Type Detection on Amazon: Movie or TV Series?

This project aims to develop a machine learning model capable of automatically classifying products listed on Amazon as either movies or TV seasons. Leveraging a dataset of Amazon product titles and descriptions, we will employ natural language processing techniques and machine learning algorithms to predict the type of content each product represents. By automating this classification task, we aim to enhance the efficiency of content categorization, helping users easily find and purchase their desired movies and TV series on the platform.

Import Libraries

In [130]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from wordcloud import WordCloud
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score, confusion_matrix, classificatio
from sklearn.preprocessing import LabelEncoder
from sklearn.ensemble import RandomForestClassifier
from sklearn.neural_network import MLPClassifier
import nltk
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize
import warnings
warnings.filterwarnings('ignore')
```

Uploading CSV

uploading csv, storing in dataframe and displaying first 5 entries of dataframe

In [131]:
```
df = pd.read_csv('amazon_prime_titles.csv')
df.head(5)
```

Out[131]:

	show_id	type	title	director	cast	country	date_added	release_year	ratin
0	s1	Movie	The Grand Seduction	Don McKellar	Brendan Gleeson, Taylor Kitsch, Gordon Pinsent	Canada	March 30, 2021	2014	Na
1	s2	Movie	Take Care Good Night	Girish Joshi	Mahesh Manjrekar, Abhay Mahajan, Sachin Khedekar	India	March 30, 2021	2018	13
2	s3	Movie	Secrets of Deception	Josh Webber	Tom Sizemore, Lorenzo Lamas, Robert LaSardo, R...	United States	March 30, 2021	2017	Na
3	s4	Movie	Pink: Staying True	Sonia Anderson	Interviews with: Pink, Adele, Beyoncé, Britney...	United States	March 30, 2021	2014	Na
4	s5	Movie	Monster Maker	Giles Foster	Harry Dean Stanton, Kieran O'Brien, George Cos...	United Kingdom	March 30, 2021	1989	Na

.shape

returns a tuple representing the dimensions (number of rows and columns) of a pandas DataFrame.

In [132]:
```
df.shape
```

Out[132]:
```
(9668, 12)
```

renaming and dropping

renaming column listen_in to genre and dropping column show_id.

In [133]:
```
df.rename(columns={'listed_in':'genre'},inplace=True)
df.drop(['show_id'], axis = 1, inplace = True)
df.head()
```

Out[133]:

	type	title	director	cast	country	date_added	release_year	rating	duratio
0	Movie	The Grand Seduction	Don McKellar	Brendan Gleeson, Taylor Kitsch, Gordon Pinsent	Canada	March 30, 2021	2014	NaN	113 m
1	Movie	Take Care Good Night	Girish Joshi	Mahesh Manjrekar, Abhay Mahajan, Sachin Khedekar	India	March 30, 2021	2018	13+	110 m
2	Movie	Secrets of Deception	Josh Webber	Tom Sizemore, Lorenzo Lamas, Robert LaSardo, R...	United States	March 30, 2021	2017	NaN	74 m
3	Movie	Pink: Staying True	Sonia Anderson	Interviews with: Pink, Adele, Beyoncé, Britney...	United States	March 30, 2021	2014	NaN	69 m
4	Movie	Monster Maker	Giles Foster	Harry Dean Stanton, Kieran O'Brien, George Cos...	United Kingdom	March 30, 2021	1989	NaN	45 m

.info

provides a concise summary of information about a pandas DataFrame, including data types, non-null counts, and memory usage.

In [134]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9668 entries, 0 to 9667
Data columns (total 11 columns):
 #   Column        Non-Null Count  Dtype 
---  ------        --------------  ----- 
 0   type          9668 non-null   object
 1   title         9668 non-null   object
 2   director      7586 non-null   object
 3   cast          8435 non-null   object
 4   country       672 non-null    object
 5   date_added    155 non-null    object
 6   release_year  9668 non-null   int64 
 7   rating        9331 non-null   object
 8   duration      9668 non-null   object
 9   genre         9668 non-null   object
 10  description   9668 non-null   object
dtypes: int64(1), object(10)
memory usage: 831.0+ KB
```

features types

assinging and displaying features types.

In [135]:
```
feature_types = {
    'type': 'Nominal Categorical',
    'title': 'Nominal Categorical',
    'director': 'Nominal Categorical',
    'cast': 'Nominal Categorical',
    'country': 'Nominal Categorical',
    'date_added': 'Nominal Categorical',
    'release_year': 'Numerical',
    'rating': 'Nominal Categorical',
    'duration': 'Nominal Categorical',
    'genre': 'Nominal Categorical',
    'description': 'Nominal Categorical'
}

for column in df.columns:
    if column in feature_types:
        print(f"{column}: {feature_types[column]}")
    else:
        print(f"{column}: Not specified")
```

```
type: Nominal Categorical
title: Nominal Categorical
director: Nominal Categorical
cast: Nominal Categorical
country: Nominal Categorical
date_added: Nominal Categorical
release_year: Numerical
rating: Nominal Categorical
duration: Nominal Categorical
genre: Nominal Categorical
description: Nominal Categorical
```

missing data analysis

calculates and returns the count of missing (null) values for each column in a DataFrame, allowing for easy identification of data gaps.

In [136]:
```
df.isnull().sum()
```

Out[136]:
```
type               0
title              0
director        2082
cast            1233
country         8996
date_added      9513
release_year       0
rating           337
duration           0
genre              0
description        0
dtype: int64
```

dupliacted data analysis

calculates and returns the count of missing (null) values for each column in a DataFrame , helping to assess the impact of data removal on missing data patterns.

In [137]:
```
df.duplicated().sum()
```

Out[137]:
```
0
```

missing data percentage calculation

calculates and stores the percentage of missing (null) values for each column in a DataFrame (df). It divides the count of missing values by the total number of rows in the DataFrame and then rounds the result to two decimal places, providing insights into the proportion of missing data for each column.

In [138]:
```
percentage = (df.isnull().sum() / df.shape[0] * 100).round(2)
percentage
```

Out[138]:
```
type             0.00
title            0.00
director        21.53
cast            12.75
country         93.05
date_added      98.40
release_year     0.00
rating           3.49
duration         0.00
genre            0.00
description      0.00
dtype: float64
```

high-missing-value columns removal

columns_to_drop is a list of column names where the percentage of missing values exceeds 90%. These columns are then removed from the DataFrame df to create a new DataFrame

In [139]:
```
columns_to_drop = percentage[percentage > 90].index.tolist()
df_dropped = df.drop(columns=columns_to_drop)
```

initial data preview

displays the top rows of the DataFrame, allowing a quick overview of its structure and content following the removal of high-missing-value columns.

In [140]:
```
df_dropped.head()
```

Out[140]:

	type	title	director	cast	release_year	rating	duration	genre	descri
0	Movie	The Grand Seduction	Don McKellar	Brendan Gleeson, Taylor Kitsch, Gordon Pinsent	2014	NaN	113 min	Comedy, Drama	A f village proc loc
1	Movie	Take Care Good Night	Girish Joshi	Mahesh Manjrekar, Abhay Mahajan, Sachin Khedekar	2018	13+	110 min	Drama, International	A F deci 1 (Cri
2	Movie	Secrets of Deception	Josh Webber	Tom Sizemore, Lorenzo Lamas, Robert LaSardo, R...	2017	NaN	74 min	Action, Drama, Suspense	After a disc his v cheati
3	Movie	Pink: Staying True	Sonia Anderson	Interviews with: Pink, Adele, Beyoncé, Britney...	2014	NaN	69 min	Documentary	Pink b the once a bringir
4	Movie	Monster Maker	Giles Foster	Harry Dean Stanton, Kieran O'Brien, George Cos...	1989	NaN	45 min	Drama, Fantasy	Tee Ba wa work fa

missing value imputation

creates a new DataFrame by filling all missing values in the previous DataFrame with the string "unattainable," addressing missing data by replacing it with a specified placeholder value.

In [141]:
```
df_dropped_filled = df_dropped.fillna("unattainable")
```

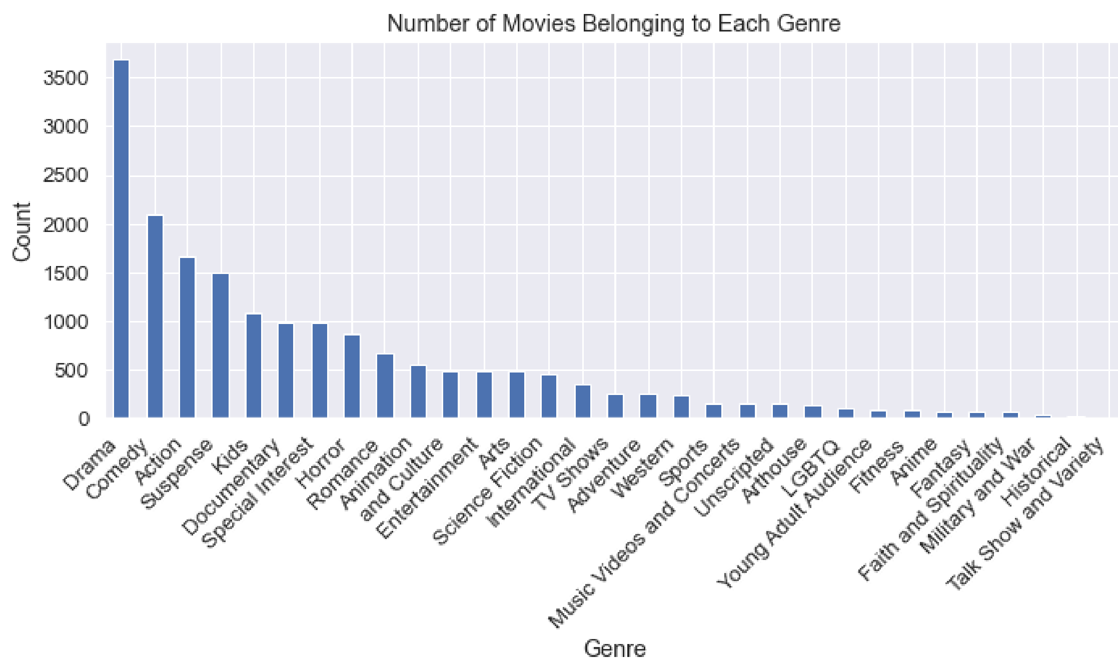
In [142]:
```
df_visualization = df_dropped_filled.copy()
```

Visualizations

Genre Distribution of Movies

In [143]:

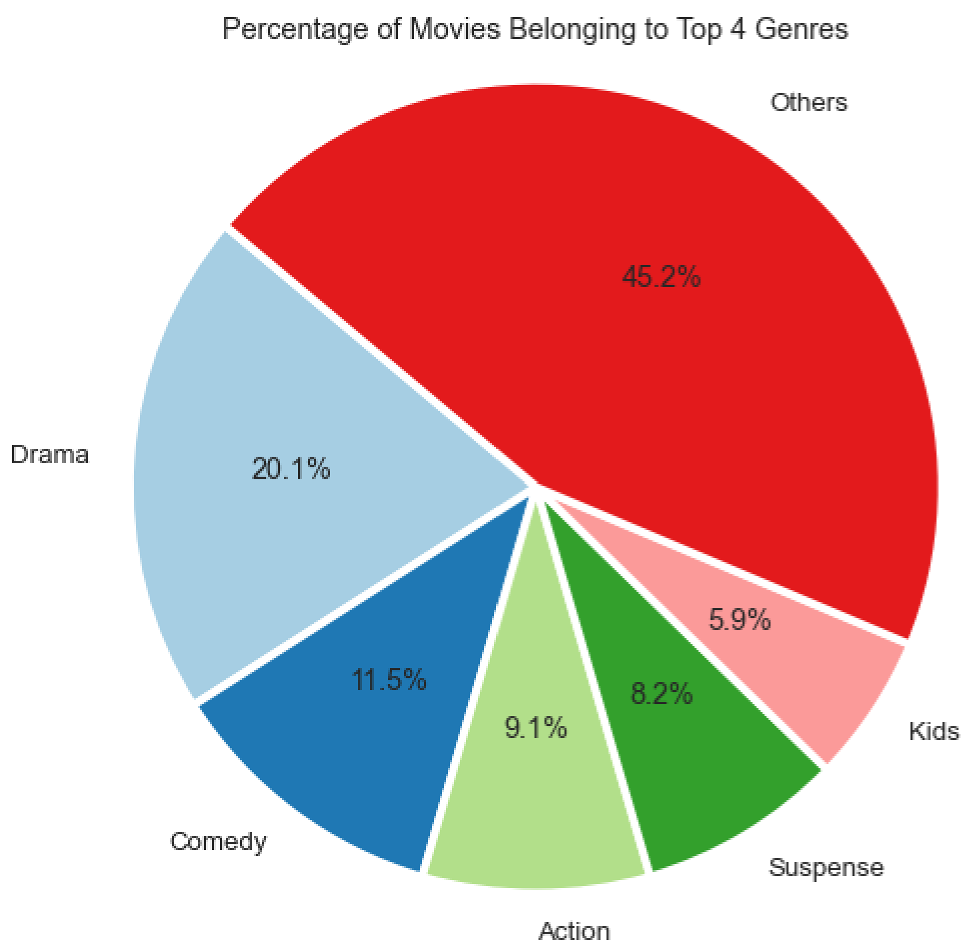
```
all_genres = df_visualization['genre'].str.split(',').explode().str.strip(
genre_counts = all_genres.value_counts()
plt.figure(figsize=(10, 6))
genre_counts.plot(kind='bar')
plt.xlabel('Genre')
plt.ylabel('Count')
plt.title('Number of Movies Belonging to Each Genre')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```



Top 4 Genre Distribution

In [144]:

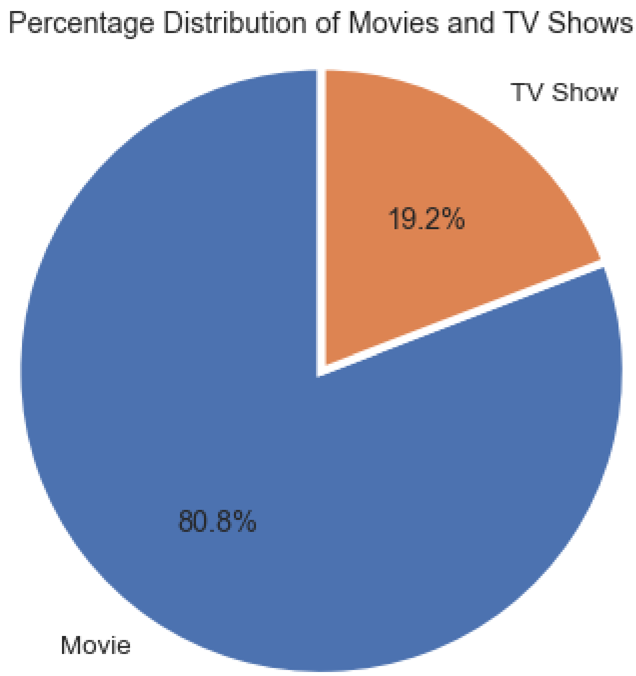
```
top_4_genres = genre_counts.nlargest(5)
other_genres_count = genre_counts[~genre_counts.index.isin(top_4_genres.inc
combined_genre_counts = pd.concat([top_4_genres, pd.Series({'Others': other
plt.figure(figsize=(8, 8))
plt.pie(combined_genre_counts, labels=combined_genre_counts.index, autopct=
plt.title('Percentage of Movies Belonging to Top 4 Genres')
plt.axis('equal')
plt.show()
```



Percentage Distribution of Content Type

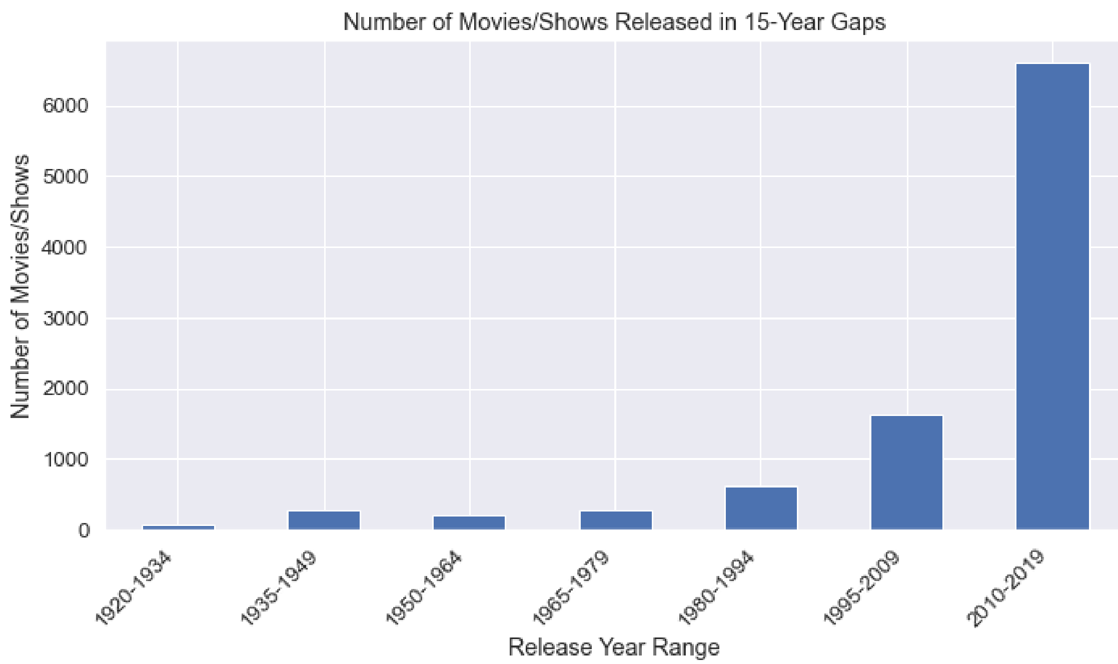
In [145]:

```
type_counts = df_visualization['type'].value_counts()
plt.figure(figsize=(6, 6))
plt.pie(type_counts, labels=type_counts.index, autopct='%1.1f%%', startangl
plt.title('Percentage Distribution of Movies and TV Shows')
plt.axis('equal')
plt.show()
```



Number of Movies/Shows Released in 15-Year Intervals

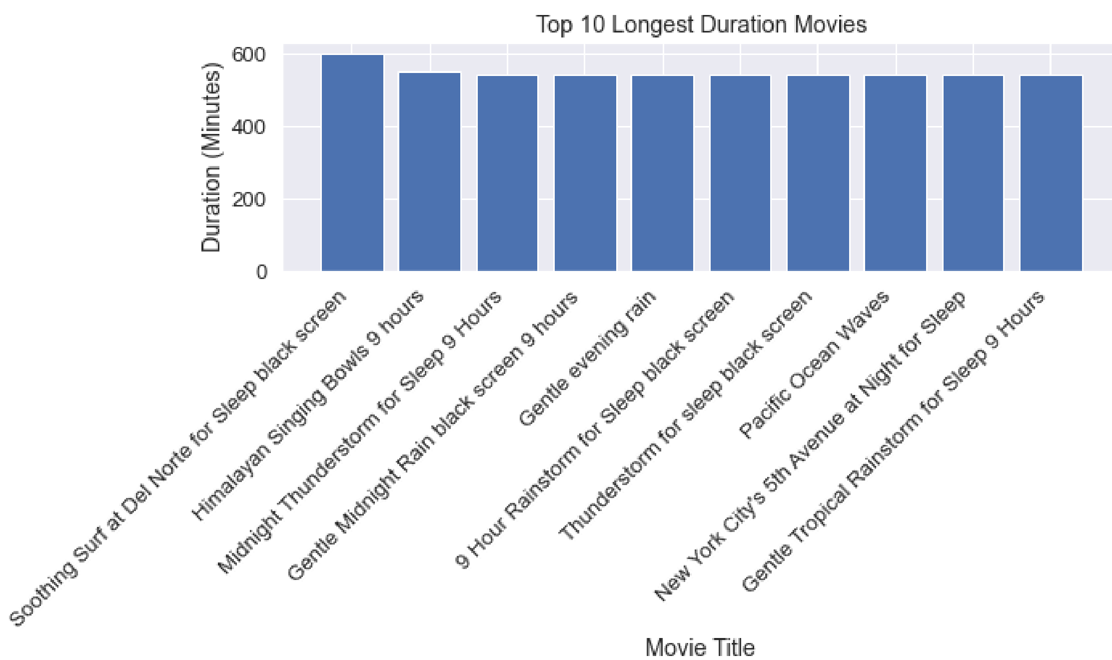
In [146]:
```
year_gaps = range(min(df_visualization['release_year']), max(df_visualizati
labels = []
for year in year_gaps:
    if(year==2010):
        labels.append(f"{year}-2019")
    else:
        labels.append(f"{year}-{year+14}")
grouped_counts = df.groupby(pd.cut(df['release_year'], bins=[*year_gaps, f]
plt.figure(figsize=(10, 6))
grouped_counts.plot(kind='bar')
plt.xlabel('Release Year Range')
plt.ylabel('Number of Movies/Shows')
plt.title('Number of Movies/Shows Released in 15-Year Gaps')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
```

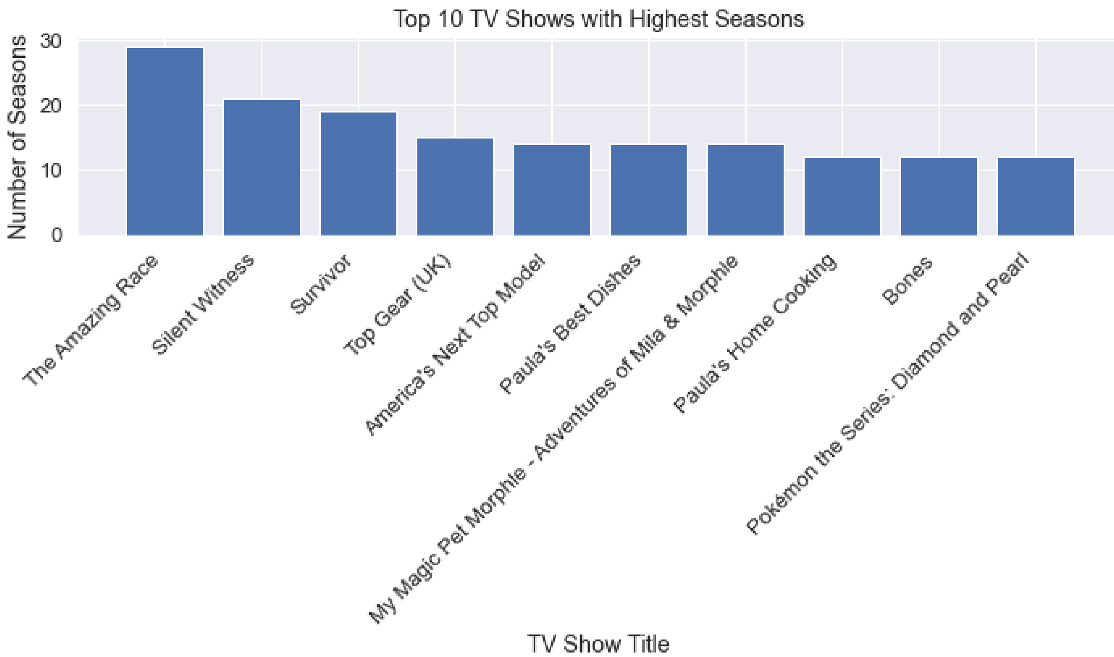


Top 10 Longest Duration Movies and Top 10 TV Shows with Highest Seasons

In [147]:

```
df_visualization['duration_minutes'] = df_visualization['duration'].str.ext
df_visualization['num_seasons'] = df_visualization['duration'].str.extract(
top_10_longest_movies = df_visualization[df_visualization['type'] == 'Movie
top_10_highest_seasons_tv = df_visualization[df_visualization['type'] == 'T
plt.figure(figsize=(10, 6))
plt.bar(top_10_longest_movies['title'], top_10_longest_movies['duration_mir
plt.xlabel('Movie Title')
plt.ylabel('Duration (Minutes)')
plt.title('Top 10 Longest Duration Movies')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
plt.figure(figsize=(10, 6))
plt.bar(top_10_highest_seasons_tv['title'], top_10_highest_seasons_tv['num_
plt.xlabel('TV Show Title')
plt.ylabel('Number of Seasons')
plt.title('Top 10 TV Shows with Highest Seasons')
plt.xticks(rotation=45, ha='right')
plt.tight_layout()
plt.show()
df_visualization.drop(['duration_minutes'], axis = 1, inplace = True)
df_visualization.drop(['num_seasons'], axis = 1, inplace = True)
```





Most Common Words in Descriptions

In [148]:
```
plt.figure(figsize=(20,20))
plt.title('The Most Common Word in Description\n', fontsize=30, weight=600,
wc = WordCloud(max_words=1000, min_font_size=10,
                height=800,width=1600,background_color="white").generate('
plt.imshow(wc)
```

Out[148]: <matplotlib.image.AxesImage at 0x1b887cccf40>

label encoding for visualization

In [149]:

```
label_encoder = LabelEncoder()
df_visualization['type'] = label_encoder.fit_transform(df_visualization['ty
df_visualization['release_year'] = label_encoder.fit_transform(df_visualiza
```

season duration transformation

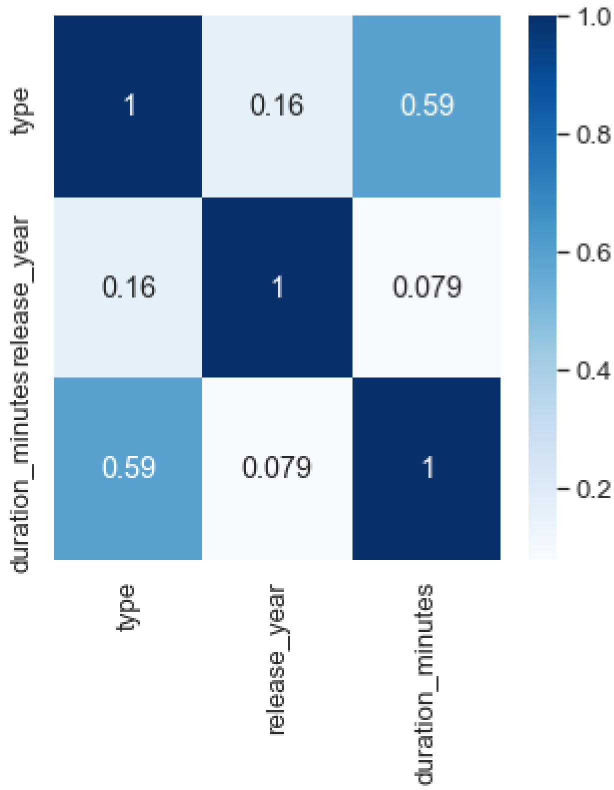
In [150]:

```
#transformation of TV show durations from 'duration' to 'duration_minutes' c
average_season_duration = 400
def seasons_to_minutes(row):
    if 'Season' in row['duration']:
        num_seasons = int(row['duration'].split()[0])
        return num_seasons * average_season_duration
    return int(row['duration'].split()[0])
def minutes_to_seasons(row):
    if 'min' in row['duration']:
        num_minutes = int(row['duration'].split()[0])
        return num_minutes // average_season_duration
    return int(row['duration'].split()[0])
df_visualization['duration_minutes'] = df_visualization.apply(seasons_to_mi
df_visualization['duration_seasons'] = df_visualization.apply(minutes_to_se
df_visualization.drop(['duration'], axis = 1, inplace = True)
```

Correlation Heatmap of Content Type, Release Year, and Duration

In [151]:
```
sns.set(rc={'figure.figsize':(5, 5)})
sns.set(font_scale=1.2)
sns.heatmap(data=df_visualization[['type', 'release_year', 'duration_minute
```

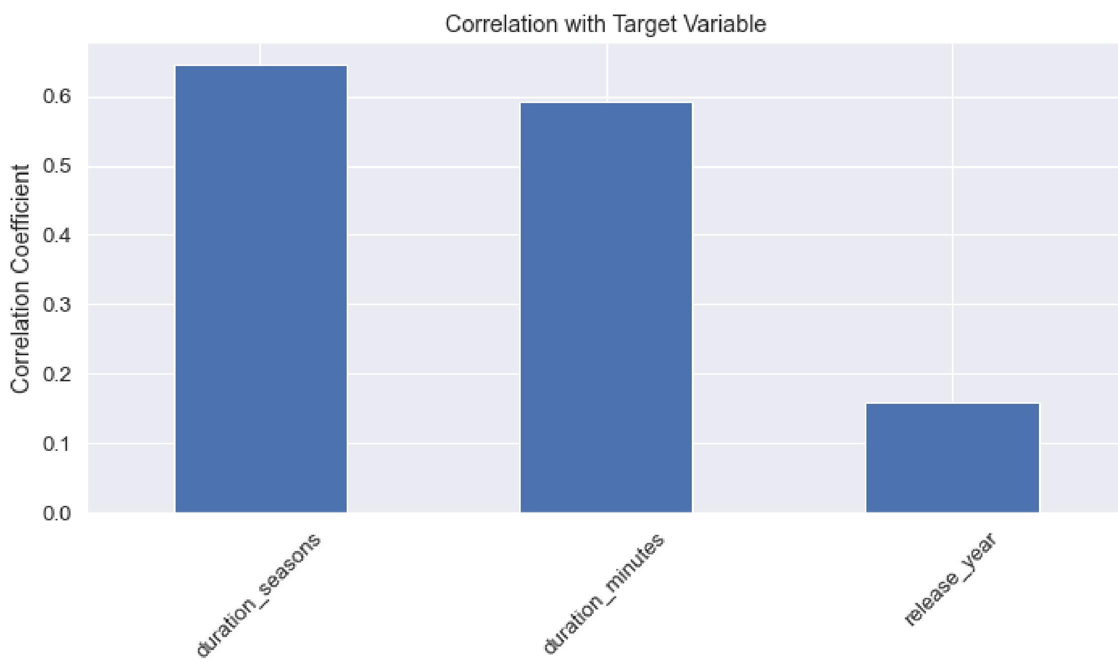
Out[151]: <Axes: >



Correlation with Content Type

In [152]:

```
correlation_matrix = df_visualization.corr()
target_correlation = correlation_matrix['type'].drop('type')
target_correlation = target_correlation.sort_values(ascending=False)
plt.figure(figsize=(10, 6))
target_correlation.plot(kind='bar')
plt.title('Correlation with Target Variable')
plt.ylabel('Correlation Coefficient')
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



Data Preprocessing

Text Data Preprocessing Functions

These functions, text_preprocessing, remove_stop_words, stemming, and lemmatization, serve various text data preprocessing purposes:

1. text_preprocessing: Tokenizes text, converts it to lowercase, and removes non-alphanumeric characters.
2. remove_stop_words: Removes common English stop words from the text.
3. stemming: Applies Porter stemming to reduce words to their root form.
4. lemmatization: Utilizes WordNet lemmatization to reduce words to their base or dictionary form.

In [154]:
```
def text_preprocessing(text):
    words = word_tokenize(text)
    words = [word.lower() for word in words]
    words = [word for word in words if word.isalnum()]
    return ' '.join(words)

def remove_stop_words(text):
    stop_words = set(stopwords.words('english'))
    words = word_tokenize(text)
    words = [word for word in words if word.lower() not in stop_words]
    return ' '.join(words)

def stemming(text):
    stemmer = PorterStemmer()
    words = word_tokenize(text)
    words = [stemmer.stem(word) for word in words]
    return ' '.join(words)

def lemmatization(text):
    lemmatizer = WordNetLemmatizer()
    words = word_tokenize(text)
    words = [lemmatizer.lemmatize(word) for word in words]
    return ' '.join(words)
```

In [155]:
```
df_visualization['merged_text'] = df_visualization['title'] + ' ' + df_visu
df_visualization['merged_text'] = df_visualization['merged_text'].apply(tex
df_visualization['merged_text'] = df_visualization['merged_text'].apply(rem
df_visualization['merged_text'] = df_visualization['merged_text'].apply(ste
df_visualization['merged_text'] = df_visualization['merged_text'].apply(lem
df_visualization['merged_text'] = df_visualization['merged_text'].str.repla
df_visualization['merged_text'] = df_visualization['merged_text'].str.repla
df_visualization['merged_text'] = df_visualization['merged_text'].str.repla
df_visualization.drop(columns=['title', 'description'], inplace=True)
```

Text Data Vectorization and Integration

a CountVectorizer is used to convert text data from the column in the DataFrame into a numerical matrix title_matrix. The resulting matrix is then transformed into a DataFrame, with columns representing the unique words in the text. Finally, these word frequency features are concatenated with the original DataFrame before removing the previous column to create a consolidated dataset for further analysis.

In [156]:
```
count_vectorizer = CountVectorizer()
title_matrix = count_vectorizer.fit_transform(df_visualization['merged_text
title_df = pd.DataFrame(title_matrix.toarray(), columns=count_vectorizer.ge
df_visualization = pd.concat([df_visualization, title_df], axis=1)
df_visualization.drop(['merged_text'], axis = 1, inplace = True)
```

One-Hot Encoding for Categorical Data

The apply_one_hot_encoding function is applied to the DataFrame for various categorical columns ('director', 'cast', 'rating', 'genre'). The process involves the following steps:

1. Adding an 'ID' column to uniquely identify rows.
2. Splitting the specified column by commas and creating multiple rows for each value using explode.
3. Creating one-hot encoded columns for each unique value in the exploded column.
4. Grouping by 'ID' and selecting the maximum value to consolidate the one-hot encoded data.
5. Dropping the original categorical column and the 'ID' column to obtain the final one-hot encoded representation for the specified column.

In [157]:
```
def apply_one_hot_encoding(df_visualization,column):
    df_visualization['ID'] = range(1, len(df_visualization) + 1)
    df_visualization[column] = df_visualization[column].apply(lambda x: x.s
    df_long = df_visualization.explode(column)
    df_visualization = pd.concat([df_visualization, pd.get_dummies(df_long[
    df_visualization = df_visualization.groupby('ID').max().reset_index()
    df_visualization = df_visualization.drop(column, axis=1)
    df_visualization = df_visualization.drop('ID', axis=1)
    return df_visualization
df_visualization = apply_one_hot_encoding(df_visualization,'director')
df_visualization = apply_one_hot_encoding(df_visualization,'cast')
df_visualization = apply_one_hot_encoding(df_visualization,'rating')
df_visualization = apply_one_hot_encoding(df_visualization,'genre')
```

Model Preparing

Feature-Target Split

In [158]:
```
y =  df_visualization['type']
X = df_visualization.drop(['type'], axis=1)
X.columns = X.columns.astype(str)
```

Train-Test Split

In [159]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, ra
```

Model Training and Testing

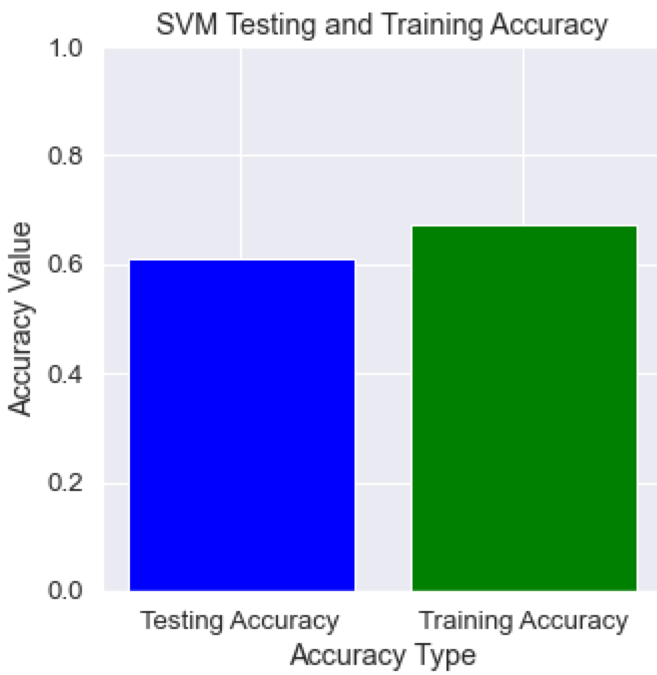
Support Vector Machine (SVM) Classifier and Accuracy Visualization

A Support Vector Machine (SVM) classifier is trained and evaluated on the provided training and testing datasets (X_train, y_train, X_test, y_test). The classifier's accuracy on both the testing and training sets is calculated and displayed.

In [161]:

```
svm_classifier = SVC(C=0.001)
svm_classifier.fit(X_train, y_train)
svm_preds = svm_classifier.predict(X_test)
svm_accuracy = accuracy_score(y_test, svm_preds)
svm_train_preds = svm_classifier.predict(X_train)
svm_train_accuracy = accuracy_score(y_train, svm_train_preds)
print(f"SVM  Testing Accuracy: {svm_accuracy}")
print(f"SVM Training Accuracy: {svm_train_accuracy}")
categories = ['Testing Accuracy', 'Training Accuracy']
values = [svm_accuracy, svm_train_accuracy]
plt.bar(categories, values, color=['blue', 'green'])
plt.xlabel('Accuracy Type')
plt.ylabel('Accuracy Value')
plt.title('SVM Testing and Training Accuracy')
plt.ylim(0, 1)  # Set the y-axis limits appropriately
plt.show()
```

```
SVM  Testing Accuracy: 0.61
SVM Training Accuracy: 0.6725
```

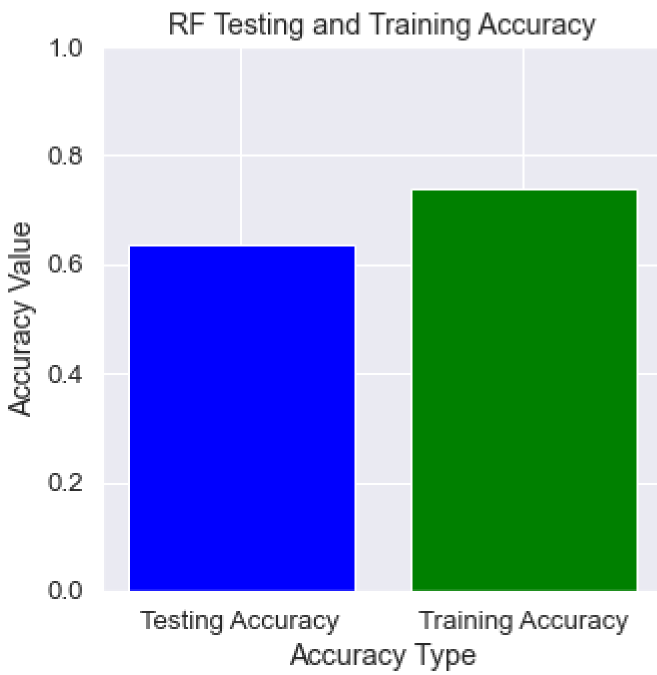


Random Forest Classification and Accuracy Visualization

A Random Forest classifier to the training data, calculates both testing and training accuracies, and then displays the results. It also visualizes the accuracies using a bar chart, illustrating the performance of the Random Forest model on the dataset.

In [162]:
```
rf_classifier = RandomForestClassifier(max_depth=7)
rf_classifier.fit(X_train, y_train)
rf_preds = rf_classifier.predict(X_test)
rf_accuracy = accuracy_score(y_test, rf_preds)
rf_train_preds = rf_classifier.predict(X_train)
rf_train_accuracy = accuracy_score(y_train, rf_train_preds)
print(f"RF Testing Accuracy: {rf_accuracy}")
print(f"RF Training Accuracy: {rf_train_accuracy}")
categories = ['Testing Accuracy', 'Training Accuracy']
values = [rf_accuracy, rf_train_accuracy]
plt.bar(categories, values, color=['blue', 'green'])
plt.xlabel('Accuracy Type')
plt.ylabel('Accuracy Value')
plt.title('RF Testing and Training Accuracy')
plt.ylim(0, 1)  # Set the y-axis limits appropriately
plt.show()
```

```
RF Testing Accuracy: 0.635
RF Training Accuracy: 0.7375
```

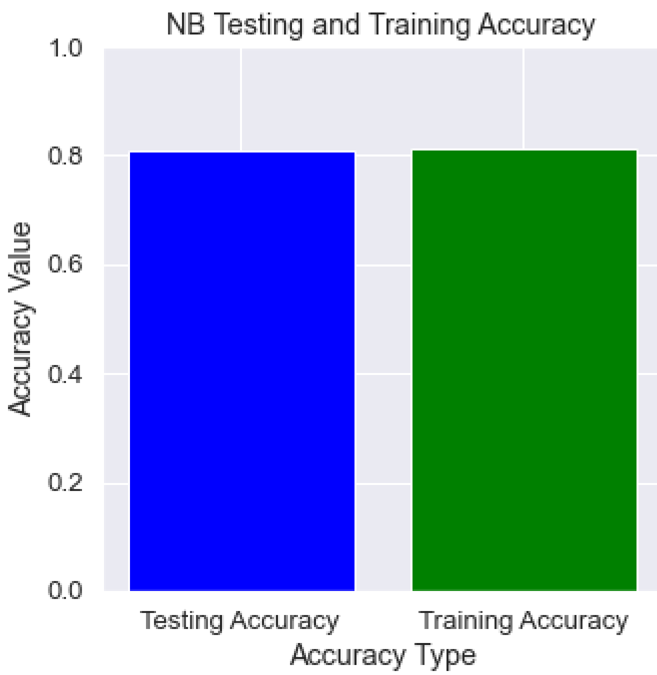


Naive Bayes Classification and Accuracy Visualization

A Multinomial Naive Bayes (NB) classifier with a specified alpha value is applied to the training data. It calculates and displays both testing and training accuracies for the NB model. The code also visualizes the accuracies using a bar chart, illustrating the performance of the NB model on the dataset.

In [164]:
```
nb_classifier = MultinomialNB(alpha=10)
nb_classifier.fit(X_train, y_train)
nb_preds = nb_classifier.predict(X_test)
nb_accuracy = accuracy_score(y_test, nb_preds)
nb_train_preds = nb_classifier.predict(X_train)
nb_train_accuracy = accuracy_score(y_train, nb_train_preds)
print(f"NB  Testing Accuracy: {nb_accuracy}")
print(f"NB Training Accuracy: {nb_train_accuracy}")
categories = ['Testing Accuracy', 'Training Accuracy']
values = [nb_accuracy, nb_train_accuracy]
plt.bar(categories, values, color=['blue', 'green'])
plt.xlabel('Accuracy Type')
plt.ylabel('Accuracy Value')
plt.title('NB Testing and Training Accuracy')
plt.ylim(0, 1)  # Set the y-axis limits appropriately
plt.show()
```

```
NB  Testing Accuracy: 0.81
NB Training Accuracy: 0.81375
```



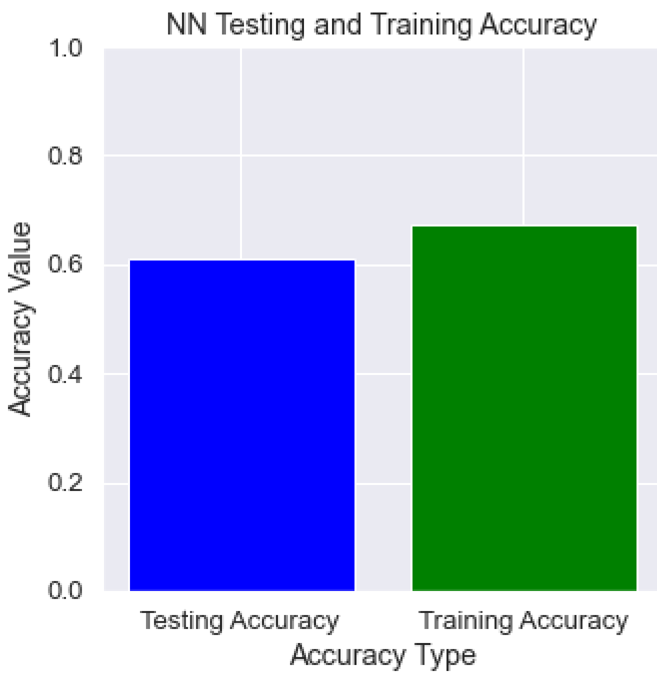
Neural Network Classification and Accuracy Visualization

A Multi-Layer Perceptron (MLP) classifier with specific hidden layer sizes and alpha value is applied to the training data. It calculates and displays both testing and training accuracies for the MLP model. Additionally, the code visualizes the accuracies using a bar chart, illustrating the performance of the Neural Network model on the dataset.

In [165]:

```
nn_classifier = MLPClassifier(hidden_layer_sizes=(64,32,16),alpha=1000)
nn_classifier.fit(X_train, y_train)
nn_preds = nn_classifier.predict(X_test)
nn_accuracy = accuracy_score(y_test, nn_preds)
nn_train_preds = nn_classifier.predict(X_train)
nn_train_accuracy = accuracy_score(y_train, nn_train_preds)
print(f"NN  Testing Accuracy: {nn_accuracy}")
print(f"NN Training Accuracy: {nn_train_accuracy}")
categories = ['Testing Accuracy', 'Training Accuracy']
values = [nn_accuracy, nn_train_accuracy]
plt.bar(categories, values, color=['blue', 'green'])
plt.xlabel('Accuracy Type')
plt.ylabel('Accuracy Value')
plt.title('NN Testing and Training Accuracy')
plt.ylim(0, 1)  # Set the y-axis limits appropriately
plt.show()
```

```
NN  Testing Accuracy: 0.61
NN Training Accuracy: 0.6725
```



In [ ]: