In [7]:
```
import pandas as pd

ratings = pd.read_csv(r"C:\Users\Mayo\Downloads\ml-latest-small\ml-latest-small\ratings.csv")
links = pd.read_csv(r"C:\Users\Mayo\Downloads\ml-latest-small\ml-latest-small\links.csv")
tags = pd.read_csv(r"C:\Users\Mayo\Downloads\ml-latest-small\ml-latest-small\tags.csv")
movies = pd.read_csv(r"C:\Users\Mayo\Downloads\ml-latest-small\ml-latest-small\movies.csv")
links.info()
tags.info()
movies.info()
ratings.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9742 entries, 0 to 9741
Data columns (total 3 columns):
 #   Column   Non-Null Count  Dtype
---  ------   --------------  -----
 0   movieId  9742 non-null   int64
 1   imdbId   9742 non-null   int64
 2   tmdbId   9734 non-null   float64
dtypes: float64(1), int64(2)
memory usage: 228.5 KB
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 3683 entries, 0 to 3682
Data columns (total 4 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   userId     3683 non-null   int64
 1   movieId    3683 non-null   int64
 2   tag        3683 non-null   object
 3   timestamp  3683 non-null   int64
dtypes: int64(3), object(1)
memory usage: 115.2+ KB
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9742 entries, 0 to 9741
Data columns (total 3 columns):
 #   Column   Non-Null Count  Dtype
---  ------   --------------  -----
 0   movieId  9742 non-null   int64
 1   title    9742 non-null   object
 2   genres   9742 non-null   object
dtypes: int64(1), object(2)
memory usage: 228.5+ KB
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100836 entries, 0 to 100835
Data columns (total 4 columns):
 #   Column     Non-Null Count   Dtype
---  ------     --------------   -----
 0   userId     100836 non-null  int64
 1   movieId    100836 non-null  int64
 2   rating     100836 non-null  float64
 3   timestamp  100836 non-null  int64
```

```
dtypes: float64(1), int64(3)
memory usage: 3.1 MB
```

In [10]:
```
duplicate_count = merged_df.duplicated().sum()
duplicate_count
```

Out[10]:
```
np.int64(0)
```

In [11]:
```
missing_values = merged_df.isnull().sum()
missing_values
```

Out[11]:
```
movieId                0
title                  0
genres                 0
userId_rating         21
rating                21
timestamp_rating      21
userId_tag         52549
tag                52549
timestamp_tag      52549
imdbId                 0
tmdbId                13
dtype: int64
```

In [9]:
```
merged_df = pd.merge(movies, ratings, on="movieId", how = "left")
merged_df = pd.merge(merged_df, tags, on="movieId", how="left", suffixes=('_rating', '_tag'))
merged_df = pd.merge(merged_df, links, on = "movieId", how = "left")
merged_df.head()
```

Out[9]:

	movieId	title	genres	userId_rating	rating	timestamp_rating	userId_tag	tag	timestamp_tag
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	1.0	4.0	964982703.0	336.0	pixar	1.139046e+09
1	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	1.0	4.0	964982703.0	474.0	pixar	1.137207e+09
2	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	1.0	4.0	964982703.0	567.0	fun	1.525286e+09
3	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	5.0	4.0	847434962.0	336.0	pixar	1.139046e+09
4	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	5.0	4.0	847434962.0	474.0	pixar	1.137207e+09

In [ ]:
```
merged_df = merged_df.drop(columns=['timestamp_tag','userId_rating','userId_tag'], errors='ignore')
merged_df.head()
```

Out[ ]:

	movieId	title	genres	rating	timestamp_rating	tag	imdbId	tmdbId
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	4.0	964982703.0	pixar	114709	862.0
1	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	4.0	964982703.0	pixar	114709	862.0
2	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	4.0	964982703.0	fun	114709	862.0
3	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	4.0	847434962.0	pixar	114709	862.0
4	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	4.0	847434962.0	pixar	114709	862.0

In [12]:
```
merged_df['timestamp_rating'] = pd.to_datetime(merged_df['timestamp_rating'], unit='s')
merged_df.head()
```

Out[12]:

	movieId	title	genres	userId_rating	rating	timestamp_rating	userId_tag	tag	timestamp_tag
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	1.0	4.0	2000-07-30 18:45:03	336.0	pixar	1.139046e+09
1	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	1.0	4.0	2000-07-30 18:45:03	474.0	pixar	1.137207e+09
2	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	1.0	4.0	2000-07-30 18:45:03	567.0	fun	1.525286e+09
3	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	5.0	4.0	1996-11-08 06:36:02	336.0	pixar	1.139046e+09
4	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	5.0	4.0	1996-11-08 06:36:02	474.0	pixar	1.137207e+09

In [13]:

```
df = merged_df.groupby(['movieId', 'title', 'genres', 'imdbId', 'tmdbId'], as_index=False).agg({
    'rating': 'mean',
    'timestamp_rating': 'max',
    'tag': lambda x: ', '.join(sorted(set(x.dropna())))
})
df.rename(columns={'rating': 'avg_rating', 'timestamp_rating': 'last_rating_date'}, inplace=True)
df.head()
```

Out[13]:

	movieId	title	genres	imdbId	tmdbId	avg_rating	last_rating_date	tag
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	114709	862.0	3.920930	2018-08-31 10:01:06	fun, pixar
1	2	Jumanji (1995)	Adventure|Children|Fantasy	113497	8844.0	3.431818	2018-06-25 04:42:03	Robin Williams, fantasy, game, magic board game
2	3	Grumpier Old Men (1995)	Comedy|Romance	113228	15602.0	3.259615	2017-06-26 19:24:31	moldy, old
3	4	Waiting to Exhale (1995)	Comedy|Drama|Romance	114885	31357.0	2.357143	2009-03-22 22:14:15	
4	5	Father of the Bride Part II (1995)	Comedy	113041	11862.0	3.071429	2018-01-31 23:28:39	pregnancy, remake

In [14]:

```
df['release_year'] = df['title'].str.extract(r'\((\d{4})\)').astype(float)

df['movie_age'] = 2025 - df['release_year']

df['num_genres'] = df['genres'].apply(lambda x: len(x.split('|')) if isinstance(x, str) else 0)

df['main_genre'] = df['genres'].apply(lambda x: x.split('|')[0] if isinstance(x, str) else None)

df['N0_of_tags'] = df['tag'].fillna('').apply(lambda x: len([t.strip() for t in x.split(',') if t.strip() != '']))

df['rating_year'] = df['last_rating_date'].dt.year
df.head()
```

Out[14]:

	movieId	title	genres	imdbId	tmdbId	avg_rating	last_rating_date	tag	release_year
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	114709	862.0	3.920930	2018-08-31 10:01:06	fun, pixar	1995.0
1	2	Jumanji (1995)	Adventure|Children|Fantasy	113497	8844.0	3.431818	2018-06-25 04:42:03	Robin Williams, fantasy, game, magic board game	1995.0
2	3	Grumpier Old Men (1995)	Comedy|Romance	113228	15602.0	3.259615	2017-06-26 19:24:31	moldy, old	1995.0
3	4	Waiting to Exhale (1995)	Comedy|Drama|Romance	114885	31357.0	2.357143	2009-03-22 22:14:15		1995.0
4	5	Father of the Bride Part II (1995)	Comedy	113041	11862.0	3.071429	2018-01-31 23:28:39	pregnancy, remake	1995.0

In [18]:

```
df['release_year'] = df['release_year'].fillna(0).astype(int)
df['rating_year'] = df['rating_year'].fillna(0).astype(int)
df['movie_age'] = df['movie_age'].fillna(0).astype(int)
df['main_genre'] = df['main_genre'].replace(['', None], 'Unknown')
df['tag'] = df['tag'].replace(['', None], 'Unknown')
df['avg_rating'] = df['avg_rating'].round(1)

df.head()
```

Out[18]:

	movieId	title	genres	imdbId	tmdbId	avg_rating	last_rating_date	tag	release_year
0	1	Toy Story (1995)	Adventure|Animation|Children|Comedy|Fantasy	114709	862.0	3.9	2018-08-31 10:01:06	fun, pixar	1995
1	2	Jumanji (1995)	Adventure|Children|Fantasy	113497	8844.0	3.4	2018-06-25 04:42:03	Robin Williams, fantasy, game, magic board game	1995
2	3	Grumpier Old Men (1995)	Comedy|Romance	113228	15602.0	3.3	2017-06-26 19:24:31	moldy, old	1995
3	4	Waiting to Exhale (1995)	Comedy|Drama|Romance	114885	31357.0	2.4	2009-03-22 22:14:15	Unknown	1995
4	5	Father of the Bride Part II (1995)	Comedy	113041	11862.0	3.1	2018-01-31 23:28:39	pregnancy, remake	1995

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

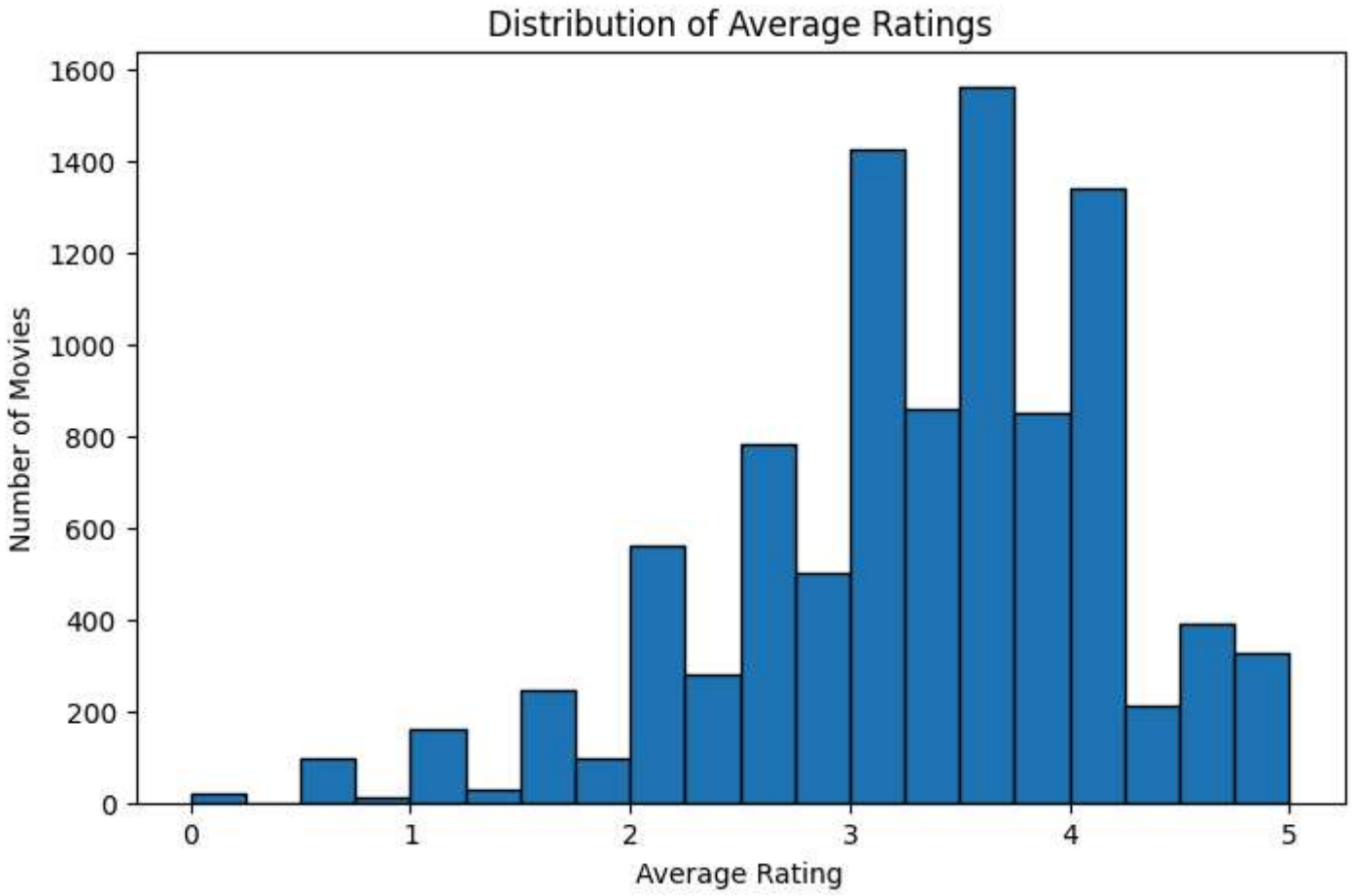
Out[ ]:
```
movieId              0
title                0
genres               0
imdbId               0
tmdbId               0
avg_rating          18
last_rating_date    18
tag                  0
release_year         0
movie_age            0
num_genres           0
main_genre           0
N0_of_tags           0
rating_year          0
dtype: int64
```

In [16]:
```
df['avg_rating'] = df['avg_rating'].fillna(0)
df['last_rating_date'] = df['last_rating_date'].fillna('Unknown')
df.isnull().sum()
```

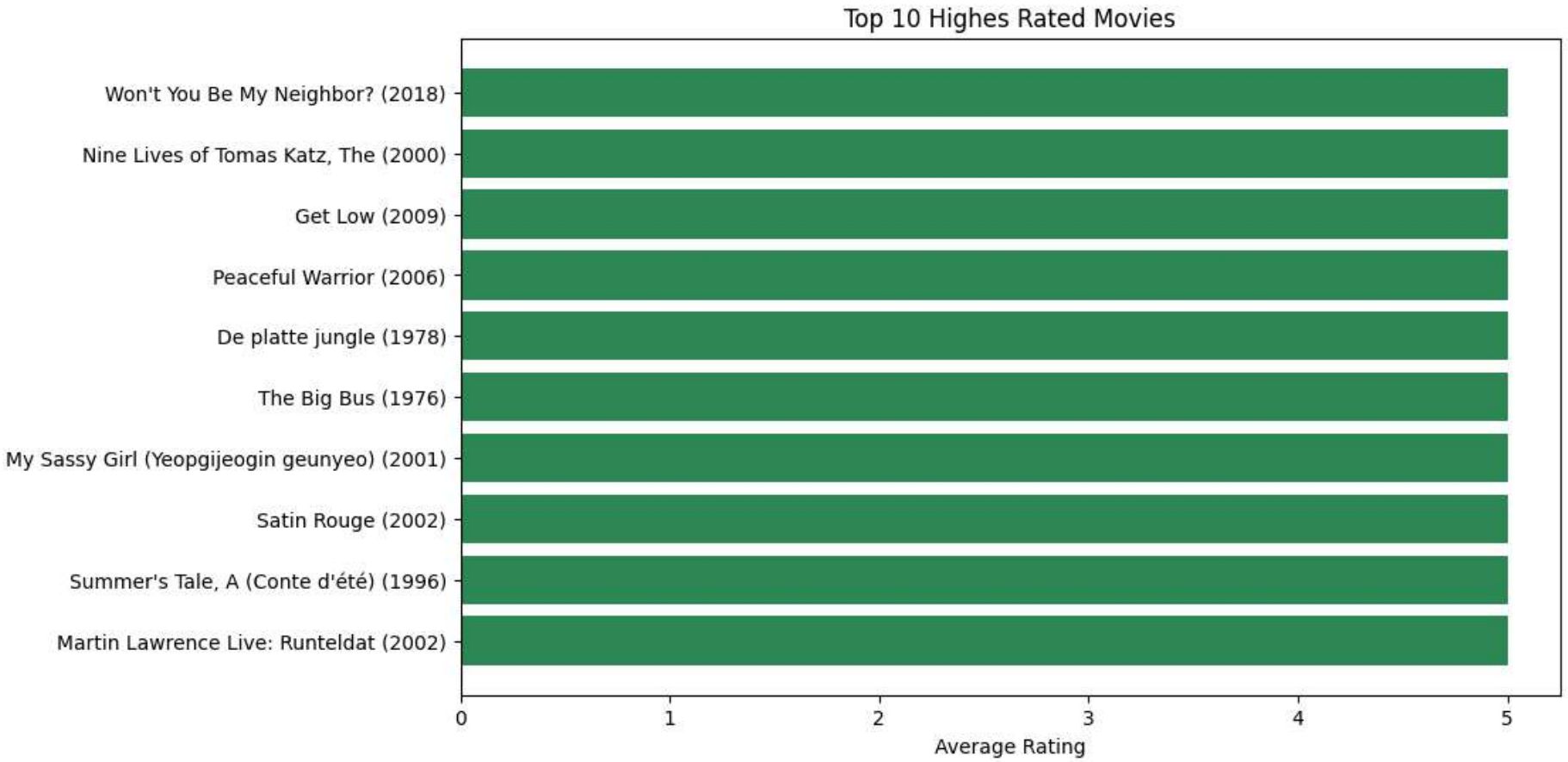
Out[16]:
```
movieId              0
title                0
genres               0
imdbId               0
tmdbId               0
avg_rating           0
last_rating_date     0
tag                  0
release_year         0
movie_age            0
num_genres           0
main_genre           0
N0_of_tags           0
rating_year          0
dtype: int64
```

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

plt.figure(figsize=(8,5))
plt.hist(df['avg_rating'], bins=20, edgecolor='black')
```

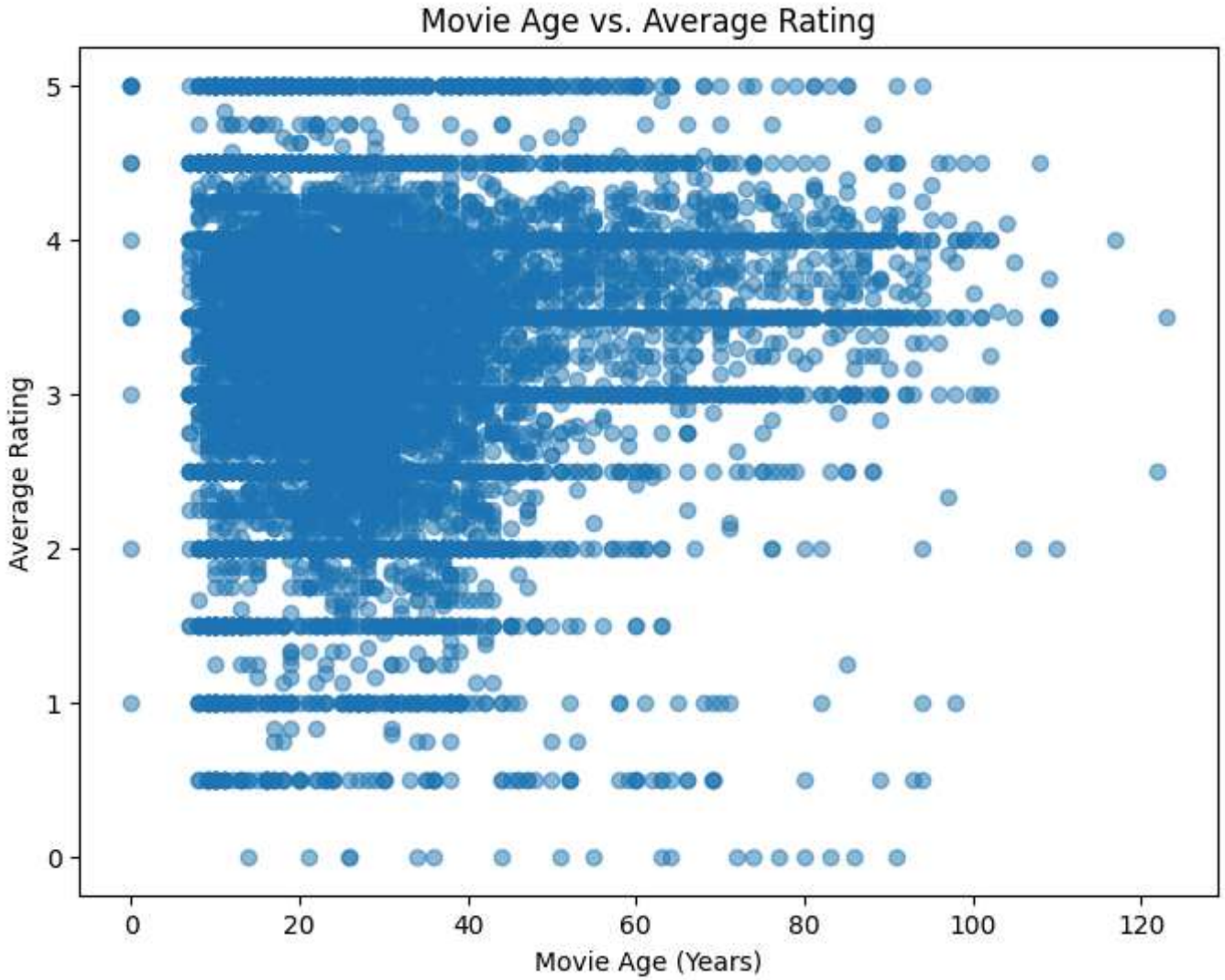
```
plt.title('Distribution of Average Ratings')
plt.xlabel('Average Rating')
plt.ylabel('Number of Movies')
plt.show()
```



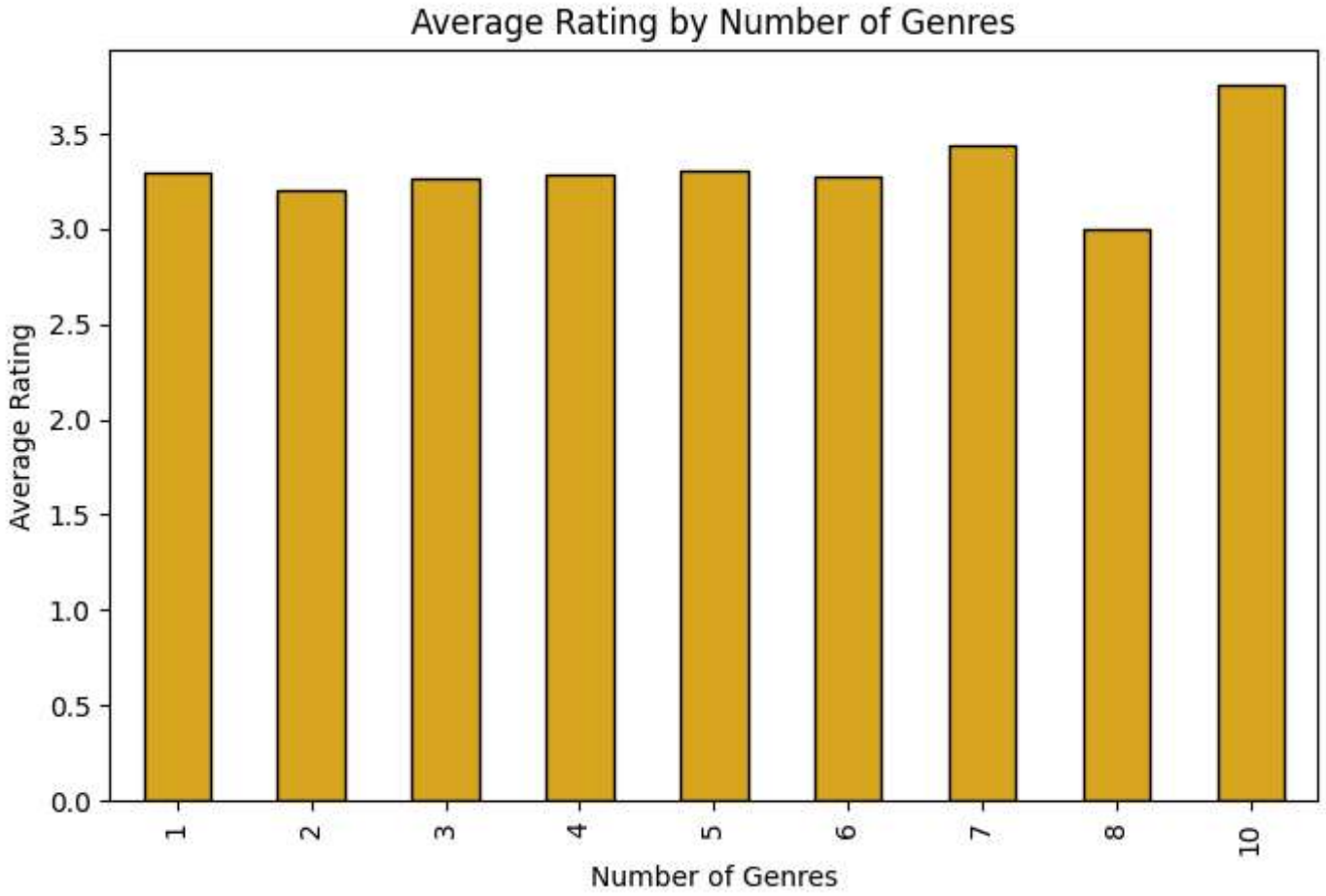
In [ ]:
```
top_movies = df.sort_values(by='avg_rating', ascending=False).head(10)
plt.figure(figsize=(10,6))
plt.barh(top_movies['title'], top_movies['avg_rating'], color='seagreen')
plt.xlabel('Average Rating')
plt.title('Top 10 Highes Rated Movies')
plt.gca().invert_yaxis()
plt.show()
```



In [ ]:
```
plt.figure(figsize=(8,6))
plt.scatter(df['movie_age'], df['avg_rating'], alpha=0.5)
plt.title('Movie Age vs. Average Rating')
plt.xlabel('Movie Age (Years)')
plt.ylabel('Average Rating')
plt.show()
```

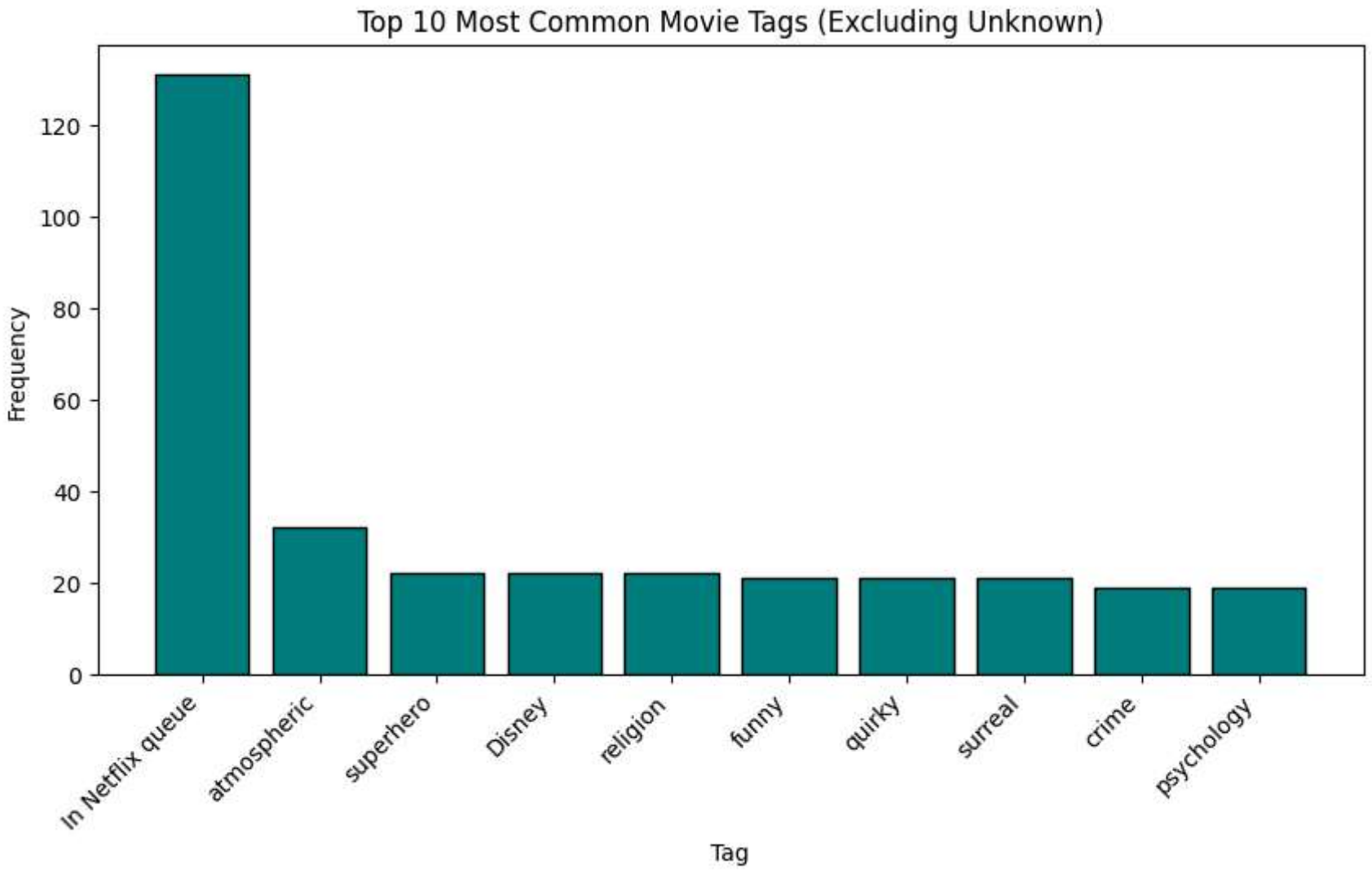


In [ ]:
```
genres_rating = df.groupby('num_genres')['avg_rating'].mean()
plt.figure(figsize=(8,5))
genres_rating.plot(kind='bar', color='goldenrod', edgecolor='black')
plt.title('Average Rating by Number of Genres')
plt.xlabel('Number of Genres')
plt.ylabel('Average Rating')
plt.show()
```



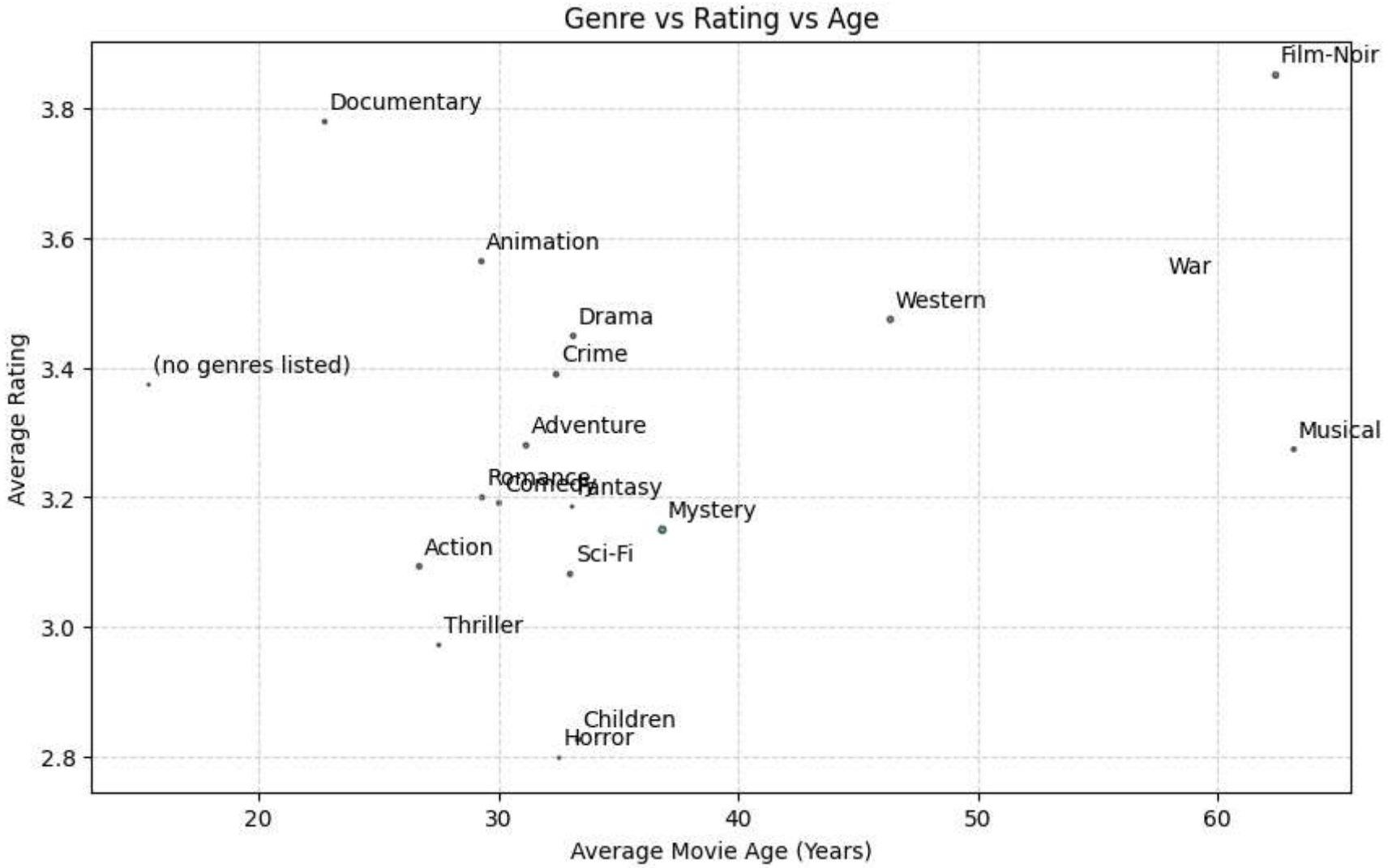
In [ ]:
```
from collections import Counter
all_tags = ', '.join(df['tag'].dropna()).split(', ')
clean_tags = [tag for tag in all_tags if tag.strip().lower() != 'unknown' and tag.strip() != '']
tag_counts = Counter(clean_tags)
top_tags = dict(tag_counts.most_common(10))
import matplotlib.pyplot as plt
plt.figure(figsize=(10,5))
plt.bar(top_tags.keys(), top_tags.values(), color='teal', edgecolor='black')
plt.xticks(rotation=45, ha='right')
plt.title('Top 10 Most Common Movie Tags (Excluding Unknown)')
plt.xlabel('Tag')
```

```
plt.ylabel('Frequency')
plt.show()
```



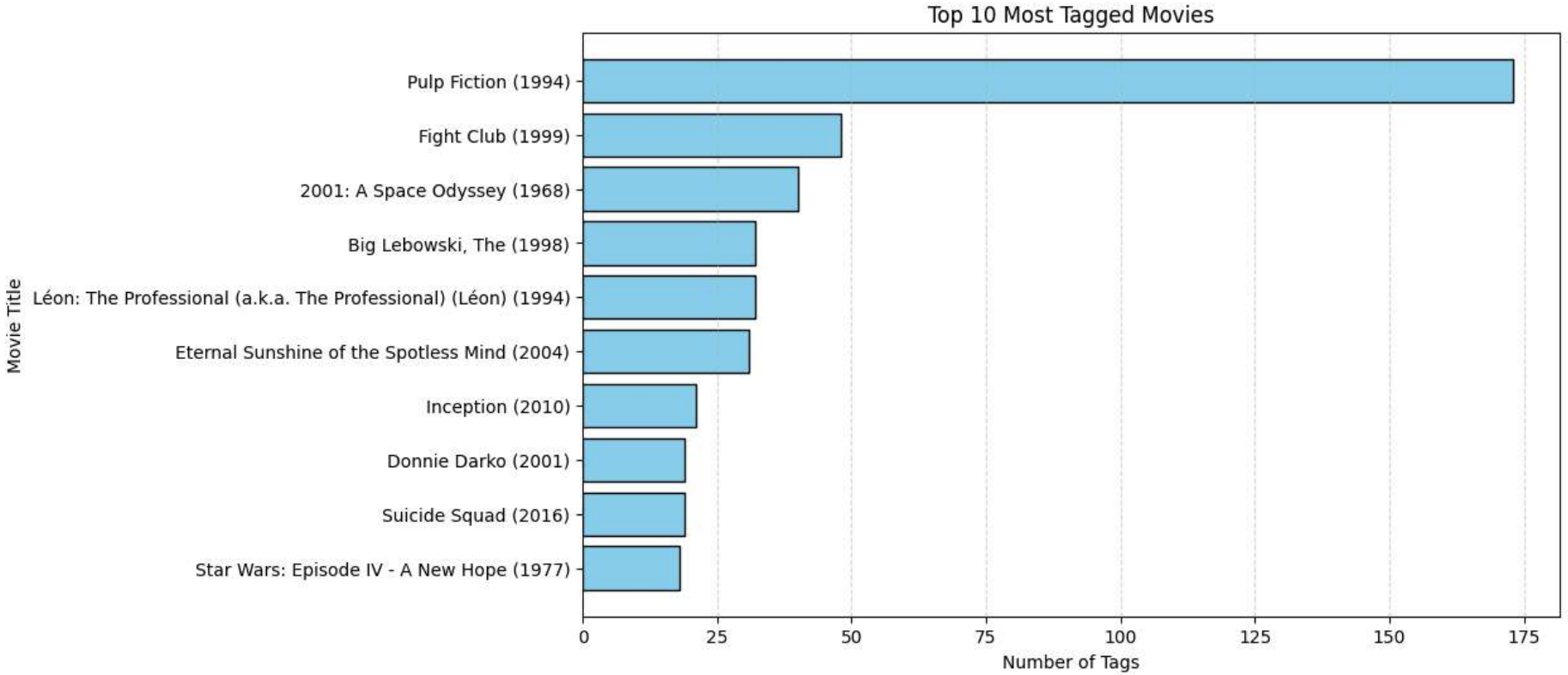
In [19]:
```
genre_summary = df.groupby('main_genre').agg({
    'avg_rating': 'mean',
    'movie_age': 'mean',
    'N0_of_tags': 'mean'
}).reset_index()
```

```python
import matplotlib.pyplot as plt

plt.figure(figsize=(10,6))
plt.scatter(
    genre_summary['movie_age'],
    genre_summary['avg_rating'],
    s=genre_summary['N0_of_tags'] * 10,   # bubble size = average tag count
    alpha=0.6,
    color='teal',
    edgecolor='black'
)

for i, txt in enumerate(genre_summary['main_genre']):
    plt.annotate(txt, (genre_summary['movie_age'][i]+0.2, genre_summary['avg_rating'][i]+0.02))

plt.title('Genre vs Rating vs Age')
plt.xlabel('Average Movie Age (Years)')
plt.ylabel('Average Rating')
plt.grid(True, linestyle='--', alpha=0.5)
plt.show()
```



In [20]:
```
top_tagged = df.sort_values(by='N0_of_tags', ascending=False).head(10)
plt.figure(figsize=(10,6))
plt.barh(top_tagged['title'], top_tagged['N0_of_tags'], color='skyblue', edgecolor='black')
plt.xlabel('Number of Tags')
plt.ylabel('Movie Title')
plt.title('Top 10 Most Tagged Movies')
plt.gca().invert_yaxis()
```

```
plt.grid(axis='x', linestyle='--', alpha=0.5)
plt.show()
```



In [ ]:
```
!jupyter nbconvert --to html "Stage1_Lawal_Mayowa_Feature_Engineering_Exploration.ipynb"
```