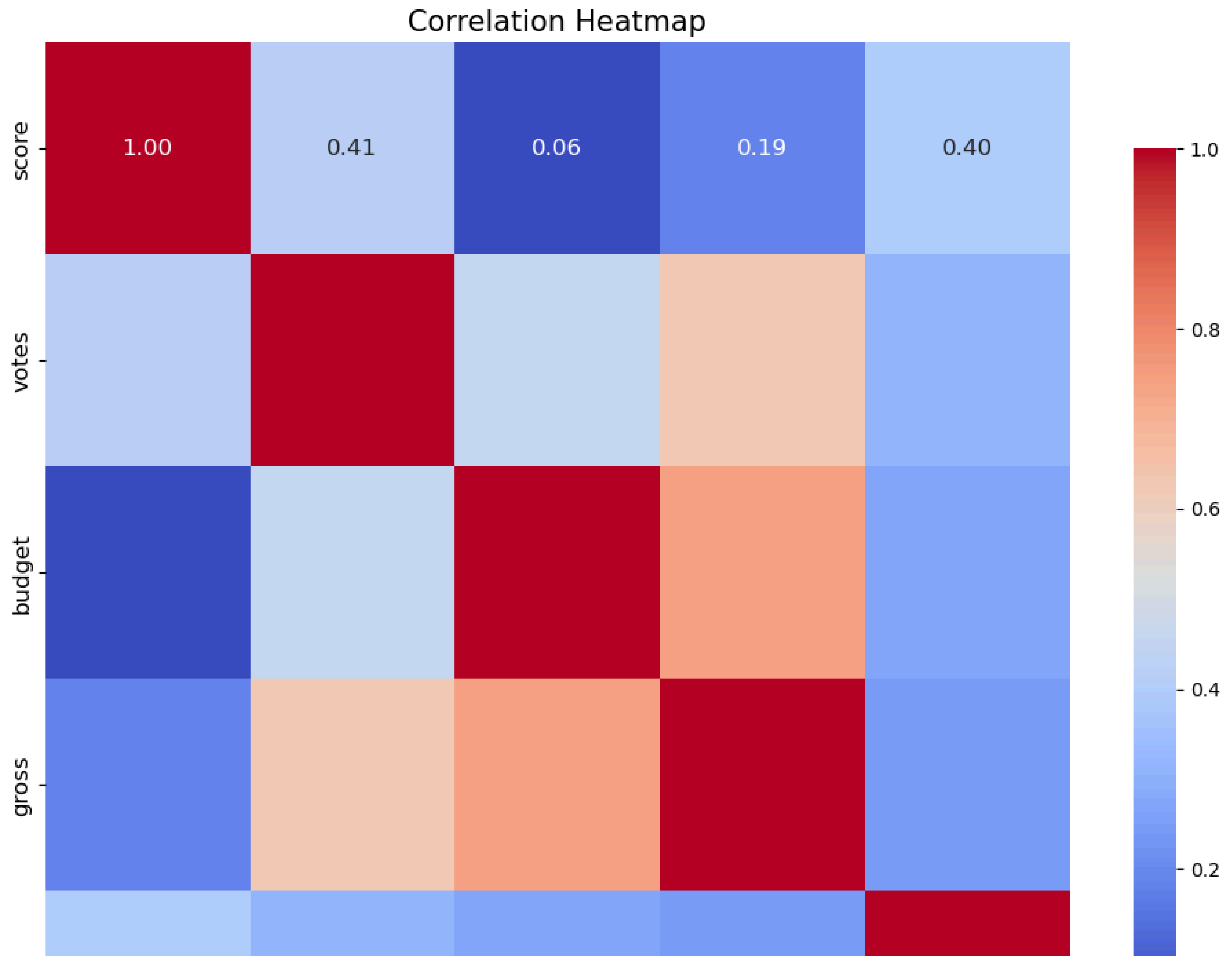
Correlation

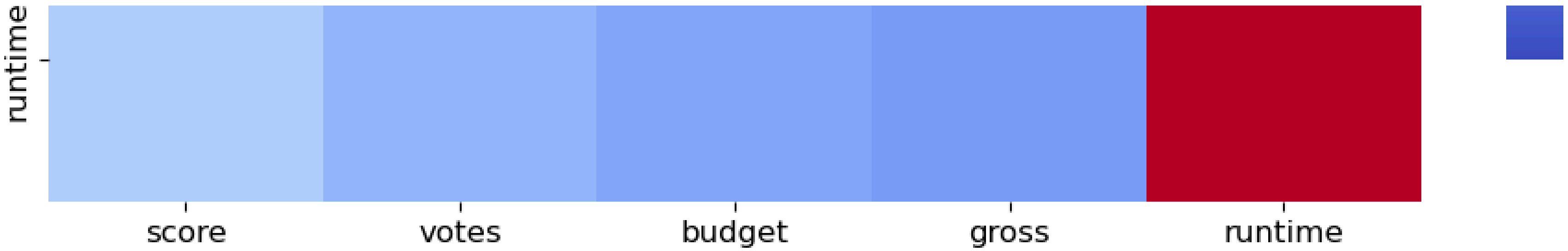
In [102…

```
df_corr = df[["score", "votes",  "budget", "gross"]]
```

In [103…

```
numeric_df = df[['score', 'votes', 'budget', 'gross', 'runtime']]

corr = numeric_df.corr()

plt.figure(figsize=(12, 10))
sns.heatmap(corr, annot=True, fmt='.2f', cmap='coolwarm', annot_kws={"size": 12}, cbar_kws={"shrink": 0.8})
plt.title('Correlation Heatmap', size=15)
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```

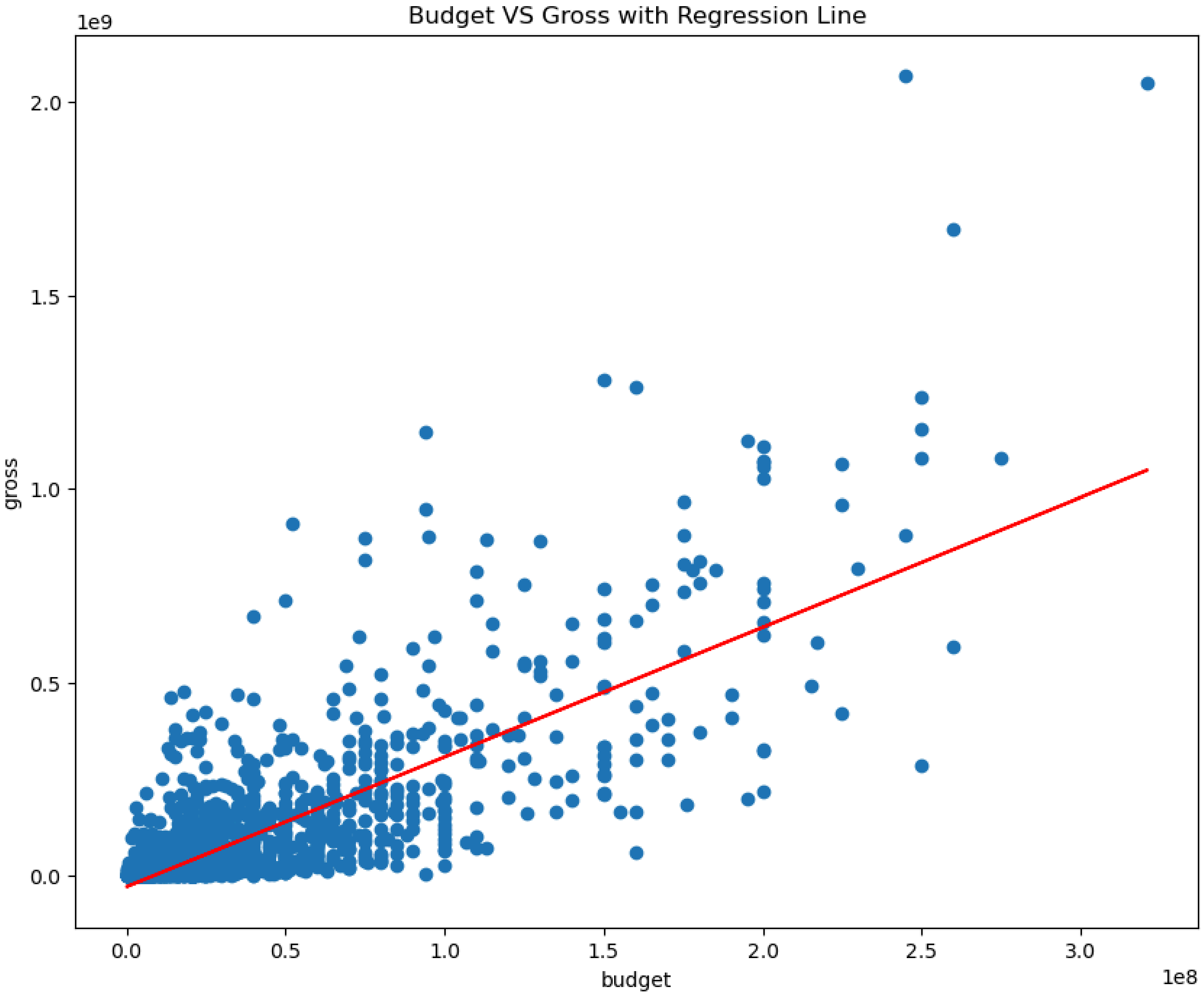

Correlation Heatmap
score
votes
budget
gross
1.00
0.41
0.06
0.19
0.40
1.0
0.8
0.6
0.4
0.2



In [104…

```
plt.figure(figsize=(10, 8))
x = df['budget'].values.reshape(-1, 1)
y = df['gross'].values

x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.3, random_state=101)

model = LinearRegression()
model.fit(x_train, y_train)

y_predicted = model.predict(x_test)

r_squared = r2_score(y_test, y_predicted)
print(f'R-squared: {round(r_squared,4)}')

rmse = mean_squared_error(y_test, y_predicted, squared =False)
print(f'Root Mean Squared Error (RMSE): {round(rmse,4)}')

plt.scatter(x_test,y_test)
plt.title('Budget VS Gross with Regression Line')
plt.xlabel("budget")
plt.ylabel("gross")
plt.plot(x_test,y_predicted, color ='red')
plt.show()
```

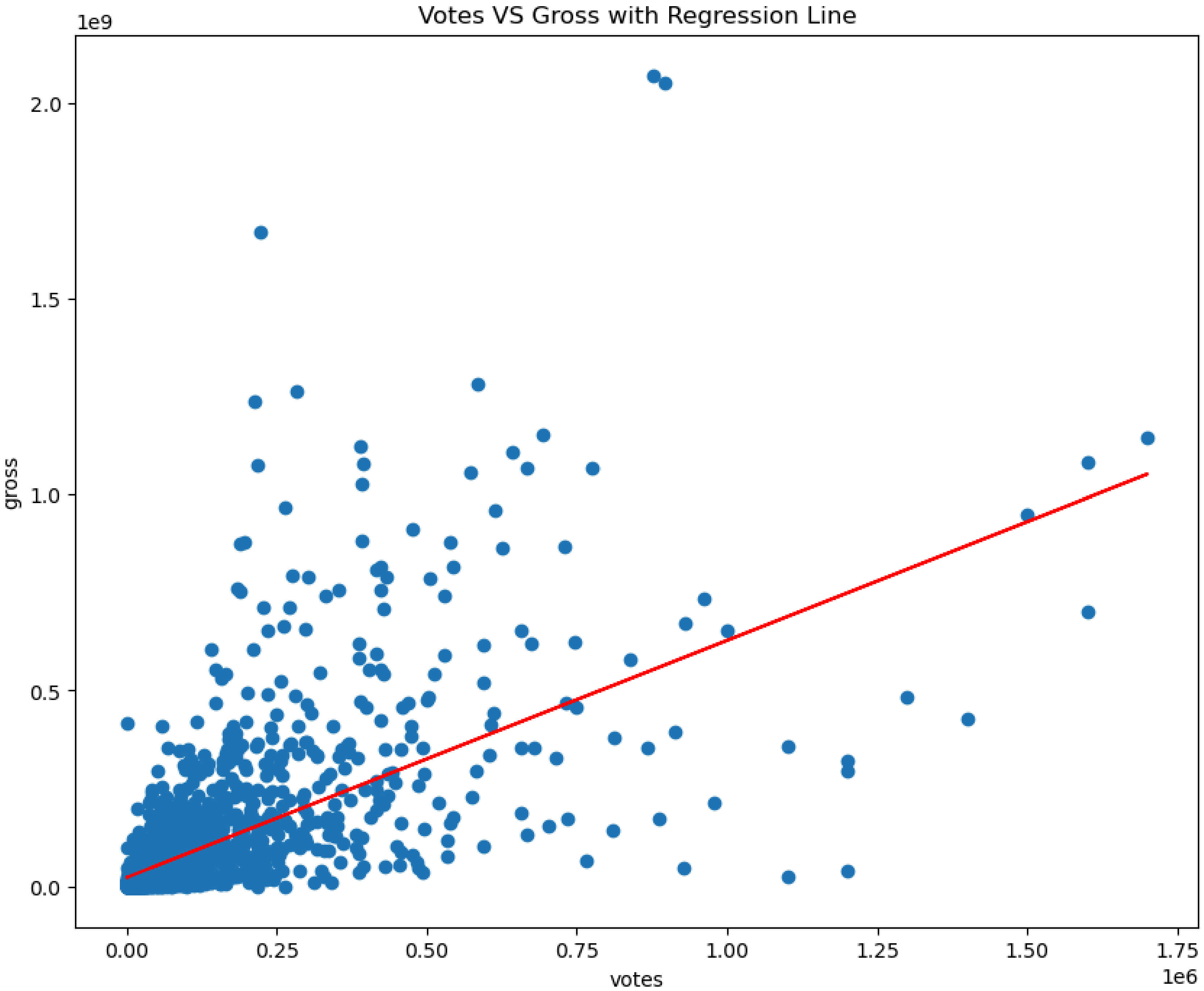
```
R-squared: 0.6165
Root Mean Squared Error (RMSE): 106403258.8573
```


Budget VS Gross with Regression Line
1e9
2.0
1.5
1.0
0.5
0.0
gross
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1e8
budget

In [105…

```
plt.figure(figsize=(10, 8))
X_votes = df['votes'].values.reshape(-1, 1)
y_gross = df['gross'].values

X_train_votes, X_test_votes, y_train_gross, y_test_gross = train_test_split(
    X_votes, y_gross, test_size=0.3, random_state=101)

model_votes = LinearRegression()
model_votes.fit(X_train_votes, y_train_gross)

y_predicted_votes = model_votes.predict(X_test_votes)

r_squared_votes = r2_score(y_test_gross, y_predicted_votes)
print(f'R-squared: {r_squared_votes:.4f}')

rmse = mean_squared_error(y_test_gross, y_predicted_votes, squared =False)
print(f'Root Mean Squared Error (RMSE): {round(rmse,4)}')

plt.scatter(X_test_votes, y_test_gross)
plt.title('Votes VS Gross with Regression Line')
plt.xlabel("votes")
plt.ylabel("gross")
plt.plot(X_test_votes, y_predicted_votes, color='red')
plt.show()
```

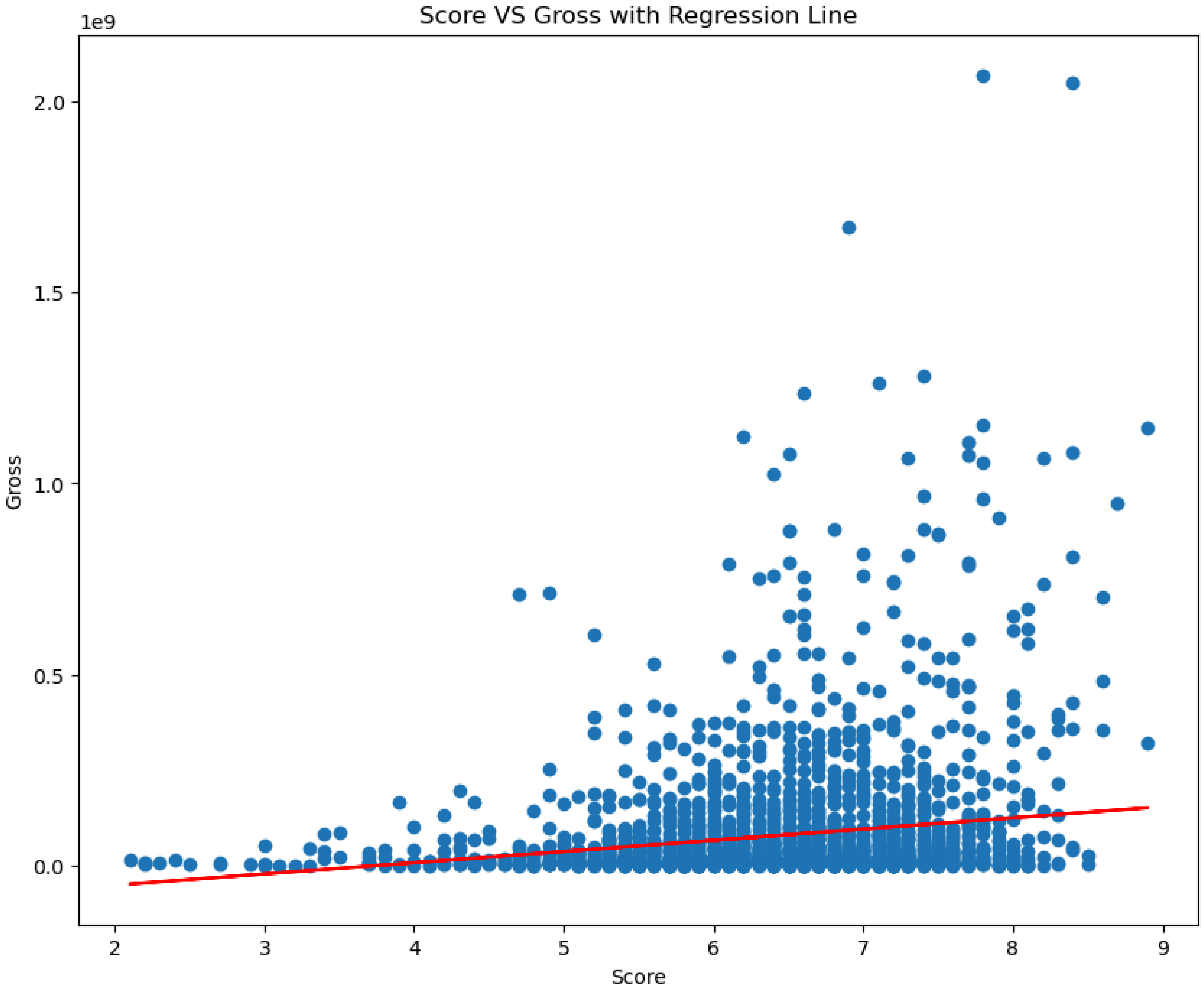
```
R-squared: 0.4342
Root Mean Squared Error (RMSE): 129238650.8175
```


Votes VS Gross with Regression Line
1e9
2.0
1.5
1.0
0.5
0.0
gross
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
votes
1e6

In [106…

```python
df = df.dropna(subset=['score', 'gross'])

X_score = df['score'].values.reshape(-1, 1)
y_gross = df['gross'].values

X_train_score, X_test_score, y_train_gross, y_test_gross = train_test_split(
    X_score, y_gross, test_size=0.3, random_state=101)

model_score = LinearRegression()
model_score.fit(X_train_score, y_train_gross)

y_predicted_score = model_score.predict(X_test_score)

r_squared_score = r2_score(y_test_gross, y_predicted_score)
rmse_score = mean_squared_error(y_test_gross, y_predicted_score, squared=False)
print(f'R-squared: {r_squared_score:.4f}')
print(f'Root Mean Squared Error (RMSE): {round(rmse_score, 4)}')

plt.figure(figsize=(10, 8))
plt.scatter(X_test_score, y_test_gross)
plt.plot(X_test_score, y_predicted_score, color='red')
plt.title('Score VS Gross with Regression Line')
plt.xlabel("Score")
plt.ylabel("Gross")
plt.show()
```

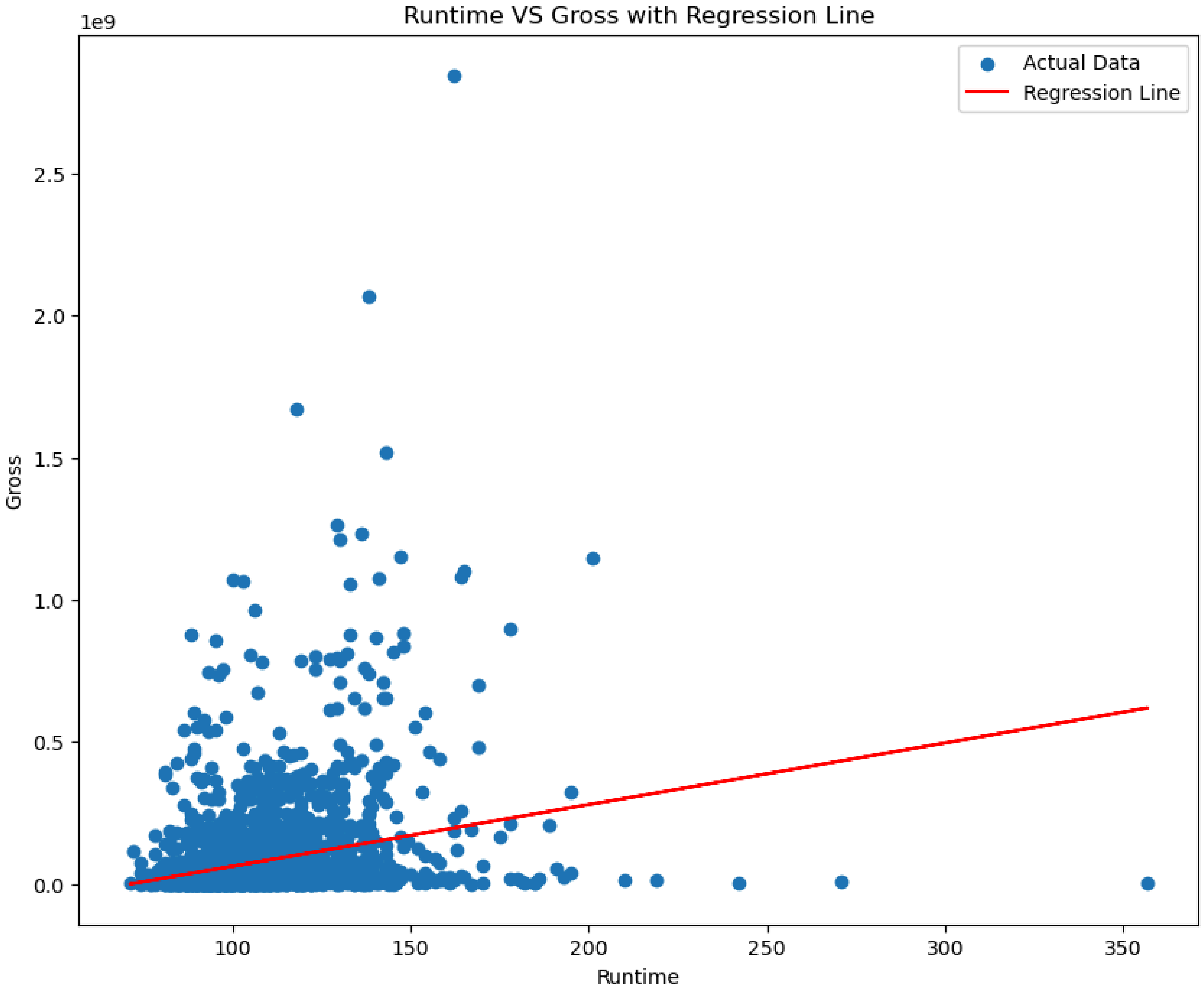
```
R-squared: 0.0409
Root Mean Squared Error (RMSE): 168261955.8808
```


Score VS Gross with Regression Line
1e9
2.0
1.5
1.0
0.5
0.0
Gross
2
3
4
5
6
7
8
9
Score

In [107…

```
df_cleaned = df.dropna(subset=['runtime', 'gross'])

X_runtime = df_cleaned['runtime'].values.reshape(-1, 1)
y_gross = df_cleaned['gross'].values

X_train_runtime, X_test_runtime, y_train_gross, y_test_gross = train_test_split(
    X_runtime, y_gross, test_size=0.3, random_state=101)

model_runtime = LinearRegression()
model_runtime.fit(X_train_runtime, y_train_gross)

y_predicted_runtime = model_runtime.predict(X_test_runtime)

r_squared_runtime = r2_score(y_test_gross, y_predicted_runtime)
rmse_runtime = mean_squared_error(y_test_gross, y_predicted_runtime, squared=False)

print(f'R-squared: {r_squared_runtime:.4f}')
print(f'Root Mean Squared Error (RMSE): {round(rmse_runtime, 4)}')

plt.figure(figsize=(10, 8))
plt.scatter(X_test_runtime, y_test_gross, label='Actual Data')
plt.plot(X_test_runtime, y_predicted_runtime, color='red', label='Regression Line')
plt.title('Runtime VS Gross with Regression Line')
plt.xlabel("Runtime")
plt.ylabel("Gross")
plt.legend()
plt.show()
```

```
R-squared: 0.0638
Root Mean Squared Error (RMSE): 166261057.7184
```


Runtime VS Gross with Regression Line
1e9
● Actual Data
Regression Line
Gross
2.5
2.0
1.5
1.0
0.5
0.0
100
150
200
250
300
350
Runtime

In [108…

```python
df_cleaned = df.dropna(subset=['budget', 'votes', 'score', 'runtime', 'gross'])

X = df_cleaned[['budget', 'votes', 'score', 'runtime']]
y = df_cleaned['gross']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=101)

model = LinearRegression()
model.fit(X_train, y_train)

y_pred = model.predict(X_test)

r_squared = r2_score(y_test, y_pred)
rmse = mean_squared_error(y_test, y_pred, squared=False)

print(f'R-squared: {r_squared:.4f}')
print(f'Root Mean Squared Error (RMSE): {round(rmse, 4)}')
```

```
R-squared: 0.6958
Root Mean Squared Error (RMSE): 94767387.124
```

Conclusions (Jungbin, Soobin)

Our analysis shows that higher budgets significantly boost a movie's gross earnings, with a strong positive correlation evident in our data. Audience engagement, measured by votes, also positively impacts financial success, highlighting the importance of effective marketing and interaction. Popular genres like comedy, action, and drama dominate the market, but exploring niche genres can capture additional audiences. The distribution of movie ratings indicates a focus on mature and teenage audiences, suggesting content should be tailored to these demographics. The film industry has grown steadily, although global events like the COVID-19 pandemic can cause disruptions. Key contributors such as prolific directors and actors play a significant role in industry trends. To ensure continued growth, investing in high-quality production, active audience engagement, and adaptable strategies is essential. Utilizing data-driven insights will help filmmakers make informed decisions and succeed in a competitive market.