```
# Import libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics.pairwise import cosine_similarity
from sklearn.feature_selection import SelectKBest, f_regression
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score

# --- Load Data ---
movies = pd.read_csv('movies.csv')
ratings = pd.read_csv('ratings.csv')

# --- Merge Data ---
merged_data = pd.merge(ratings, movies, on='movieId')

# Display head and tail
print("Merged Data (Head):")
print(merged_data.head())
print("\nMerged Data (Tail):")
print(merged_data.tail())

# Join head and tail for quick view
joined = pd.concat([merged_data.head(5), merged_data.tail(5)])
print("\nCombined Head and Tail:")
print(joined)

# --- Exploratory Data Analysis (EDA) ---

# Univariate Analysis
print("\n--- Univariate Analysis ---")
print("\nMovies Data (Numerical):")
print(movies.describe())
print("\nRatings Data (Numerical):")
print(ratings.describe())
print("\nMovies Data (Non-Numerical):")
print(movies.describe(include='object'))

# Plot rating distribution
plt.figure(figsize=(8, 5))
sns.histplot(ratings['rating'], kde=True)
plt.title('Distribution of Ratings')
plt.xlabel('Rating')
plt.ylabel('Frequency')
plt.show()

# Bivariate Analysis
print("\n--- Bivariate Analysis ---")
avg_ratings = ratings.groupby('movieId')['rating'].mean().sort_values(ascending=False)
print("\nTop 10 Movies by Average Rating:")
print(movies[movies['movieId'].isin(avg_ratings.head(10).index)]['title'])

# Plot user average ratings
user_avg_ratings = ratings.groupby('userId')['rating'].mean()
plt.figure(figsize=(8, 5))
sns.histplot(user_avg_ratings, kde=True)
```

```
plt.title('Distribution of Average User Ratings')
plt.xlabel('Average Rating')
plt.ylabel('Frequency')
plt.show()

# Multivariate Analysis
print("\n--- Multivariate Analysis ---")
ratings_count = ratings.groupby('movieId')['rating'].count()
movie_stats = pd.DataFrame({'average_rating': avg_ratings, 'rating_count': ratings_count})
plt.figure(figsize=(10, 6))
sns.scatterplot(x='rating_count', y='average_rating', data=movie_stats)
plt.title('Average Rating vs. Number of Ratings')
plt.xlabel('Number of Ratings')
plt.ylabel('Average Rating')
plt.xscale('log')
plt.show()

# --- Feature Engineering ---
merged_data = pd.merge(ratings, movies, on='movieId')
movie_stats = merged_data.groupby('movieId')['rating'].agg(['count', 'mean']).reset_index()
movie_stats.columns = ['movieId', 'movie_rating_count', 'movie_avg_rating']
merged_data = pd.merge(merged_data, movie_stats, on='movieId', how='left')

user_avg_rating = merged_data.groupby('userId')['rating'].mean().reset_index(name='user_avg
merged_data = pd.merge(merged_data, user_avg_rating, on='userId', how='left')

# --- Feature Selection ---
features_to_consider = ['userId', 'movieId', 'movie_rating_count', 'movie_avg_rating', 'use
data_for_selection = merged_data.dropna(subset=features_to_consider + ['rating']).copy()

if not data_for_selection.empty:
    X = data_for_selection[features_to_consider]
    y = data_for_selection['rating']
    X = X.replace([float('inf'), float('-inf')], pd.NA).dropna()
    y = y[X.index]

    if not X.empty:
        selector = SelectKBest(score_func=f_regression, k=3)
        selector.fit(X, y)
        selected_features = X.columns[selector.get_support(indices=True)].tolist()
        print("\nSelected Top 3 Features:", selected_features)
    else:
        print("\nNo valid data for feature selection after cleaning.")
        selected_features = []
else:
    print("\nNo valid data for feature selection.")
    selected_features = []

# --- Feature Impact Visualization ---
if 'user_avg_rating' in merged_data.columns and not merged_data['user_avg_rating'].isnull()
    merged_data['user_avg_rating_bin'] = pd.cut(merged_data['user_avg_rating'], bins=5, lab
    plt.figure(figsize=(10, 6))
    sns.boxplot(x='user_avg_rating_bin', y='rating', data=merged_data.dropna(subset=['user_
    plt.title('Impact of User Average Rating on Rating')
    plt.xlabel('User Avg Rating Bin')
    plt.ylabel('Rating')
    plt.show()
    merged_data = merged_data.drop('user_avg_rating_bin', axis=1)
else:
    print("\nSkipping boxplot due to missing values.")
```

```
# --- Model Building and Evaluation ---

# Prepare modeling data
user_avg_rating = merged_data.groupby('userId')['rating'].mean().reset_index(name='user_avg
movie_avg_rating = merged_data.groupby('movieId')['rating'].mean().reset_index(name='movie_
merged_data = pd.merge(merged_data, user_avg_rating, on='userId', how='left')
merged_data = pd.merge(merged_data, movie_avg_rating, on='movieId', how='left')



# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Linear Regression
print("\n--- Evaluating Linear Regression ---")
linear_model = LinearRegression()
linear_model.fit(X_train, y_train)
y_pred_linear = linear_model.predict(X_test)

print(f"Linear Regression MSE: {mean_squared_error(y_test, y_pred_linear):.4f}")
print(f"Linear Regression RMSE: {np.sqrt(mean_squared_error(y_test, y_pred_linear)):.4f}")
print(f"Linear Regression MAE: {mean_absolute_error(y_test, y_pred_linear):.4f}")
print(f"Linear Regression R2 Score: {r2_score(y_test, y_pred_linear):.4f}")

# Random Forest Regression
print("\n--- Evaluating Random Forest Regression ---")
random_forest_model = RandomForestRegressor(n_estimators=100, random_state=42)
random_forest_model.fit(X_train, y_train)
y_pred_rf = random_forest_model.predict(X_test)

print(f"Random Forest MSE: {mean_squared_error(y_test, y_pred_rf):.4f}")
print(f"Random Forest RMSE: {np.sqrt(mean_squared_error(y_test, y_pred_rf)):.4f}")
print(f"Random Forest MAE: {mean_absolute_error(y_test, y_pred_rf):.4f}")
print(f"Random Forest R2 Score: {r2_score(y_test, y_pred_rf):.4f}")# Import libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics.pairwise import cosine_similarity
from sklearn.feature_selection import SelectKBest, f_regression
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error, mean_absolute_error, r2_score

# --- Load Data ---
movies = pd.read_csv('movies.csv')
ratings = pd.read_csv('ratings.csv')

# --- Merge Data ---
merged_data = pd.merge(ratings, movies, on='movieId')

# Display head and tail
print("Merged Data (Head):")
print(merged_data.head())
print("\nMerged Data (Tail):")
print(merged_data.tail())

# Join head and tail for quick view
```

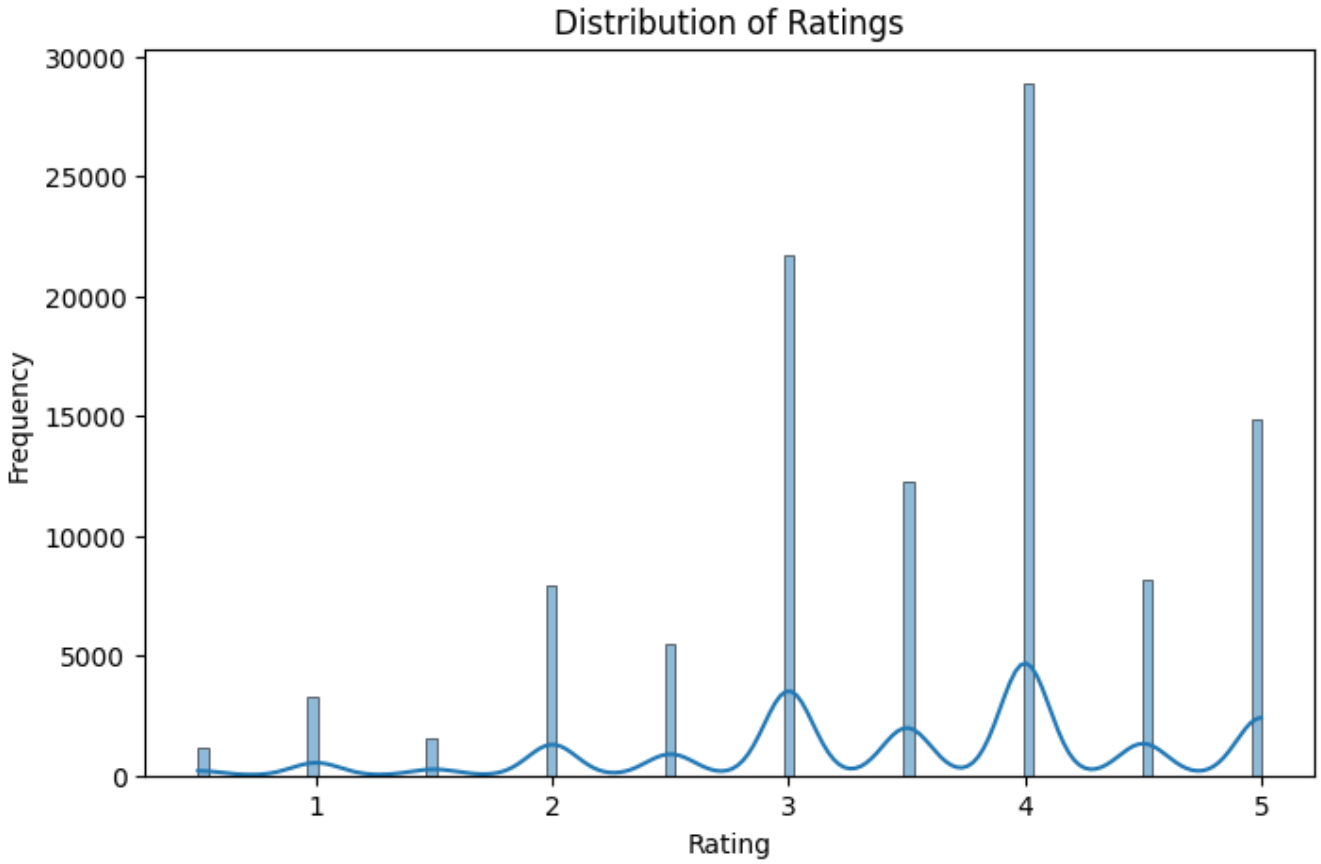
```
joined = pd.concat([merged_data.head(5), merged_data.tail(5)])
print("\nCombined Head and Tail:")
print(joined)

# --- Exploratory Data Analysis (EDA) ---

# Univariate Analysis
print("\n--- Univariate Analysis ---")
print("\nMovies Data (Numerical):")
print(movies.describe())
print("\nRatings Data (Numerical):")
print(ratings.describe())
print("\nMovies Data (Non-Numerical):")
print(movies.describe(include='object'))

# Plot rating distribution
plt.figure(figsize=(8, 5))
sns.histplot(ratings['rating'], kde=True)
plt.title('Distribution of Ratings')
plt.xlabel('Rating')
plt.ylabel('Frequency')
plt.show()

# Bivariate Analysis
print("\n--- Bivariate Analysis ---")
avg_ratings = ratings.groupby('movieId')['rating'].mean().sort_values(ascending=False)
print("\nTop 10 Movies by Average Rating:")
print(movies[movies['movieId'].isin(avg_ratings.head(10).index)]['title'])

# Plot user average ratings
user_avg_ratings = ratings.groupby('userId')['rating'].mean()
plt.figure(figsize=(8, 5))
sns.histplot(user_avg_ratings, kde=True)
plt.title('Distribution of Average User Ratings')
plt.xlabel('Average Rating')
plt.ylabel('Frequency')
plt.show()

# Multivariate Analysis
print("\n--- Multivariate Analysis ---")
ratings_count = ratings.groupby('movieId')['rating'].count()
movie_stats = pd.DataFrame({'average_rating': avg_ratings, 'rating_count': ratings_count})
plt.figure(figsize=(10, 6))
sns.scatterplot(x='rating_count', y='average_rating', data=movie_stats)
plt.title('Average Rating vs. Number of Ratings')
plt.xlabel('Number of Ratings')
plt.ylabel('Average Rating')
plt.xscale('log')
plt.show()

# --- Feature Engineering ---
merged_data = pd.merge(ratings, movies, on='movieId')
movie_stats = merged_data.groupby('movieId')['rating'].agg(['count', 'mean']).reset_index()
movie_stats.columns = ['movieId', 'movie_rating_count', 'movie_avg_rating']
merged_data = pd.merge(merged_data, movie_stats, on='movieId', how='left')

user_avg_rating = merged_data.groupby('userId')['rating'].mean().reset_index(name='user_avg
merged_data = pd.merge(merged_data, user_avg_rating, on='userId', how='left')

# --- Feature Selection ---
```

```
features_to_consider = ['userId', 'movieId', 'movie_rating_count', 'movie_avg_rating', 'use
data_for_selection = merged_data.dropna(subset=features_to_consider + ['rating']).copy()

if not data_for_selection.empty:
    X = data_for_selection[features_to_consider]
    y = data_for_selection['rating']
    X = X.replace([float('inf'), float('-inf')], pd.NA).dropna()
    y = y[X.index]

    if not X.empty:
        selector = SelectKBest(score_func=f_regression, k=3)
        selector.fit(X, y)
        selected_features = X.columns[selector.get_support(indices=True)].tolist()
        print("\nSelected Top 3 Features:", selected_features)
    else:
        print("\nNo valid data for feature selection after cleaning.")
        selected_features = []
else:
    print("\nNo valid data for feature selection.")
    selected_features = []

# --- Feature Impact Visualization ---
if 'user_avg_rating' in merged_data.columns and not merged_data['user_avg_rating'].isnull()
    merged_data['user_avg_rating_bin'] = pd.cut(merged_data['user_avg_rating'], bins=5, lab
    plt.figure(figsize=(10, 6))
    sns.boxplot(x='user_avg_rating_bin', y='rating', data=merged_data.dropna(subset=['user_
    plt.title('Impact of User Average Rating on Rating')
    plt.xlabel('User Avg Rating Bin')
    plt.ylabel('Rating')
    plt.show()
    merged_data = merged_data.drop('user_avg_rating_bin', axis=1)
else:
    print("\nSkipping boxplot due to missing values.")

# --- Model Building and Evaluation ---

# Prepare modeling data
user_avg_rating = merged_data.groupby('userId')['rating'].mean().reset_index(name='user_avg
movie_avg_rating = merged_data.groupby('movieId')['rating'].mean().reset_index(name='movie_
merged_data = pd.merge(merged_data, user_avg_rating, on='userId', how='left')
merged_data = pd.merge(merged_data, movie_avg_rating, on='movieId', how='left')



# Train-test split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

# Linear Regression
print("\n--- Evaluating Linear Regression ---")
linear_model = LinearRegression()
linear_model.fit(X_train, y_train)
y_pred_linear = linear_model.predict(X_test)

print(f"Linear Regression MSE: {mean_squared_error(y_test, y_pred_linear):.4f}")
print(f"Linear Regression RMSE: {np.sqrt(mean_squared_error(y_test, y_pred_linear)):.4f}")
print(f"Linear Regression MAE: {mean_absolute_error(y_test, y_pred_linear):.4f}")
print(f"Linear Regression R2 Score: {r2_score(y_test, y_pred_linear):.4f}")

# Random Forest Regression
print("\n--- Evaluating Random Forest Regression ---")
```

```
random_forest_model = RandomForestRegressor(n_estimators=100, random_state=42)
random_forest_model.fit(X_train, y_train)
y_pred_rf = random_forest_model.predict(X_test)

print(f"Random Forest MSE: {mean_squared_error(y_test, y_pred_rf):.4f}")
print(f"Random Forest RMSE: {np.sqrt(mean_squared_error(y_test, y_pred_rf)):.4f}")
print(f"Random Forest MAE: {mean_absolute_error(y_test, y_pred_rf):.4f}")
print(f"Random Forest R2 Score: {r2_score(y_test, y_pred_rf):.4f}")
```

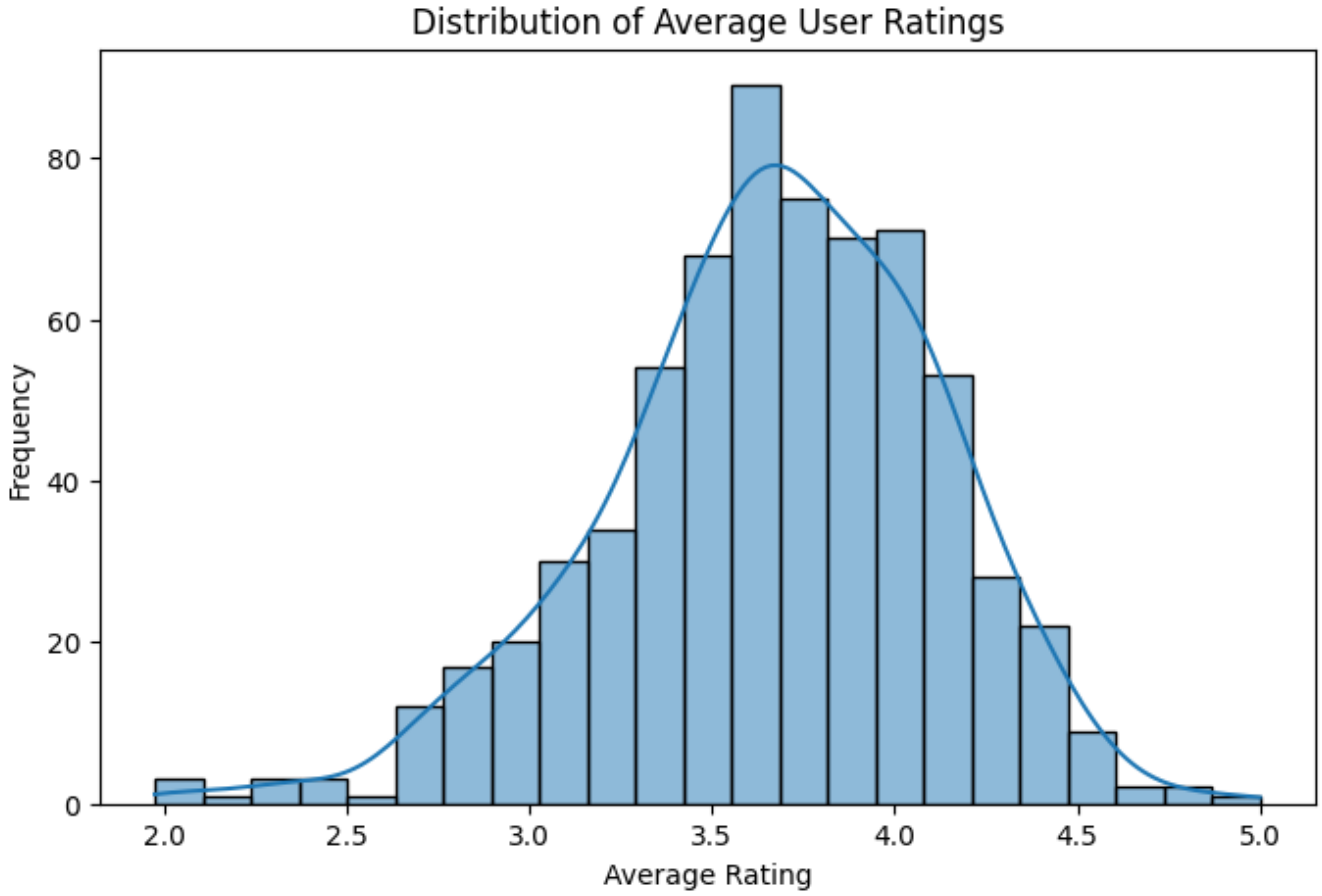
```
Merged Data (Head):
   userId  movieId  rating   timestamp  \
0       1       16     4.0  1217897793
1       1       24     1.5  1217895807
2       1       32     4.0  1217896246
3       1       47     4.0  1217896556
4       1       50     4.0  1217896523

                                     title                   genres
0                           Casino (1995)              Crime|Drama
1                           Powder (1995)             Drama|Sci-Fi
2  Twelve Monkeys (a.k.a. 12 Monkeys) (1995)  Mystery|Sci-Fi|Thriller
3               Seven (a.k.a. Se7en) (1995)         Mystery|Thriller
4                Usual Suspects, The (1995)   Crime|Mystery|Thriller

Merged Data (Tail):
        userId  movieId  rating   timestamp                  title  \
105334     668   142488     4.0  1451535844       Spotlight (2015)
105335     668   142507     3.5  1451535889   Pawn Sacrifice (2015)
105336     668   143385     4.0  1446388585  Bridge of Spies (2015)
105337     668   144976     2.5  1448656898    Bone Tomahawk (2015)
105338     668   148626     4.5  1451148148    The Big Short (2015)

                genres
105334        Thriller
105335           Drama
105336  Drama|Thriller
105337  Horror|Western
105338           Drama

Combined Head and Tail:
        userId  movieId  rating   timestamp  \
0            1       16     4.0  1217897793
1            1       24     1.5  1217895807
2            1       32     4.0  1217896246
3            1       47     4.0  1217896556
4            1       50     4.0  1217896523
105334     668   142488     4.0  1451535844
105335     668   142507     3.5  1451535889
105336     668   143385     4.0  1446388585
105337     668   144976     2.5  1448656898
105338     668   148626     4.5  1451148148

                                        title                   genres
0                              Casino (1995)              Crime|Drama
1                              Powder (1995)             Drama|Sci-Fi
2       Twelve Monkeys (a.k.a. 12 Monkeys) (1995)  Mystery|Sci-Fi|Thriller
3                   Seven (a.k.a. Se7en) (1995)         Mystery|Thriller
4                    Usual Suspects, The (1995)   Crime|Mystery|Thriller
105334                       Spotlight (2015)                Thriller
105335                    Pawn Sacrifice (2015)                   Drama
105336                   Bridge of Spies (2015)           Drama|Thriller
105337                     Bone Tomahawk (2015)           Horror|Western
105338                     The Big Short (2015)                   Drama

--- Univariate Analysis ---
```

```
Movies Data (Numerical):
             movieId
count   10329.000000
mean    31924.282893
std     37734.741149
min         1.000000
25%      3240.000000
50%      7088.000000
75%     59900.000000
max    149532.000000

Ratings Data (Numerical):
              userId        movieId         rating     timestamp
count  105339.000000  105339.000000  105339.000000  1.053390e+05
mean      364.924539   13381.312477       3.516850  1.130424e+09
std       197.486905   26170.456869       1.044872  1.802660e+08
min         1.000000       1.000000       0.500000  8.285650e+08
25%       192.000000    1073.000000       3.000000  9.711008e+08
50%       383.000000    2497.000000       3.500000  1.115154e+09
75%       557.000000    5991.000000       4.000000  1.275496e+09
max       668.000000  149532.000000       5.000000  1.452405e+09

Movies Data (Non-Numerical):
                          title genres
count                     10329  10329
unique                    10327    938
top     War of the Worlds (2005)  Drama
freq                          2   1385
```

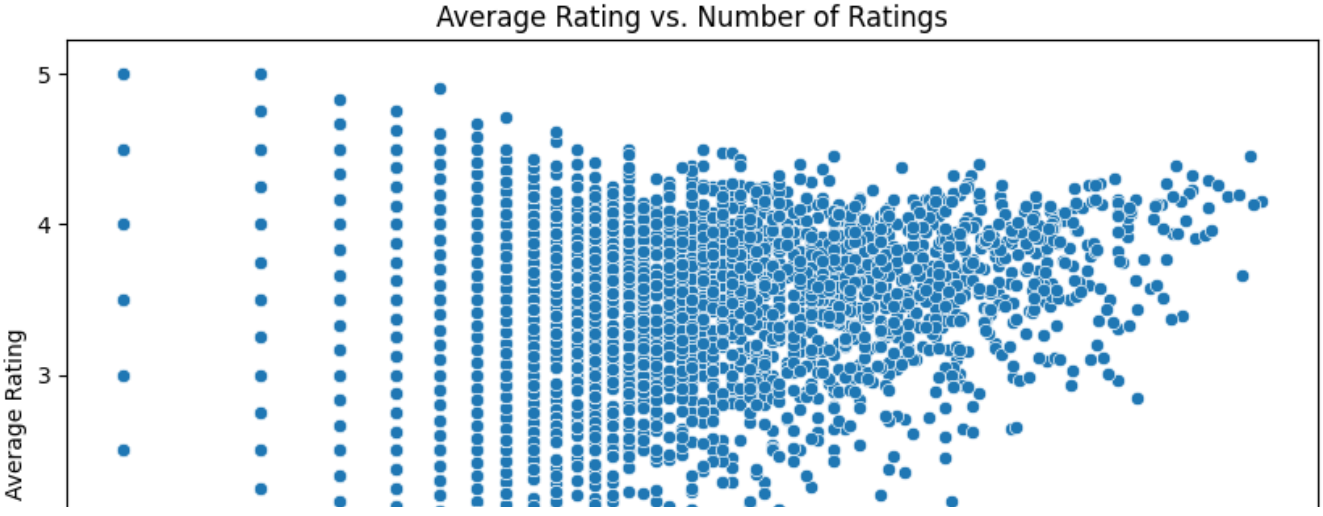


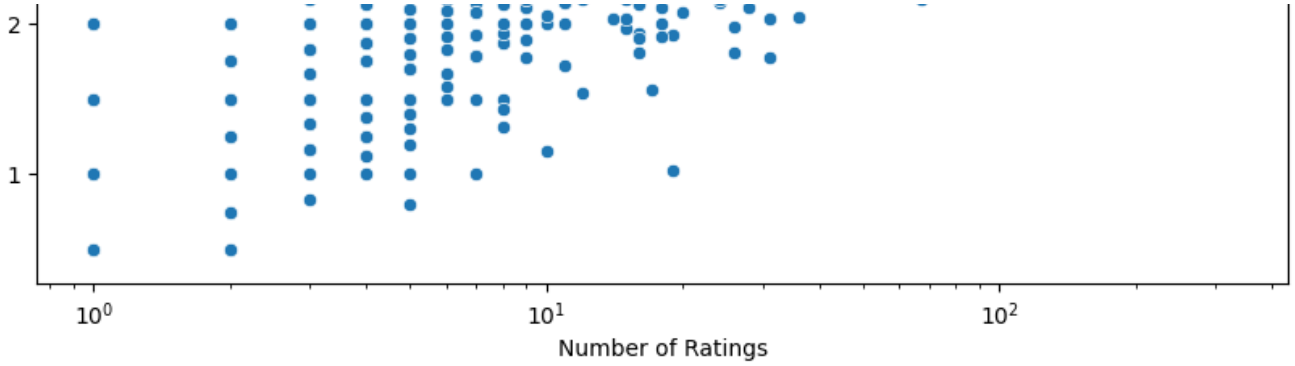

```
--- Bivariate Analysis ---
```

```
Top 10 Movies by Average Rating:
412                                Heaven & Earth (1993)
1854                               Hard Core Logo (1996)
2653                       Bride of the Monster (1955)
2824                                 Limelight (1952)
2866                                Possession (1981)
8486                         Flesh and the Devil (1926)
8881     Castaway on the Moon (Kimssi pyoryugi) (2009)
10283                               The Revenant (2015)
10285               Everything's Gonna Be Great (1998)
10300                                        Air (2015)
Name: title, dtype: object
```

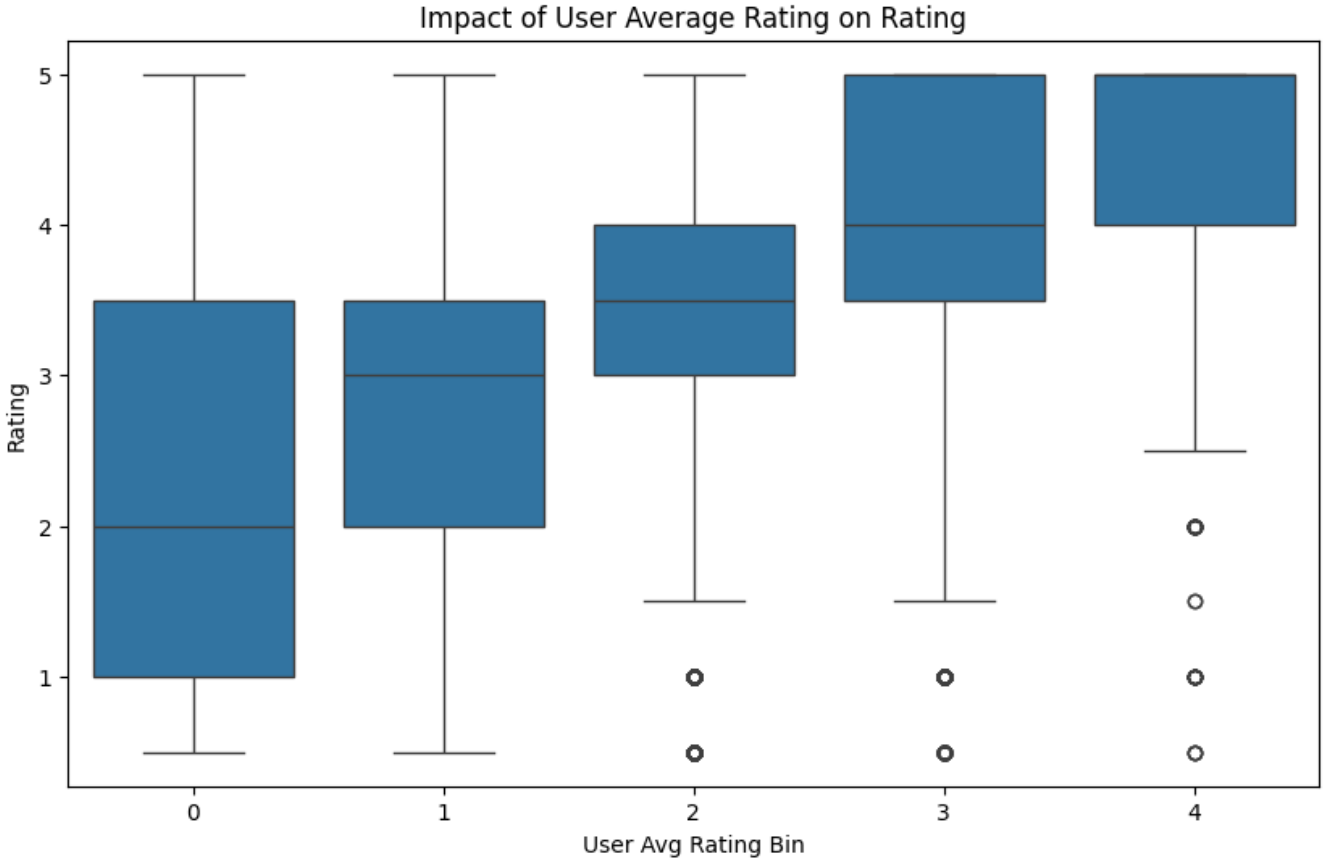



```
--- Multivariate Analysis ---
```






```
Selected Top 3 Features: ['movie_rating_count', 'movie_avg_rating', 'user_avg_ra
```




```
--- Evaluating Linear Regression ---
Linear Regression MSE: 0.6456
Linear Regression RMSE: 0.8035
Linear Regression MAE: 0.6153
Linear Regression R2 Score: 0.4038

--- Evaluating Random Forest Regression ---
Random Forest MSE: 0.6688
Random Forest RMSE: 0.8178
Random Forest MAE: 0.6160
Random Forest R2 Score: 0.3823
Merged Data (Head):
   userId  movieId  rating   timestamp  \
0       1       16     4.0  1217897793
1       1       24     1.5  1217895807
2       1       32     4.0  1217896246
3       1       47     4.0  1217896556
4       1       50     4.0  1217896523
```

```
4       1       50     4.0  1217896523

                                     title                   genres
0                            Casino (1995)              Crime|Drama
1                            Powder (1995)             Drama|Sci-Fi
2  Twelve Monkeys (a.k.a. 12 Monkeys) (1995)  Mystery|Sci-Fi|Thriller
3                Seven (a.k.a. Se7en) (1995)         Mystery|Thriller
4                 Usual Suspects, The (1995)   Crime|Mystery|Thriller

Merged Data (Tail):
        userId  movieId  rating   timestamp                  title  \
105334     668   142488     4.0  1451535844        Spotlight (2015)
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105336     668   143385     4.0  1446388585  Bridge of Spies (2015)
105337     668   144976     2.5  1448656898    Bone Tomahawk (2015)
105338     668   148626     4.5  1451148148    The Big Short (2015)

                genres
105334        Thriller
105335           Drama
105336  Drama|Thriller
105337  Horror|Western
105338           Drama

Combined Head and Tail:
        userId  movieId  rating   timestamp  \
0            1       16     4.0  1217897793
1            1       24     1.5  1217895807
2            1       32     4.0  1217896246
3            1       47     4.0  1217896556
4            1       50     4.0  1217896523
105334     668   142488     4.0  1451535844
105335     668   142507     3.5  1451535889
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105337     668   144976     2.5  1448656898
105338     668   148626     4.5  1451148148

                                         title                   genres
0                                Casino (1995)              Crime|Drama
1                                Powder (1995)             Drama|Sci-Fi
2       Twelve Monkeys (a.k.a. 12 Monkeys) (1995)  Mystery|Sci-Fi|Thriller
3                    Seven (a.k.a. Se7en) (1995)         Mystery|Thriller
4                     Usual Suspects, The (1995)   Crime|Mystery|Thriller
105334                         Spotlight (2015)                 Thriller
105335                      Pawn Sacrifice (2015)                    Drama
105336                     Bridge of Spies (2015)           Drama|Thriller
105337                       Bone Tomahawk (2015)           Horror|Western
105338                       The Big Short (2015)                    Drama

--- Univariate Analysis ---

Movies Data (Numerical):
             movieId
count   10329.000000
mean    31924.282893
std     37734.741149
min         1.000000
```