TMDb Movie Data Analysis and Building a Movie Recommendation System

- # Part 1: Data Cleaning/Transformation ### In this project, we will analyze movie data from the TMDB database, and try to extract some meaningful insight from it with Exploratory Data Analysis, visualization, and DataFrame manipulations. ### There are four parts to this end-to-end project: ### • Data download, data cleaning, feature engineering. ### • Exploratory Data Analysis. ### • Creating the final dataset and creating the recommendation algorithm. ### • Creating a Streamlit app to be deployed on Heroku. ### The first part of this project will focus on cleaning and manipulating the DataFrame, extracting any valuable information and removing any data that is not needed. ### The end result will be a movie recommendation system based on movie vector similarity.

- **id:** The ID of the movie (clear/unique identifier).
- **title:** The Official Title of the movie.
- **tagline:** The tagline of the movie.
- **release_date:** Theatrical Release Date of the movie.
- **genres:** Genres associated with the movie.
- **belongs_to_collection:** Gives information on the movie series/franchise the particular film belongs to.
- **original_language:** The language in which the movie was originally shot in.
- **budget_musd:** The budget of the movie in million dollars.
- **revenue_musd:** The total revenue of the movie in million dollars.
- **production_companies:** Production companies involved with the making of the movie.
- **production_countries:** Countries where the movie was shot/produced in.
- **vote_count:** The number of votes by users, as counted by TMDB.
- **vote_average:** The average rating of the movie.
- **popularity:** The Popularity Score assigned by TMDB.
- **runtime:** The runtime of the movie in minutes.
- **overview:** A brief blurb of the movie.
- **spoken_languages:** Spoken languages in the film.
- **poster_path:** The URL of the poster image.
- **cast:** (Main) Actors appearing in the movie.
- **cast_size:** number of Actors appearing in the movie.
- **director:** Director of the movie.
- **crew_size:** Size of the film crew (incl. director, excl. actors).

Loading the main libraries

In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from ast import literal_eval
import urllib
import requests
import json
import gzip
import time
from tqdm import tqdm

pd.options.display.max_columns = 20
```

Getting all valid movie IDs from TMDB's Daily File Exports

In [3]:
```
def get_movie_ids():
    json_gz_path = 'http://files.tmdb.org/p/exports/movie_ids_10_28_2021.json.
    urllib.request.urlretrieve(json_gz_path,'movie_ids_10_28_2021.json.gz') #
    movie_ids = []
    with gzip.open('movie_ids_10_28_2021.json.gz', 'r') as f:
        for line in f:
            movie_ids.append(json.loads(line)['id'])
    return movie_ids
```

In [4]:
```
movie_ids = get_movie_ids()
```

In [5]:
```
print(f"First 10 movie ids: {movie_ids[:10]}")
print(f"# of movie ids: {format(len(movie_ids), ',d')}")
```

```
First 10 movie ids: [3924, 6124, 8773, 25449, 31975, 2, 3, 5, 6, 8]
# of movie ids: 650,449
```

Downloading the movie dataset using TMDB's API

In [18]:
```
session = requests.Session()
session.headers = {
    "User-Agent": "Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.3
    "Accept-Encoding": "*",
    "Connection": "keep-alive"
}
```

In [22]:
```
def retry(func, retries=10):
    def retry_wrapper(*args, **kwargs):
        attempts = 0
        while attempts < retries:
            try:
                return func(*args, **kwargs)
            except requests.exceptions.RequestException as e:
                print(e)
                time.sleep(5)
                attempts += 1

    return retry_wrapper
```

In [30]:
```
from api_key import api # Personal API key used to download the data.

failed_ids = []

@retry
def download_movie_data(movie_id, session=session):
    link = f'https://api.themoviedb.org/3/movie/{movie_id}?api_key={api}&langu
    response = session.get(link)
    if response.status_code == 200:
        return response.json()
    else:
        failed_ids.append(movie_id)
        return np.nan
```

In [ ]:
```
movies = []
pbar = tqdm(total=len(movie_ids))
for movie_id in movie_ids:
    movies.append(download_movie_data(movie_id))
    pbar.update(1)
pbar.close()
```

In [117…

```
len(movies)
```

Out[117]:

```
650643
```

In [118…

```
len(failed_ids)
```

Out[118]:

```
194
```

Retrying failed movie requests

In [107…

```
failed_movies = []
for failed_movie_id in failed_ids:
    failed_movies.append(download_movie_data(movie_id))
```

In [110…

```
movies.extend(failed_movies)
```

In [111…

```
len(movies)
```

Out[111]:

```
650643
```

Saving the resultant movies dataset

In [112…

```
movies_series = pd.Series(movies).dropna()
```

In [113…

```
df = pd.DataFrame.from_records(movies_series)
```

In [119…

```
df.head()
```

Out[119]:

	adult	backdrop_path	belongs_to_collection	budget	genres	
0	False	/dvQj1GBZAZirz1skEEZyWH2ZqQP.jpg	{'id': 177062, 'name': 'Blondie Collection', '...	0	[{'id': 35, 'name': 'Comedy'}]	
1	False	NaN	NaN	0	[{'id': 12, 'name': 'Adventure'}]	
2	False	/uJlc4aNPF3Y8yAqahJTKBwgwPVW.jpg	NaN	0	[{'id': 18, 'name': 'Drama'}, {'id': 10749, 'n...	
3	False	NaN	{'id': 425256, 'name': 'New World Disorder', '...	0	[]	http://ww
4	False	NaN	NaN	0	[{'id': 10751, 'name': 'Family'}]	

5 rows × 25 columns

In [115…

```
df.to_csv('movies_metadata.csv', index=False)
```

Downloading credits datasets for each movie

In [125…

```
failed_ids = []

@retry
def download_credits_data(movie_id, session=session):
    link = f'https://api.themoviedb.org/3/movie/{movie_id}/credits?api_key={ap
    response = session.get(link)
    if response.status_code == 200:
        return response.json()
    else:
        failed_ids.append(movie_id)
        return np.nan
```

In [126…

```
credits = []
pbar = tqdm(total=len(movie_ids))
for movie_id in movie_ids:
    credits.append(download_credits_data(movie_id))
    pbar.update(1)
pbar.close()
```

```
100%|██████████████████████████████████████████████████████████████████████████|
650449/650449 [12:30:37<00:00, 14.44it/s]
```

In [132…
```
credits_series = pd.Series(credits).dropna()
```

In [133…
```
credits_df = pd.DataFrame(credits_series)
credits_df.to_csv('credits.csv', index=False)
del credits_df
```

Out[133]:

	0
0	{'id': 3924, 'cast': [{'adult': False, 'gender...
1	{'id': 6124, 'cast': [{'adult': False, 'gender...
2	{'id': 8773, 'cast': [{'adult': False, 'gender...
3	{'id': 25449, 'cast': [{'adult': False, 'gende...
4	{'id': 31975, 'cast': [], 'crew': []}
5	{'id': 2, 'cast': [{'adult': False, 'gender': ...
6	{'id': 3, 'cast': [{'adult': False, 'gender': ...
7	{'id': 5, 'cast': [{'adult': False, 'gender': ...
8	{'id': 6, 'cast': [{'adult': False, 'gender': ...
9	{'id': 8, 'cast': [], 'crew': [{'adult': False...
10	{'id': 9, 'cast': [{'adult': False, 'gender': ...
11	{'id': 11, 'cast': [{'adult': False, 'gender':...
12	{'id': 12, 'cast': [{'adult': False, 'gender':...
13	{'id': 13, 'cast': [{'adult': False, 'gender':...
14	{'id': 14, 'cast': [{'adult': False, 'gender':...
15	{'id': 15, 'cast': [{'adult': False, 'gender':...
16	{'id': 16, 'cast': [{'adult': False, 'gender':...
17	{'id': 17, 'cast': [{'adult': False, 'gender':...
18	{'id': 18, 'cast': [{'adult': False, 'gender':...
19	{'id': 19, 'cast': [{'adult': False, 'gender':...
20	{'id': 20, 'cast': [{'adult': False, 'gender':...
21	{'id': 21, 'cast': [{'adult': False, 'gender':...
22	{'id': 22, 'cast': [{'adult': False, 'gender':...
23	{'id': 24, 'cast': [{'adult': False, 'gender':...
24	{'id': 25, 'cast': [{'adult': False, 'gender':...
25	{'id': 26, 'cast': [{'adult': False, 'gender':...
26	{'id': 27, 'cast': [{'adult': False, 'gender':...
27	{'id': 28, 'cast': [{'adult': False, 'gender':...
28	{'id': 33, 'cast': [{'adult': False, 'gender':...
29	{'id': 35, 'cast': [{'adult': False, 'gender':...
30	{'id': 38, 'cast': [{'adult': False, 'gender':...
31	{'id': 55, 'cast': [{'adult': False, 'gender':...
32	{'id': 58, 'cast': [{'adult': False, 'gender':...
33	{'id': 59, 'cast': [{'adult': False, 'gender':...
34	{'id': 62, 'cast': [{'adult': False, 'gender':...
35	{'id': 63, 'cast': [{'adult': False, 'gender':...

	0
36	{'id': 64, 'cast': [{'adult': False, 'gender':...
37	{'id': 65, 'cast': [{'adult': False, 'gender':...
38	{'id': 66, 'cast': [{'adult': False, 'gender':...
39	{'id': 67, 'cast': [{'adult': False, 'gender':...
40	{'id': 68, 'cast': [{'adult': False, 'gender':...
41	{'id': 69, 'cast': [{'adult': False, 'gender':...
42	{'id': 70, 'cast': [{'adult': False, 'gender':...
43	{'id': 71, 'cast': [{'adult': False, 'gender':...
44	{'id': 73, 'cast': [{'adult': False, 'gender':...
45	{'id': 74, 'cast': [{'adult': False, 'gender':...
46	{'id': 75, 'cast': [{'adult': False, 'gender':...
47	{'id': 76, 'cast': [{'adult': False, 'gender':...
48	{'id': 77, 'cast': [{'adult': False, 'gender':...
49	{'id': 78, 'cast': [{'adult': False, 'gender':...

- All of our data are downloaded and ready to view.

Data Cleaning

Some of the data attributes are in json format, so we will have to extract the columns/variables from json dictionary strings.

In [2]:
```
df = pd.read_csv('movies_metadata.csv', low_memory=False)
df
```

Out[2]:

	adult	backdrop_path	belongs_to_collection	budget	genres
0	False	/dvQj1GBZAZirz1skEEZyWH2ZqQP.jpg	{'id': 177062, 'name': 'Blondie Collection', '...	0	[{'id': 35, 'name': 'Comedy'}]
1	False	NaN	NaN	0	[{'id': 12, 'name': 'Adventure'}]
2	False	/uJlc4aNPF3Y8yAqahJTKBwgwPVW.jpg	NaN	0	[{'id': 18, 'name': 'Drama'}, {'id': 10749, 'n...
3	False	NaN	{'id': 425256, 'name': 'New World Disorder', '...	0	[]
4	False	NaN	NaN	0	[{'id': 10751, 'name': 'Family'}]
...	...	...	...	...	...
650444	False	NaN	NaN	0	[{'id': 99, 'name': 'Documentary'}]
650445	False	NaN	NaN	0	[{'id': 99, 'name': 'Documentary'}]
650446	False	NaN	NaN	0	[{'id': 99, 'name': 'Documentary'}]
650447	False	NaN	NaN	0	[{'id': 99, 'name': 'Documentary'}]
650448	False	NaN	NaN	0	[{'id': 99, 'name': 'Documentary'}]

650449 rows × 25 columns

In [3]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 650449 entries, 0 to 650448
Data columns (total 25 columns):
 #   Column                 Non-Null Count   Dtype  
---  ------                 --------------   -----  
 0   adult                  650449 non-null  bool   
 1   backdrop_path          166759 non-null  object 
 2   belongs_to_collection  16176 non-null   object 
 3   budget                 650449 non-null  int64  
 4   genres                 650449 non-null  object 
 5   homepage               75382 non-null   object 
 6   id                     650449 non-null  int64  
 7   imdb_id                432724 non-null  object 
 8   original_language      650449 non-null  object 
 9   original_title         650446 non-null  object 
 10  overview               538518 non-null  object 
 11  popularity             650449 non-null  float64
 12  poster_path            438992 non-null  object 
 13  production_companies   650449 non-null  object 
 14  production_countries   650449 non-null  object 
 15  release_date           590521 non-null  object 
 16  revenue                650449 non-null  int64  
 17  runtime                597471 non-null  float64
 18  spoken_languages       650449 non-null  object 
 19  status                 650449 non-null  object 
 20  tagline                91811 non-null   object 
 21  title                  650446 non-null  object 
 22  video                  650449 non-null  bool   
 23  vote_average           650449 non-null  float64
 24  vote_count             650449 non-null  int64  
dtypes: bool(2), float64(3), int64(4), object(16)
memory usage: 115.4+ MB
```

Dropping irrelevant columns that will not be needed.

In [4]:
```
df.drop(columns=['adult', 'imdb_id', 'original_title', 'video', 'homepage', 'b
df.head()
```

Out[4]:

	belongs_to_collection	budget	genres	id	original_language	overview	popularity	
0	{'id': 177062, 'name': 'Blondie Collection', '...	0	[{'id': 35, 'name': 'Comedy'}]	3924	en	Blondie and Dagwood are about to celebrate the...	2.445	/o6
1	NaN	0	[{'id': 12, 'name': 'Adventure'}]	6124	de	Der Mann ohne Namen is a German adventure movi...	0.600	
2	NaN	0	[{'id': 18, 'name': 'Drama'}, {'id': 10749, 'n...	8773	fr	Love at Twenty unites five directors from five...	4.985	/a
3	{'id': 425256, 'name': 'New World Disorder', '...	0	[]	25449	en	Gee Atherton ripping the Worlds course the day...	1.337	/okQ
4	NaN	0	[{'id': 10751, 'name': 'Family'}]	31975	en	Elmo is making a very, very super special surp...	0.600	/qK

How to Handle Stringified JSON Columns

Columns that contain dictionaries or lists are treated as strings in pandas.

In order to access their entries, they will be converted to their appropriate form using the **ast** module.

In [5]:
```
import json
import ast
```

In [6]:
```
json_col = ['belongs_to_collection', 'genres', 'production_countries', 'produc
```

In [7]:
```
df[json_col].head()
```

Out[7]:

	belongs_to_collection	genres	production_countries	production_companies	spoken_langu
0	{'id': 177062, 'name': 'Blondie Collection', '...	[{'id': 35, 'name': 'Comedy'}]	[{'iso_3166_1': 'US', 'name': 'United States o...	[{'id': 5, 'logo_path': '/71BqEFAF4V3qjjMPCpLu...	[{'english_ 'Er 'iso_639_1'
1	NaN	[{'id': 12, 'name': 'Adventure'}]	[{'iso_3166_1': 'DE', 'name': 'Germany'}]	[]	
2	NaN	[{'id': 18, 'name': 'Drama'}, {'id': 10749, 'n...	[{'iso_3166_1': 'DE', 'name': 'Germany'}, {'is...	[{'id': 38936, 'logo_path': '/ypvTqUeQOxORhFEF...	[{'english_ 'Ge 'iso_639_1':
3	{'id': 425256, 'name': 'New World Disorder', '...	[]	[]	[]	[{'english_ 'Er 'iso_639_1'
4	NaN	[{'id': 10751, 'name': 'Family'}]	[]	[]	

In [2]:
```python
def lit_eval(column):
    return column.apply(lambda x: literal_eval(x) if isinstance(x, str) else n
```

In [9]:
```python
for column in json_col:
    print(f"\n{'='*40}\nColumn Name: {column}\nOriginal dtype: {type(df[column
    df[column] = lit_eval(df[column])
    print(f"New dtype: {type(df[column][0])}")
```

```
========================================
Column Name: belongs_to_collection
Original dtype: <class 'str'>
New dtype: <class 'dict'>

========================================
Column Name: genres
Original dtype: <class 'str'>
New dtype: <class 'list'>

========================================
Column Name: production_countries
Original dtype: <class 'str'>
New dtype: <class 'list'>

========================================
Column Name: production_companies
Original dtype: <class 'str'>
New dtype: <class 'list'>

========================================
Column Name: spoken_languages
Original dtype: <class 'str'>
New dtype: <class 'list'>
```

The end result is that all of the JSON columns that were not accessible due to being treated as strings are now in the form of either a list or a dictionary, and are ready to be accessed/have their values extracted.

In [10]:
```
df.head()
```

Out[10]:

	belongs_to_collection	budget	genres	id	original_language	overview	popularity	
0	{'id': 177062, 'name': 'Blondie Collection', '...	0	[{'id': 35, 'name': 'Comedy'}]	3924	en	Blondie and Dagwood are about to celebrate the...	2.445	/o6
1	NaN	0	[{'id': 12, 'name': 'Adventure'}]	6124	de	Der Mann ohne Namen is a German adventure movi...	0.600	
2	NaN	0	[{'id': 18, 'name': 'Drama'}, {'id': 10749, 'n...	8773	fr	Love at Twenty unites five directors from five...	4.985	/a
3	{'id': 425256, 'name': 'New World Disorder', '...	0	[]	25449	en	Gee Atherton ripping the Worlds course the day...	1.337	/okQ
4	NaN	0	[{'id': 10751, 'name': 'Family'}]	31975	en	Elmo is making a very, very super special surp...	0.600	/qK

Extracting the useful information from each JSON column.

Each one of the JSON columns has a "name" variable that is an attribute of each column. (ex. "Romance" under "genres", "en" under "spoken_languages", etc.)

This for loop checks the data type of each column. If it's in dictionary format, there is going to be only one "name" key for that row/column.

If it's in a dictionary format, then there might be multiple "name" keys for each dictionary in that list, which will be combined using a pipe ("|") symbol where applicable.

In [11]:
```
for column in json_col:
    if type(df[column][0]) == list:
            df[column] = df[column].apply(lambda x: '|'.join(i['name'] for i i
    else:
           df[column] = df[column].apply(lambda x: x['name'] if isinstance(x,
```

Here is the end result for a specific row and each column that was converted. (Compare to same code above)

In [12]:
```
for column in json_col:
    print(f'Column "{column}": {df[column][2]}\n{"="*100}')
```

```
Column "belongs_to_collection": nan
==============================================================================
======================
Column "genres": Drama|Romance
==============================================================================
======================
Column "production_countries": Germany|France|Italy|Japan|Poland
==============================================================================
======================
Column "production_companies": Ulysse Productions|Unitec Films|Cinesecolo|Toho
Co.|Beta Film|Film Polski|Zespół Filmowy "Kamera"
==============================================================================
======================
Column "spoken_languages": Deutsch|Français|Italiano|日本語|Polski
==============================================================================
======================
```

Replacing blank entries with NaN

Some of the rows have empty strings for each column attribute.

In [13]:
```
for column in json_col:
    print(f"*** {column} ***")
    print(f"{df[column].value_counts(dropna=False).head()}\n{'='*50}")
```

```
*** belongs_to_collection ***
NaN                                  634273
Our Gang: The Roach/MGM talkies          80
Hopalong Cassidy Collection              66
Our Gang: The Roach/Pathé silents        66
The Durango Kid Collection               65
Name: belongs_to_collection, dtype: int64
==================================================
*** genres ***
               215618
Documentary     79318
Drama           67732
Comedy          41816
Music           16955
Name: genres, dtype: int64
==================================================
*** production_countries ***
                            266260
United States of America     95773
Germany                      23767
United Kingdom               21261
France                       20550
Name: production_countries, dtype: int64
==================================================
*** production_companies ***
                         371837
Metro-Goldwyn-Mayer        1970
Columbia Pictures          1758
Warner Bros. Pictures      1670
BBC                        1539
Name: production_companies, dtype: int64
==================================================
*** spoken_languages ***
            272572
English     129138
Español      23604
Français     21461
日本語         20586
Name: spoken_languages, dtype: int64
==================================================
```

Using a simple for loop, each empty string will be replaced with NaN. The final result is below.

In [16]:
```python
for column in json_col:
    df[column].replace('', np.nan, inplace=True)
```

In [17]:
```python
for column in json_col:
    print(f"*** {column} ***")
    print(f"{df[column].value_counts(dropna=False).head()}\n{'='*50}")
```

```
*** belongs_to_collection ***
NaN                                  634273
Our Gang: The Roach/MGM talkies          80
Hopalong Cassidy Collection              66
Our Gang: The Roach/Pathé silents        66
The Durango Kid Collection               65
Name: belongs_to_collection, dtype: int64
==================================================
*** genres ***
NaN            215618
Documentary     79318
Drama           67732
Comedy          41816
Music           16955
Name: genres, dtype: int64
==================================================
*** production_countries ***
NaN                         266260
United States of America     95773
Germany                      23767
United Kingdom               21261
France                       20550
Name: production_countries, dtype: int64
==================================================
*** production_companies ***
NaN                      371837
Metro-Goldwyn-Mayer        1970
Columbia Pictures          1758
Warner Bros. Pictures      1670
BBC                        1539
Name: production_companies, dtype: int64
==================================================
*** spoken_languages ***
NaN         272572
English     129138
Español      23604
Français     21461
日本語          20586
Name: spoken_languages, dtype: int64
==================================================
```

Replacing all zero values for "budget" and "revenue" with NaN

Changing the scale of the data to millions USD

In [18]:
```
for column in ['budget', 'revenue']:
    df[column] = df[column].replace(0, np.nan)
    df[column] = df[column].div(1000000)
    df.rename(columns={column: column + '_musd'}, inplace=True)
```

Replacing all zero values for runtime with NaN

In [19]:
```
print(f"Original:\n{df.runtime.value_counts(dropna=False).head()}\n{'='*50}")
df.runtime.replace(0, np.nan, inplace=True)
print(f"New:\n{df.runtime.value_counts(dropna=False).head()}\n{'='*50}")
```

```
Original:
0.0     111613
NaN      52978
90.0     21644
10.0      9944
7.0       9143
Name: runtime, dtype: int64
==================================================
New:
NaN     164591
90.0     21644
10.0      9944
7.0       9143
6.0       8845
Name: runtime, dtype: int64
==================================================
```

Replacing entries where vote_average equals zero with NaN

In [20]:
```
df.loc[df.vote_count == 0, 'vote_average'] = np.nan
```

Converting "release_date" column to datetime format

In [21]:
```
df['release_date'] = pd.to_datetime(df['release_date'])
df['release_date'].dtype
```

Out[21]:
```
dtype('<M8[ns]')
```

Creating a "year" column containing the release year

In [22]:
```
df['year'] = df['release_date'].apply(lambda x: str(x).split('-')[0] if len(st
```

In [23]:
```
df.year.value_counts()
```

Out[23]:
```
NaT     59928
2019    28403
2020    27592
2018    25765
2017    24644
        ...  
1879        1
2030        1
1882        1
2050        1
2032        1
Name: year, Length: 156, dtype: int64
```

Replacing entries in "overview" column where the entry explicates missing overview

In [24]:
```
df.overview.value_counts(dropna=False).head(30)
```

Out[24]:
```
NaN
111931
No overview found.
1063
Mexican feature film
952
No overview found
309
No synopsis
303
No Overview
287
Plot unknown.
210
Testimonies of seven prominent photographers active in the juncture of the stu
dent movement of 1968
195
Know what this is about?
171
Documentary film.
169
No Synopsis
143
What the movie has in store for you, wait and watch this space for more update
s.
139
Coming Soon
131
Overview Coming Soon...
124
Feature film.
97
No description
93
Short film.
89
Mexican movie
87
Lift your butt, sculpt your core, and get an incredible total body transformat
ion with 80 unique “real-time” workouts and a Timed-Nutrition Eating Plan.
82

77
Transform :20 is a high-intensity, six-week workout and nutrition program that
will help transform your body and mind in just 20 minutes a day.
67
No overview.
62
»
59
Add the plot.
55
coming soon..
54
Japanese comedy film.
53
An Eternalism film.
52
shaw production
49
```

```
A short animation by Shintaro Kago.
49
Combat Bulletin was a new reel type series keeping folks up-to-date with the c
ombat of World War II.
49
Name: overview, dtype: int64
```

In [25]:
```
recurring_text = ['No overview found.', 'No overview found', 'No synopsis', 'N
                  'Overview Coming Soon...', 'Feature film.', 'No description'
                  'No description.', 'not available']

df.replace(dict.fromkeys(recurring_text, np.nan), inplace=True)
```

Replacing all blank values in the dataset with NaN

In [26]:
```
df.replace(dict.fromkeys([' ', '  ', '   '], np.nan), inplace=True)
```

Removing duplicate entries from the dataset

In [27]:
```
print(f"Duplicate Rows:\n{df.duplicated(keep=False).value_counts()}")
```

```
Duplicate Rows:
False    650254
True        195
dtype: int64
```

In [28]:
```
df.drop_duplicates(inplace=True)
```

In [29]:
```
print(f"Duplicate Rows:\n{df.duplicated(keep=False).value_counts()}")
```

```
Duplicate Rows:
False    650255
dtype: int64
```

Handling Missing Values & Removing Observations

In [30]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 650255 entries, 0 to 650254
Data columns (total 20 columns):
 #   Column                 Non-Null Count   Dtype
---  ------                 --------------   -----
 0   belongs_to_collection  16176 non-null   object
 1   budget_musd            31064 non-null   float64
 2   genres                 434637 non-null  object
 3   id                     650255 non-null  int64
 4   original_language      650255 non-null  object
 5   overview               535077 non-null  object
 6   popularity             650255 non-null  float64
 7   poster_path            438798 non-null  object
 8   production_companies   278418 non-null  object
 9   production_countries   383995 non-null  object
 10  release_date           590327 non-null  datetime64[ns]
 11  revenue_musd           14732 non-null   float64
 12  runtime                485664 non-null  float64
 13  spoken_languages       377683 non-null  object
 14  status                 650255 non-null  object
 15  tagline                91771 non-null   object
 16  title                  650244 non-null  object
 17  vote_average           259878 non-null  float64
 18  vote_count             650255 non-null  int64
 19  year                   650255 non-null  object
dtypes: datetime64[ns](1), float64(5), int64(2), object(12)
memory usage: 104.2+ MB
```

In [31]:
```python
df.isna().sum()
```

Out[31]:
```
belongs_to_collection    634079
budget_musd              619191
genres                   215618
id                            0
original_language             0
overview                 115178
popularity                    0
poster_path              211457
production_companies     371837
production_countries     266260
release_date              59928
revenue_musd             635523
runtime                  164591
spoken_languages         272572
status                        0
tagline                  558484
title                        11
vote_average             390377
vote_count                    0
year                          0
dtype: int64
```

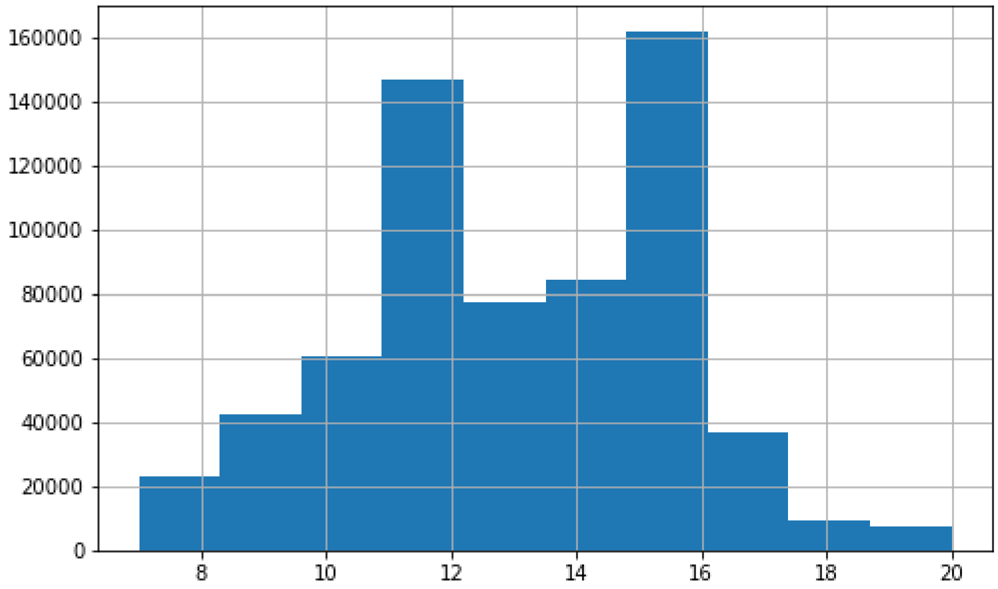
Removing rows with no "title" values

In [32]:
```python
df.dropna(subset=['title'], inplace=True)
```

Removing rows that have less than 10 non-null values in total

In [33]:
```
df.notna().sum(axis=1).hist(figsize=(8,5), bins=10)
```

Out[33]:
```
<AxesSubplot:>
```



In [34]:
```
df.notna().sum(axis=1).value_counts()
```

Out[34]:
```
14    84147
16    81079
15    80786
13    77539
12    74197
11    72882
10    60670
9     42252
17    36637
8     18631
18     9407
19     5834
7      4615
20     1568
dtype: int64
```

In [35]:
```
df = df.dropna(thresh=10).reset_index()
```

In [36]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 584746 entries, 0 to 584745
Data columns (total 21 columns):
 #   Column                 Non-Null Count   Dtype
---  ------                 --------------   -----
 0   index                  584746 non-null  int64
 1   belongs_to_collection  16130 non-null   object
 2   budget_musd            30891 non-null   float64
 3   genres                 430520 non-null  object
 4   id                     584746 non-null  int64
 5   original_language      584746 non-null  object
 6   overview               502425 non-null  object
 7   popularity             584746 non-null  float64
 8   poster_path            423837 non-null  object
 9   production_companies   278019 non-null  object
 10  production_countries   382146 non-null  object
 11  release_date           557774 non-null  datetime64[ns]
 12  revenue_musd           14696 non-null   float64
 13  runtime                475636 non-null  float64
 14  spoken_languages       375259 non-null  object
 15  status                 584746 non-null  object
 16  tagline                91436 non-null   object
 17  title                  584746 non-null  object
 18  vote_average           256255 non-null  float64
 19  vote_count             584746 non-null  int64
 20  year                   584746 non-null  object
dtypes: datetime64[ns](1), float64(5), int64(3), object(12)
memory usage: 93.7+ MB
```

Final Cleaning Steps

All rows that contain movies that are not released will be dropped, since we are only interested in analyzing released movies.

In [37]:
```
df.status.value_counts()
```

Out[37]:
```
Released           578044
In Production        2494
Planned              2159
Post Production      1849
Rumored               117
Canceled               83
Name: status, dtype: int64
```

In [38]:
```
df = df.loc[df.status == 'Released'].copy()
```

In [39]:
```
df
```

Out[39]:

	index	belongs_to_collection	budget_musd	genres	id	original_langu
0	0	Blondie Collection	NaN	Comedy	3924	
1	1	NaN	NaN	Adventure	6124	
2	2	NaN	NaN	Drama|Romance	8773	
3	3	New World Disorder	NaN	NaN	25449	
4	4	NaN	NaN	Family	31975	
...	...	...	...	...	...	
584741	650250	NaN	NaN	Drama|Romance	890928	
584742	650251	NaN	NaN	Comedy	890929	
584743	650252	NaN	NaN	Comedy|Fantasy	890930	
584744	650253	NaN	NaN	Family|Comedy|Romance	890931	
584745	650254	NaN	NaN	Documentary	890932	

578044 rows × 21 columns

In [40]:
```
df.drop('status', axis=1, inplace=True)
```

Concatenating the poster_path column values into full URL format and creating a HTML image tag column

In [41]:
```
df.poster_path[0:4]
```

Out[41]:
```
0    /o6UMTE2LzQdlKVxRnFECPmtQjsJ.jpg
1    /6xUbUCvndklbGVYiljHr34NTxSl.jpg
2    /aup2QCYCsyEeQfpboXy0f4uj8aE.jpg
3    /okQY6jVmRU19CUbYPUZC77K3XBE.jpg
Name: poster_path, dtype: object
```

In [42]:
```
def html_poster_path(value, return_html=False):
    if type(value) == str:
        if return_html == False:

            return f"https://image.tmdb.org/t/p/w500{value}"
        else:
            return f"<img src='https://image.tmdb.org/t/p/w500{value}' style='
    else:
        return np.nan
```

In [43]:
```
df['html'] = df['poster_path'].apply(lambda x: html_poster_path(x, True))
df['poster_path'] = df['poster_path'].apply(lambda x: html_poster_path(x))
```

In [44]:
```
df[['html', 'poster_path']].head()
```

Out[44]:

	html	poster_path
0	<img src='https://image.tmdb.org/t/p/w500/o6UM...	https://image.tmdb.org/t/p/w500/o6UMTE2LzQdlKV...
1	<img src='https://image.tmdb.org/t/p/w500/6xUb...	https://image.tmdb.org/t/p/w500/6xUbUCvndklbGV...
2	<img src='https://image.tmdb.org/t/p/w500/aup2...	https://image.tmdb.org/t/p/w500/aup2QCYCsyEeQf...
3	<img src='https://image.tmdb.org/t/p/w500/okQY...	https://image.tmdb.org/t/p/w500/okQY6jVmRU19CU...
4	<img src='https://image.tmdb.org/t/p/w500/qKWc...	https://image.tmdb.org/t/p/w500/qKWcCmvGr4g0dg...

Next, credits and cast information will be added to the DataFrame from the previously downloaded dataset.

In [3]:
```
credits = pd.read_csv('credits.csv')
credits
```

Out[3]:

	0
0	{'id': 3924, 'cast': [{'adult': False, 'gender...
1	{'id': 6124, 'cast': [{'adult': False, 'gender...
2	{'id': 8773, 'cast': [{'adult': False, 'gender...
3	{'id': 25449, 'cast': [{'adult': False, 'gende...
4	{'id': 31975, 'cast': [], 'crew': []}
...	...
650241	{'id': 890928, 'cast': [], 'crew': []}
650242	{'id': 890929, 'cast': [], 'crew': []}
650243	{'id': 890930, 'cast': [{'adult': False, 'gend...
650244	{'id': 890931, 'cast': [{'adult': False, 'gend...
650245	{'id': 890932, 'cast': [{'adult': False, 'gend...

650246 rows × 1 columns

In [4]:
```
credits.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 650246 entries, 0 to 650245
Data columns (total 1 columns):
 #   Column  Non-Null Count   Dtype 
---  ------  --------------   ----- 
 0   0       650246 non-null  object
dtypes: object(1)
memory usage: 5.0+ MB
```

Evaluating each value using literal_eval

In [46]:
```
credits['0'] = lit_eval(credits['0'])
```

In [47]:
```
credits = pd.json_normalize(credits['0'])
credits.head()
```

Out[47]:

	id	cast	crew
0	3924	[{'adult': False, 'gender': 1, 'id': 34178, 'k...	[{'adult': False, 'gender': 0, 'id': 34170, 'k...
1	6124	[{'adult': False, 'gender': 2, 'id': 48038, 'k...	[{'adult': False, 'gender': 2, 'id': 2902, 'kn...
2	8773	[{'adult': False, 'gender': 2, 'id': 1653, 'kn...	[{'adult': False, 'gender': 2, 'id': 1650, 'kn...
3	25449	[{'adult': False, 'gender': 0, 'id': 84130, 'k...	[{'adult': False, 'gender': 0, 'id': 112786, '...
4	31975	[]	[]

Replacing empty list entries with NaN

In [30]:
```
for column in ['cast', 'crew']:
    credits[column] = credits[column].apply(lambda x: np.nan if len(x) == 0 el
```

In [31]:
```
credits.isnull().sum()
```

Out[31]:
```
id            0
cast     217840
crew     116372
dtype: int64
```

Dropping rows with less than 2 entries

In [32]:
```
credits.dropna(thresh=2, inplace=True)
```

Extracting the names of both cast and crew columns for each row

In [33]:
```
credits['cast_names'] = credits['cast'].apply(lambda x: '|'.join([i['name'] fo
credits['crew_names'] = credits['crew'].apply(lambda x: '|'.join([i['name'] fo
```

Getting cast and crew size for each movie.

In [34]:
```
credits['cast_size'] = credits.cast.apply(lambda x: len(x) if type(x) != float
credits['crew_size'] = credits.crew.apply(lambda x: len(x) if type(x) != float
```

Extracting the director name for each movie

In [35]:
```
def get_director(x):
    if type(x) != float:
        for i in x:
            if i['job'] == 'Director':
                return i['name']
        return np.nan
```

In [36]:
```
credits['director'] = credits.crew.apply(get_director)
```

In [37]:
```
credits['director'].value_counts(dropna=False)
```

Out[37]:
```
NaN                      46510
Dave Fleischer             494
D. W. Griffith             417
Kevin Dunn                 373
Stan Brakhage              358
                         ...  
Cecily Fay                   1
Raaghav                      1
Yann Sông Le Van Ho          1
Kim Hyun-joon                1
Junca Avilés                 1
Name: director, Length: 186778, dtype: int64
```

Removing duplicate entries

```
In [38]: credits.drop_duplicates(subset='id', inplace=True)
```

Joining Both DataFrames

```
In [81]: combined_df = df.merge(credits[['id', 'cast_names', 'crew_names', 'director']]
```

```
In [82]: combined_df.head()
```

Out[82]:

	index	belongs_to_collection	budget_musd	genres	id	original_language	overview
0	0	Blondie Collection	NaN	Comedy	3924	en	Blondie and Dagwood are about to celebrate the...
1	1	NaN	NaN	Adventure	6124	de	Der Mann ohne Namen is a German adventure movi...
2	2	NaN	NaN	Drama|Romance	8773	fr	Love at Twenty unites five directors from five...
3	3	New World Disorder	NaN	NaN	25449	en	Gee Atherton ripping the Worlds course the day...
4	4	NaN	NaN	Family	31975	en	Elmo is making a very, very super special surp...

5 rows × 24 columns

Saving the final DataFrame into a csv file.

```
In [83]: combined_df.to_csv('movies_complete.csv', index = False)
```

In Part 2 of this project, we will try and gain some insight from the cleaned data about what types of movies are more popular, the

average budget and revenue of the most successful movies, what genres are more popular, and many more.