PDS Final

December 22, 2024

1 Plot Twist: What Data Reveals About Gender Equity in Cinema

[315]:
```
pip install kaggle
```

```
Requirement already satisfied: kaggle in /opt/anaconda3/lib/python3.12/site-
packages (1.6.17)
Requirement already satisfied: six>=1.10 in /opt/anaconda3/lib/python3.12/site-
packages (from kaggle) (1.16.0)
Requirement already satisfied: certifi>=2023.7.22 in
/opt/anaconda3/lib/python3.12/site-packages (from kaggle) (2024.8.30)
Requirement already satisfied: python-dateutil in
/opt/anaconda3/lib/python3.12/site-packages (from kaggle) (2.9.0.post0)
Requirement already satisfied: requests in /opt/anaconda3/lib/python3.12/site-
packages (from kaggle) (2.32.3)
Requirement already satisfied: tqdm in /opt/anaconda3/lib/python3.12/site-
packages (from kaggle) (4.66.5)
Requirement already satisfied: python-slugify in
/opt/anaconda3/lib/python3.12/site-packages (from kaggle) (5.0.2)
Requirement already satisfied: urllib3 in /opt/anaconda3/lib/python3.12/site-
packages (from kaggle) (2.2.3)
Requirement already satisfied: bleach in /opt/anaconda3/lib/python3.12/site-
packages (from kaggle) (4.1.0)
Requirement already satisfied: packaging in /opt/anaconda3/lib/python3.12/site-
packages (from bleach->kaggle) (24.1)
Requirement already satisfied: webencodings in
/opt/anaconda3/lib/python3.12/site-packages (from bleach->kaggle) (0.5.1)
Requirement already satisfied: text-unidecode>=1.3 in
/opt/anaconda3/lib/python3.12/site-packages (from python-slugify->kaggle) (1.3)
Requirement already satisfied: charset-normalizer<4,>=2 in
/opt/anaconda3/lib/python3.12/site-packages (from requests->kaggle) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in
/opt/anaconda3/lib/python3.12/site-packages (from requests->kaggle) (3.7)
Note: you may need to restart the kernel to use updated packages.
```

[316]:
```
import os
os.environ['KAGGLE_CONFIG_DIR'] = '/Users/aqsa/Desktop/kaggle.json'
```

[317]:
```
!kaggle datasets download -d mehmetisik/movie-metadata -p
```

```
usage: kaggle datasets download [-h] [-f FILE_NAME] [-p PATH] [-w] [--unzip]
                                [-o] [-q]
                                [dataset]
kaggle datasets download: error: argument -p/--path: expected one argument
```

[318]:
```
import zipfile

with zipfile.ZipFile('movie-metadata.zip', 'r') as zip_ref:
    zip_ref.extractall('movie-metadata')
```

[319]:
```
import pandas as pd
df = pd.read_csv('/Users/aqsa/Desktop/movies_metadata.csv')
df.head(10)
```

[319]:

	adult	belongs_to_collection	budget	genres	homepage	id	imdb_id
0	False	{'id': 10194, 'name': 'Toy Story Collection', …	30000000	[{'id': 16, 'name': 'Animation'}, {'id': 35, '…	http://toystory.disney.com/toy-story	862	tt0114709
1	False	NaN	65000000	[{'id': 12, 'name': 'Adventure'}, {'id': 14, '…	NaN	8844	tt0113497
2	False	{'id': 119050, 'name': 'Grumpy Old Men Collect…	0	[{'id': 10749, 'name': 'Romance'}, {'id': 35, …	NaN	15602	tt0113228
3	False	NaN	16000000	[{'id': 35, 'name': 'Comedy'}, {'id': 18, 'nam…	NaN	31357	tt0114885
4	False	{'id': 96871, 'name': 'Father of the Bride Col…	0	[{'id': 35, 'name': 'Comedy'}]	NaN	11862	tt0113041
5	False	NaN	60000000	[{'id': 28, 'name': 'Action'}, {'id': 80, 'nam…	NaN	949	tt0113277
6	False	NaN	58000000	[{'id': 35, 'name': 'Comedy'}, {'id': 10749, '…	NaN	11860	tt0114319
7	False	NaN	0	[{'id': 28, 'name': 'Action'}, {'id': 12, 'nam…	NaN	45325	tt0112302
8	False	NaN	35000000	[{'id': 28, 'name': 'Action'}, {'id': 12, 'nam…	NaN	9091	tt0114576
9	False	{'id': 645, 'name': 'James Bond Collection', '…	58000000	[{'id': 12, 'name': 'Adventure'}, {'id': 28, '…	NaN	710	tt0113189

```
7                                          NaN  45325  tt0112302
8                                          NaN   9091  tt0114576
9  http://www.mgm.com/view/movie/757/Goldeneye/    710  tt0113189

  original_language              original_title  \
0                en                   Toy Story
1                en                     Jumanji
2                en            Grumpier Old Men
3                en           Waiting to Exhale
4                en  Father of the Bride Part II
5                en                        Heat
6                en                     Sabrina
7                en                Tom and Huck
8                en                Sudden Death
9                en                   GoldenEye

                                        overview  … release_date  \
0  Led by Woody, Andy's toys live happily in his …  …   1995-10-30
1  When siblings Judy and Peter discover an encha…  …   1995-12-15
2  A family wedding reignites the ancient feud be…  …   1995-12-22
3  Cheated on, mistreated and stepped on, the wom…  …   1995-12-22
4  Just when George Banks has recovered from his …  …   1995-02-10
5  Obsessive master thief, Neil McCauley leads a …  …   1995-12-15
6  An ugly duckling having undergone a remarkable…  …   1995-12-15
7  A mischievous young boy, Tom Sawyer, witnesses…  …   1995-12-22
8  International action superstar Jean Claude Van…  …   1995-12-22
9  James Bond must unmask the mysterious head of …  …   1995-11-16

       revenue runtime                                  spoken_languages  \
0  373554033.0    81.0           [{'iso_639_1': 'en', 'name': 'English'}]
1  262797249.0   104.0  [{'iso_639_1': 'en', 'name': 'English'}, {'iso…
2          0.0   101.0           [{'iso_639_1': 'en', 'name': 'English'}]
3   81452156.0   127.0           [{'iso_639_1': 'en', 'name': 'English'}]
4   76578911.0   106.0           [{'iso_639_1': 'en', 'name': 'English'}]
5  187436818.0   170.0  [{'iso_639_1': 'en', 'name': 'English'}, {'iso…
6          0.0   127.0  [{'iso_639_1': 'fr', 'name': 'Français'}, {'is…
7          0.0    97.0  [{'iso_639_1': 'en', 'name': 'English'}, {'iso…
8   64350171.0   106.0           [{'iso_639_1': 'en', 'name': 'English'}]
9  352194034.0   130.0  [{'iso_639_1': 'en', 'name': 'English'}, {'iso…

     status                                            tagline  \
0  Released                                               NaN
1  Released          Roll the dice and unleash the excitement!
2  Released  Still Yelling. Still Fighting. Still Ready for…
3  Released  Friends are the people who let you be yourself…
4  Released  Just When His World Is Back To Normal… He's …
5  Released                          A Los Angeles Crime Saga
```

```
6  Released  You are cordially invited to the most surprisi…
7  Released                              The Original Bad Boys.
8  Released                          Terror goes into overtime.
9  Released               No limits. No fears. No substitutes.

                         title  video vote_average vote_count
0                    Toy Story  False          7.7     5415.0
1                      Jumanji  False          6.9     2413.0
2             Grumpier Old Men  False          6.5       92.0
3            Waiting to Exhale  False          6.1       34.0
4  Father of the Bride Part II  False          5.7      173.0
5                         Heat  False          7.7     1886.0
6                      Sabrina  False          6.2      141.0
7                 Tom and Huck  False          5.4       45.0
8                 Sudden Death  False          5.5      174.0
9                    GoldenEye  False          6.6     1194.0

[10 rows x 24 columns]
```

Import Libraries

[320]:
```
import pandas as pd
import numpy as np
```

1.0.1 Read all of the movies on the Bechdel API (bechdeltest.com)

- I will retrieve the full movie list and the imdbid from the Bechdel API

[321]:
```
bech_df = pd.read_json('http://bechdeltest.com/api/v1/getAllMovies') #Date of␣
 ↪Retrieval: 11/27/2024
#keep in mind that these are all of the APPROVED movies submitted to the␣
 ↪database increasing the accuracy of the dataset
```

[322]:
```
bech_df.head(5)
```

[322]:
```
     imdbid  rating  year                        title    id
0   3155794       0  1874             Passage de Venus  9602
1  14495706       0  1877            La Rosace Magique  9804
2   2221420       0  1878  Sallie Gardner at a Gallop  9603
3  12592084       0  1878            Le singe musicien  9806
4   7816420       0  1881      Athlete Swinging a Pick  9816
```

[323]:
```
bech_df.tail(5)
```

[323]:
```
          imdbid  rating  year           title     id
10442  27410895       3  2024          Let go  11507
10443   9218128       1  2024    Gladiator II  11508
10444   1262426       3  2024  Wicked: Part 1  11509
```

```
 10445  31807233       2  2024       Her story  11510
 10446  24176060       1  2024           Queer  11513
```

[324]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 45466 entries, 0 to 45465
Data columns (total 24 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   adult                  45466 non-null  object
 1   belongs_to_collection  4494 non-null   object
 2   budget                 45466 non-null  object
 3   genres                 45466 non-null  object
 4   homepage               7782 non-null   object
 5   id                     45466 non-null  object
 6   imdb_id                45449 non-null  object
 7   original_language      45455 non-null  object
 8   original_title         45466 non-null  object
 9   overview               44512 non-null  object
 10  popularity             45461 non-null  object
 11  poster_path            45080 non-null  object
 12  production_companies   45463 non-null  object
 13  production_countries   45463 non-null  object
 14  release_date           45379 non-null  object
 15  revenue                45460 non-null  float64
 16  runtime                45203 non-null  float64
 17  spoken_languages       45460 non-null  object
 18  status                 45379 non-null  object
 19  tagline                20412 non-null  object
 20  title                  45460 non-null  object
 21  video                  45460 non-null  object
 22  vote_average           45460 non-null  float64
 23  vote_count             45460 non-null  float64
dtypes: float64(4), object(20)
memory usage: 8.3+ MB
```

[325]:
```
bech_df.to_csv('/Users/aqsa/Desktop/Bechdel.csv')
```

[326]:
```
print(bech_df.columns)
```

```
Index(['imdbid', 'rating', 'year', 'title', 'id'], dtype='object')
```

[327]:
```
bech_df = pd.read_csv('/Users/aqsa/Desktop/Bechdel.csv')
```

[328]:
```
bech_df.head(5)
```

[328]:

	Unnamed: 0	imdbid	rating	year	title	id
0	0	3155794.0	0	1874	Passage de Venus	9602
1	1	14495706.0	0	1877	La Rosace Magique	9804
2	2	2221420.0	0	1878	Sallie Gardner at a Gallop	9603
3	3	12592084.0	0	1878	Le singe musicien	9806
4	4	7816420.0	0	1881	Athlete Swinging a Pick	9816

[329]:
```
bech_df.shape
```

[329]: (10447, 6)

2 Data Cleaning + Integrity

2.0.1 Now that I have both datasets loaded, I am going to inspect them separately for missing/null values before I merge them.

2.0.2 BECHDEL DATA

[330]:
```
print(bech_df.isnull().sum())
```

```
Unnamed: 0    0
imdbid        2
rating        0
year          0
title         0
id            0
dtype: int64
```

[331]:
```
bech_df[bech_df['imdbid'].isnull()]
```

[331]:

	Unnamed: 0	imdbid	rating	year	title	id
5852	5852	NaN	1	2008	Machan	11315
10403	10403	NaN	3	2024	A Little Family Drama	11379

Since there are only two values i went ahead and looked them up on imdb myself to replace the null values with actual values

[332]:
```
bech_df.loc[bech_df['title'] == 'Machan', 'imdbid'] = 1172522
bech_df.loc[bech_df['title'] == 'A Little Family Drama', 'imdbid'] = 21337754
print(bech_df.isnull().sum())
```

```
Unnamed: 0    0
imdbid        0
rating        0
year          0
title         0
id            0
dtype: int64
```

2.1 MOVIE DATA

[333]:
```
df.columns
```

[333]:
```
Index(['adult', 'belongs_to_collection', 'budget', 'genres', 'homepage', 'id',
       'imdb_id', 'original_language', 'original_title', 'overview',
       'popularity', 'poster_path', 'production_companies',
       'production_countries', 'release_date', 'revenue', 'runtime',
       'spoken_languages', 'status', 'tagline', 'title', 'video',
       'vote_average', 'vote_count'],
      dtype='object')
```

[334]:
```
df.shape
```

[334]:
```
(45466, 24)
```

[335]:
```
df.head(2)
```

[335]:

	adult	belongs_to_collection	budget	genres	homepage	id	imdb_id	original_language	original_title	overview	…	release_date	revenue	runtime	spoken_languages	status	tagline	title	video	vote_average	vote_count
0	False	{'id': 10194, 'name': 'Toy Story Collection', …	30000000	[{'id': 16, 'name': 'Animation'}, {'id': 35, '…	http://toystory.disney.com/toy-story	862	tt0114709	en	Toy Story	Led by Woody, Andy's toys live happily in his …	…	1995-10-30	373554033.0	81.0	[{'iso_639_1': 'en', 'name': 'English'}]	Released	NaN	Toy Story	False	7.7	5415.0
1	False	NaN	65000000	[{'id': 12, 'name': 'Adventure'}, {'id': 14, '…	NaN	8844	tt0113497	en	Jumanji	When siblings Judy and Peter discover an encha…	…	1995-12-15	262797249.0	104.0	[{'iso_639_1': 'en', 'name': 'English'}, {'iso…	Released	Roll the dice and unleash the excitement!	Jumanji	False	6.9	

```
1     2413.0

[2 rows x 24 columns]
```

[336]:
```
print(df.isnull().sum())
```

```
adult                        0
belongs_to_collection    40972
budget                       0
genres                       0
homepage                 37684
id                           0
imdb_id                     17
original_language           11
original_title               0
overview                   954
popularity                   5
poster_path                386
production_companies         3
production_countries         3
release_date                87
revenue                      6
runtime                    263
spoken_languages             6
status                      87
tagline                  25054
title                        6
video                        6
vote_average                 6
vote_count                   6
dtype: int64
```

I am going to reduce the amount of features i have to work with by dropping columns that do not add any value to my analysis

[337]:
```
df= df.drop(columns=['belongs_to_collection', 'homepage'])
```

[338]:
```
df= df.drop(columns=['overview', 'poster_path'])
```

[339]:
```
df= df.drop(columns= 'tagline')
```

[340]:
```
print(df.isnull().sum())
```

```
adult                    0
budget                   0
genres                   0
id                       0
imdb_id                 17
original_language       11
```

```
original_title            0
popularity                5
production_companies      3
production_countries      3
release_date             87
revenue                   6
runtime                 263
spoken_languages          6
status                   87
title                     6
video                     6
vote_average              6
vote_count                6
dtype: int64
```

2.1.1 Summary of data cleaning still to be implemented:

- IMDB_ID - since there are only 17/45,000 movies that do not have an id, I am going to drop these null valuessince the make up a small number from my sample and the imdb_id is a critical feature for my merge with the bechdel dataset
- release_date - going to set the null values as "unknown", i am going to extract the year from this column later in my analysis
- runtime - replace with the 'unknown' value
- production_* - fill the 6 values with 'unknown'

[341]:
```
print(type(df))  # This was outputting nonetype before
```

```
<class 'pandas.core.frame.DataFrame'>
```

[342]:
```
df = df[df['imdb_id'].notnull()]
df['release_date'].fillna("Unknown", inplace=True)
df['runtime'].fillna("Unknown", inplace=True)
df['production_companies'].fillna("Unknown", inplace=True)
df['production_countries'].fillna("Unknown", inplace=True)
```

[343]:
```
print(df.isnull().sum())
```

```
adult                    0
budget                   0
genres                   0
id                       0
imdb_id                  0
original_language       11
original_title           0
popularity               5
production_companies     0
production_countries     0
release_date             0
revenue                  6
```

```
runtime                 0
spoken_languages        6
status                 87
title                   6
video                   6
vote_average            6
vote_count              6
dtype: int64
```

So these values where spoken_language is null are showing quite a few empty/null/0 values in other columns like production_countries, production_companies, and release_date. I am going to remove those values from the dataset as I would like to examine them further.

[344]:
```
df[df['spoken_languages'].isnull()]
```

[344]:

```
                                                  adult  \
19729                                             False
19730                                - Written by Ørnås
29502                                             False
29503   Rune Balot goes to a casino connected to the …
35586                                             False
35587   Avalanche Sharks tells the story of a bikini …

                                budget  \
19729                                0
19730  /ff9qCepilowshEtG2GYWwzt2bs4.jpg
29502                                0
29503  /zV8bHuSL6WXoD6FWogP9j4x80bL.jpg
35586                                0
35587  /zaSf5OG7V8X8gqFvly88zDdRm46.jpg

                                                  genres          id  \
19729  [{'id': 28, 'name': 'Action'}, {'id': 53, 'nam…       82663
19730  [{'name': 'Carousel Productions', 'id': 11176}…  1997-08-20
29502  [{'id': 16, 'name': 'Animation'}, {'id': 878, …      122662
29503  [{'name': 'Aniplex', 'id': 2883}, {'name': 'Go…  2012-09-29
35586  [{'id': 10770, 'name': 'TV Movie'}, {'id': 28,…      249260
35587  [{'name': 'Odyssey Media', 'id': 17161}, {'nam…  2014-01-01

         imdb_id original_language                              original_title  \
19729  tt0113002                en                                 Midnight Man
19730          0             104.0  [{'iso_639_1': 'en', 'name': 'English'}]
29502  tt2423504                ja
29503          0              68.0      [{'iso_639_1': 'ja', 'name': '  '}]
35586  tt2622826                en                             Avalanche Sharks
35587          0              82.0  [{'iso_639_1': 'en', 'name': 'English'}]

                popularity production_companies production_countries  \
```

```
19729                    NaN             Unknown              Unknown
19730                    NaN               False                  6.0
29502                    NaN             Unknown              Unknown
29503                    NaN               False                  7.0
35586                    NaN             Unknown              Unknown
35587  Beware Of Frost Bites               False                  4.3

      release_date  revenue  runtime spoken_languages status title video  \
19729      Unknown      NaN  Unknown               NaN    NaN   NaN   NaN
19730            1      NaN  Unknown               NaN    NaN   NaN   NaN
29502      Unknown      NaN  Unknown               NaN    NaN   NaN   NaN
29503           12      NaN  Unknown               NaN    NaN   NaN   NaN
35586      Unknown      NaN  Unknown               NaN    NaN   NaN   NaN
35587           22      NaN  Unknown               NaN    NaN   NaN   NaN

       vote_average  vote_count
19729           NaN         NaN
19730           NaN         NaN
29502           NaN         NaN
29503           NaN         NaN
35586           NaN         NaN
35587           NaN         NaN
```

[345]:
```
df = df.dropna(subset=['spoken_languages'])
```

[346]:
```
print(df.isnull().sum())
```

```
adult                     0
budget                    0
genres                    0
id                        0
imdb_id                   0
original_language        11
original_title            0
popularity                0
production_companies      0
production_countries      0
release_date              0
revenue                   0
runtime                   0
spoken_languages          0
status                   81
title                     0
video                     0
vote_average              0
vote_count                0
dtype: int64
```

[347]:
```
df['status'].nunique()
df['status'].value_counts()
```

[347]:
```
status
Released            44999
Rumored               228
Post Production        98
In Production          20
Planned                15
Canceled                2
Name: count, dtype: int64
```

So after examining this feature I want to get rid of all of the types of 'status' the film could have since the bechdel dataset has purely released movies (you can only apply the test on a completed movie anyway!) so I will go ahead and delete all the values and only keep the rows that have 'status' = to 'released'

[348]:
```
df = df[df['status'] == 'Released']
```

[349]:
```
df['status'].nunique()
df['status'].value_counts()
```

[349]:
```
status
Released    44999
Name: count, dtype: int64
```

[350]:
```
df[df['original_language'].isnull()]
```

[350]:

	adult	budget	genres	\
19574	False	0	[{'id': 99, 'name': 'Documentary'}]	
21602	False	0	[{'id': 10749, 'name': 'Romance'}, {'id': 18, …	
22832	False	0	[{'id': 10752, 'name': 'War'}, {'id': 37, 'nam…	
32141	False	0	[{'id': 35, 'name': 'Comedy'}]	
37407	False	0	[{'id': 16, 'name': 'Animation'}]	
41047	False	0	[{'id': 99, 'name': 'Documentary'}]	
41872	False	0	[{'id': 99, 'name': 'Documentary'}]	
44057	False	0	[{'id': 18, 'name': 'Drama'}]	
44410	False	0	[{'id': 16, 'name': 'Animation'}, {'id': 99, '…	
44576	False	0	[]	

	id	imdb_id	original_language	original_title	\
19574	283101	tt0429086	NaN	Shadowing the Third Man	
21602	103902	tt0838231	NaN	Unfinished Sky	
22832	359195	tt0053558	NaN	13 Fighting Men	
32141	147050	tt0122580	NaN	Lambchops	
37407	257095	tt0225145	NaN	Bajaja	
41047	332742	tt4432912	NaN	Song of Lahore	
41872	144410	tt0154152	NaN	Annabelle Serpentine Dance	

```
44057  380438  tt0298411              NaN       Lettre d'une inconnue
44410  381096  tt5333518              NaN                        Garn
44576  381525  tt5376720              NaN                      WiNWiN

      popularity                                production_companies  \
19574   0.017007  [{'name': 'StudioCanal', 'id': 694}, {'name': …
21602   0.359818  [{'name': 'New Holland Pictures', 'id': 10229}…
22832   0.070647  [{'name': 'Associated Producers (API)', 'id': …
32141   0.073418  [{'name': 'Warner Bros.', 'id': 6194}, {'name'…
37407   0.036841  [{'name': 'Ceskoslovenský Státní Film', 'id': …
41047   0.373688                                                []
41872    1.58434  [{'name': 'Edison Manufacturing Company', 'id'…
44057   0.001283                                                []
44410   0.067624                                                []
44576   0.030766                                                []

                                production_countries release_date  \
19574  [{'iso_3166_1': 'AT', 'name': 'Austria'}, {'is…   2004-10-11
21602       [{'iso_3166_1': 'AU', 'name': 'Australia'}]   2007-08-04
22832  [{'iso_3166_1': 'US', 'name': 'United States o…   1960-03-31
32141  [{'iso_3166_1': 'US', 'name': 'United States o…   1929-10-31
37407   [{'iso_3166_1': 'CZ', 'name': 'Czech Republic'}]   1950-01-26
41047                                                []   2015-11-13
41872  [{'iso_3166_1': 'US', 'name': 'United States o…   1895-04-01
44057          [{'iso_3166_1': 'FR', 'name': 'France'}]   2001-01-01
44410                                                []   2016-03-12
44576         [{'iso_3166_1': 'AT', 'name': 'Austria'}]   2016-01-27

       revenue runtime                                   spoken_languages  \
19574      0.0    95.0  [{'iso_639_1': 'de', 'name': 'Deutsch'}, {'iso…
21602      0.0    94.0           [{'iso_639_1': 'en', 'name': 'English'}]
22832      0.0    69.0           [{'iso_639_1': 'en', 'name': 'English'}]
32141      0.0     8.0           [{'iso_639_1': 'en', 'name': 'English'}]
37407      0.0    87.0             [{'iso_639_1': 'cs', 'name': 'Český'}]
41047      0.0    82.0  [{'iso_639_1': 'ur', 'name': '  '{, {'iso_63…
41872      0.0     1.0       [{'iso_639_1': 'xx', 'name': 'No Language'}]
44057      0.0     0.0          [{'iso_639_1': 'fr', 'name': 'Français'}]
44410      0.0    76.0  [{'iso_639_1': 'sv', 'name': 'svenska'}, {'iso…
44576      0.0    84.0  [{'iso_639_1': 'de', 'name': 'Deutsch'}, {'iso…

         status                      title  video  vote_average  vote_count
19574  Released     Shadowing the Third Man  False           0.0         0.0
21602  Released               Unfinished Sky  False           6.4         8.0
22832  Released             13 Fighting Men  False           0.0         0.0
32141  Released                   Lambchops  False           6.5         2.0
37407  Released                Prince Bayaya  False           5.0         1.0
41047  Released               Song of Lahore  False           6.5         2.0
```

```
41872  Released  Annabelle Serpentine Dance  False           5.7        20.0
44057  Released       Lettre d'une inconnue  False           0.0         0.0
44410  Released                        Yarn  False           0.0         0.0
44576  Released                      WiNWiN  False           0.0         0.0
```

The null values for original_language seem to have quite a few instances of null/none values in other columns like revenue and vote_average which are both two features i will examine in my work so I am going to delete these ten null values.

[351]:
```
df = df.dropna(subset='original_language')
```

[352]:
```
df.isnull().sum()
```

[352]:
```
adult                    0
budget                   0
genres                   0
id                       0
imdb_id                  0
original_language        0
original_title           0
popularity               0
production_companies     0
production_countries     0
release_date             0
revenue                  0
runtime                  0
spoken_languages         0
status                   0
title                    0
video                    0
vote_average             0
vote_count               0
dtype: int64
```

2.2 I am going to prepare for the merge and need to examine the imdb_id for both datasets to make sure things are consistent and I do not run into any issues

[353]:
```
bech_df['imdbid'].dtypes
bech_df["imdbid"]
```

[353]:
```
0         3155794.0
1        14495706.0
2         2221420.0
3        12592084.0
4         7816420.0
             ...
10442    27410895.0
```

```
10443     9218128.0
10444     1262426.0
10445    31807233.0
10446    24176060.0
Name: imdbid, Length: 10447, dtype: float64
```

[354]:
```
df['imdb_id'].dtypes
df["imdb_id"]
```

[354]:
```
0        tt0114709
1        tt0113497
2        tt0113228
3        tt0114885
4        tt0113041
            …
45461    tt6209470
45462    tt2028550
45463    tt0303758
45464    tt0008536
45465    tt6980792
Name: imdb_id, Length: 44989, dtype: object
```

As expected, one of the ids is an object and the other is a float. I am going to create consistency by getting rid of the 'tt' prefix and then going in and changing the datatype before the merge.

[355]:
```
df['imdb_id'] = df['imdb_id'].str.lstrip('t0')
```

[356]:
```
df["imdb_id"]
```

[356]:
```
0         114709
1         113497
2         113228
3         114885
4         113041
            …
45461    6209470
45462    2028550
45463     303758
45464       8536
45465    6980792
Name: imdb_id, Length: 44989, dtype: object
```

[357]:
```
# this makes sure that 'imdbid' and 'imdb_id' are strings for consistency
df['imdb_id'] = df['imdb_id'].astype(str)
bech_df['imdbid'] = bech_df['imdbid'].astype(str)
```

[358]:
```
print(bech_df['imdbid'].dtypes)
print(df['imdb_id'].dtypes)
```

```
object
object
```

Lastly, i will rename the columns to the same name

[359]:
```
bech_df.rename(columns={"imdbid": "imdb_id"}, inplace=True)
```

[360]:
```
bech_df['imdb_id'] = bech_df['imdb_id'].str.replace(r'\.0$', '', regex=True)
```

[361]:
```
print(df.shape)
print(bech_df.shape)
```

```
(44989, 19)
(10447, 6)
```

[362]:
```
bech_df.head(3)
```

[362]:

	Unnamed: 0	imdb_id	rating	year	title	id
0	0	3155794	0	1874	Passage de Venus	9602
1	1	14495706	0	1877	La Rosace Magique	9804
2	2	2221420	0	1878	Sallie Gardner at a Gallop	9603

2.2.1 Movie Dataset:

- original data: (45466, 24)
- cleaned data: (44989, 19)

2.2.2 Bechdel Dataset:

- original dataset had the same amount of values with two null imdb ids that I manually filled in!

I was able to keep majority of the dataset which is great as I move forward with more analysis.

Now, that I have things cleaned up, I am going to merge the two csv files together!

3 Merging of Datasets - inner join

[363]:
```
df_merged = df.merge(bech_df, how='inner', on='imdb_id')
```

[364]:
```
df_merged.head(20)
```

[364]:

	adult	budget	genres	id_x	\
0	False	30000000	[{'id': 16, 'name': 'Animation'}, {'id': 35, '…	862	
1	False	65000000	[{'id': 12, 'name': 'Adventure'}, {'id': 14, '…	8844	
2	False	0	[{'id': 10749, 'name': 'Romance'}, {'id': 35, …	15602	
3	False	16000000	[{'id': 35, 'name': 'Comedy'}, {'id': 18, 'nam…	31357	
4	False	60000000	[{'id': 28, 'name': 'Action'}, {'id': 80, 'nam…	949	
5	False	58000000	[{'id': 35, 'name': 'Comedy'}, {'id': 10749, '…	11860	
6	False	58000000	[{'id': 12, 'name': 'Adventure'}, {'id': 28, '…	710	

```
7   False  62000000  [{'id': 35, 'name': 'Comedy'}, {'id': 18, 'nam…   9087
8   False         0  [{'id': 35, 'name': 'Comedy'}, {'id': 27, 'nam…  12110
9   False         0  [{'id': 10751, 'name': 'Family'}, {'id': 16, '…  21032
10  False  98000000  [{'id': 28, 'name': 'Action'}, {'id': 12, 'nam…   1408
11  False  52000000  [{'id': 18, 'name': 'Drama'}, {'id': 80, 'name…    524
12  False  16500000  [{'id': 18, 'name': 'Drama'}, {'id': 10749, 'n…   4584
13  False   4000000  [{'id': 80, 'name': 'Crime'}, {'id': 35, 'name…      5
14  False  30000000  [{'id': 80, 'name': 'Crime'}, {'id': 35, 'name…   9273
15  False         0  [{'id': 18, 'name': 'Drama'}, {'id': 53, 'name…   1710
16  False  50000000  [{'id': 28, 'name': 'Action'}, {'id': 12, 'nam…   9691
17  False   3600000  [{'id': 18, 'name': 'Drama'}, {'id': 10749, 'n…    451
18  False         0                      [{'id': 18, 'name': 'Drama'}]  16420
19  False  12000000  [{'id': 35, 'name': 'Comedy'}, {'id': 18, 'nam…   9263

   imdb_id original_language                original_title popularity  \
0   114709                en                     Toy Story  21.946943
1   113497                en                       Jumanji  17.015539
2   113228                en              Grumpier Old Men    11.7129
3   114885                en             Waiting to Exhale   3.859495
4   113277                en                          Heat  17.924927
5   114319                en                       Sabrina   6.677277
6   113189                en                      GoldenEye  14.686036
7   112346                en       The American President   6.318445
8   112896                en   Dracula: Dead and Loving It   5.430331
9   112453                en                         Balto  12.140733
10  112760                en              Cutthroat Island   7.284477
11  112641                en                        Casino  10.137389
12  114388                en         Sense and Sensibility  10.673167
13  113101                en                   Four Rooms   9.026586
14  112281                en  Ace Ventura: When Nature Calls   8.205448
15  112722                en                       Copycat  10.701801
16  112401                en                      Assassins  11.065939
17  113627                en             Leaving Las Vegas  10.332025
18  114057                en                       Othello   1.845899
19  114011                en                  Now and Then   8.681325

                              production_companies  \
0      [{'name': 'Pixar Animation Studios', 'id': 3}]
1   [{'name': 'TriStar Pictures', 'id': 559}, {'na…
2   [{'name': 'Warner Bros.', 'id': 6194}, {'name'…
3   [{'name': 'Twentieth Century Fox Film Corporat…
4   [{'name': 'Regency Enterprises', 'id': 508}, {…
5   [{'name': 'Paramount Pictures', 'id': 4}, {'na…
6   [{'name': 'United Artists', 'id': 60}, {'name'…
7   [{'name': 'Columbia Pictures', 'id': 5}, {'nam…
8   [{'name': 'Columbia Pictures', 'id': 5}, {'nam…
9   [{'name': 'Universal Pictures', 'id': 33}, {'n…
```

```
10  [{'name': 'Le Studio Canal+', 'id': 183}, {'na…
11  [{'name': 'Universal Pictures', 'id': 33}, {'n…
12  [{'name': 'Columbia Pictures Corporation', 'id…
13  [{'name': 'Miramax Films', 'id': 14}, {'name':…
14  [{'name': 'O Entertainment', 'id': 5682}, {'na…
15  [{'name': 'Regency Enterprises', 'id': 508}, {…
16  [{'name': 'Silver Pictures', 'id': 1885}, {'na…
17  [{'name': 'United Artists', 'id': 60}, {'name'…
18  [{'name': 'Columbia Pictures', 'id': 5}, {'nam…
19            [{'name': 'New Line Cinema', 'id': 12}]

                                production_countries  …    status  \
0   [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
1   [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
2   [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
3   [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
4   [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
5   [{'iso_3166_1': 'DE', 'name': 'Germany'}, {'is…  …  Released
6   [{'iso_3166_1': 'GB', 'name': 'United Kingdom'…  …  Released
7   [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
8   [{'iso_3166_1': 'FR', 'name': 'France'}, {'iso…  …  Released
9   [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
10  [{'iso_3166_1': 'FR', 'name': 'France'}, {'iso…  …  Released
11  [{'iso_3166_1': 'FR', 'name': 'France'}, {'iso…  …  Released
12  [{'iso_3166_1': 'GB', 'name': 'United Kingdom'…  …  Released
13  [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
14  [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
15  [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
16  [{'iso_3166_1': 'FR', 'name': 'France'}, {'iso…  …  Released
17  [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released
18            [{'iso_3166_1': 'IT', 'name': 'Italy'}]  …  Released
19  [{'iso_3166_1': 'US', 'name': 'United States o…  …  Released

                          title_x  video vote_average vote_count Unnamed: 0  \
0                       Toy Story  False          7.7     5415.0       3171
1                         Jumanji  False          6.9     2413.0       3234
2                Grumpier Old Men  False          6.5       92.0       3291
3               Waiting to Exhale  False          6.1       34.0       3280
4                            Heat  False          7.7     1886.0       3201
5                         Sabrina  False          6.2      141.0       3208
6                        GoldenEye  False          6.6     1194.0       3256
7          The American President  False          6.5      199.0       3233
8     Dracula: Dead and Loving It  False          5.7      210.0       3245
9                           Balto  False          7.1      423.0       3199
10               Cutthroat Island  False          5.7      137.0       3292
11                         Casino  False          7.8     1343.0       3213
12          Sense and Sensibility  False          7.2      364.0       3180
```

```
13                      Four Rooms  False          6.5      539.0       3197
14  Ace Ventura: When Nature Calls  False          6.1     1128.0       3250
15                         Copycat  False          6.5      199.0       3211
16                       Assassins  False          6.0      394.0       3239
17                Leaving Las Vegas  False          7.1      365.0       3277
18                         Othello  False          7.0       33.0       3257
19                     Now and Then  False          6.6       91.0       3191

   rating  year                          title_y   id_y
0       1  1995                        Toy Story     87
1       3  1995                          Jumanji   3801
2       3  1995                 Grumpier Old Men  10697
3       2  1995                Waiting To Exhale   9104
4       2  1995                             Heat   1037
5       3  1995                          Sabrina   1643
6       3  1995                         GoldenEye   6251
7       3  1995          American President, The   3684
8       3  1995      Dracula: Dead and Loving It   5084
9       2  1995                            Balto   1031
10      1  1995                 Cutthroat Island  10715
11      2  1995                           Casino   2220
12      3  1995            Sense and Sensibility    267
13      3  1995                       Four rooms    986
14      0  1995  Ace Ventura: When Nature Calls   5710
15      3  1995                           Copycat   2100
16      1  1995                         Assassins   4640
17      2  1995                Leaving Las Vegas   8923
18      2  1995                           Othello   6544
19      3  1995                       Now and Then    897

[20 rows x 24 columns]
```

[365]:
```
df_merged.shape
```

[365]:
```
(7965, 24)
```

[366]:
```
df_merged.drop(columns='release_date', inplace=True)
```

[367]:
```
df_merged.drop(columns='spoken_languages', inplace=True)
```

[368]:
```
import ast


def extract_names(column):
    return column.apply(lambda x: ', '.join([item['name'] for item in ast.
 ↪literal_eval(x)]))
```

```
df_merged['genres'] = extract_names(df_merged['genres'])
df_merged['production_countries'] =␣
 ↪extract_names(df_merged['production_countries'])
```

[369]:
```
import ast

def extract_names(column):
    return column.apply(lambda x: ', '.join([item['name'] for item in ast.
 ↪literal_eval(x)]))

df_merged['production_companies'] =␣
 ↪extract_names(df_merged['production_companies'])
```

Created a list of names instead of string so that I can use then in my analysis later

[370]:
```
def split_string(column):
    """Split strings into lists by comma and clean whitespace."""
    return column.apply(lambda x: x.split(', ') if pd.notna(x) else [])

df_merged['genres'] = split_string(df_merged['genres'])
df_merged['production_countries'] =␣
 ↪split_string(df_merged['production_countries'])
df_merged['production_companies'] =␣
 ↪extract_names(df_merged['production_companies'])
```

```
Traceback (most recent call last):

  File /opt/anaconda3/lib/python3.12/site-packages/IPython/core/interactiveshel
 ↪py:3577 in run_code
    exec(code_obj, self.user_global_ns, self.user_ns)

  Cell In[370], line 8
    df_merged['production_companies'] =␣
 ↪extract_names(df_merged['production_companies'])

  Cell In[369], line 5 in extract_names
    return column.apply(lambda x: ', '.join([item['name'] for item in ast.
 ↪literal_eval(x)]))

  File /opt/anaconda3/lib/python3.12/site-packages/pandas/core/series.py:4924 i
 ↪apply
    ).apply()

  File /opt/anaconda3/lib/python3.12/site-packages/pandas/core/apply.py:1427 in
 ↪apply
    return self.apply_standard()
```

```
  File /opt/anaconda3/lib/python3.12/site-packages/pandas/core/apply.py:1507 in
↪apply_standard
    mapped = obj._map_values(

  File /opt/anaconda3/lib/python3.12/site-packages/pandas/core/base.py:921 in␣
↪_map_values
    return algorithms.map_array(arr, mapper, na_action=na_action,␣
↪convert=convert)

  File /opt/anaconda3/lib/python3.12/site-packages/pandas/core/algorithms.py:
↪1743 in map_array
    return lib.map_infer(values, mapper, convert=convert)

  File lib.pyx:2972 in pandas._libs.lib.map_infer

  Cell In[369], line 5 in <lambda>
    return column.apply(lambda x: ', '.join([item['name'] for item in ast.
↪literal_eval(x)]))

  File /opt/anaconda3/lib/python3.12/ast.py:66 in literal_eval
    node_or_string = parse(node_or_string.lstrip(" \t"), mode='eval')

  File /opt/anaconda3/lib/python3.12/ast.py:52 in parse
    return compile(source, filename, mode, flags,

  File <unknown>:1
    Pixar Animation Studios
          ^
SyntaxError: invalid syntax
```

[ ]:
```
df_merged.drop(columns=['title_x', 'video','Unnamed: 0', 'id_y'], inplace=True)
```

[371]:
```
df_merged.head(2)
```

[371]:

	adult	budget	genres	id_x	imdb_id	original_language	original_title	popularity	production_companies
0	False	30000000	[Animation, Comedy, Family]	862	114709	en	Toy Story	21.946943	Pixar Animation Studios
1	False	65000000	[Adventure, Fantasy, Family]	8844	113497	en	Jumanji	17.015539	

```
1  TriStar Pictures, Teitler Film, Interscope Com…

         production_countries  …    status    title_x  video vote_average  \
0  [United States of America]  …  Released  Toy Story  False          7.7
1  [United States of America]  …  Released    Jumanji  False          6.9

  vote_count  Unnamed: 0  rating  year    title_y  id_y
0     5415.0        3171       1  1995  Toy Story    87
1     2413.0        3234       3  1995    Jumanji  3801

[2 rows x 22 columns]
```

[372]:
```
unique_countries = df_merged['original_language'].explode().unique()


print(unique_countries)
```

```
['en' 'fr' 'nl' 'cn' 'zh' 'es' 'ja' 'sr' 'bn' 'de' 'it' 'ru' 'sv' 'fa'
 'pt' 'da' 'xx' 'hi' 'ko' 'el' 'he' 'pl' 'th' 'fi' 'hu' 'no' 'tr' 'la'
 'cs' 'ro' 'mn' 'ar' 'bs' 'wo' 'nb' 'ta' 'id' 'sq' 'is' 'te' 'et' 'kn'
 'lt' 'mr' 'bg' 'ab' 'hr' 'uk']
```

[373]:
```
language_mapping = {
    'en': 'English',
    'fr': 'French',
    'nl': 'Dutch',
    'cn': 'Chinese',
    'zh': 'Chinese',
    'es': 'Spanish',
    'ja': 'Japanese',
    'sr': 'Serbian',
    'bn': 'Bengali',
    'de': 'German',
    'it': 'Italian',
    'ru': 'Russian',
    'sv': 'Swedish',
    'fa': 'Farsi',
    'pt': 'Portuguese',
    'da': 'Danish',
    'xx': 'Unknown',
    'hi': 'Hindi',
    'ko': 'Korean',
    'el': 'Greek',
    'he': 'Hebrew',
    'pl': 'Polish',
    'th': 'Thai',
    'fi': 'Finnish',
    'hu': 'Hungarian',
```

```
    'no': 'Norwegian',
    'tr': 'Turkish',
    'la': 'Latin',
    'cs': 'Czech',
    'ro': 'Romanian',
    'mn': 'Mongolian',
    'ar': 'Arabic',
    'bs': 'Bosnian',
    'wo': 'Wolof',
    'nb': 'Norwegian',
    'ta': 'Tamil',
    'id': 'Indonesian',
    'sq': 'Albanian',
    'is': 'Icelandic',
    'te': 'Telugu',
    'et': 'Estonian',
    'kn': 'Kannada',
    'lt': 'Lithuanian',
    'mr': 'Marathi',
    'bg': 'Bulgarian',
    'ab': 'Abkhazian',
    'hr': 'Croatian',
    'uk': 'Ukrainian'
}



df_merged['original_language'] = df_merged['original_language'].apply(lambda x:␣
 ↪language_mapping.get(x, 'Unknown/Custom'))
```

[374]:
```
df_merged.shape
```

[374]:
```
(7965, 22)
```

[375]:
```
df_merged.head(5)
```

[375]:
```
   adult    budget                                genres   id_x imdb_id  \
0  False  30000000       [Animation, Comedy, Family]    862  114709
1  False  65000000      [Adventure, Fantasy, Family]   8844  113497
2  False         0                   [Romance, Comedy]  15602  113228
3  False  16000000          [Comedy, Drama, Romance]  31357  114885
4  False  60000000  [Action, Crime, Drama, Thriller]    949  113277

  original_language     original_title popularity  \
0           English          Toy Story  21.946943
1           English            Jumanji  17.015539
2           English   Grumpier Old Men    11.7129
```

```
3           English  Waiting to Exhale   3.859495
4           English               Heat  17.924927

                               production_companies  \
0                           Pixar Animation Studios
1  TriStar Pictures, Teitler Film, Interscope Com…
2                       Warner Bros., Lancaster Gate
3              Twentieth Century Fox Film Corporation
4    Regency Enterprises, Forward Pass, Warner Bros.

         production_countries  …    status            title_x  video  \
0  [United States of America]  …  Released          Toy Story  False
1  [United States of America]  …  Released            Jumanji  False
2  [United States of America]  …  Released   Grumpier Old Men  False
3  [United States of America]  …  Released  Waiting to Exhale  False
4  [United States of America]  …  Released               Heat  False

  vote_average vote_count  Unnamed: 0  rating  year            title_y   id_y
0          7.7     5415.0        3171       1  1995          Toy Story     87
1          6.9     2413.0        3234       3  1995            Jumanji   3801
2          6.5       92.0        3291       3  1995   Grumpier Old Men  10697
3          6.1       34.0        3280       2  1995  Waiting To Exhale   9104
4          7.7     1886.0        3201       2  1995               Heat   1037

[5 rows x 22 columns]
```

[376]:
```
df_merged.to_csv('/Users/aqsa/Desktop/finalmerged.csv')
```

[377]:
```
df_merged.isnull().sum()
```

[377]:
```
adult                    0
budget                   0
genres                   0
id_x                     0
imdb_id                  0
original_language        0
original_title           0
popularity               0
production_companies     0
production_countries     0
revenue                  0
runtime                  0
status                   0
title_x                  0
video                    0
vote_average             0
vote_count               0
```

```
Unnamed: 0              0
rating                  0
year                    0
title_y                 0
id_y                    0
dtype: int64
```

[378]:
```
df_merged['pass_bechdel'] = df_merged['rating'].apply(lambda x: 1 if x >= 3␣
 ↪else 0)
df_merged
```

[378]:

	adult	budget	genres	id_x	imdb_id	\
0	False	30000000	[Animation, Comedy, Family]	862	114709	
1	False	65000000	[Adventure, Fantasy, Family]	8844	113497	
2	False	0	[Romance, Comedy]	15602	113228	
3	False	16000000	[Comedy, Drama, Romance]	31357	114885	
4	False	60000000	[Action, Crime, Drama, Thriller]	949	113277	
…	…	…	…	…	…	
7960	False	0	[Fantasy, Comedy]	49277	135122	
7961	False	0	[Fantasy, Comedy]	49271	127948	
7962	False	0	[]	44324	135631	
7963	False	0	[Fantasy, Action, Thriller]	49280	135453	
7964	False	0	[Drama, Action, Romance]	30840	102797	

	original_language	original_title	popularity	\
0	English	Toy Story	21.946943	
1	English	Jumanji	17.015539	
2	English	Grumpier Old Men	11.7129	
3	English	Waiting to Exhale	3.859495	
4	English	Heat	17.924927	
…	…	…	…	
7960	English	Les affiches en goguette	0.148131	
7961	English	Le locataire diabolique	0.725084	
7962	French	Le Roi du maquillage	0.213973	
7963	French	L'Homme orchestre	1.109068	
7964	English	Robin Hood	5.683753	

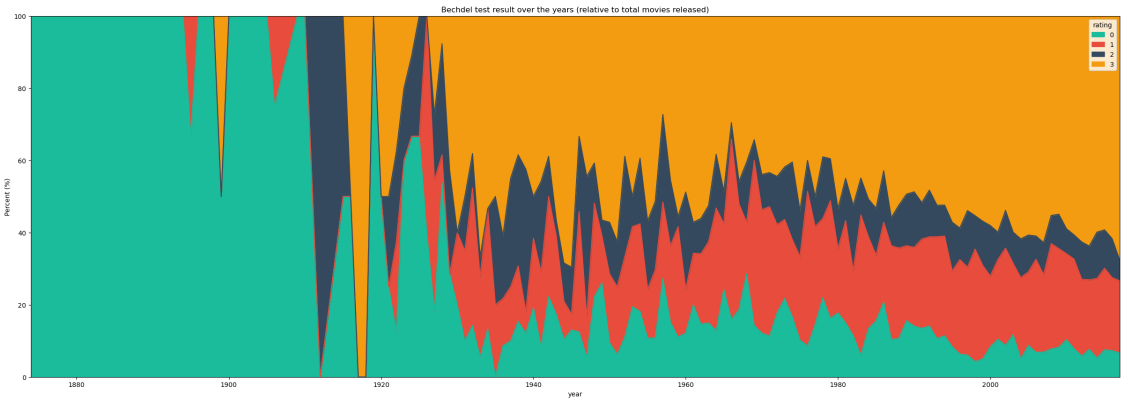
	production_companies	\
0	Pixar Animation Studios	
1	TriStar Pictures, Teitler Film, Interscope Com…	
2	Warner Bros., Lancaster Gate	
3	Twentieth Century Fox Film Corporation	
4	Regency Enterprises, Forward Pass, Warner Bros.	
…	…	
7960	Star-Film, Georges Méliès	
7961	Star Film Company	
7962	Star Film Company	

```
7963                                  Star Film Company
7964  Westdeutscher Rundfunk (WDR), Working Title Fi…

                                  production_countries  …  \
0                            [United States of America]  …
1                            [United States of America]  …
2                            [United States of America]  …
3                            [United States of America]  …
4                            [United States of America]  …
…                                                     …  …
7960                                            [France]  …
7961                                            [France]  …
7962                                            [France]  …
7963                                            [France]  …
7964  [Canada, Germany, United Kingdom, United State…  …

                     title_x  video vote_average vote_count Unnamed: 0  \
0                  Toy Story  False          7.7     5415.0       3171
1                    Jumanji  False          6.9     2413.0       3234
2           Grumpier Old Men  False          6.5       92.0       3291
3          Waiting to Exhale  False          6.1       34.0       3280
4                       Heat  False          7.7     1886.0       3201
…                          …      …            …         …          …
7960   The Hilarious Posters  False          4.5        2.0        118
7961     The Devilish Tenant  False          6.7       12.0        126
7962  The Untameable Whiskers  False          6.0        6.0        111
7963        The One-Man Band  False          6.5       22.0         92
7964              Robin Hood  False          5.7       26.0       2826

      rating  year                  title_y   id_y  pass_bechdel
0          1  1995                Toy Story     87             0
1          3  1995                  Jumanji   3801             1
2          3  1995         Grumpier Old Men  10697             1
3          2  1995        Waiting To Exhale   9104             0
4          2  1995                     Heat   1037             0
…      …   …                        …    …           …
7960       0  1906   Hilarious Posters, The   5603             0
7961       0  1909     Devilish Tenant, The   5635             0
7962       0  1904  Untamable Whiskers, The   5601             0
7963       0  1900        One-Man Band, The   4993             0
7964       1  1991               Robin Hood   7146             0

[7965 rows x 23 columns]
```

4 Data Visualizations

4.0.1 1.1 Female Representation Over The Decades

[379]:
```
import matplotlib.pyplot as plt

df_merged["rating"] = df_merged["rating"].astype("category")


bech_over_years = df_merged.groupby(["year", "rating"])["rating"].count()
bech_over_years = bech_over_years.unstack()

colors = [
   '#1abc9c',
    '#e74c3c',
    '#34495e',
    '#f39c12'
]

stacked_data = bech_over_years.apply(lambda x: x*100/sum(x), axis=1)
stacked_data.plot(kind ="area", stacked=True, figsize=(30,10) , color=colors)

plt.ylabel('Percent (%)')
plt.autoscale(enable=True, axis='both', tight=True)
plt.title("Bechdel test result over the years (relative to total movies␣
 ↪released)")
plt.show()
```

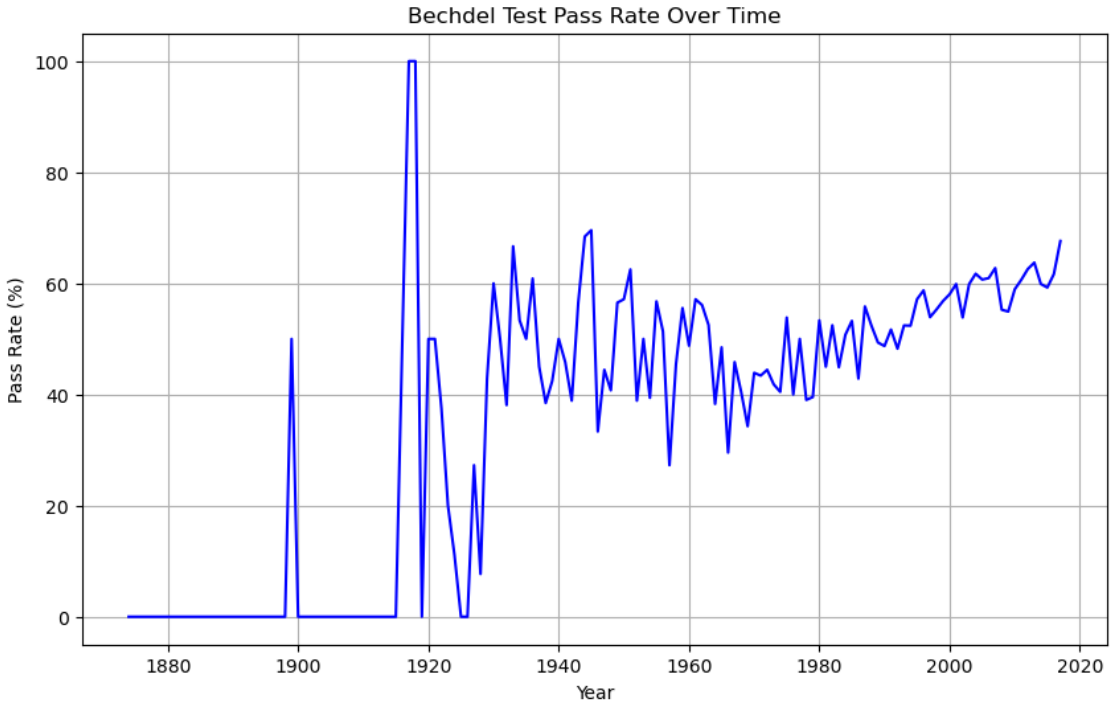


4.0.2 1.1 Analysis

This graphic tells me that over the years, out of all movies released in the year, more movies pass the bechdel test.

4.0.3 1.2 Bechdel Pass Rate over Time

[380]:
```
df_merged['year'] = pd.to_datetime(df_merged['year'], format='%Y')
bechdel_rate = df_merged.groupby(df_merged['year'].dt.year)['pass_bechdel'].
↪mean() * 100
plt.figure(figsize=(10, 6))
bechdel_rate.plot(kind='line', color='b')
plt.title("Bechdel Test Pass Rate Over Time")
plt.xlabel("Year")
plt.ylabel("Pass Rate (%)")
plt.grid(True)
plt.show()
```



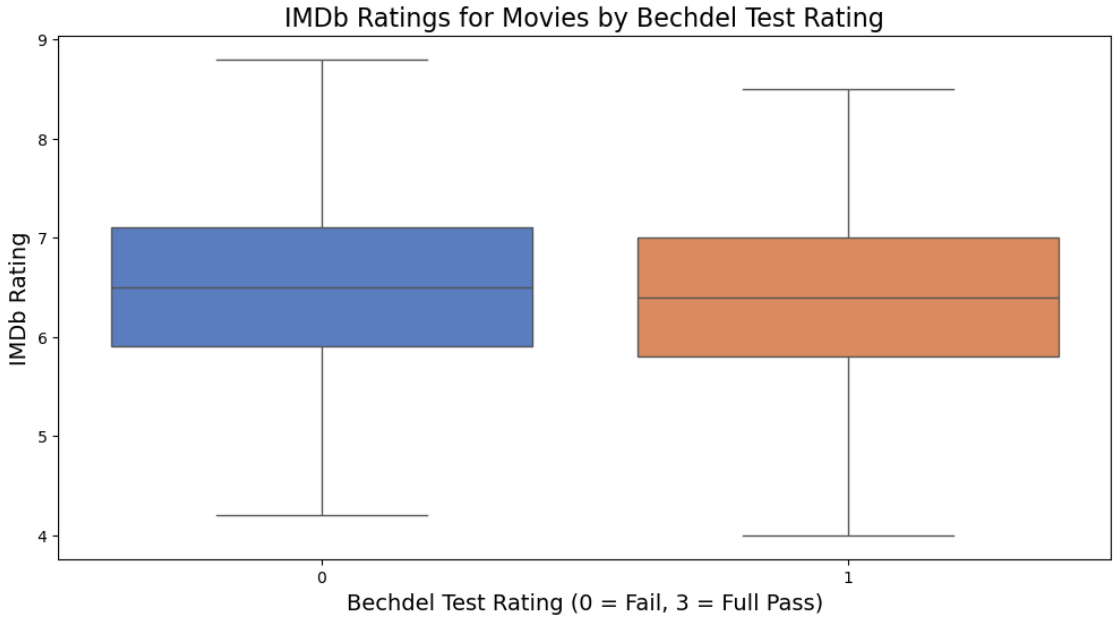
4.0.4 1.2 Analysis

This shows a similar relationship to the graph above but this graph is different as it only considers if the movie passed (0) or failed (1) it does not consider the other parts of the bechdel test.

4.0.5 1.3 IMDb ratings compared for movies that pass vs. fail the Bechdel Test.

[381]:
```
import seaborn as sns
import matplotlib.pyplot as plt
plt.figure(figsize=(12, 6))
```

```
sns.boxplot(data=df_merged, x="pass_bechdel", y="vote_average",␣
 ↪palette="muted", showfliers=False)
# Customize the plot
plt.title("IMDb Ratings for Movies by Bechdel Test Rating", fontsize=16)
plt.xlabel("Bechdel Test Rating (0 = Fail, 3 = Full Pass)", fontsize=14)
plt.ylabel("IMDb Rating", fontsize=14)


plt.show()
```

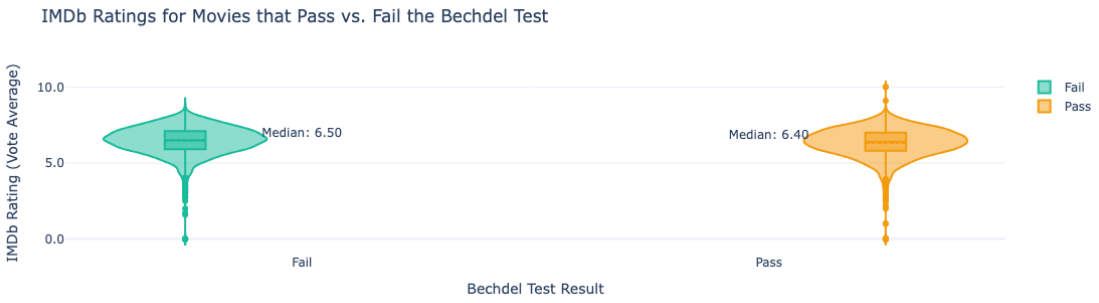


4.0.6 1.3 Analysis

[382]:
```
import plotly.graph_objects as go


fig = go.Figure()


fail_data = df_merged['vote_average'][df_merged['pass_bechdel'] == 0]
pass_data = df_merged['vote_average'][df_merged['pass_bechdel'] == 1]


fig.add_trace(go.Violin(
    x=['Fail'] * len(fail_data),
    y=fail_data,
    name='Fail',
```

```
    box_visible=True,
    meanline_visible=True,
    line_color='#1abc9c'
))


fig.add_trace(go.Violin(
    x=['Pass'] * len(pass_data),
    y=pass_data,
    name='Pass',
    box_visible=True,
    meanline_visible=True,
    line_color='#f39c12'
))


fail_median = fail_data.median()
pass_median = pass_data.median()

fig.add_trace(go.Scatter(
    x=['Fail'], y=[fail_median],
    mode='text',
    text=[f"Median: {fail_median:.2f}"],
    textposition="top center",
    showlegend=False
))

fig.add_trace(go.Scatter(
    x=['Pass'], y=[pass_median],
    mode='text',
    text=[f"Median: {pass_median:.2f}"],
    textposition="top center",
    showlegend=False
))

# Customize layout
fig.update_layout(
    title="IMDb Ratings for Movies that Pass vs. Fail the Bechdel Test",
    xaxis_title="Bechdel Test Result",
    yaxis_title="IMDb Rating (Vote Average)",
    violingap= 0,
    violinmode="group",
    template="plotly_white",
    yaxis=dict(tickformat=".1f")
)
```

```
fig.show()
```

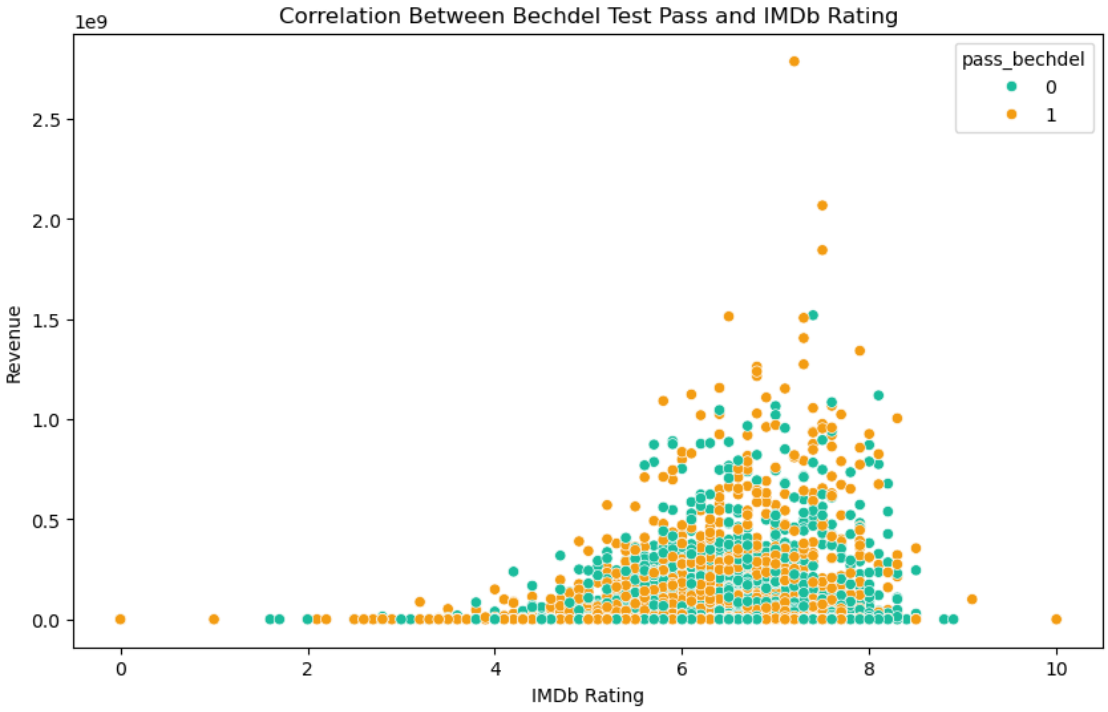


4.0.7 1.2 + 1.3 Analysis

Both of these graphs show the distribution of bechdel pass/fail results given the imdb rating of that specific movie. Some insights I gather: - the

4.0.8 1.4 Correlation Between Bechdel Test Pass and IMDb Rating

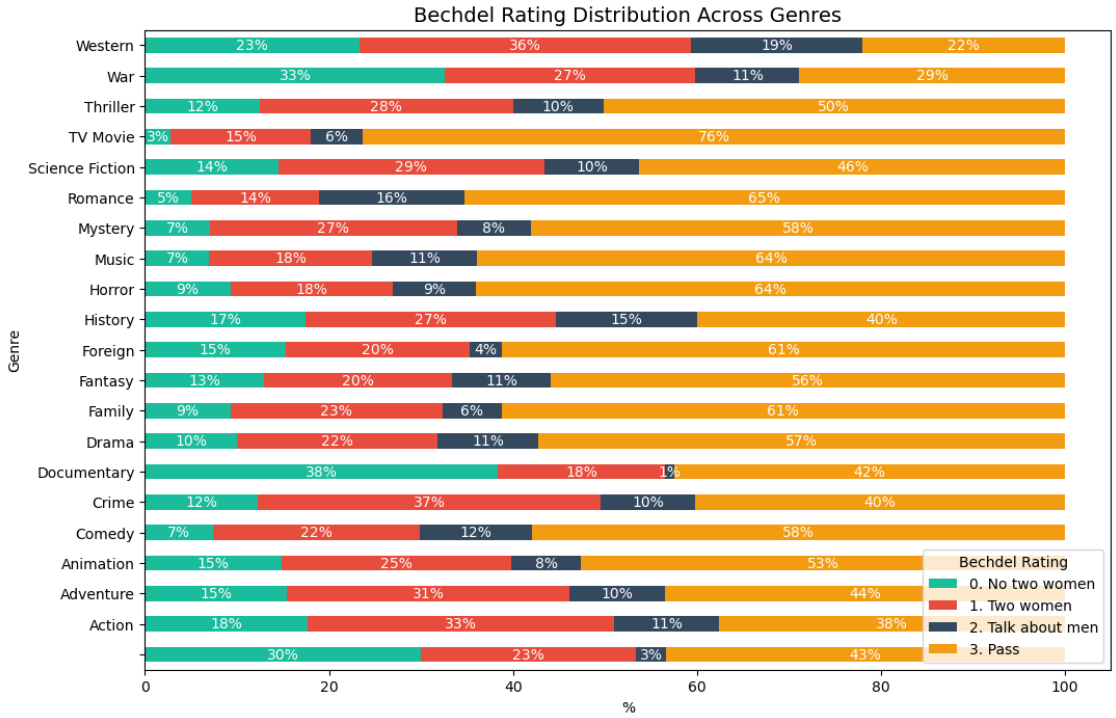
[383]:
```
plt.figure(figsize=(10, 6))
sns.scatterplot(x='vote_average', y='revenue', hue='pass_bechdel',␣
 ↪data=df_merged, palette= [ '#1abc9c',
    '#f39c12'])
plt.title("Correlation Between Bechdel Test Pass and IMDb Rating")
plt.xlabel("IMDb Rating")
plt.ylabel("Revenue")
plt.show()
```



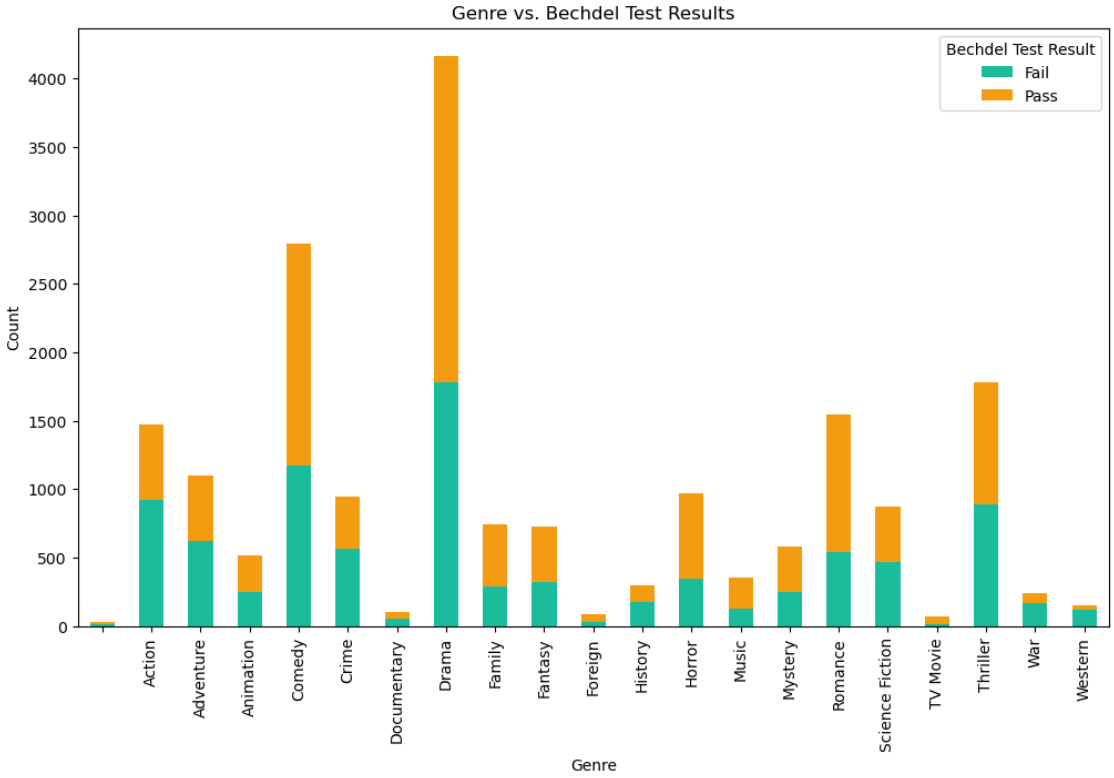
4.0.9 1.5 Is there a genre-based difference in passing rates for the Bechdel Test?

[384]:
```
import pandas as pd
import matplotlib.pyplot as plt


flattened = df_merged.explode("genres")


grouped = flattened.groupby(["genres", "rating"]).size().
 ↪reset_index(name="count")


pivot = grouped.pivot(index="genres", columns="rating", values="count").
 ↪fillna(0)
pivot_percentage = pivot.div(pivot.sum(axis=1), axis=0) * 100


plt.figure(figsize=(12, 8))

colors = [ '#1abc9c',
    '#e74c3c',
    '#34495e',
```

```
    '#f39c12']
pivot_percentage.plot(kind="barh", stacked=True, color=colors,␣
 ↪edgecolor="none", ax=plt.gca())


for i, genre in enumerate(pivot_percentage.index):
    cumulative = 0
    for rating, value in pivot_percentage.loc[genre].items():
        if value > 0:
            plt.text(
                cumulative + value / 2,
                i,
                f"{value:.0f}%",
                ha="center", va="center", fontsize=10, color="white"
            )
            cumulative += value


plt.xlabel("%")
plt.ylabel("Genre")
plt.title("Bechdel Rating Distribution Across Genres", fontsize=14)
plt.legend(title="Bechdel Rating", labels=["0. No two women", "1. Two women",␣
 ↪"2. Talk about men", "3. Pass"], loc="lower right", fontsize=10)
plt.subplots_adjust()


plt.show()
```

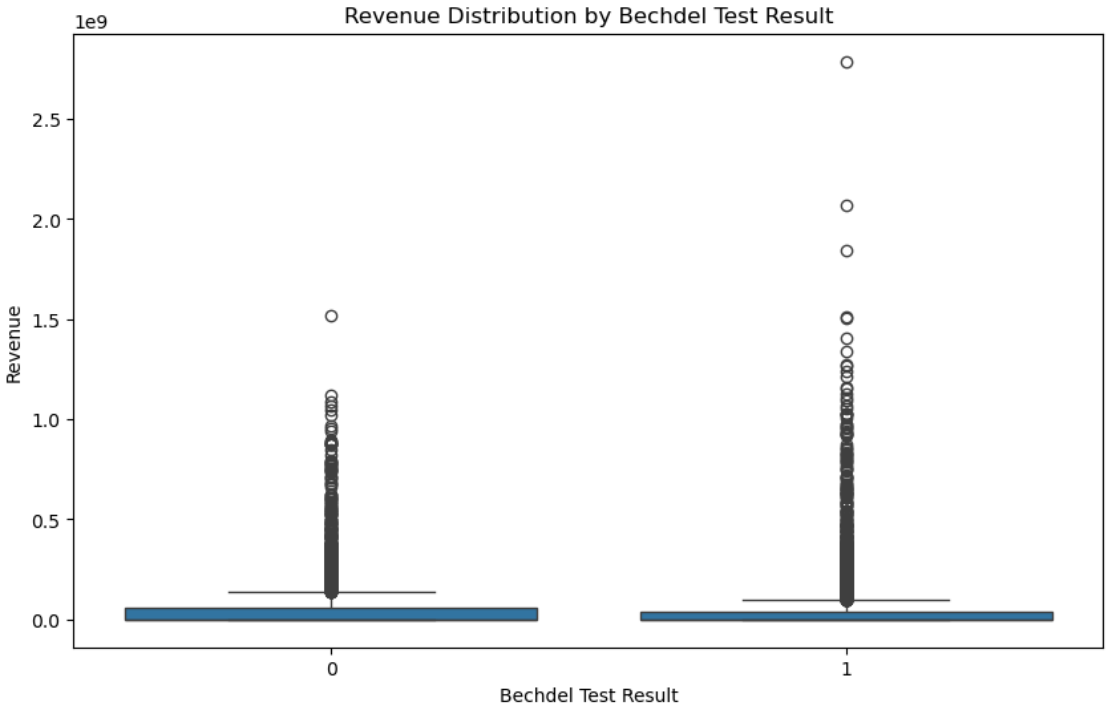


[385]:
```
genre_bechdel = df_merged.explode('genres').groupby(['genres', 'pass_bechdel']).
↪size().unstack().fillna(0)
genre_bechdel.plot(kind='bar', stacked=True, figsize=(12, 7), color =['#1abc9c',
    '#f39c12'])
plt.title("Genre vs. Bechdel Test Results")
plt.xlabel("Genre")
plt.ylabel("Count")
plt.xticks(rotation=90)
plt.legend(title="Bechdel Test Result", labels=["Fail", "Pass"])
plt.show()
```



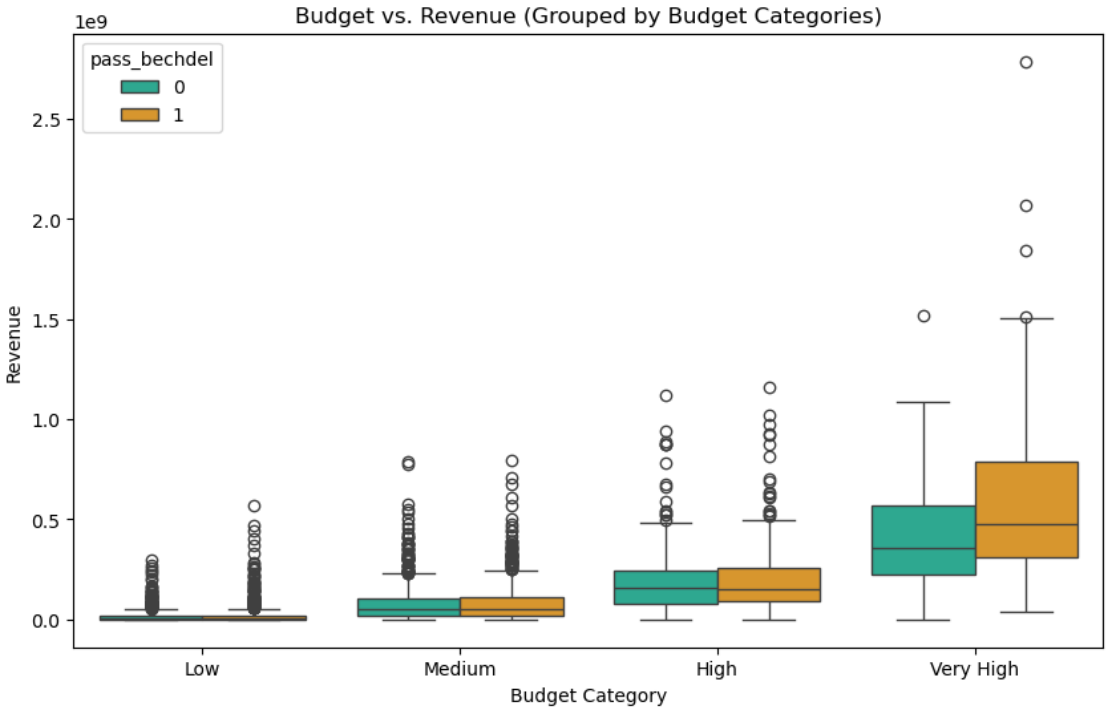
4.0.10 1.6 Revenue Distribution by Bechdel Test Result

[386]:
```
plt.figure(figsize=(10, 6))
sns.boxplot(x='pass_bechdel', y='revenue', data=df_merged)
plt.title("Revenue Distribution by Bechdel Test Result")
plt.xlabel("Bechdel Test Result")
plt.ylabel("Revenue")
plt.show()
```



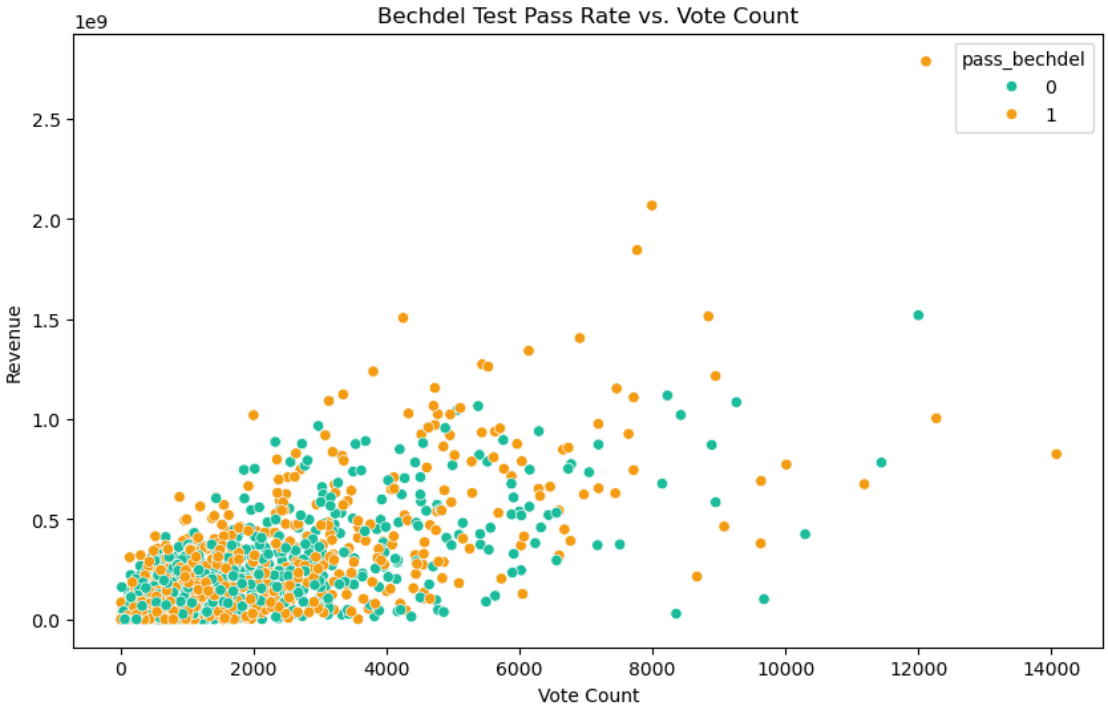
4.0.11 1.7 Budget vs. Bechdel Test Results

[387]:
```
df_merged['budget'] = pd.to_numeric(df_merged['budget'], errors='coerce')


df_merged = df_merged[(df_merged['budget'] > 0)]

bins = [0, 10000000, 50000000, 100000000, float('inf')]
labels = ['Low', 'Medium', 'High', 'Very High']


df_merged['budget_category'] = pd.cut(df_merged['budget'], bins=bins,␣
 ↪labels=labels)


plt.figure(figsize=(10, 6))
sns.boxplot(x='budget_category', y='revenue', hue='pass_bechdel',␣
 ↪data=df_merged, palette=['#1abc9c', '#f39c12'])
plt.title("Budget vs. Revenue (Grouped by Budget Categories)")

plt.xlabel("Budget Category")
plt.ylabel("Revenue")
plt.show()
```



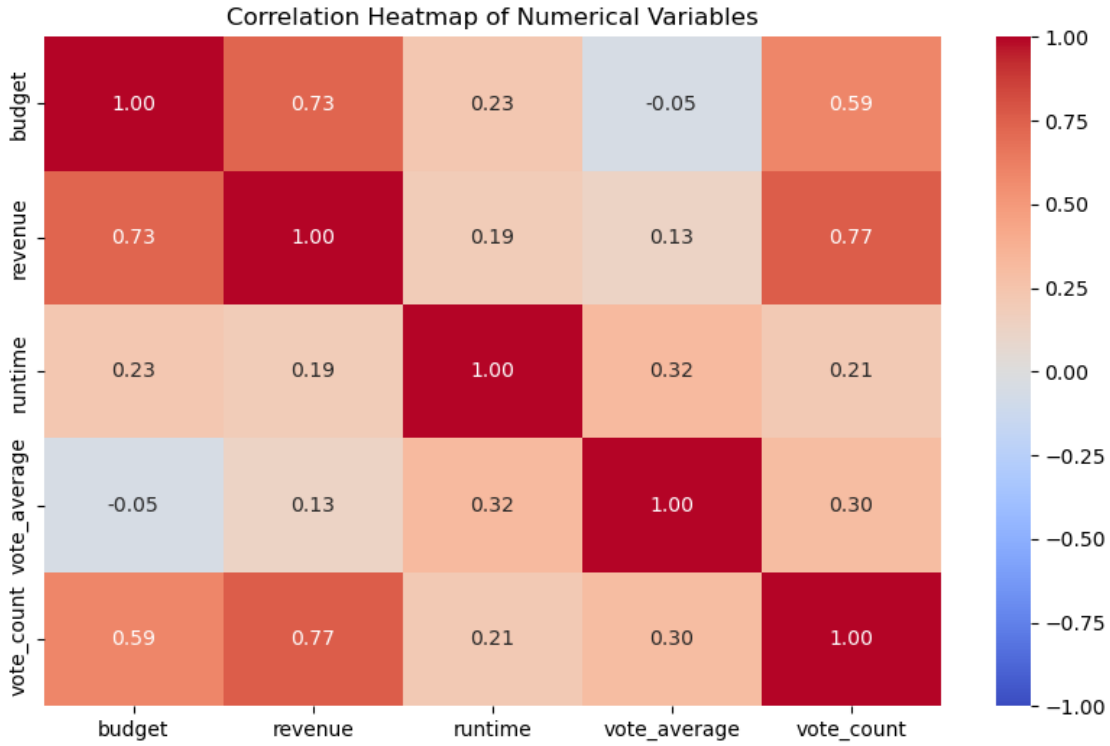
4.0.12 1.8 Bechdel Test Pass Rate vs. Vote Count

[388]:
```
plt.figure(figsize=(10, 6))
sns.scatterplot(x='vote_count', y='revenue', hue='pass_bechdel',␣
 ↪data=df_merged,  palette= [ '#1abc9c',
    '#f39c12'])
plt.title("Bechdel Test Pass Rate vs. Vote Count")
plt.xlabel("Vote Count")
plt.ylabel("Revenue")
plt.show()
```



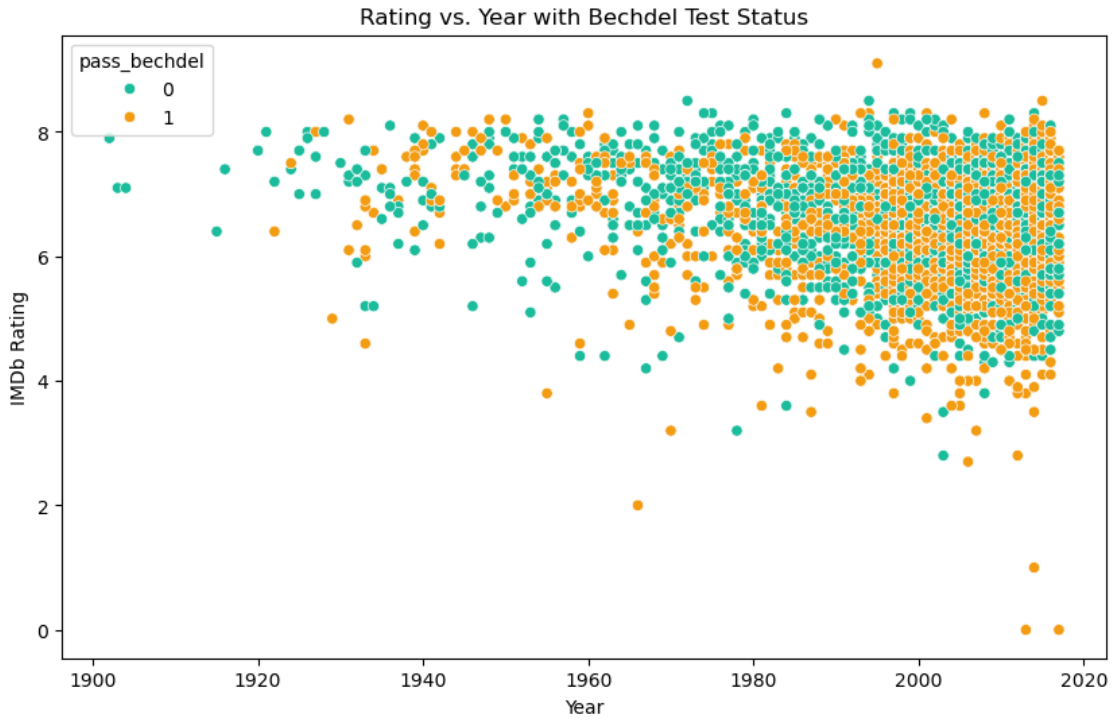
4.0.13 1.9 Heatmap of Correlation Between Numerical Variables

[389]:
```
numerical_features = df_merged[['budget', 'revenue', 'runtime', 'vote_average',␣
↪'vote_count']]
correlation = numerical_features.corr()
plt.figure(figsize=(10, 6))
sns.heatmap(correlation, annot=True, cmap='coolwarm', fmt='.2f', vmin=-1,␣
↪vmax=1)
plt.title("Correlation Heatmap of Numerical Variables")
plt.show()
```



4.0.14 2.1 Rating vs. Year with Bechdel Test Status

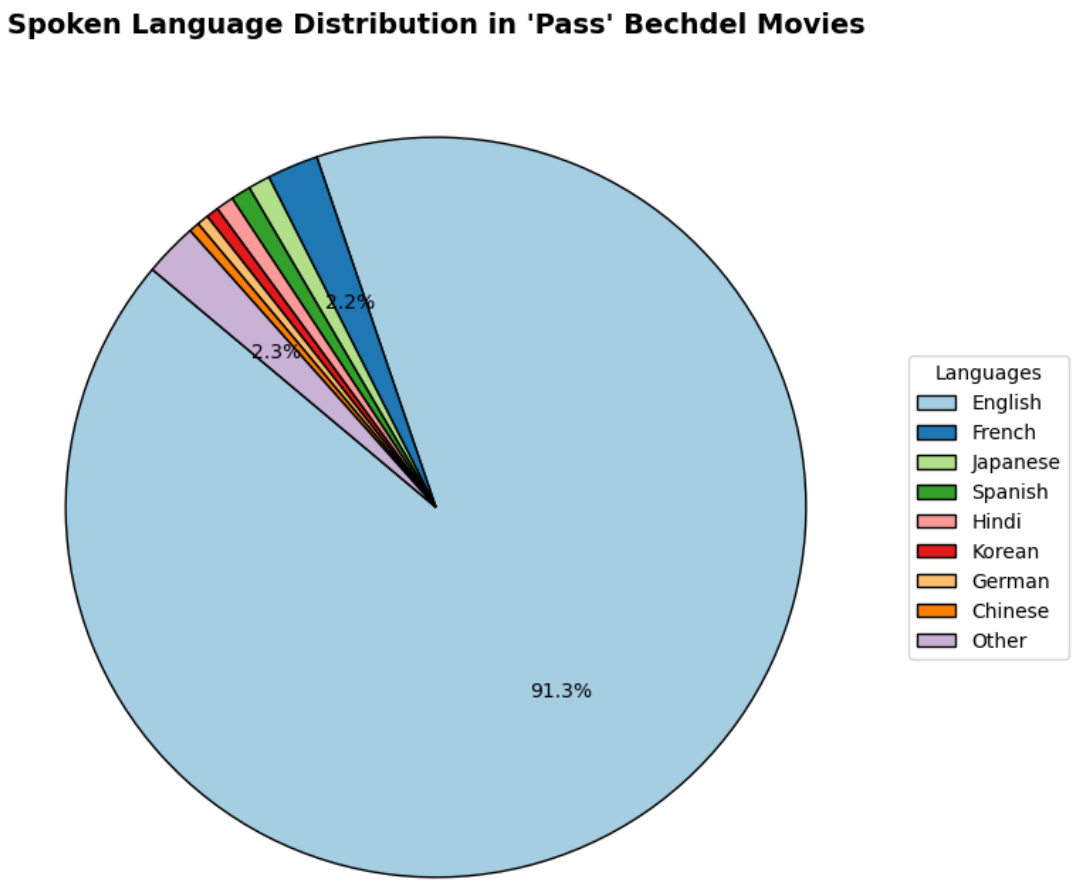
[391]:
```
plt.figure(figsize=(10, 6))
sns.scatterplot(x='year', y='vote_average', hue='pass_bechdel', data=df_merged,␣
↪palette= [ '#1abc9c',
    '#f39c12'])
plt.title("Rating vs. Year with Bechdel Test Status")
plt.xlabel("Year")
plt.ylabel("IMDb Rating")
plt.show()
```



4.0.15 1.6 Pie Chart Spoken Language and 'Pass' Bechdel Score

[392]:
```
df_pass = df_merged[df_merged['pass_bechdel'] == 1]


language_counts = df_pass['original_language'].value_counts()


if len(language_counts) == 0:
    print("No data available for 'Pass' Bechdel movies.")
else:

    top_languages = language_counts.head(8)
    other_count = language_counts[8:].sum()


    if other_count > 0:
        top_languages = pd.concat([top_languages, pd.Series({'Other':␣
 ↪other_count})])


    plt.figure(figsize=(8, 8))
    wedges, texts, autotexts = plt.pie(
```

```
        top_languages,
        labels=None,
        autopct=lambda pct: f'{pct:.1f}%' if pct > 2 else '',
        startangle=140,
        colors=plt.cm.Paired.colors,
        wedgeprops={'edgecolor': 'black'}
    )


    for autotext in autotexts:
        autotext.set_color('black')
        autotext.set_fontsize(10)



    plt.legend(
        wedges,
        top_languages.index,
        title="Languages",
        loc="center left",
        bbox_to_anchor=(1, 0, 0.5, 1)
    )


    plt.title("Spoken Language Distribution in 'Pass' Bechdel Movies",␣
↪fontsize=14, fontweight='bold')
    plt.tight_layout()
    plt.show()
```



[393]:
```
unique_countries = df_merged['production_countries'].explode().unique()

print(unique_countries)
```

```
['United States of America' 'Germany' 'United Kingdom' 'France' 'Italy'
 'Spain' 'Australia' 'Netherlands' 'Belgium' 'Hong Kong' 'Canada' 'Japan'
 'Austria' 'Switzerland' 'New Zealand' 'Mexico' 'Peru' 'Liechtenstein'
 'Denmark' 'Portugal' 'Ireland' 'Russia' 'Serbia' 'Hungary'
 'Czech Republic' 'Finland' 'India' 'Sweden' 'Brazil' '' 'China' 'Iran'
 'Iceland' 'Luxembourg' 'Ecuador' 'Bahamas' 'Malaysia' 'Argentina'
 'Norway' 'Taiwan' 'Pakistan' 'Thailand' 'Namibia' 'South Africa'
 'South Korea' 'Poland' 'Greece' 'Romania' 'Malta' 'Algeria' 'Morocco'
 'Uruguay' 'Paraguay' 'Qatar' 'Tunisia' 'Turkey' 'Israel' 'Slovenia'
 'Lithuania' 'Singapore' 'Angola' 'United Arab Emirates'
 'Serbia and Montenegro' 'Indonesia' 'Cyprus' 'Philippines' 'Chile'
 'Uganda' 'Ukraine' 'Cambodia' 'Puerto Rico']
```

[394]:
```
country_name_mapping = {
    'United States of America': 'United States',
    'United Kingdom': 'UK',
    'South Korea': 'Korea, South',
    'Hong Kong': 'China',
    'Soviet Union': 'Russia',
    'Puerto Rico': 'United States',
    'Palestinian Territory': 'Palestine',
    'Serbia and Montenegro': 'Serbia',
    'Bahamas': 'The Bahamas',
    'Czech Republic': 'Czechia',
    'Bosnia and Herzegovina': 'Bosnia and Herz.',
    'French Polynesia': 'French Polynesia',
    'Netherlands Antilles': 'Netherlands',
    'Soviet Union': 'Russia',
    'Bulgaria': 'Bulgaria',
    'Malta': 'Malta',
    'Congo': 'Republic of the Congo',
    'Indonesia': 'Indonesia',
    'South Africa': 'South Africa',
    'Venezuela': 'Venezuela',
    'Algeria': 'Algeria',
    'Iceland': 'Iceland',
    'Ecuador': 'Ecuador',
    'Slovakia': 'Slovakia',
    'Greece': 'Greece',
    'Lebanon': 'Lebanon',
    'Jordan': 'Jordan',
    'Tunisia': 'Tunisia',
    'Romania': 'Romania',
    'Turkey': 'Turkey',
    'Colombia': 'Colombia',
    'Georgia': 'Georgia',
    'Cuba': 'Cuba',
    'Panama': 'Panama',
    'Qatar': 'Qatar',
    'Uruguay': 'Uruguay',
    'Kazakhstan': 'Kazakhstan',
    'Cyprus': 'Cyprus',
    'Cambodia': 'Cambodia',
    'Luxembourg': 'Luxembourg',
    'Finland': 'Finland',
    'Norway': 'Norway',
    'Sweden': 'Sweden',
    'Brazil': 'Brazil',
    'Italy': 'Italy',
    'France': 'France',
```

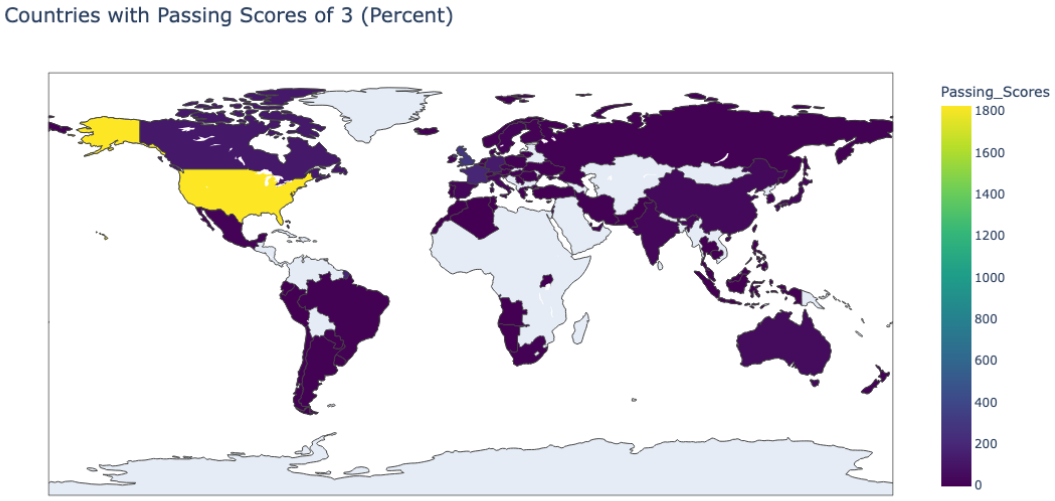
```
    'Germany': 'Germany',
    'Spain': 'Spain',
    'Australia': 'Australia',
    'Canada': 'Canada',
    'Netherlands': 'Netherlands',
    'Belgium': 'Belgium',
    'Austria': 'Austria',
    'Switzerland': 'Switzerland',
    'Ireland': 'Ireland',
    'Taiwan': 'Taiwan',
    'New Zealand': 'New Zealand',
    'Mexico': 'Mexico',
    'Poland': 'Poland',
    'Peru': 'Peru',
    'Liechtenstein': 'Liechtenstein',
    'China': 'China',
    'Denmark': 'Denmark',
    'Portugal': 'Portugal',
    'Russia': 'Russia',
    'Serbia': 'Serbia',
    'Hungary': 'Hungary',
    'India': 'India',
    'Argentina': 'Argentina',
    'Croatia': 'Croatia',
    'Sweden': 'Sweden',
    'Finland': 'Finland',
    'Iran': 'Iran',
    'Iceland': 'Iceland',
    'Romania': 'Romania',
    'Malaysia': 'Malaysia',
    'South Africa': 'South Africa',
    'Pakistan': 'Pakistan',
    'Thailand': 'Thailand',
    'Namibia': 'Namibia',
    'Cameroon': 'Cameroon',
    'Philippines': 'Philippines',
    'Algeria': 'Algeria',
    'South Korea': 'Korea, South',
    'Israel': 'Israel',
    'Vietnam': 'Vietnam',
    'Malta': 'Malta',
    'Colombia': 'Colombia',
    'Chile': 'Chile',
    'Turkey': 'Turkey',
    'Morocco': 'Morocco',
    'Aruba': 'Aruba',
    'Georgia': 'Georgia',
```

```
    'Palestinian Territory': 'Palestine',
    'Uruguay': 'Uruguay',
    'Paraguay': 'Paraguay',
    'Qatar': 'Qatar',
    'Tunisia': 'Tunisia',
    'Mongolia': 'Mongolia',
    'Slovakia': 'Slovakia',
    'Lebanon': 'Lebanon',
    'Slovenia': 'Slovenia',
    'Lithuania': 'Lithuania',
    'Singapore': 'Singapore',
    'Ukraine': 'Ukraine',
    'Bosnia and Herzegovina': 'Bosnia and Herz.',
    'Egypt': 'Egypt',
    'Bulgaria': 'Bulgaria',
    'Senegal': 'Senegal',
    'Angola': 'Angola',
    'United Arab Emirates': 'United Arab Emirates',
    'Costa Rica': 'Costa Rica',
    'Venezuela': 'Venezuela',
    'Serbia and Montenegro': 'Serbia',
    'Indonesia': 'Indonesia',
    'Congo': 'Congo',
    'Albania': 'Albania',
    'Bolivia': 'Bolivia',
    'Kazakhstan': 'Kazakhstan',
    'Cuba': 'Cuba',
    'Uganda': 'Uganda',
    'Saudi Arabia': 'Saudi Arabia',
    'Jordan': 'Jordan',
    'Cyprus': 'Cyprus',
    'Estonia': 'Estonia',
    'French Polynesia': 'French Polynesia',
    'Netherlands Antilles': 'Netherlands',
    'Panama': 'Panama',
    'Montenegro': 'Montenegro',
    'Cambodia': 'Cambodia',
}

df_merged['production_countries'] = df_merged['production_countries'].apply(
    lambda x: [country_name_mapping.get(country, country) for country in x]
)
```

[395]:
```
passing_data = df_merged[df_merged['rating'] == 3]
country_counts = passing_data['production_countries'].explode().value_counts().
 ↪reset_index()
country_counts.columns = ['Country', 'Passing_Scores']
```

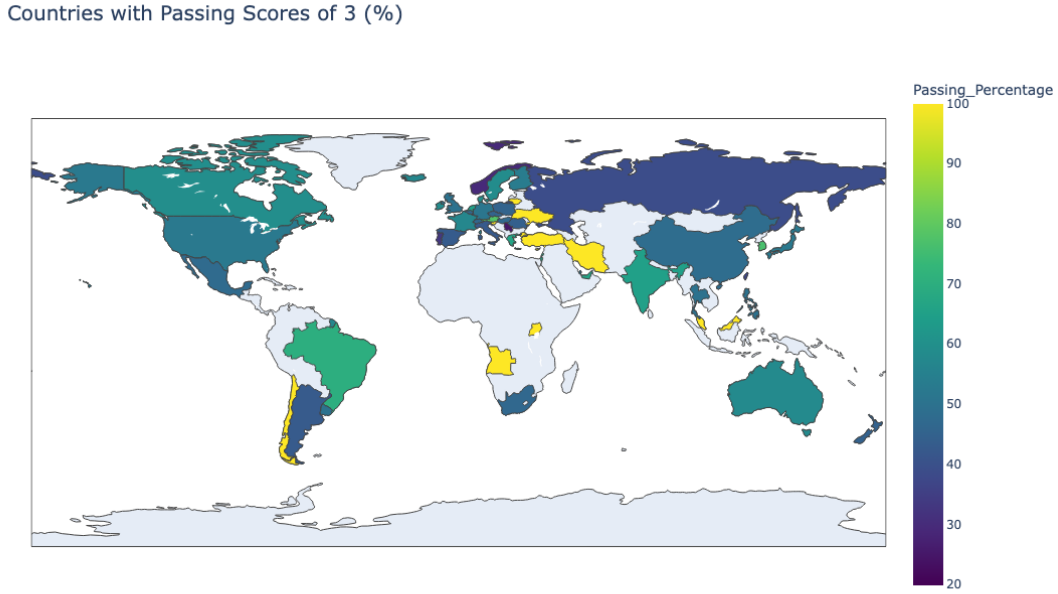
```
country_stats['Passing_Percentage'] = (country_stats['Passing_Scores'] /␣
 ↪country_stats['Total_Movies']) * 100

print("Original Countries Before Replacement:")
print(country_stats['Country'].unique())
print(country_counts.head())

fig = px.choropleth(country_stats,
                    locations='Country',
                    locationmode='country names',
                    color='Passing_Scores',
                    hover_name='Country',
                    color_continuous_scale="Viridis",
                    title="Countries with Passing Scores of 3 (Percent)")


fig.update_layout(
    width=1000,
    height=600,
    title_font_size=20
)


fig.show()
```

```
Original Countries Before Replacement:
['United States' 'UK' 'France' 'Germany' 'Canada' 'Italy' 'Australia'
 'China' 'Japan' 'Spain' 'India' 'Ireland' 'Belgium' 'Sweden'
 'New Zealand' 'Denmark' 'Netherlands' 'Mexico' 'Czechia' 'Russia'
 'Hungary' 'Korea, South' 'Norway' '' 'South Africa' 'Finland'
 'Switzerland' 'Poland' 'Brazil' 'United Arab Emirates' 'Austria'
 'Romania' 'Taiwan' 'Iceland' 'Argentina' 'Portugal' 'Luxembourg' 'Iran'
 'Malta' 'Serbia' 'Qatar' 'Greece' 'Morocco' 'Tunisia' 'Chile' 'Peru'
 'Israel' 'Thailand' 'Turkey' 'Algeria' 'Uruguay' 'Indonesia' 'Singapore'
 'Philippines' 'Cyprus' 'Uganda' 'Ukraine' 'Angola' 'The Bahamas'
 'Lithuania' 'Slovenia' 'Paraguay' 'Namibia' 'Pakistan' 'Malaysia'
 'Ecuador' 'Liechtenstein' 'Cambodia']
         Country  Passing_Scores
0  United States            1827
1             UK             297
2         France             193
3        Germany             137
4         Canada             120
```



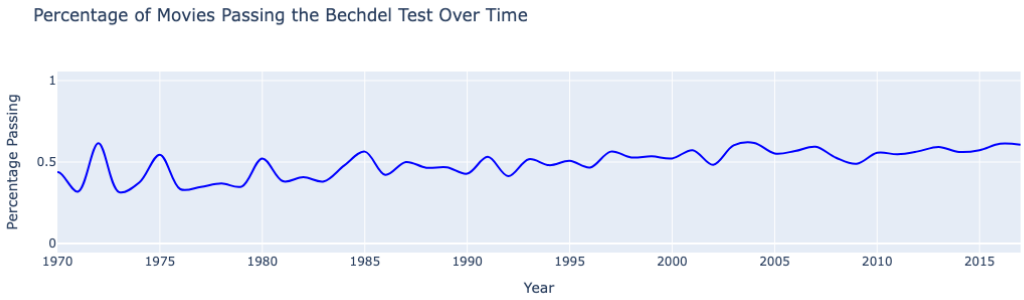
[396]:
```
passing_data = df_merged[df_merged['rating'] == 3]

country_counts = passing_data['production_countries'].explode().value_counts().
 ↪reset_index()
country_counts.columns = ['Country', 'Passing_Scores']

total_counts = df_merged['production_countries'].explode().value_counts().
 ↪reset_index()
total_counts.columns = ['Country', 'Total_Movies']

country_stats = pd.merge(country_counts, total_counts, on='Country', how='left')


country_stats['Passing_Percentage'] = (country_stats['Passing_Scores'] /␣
 ↪country_stats['Total_Movies']) * 100

world_geojson = px.data.gapminder().query('year == 2007')

fig = px.choropleth(country_stats,
                    locations='Country',
                    locationmode='country names',
                    color='Passing_Percentage',
                    hover_name='Country',
                    color_continuous_scale="Viridis",
                    title="Countries with Passing Scores of 3 (%)")
```

```
fig.update_layout(
    width=1000,
    height=700,
    title_font_size=20
)


fig.show()
```



[397]:
```
import plotly.express as px
df_merged['pass_bechdel'] = df_merged['rating'].apply(lambda x: 1 if x >= 3␣
 ↪else 0)
df_yearly = df_merged.groupby('year')['pass_bechdel'].mean().reset_index()


fig = px.line(
    df_yearly,
    x='year',
    y='pass_bechdel',
    title='Percentage of Movies Passing the Bechdel Test Over Time',
    labels={'pass_bechdel': 'Percentage Passing', 'year': 'Year'},
    line_shape='spline'
)
```

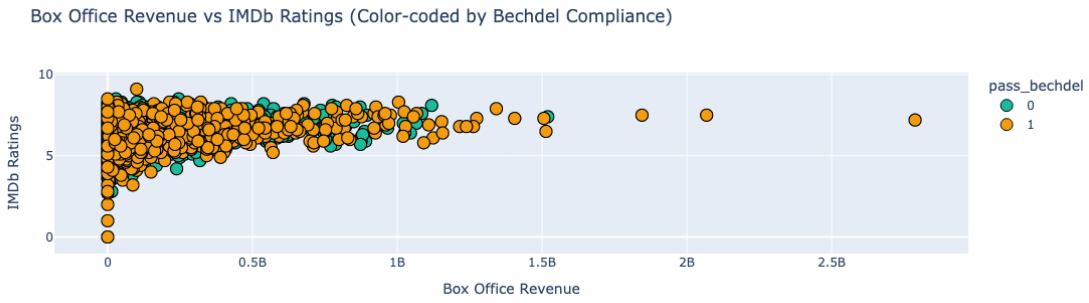
```
fig.update_traces(line=dict(color='blue', width=2))


fig.update_layout(
    xaxis=dict(range=[1889, df_yearly['year'].max()])
)

fig.show()
```



4.1 Scatter Plot: Box Office Revenue vs. IMDb Ratings, Color-Coded by Bechdel Compliance

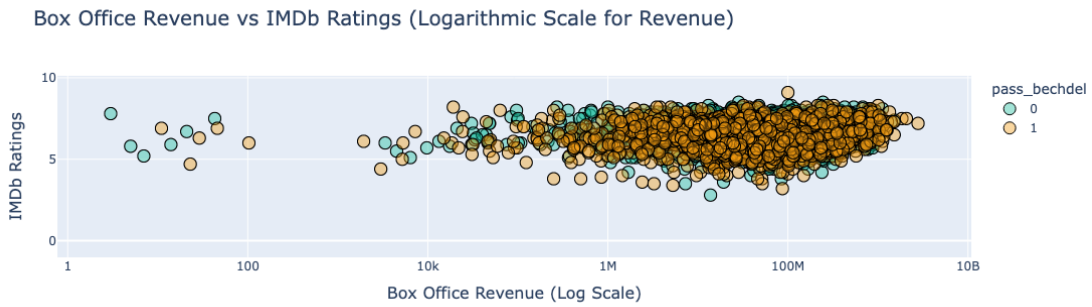
[398]:
```
df_filtered = df_merged.dropna(subset=['revenue', 'vote_average'])


df_filtered['pass_bechdel'] = df_filtered['pass_bechdel'].astype('category')

fig = px.scatter(
    df_filtered,
    x='revenue',
    y='vote_average',
    color='pass_bechdel',
    title='Box Office Revenue vs IMDb Ratings (Color-coded by Bechdel␣
 ↪Compliance)',
    labels={'revenue': 'Box Office Revenue', 'vote_average': 'IMDb Ratings'},
    color_discrete_sequence=['#1abc9c',
    '#f39c12'],
    hover_data=['original_title', 'year', 'genres']
)

fig.update_traces(marker=dict(size=12, line=dict(color='black', width=1)))
```

```
fig.show()
```



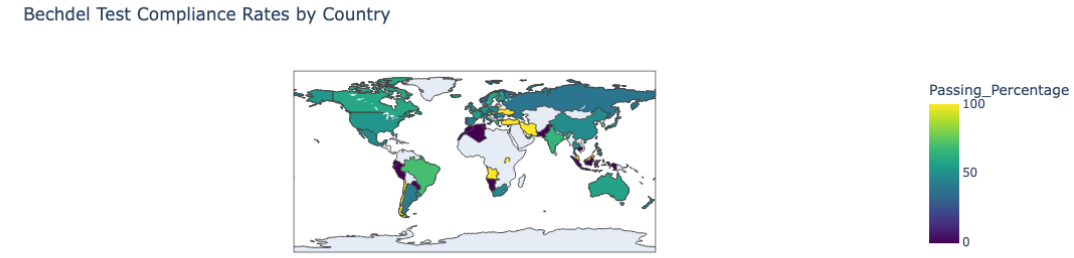
[399]:
```
df_filtered = df_merged.dropna(subset=['revenue', 'vote_average'])

df_filtered['pass_bechdel'] = df_filtered['pass_bechdel'].astype('category')

fig = px.scatter(
    df_filtered,
    x='revenue',
    y='vote_average',
    color='pass_bechdel',
    title='Box Office Revenue vs IMDb Ratings (Logarithmic Scale for Revenue)',
    labels={'revenue': 'Box Office Revenue', 'vote_average': 'IMDb Ratings'},
    color_discrete_sequence=['rgba(26, 188, 156, 0.4)',
                             'rgba(243, 156, 18, 0.4)'],
    hover_data=['original_title', 'year', 'genres']
)

fig.update_layout(
    xaxis=dict(
        type='log',
        title='Box Office Revenue (Log Scale)',
        title_font=dict(size=16),
        tickfont=dict(size=12)
    ),
    yaxis=dict(
        title='IMDb Ratings',
        title_font=dict(size=16),
        tickfont=dict(size=12)
    ),
    title=dict(
        text='Box Office Revenue vs IMDb Ratings (Logarithmic Scale for␣
 ↪Revenue)',
        font=dict(size=20)
```

```
    )
)


fig.update_traces(marker=dict(size=12, line=dict(color='black', width=1)))


fig.show()
```



4.2 Choropleth Map: Bechdel Test Compliance Rates by Country

[400]:
```
country_compliance = df_merged['production_countries'].explode().value_counts().
 ↪reset_index()
country_compliance.columns = ['Country', 'Total_Movies']

country_passed = df_merged[df_merged['pass_bechdel'] ==␣
 ↪1]['production_countries'].explode().value_counts().reset_index()
country_passed.columns = ['Country', 'Passing_Scores']

country_stats = pd.merge(country_compliance, country_passed, on='Country',␣
 ↪how='left').fillna(0)
country_stats['Passing_Percentage'] = (country_stats['Passing_Scores'] /␣
 ↪country_stats['Total_Movies']) * 100

fig = px.choropleth(country_stats,
                    locations='Country',
                    locationmode='country names',
                    color='Passing_Percentage',
                    hover_name='Country',
                    color_continuous_scale='Viridis',
                    title='Bechdel Test Compliance Rates by Country'
)
fig.show()
```



[401]:
```
df_merged['popularity'] = pd.to_numeric(df_merged['popularity'],␣
 ↪errors='coerce')

df_merged = df_merged.dropna(subset=['popularity'])
```

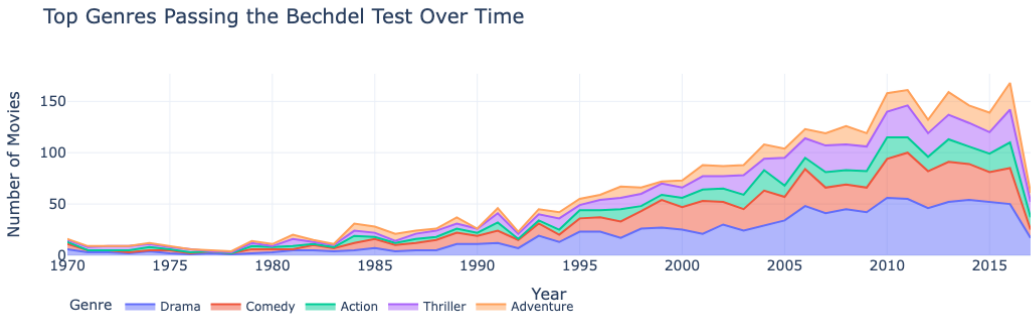
4.3 Box Plot: IMDb Ratings by Genre, Split by Bechdel Compliance

[402]:
```
df_genres = df_merged.explode('genres')

fig = px.box(
    df_genres,
    x='genres',
    y='vote_average',
    color='pass_bechdel',
    title='IMDb Ratings by Genre, Split by Bechdel Compliance',
    labels={'vote_average': 'IMDb Ratings', 'genres': 'Genre'},
    color_discrete_sequence=['#1abc9c',
    '#f39c12'],
    category_orders={'genres': sorted(df_genres['genres'].unique())}
)
fig.update_layout(xaxis_tickangle=45)
fig.show()
```

4.4 Stacked Area Chart: Bechdel Test Passing Movies by Genre Over Time

[403]:
```
df_merged['pass_bechdel'] = df_merged['rating'].apply(lambda x: 1 if x >= 3␣
↪else 0)

df_genre_time = df_merged.explode('genres')

top_genres = (
    df_genre_time['genres']
    .value_counts()
    .nlargest(5)
    .index.tolist()
)


df_genre_time_filtered = df_genre_time[df_genre_time['genres'].isin(top_genres)]


df_genre_time_grouped = (
    df_genre_time_filtered.groupby(['year', 'genres', 'pass_bechdel'])
    .size()
    .reset_index(name='count')
)


df_genre_pass = df_genre_time_grouped[df_genre_time_grouped['pass_bechdel'] ==␣
↪1]


fig = px.area(
    df_genre_pass,
    x='year',
    y='count',
    color='genres',
    title='Top Genres Passing the Bechdel Test Over Time',
    labels={
        'count': 'Number of Movies',
        'year': 'Year',
        'genres': 'Genre'
    },
    template='plotly_white'
)
```

```
fig.update_layout(
    title=dict(
        text='Top Genres Passing the Bechdel Test Over Time',
        font=dict(size=20)
    ),
    xaxis=dict(
        title='Year',
        title_font=dict(size=16),
        range=[1889, df_genre_time['year'].max()],
        tickfont=dict(size=14)
    ),
    yaxis=dict(
        title='Number of Movies',
        title_font=dict(size=16),
        tickfont=dict(size=14)
    ),
    legend=dict(
        title='Genre',
        font=dict(size=12),
        orientation="h",
        y=-0.2
    )
)
fig.update_layout(
    xaxis=dict(range=[1920, df_yearly['year'].max()])
)

fig.show()
```



4.5 Sentiment Word Cloud for Passing vs. Failing Movies

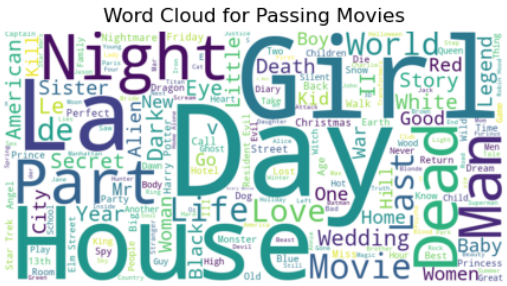
[404]:
```
!pip install wordcloud
```

```
Requirement already satisfied: wordcloud in /opt/anaconda3/lib/python3.12/site-
```

```
packages (1.9.4)
Requirement already satisfied: numpy>=1.6.1 in
/opt/anaconda3/lib/python3.12/site-packages (from wordcloud) (1.26.4)
Requirement already satisfied: pillow in /opt/anaconda3/lib/python3.12/site-
packages (from wordcloud) (10.4.0)
Requirement already satisfied: matplotlib in /opt/anaconda3/lib/python3.12/site-
packages (from wordcloud) (3.9.2)
Requirement already satisfied: contourpy>=1.0.1 in
/opt/anaconda3/lib/python3.12/site-packages (from matplotlib->wordcloud) (1.2.0)
Requirement already satisfied: cycler>=0.10 in
/opt/anaconda3/lib/python3.12/site-packages (from matplotlib->wordcloud)
(0.11.0)
Requirement already satisfied: fonttools>=4.22.0 in
/opt/anaconda3/lib/python3.12/site-packages (from matplotlib->wordcloud)
(4.51.0)
Requirement already satisfied: kiwisolver>=1.3.1 in
/opt/anaconda3/lib/python3.12/site-packages (from matplotlib->wordcloud) (1.4.4)
Requirement already satisfied: packaging>=20.0 in
/opt/anaconda3/lib/python3.12/site-packages (from matplotlib->wordcloud) (24.1)
Requirement already satisfied: pyparsing>=2.3.1 in
/opt/anaconda3/lib/python3.12/site-packages (from matplotlib->wordcloud) (3.1.2)
Requirement already satisfied: python-dateutil>=2.7 in
/opt/anaconda3/lib/python3.12/site-packages (from matplotlib->wordcloud)
(2.9.0.post0)
Requirement already satisfied: six>=1.5 in /opt/anaconda3/lib/python3.12/site-
packages (from python-dateutil>=2.7->matplotlib->wordcloud) (1.16.0)
```

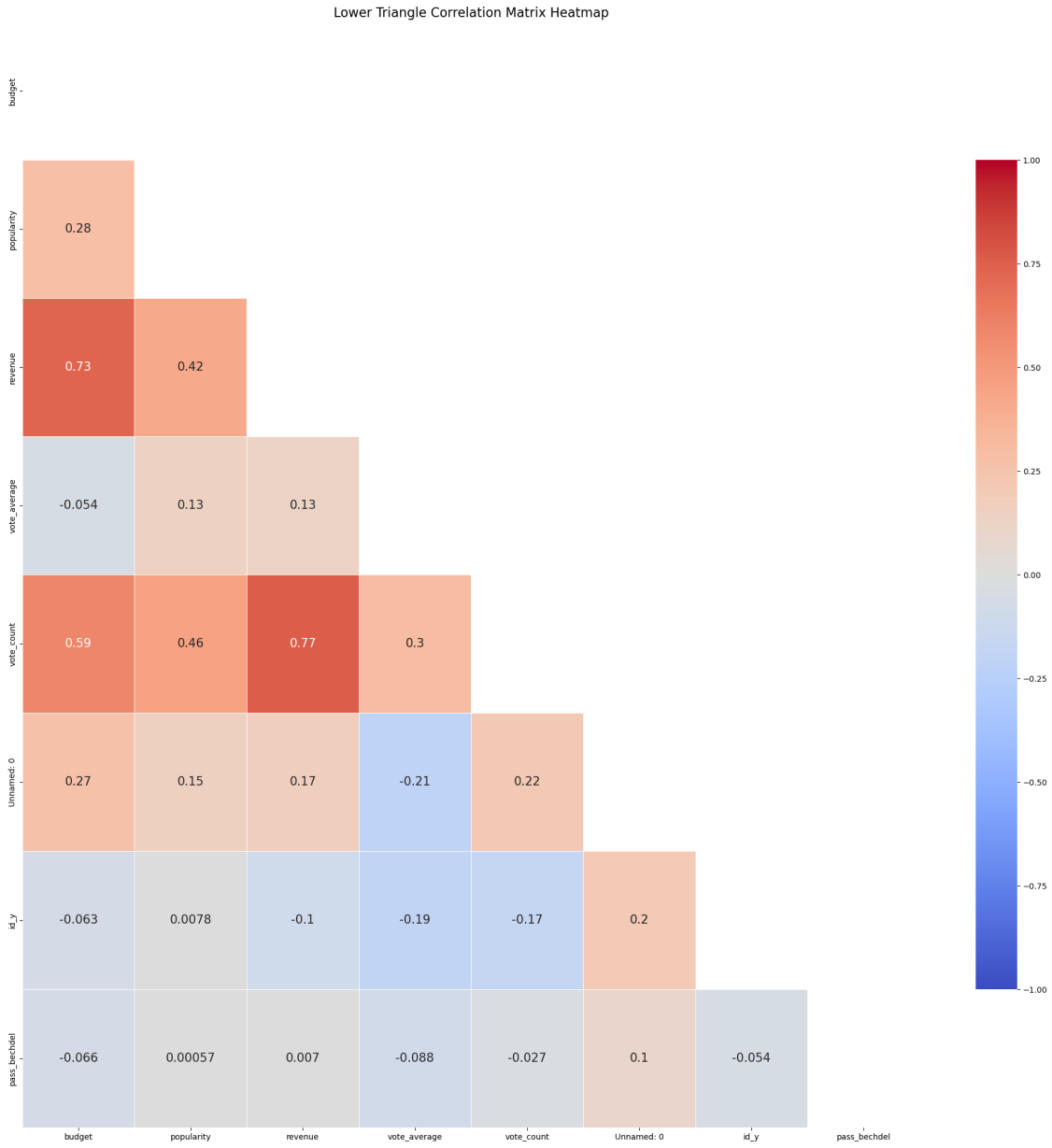
[405]:
```
from wordcloud import WordCloud

passing_movies = df_merged[df_merged['pass_bechdel'] == 1]['original_title']
failing_movies = df_merged[df_merged['pass_bechdel'] == 0]['original_title']


passing_text = " ".join(passing_movies)
failing_text = " ".join(failing_movies)

passing_wordcloud = WordCloud(width=800, height=400, background_color="white").
 ↪generate(passing_text)
failing_wordcloud = WordCloud(width=800, height=400, background_color="white").
 ↪generate(failing_text)


plt.figure(figsize=(12, 6))

plt.subplot(1, 2, 1)
plt.imshow(passing_wordcloud, interpolation="bilinear")
plt.title("Word Cloud for Passing Movies")
```

```
plt.axis("off")

plt.subplot(1, 2, 2)
plt.imshow(failing_wordcloud, interpolation="bilinear")
plt.title("Word Cloud for Failing Movies")
plt.axis("off")

plt.show()
```

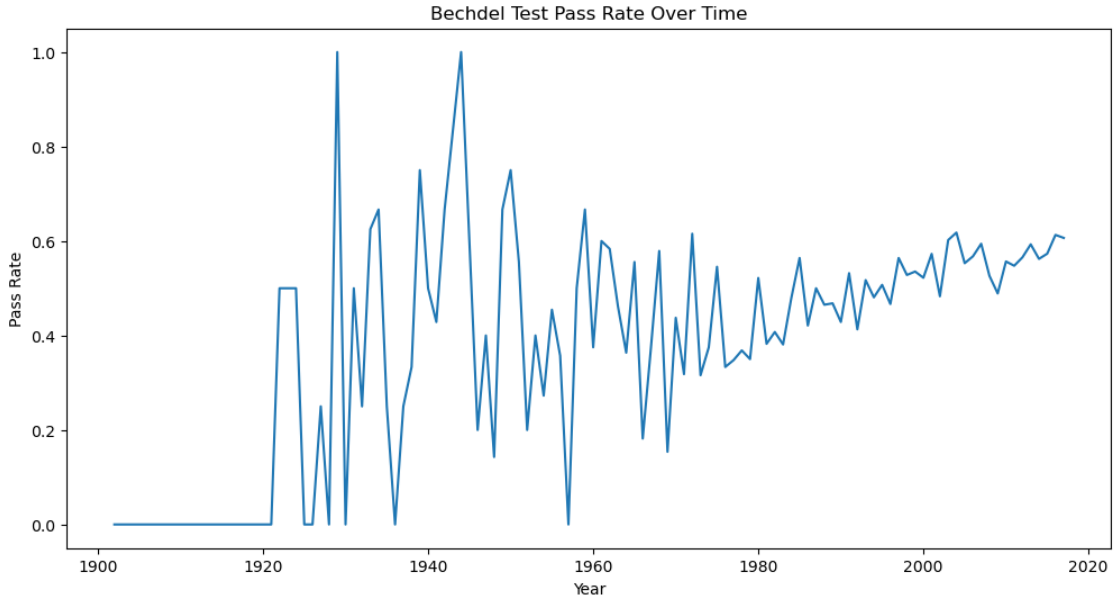


[406]:
```
columns_to_exclude = ['adult',  'genres', 'original_language',␣
 ↪'production_companies','production_countries','status', 'title_y',␣
 ↪'original_title']

df_filtered = df_merged.drop(columns=columns_to_exclude)

df_numeric = df_filtered.select_dtypes(include=[np.number])


correlation_matrix = df_numeric.corr()
mask = np.triu(np.ones_like(correlation_matrix, dtype=bool))


plt.figure(figsize=(20, 20))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt='.2', vmin=-1,␣
 ↪vmax=1,
            mask=mask, linewidths=0.5, annot_kws={"size": 15},␣
 ↪cbar_kws={"shrink": 0.75})


plt.title("Lower Triangle Correlation Matrix Heatmap", fontsize=16)


plt.tight_layout()

plt.show()
```

```
plt.show()
```



[410]:
```
pass_rate = df_merged.groupby('year')['pass_bechdel'].mean()

plt.figure(figsize=(12, 6))
sns.lineplot(x=pass_rate.index, y=pass_rate.values)
plt.title('Bechdel Test Pass Rate Over Time')
plt.xlabel('Year')
plt.ylabel('Pass Rate')
plt.show()
```



5 Machine Learning

5.1 Comparing Random Forest and Logistic Regression and XGBoost

[407]:
```
df_merged['pass_bechdel'].value_counts()
```

[407]:
```
pass_bechdel
1    2191
0    1970
Name: count, dtype: int64
```

[408]:
```
y.value_counts(normalize=True)
```

[408]:
```
pass_bechdel
1.0    0.501268
0.0    0.498732
Name: proportion, dtype: float64
```

[409]:
```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import OneHotEncoder, StandardScaler
from sklearn.impute import SimpleImputer
from sklearn.compose import ColumnTransformer
from sklearn.pipeline import Pipeline


from sklearn.ensemble import RandomForestClassifier, RandomForestRegressor
from sklearn.linear_model import LogisticRegression
```

```
from sklearn.cluster import KMeans
from sklearn.metrics import classification_report, roc_auc_score,␣
 ↪mean_squared_error
from sklearn.decomposition import PCA


from sklearn.utils.class_weight import compute_class_weight
import warnings
warnings.filterwarnings('ignore')
```

[436]:
```
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
import xgboost as xgb
from sklearn.metrics import accuracy_score, confusion_matrix,␣
 ↪classification_report


X = df_merged[['budget', 'revenue', 'vote_average', 'vote_count', 'popularity',␣
 ↪'year']]
y = df_merged['pass_bechdel']

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)


models = {
    'Logistic Regression': LogisticRegression(),
    'Random Forest': RandomForestClassifier(),
    'XGBoost': xgb.XGBClassifier()
}


for model_name, model in models.items():
    # Train model
    model.fit(X_train, y_train)

    # Make predictions
    y_pred = model.predict(X_test)

    # Evaluate performance
    print(f'{model_name} Evaluation:')
    print('Accuracy:', accuracy_score(y_test, y_pred))
    print('Confusion Matrix:\n', confusion_matrix(y_test, y_pred))
    print('Classification Report:\n', classification_report(y_test, y_pred))
    print('\n' + '-'*50)
```

```
Logistic Regression Evaluation:
Accuracy: 0.5414165666266506
Confusion Matrix:
 [[ 97 324]
 [ 58 354]]
Classification Report:
              precision    recall  f1-score   support

           0       0.63      0.23      0.34       421
           1       0.52      0.86      0.65       412

    accuracy                           0.54       833
   macro avg       0.57      0.54      0.49       833
weighted avg       0.57      0.54      0.49       833


--------------------------------------------------
Random Forest Evaluation:
Accuracy: 0.5798319327731093
Confusion Matrix:
 [[221 200]
 [150 262]]
Classification Report:
              precision    recall  f1-score   support

           0       0.60      0.52      0.56       421
           1       0.57      0.64      0.60       412

    accuracy                           0.58       833
   macro avg       0.58      0.58      0.58       833
weighted avg       0.58      0.58      0.58       833


--------------------------------------------------
XGBoost Evaluation:
Accuracy: 0.5462184873949579
Confusion Matrix:
 [[209 212]
 [166 246]]
Classification Report:
              precision    recall  f1-score   support

           0       0.56      0.50      0.53       421
           1       0.54      0.60      0.57       412

    accuracy                           0.55       833
   macro avg       0.55      0.55      0.55       833
weighted avg       0.55      0.55      0.55       833
```

5.2 After applying cross validatioin and hyperparameter tuning:

[443]:
```
X = df_merged[['budget', 'revenue', 'vote_average', 'vote_count', 'popularity',␣
 ↪'year']]
y = df_merged['pass_bechdel']


X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)


models = {
    'Logistic Regression': LogisticRegression(),
    'Random Forest': RandomForestClassifier(),
    'XGBoost': xgb.XGBClassifier()
}

# Train and evaluate each model with cross-validation
for model_name, model in models.items():
    # Train the model with cross-validation
    cv_scores = cross_val_score(model, X_train, y_train, cv=5,␣
 ↪scoring='accuracy')  # 5-fold cross-validation

    # Output the average cross-validation score
    print(f'{model_name} - Cross-Validation Accuracy: {np.mean(cv_scores):.4f}')

    # Train the model on the entire training set
    model.fit(X_train, y_train)

    # Make predictions
    y_pred = model.predict(X_test)

    # Evaluate performance
    print(f'{model_name} Evaluation on Test Data:')
    print('Accuracy:', accuracy_score(y_test, y_pred))
    print('Confusion Matrix:\n', confusion_matrix(y_test, y_pred))
    print('Classification Report:\n', classification_report(y_test, y_pred))
    print('\n' + '-'*50)
```

```
Logistic Regression - Cross-Validation Accuracy: 0.5637
Logistic Regression Evaluation on Test Data:
Accuracy: 0.5414165666266506
Confusion Matrix:
 [[ 97 324]
```

```
 [ 58 354]]
Classification Report:
              precision    recall  f1-score   support

           0       0.63      0.23      0.34       421
           1       0.52      0.86      0.65       412

    accuracy                           0.54       833
   macro avg       0.57      0.54      0.49       833
weighted avg       0.57      0.54      0.49       833


--------------------------------------------------
Random Forest - Cross-Validation Accuracy: 0.5727
Random Forest Evaluation on Test Data:
Accuracy: 0.5654261704681873
Confusion Matrix:
 [[220 201]
 [161 251]]
Classification Report:
              precision    recall  f1-score   support

           0       0.58      0.52      0.55       421
           1       0.56      0.61      0.58       412

    accuracy                           0.57       833
   macro avg       0.57      0.57      0.56       833
weighted avg       0.57      0.57      0.56       833


--------------------------------------------------
XGBoost - Cross-Validation Accuracy: 0.5372
XGBoost Evaluation on Test Data:
Accuracy: 0.5462184873949579
Confusion Matrix:
 [[209 212]
 [166 246]]
Classification Report:
              precision    recall  f1-score   support

           0       0.56      0.50      0.53       421
           1       0.54      0.60      0.57       412

    accuracy                           0.55       833
   macro avg       0.55      0.55      0.55       833
weighted avg       0.55      0.55      0.55       833
```

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[444]:
```
# GridSearchCV for Random Forest
param_grid_rf = {
    'n_estimators': [100, 200],
    'max_depth': [10, 20, None],
    'min_samples_split': [2, 5],
}

grid_search_rf = GridSearchCV(RandomForestClassifier(), param_grid_rf, cv=5,␣
 ↪n_jobs=-1)
grid_search_rf.fit(X_train, y_train)

print("Best hyperparameters for Random Forest:", grid_search_rf.best_params_)
best_rf_model = grid_search_rf.best_estimator_
```

```
Best hyperparameters for Random Forest: {'max_depth': 10, 'min_samples_split':
5, 'n_estimators': 200}
```

[445]:
```
param_grid_xgb = {
    'max_depth': [3, 6, 10],
    'learning_rate': [0.01, 0.1, 0.2],
    'n_estimators': [100, 200]
}

grid_search_xgb = GridSearchCV(xgb.XGBClassifier(), param_grid_xgb, cv=5,␣
 ↪n_jobs=-1)
grid_search_xgb.fit(X_train, y_train)

print("Best hyperparameters for XGBoost:", grid_search_xgb.best_params_)
best_xgb_model = grid_search_xgb.best_estimator_
```

```
Best hyperparameters for XGBoost: {'learning_rate': 0.1, 'max_depth': 3,
'n_estimators': 100}
```

[446]:
```
# For Random Forest
rf_feature_importance = best_rf_model.feature_importances_
print('Feature Importance for Random Forest:', rf_feature_importance)

# For XGBoost
xgb_feature_importance = best_xgb_model.feature_importances_
print('Feature Importance for XGBoost:', xgb_feature_importance)
```

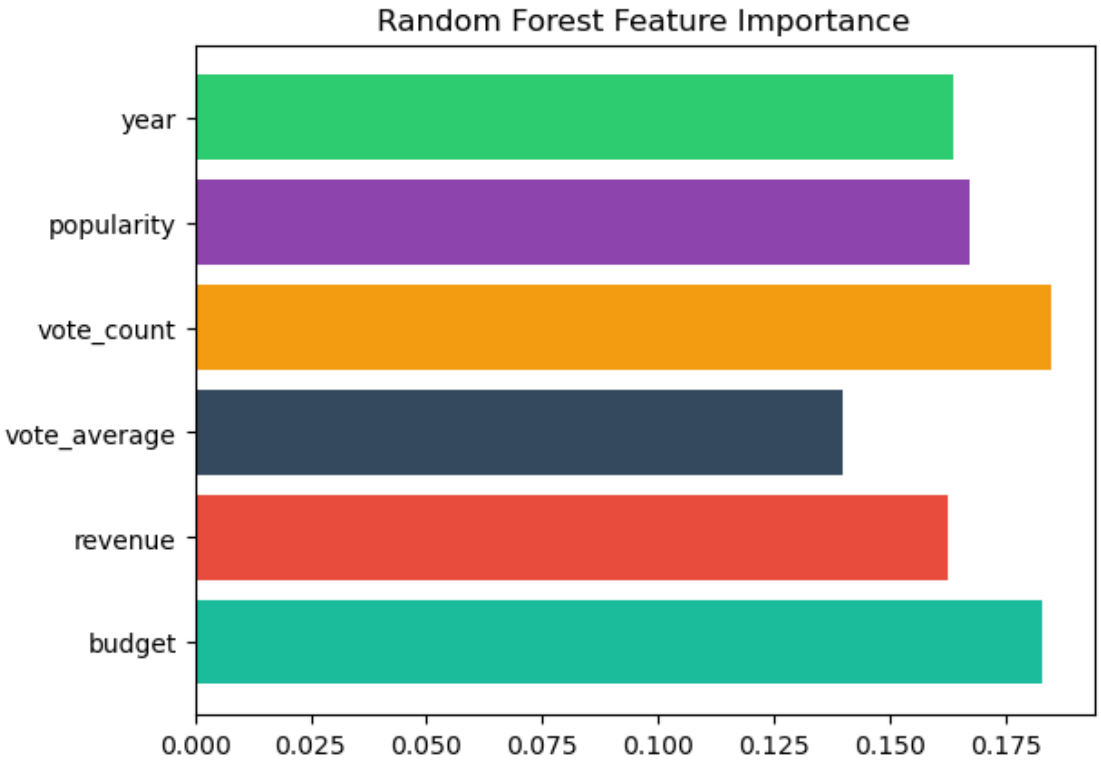
```
Feature Importance for Random Forest: [0.18259435 0.16225099 0.1398328
0.18469043 0.16716443 0.163467  ]
Feature Importance for XGBoost: [0.19387145 0.17448866 0.16569029 0.17277744
0.1209092  0.17226297]
```

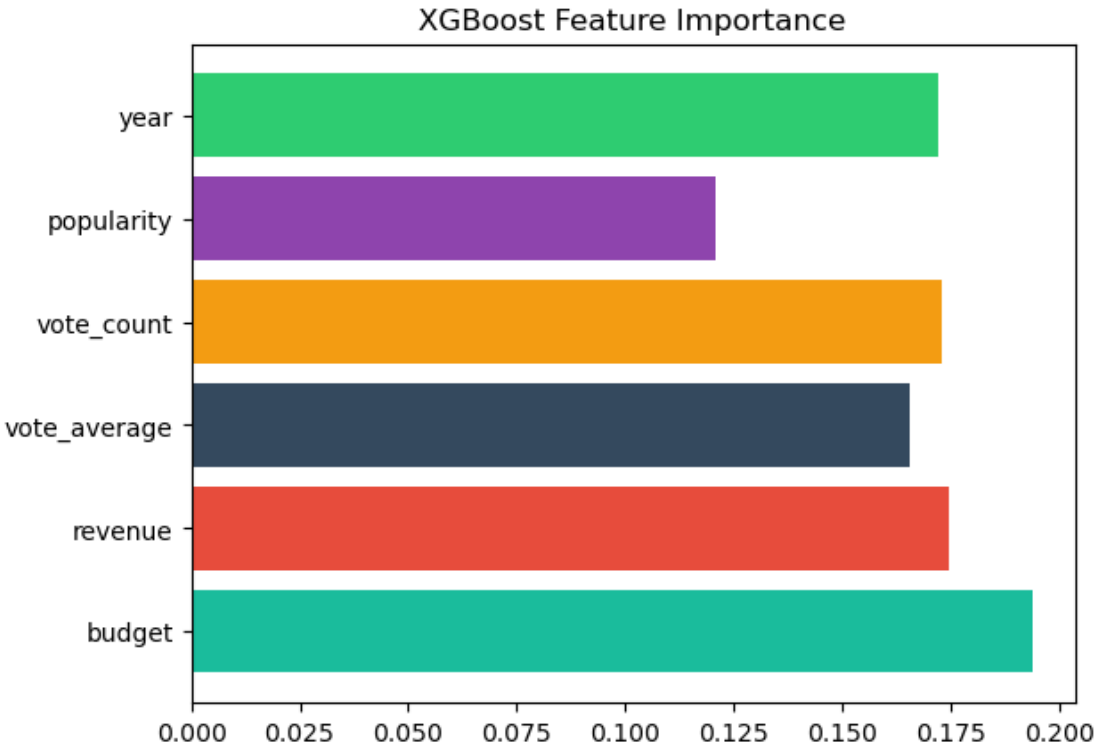
[447]:
```
feature_names = X.columns


colors = ['#1abc9c', '#e74c3c', '#34495e', '#f39c12', '#8e44ad','#2ecc71']

# For Random Forest Plot
plt.barh(feature_names, rf_feature_importance, color=colors *␣
 ↪(len(feature_names) // len(colors)) + colors[:len(feature_names) %␣
 ↪len(colors)])
plt.title('Random Forest Feature Importance')
plt.show()

# For XGBoost Plot
plt.barh(feature_names, xgb_feature_importance, color=colors *␣
 ↪(len(feature_names) // len(colors)) + colors[:len(feature_names) %␣
 ↪len(colors)])
plt.title('XGBoost Feature Importance')
plt.show()
```




XGBoost Feature Importance
year
popularity
vote_count
vote_average
revenue
budget
0.000
0.025
0.050
0.075
0.100
0.125
0.150
0.175
0.200

[ ]: