

STAT 430: Final Project

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1. Introduction and Dataset Research

Motivation

For this project we wanted to perform an analysis on a dataset that we found interesting but also relevant to our personal lives. We decided to use the "Movies on Netflix, Prime Video, Hulu and Disney+" Dataset from Kaggle, which can be found at <https://www.kaggle.com/ruchi798/movies-on-netflix-prime-video-hulu-and-disney>. The Netflix Prize brought more attention to how important recommender systems are and how they may be used in many applications. While algorithms designed to recommend movies, products, or other services to customers are very beneficial to businesses and customers alike, sometimes they can perform poorly due to insufficient data or skewed analysis. Industry practitioners want these recommendations to be fast, simple, and accurate to make it as easy as possible for customers to see it and decide that it's something they want to buy (Technophilo, 2012) Recommendation systems can work very well because they provide customers a way to give their feedback about what they liked or disliked. This feedback helps businesses generate predictions on what other movies or products that the customer is most likely to watch or buy, which can increase the amount of business that is made (Aggarwal, 2016). While our end goal for the project isn't to build a recommendation system, this is a big part of what drew us to this dataset, which contains not just data from Netflix but from three other streaming services as well. We were also excited to find any possible relationships between movie ratings, production details, age, target audience, and streaming services that we may or may not already know. The motivation of someone who would analyze this kind of data more extensively would likely be to build a recommendation system for one of these streaming services or for other movie retailers. These businesses would be able to advertise or recommend movies to customers who would be more likely to watch or pay for it. For instance, Netflix and Prime Video are likely to have a large selection of movies available for all age ratings and would benefit from being able to recommend the best movie for a viewer who prefers 18+ rated Horror and Thriller movies vs another viewer who prefers Comedy and Drama but has no discrimination for age ratings. Another application is to evaluate how well movies in different clusters are rated across different geographic regions, so Netflix could make decisions on what movies to add or remove from different regions of their service. This dataset could even be expanded by including social media ratings and response to movies, movie revenue, how much was watched, and user-specific information that could be more useful for a recommendation system. This kind of data can also be useful to the movie production industry in general since it can help them measure the success of a movie based on ratings, where it's most popular, what genres or other characteristics are trending, and even what streaming service might add the movie to their library. This dataset can also be expanded by including movie rating changes over time to be even more useful for the movie industry (Moon et al, 2010).

1. Aggarwal C.C. (2016) An Introduction to Recommender Systems. In: Recommender Systems. Springer, Cham. https://doi.org/10.1007/978-3-319-29659-3_1
2. Moon, S., Bergey, P. K., & Iacobucci, D. (2010). Dynamic Effects among Movie Ratings, Movie Revenues, and Viewer Satisfaction. *Journal of Marketing*, 74(1), 108–121. <https://doi.org/10.1509/jmkg.74.1.108>
3. Technophilo. (2012, October). Recommender Systems: Pros and Cons. *Technophilo*. <http://www.technophilo.in/2012/10/recommender-systems-pros-and-cons.html>

Dataset Information

We retrieved this dataset from Kaggle, which is maintained by Ruchi Bhatia. Part of the data was scraped, which contains attribute information of movies that were available on the streaming platforms. The remaining data came from the IMDb dataset. The Kaggle user was inspired to make this dataset from the following questions:

1. Which streaming platform(s) can I find this movie on?
2. Average IMDb rating of movies produced in a country?
3. Target age group movies vs the streaming [platform] they can be found on.
4. The year during which a movie was produced and the streaming platform they can be found on.
5. Analysis of the popularity of a movie vs directors.

She provides a link to her own data visualization that answers these questions, but we will not focus on or be limited to these questions for our own analysis. The dataset has 16744 observations (movies) and 17 columns for row index, movie ID, title, year of production, age rating, IMDb rating, Rotten Tomatoes rating, Netflix Dummy Variable (DV), Hulu DV, Prime Video DV, Disney+ DV, Type (movie or tv show), Directors (names), Genres, Country(s) available in, Language(s), and Runtime (movie length).

There was no further details including on what if any preprocessing was used, but there may likely have been some binning used since movies are usually region specific for most if not all platforms. For instance, the movie 'Inception' is listed on Netflix only but might only be available in the United States. Another possible issue is that the 'Country' column could refer to these region specific availabilities or to where the movie was produced, neither was explicitly stated (similar issues for 'Genres', 'Language', and 'Directors'). We are not sure exactly which attributes come from IMDb or streaming services, but we think it would safe to assume that the attributes we mentioned likely came from the streaming services.

2. Preliminary Exploratory Data Analysis (EDA)

Package Imports

In [1]:

```
import warnings
warnings.filterwarnings('ignore')

import numpy as np
import pandas as pd
```

```

import matplotlib.pyplot as plt
import seaborn as sns
import matplotlib.cm as cm
%matplotlib inline
import statistics as st

import time
import math

from sklearn.cluster import KMeans, MiniBatchKMeans, Birch, DBSCAN, AgglomerativeClustering
from sklearn.manifold import TSNE
from sklearn.datasets import make_blobs, load_digits
from sklearn.metrics import adjusted_rand_score, silhouette_score, silhouette_samples
#, calinski_harabaz_score
from sklearn.metrics.pairwise import pairwise_distances
from sklearn.neighbors import NearestNeighbors
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA

from kmodes.kmodes import KModes

from scipy.spatial.distance import pdist, squareform
from scipy.cluster.hierarchy import linkage, dendrogram, cophenet

from pyclustertend import hopkins
from sklearn import preprocessing

```

The above packages are necessary for the exploratory data analysis and unsupervised learning algorithms needed for the dataset. These functions will be used throughout the report and are pivotal for mining important insights from the data.

Loading Dataset

In [2]:

```

# Load the data set
df = pd.read_csv('MoviesOnStreamingPlatforms_updated.csv')
print(df.shape)
df.head()

```

(16744, 17)

Out[2]:

	Unnamed: 0	ID	Title	Year	Age	IMDb	Rotten Tomatoes	Netflix	Hulu	Prime Video	Disney+	Type	Ct
0	0	1	Inception	2010	13+	8.8	87%	1	0	0	0	0	Cf
1	1	2	The Matrix	1999	18+	8.7	87%	1	0	0	0	0	Wach
2	2	3	Avengers: Infinity War	2018	13+	8.5	84%	1	0	0	0	0	
3	3	4	Back to the Future	1985	7+	8.5	96%	1	0	0	0	0	

	Unnamed: 0	ID	Title	Year	Age	IMDb	Rotten Tomatoes	Netflix	Hulu	Prime Video	Disney+	Type
4	4	5	The Good, the Bad and the Ugly	1966	18+	8.8	97%	1	0	1	0	Seri

The data shown above closely resembles the raw data file given on Kaggle. Although the dataset was briefly described in the introduction of the report, there are still some key features that should be emphasized. First, it is important to note the overall structures of most features in the dataset: categorical. In other words, many of the clustering/unsupervised learning techniques mentioned in class may not yield substantial results, due to the lack of numerical attributes. There are several ways to combat this issue in order to allow the data to be usable for unsupervised learning. One method, which is implemented in this report, is the use of dummy variables. Instead of having strings of data in each column, like types of genres and name of the directors, it may be more helpful to convert those features into numerical, 1s or 0s, data. This process is outlined later in the Preliminary Exploratory Data Analysis section; however, by doing this, unsupervised learning techniques can be better applied to the dataset.

Summary Statistics of Numerical Attributes

In [3]:

```
df.describe()
```

Out[3]:

	Unnamed: 0	ID	Year	IMDb	Netflix	Hulu	Prime Vide
count	16744.000000	16744.000000	16744.000000	16173.000000	16744.000000	16744.000000	16744.000000
mean	8371.500000	8372.500000	2003.014035	5.902751	0.212613	0.053930	0.73781
std	4833.720789	4833.720789	20.674321	1.347867	0.409169	0.225886	0.43983
min	0.000000	1.000000	1902.000000	0.000000	0.000000	0.000000	0.00000
25%	4185.750000	4186.750000	2000.000000	5.100000	0.000000	0.000000	0.00000
50%	8371.500000	8372.500000	2012.000000	6.100000	0.000000	0.000000	1.00000
75%	12557.250000	12558.250000	2016.000000	6.900000	0.000000	0.000000	1.00000
max	16743.000000	16744.000000	2020.000000	9.300000	1.000000	1.000000	1.00000

By importing the dataset into a Pandas dataframe, the summary statistics can be invoked by using the `.describe()` function. Unfortunately, only the numerical features are shown for the summary statistics because the categorical data cannot be described in this way. One thing to note is that the count of each attribute is different, hinting that there may be missing values in the dataset that must be cleansed. Next, the Netflix , Hulu , Amazon Prime Video and Disney+ columns do not provide valuable insights on each of the parameters. This is mainly due to the fact that those columns are encoded as dummy variables (1s or 0s), meaning that the data shows whether or not an observation has either Netflix or no Netflix . However, we can see that the average values are

quite small for Netflix , Hulu and Disney+ , meaning that there are probably very few movies on those streaming platforms within the dataset. On the other hand, Prime Video has a value (0.74) relatively close to 1, meaning that most observations are Prime Video m. Next, one interesting feature worth noting are the IMDb scores of movies. The movies on average have a score of about 5.9, but the standard deviation of the scores is quite large with 1.35. This means that most of the data points in the dataset are between a score of 4.55 and 7.25. Lastly, the Years the movies were made spanned a multitude of decades. The oldest movie was made in 1902 and the most recent movie was made in 2020, meaning there is a range of more than 100 years among movies in the dataset. These attributes will provide interesting insights on consumer behavior when unsupervised learning algorithms are applied on the dataset.

Number of observations per unique value in each categorical variable

In [4]: `df['Age'].value_counts()`

Out[4]:

18+	3474
7+	1462
13+	1255
all	843
16+	320

Name: Age, dtype: int64

Using the `.value_counts()` function in Python, the counts for each value of age can be found. It is apparent that most of the movie options are 18+, which isn't too surprising. Additionally, since there are streaming platforms, like Disney+, in this dataset, it makes sense that there would be a 1462 observations with 7+ movies and 1255 observations with 13+ movies. The Age variable will definitely provide insight on types of movies presented in each of the clusters.

`catSeparate` is a function used to separate categorical values in text cells for Country , Language , Directors , and Genres columns.

In [5]:

```
def catSeparate(X):
    lst = []
    lst_ct = []
    large = 0
    n = len(X)
    for i in range(0, n):
        c = X[i].split(",")
        if (len(c) > large):
            large = len(c)
        else:
            pass
        for j in range(0, len(c)):
            lst_ct.append(c[j])
            if (c[j] in lst):
                pass
            else:
                lst.append(c[j])

    print(large)
    print(len(lst))
    return(pd.Series(lst_ct))
```

In [6]:

```
X = df.copy()
C = X['Country'].replace(np.nan, "Unknown")
catSeparate(C).value_counts().head(25)
```

27

169

Out[6]:

United States	10486
United Kingdom	1713
India	1157
Canada	1117
France	741
Germany	498
Unknown	435
Italy	417
Spain	329
Australia	321
Hong Kong	269
Japan	266
China	189
Mexico	183
South Korea	162
Belgium	151
Ireland	128
Sweden	118
Netherlands	116
Denmark	113
Argentina	106
Philippines	94
Turkey	88
South Africa	86
Taiwan	80

dtype: int64

From this analysis above, it is apparent that the `Country` variable has about 169 unique countries and a maximum of 27 countries listed for a single movie. It is also not surprising that the first 3 countries, United States, United Kingdom and India, have the highest counts. This is primarily because each of those countries have a booming film industry and are known to output popular cinematography.

In [7]:

```
L = X['Language'].replace(np.nan, "Unknown")
catSeparate(L).value_counts().head(30)
```

10

179

Out[7]:

English	13233
Spanish	872
French	799
Hindi	731
Unknown	599
German	483
Italian	440
Mandarin	352
Japanese	317
Russian	222
Arabic	190
Korean	176
Cantonese	175
Tamil	150
Telugu	112

```

Portuguese      108
Turkish         95
Hebrew          86
Swedish         82
Filipino        72
Tagalog          69
Punjabi          69
Dutch            68
Latin             63
Chinese           62
Malayalam        61
Marathi           60
Danish            60
Indonesian        59
Urdu              58
dtype: int64

```

From the code outputted above, it is apparent that the `Language` variable has 179 unique languages and a maximum of 10 languages listed for a single movie. It is also no suprise that English has the highest number of observations as it is the most popular language in the world.

```
In [8]: D = X['Directors'].replace(np.nan, "Unknown")
catSeparate(D).value_counts().head(25)
```

```

28
12454
Out[8]: Unknown      726
Jay Chapman      36
Joseph Kane      31
Cheh Chang        29
William Beaudine    23
Jim Wynorski      23
Sam Newfield      22
Raúl Campos        21
Jan Suter          21
David DeCoteau      21
Jay Karas          21
Marcus Raboy        18
Fred Olen Ray        18
Scott L. Montoya     17
William Witney      17
Lesley Selander      16
Mark Atkins          16
Paul Hoen            15
Manny Rodriguez       15
William Nigh          14
Robert Stevenson       14
Robert N. Bradbury     13
Roger Corman          13
Mario Bava            13
Philip Gardiner        13
dtype: int64

```

Next, it is apparent that the `Directors` column has a plethora of different options for movies. Specifically, there are 12,454 unique directors and a maximum of 28 directors listed for a single movie. Although this variable is very diverse, it does not seem to be a great option for clustering as there seems to be a lot of `Unknown` directors and the rest of the knowns directors are spread very thin.

```
In [9]: G = X['Genres'].replace(np.nan, "Unknown")
```

```
catSeparate(G).value_counts().head(25)
```

```
9
28
Out[9]: Drama      7227
          Comedy     4637
          Thriller   3354
          Action     2683
          Documentary 2546
          Romance    2359
          Horror     2201
          Crime      1833
          Adventure   1778
          Family     1514
          Mystery    1274
          Sci-Fi     1228
          Fantasy    1089
          Biography   821
          History    715
          Animation   711
          Music      667
          War        539
          Western    499
          Sport       404
          Musical    401
          Short      386
          Unknown    275
          News       105
          Film-Noir   79
          dtype: int64
```

Lastly, the `Genre` feature provides a lot of insight on the types of movies that are on the streaming platforms. There seems to be 28 unique genres spread across the dataset and a maximum of 9 genres listed for a single movie. This feature will definitely be the most interesting to analyze as most cluster groups tend to have similar genres of movies.

Checking datatypes of each column

```
In [10]: df.dtypes
```

```
Out[10]: Unnamed: 0      int64
          ID            int64
          Title         object
          Year           int64
          Age            object
          IMDb          float64
          Rotten Tomatoes  object
          Netflix        int64
          Hulu           int64
          Prime Video    int64
          Disney+        int64
          Type           int64
          Directors      object
          Genres          object
          Country         object
          Language        object
          Runtime         float64
          dtype: object
```

Preprocessing and Data Cleaning

In [11]:

df.head()

Out[11]:

	Unnamed: 0	ID	Title	Year	Age	IMDb	Rotten Tomatoes	Netflix	Hulu	Prime Video	Disney+	Type
0	0	1	Inception	2010	13+	8.8	87%	1	0	0	0	Crt
1	1	2	The Matrix	1999	18+	8.7	87%	1	0	0	0	Wach
2	2	3	Avengers: Infinity War	2018	13+	8.5	84%	1	0	0	0	Crt
3	3	4	Back to the Future	1985	7+	8.5	96%	1	0	0	0	0
4	4	5	The Good, the Bad and the Ugly	1966	18+	8.8	97%	1	0	1	0	Seri

In [12]:

df.isnull().sum(axis = 0)

Out[12]:

Unnamed: 0	0
ID	0
Title	0
Year	0
Age	9390
IMDb	571
Rotten Tomatoes	11586
Netflix	0
Hulu	0
Prime Video	0
Disney+	0
Type	0
Directors	726
Genres	275
Country	435
Language	599
Runtime	592
dtype: int64	

There's a considerable amount of missing data in some columns, the largest being Rotten Tomatoes with 11586 missing values out of a total of 16744 values. Hence, the Rotten Tomatoes variable will be dropped, but other variables will be kept and will be cleaned by dropping their respective NA values. Additionally, ID , Unnamed: 0 , and Type will be dropped since they contain irrelevant information for the analysis.

In [13]:

```
DF = df.copy()
DF['Runtime'] = DF['Runtime'].replace(np.nan, st.mean(DF['Runtime']))
DF = DF.drop(['Rotten Tomatoes', 'ID', 'Unnamed: 0', 'Type'], axis=1)
```

```
DF = DF.dropna()
DF.reset_index(drop=True, inplace=True)
print(DF.shape)
DF.head()
```

(7046, 13)

Out[13]:

	Title	Year	Age	IMDb	Netflix	Hulu	Prime Video	Disney+	Directors	Genres
0	Inception	2010	13+	8.8	1	0	0	0	Christopher Nolan	Action,Adventure,Sci-Fi,Thriller
1	The Matrix	1999	18+	8.7	1	0	0	0	Lana Wachowski,Lilly Wachowski	Action,Sci-Fi
2	Avengers: Infinity War	2018	13+	8.5	1	0	0	0	Anthony Russo,Joe Russo	Action,Adventure,Sci-Fi
3	Back to the Future	1985	7+	8.5	1	0	0	0	Robert Zemeckis	Adventure,Comedy,Sci-Fi
4	The Good, the Bad and the Ugly	1966	18+	8.8	1	0	1	0	Sergio Leone	Western



dummyDF is a function that separates the categories in text cells and creates a dummy variable dataframe for the specified column.

In [14]:

```
def dummyDF(X):
    temp = pd.DataFrame(X)
    lst = []
    n = len(X)
    for i in range(0, n):
        c = X[i].split(",")
        for j in range(0, len(c)):
            if (c[j] not in lst):
                lst.append(c[j])
                temp[c[j]] = ""
            temp.iloc[i, temp.columns.get_loc(c[j])] = 1
    COL = temp.replace("", 0).drop(temp.columns[0], axis=1)
    print(COL.shape)
    return(COL)

# pd.set_option('display.max_columns', None)
# print(GENRE.shape)
# GENRE.head(15)
```

In [15]:

```
Ldf = dummyDF(DF['Language'])
Gdf = dummyDF(DF['Genres'])
Ddf = dummyDF(DF['Directors'])
Cdf = dummyDF(DF['Country'])
```

(7046, 131)
 (7046, 25)
 (7046, 5725)
 (7046, 125)

Considering the large number of categorical levels in these dummy variable dataframes, it will be the most efficient to only use the total number of values per observation instead. Because of this, the Genres dummy variable dataframe will be the only one used, and the Language and Country dummy variable dataframes will be dimensionally reduced by combining levels into larger groups (e.g. merging all European levels of Country into one column called European).

In [16]:

```
CX = Cdf.copy()

NA = ['United States', 'Mexico', 'Canada', 'Bermuda', 'Costa Rica', 'Guatemala', 'Panam  

'Bahamas', 'Dominican Republic', 'Haiti', 'Puerto Rico', 'Cayman Islands', 'Cuba', 'Jam

SA = ['Aruba', 'Brazil', 'Argentina', 'Chile', 'Colombia', 'Peru', 'Ecuador', 'Uruguay'  

'Trinidad and Tobago']

EU = ['United Kingdom', 'Italy', 'Spain', 'West Germany', 'France', 'Poland', 'Germany'  

'Belgium', 'East Germany', 'Sweden', 'Finland', 'Denmark', 'Luxembourg', 'Greece', 'Net  

'Switzerland', 'Hungary', 'Norway', 'Romania', 'Iceland', 'Russia', 'Croatia', 'Holy Se  

'Bulgaria', 'Malta', 'Latvia', 'Slovenia', 'Austria', 'Albania', 'Portugal', 'Serbia',  

'Federal Republic of Yugoslavia', 'Monaco', 'Lithuania', 'Ukraine', 'Czechoslovakia', '  

'Soviet Union', 'Yugoslavia', 'Belarus', 'Slovakia', 'Bosnia and Herzegovina', 'Montene

AS = ['Hong Kong', 'China', 'Japan', 'South Korea', 'Taiwan', 'Afghanistan', 'Banglades  

'India', 'Kazakhstan', 'Kyrgyzstan', 'Nepal', 'Pakistan',  

'Thailand', 'Cambodia', 'Laos', 'Malaysia', 'Vietnam', 'Singapore', 'Indonesia', 'Phi  

'Bahrain', 'Iran', 'Iraq', 'Israel', 'Jordan', 'Lebanon', 'Qatar', 'Saudi Arabia',  

'Syria', 'Turkey', 'Palestine', 'United Arab Emirates']

AU = ['Australia', 'New Zealand', 'Papua New Guinea']

AF = ['Senegal', 'Nigeria', 'Ghana', 'Burkina Faso', 'Egypt', 'Libya', 'Morocco', 'Tuni  

'Angola', 'Congo', 'Ethiopia', 'Kenya', 'Malawi', 'Rwanda', 'Somalia', 'Tanzania', 'Uga  

'Zambia', 'Botswana', 'Namibia', 'South Africa']

Regions = NA + SA + EU + AS + AU + AF

CX['North America'] = CX[NA].sum(axis=1)
CX['South America'] = CX[SA].sum(axis=1)
CX['Europe'] = CX[EU].sum(axis=1)
CX['Asia'] = CX[AS].sum(axis=1)
CX['Australia and Pacific'] = CX[AU].sum(axis=1)
CX['Africa'] = CX[AF].sum(axis=1)

CX = CX.drop(Regions, axis=1)

for i in CX.columns:
    for ii in range(0, len(CX)):
        if CX[i][ii] == 0 or CX[i][ii] == 1:
            pass
        if CX[i][ii] > 1:
            CX[i][ii] = 1

CX.head()
```

Out[16]:

	North America	South America	Europe	Asia	Australia and Pacific	Africa
0	1	0	1	0	0	0
1	1	0	0	0	0	0
2	1	0	0	0	0	0
3	1	0	0	0	0	0
4	0	0	1	0	0	0

In [17]:

```
# English      13233
# Spanish     872
# French      799
# Arabic       190
# Portuguese   108

LX = Ldf.copy()

NA = ['North American Indian', 'East-Greenlandic', 'Cheyenne', 'Navajo', 'Maya', 'Middl
'Inuktitut', 'Sioux', 'Creek', 'Athapascan languages', 'Apache languages', 'Micmac']

SA = ['Quechua', 'Mapudungun', 'Papiamento', 'Tupi', 'Guarani']

EU = ['Basque', 'Finnish', 'Serbo-Croatian', 'Swiss German', 'Croatian', 'Aramaic', 'Sa
'Hungarian', 'Estonian', 'Serbian', 'Bosnian', 'Lithuanian', 'Latin', 'Greek', 'Irish',
'Norwegian', 'Romanian', 'Scottish Gaelic', 'Danish', 'Flemish', 'Slovenian', 'Catalan'
'Icelandic', 'Ukrainian', 'Dutch', 'Polish', 'Czech', 'Welsh', 'Luxembourgish', 'Cornis
'Maltese', 'Scots', 'Slovak', 'Low German', 'Bulgarian', 'Swedish', 'German', 'Italian'

AS = ['Kudmali', 'Bhojpuri', 'Sanskrit', 'Pushto', 'Sinhalese', 'Awadhi', 'Vietnamese',
'Armenian', 'Kannada', 'Nepali', 'Urdu', 'Persian', 'Kurdish', 'Bengali', 'Thai', 'Indo
'Khmer', 'Tagalog', 'Turkmen', 'Tibetan', 'Min Nan', 'Chinese', 'Malayalam', 'Mongolian
'Malay', 'Hakka', 'Shanghainese', 'Gujarati', 'Assyrian Neo-Aramaic', 'Dari', 'Filipino
'Cantonese', 'Korean', 'Hindi', 'Tamil', 'Telugu', 'Japanese', 'Mandarin', 'Hebrew']

AU = ['Polynesian', 'Aboriginal', 'Maori', 'Hawaiian']

AF = ['Masai', 'Dyula', 'Nama', 'Amharic', 'Southern Sotho', 'Lingala', 'Berber languag
'Nyanja', 'Afrikaans', 'Zulu', 'Xhosa', 'Swahili', 'Yoruba', 'Kinyarwanda']

SL = ['Japanese Sign Language', 'American Sign Language', 'Sign Languages',
'French Sign Language', 'None', 'Brazilian Sign Language']

OT = ['Esperanto', 'Klingon', 'None']

Regions = NA + SA + EU + AS + AU + AF + OT + SL

LX['North American'] = LX[NA].sum(axis=1)
LX['South American'] = LX[SA].sum(axis=1)
LX['European'] = LX[EU].sum(axis=1)
LX['Asian'] = LX[AS].sum(axis=1)
LX['Australian and Pacific'] = LX[AU].sum(axis=1)
LX['African'] = LX[AF].sum(axis=1)
LX['Sign Lang.'] = LX[SL].sum(axis=1)
LX['Other'] = LX[OT].sum(axis=1)

LX = LX.drop(Regions, axis=1)
```

```

for i in LX.columns:
    for ii in range(0,len(LX)):
        if LX[i][ii] == 0 or LX[i][ii] == 1:
            pass
        if LX[i][ii] > 1:
            LX[i][ii] = 1

LX.head()

```

Out[17]:

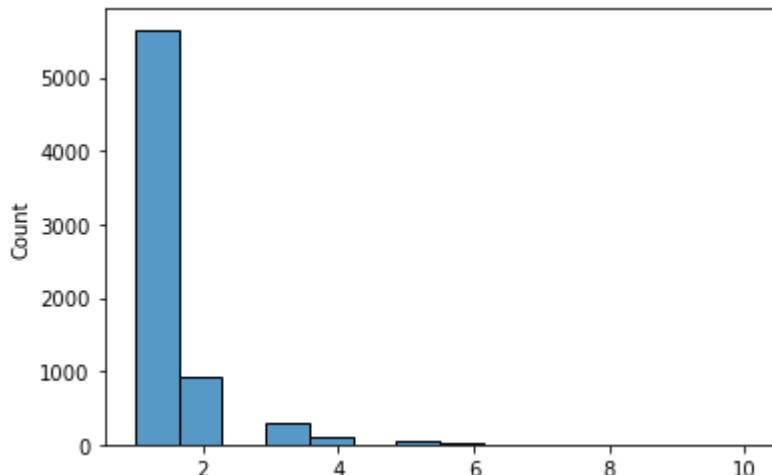
	English	French	Spanish	Arabic	Portuguese	North American	South American	European	Asian	Australian and Pacific	Af
0	1	1	0	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	1	0	0	0



In [18]:

```
sns.histplot(Ldf.sum(axis=1))
```

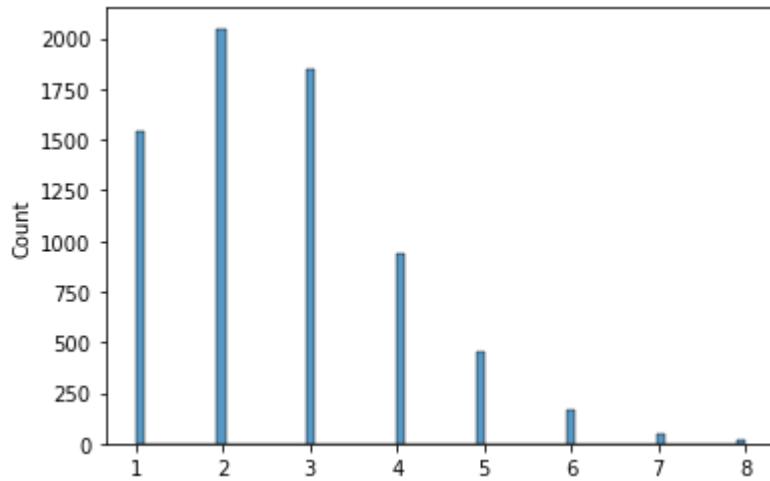
Out[18]: <AxesSubplot:ylabel='Count'>



In [19]:

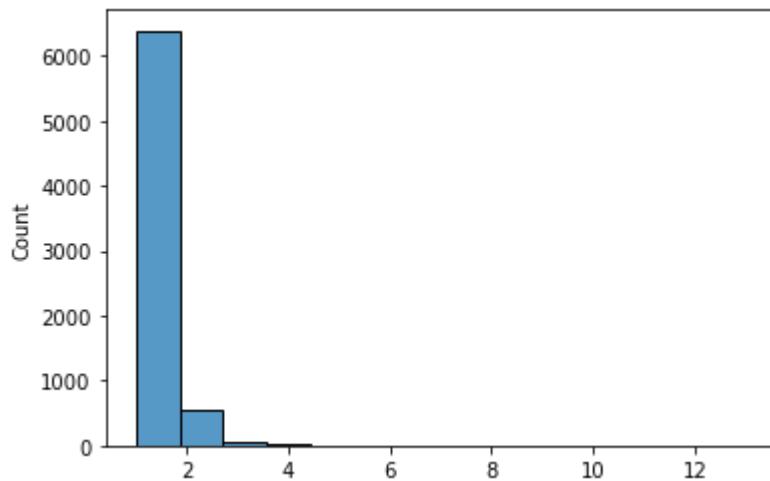
```
sns.histplot(Gdf.sum(axis=1))
```

Out[19]: <AxesSubplot:ylabel='Count'>



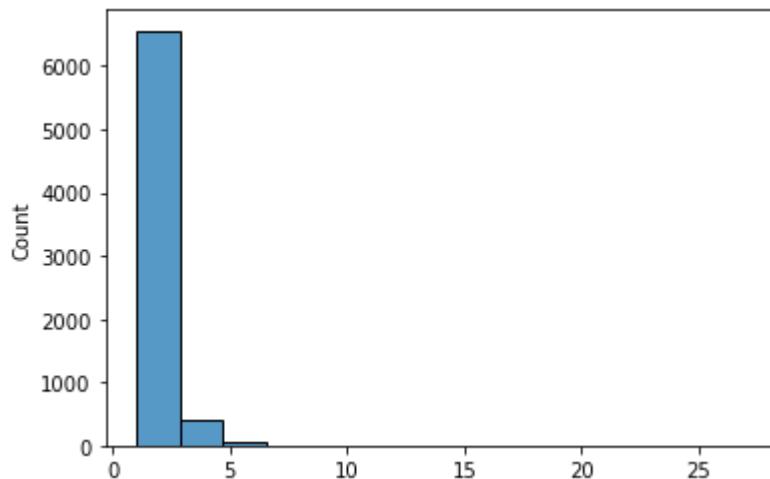
```
In [20]: sns.histplot(Ddf.sum(axis=1))
```

```
Out[20]: <AxesSubplot:ylabel='Count'>
```



```
In [21]: sns.histplot(Cdf.sum(axis=1))
```

```
Out[21]: <AxesSubplot:ylabel='Count'>
```



```
In [22]: X = DF.copy()
```

```
X = X.drop(['Genres', 'Country', 'Language', 'Directors'], axis=1)
X['Total Genres'] = Gdf.sum(axis=1)
X['Total Countries'] = Cdf.sum(axis=1)
X['Total Languages'] = Ldf.sum(axis=1)
X['Total Directors'] = Ddf.sum(axis=1)
print(X.shape)
X.head()
```

(7046, 13)

Out[22]:

	Title	Year	Age	IMDb	Netflix	Hulu	Prime Video	Disney+	Runtime	Total Genres	Total Countries	Total Languages
0	Inception	2010	13+	8.8	1	0	0	0	148.0	4	2	
1	The Matrix	1999	18+	8.7	1	0	0	0	136.0	2	1	
2	Avengers: Infinity War	2018	13+	8.5	1	0	0	0	149.0	3	1	
3	Back to the Future	1985	7+	8.5	1	0	0	0	116.0	3	1	
4	The Good, the Bad and the Ugly	1966	18+	8.8	1	0	1	0	161.0	1	3	

We will also replace the Year column with movie_age for better interpretation.

In [23]:

```
X['movie_age'] = 2020 - X['Year']
X = X.drop('Year', axis=1)
```

Age dummy variable:

In [24]:

```
age = pd.get_dummies(X, columns=['Age'])
mdf = pd.concat([age, Gdf, CX, LX], axis=1)
```

Below is the modified dataset:

In [25]:

```
mdf.head()
```

Out[25]:

	Title	IMDb	Netflix	Hulu	Prime Video	Disney+	Runtime	Total Genres	Total Countries	Total Languages	...	Arabi
0	Inception	8.8	1	0	0	0	148.0	4	2	3	...	(
1	The Matrix	8.7	1	0	0	0	136.0	2	1	1	...	(

	Title	IMDb	Netflix	Hulu	Prime Video	Disney+	Runtime	Total Genres	Total Countries	Total Languages	...	Arabi
2	Avengers: Infinity War	8.5	1	0	0	0	149.0	3	1	1	...	0
3	Back to the Future	8.5	1	0	0	0	116.0	3	1	1	...	0
4	The Good, the Bad and the Ugly	8.8	1	0	1	0	161.0	1	3	1	...	0

5 rows × 61 columns



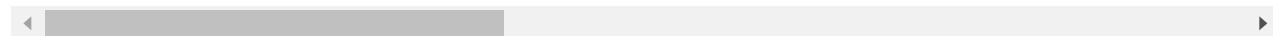
In [26]:

```
mdf.describe()
```

Out[26]:

	IMDb	Netflix	Hulu	Prime Video	Disney+	Runtime	Total Genres	C
count	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000
mean	5.847559	0.228357	0.080471	0.675703	0.069401	97.586858	2.637099	1
std	1.333326	0.419803	0.272041	0.468145	0.254153	21.929089	1.334111	0
min	1.000000	0.000000	0.000000	0.000000	0.000000	2.000000	1.000000	1
25%	5.000000	0.000000	0.000000	0.000000	0.000000	87.000000	2.000000	1
50%	6.000000	0.000000	0.000000	1.000000	0.000000	95.000000	2.000000	1
75%	6.800000	0.000000	0.000000	1.000000	0.000000	106.000000	3.000000	1
max	9.100000	1.000000	1.000000	1.000000	1.000000	260.000000	8.000000	27

8 rows × 60 columns



In [27]:

```
Cmat_mdf = mdf.corr()
```

In [28]:

```
lst = []
point = []
for i in Cmat_mdf.columns:
    for j in Cmat_mdf.columns:
        if abs(Cmat_mdf[str(i)][str(j)]) >= 0.4:
            if i==j:
                pass
            else:
                temp = str(i) + "," + str(j)
                if (str(j) + "," + str(i)) in lst:
```

```

        pass
    else:
        lst.append(temp)
        point.append(Cmat_mdf[str(i)][str(j)])
else:
    pass

```

Pairwise Relationships

In [29]:

```

pair_mdf = pd.DataFrame({'row,col': lst, 'corr': point})
print(pair_mdf.shape)
pair_mdf.head(16)

```

(16, 2)

Out[29]:

	row,col	corr
0	Netflix,Prime Video	-0.666071
1	Disney+,Family	0.531371
2	Total Genres,Adventure	0.482358
3	Total Countries,Europe	0.500749
4	Total Languages,French	0.479866
5	Total Languages,European	0.574736
6	Age_13+,Age_18+	-0.431196
7	Age_18+,Age_7+	-0.474986
8	Age_all,Family	0.468911
9	Animation,Family	0.471550
10	North America,Asia	-0.483256
11	North America,English	0.614397
12	North America,Asian	-0.469579
13	Asia,English	-0.580385
14	Asia,Asian	0.767136
15	English,Asian	-0.569026

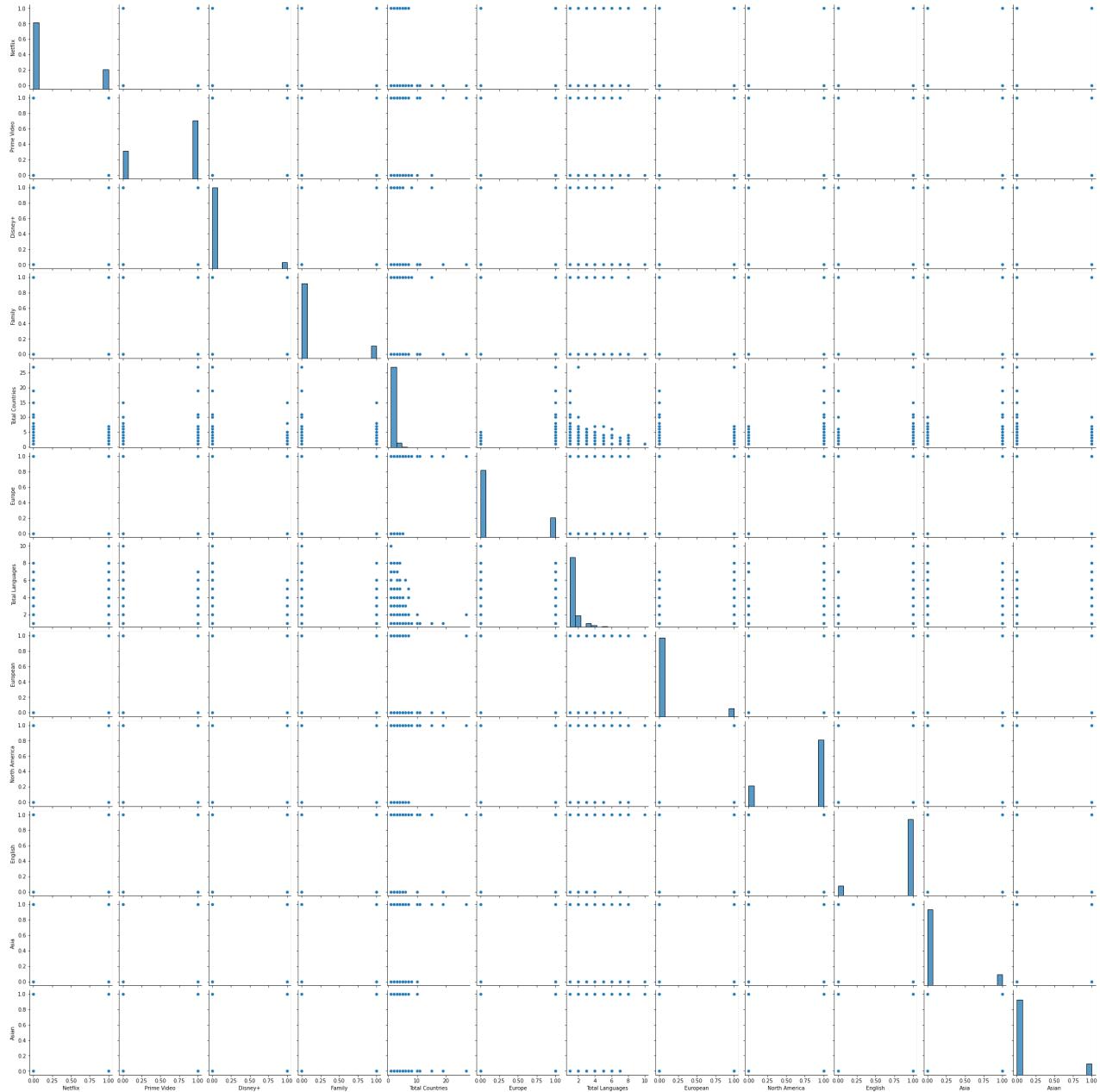
The output above shows pairwise correlations for features that have a correlation values of greater than 0.4 or less than -0.4. This shows what features are adequately correlated with one another in both the positive and negative directions. Some features, like `Asia` and `Asian`, make sense that they have a large correlation between them, while others, like `Netflix` and `Prime Video`, are much more interesting. For instance, seeing a strong, negative correlation between the 2 streaming platforms means that there is an inverse relationship between movies in both platforms, meaning that for any movie that is on `Prime Video` there is less chance that `Netflix` will have it, and vice versa. Additionally, seeing a correlation between `Animation` and `Family`, and `Disney+` and `Family` is reassuring as it makes sense for those features to have a positive correlation with one another. In other words, it makes sense that animation films as well as films on `Disney+` cater to the

family genre. It is also worth noting the high correlations between North America and English , and North America and Asian as it wouldn't readily make sense for such relationships to be prevalent. Overall, there seems to be some interesting pairwise relationships within the dataset that may be brought into light as unsupervised learning is applied to the dataset.

In [30]:

```
# Strong/Interesting relationships visualized.
mdf_rel = mdf[['Netflix', 'Prime Video', 'Disney+', 'Family', 'Total Countries', 'Europe',
'Total Languages', 'European', 'North America', 'English', 'Asia', 'Asian']]
sns.pairplot(mdf_rel)
```

Out[30]: <seaborn.axisgrid.PairGrid at 0x2015b2d14f0>



Shown above are some pairplots of the different features within the dataset. Unfortunately, since most of the data is encoded as dummy variables, these pairwise relationships do not provide any significant information in terms of the relationship between features. In other words, most of the graphs are 0s or 1s data values, which doesn't follow any conventional correlations. However, from

the correlation coefficients found in the previous block of code, there is enough preliminary exploratory data analysis to help drive the unsupervised learning in the next sections.

Scaling of Dataset

In [31]:

```
Xs = mdf.copy()
Xs = Xs.drop('Title', axis=1)
Xs_col = Xs.columns
Xs.reset_index(drop=True, inplace=True)
Xs = StandardScaler().fit_transform(Xs)
Xs = pd.DataFrame(Xs, columns=Xs_col)
Xs.describe()
```

Out[31]:

	IMDb	Netflix	Hulu	Prime Video	Disney+	Runtime	Total
count	7.046000e+03	7.046000e+03	7.046000e+03	7.046000e+03	7.046000e+03	7.046000e+03	7.046000e+03
mean	5.163183e-16	-2.581592e-16	-6.453979e-17	3.226989e-17	3.226989e-17	1.613495e-16	-4.437e-17
std	1.000071e+00	1.000071e+00	1.000071e+00	1.000071e+00	1.000071e+00	1.000071e+00	1.000071e+00
min	-3.635946e+00	-5.439993e-01	-2.958268e-01	-1.443464e+00	-2.730875e-01	-4.359216e+00	-1.2271
25%	-6.357176e-01	-5.439993e-01	-2.958268e-01	-1.443464e+00	-2.730875e-01	-4.828112e-01	-4.7751
50%	1.143395e-01	-5.439993e-01	-2.958268e-01	6.927779e-01	-2.730875e-01	-1.179730e-01	-4.7751
75%	7.143853e-01	-5.439993e-01	-2.958268e-01	6.927779e-01	-2.730875e-01	3.836794e-01	2.7201
max	2.439517e+00	1.838238e+00	3.380356e+00	6.927779e-01	3.661830e+00	7.406813e+00	4.0201

8 rows × 60 columns

One main issue that was presented in the original dataset was the standard deviation within each feature. Specifically, there seemed to be a large spread among numerical data as well as created dummy variables. Because of this, the dataset was a bit unbalanced and it was much more difficult to derive insights through clustering. To combat this, scaling was applied to the dataset to stabilize the standard deviations of all variables in the dataset. In the table above, most, if not all, features have a standard deviation of about 1, meaning that the dataset was scaled appropriately.

Final Data Preparation

The code in this section transforms the `mdf` dataframe into a complete categorical dataset via binning and encoding.

In [32]:

```
mdf_bin = mdf.copy()
mdf_bin = mdf_bin.dropna()

mdf_bin['runtime_bin'] = pd.cut(mdf_bin['Runtime'], [0, 87, 95, 106, 260],
```

```

labels=['0-87', '87-95', '95-106', '106-260'], include_lowest=True)
mdf_bin['move_age_bin'] = pd.cut(mdf_bin['movie_age'], [0, 10, 20, 30, 40, 50, 60, 70,
labels=['0-10', '10-20', '20-30', '30-40', '40-50', '50-60', '60-70', '70-80', '80-90',
mdf_bin['imdb_bin'] = pd.cut(mdf_bin['IMDb'], [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
labels=['0-1', '1-2', '2-3', '3-4', '4-5', '5-6', '6-7', '7-8', '8-9', '9-10'], include_lowest=True)

mdf_cat = mdf_bin.drop(['Title', 'IMDb', 'Runtime', 'movie_age'], axis=1)

lab_enc = preprocessing.LabelEncoder()
mdf_cat = mdf_cat.apply(lab_enc.fit_transform)
mdf_cat.head()

```

Out[32]:

	Netflix	Hulu	Prime Video	Disney+	Total Genres	Total Countries	Total Languages	Total Directors	Age_13+	Age_16+	...	Ar
0	1	0	0	0	3	1	2	0	1	0	...	
1	1	0	0	0	1	0	0	1	0	0	...	
2	1	0	0	0	2	0	0	1	1	0	...	
3	1	0	0	0	2	0	0	0	0	0	...	
4	1	0	1	0	0	2	0	0	0	0	...	

5 rows × 60 columns



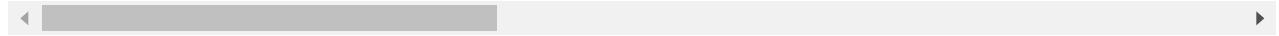
In [33]:

```
mdf_cat.describe()
```

Out[33]:

	Netflix	Hulu	Prime Video	Disney+	Total Genres	Total Countries	Total Languages	D
count	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000	7046.000000
mean	0.228357	0.080471	0.675703	0.069401	1.637099	0.330968	0.304428	0.000000
std	0.419803	0.272041	0.468145	0.254153	1.334111	0.794247	0.742505	0.000000
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000
50%	0.000000	0.000000	1.000000	0.000000	1.000000	0.000000	0.000000	0.000000
75%	0.000000	0.000000	1.000000	0.000000	2.000000	0.000000	0.000000	0.000000
max	1.000000	1.000000	1.000000	1.000000	7.000000	12.000000	8.000000	11.000000

8 rows × 60 columns



In [34]:

```
pd.concat([mdf_bin['runtime_bin'], mdf_cat['runtime_bin']], axis=1).drop_duplicates()
```

Out[34]:

	runtime_bin	runtime_bin
0	106-260	1

	runtime_bin	runtime_bin
14	87-95	2
17	95-106	3
60	0-87	0

In [35]: `pd.concat([mdf_bin['move_age_bin'], mdf_cat['move_age_bin']], axis=1).drop_duplicates()`

	move_age_bin	move_age_bin
0	0-10	0
1	20-30	4
3	30-40	5
4	50-60	7
6	10-20	1
10	40-50	6
1132	70-80	9
2165	60-70	8
2182	110-120	3
2183	90-100	11
2402	80-90	10
2482	100-110	2

In [36]: `pd.concat([mdf_bin['imdb_bin'], mdf_cat['imdb_bin']], axis=1).drop_duplicates()`

	imdb_bin	imdb_bin
0	8-9	8
17	7-8	7
87	6-7	6
350	5-6	5
564	4-5	4
955	3-4	3
1405	2-3	2
3795	9-10	9
5800	1-2	1
5857	0-1	0

3. Pre-Analysis Questions

Is the Dataset Clusterable?

In [37]:

```
num_trials=5
hopkins_stats=[]
for i in range(0,num_trials):
    n = len(Xs)
    p = int(0.1 * n)
    hopkins_stats.append(hopkins(Xs,p))
print(hopkins_stats)
```

```
[0.04824812911096619, 0.05152049449609971, 0.047458538990526856, 0.046517620296658596,
0.04995540076274805]
```

In [38]:

```
X = mdf.copy()
X = X.drop('Title', axis=1)
num_trials=5
hopkins_stats=[]
for i in range(0,num_trials):
    n = len(X)
    p = int(0.1 * n)
    hopkins_stats.append(hopkins(X,p))
print(hopkins_stats)
```

```
[0.11392417006092573, 0.11455009249231803, 0.11478497716447815, 0.11572375548057613, 0.1
1519468488695701]
```

In [39]:

```
X = mdf_cat.copy()
num_trials=5
hopkins_stats=[]
for i in range(0,num_trials):
    n = len(X)
    p = int(0.1 * n)
    hopkins_stats.append(hopkins(X,p))
print(hopkins_stats)
```

```
[0.15989491388776855, 0.16828556923537832, 0.16489664623048014, 0.15876823486309796, 0.1
5745325495956194]
```

In [40]:

```
def tsne_df(XDF, DF, PR, RS):
    tsne = TSNE(n_components=2, perplexity=PR, random_state=RS)
    data_tsne = tsne.fit_transform(XDF)
    df_tsne = pd.DataFrame(data_tsne, columns=['x', 'y'], index=XDF.index)
    dff = pd.concat([DF, df_tsne], axis=1)
    return(dff)

def tsne_plot(DFF, W, H, FS):
    fig, ax = plt.subplots(figsize=(W, H))
    with sns.plotting_context("notebook", font_scale=FS):
        sns.scatterplot(x='x',
                        y='y',
                        sizes=(30, 400),
                        data=DFF,
                        ax=ax)
    ax.set_xlabel(r'$x$')
    ax.set_ylabel(r'$y$')
```

```

plt.show()

def tsne_plot_hue(DFF, W, H, FS, HUE):
    fig, ax = plt.subplots(figsize=(W, H))
    with sns.plotting_context("notebook", font_scale=FS):
        sns.scatterplot(x='x',
                        y='y',
                        sizes=(30, 400),
                        hue=HUE,
                        data=DFF,
                        ax=ax)
    ax.set_xlabel(r'$x$')
    ax.set_ylabel(r'$y$')
    plt.show()

```

In [41]:

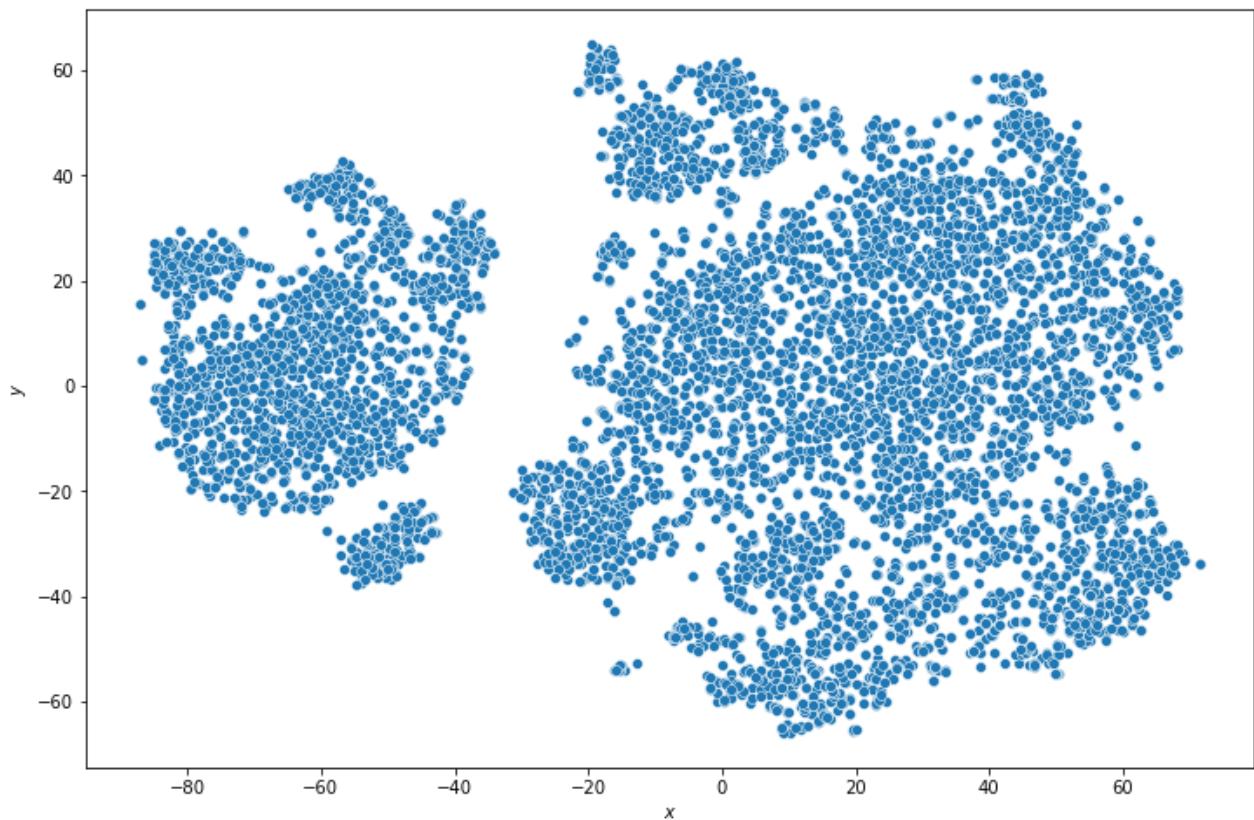
```
X_cat = mdf_cat.copy()
tdf35 = tsne_df(XDF=X_cat, DF=mdf_cat, PR=35, RS=1000)
```

In [42]:

```
tdf45 = tsne_df(XDF=X_cat, DF=mdf_cat, PR=45, RS=1000)
```

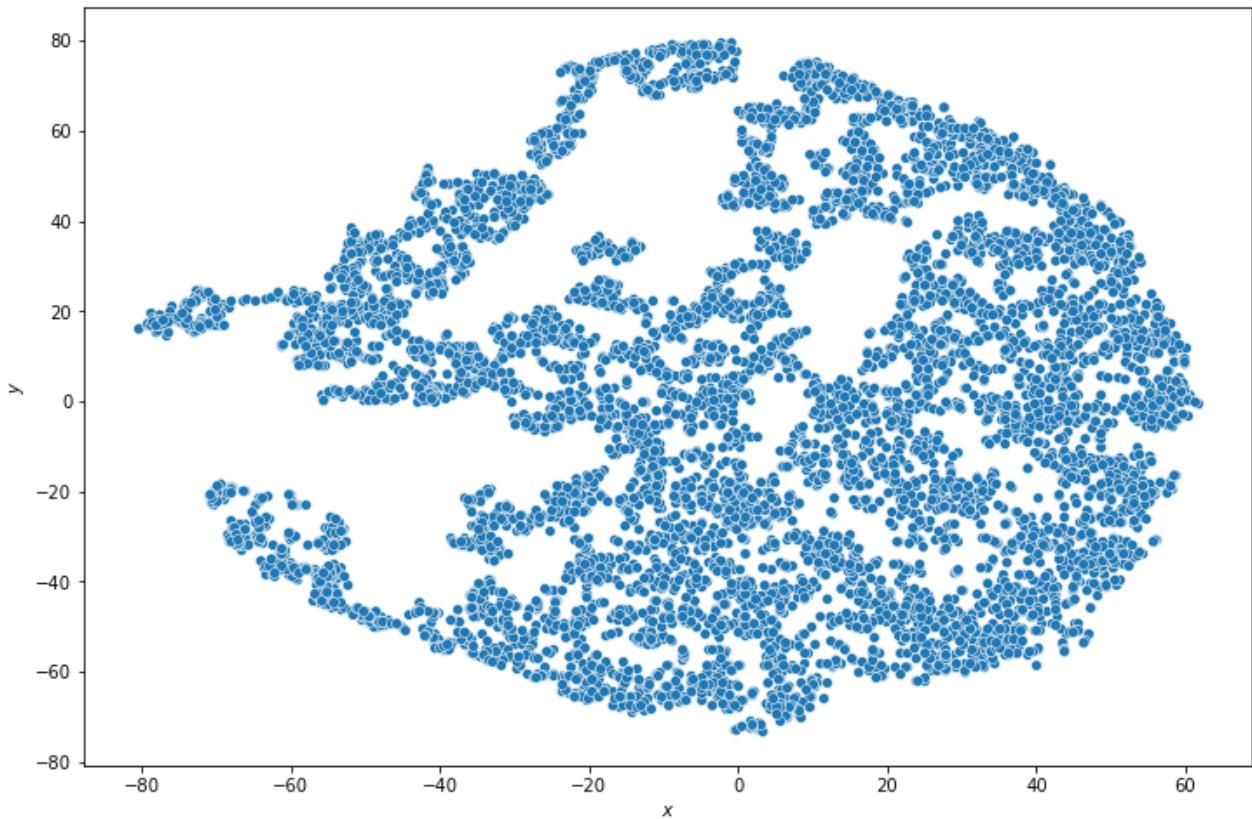
In [43]:

```
tsne_plot(DFF=tdf35, W=12, H=8, FS=1.5)
```



In [44]:

```
Xu = mdf.copy()
Xu = Xu.drop('Title', axis=1)
tdf35u = tsne_df(XDF=Xu, DF=Xu, PR=35, RS=1000)
tsne_plot(DFF=tdf35u, W=12, H=8, FS=1.5)
```



From the analysis above, this dataset is clusterable. The main metric used to deduce the clusterability of the two datasets used in the analysis is the hopkins statistic. After running the algorithm on both datasets, the hopkins statistic provided values ranging from 0.04 and 0.16. The closer the hopkins statistic is to 0, the more clusterable the dataset is, which confirms that both datasets are ready for unsupervised learning. As stated earlier, there are 2 main datasets used in this report: `mdf` and `mdf_cat`. The t-sne plot for `mdf_cat` is shown first and the t-sne plot for `mdf` is shown second. For `mdf_cat`, there seems to be 2 main large clusters with many smaller cluster hovering around it, while `mdf` seems like one large cluster with a few less spherical clusters attached to it. Both clusters seem to have a shape that is approximately spherical with very little separation and cohesion. Additionally, both plots show that the clusters are not balanced in size as some are larger than others, and due to the lack of separation there is a large chance that many of the clusters overlap with one another. Although these plots do not present promising results, the different unsupervised learning algorithms may be able to identify some hidden cluster structures that can shed light on some possible findings in the data.

4. Algorithm Selection Motivation

This dataset was heavily dependent on categorical variables with very few numerical attributes. Additionally, there were a large amount of missing data and pre-processing that must be done for the dataset to be usable under any unsupervised modeling. During the processing phase, many of the observations were converted from categorical values to dummy variables as well as encoded into bins and then scaled to be on par with the rest of the features in the dataset. This allowed the dataset to be ready for a categorical based clustering. In fact, this dataset became a perfect specimen for agglomerative hierarchical clustering because of the dummy variables and standardized data. Additionally, since the dataset was categorical heavy, the k-modes algorithm was also chosen

to cluster the dataset. Both of these clustering algorithms are known for their efficacy in categorical datasets and tend to give accurate clusterings. This is why they were chosen and implemented in the next section.

5. Algorithm Results

Agglomerative Hierarchical Clustering Algorithm

In [45]:

```
hierarch_df = mdf.copy()
hierarch_df = hierarch_df.drop(['Title'], axis = 1)
X = mdf.copy()
X = X.drop(['Title'], axis = 1)
```

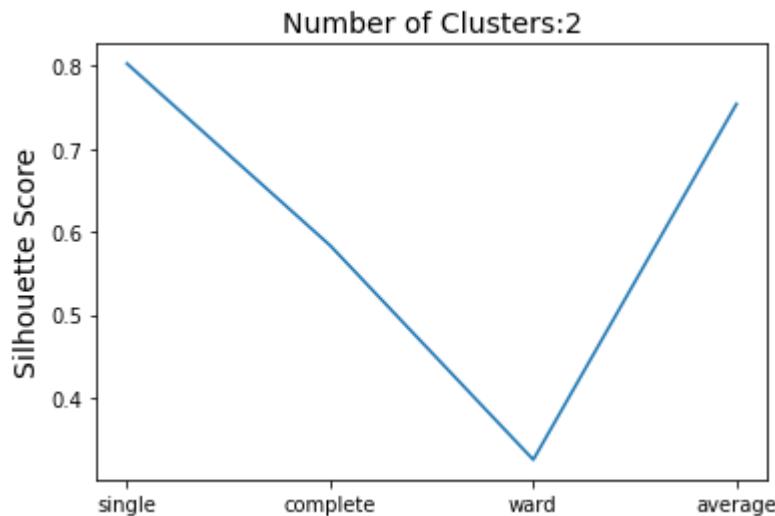
In [46]:

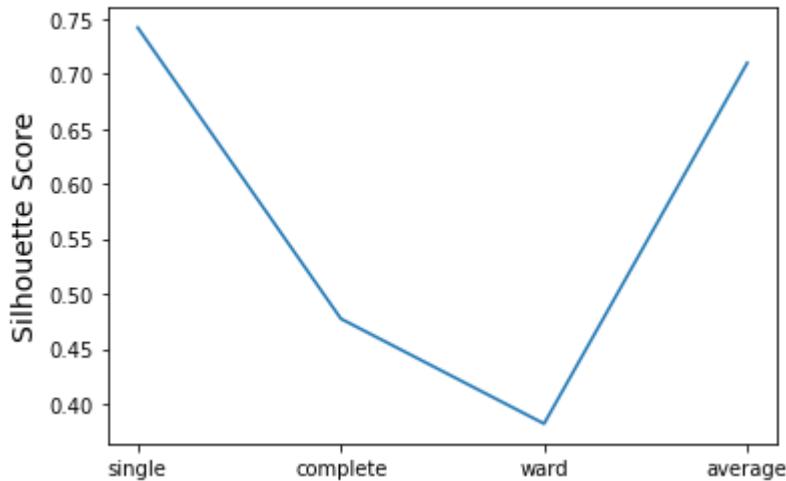
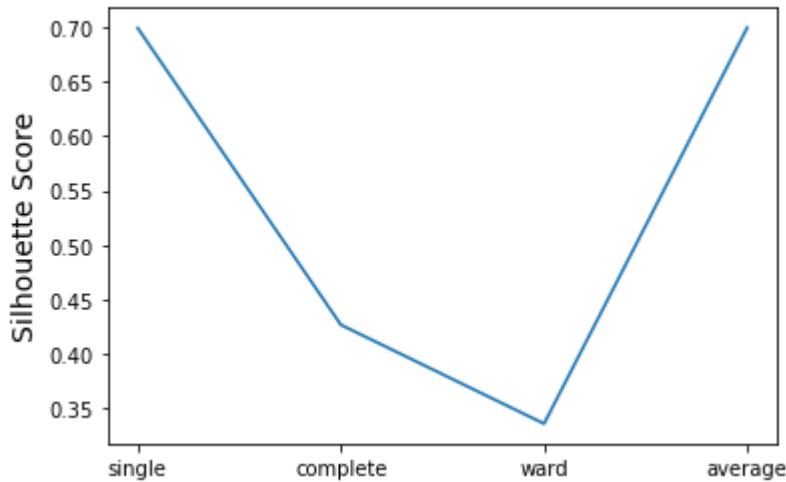
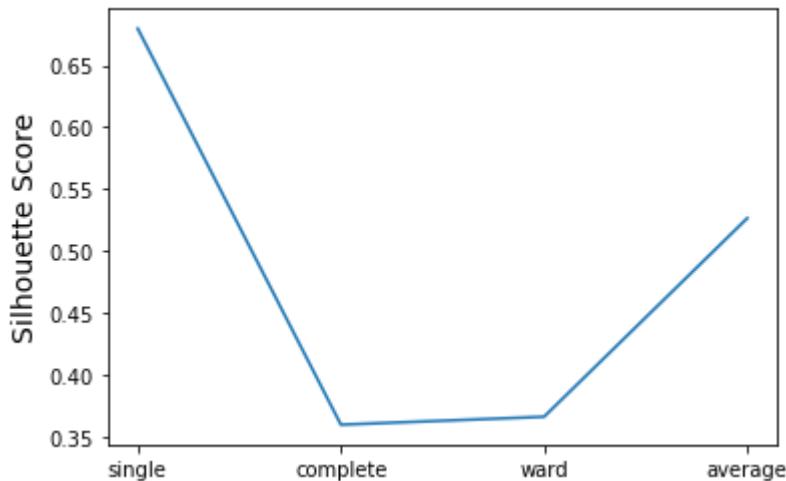
```
nb_clusters = range(2,15)
linkages = ['single', 'complete', 'ward', 'average']

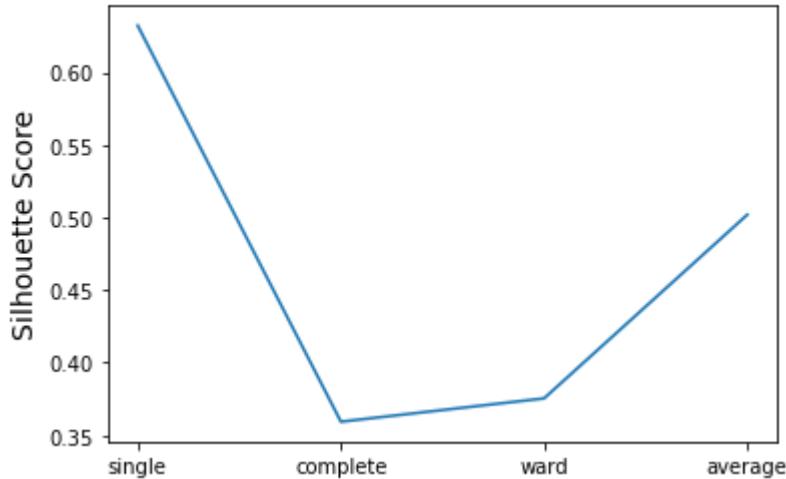
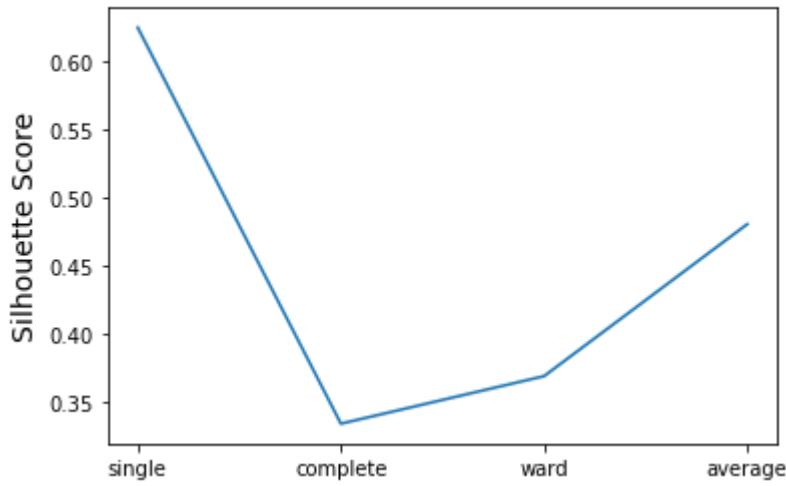
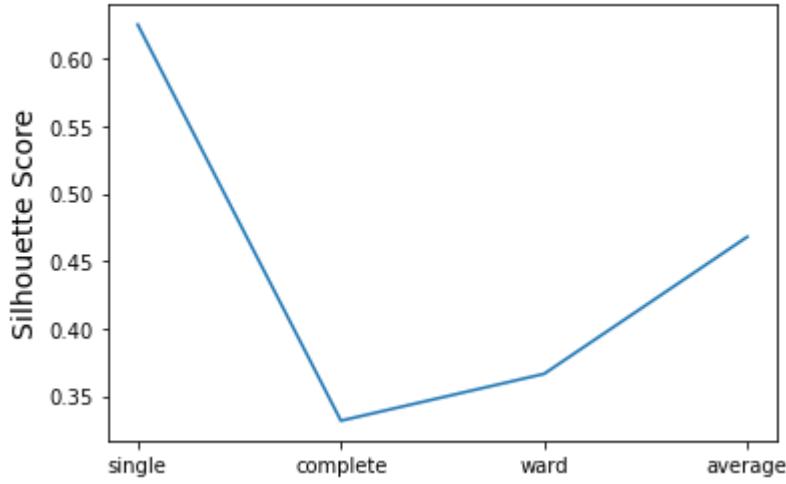
silhouette_scores = np.zeros(shape = (len(linkages),len(nb_clusters)))

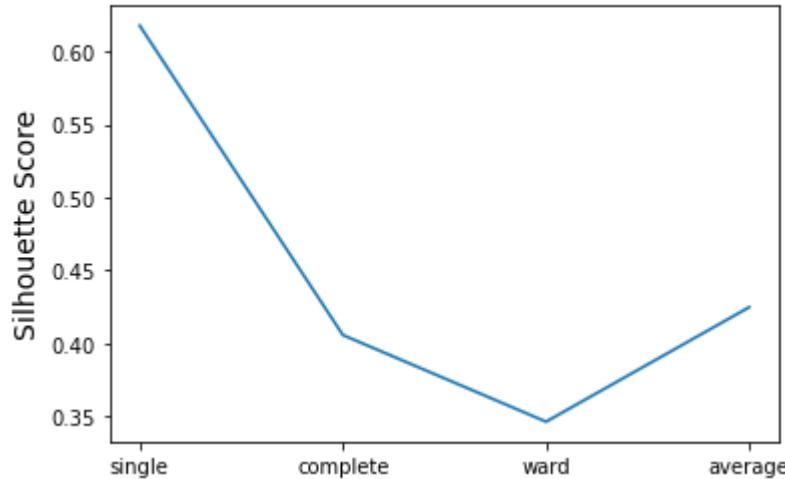
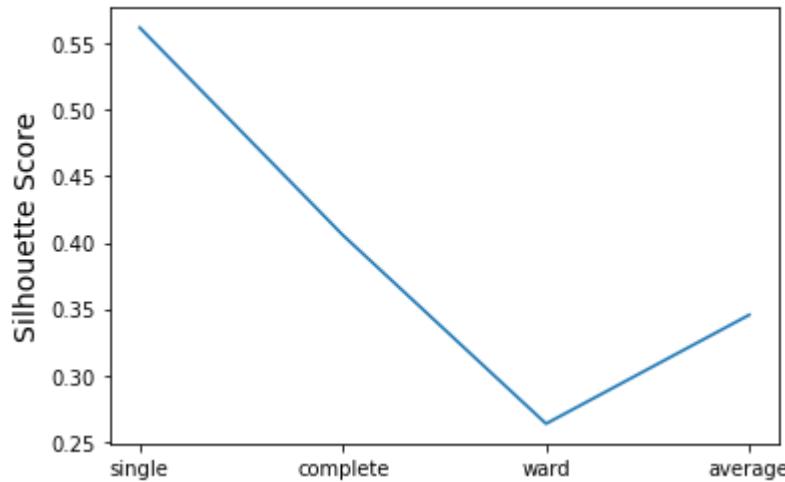
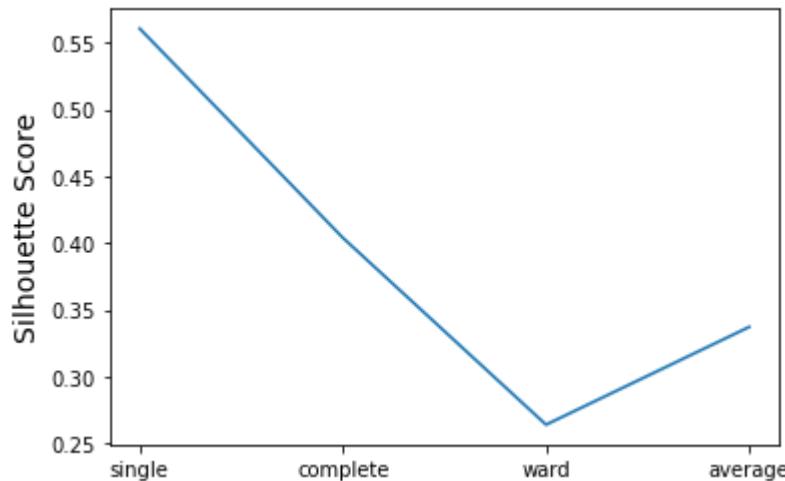
for i,l in enumerate(linkages):
    for j,nbc in enumerate(nb_clusters):
        ag = AgglomerativeClustering(n_clusters=nbc, affinity='euclidean', linkage=l)
        Y_pred = ag.fit_predict(hierarch_df)
        sls = silhouette_score(hierarch_df,Y_pred,random_state=1002)
        silhouette_scores[i,j] = sls

for i in range(len(nb_clusters)):
    plt.plot(silhouette_scores[:,i])
    plt.ylabel('Silhouette Score', fontsize = 14)
    plt.title('Number of Clusters:' + str(nb_clusters[i]), fontsize = 14)
    plt.xticks(np.arange(len(linkages)), linkages)
    plt.show()
```

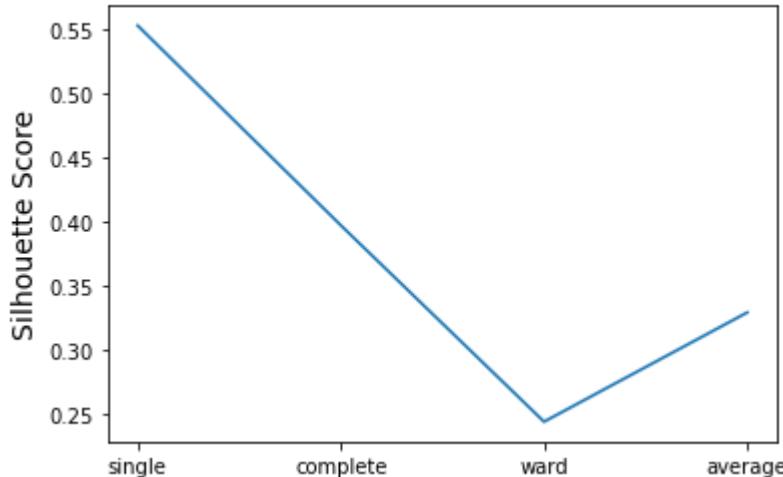


Number of Clusters:3**Number of Clusters:4****Number of Clusters:5**

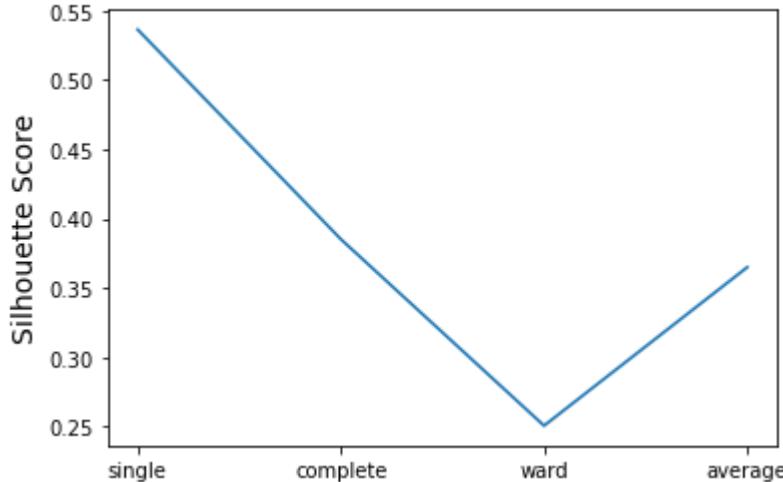
Number of Clusters:6**Number of Clusters:7****Number of Clusters:8**

Number of Clusters:9**Number of Clusters:10****Number of Clusters:11**

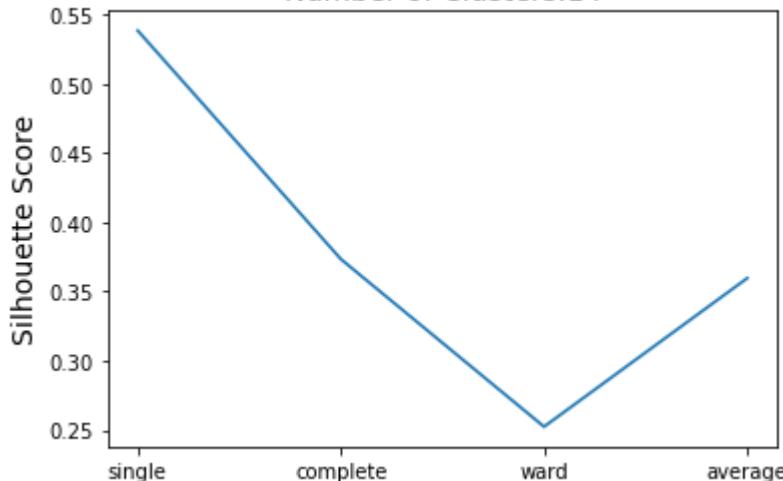
Number of Clusters:12



Number of Clusters:13



Number of Clusters:14



In [47]:

```

sil_df = pd.DataFrame(silhouette_scores)
sil_df = sil_df.rename(columns={0:'2 Clusters', 1:'3 Clusters', 2:'4 Clusters', 3:'5 Clusters'})
sil_df = sil_df.rename(index={0:'Single', 1:'Complete', 2:'Ward', 3:'Average'})
print(np.max(sil_df, axis=1))
print(sil_df.idxmax(axis=0, skipna=True))
sil_df.head()

```

Single	0.802377
Complete	0.583415

```

Ward      0.381852
Average   0.753833
dtype: float64
2 Clusters    Single
3 Clusters    Single
4 Clusters    Average
5 Clusters    Single
6 Clusters    Single
7 Clusters    Single
8 Clusters    Single
9 Clusters    Single
10 Clusters   Single
11 Clusters   Single
12 Clusters   Single
13 Clusters   Single
14 Clusters   Single
dtype: object

```

Out[47]:

	2 Clusters	3 Clusters	4 Clusters	5 Clusters	6 Clusters	7 Clusters	8 Clusters	9 Clusters	10 Clusters	Clu
Single	0.802377	0.742033	0.699092	0.679815	0.632251	0.625272	0.625197	0.617806	0.562021	0.56
Complete	0.583415	0.477275	0.426665	0.359481	0.359329	0.333615	0.331627	0.405747	0.405563	0.40
Ward	0.325486	0.381852	0.335937	0.365892	0.375388	0.368624	0.366323	0.346365	0.263466	0.26
Average	0.753833	0.709916	0.699513	0.526458	0.501937	0.480529	0.467910	0.424836	0.345477	0.33

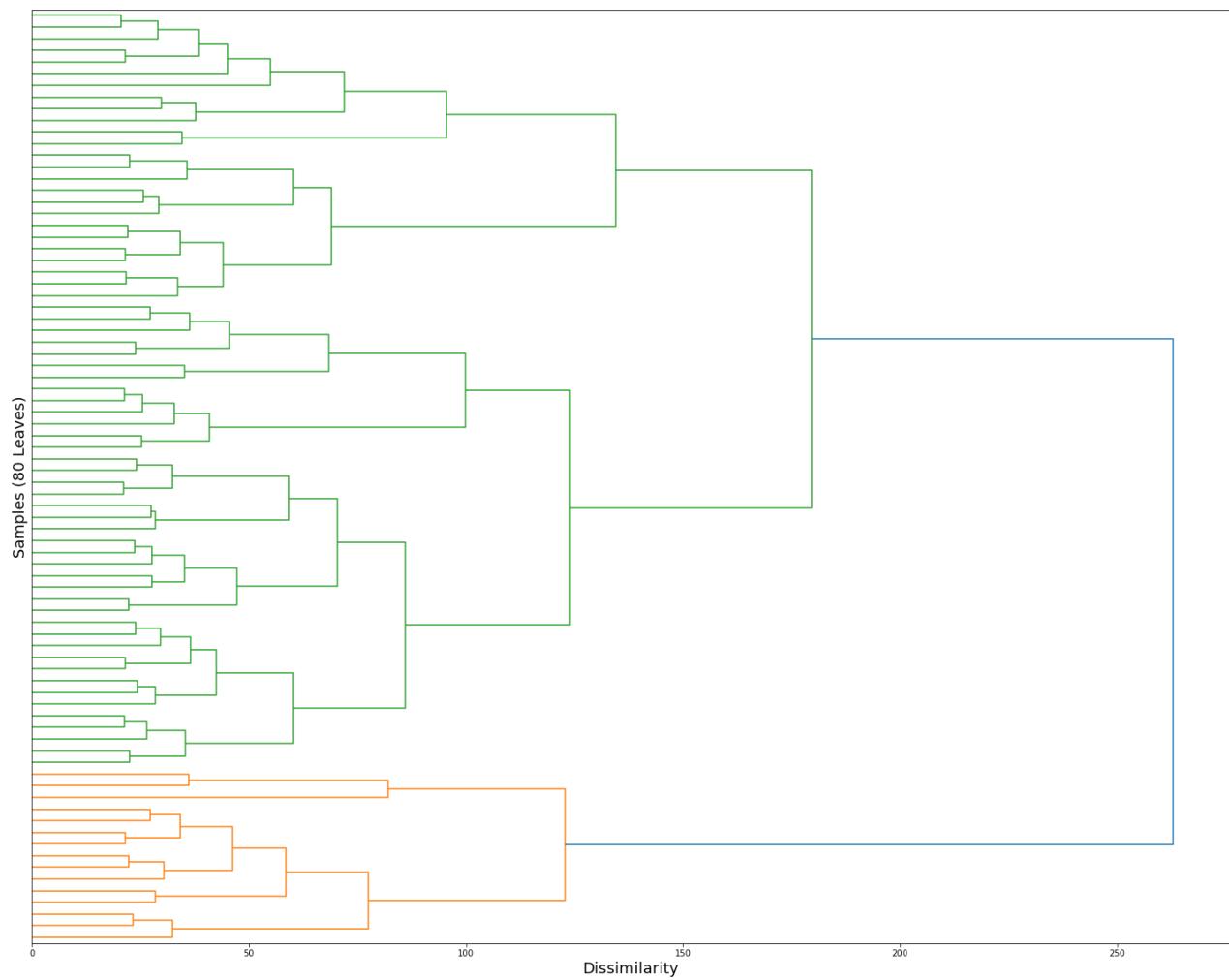
From the results shown above, several silhouette scores were computed based on 4 different linkages: single, complete, ward and average. From the summary table, it is apparent that the single linkage was the most dominant linkage for the agglomerative hierarchical clustering. These high scores indicate the best linkage option as well as the best number of clusters. Based on the silhouette scores alone, it seem that a single linkage with 2 clusters is perfect for the agglomerative hierarchical clustering algorithm. The next best option was average linkage and then complete linkage. Each linkage has its pros and cons for clustering, so a great next step would be to visualize the most predominant linkages on a t-sne plot over a range of clusterings to see what is the best option for the agglomerative hierarchical clustering.

In [48]:

```

dm = pdist(hierarch_df,metric='euclidean')
Z = linkage(dm, method='complete')
fig,ax = plt.subplots(figsize = (25,20))
d = dendrogram(Z,orientation = 'right', truncate_mode='lastp', p=80, no_labels=True, ax=ax)
ax.set_xlabel('Dissimilarity', fontsize = 18)
ax.set_ylabel('Samples (80 Leaves)', fontsize = 18)
plt.show()

```

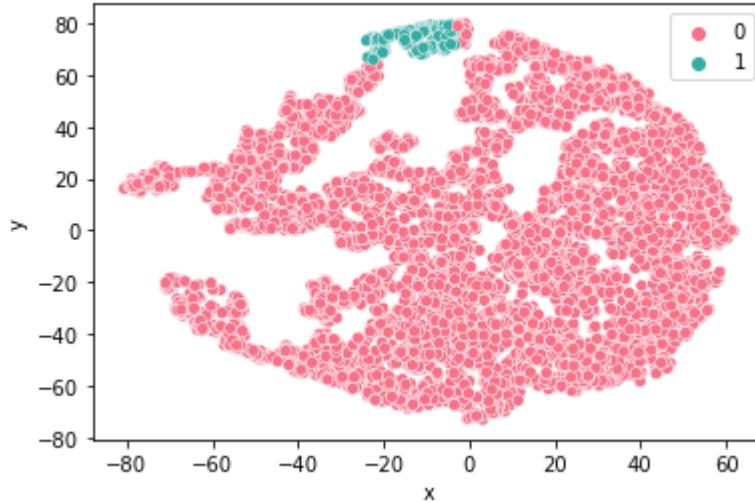


In [49]:

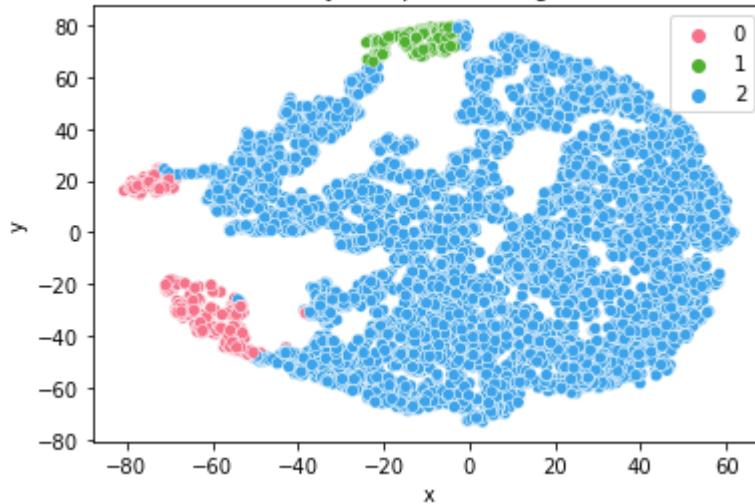
```
tdf35 = tsne_df(XDF=X, DF=mdf, PR=35, RS=1000)
for n in range(2,15):
    ag = AgglomerativeClustering(n_clusters=n, affinity='euclidean', linkage='complete')
    Y_pred = ag.fit_predict(hierarch_df)
    df_pred = pd.Series(Y_pred, name='Cluster', index = hierarch_df.index)
    pdff = pd.concat([tdf35,df_pred], axis = 1)

    sns.scatterplot(x = 'x', y = 'y', hue='Cluster', palette=sns.color_palette('husl',
    plt.title('T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering')
    plt.legend(bbox_to_anchor = (1,1))
    plt.show()
```

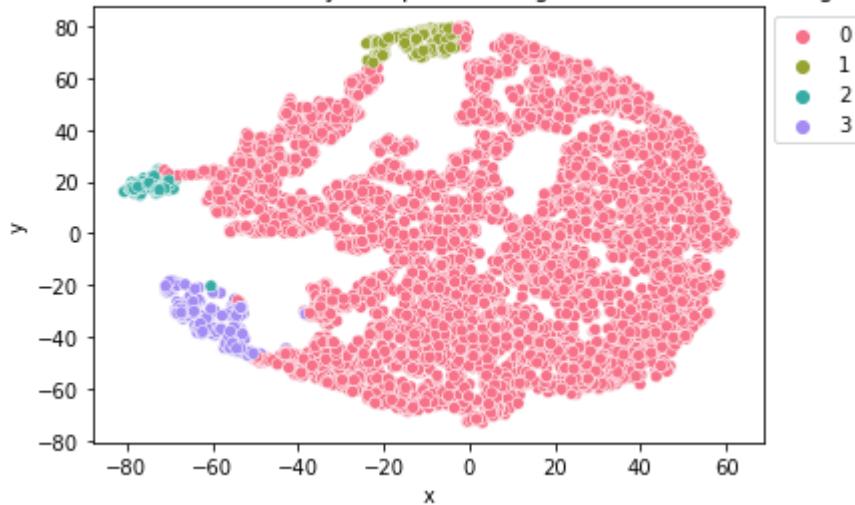
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



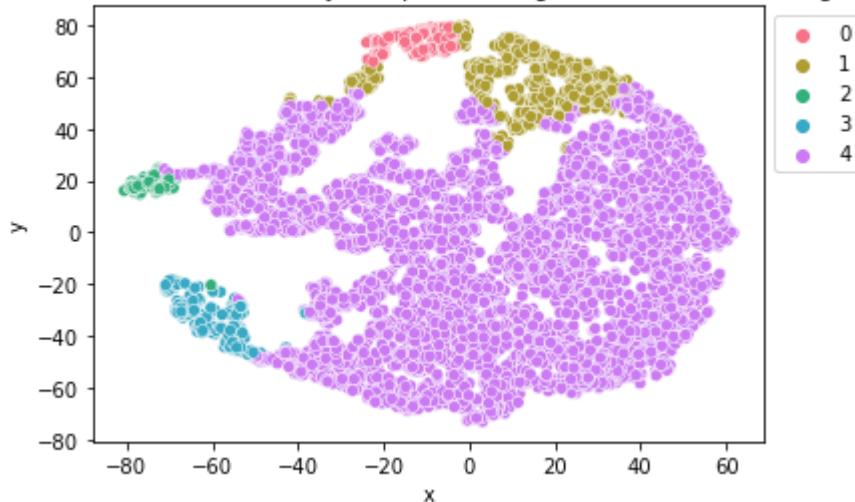
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



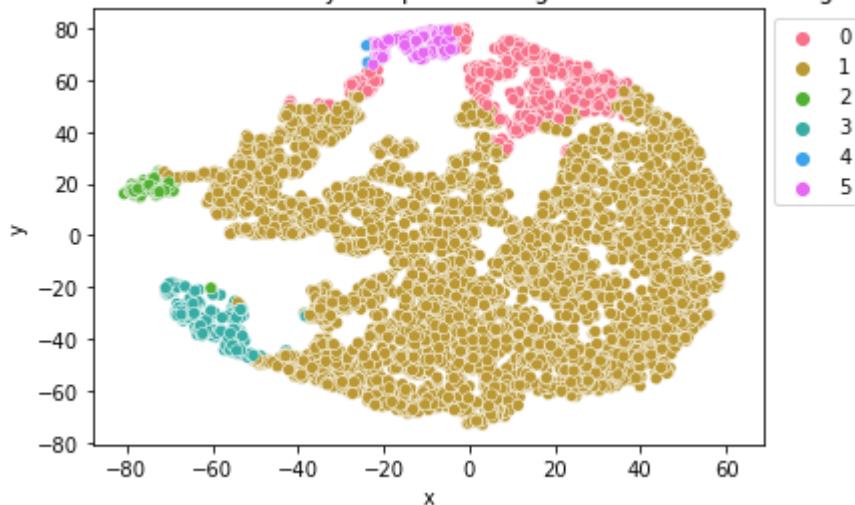
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



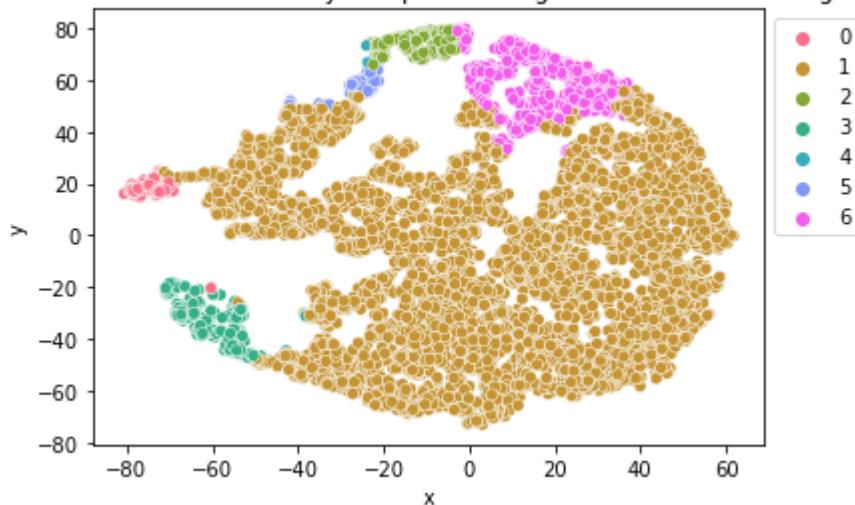
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



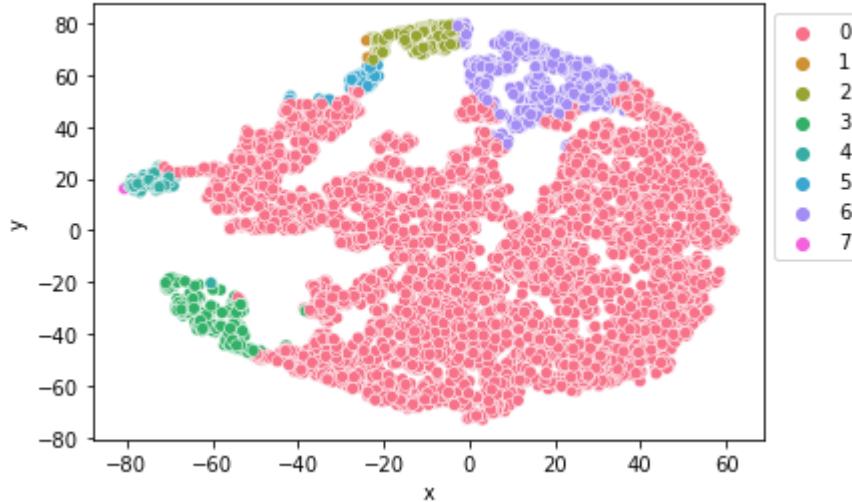
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



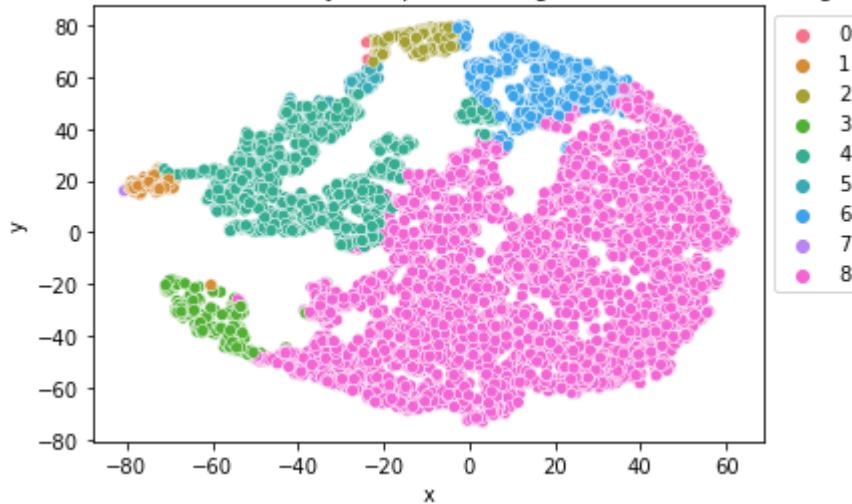
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



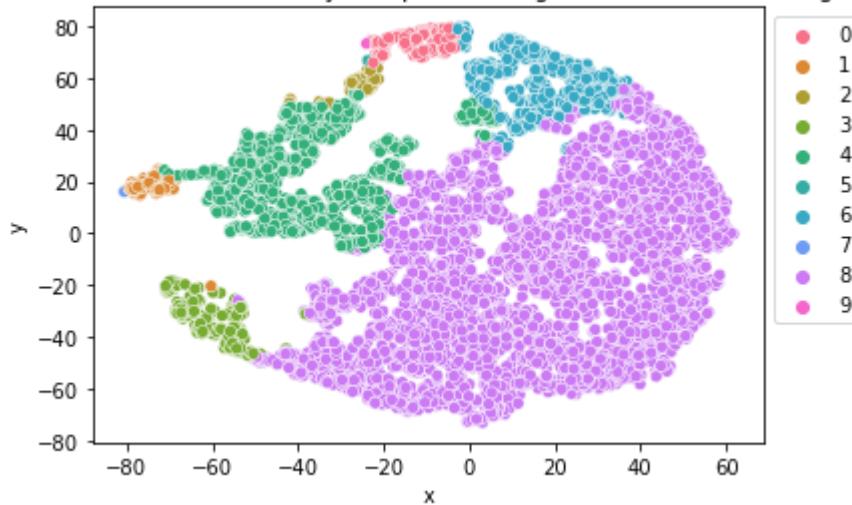
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



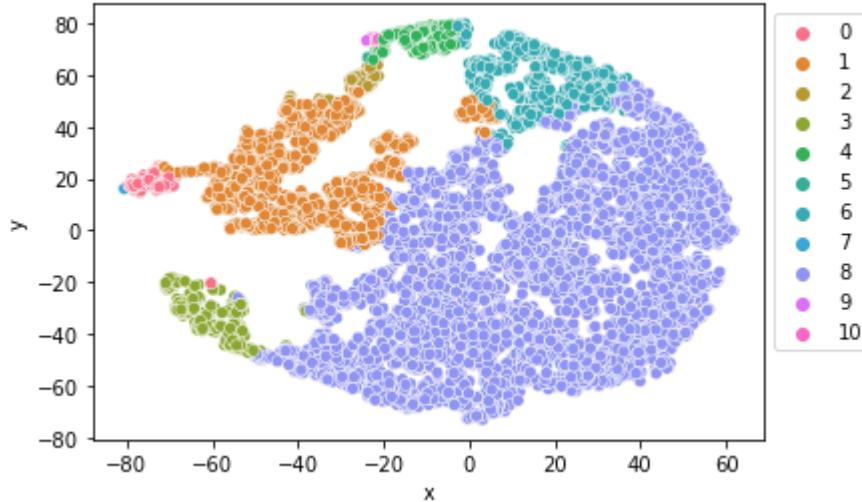
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



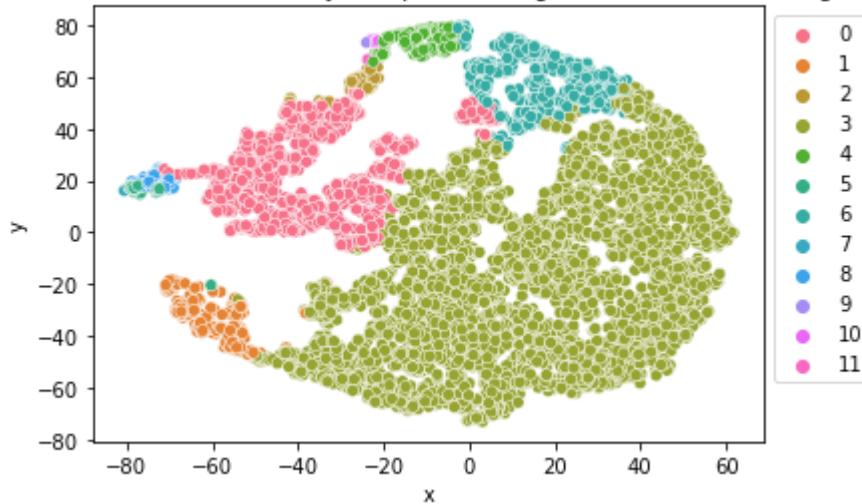
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



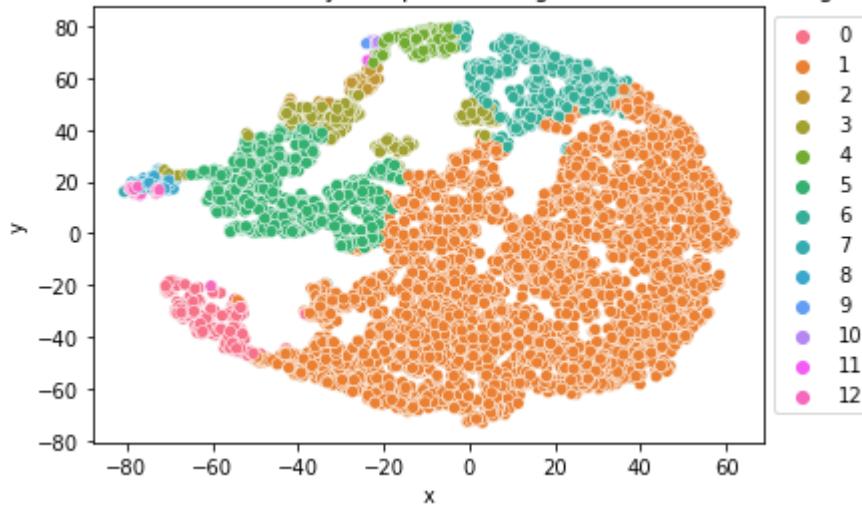
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



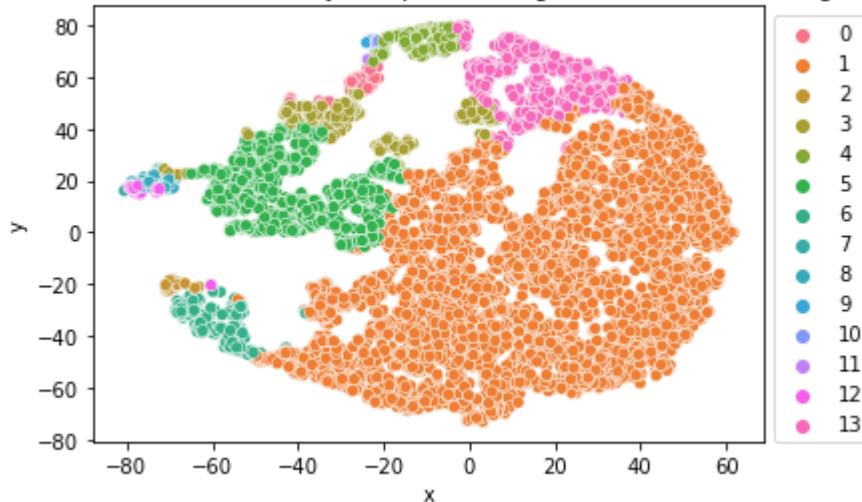
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



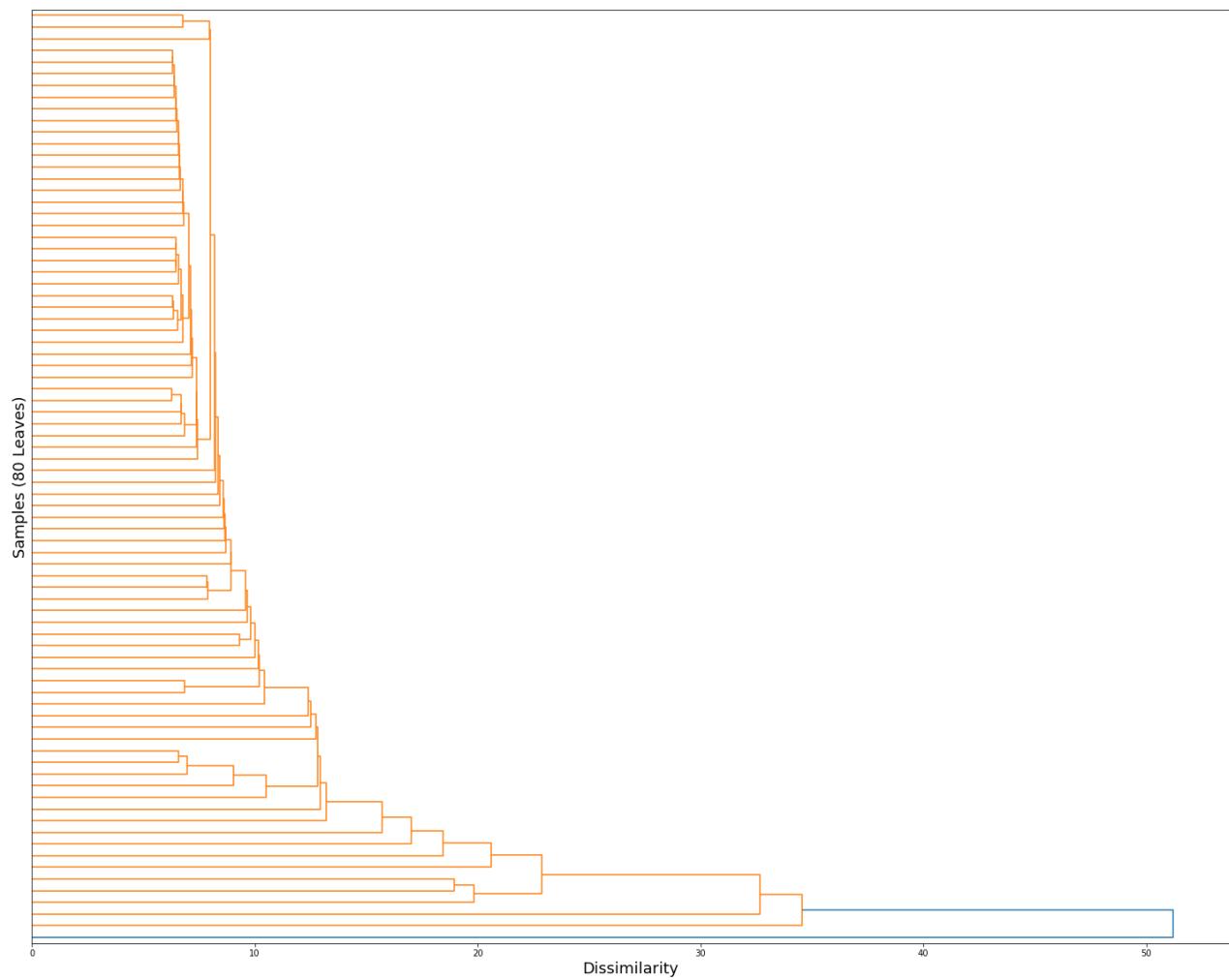
T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



The first option to be explored was the complete linkage over 2-14 different clusters. Firstly, the dendrogram is created based on the data (`mdf`) used for the hierachial clustering. From the dendrogram, it is apparent that the relationships/clusters are evenly spread out, hinting that there is a balanced cluster structure. After around 4 clusters, the dendrogram produces really small clusters, which may be more useful for identifying outlier groups in the dataset. From the t-sne plots, it is evident that the agglomerative hierachial clustering algorithm with complete linkage tends to break down the main big cluster into smaller subsets. This means that the algorithm may not be able to identify the main clusters in the dataset.

In [50]:

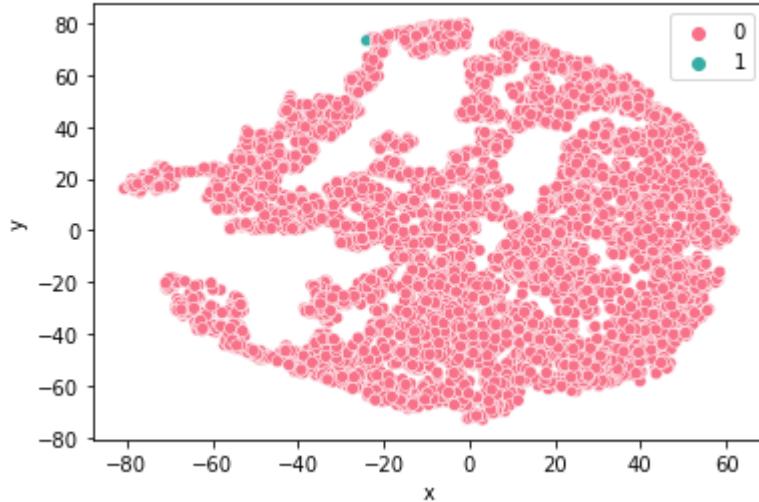
```
dm = pdist(hierarch_df,metric='euclidean')
Z = linkage(dm, method='single')
fig,ax = plt.subplots(figsize = (25,20))
d = dendrogram(Z,orientation = 'right', truncate_mode='lastp', p=80, no_labels=True, ax=ax)
ax.set_xlabel('Dissimilarity', fontsize = 18)
ax.set_ylabel('Samples (80 Leaves)', fontsize = 18)
plt.show()
```



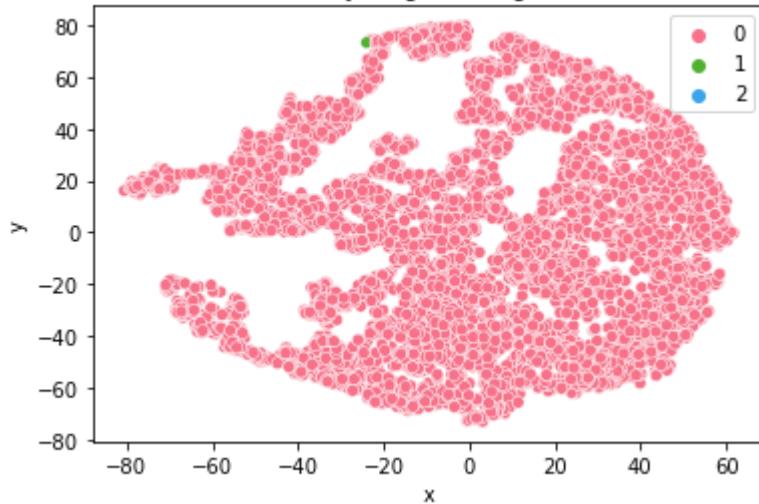
```
In [51]: tdf35 = tsne_df(XDF=X, DF=mdf, PR=35, RS=1000)
for n in range(2,15):
    ag = AgglomerativeClustering(n_clusters=n, affinity='euclidean', linkage='single')
    Y_pred = ag.fit_predict(hierarch_df)
    df_pred = pd.Series(Y_pred, name='Cluster', index = hierarch_df.index)
    pdff = pd.concat([tdf35,df_pred], axis = 1)

    sns.scatterplot(x = 'x', y = 'y', hue='Cluster', palette=sns.color_palette('husl',
    plt.title('T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering')
    plt.legend(bbox_to_anchor = (1,1))
    plt.show()
```

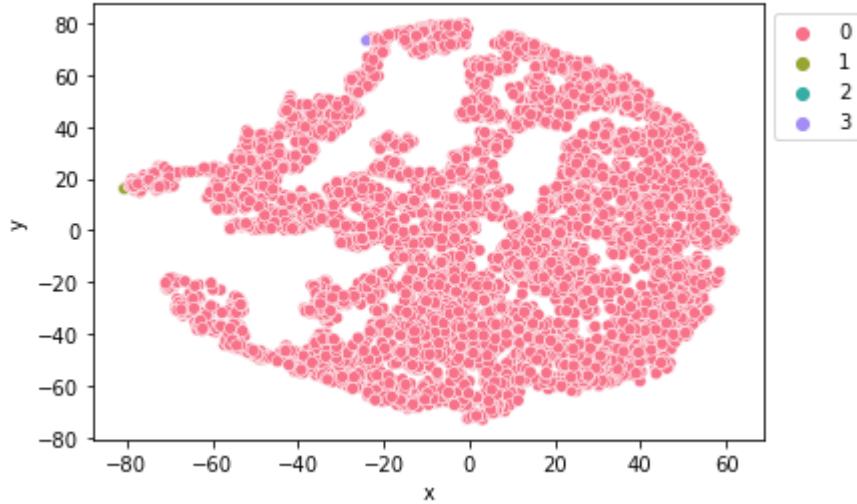
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



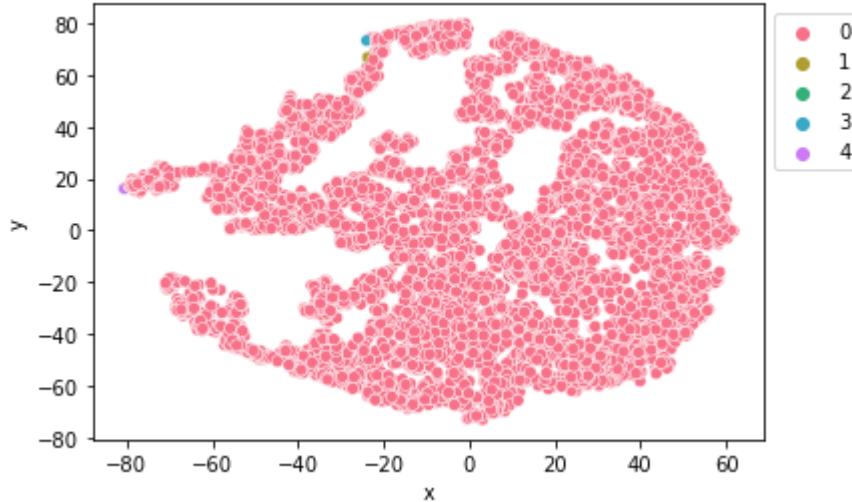
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



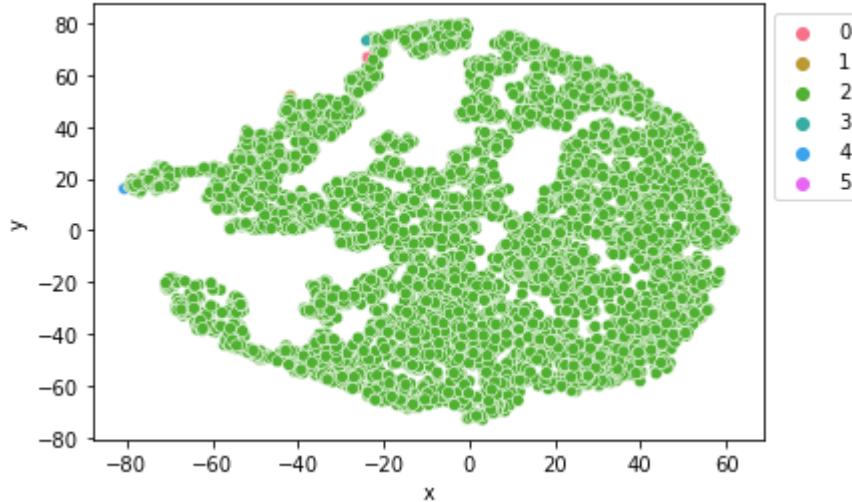
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



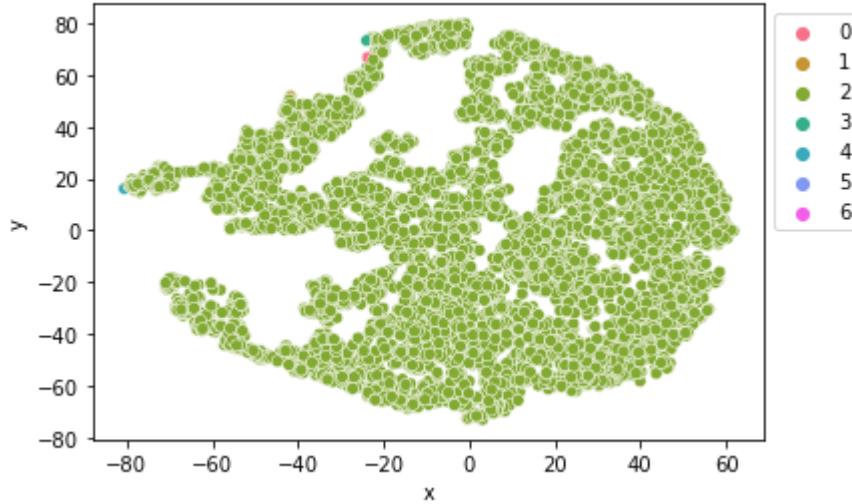
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



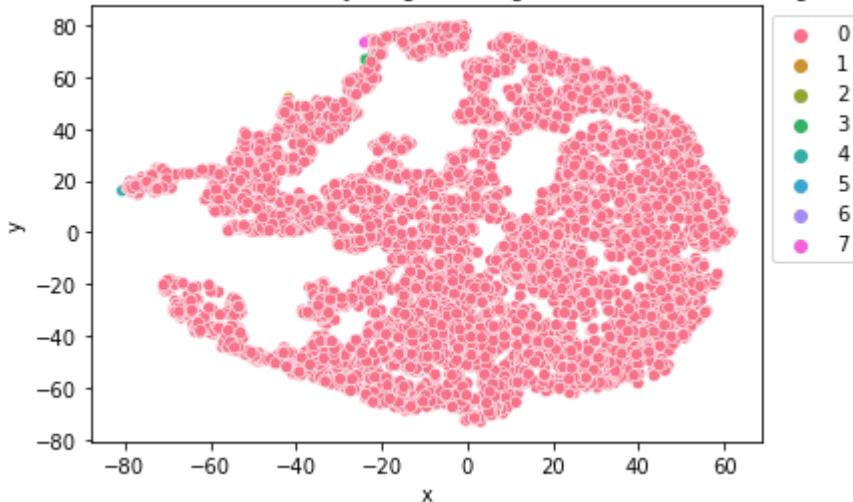
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



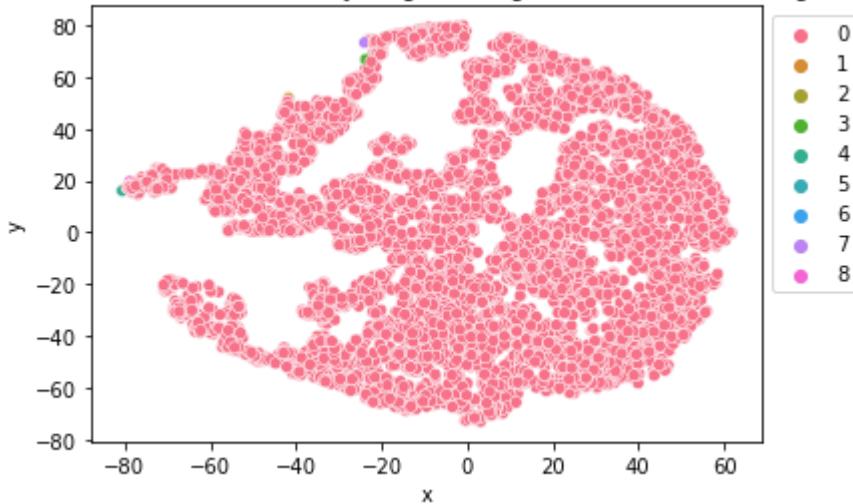
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



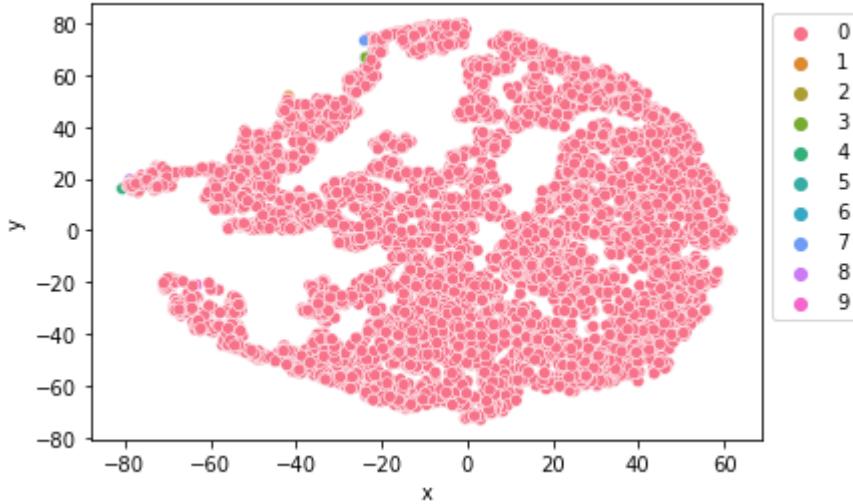
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



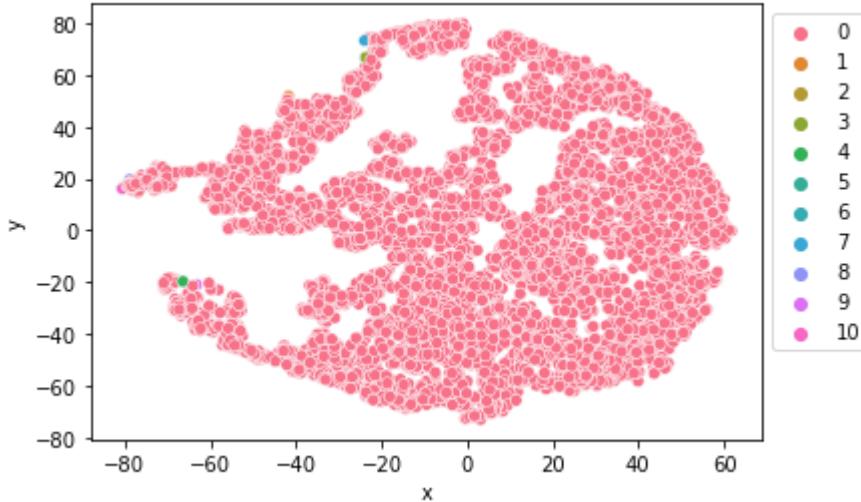
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



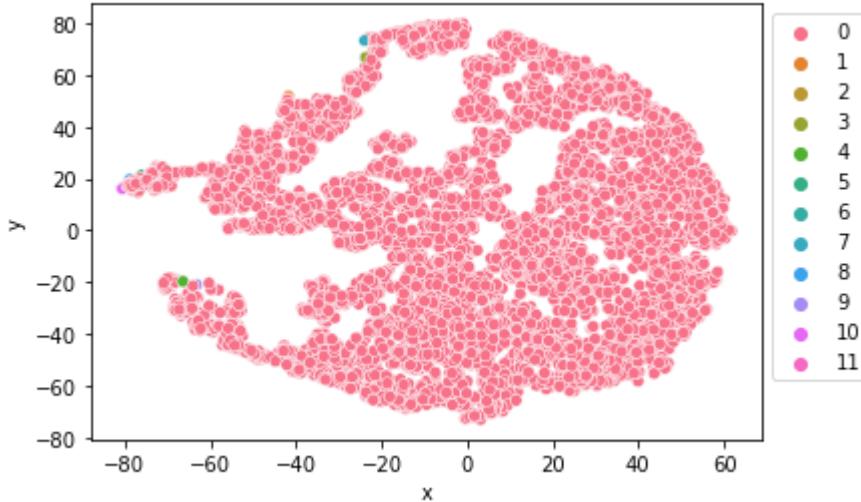
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



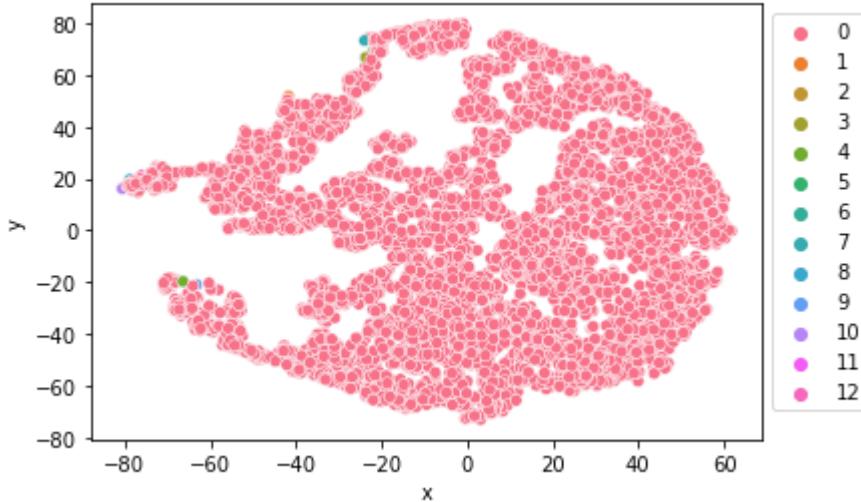
T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering

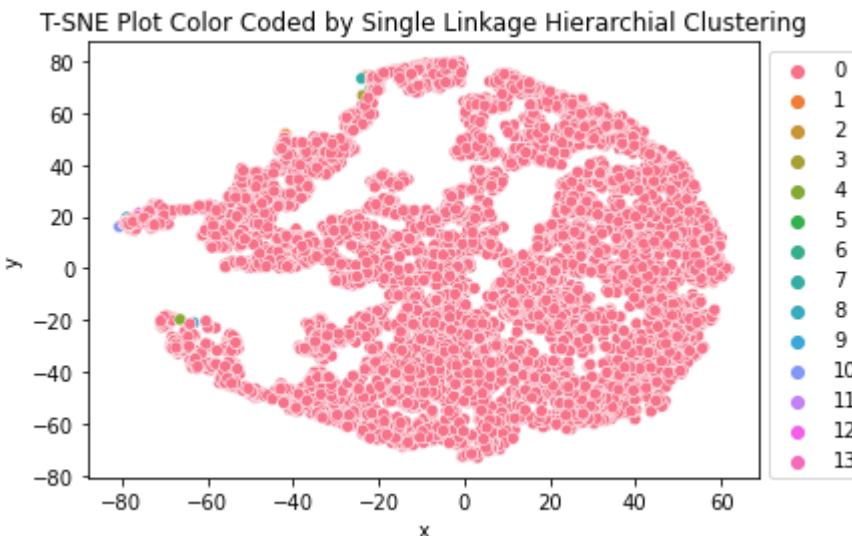


T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering



T-SNE Plot Color Coded by Single Linkage Hierarchical Clustering

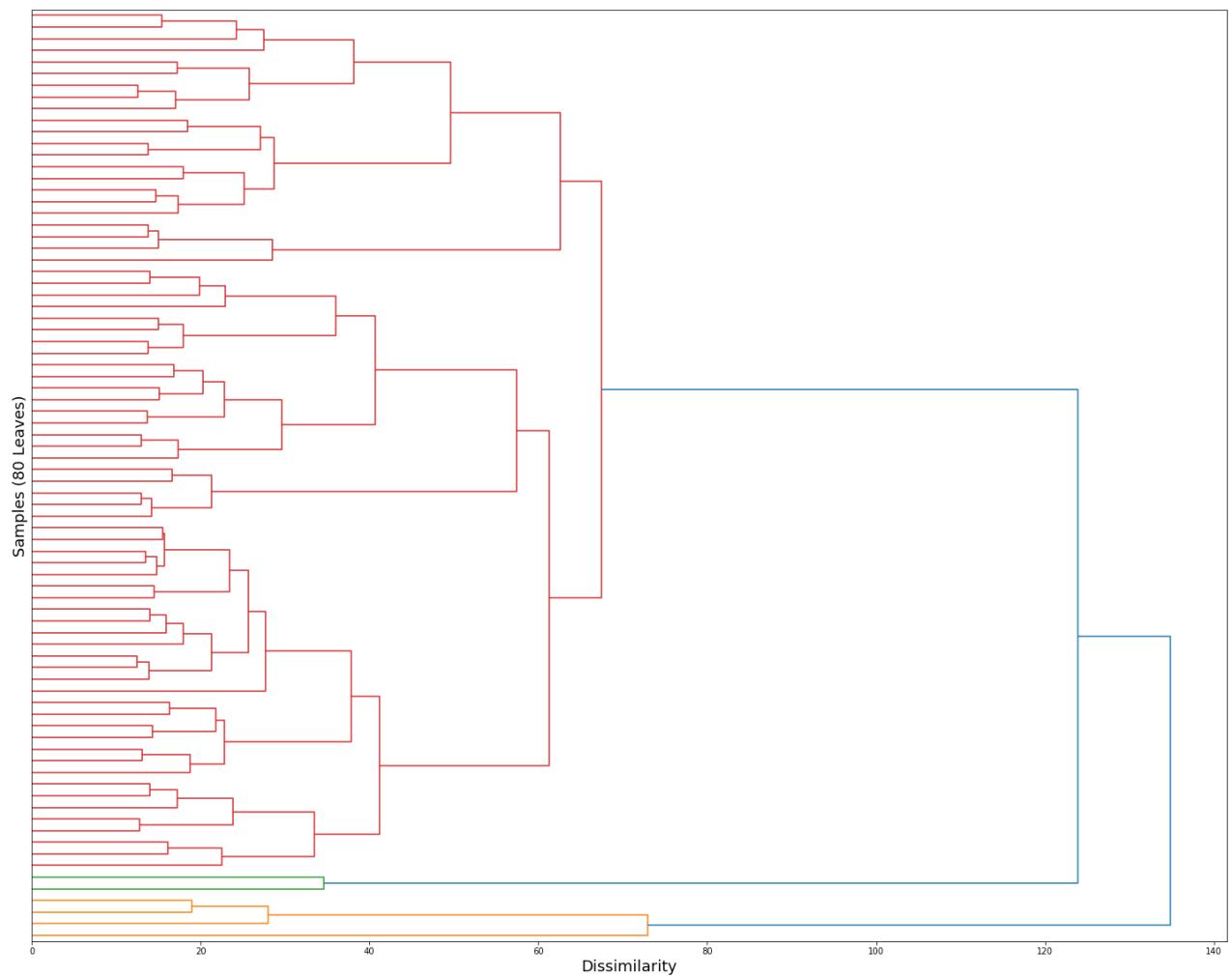




The second option to be explored was the single linkage over 2-14 different clusters. Firstly, the dendrogram is created based on the data (`mdf`) used for the hierachial clustering. From the dendrogram, it is apparent that the relationships/clusters do not provide well-balanced clusters at the 2-4 cluster levels. After around 4 clusters, the dendrogram produces really small clusters, which may be more useful for identifying outlier groups in the dataset. From the t-sne plots, it is evident that the agglomerative hierachial clustering algorithm with single linkage tends to identify only a few observations per cluster. In other words, the single linkage hierachial clustering is finding outlier cluster groups within the dataset. This means that the algorithm may not be able to identify the main clusters in the dataset.

In [52]:

```
dm = pdist(hierarch_df, metric='euclidean')
Z = linkage(dm, method='average')
fig,ax = plt.subplots(figsize = (25,20))
d = dendrogram(Z,orientation = 'right', truncate_mode='lastp', p=80, no_labels=True, ax=ax)
ax.set_xlabel('Dissimilarity', fontsize = 18)
ax.set_ylabel('Samples (80 Leaves)', fontsize = 18)
plt.show()
```

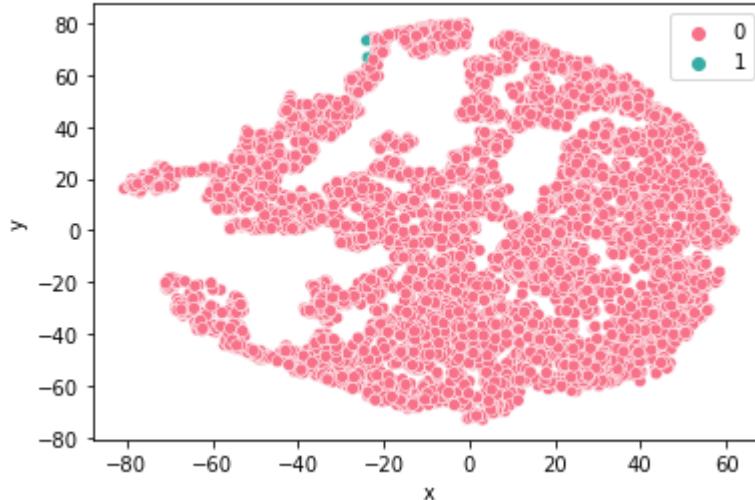


In [53]:

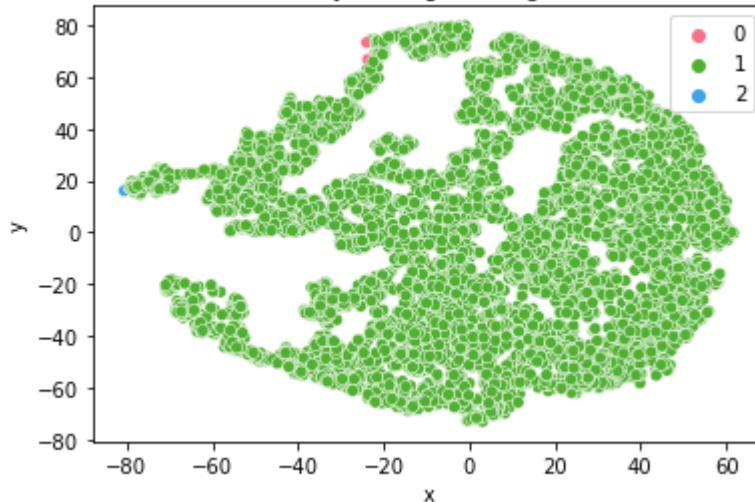
```
tdf35 = tsne_df(XDF=X, DF=mdf, PR=35, RS=1000)
for n in range(2,15):
    ag = AgglomerativeClustering(n_clusters=n, affinity='euclidean', linkage='average')
    Y_pred = ag.fit_predict(hierarch_df)
    df_pred = pd.Series(Y_pred, name='Cluster', index = hierarch_df.index)
    pdff = pd.concat([tdf35,df_pred], axis = 1)

    sns.scatterplot(x = 'x', y = 'y', hue='Cluster', palette=sns.color_palette('husl',
    plt.title('T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering')
    plt.legend(bbox_to_anchor = (1,1))
    plt.show()
```

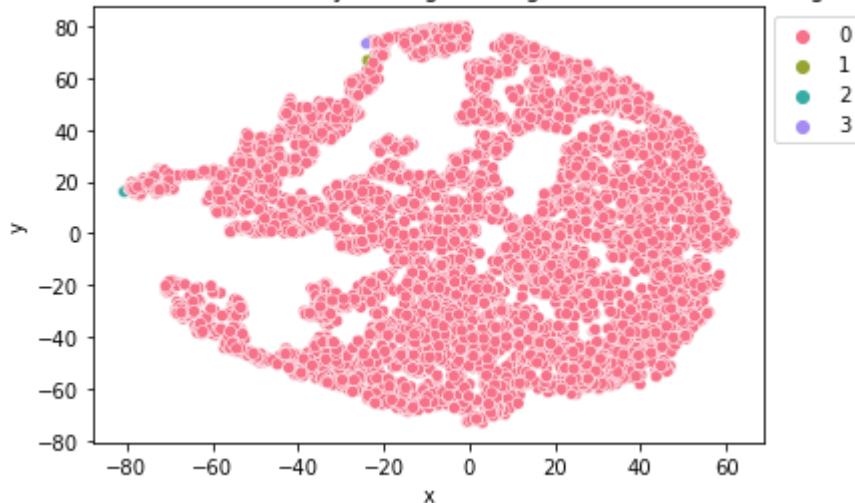
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



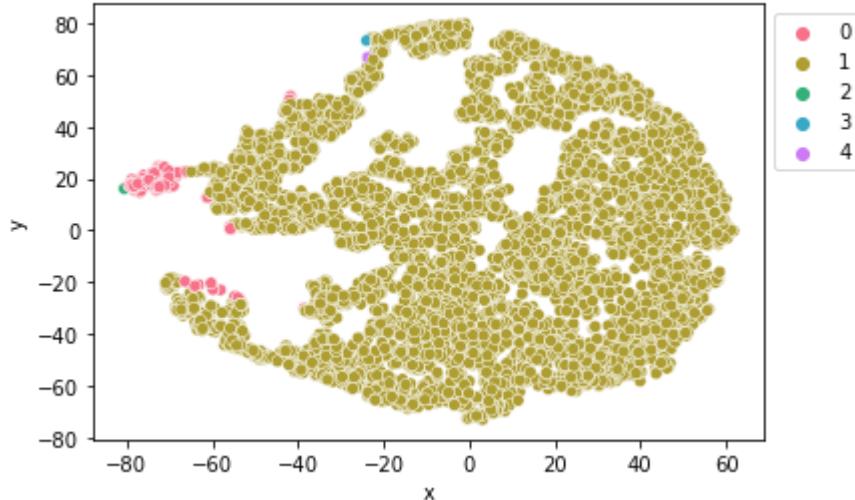
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



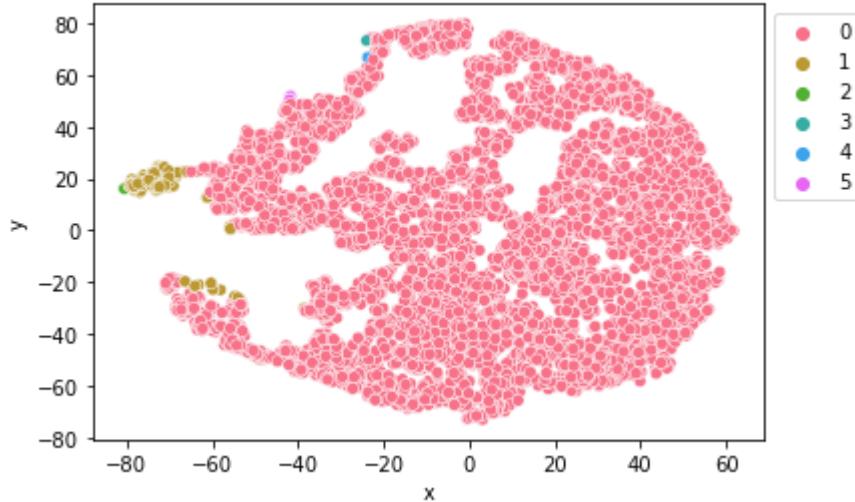
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



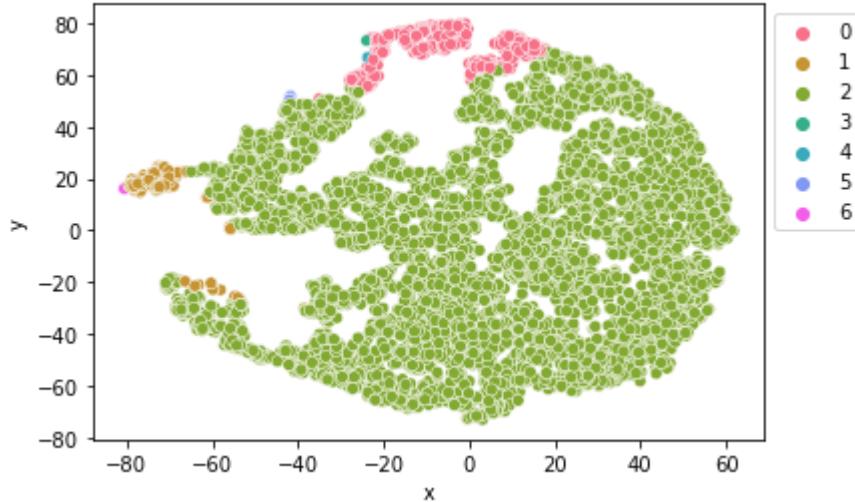
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



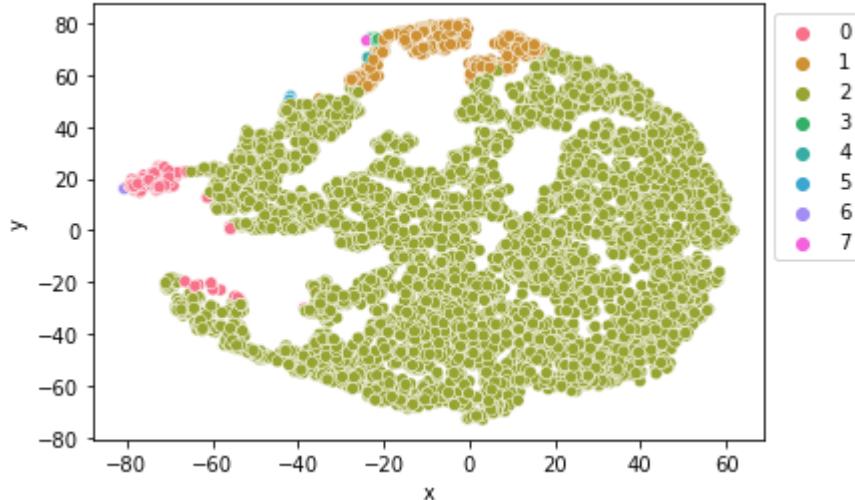
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



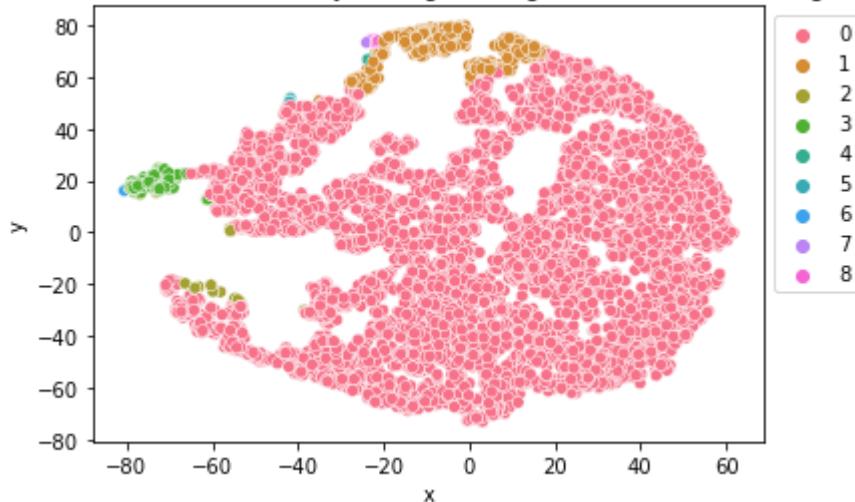
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



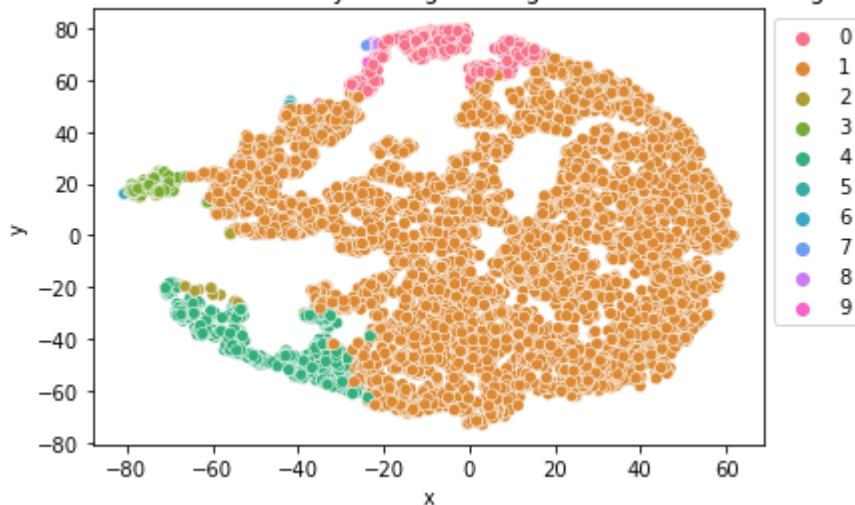
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



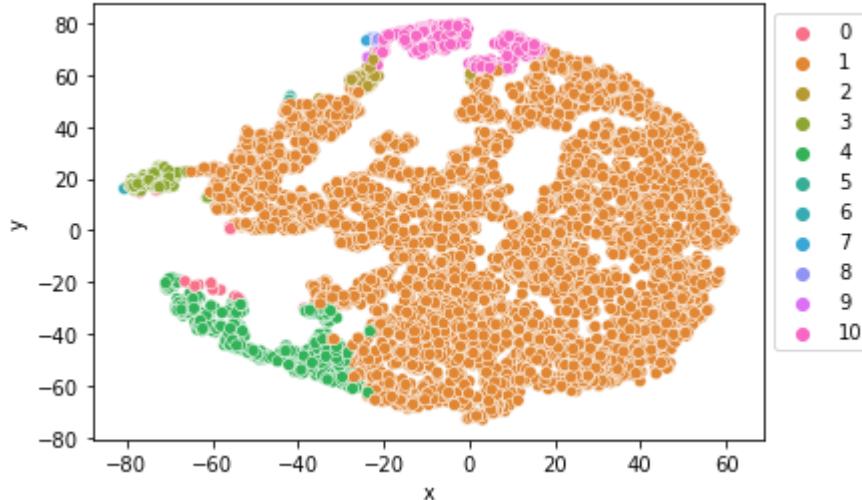
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



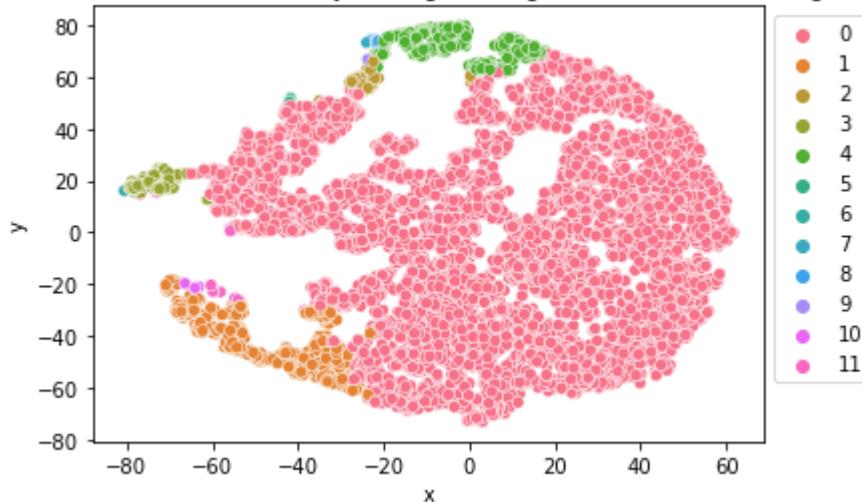
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



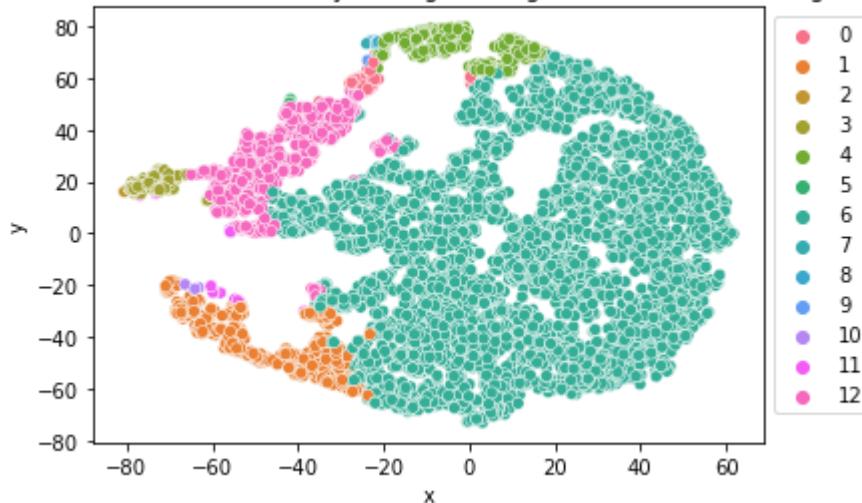
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



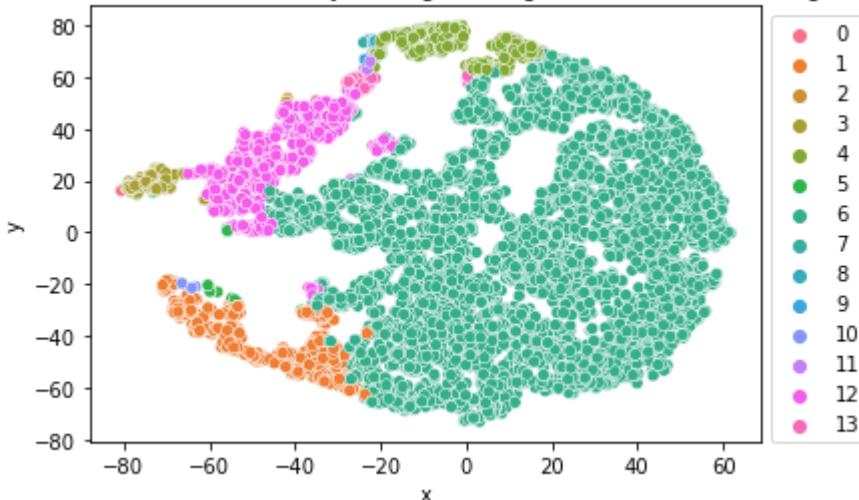
T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



T-SNE Plot Color Coded by Average Linkage Hierarchical Clustering



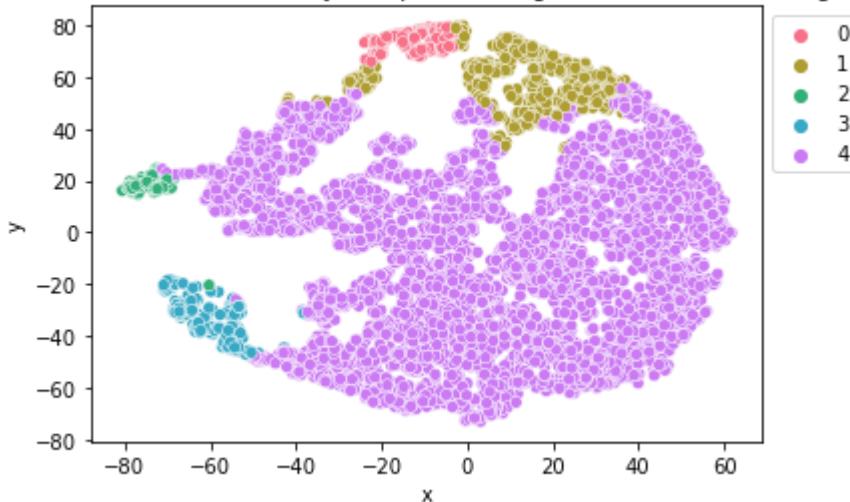
The last option to be explored was the average linkage over 2-14 different clusters. Firstly, the dendrogram is created based on the data (`mdf`) used for the hierarchical clustering. From the dendrogram, it is apparent that the relationships/clusters are more evenly spread out than that of the single linkage hierarchical clustering, hinting that there is a balanced cluster structure. After around 4 clusters, the dendrogram produced really small clusters, which may be more useful for identifying outlier groups in the dataset. From the t-sne plots, it is evident that the agglomerative hierarchical clustering algorithm with average linkage tends to identify only a few observations per cluster. In other words, the single linkage hierarchical clustering is finding outlier cluster groups within the dataset. However, as the cluster number increases to about 10, the clusters made by average linkage start to get larger and the underlying cluster structure of the dataset is brought to light. But, this means that the algorithm may not efficiently be able to identify the main clusters in the dataset.

In [54]:

```
ag = AgglomerativeClustering(n_clusters= 5, affinity='euclidean', linkage='complete')
Y_pred = ag.fit_predict(hierarch_df)
df_pred = pd.Series(Y_pred, name='Cluster', index = hierarch_df.index)
pdff = pd.concat([tdf35,df_pred], axis = 1)

sns.scatterplot(x = 'x', y = 'y', hue='Cluster', palette=sns.color_palette('husl', 5),
plt.title('T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering')
plt.legend(bbox_to_anchor = (1,1))
plt.show()
```

T-SNE Plot Color Coded by Complete Linkage Hierarchical Clustering



Overall, the options given by the t-sne plots as well as the dendograms provided a large amount of insight into choosing an adequate linkage. After an in-depth analysis, it seems that a complete linkage with 5 clusters produces decently sized clusters for the given dataset. Given the results of the dendrogram, the complete linkage tended to have the most balanced lines and clusters, hinting that it would perform more effectively than the other linkages. Additionally, the sizes of each cluster has a large amount of observations in each, implying that more concrete conclusions can be made from the unsupervised learning method. All in all, agglomerative hierarchical clustering with a complete linkage using 5 clusters produces the best visual t-sne and dendrogram results and will be used to derive insights from the data.

K-modes Clustering Algorithm

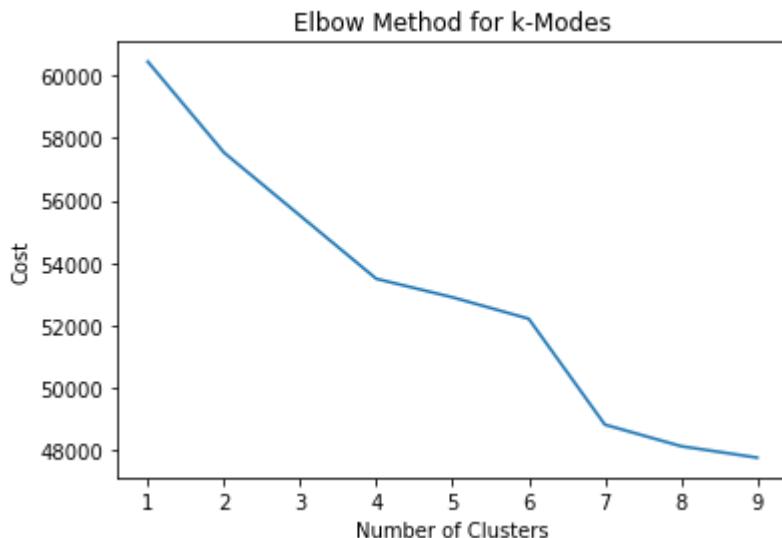
In [55]:

```
cost = []
for num_clusters in list(range(1,10)):
    print(num_clusters)
    cost_sub_list=[]
    for j in range(0,3):
        kmode = KModes(n_clusters=num_clusters)
        kmode.fit_predict(mdf_cat)
        cost_sub_list.append(kmode.cost_)
    cost.append(np.average(cost_sub_list))
```

```
1
2
3
4
5
6
7
8
9
```

In [56]:

```
plt.plot(list(range(1,10)),cost)
plt.xlabel('Number of Clusters')
plt.ylabel('Cost')
plt.title('Elbow Method for k-Modes')
plt.show()
```



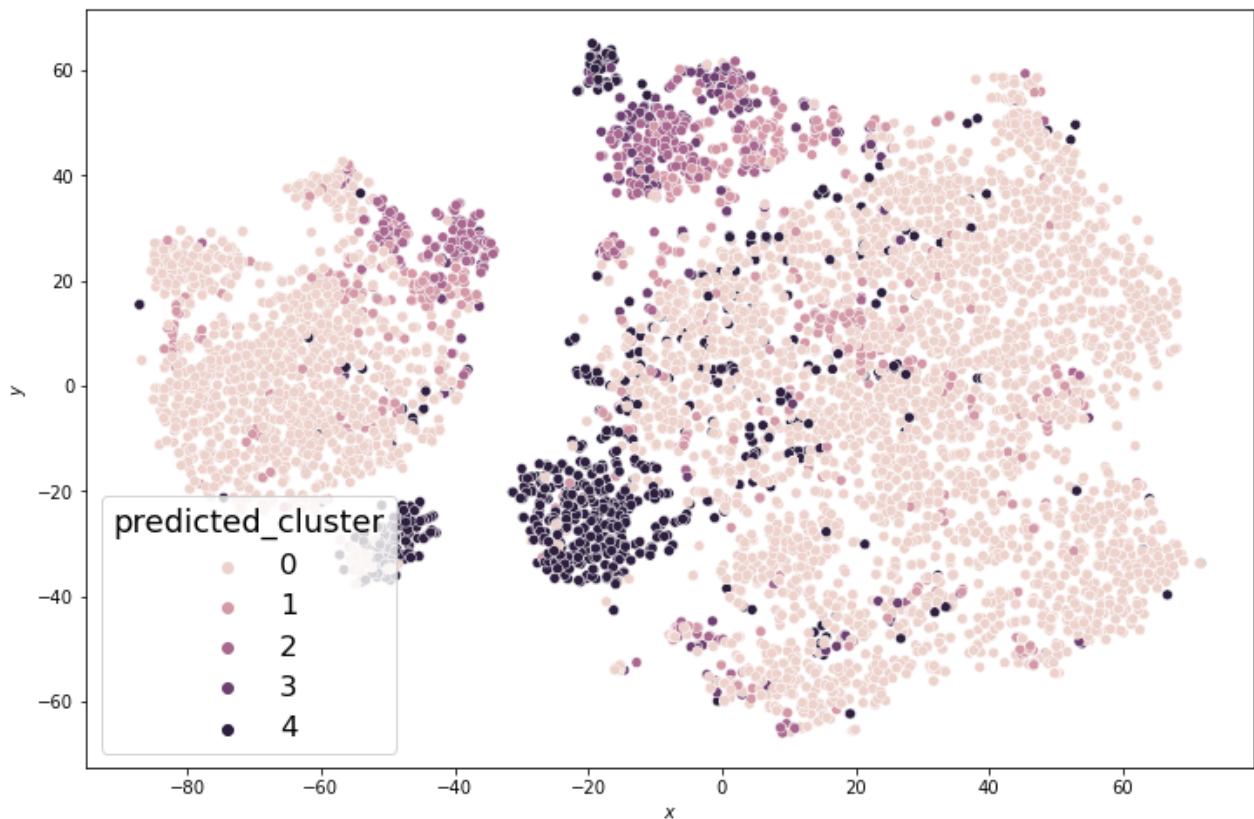
Now moving on to the k-modes clustering algorithm, it is necessary to investigate the optimal number of clusters for the unsupervised learning technique. Since, k-modes is optimal for categorical data, it should be especially effective for clustering this dataset. Using a `for` loop, the costs of the k-modes algorithm can be found for a range of clusters. The costs are then plotted to find the elbow plot shown above. Through several iterations, it was found that the elbow was between 4-6 clusters, hinting that anything in that range should yield positive results for the k-modes algorithm. Hence, for this unsupervised learning technique, 5 clusters were chosen for the k-modes algorithm.

```
In [57]: km = KModes(n_clusters=5, random_state=1000)
cluster_labels = km.fit_predict(mdf_cat)
mdf_cat['predicted_cluster']=cluster_labels
mdf_cat['predicted_cluster'].value_counts()
```

```
Out[57]: 0    5083
4     771
1     632
2     351
3     209
Name: predicted_cluster, dtype: int64
```

```
In [58]: X_cat = mdf_cat.copy()
X_cat = X_cat.drop('predicted_cluster', axis=1)
tdf_kmode = tsne_df(XDF=X_cat, DF=mdf_cat, PR=35, RS=1000)
```

```
In [59]: tsne_plot_hue(DFF=tdf_kmode, W=12, H=8, FS=1.5, HUE = 'predicted_cluster')
```



From the t-sne plot above, the k-modes algorithm did a suboptimal job in clustering the dataset. For the most part, the clusters are quite spread out with observations protruding into other cluster groups. Additionally, there does not seem to be a lot of cohesion and separation among clusters, which could cause observations to be placed in the wrong cluster labels. However, overall the clusters seem to be pretty defined and each has a large amount of observations, which could yield insightful results.

6. Post-Analysis Questions

Separation and Cohesion

In [60]:

```
def create_silhouette_plot(X, cluster_labels):
    #-----
    #INPUT:
    #-----
    #X=dataframe of objects you clustered
    #cluster_labels=cluster labels of each of the objects in the dataset X that you just
    #clustered

    #Gets the unique labels in the cluster_labels
    clabels=np.unique(cluster_labels)
    #Gets the number of unique labels
    k=len(clabels)

    #-----
    #SETTING UP THE PLOT SPACE
    # Create a subplot with 1 row and 1 columns
    fig, ax1 = plt.subplots(1, 1)
    fig.set_size_inches(18, 7)
    # The 1st subplot is the silhouette plot
    # The silhouette coefficient can range from -1, 1 but in this example all
```

```

# Lie within [-0.1, 1]
ax1.set_xlim([-0.1, 1])
# The (k+1)*10 is for inserting blank space between silhouette
# plots of individual clusters, to demarcate them clearly.
ax1.set_ylim([0, len(X) + (k + 1) * 10])

#FINDS THE SILHOUETTE SCORE FOR EACH OBJECT
sample_silhouette_values = silhouette_samples(X, cluster_labels)

y_lower = 10

for i in clabels:
    # Aggregate the silhouette scores for samples belonging to
    # cluster i, and sort them
    ith_cluster_silhouette_values = \
        sample_silhouette_values[cluster_labels == i]

    ith_cluster_silhouette_values.sort()

    size_cluster_i = ith_cluster_silhouette_values.shape[0]
    y_upper = y_lower + size_cluster_i

    color = cm.nipy_spectral(float(i) / k)
    ax1.fill_betweenx(np.arange(y_lower, y_upper),
                      0, ith_cluster_silhouette_values,
                      facecolor=color, edgecolor=color, alpha=0.7)

    # Label the silhouette plots with their cluster numbers at the middle
    ax1.text(-0.05, y_lower + 0.5 * size_cluster_i, str(i))

    # Compute the new y_lower for next plot
    y_lower = y_upper + 10 # 10 for the 0 samples

ax1.set_title("The silhouette plot for the various clusters.")
ax1.set_xlabel("The silhouette coefficient values")
ax1.set_ylabel("Cluster label")

plt.show()

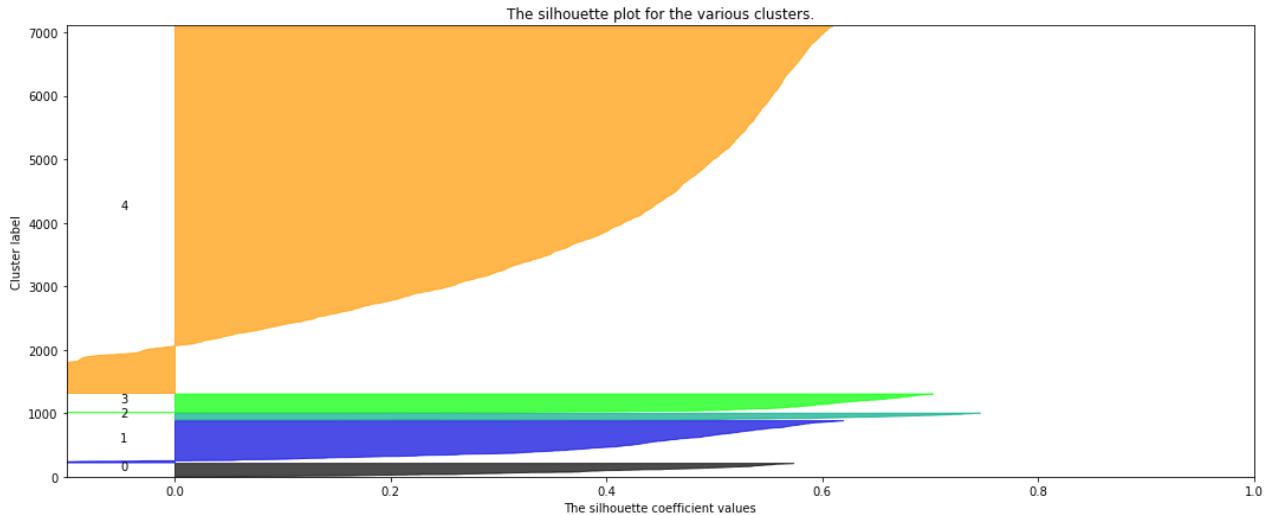
```

In [61]:

```

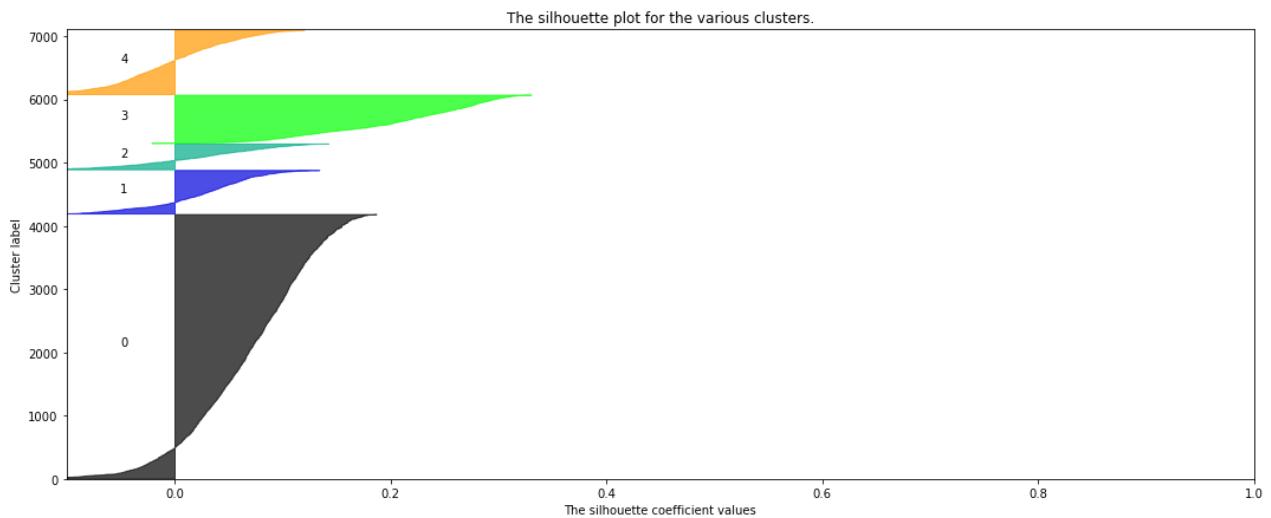
ag = AgglomerativeClustering(n_clusters= 5, affinity='euclidean', linkage='complete')
Y_pred = ag.fit_predict(hierarch_df)
create_silhouette_plot(hierarch_df, Y_pred)

```



From the silhouette plot above, it is apparent that each cluster from the agglomerative hierarchical clustering with complete linkage and 5 clusters had very good silhouette scores. In fact, most of the scores were positive and closer to 1 (most were greater than or equalled to 0.5), which hints that there is better separation and cohesion in the assigned clusters. There seems to be a large number of points in the cluster 4 that have negative silhouette scores, meaning that they are less cohesive and less separated from the other observations in the other clusters. Overall, the agglomerative hierarchical clustering with complete linkage provided very cohesive and well separated clusters.

```
In [62]: km = KMeans(n_clusters=5,random_state=1000)
cluster_labels = km.fit_predict(mdf_cat)
create_silhouette_plot(mdf_cat, cluster_labels)
```



From the silhouette plot above, it is apparent that each cluster from the k-modes clustering algorithm with 5 clusters had very mediocre silhouette scores. In fact, most of the scores were positive but were much closer to 0 than 1 (most were less than 0.4). This means that the clusters were very averagely cohesive and separated with respect to the dataset. Each of the clusters had numerous observations that dipped into a negative silhouette score, which is indicative of poor cohesion and separation. This isn't too appalling as the t-sne plots showed how spread out each cluster was and how it interfered with other clusters in the dataset. Overall, the k-modes clustering with 5 clusters provided very average cohesion and separation.

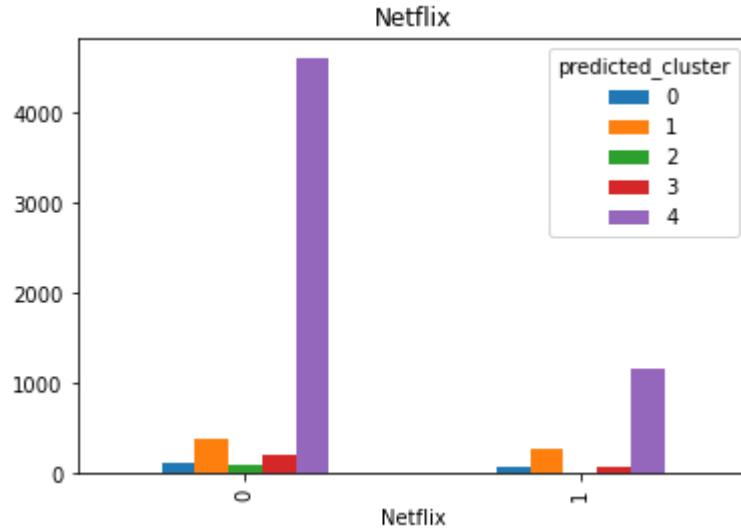
Cluster Attributes

In [63]:

```
ag = AgglomerativeClustering(n_clusters=5, affinity='euclidean', linkage='complete')
hierarch_df2 = mdf.copy()
hierarch_df2 = hierarch_df2.drop(['Title'], axis = 1)
Y_pred = ag.fit_predict(hierarch_df2)
cluster_labels = Y_pred
mdf_cat['predicted_cluster']=cluster_labels

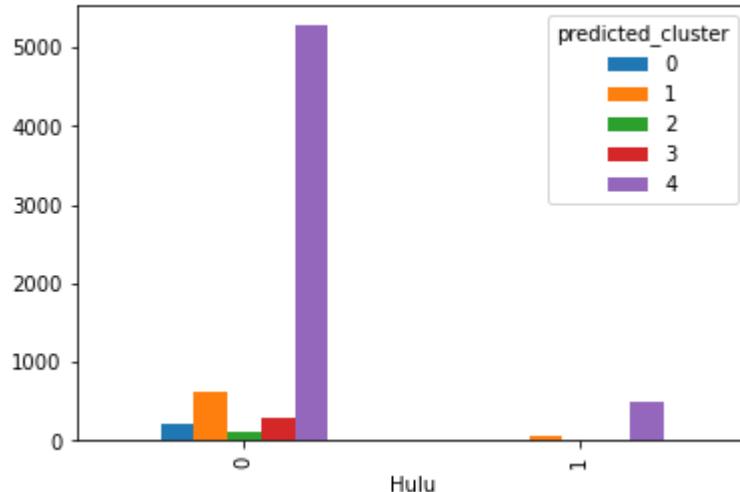
for i in mdf_cat.columns:
    ctab = pd.crosstab(mdf_cat[i], mdf_cat['predicted_cluster'])
    print(ctab)
    print(ctab / ctab.sum())
    ctab.plot.bar()
    plt.title('{}'.format(i))
    plt.xlabel(i)
    plt.show()
```

predicted_cluster	0	1	2	3	4
Netflix					
0	125	388	109	216	4599
1	84	274	0	77	1174
predicted_cluster	0	1	2	3	4
Netflix					
0	0.598086	0.586103	1.0	0.737201	0.79664
1	0.401914	0.413897	0.0	0.262799	0.20336



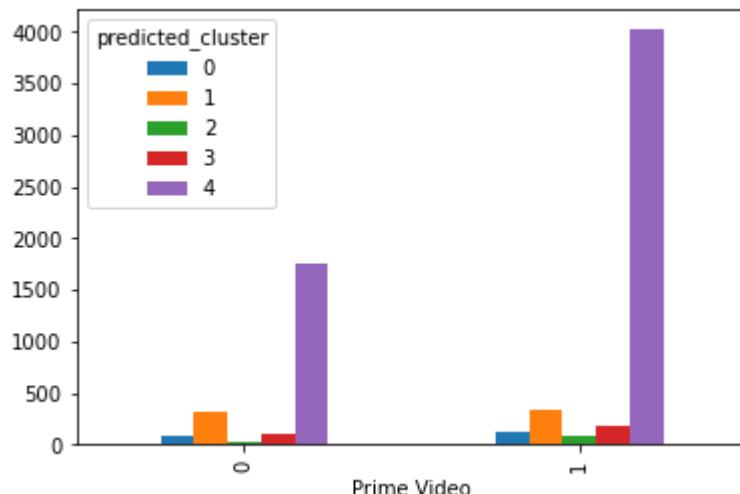
predicted_cluster	0	1	2	3	4
Hulu					
0	204	610	109	281	5275
1	5	52	0	12	498
predicted_cluster	0	1	2	3	4
Hulu					
0	0.976077	0.92145	1.0	0.959044	0.913736
1	0.023923	0.07855	0.0	0.040956	0.086264

Hulu



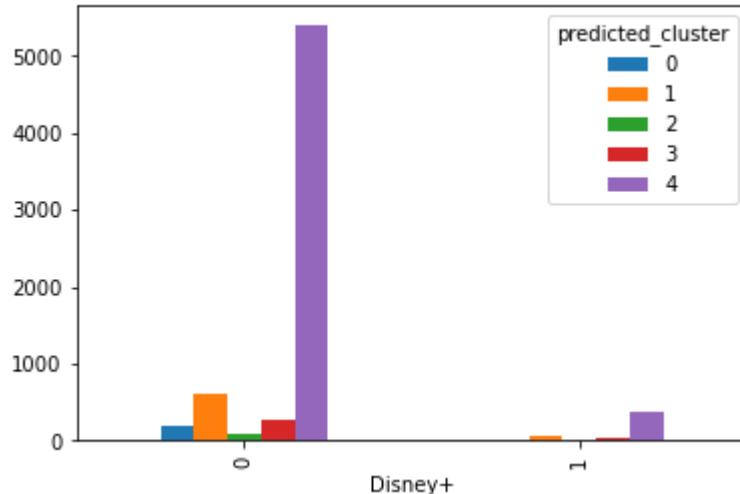
predicted_cluster	0	1	2	3	4
Prime Video					
0	81	323	18	110	1753
1	128	339	91	183	4020
predicted_cluster	0	1	2	3	4
Prime Video					
0	0.38756	0.487915	0.165138	0.375427	0.303655
1	0.61244	0.512085	0.834862	0.624573	0.696345

Prime Video



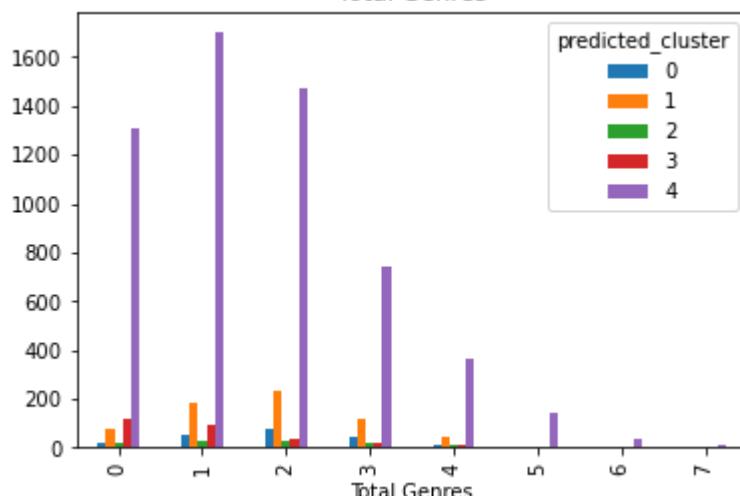
predicted_cluster	0	1	2	3	4
Disney+					
0	203	609	91	264	5390
1	6	53	18	29	383
predicted_cluster	0	1	2	3	4
Disney+					
0	0.971292	0.91994	0.834862	0.901024	0.933657
1	0.028708	0.08006	0.165138	0.098976	0.066343

Disney+



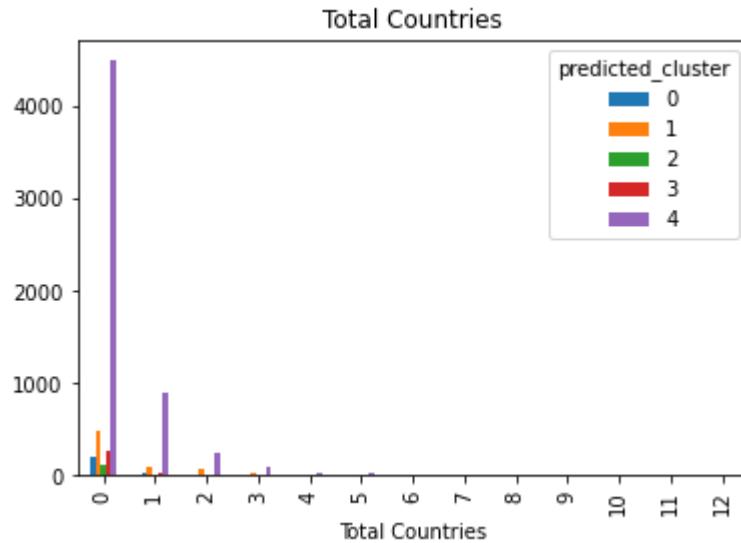
predicted_cluster	0	1	2	3	4
Total Genres					
0	0.095694	0.117825	0.146789	0.395904	0.227265
1	0.234450	0.271903	0.256881	0.313993	0.294301
2	0.387560	0.348943	0.247706	0.126280	0.254287
3	0.210526	0.175227	0.183486	0.075085	0.128010
4	0.057416	0.070997	0.128440	0.047782	0.062706
5	0.009569	0.009063	0.027523	0.023891	0.025463
6	0.004785	0.006042	0.009174	0.010239	0.006063
7	0.000000	0.000000	0.000000	0.006826	0.001905

Total Genres

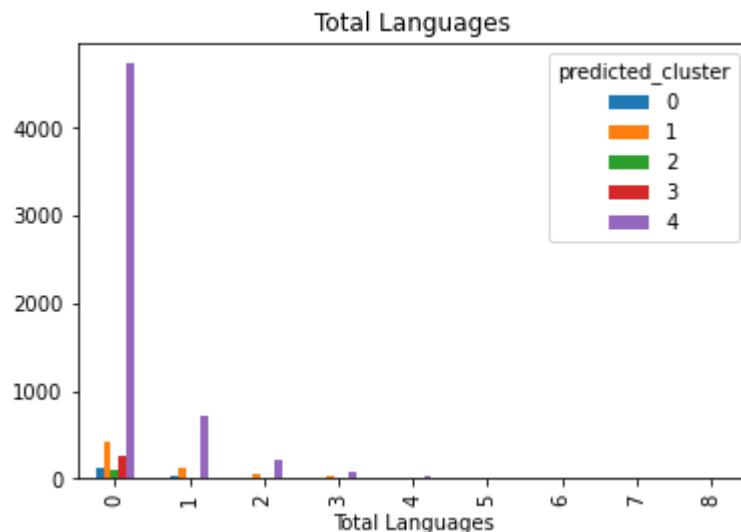


predicted_cluster	0	1	2	3	4
Total Countries					
0	186	472	103	264	4497
1	16	95	5	25	900
2	5	58	1	4	232
3	1	24	0	0	86
4	1	7	0	0	32
5	0	4	0	0	13

6	0	2	0	0	6
7	0	0	0	0	1
8	0	0	0	0	2
9	0	0	0	0	1
10	0	0	0	0	1
11	0	0	0	0	1
12	0	0	0	0	1
predicted_cluster	0	1	2	3	4
Total Countries					
0	0.889952	0.712991	0.944954	0.901024	0.778971
1	0.076555	0.143505	0.045872	0.085324	0.155898
2	0.023923	0.087613	0.009174	0.013652	0.040187
3	0.004785	0.036254	0.000000	0.000000	0.014897
4	0.004785	0.010574	0.000000	0.000000	0.005543
5	0.000000	0.006042	0.000000	0.000000	0.002252
6	0.000000	0.003021	0.000000	0.000000	0.001039
7	0.000000	0.000000	0.000000	0.000000	0.000173
8	0.000000	0.000000	0.000000	0.000000	0.000346
9	0.000000	0.000000	0.000000	0.000000	0.000173
10	0.000000	0.000000	0.000000	0.000000	0.000173
11	0.000000	0.000000	0.000000	0.000000	0.000173
12	0.000000	0.000000	0.000000	0.000000	0.000173

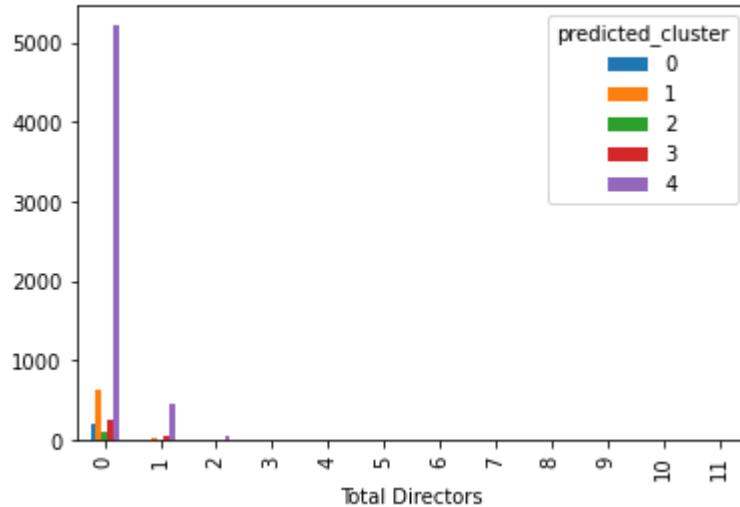


predicted_cluster	0	1	2	3	4
Total Languages					
0	130	417	101	271	4733
1	42	131	7	17	721
2	17	66	0	5	216
3	12	27	1	0	70
4	5	10	0	0	24
5	1	5	0	0	6
6	1	3	0	0	1
7	0	3	0	0	2
8	1	0	0	0	0
predicted_cluster	0	1	2	3	4
Total Languages					
0	0.622010	0.629909	0.926606	0.924915	0.819851
1	0.200957	0.197885	0.064220	0.058020	0.124892
2	0.081340	0.099698	0.000000	0.017065	0.037416
3	0.057416	0.040785	0.009174	0.000000	0.012125
4	0.023923	0.015106	0.000000	0.000000	0.004157
5	0.004785	0.007553	0.000000	0.000000	0.001039
6	0.004785	0.004532	0.000000	0.000000	0.000173
7	0.000000	0.004532	0.000000	0.000000	0.000346
8	0.004785	0.000000	0.000000	0.000000	0.000000



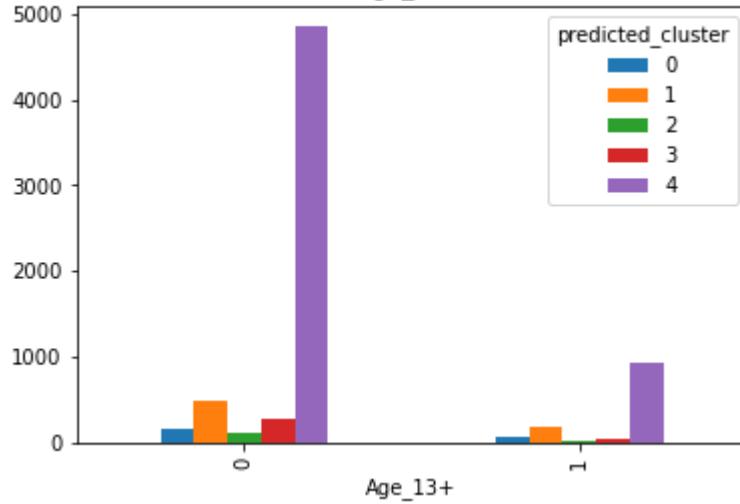
predicted_cluster	0	1	2	3	4
Total Directors					
0	197	633	94	245	5222
1	9	23	8	42	467
2	2	2	3	5	57
3	1	1	1	1	9
4	0	1	1	0	4
5	0	0	1	0	0
6	0	0	0	0	4
7	0	0	1	0	1
8	0	0	0	0	1
9	0	0	0	0	3
10	0	1	0	0	2
11	0	1	0	0	3
predicted_cluster	0	1	2	3	4
Total Directors					
0	0.942584	0.956193	0.862385	0.836177	0.904556
1	0.043062	0.034743	0.073394	0.143345	0.080894
2	0.009569	0.003021	0.027523	0.017065	0.009874
3	0.004785	0.001511	0.009174	0.003413	0.001559
4	0.000000	0.001511	0.009174	0.000000	0.000693
5	0.000000	0.000000	0.009174	0.000000	0.000000
6	0.000000	0.000000	0.000000	0.000000	0.000693
7	0.000000	0.000000	0.009174	0.000000	0.000173
8	0.000000	0.000000	0.000000	0.000000	0.000173
9	0.000000	0.000000	0.000000	0.000000	0.000520
10	0.000000	0.001511	0.000000	0.000000	0.000346
11	0.000000	0.001511	0.000000	0.000000	0.000520

Total Directors



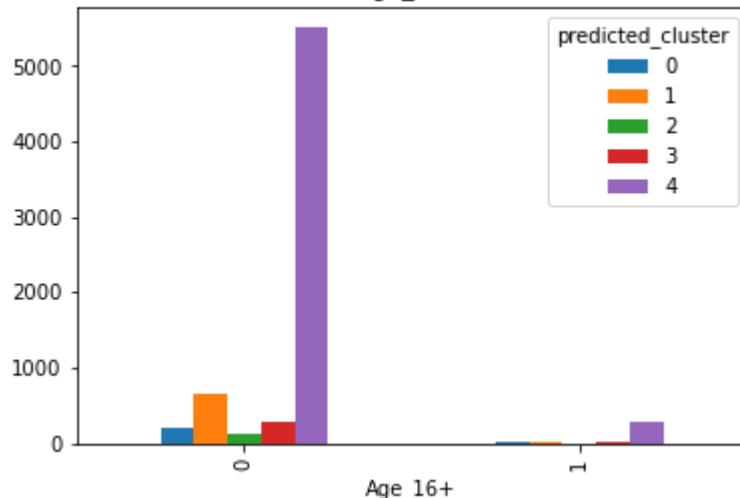
predicted_cluster	0	1	2	3	4
Age_13+					
0	155	483	105	261	4850
1	54	179	4	32	923
predicted_cluster	0	1	2	3	4
Age_13+					
0	0.741627	0.729607	0.963303	0.890785	0.840118
1	0.258373	0.270393	0.036697	0.109215	0.159882

Age_13+



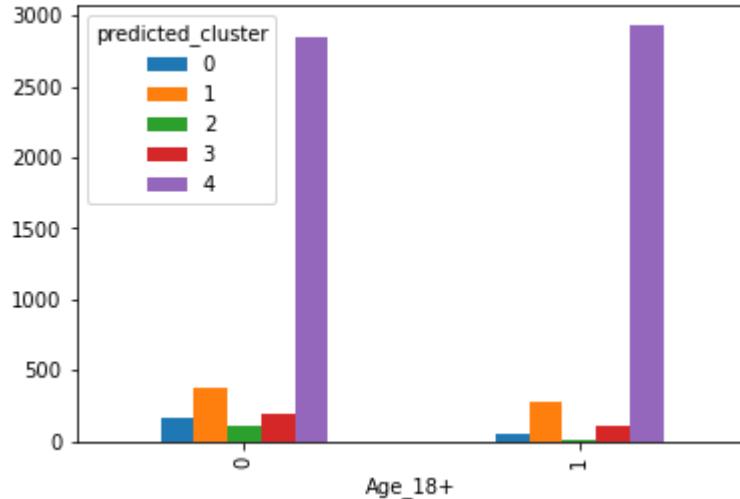
predicted_cluster	0	1	2	3	4
Age_16+					
0	204	647	109	277	5504
1	5	15	0	16	269
predicted_cluster	0	1	2	3	4
Age_16+					
0	0.976077	0.977341	1.0	0.945392	0.953404
1	0.023923	0.022659	0.0	0.054608	0.046596

Age_16+

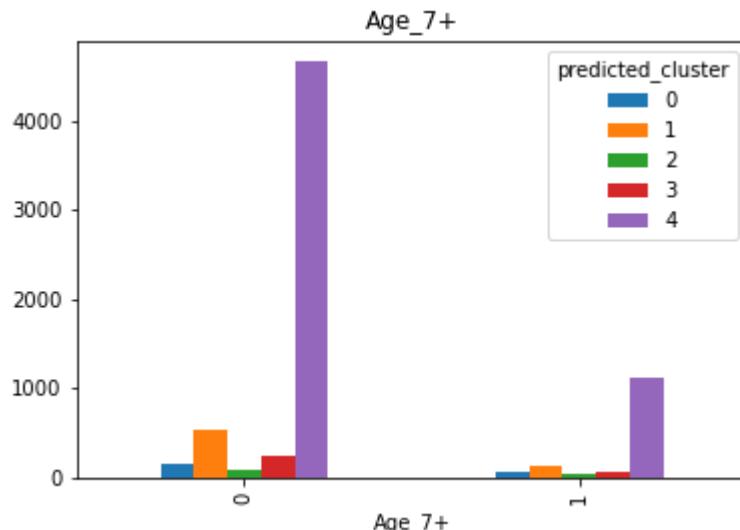


predicted_cluster	0	1	2	3	4
Age_18+					
0	0.784689	0.572508	0.990826	0.638225	0.492811
1	0.215311	0.427492	0.009174	0.361775	0.507189

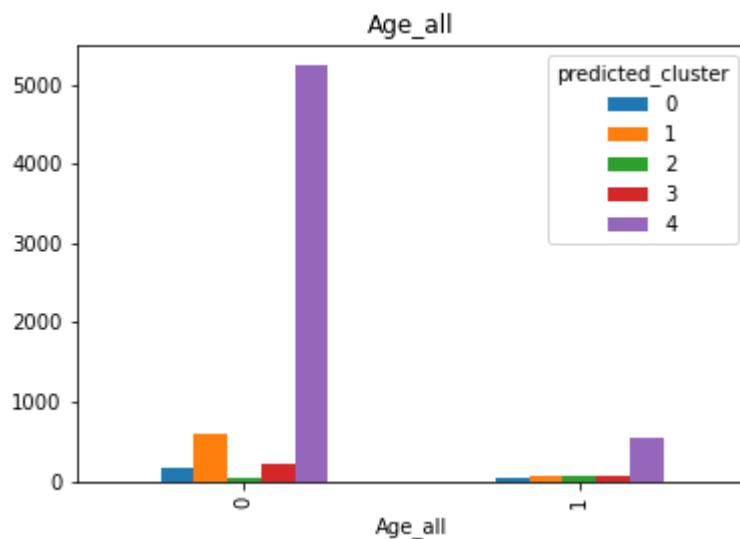
Age_18+



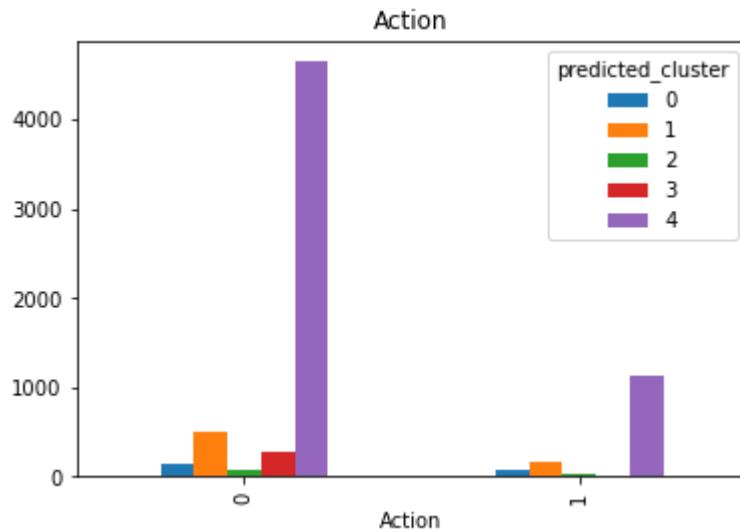
predicted_cluster	0	1	2	3	4
Age_7+					
0	144	539	78	228	4661
1	65	123	31	65	1112
predicted_cluster	0	1	2	3	4
Age_7+					
0	0.688995	0.814199	0.715596	0.778157	0.807379
1	0.311005	0.185801	0.284404	0.221843	0.192621



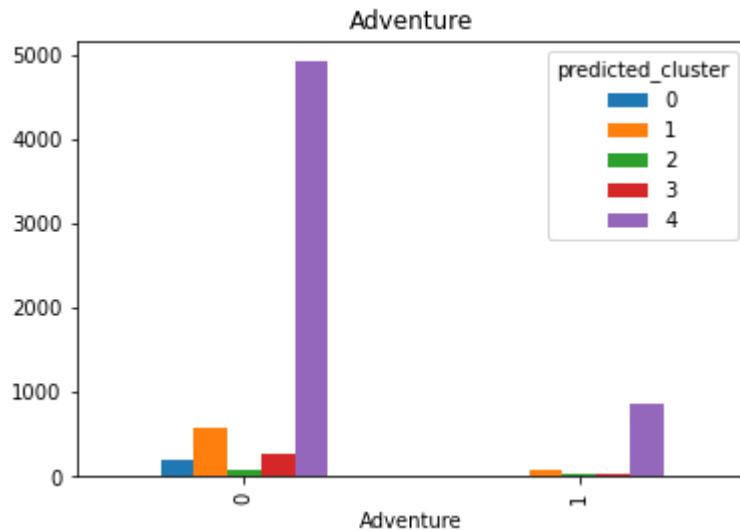
predicted_cluster	0	1	2	3	4
Age_all	0.808612	0.906344	0.330275	0.74744	0.906288
1	0.191388	0.093656	0.669725	0.25256	0.093712



predicted_cluster	0	1	2	3	4
Action	0.655502	0.746224	0.779817	0.935154	0.805301
1	0.344498	0.253776	0.220183	0.064846	0.194699

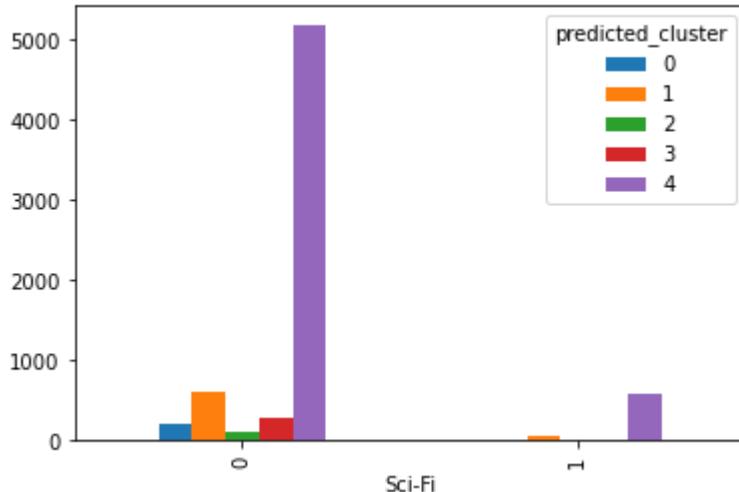


predicted_cluster	0	1	2	3	4
Adventure					
0	191	575	83	268	4913
1	18	87	26	25	860
predicted_cluster	0	1	2	3	4
Adventure					
0	0.913876	0.86858	0.761468	0.914676	0.851031
1	0.086124	0.13142	0.238532	0.085324	0.148969



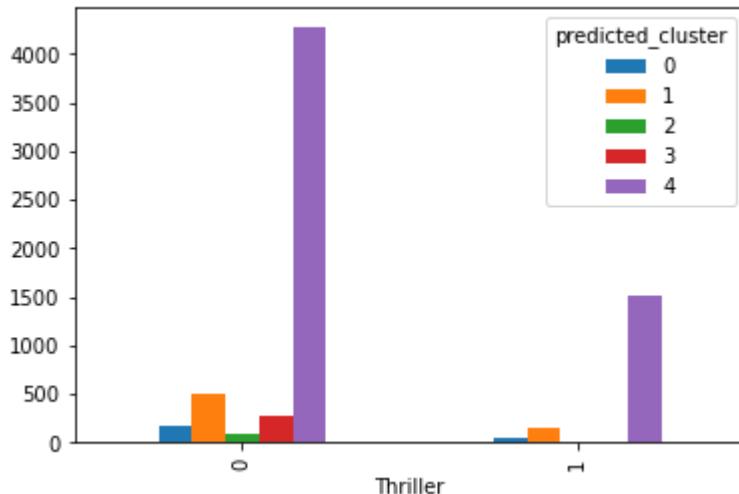
predicted_cluster	0	1	2	3	4
Sci-Fi					
0	200	600	101	286	5177
1	9	62	8	7	596
predicted_cluster	0	1	2	3	4
Sci-Fi					
0	0.956938	0.906344	0.926606	0.976109	0.896761
1	0.043062	0.093656	0.073394	0.023891	0.103239

Sci-Fi

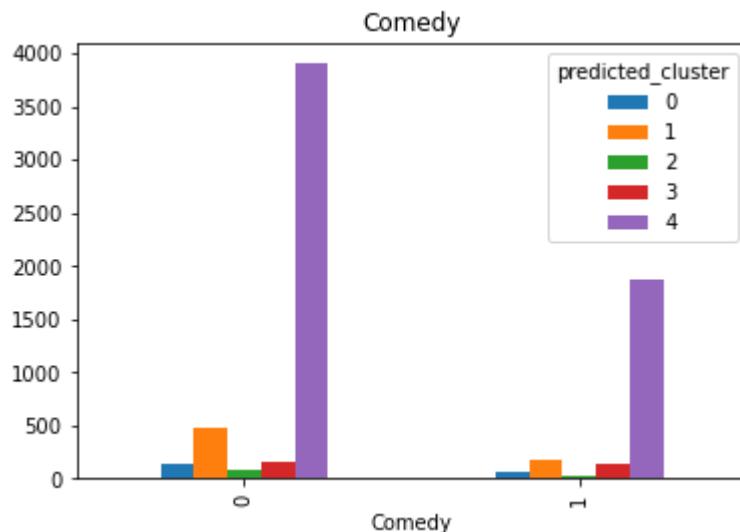


predicted_cluster	0	1	2	3	4
Thriller					
0	166	510	94	283	4269
1	43	152	15	10	1504
predicted_cluster	0	1	2	3	4
Thriller					
0	0.794258	0.770393	0.862385	0.96587	0.739477
1	0.205742	0.229607	0.137615	0.03413	0.260523

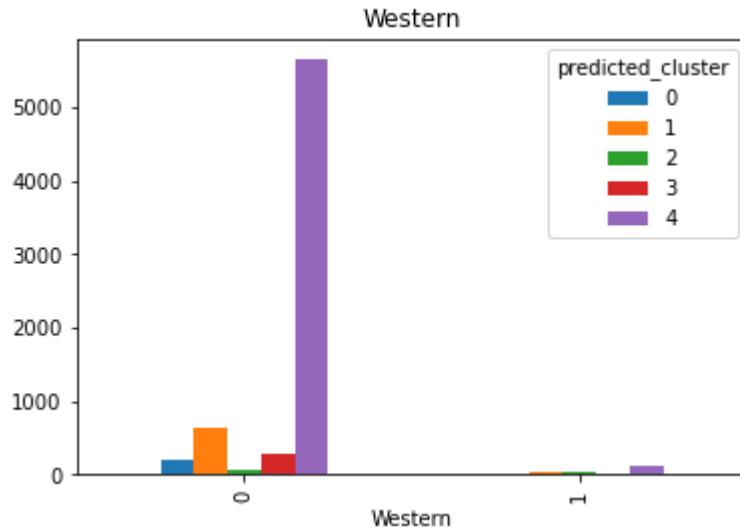
Thriller



predicted_cluster	0	1	2	3	4
Comedy					
0	144	475	76	157	3903
1	65	187	33	136	1870
predicted_cluster	0	1	2	3	4
Comedy					
0	0.688995	0.717523	0.697248	0.535836	0.676078
1	0.311005	0.282477	0.302752	0.464164	0.323922

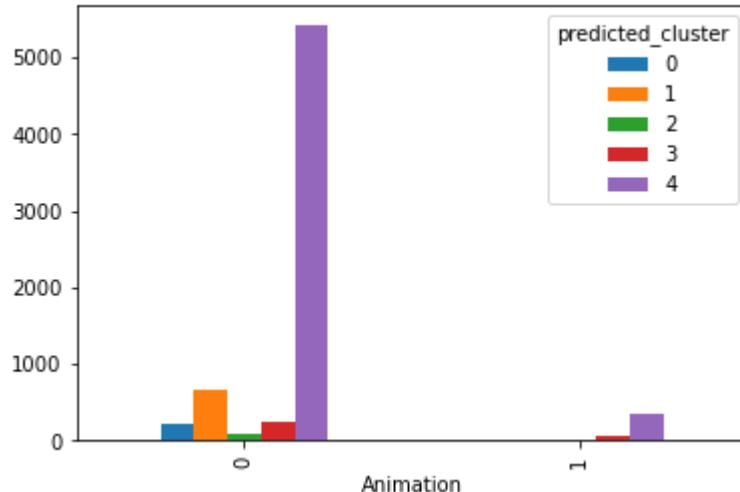


predicted_cluster	0	1	2	3	4
Western					
0	205	635	70	292	5649
1	4	27	39	1	124
predicted_cluster	0	1	2	3	4
Western					
0	0.980861	0.959215	0.642202	0.996587	0.978521
1	0.019139	0.040785	0.357798	0.003413	0.021479



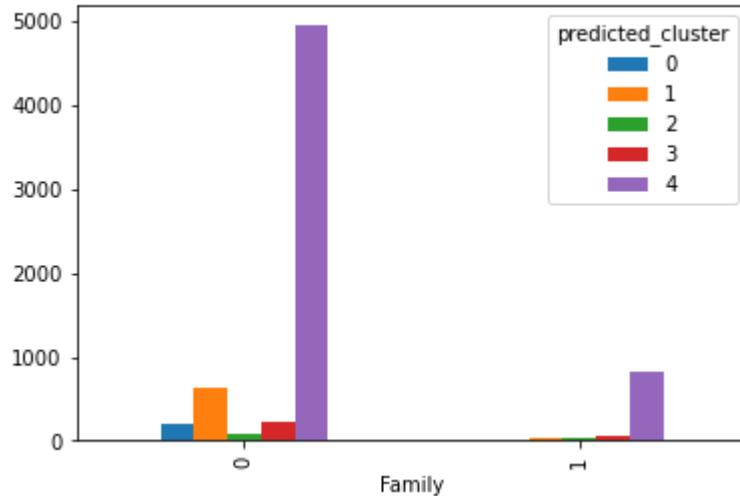
predicted_cluster	0	1	2	3	4
Animation					
0	208	655	97	237	5412
1	1	7	12	56	361
predicted_cluster	0	1	2	3	4
Animation					
0	0.995215	0.989426	0.889908	0.808874	0.937468
1	0.004785	0.010574	0.110092	0.191126	0.062532

Animation



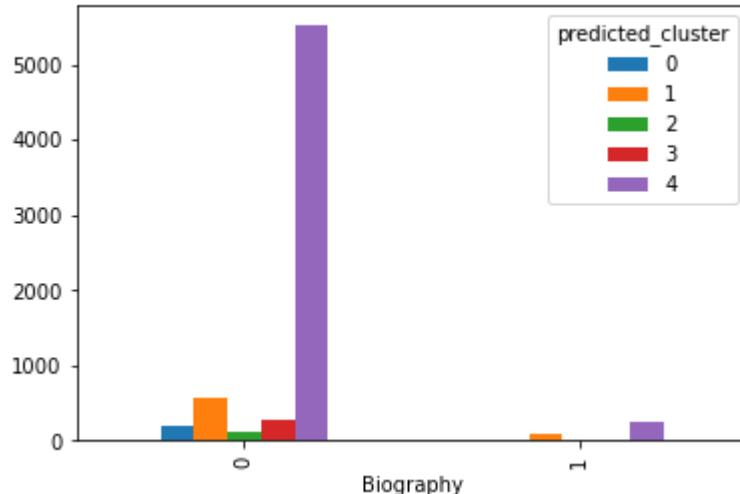
predicted_cluster	0	1	2	3	4
Family	193	619	85	235	4940
1	16	43	24	58	833
predicted_cluster	0	1	2	3	4
Family	0.923445	0.935045	0.779817	0.802048	0.855708
1	0.076555	0.064955	0.220183	0.197952	0.144292

Family



predicted_cluster	0	1	2	3	4
Biography	193	574	107	283	5514
1	16	88	2	10	259
predicted_cluster	0	1	2	3	4
Biography	0.923445	0.867069	0.981651	0.96587	0.955136
1	0.076555	0.132931	0.018349	0.03413	0.044864

Biography



predicted_cluster

Drama

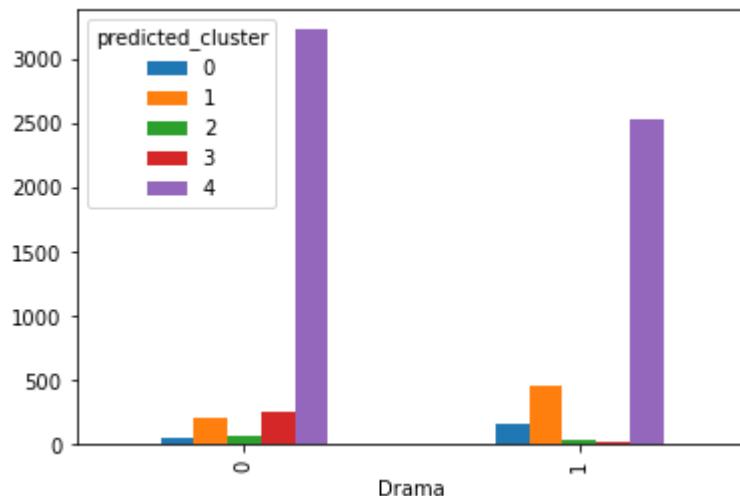
	0	1	2	3	4
0	46	203	71	264	3232
1	163	459	38	29	2541

predicted_cluster

Drama

	0	1	2	3	4
0	0.220096	0.306647	0.651376	0.901024	0.559848
1	0.779904	0.693353	0.348624	0.098976	0.440152

Drama



predicted_cluster

Music

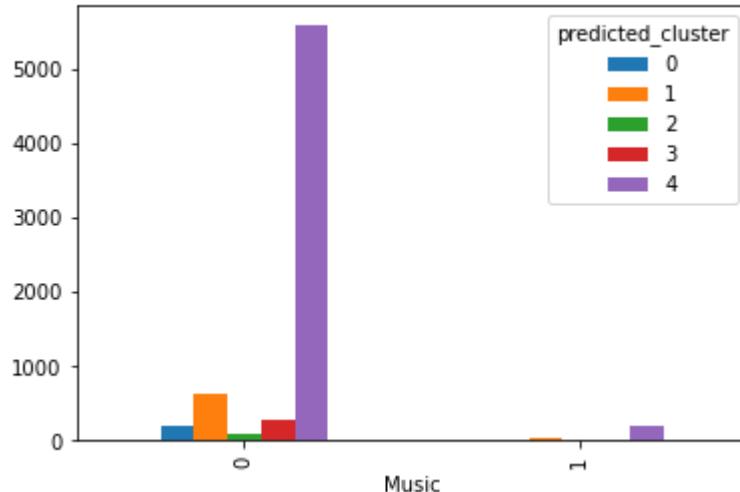
	0	1	2	3	4
0	203	637	96	279	5578
1	6	25	13	14	195

predicted_cluster

Music

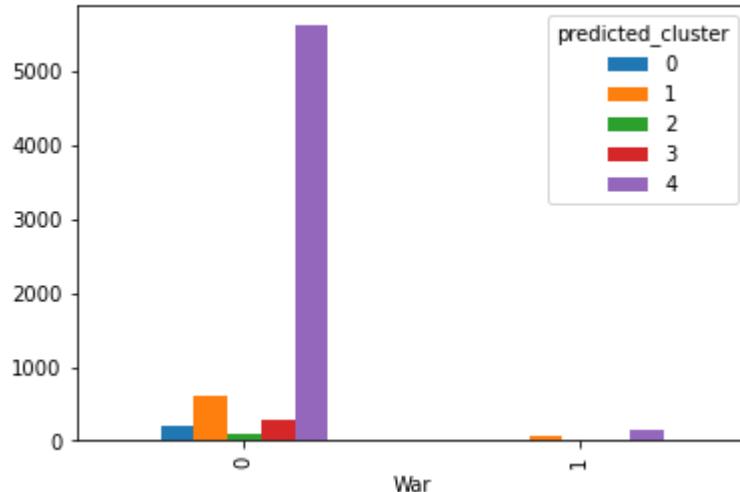
	0	1	2	3	4
0	0.971292	0.962236	0.880734	0.952218	0.966222
1	0.028708	0.037764	0.119266	0.047782	0.033778

Music



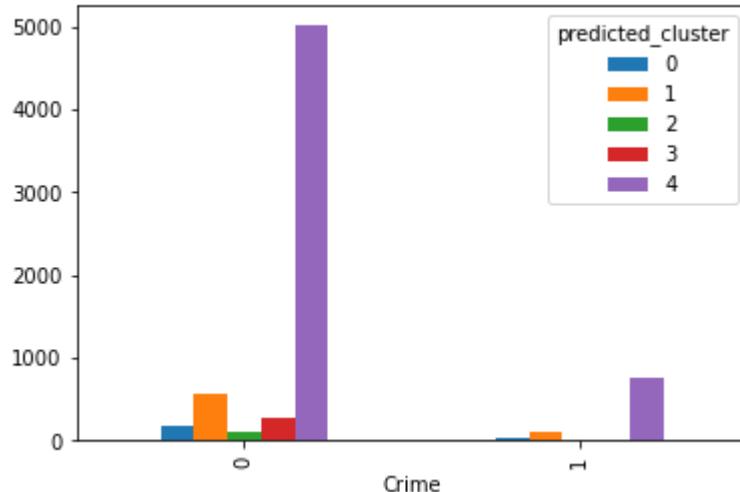
predicted_cluster	0	1	2	3	4
War	194	600	105	289	5623
0	15	62	4	4	150
predicted_cluster	0	1	2	3	4
War	0	1	2	3	4
0	0.92823	0.906344	0.963303	0.986348	0.974017
1	0.07177	0.093656	0.036697	0.013652	0.025983

War



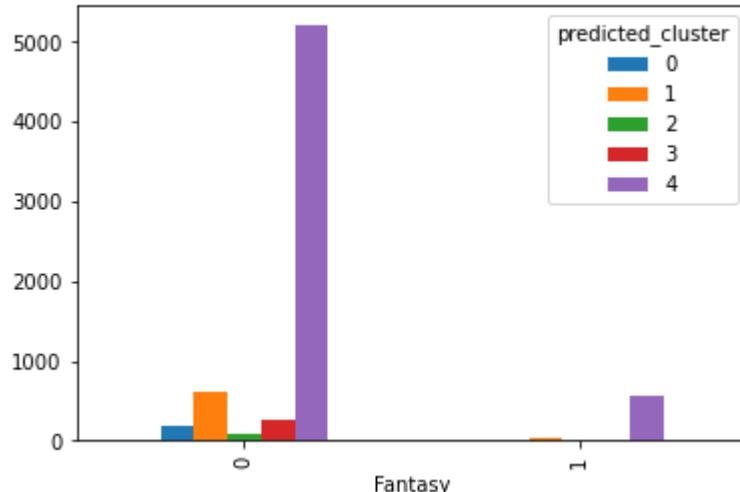
predicted_cluster	0	1	2	3	4
Crime	182	564	98	283	5012
0	27	98	11	10	761
predicted_cluster	0	1	2	3	4
Crime	0	1	2	3	4
0	0.870813	0.851964	0.899083	0.96587	0.868179
1	0.129187	0.148036	0.100917	0.03413	0.131821

Crime

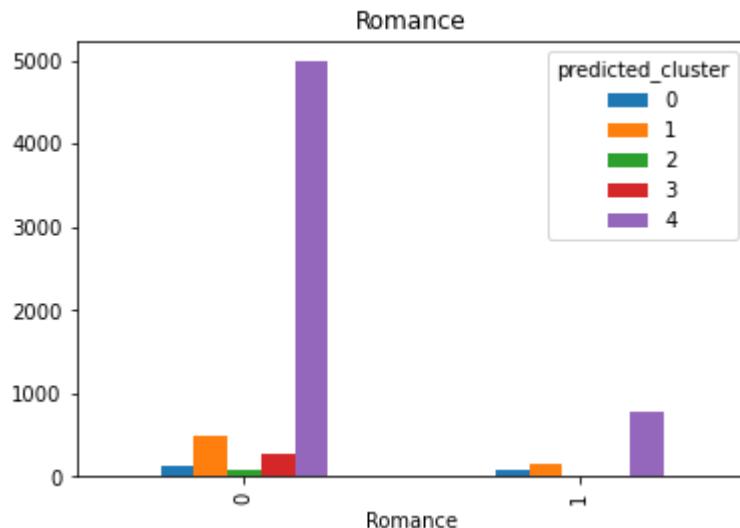


predicted_cluster	0	1	2	3	4
Fantasy	197	620	95	272	5202
1	12	42	14	21	571
predicted_cluster	0	1	2	3	4
Fantasy	0.942584	0.936556	0.87156	0.928328	0.901091
0	0.057416	0.063444	0.12844	0.071672	0.098909

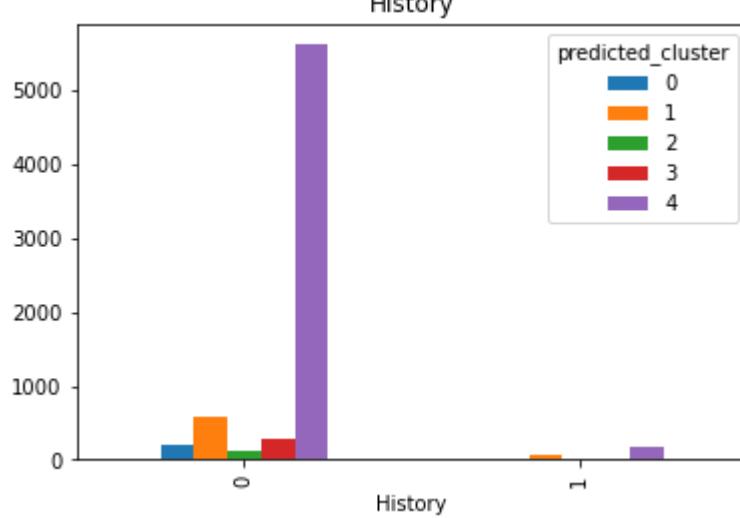
Fantasy



predicted_cluster	0	1	2	3	4
Romance	132	500	87	287	4984
1	77	162	22	6	789
predicted_cluster	0	1	2	3	4
Romance	0.631579	0.755287	0.798165	0.979522	0.863329
0	0.368421	0.244713	0.201835	0.020478	0.136671



predicted_cluster	0	1	2	3	4
0	0.909091	0.89577	0.981651	0.952218	0.971765
1	0.090909	0.10423	0.018349	0.047782	0.028235



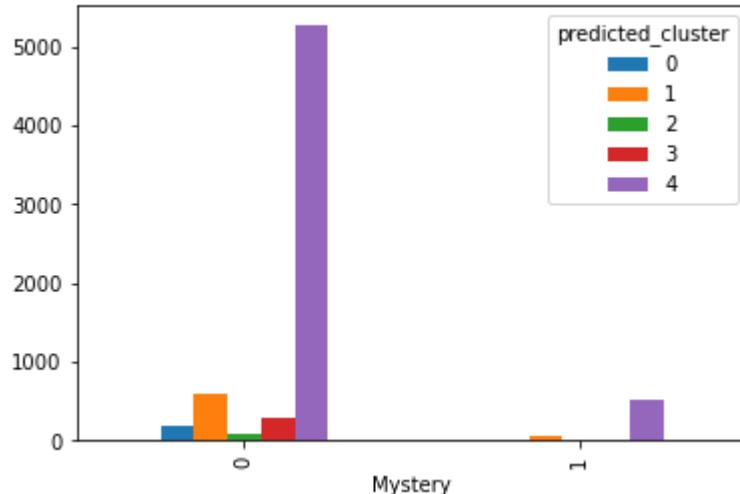
predicted_cluster	0	1	2	3	4
Mystery	199	606	99	289	5264
1	10	56	10	4	509

Mystery

predicted_cluster 0 1 2 3 4

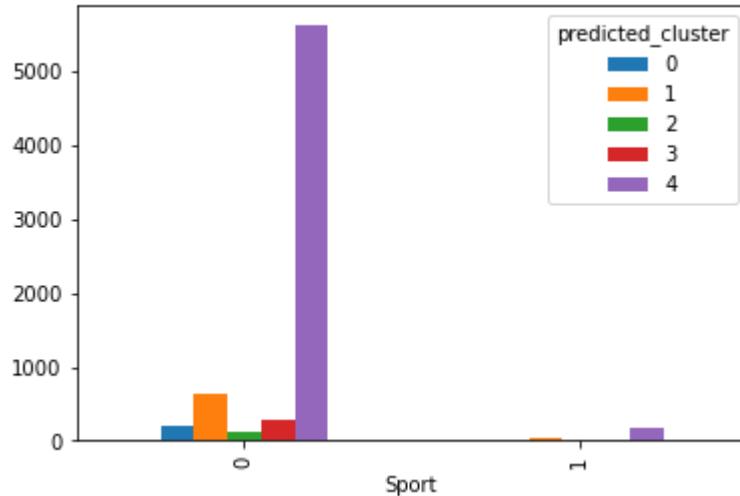
predicted_cluster	0	1	2	3	4
0	0.952153	0.915408	0.908257	0.986348	0.911831
1	0.047847	0.084592	0.091743	0.013652	0.088169

Mystery



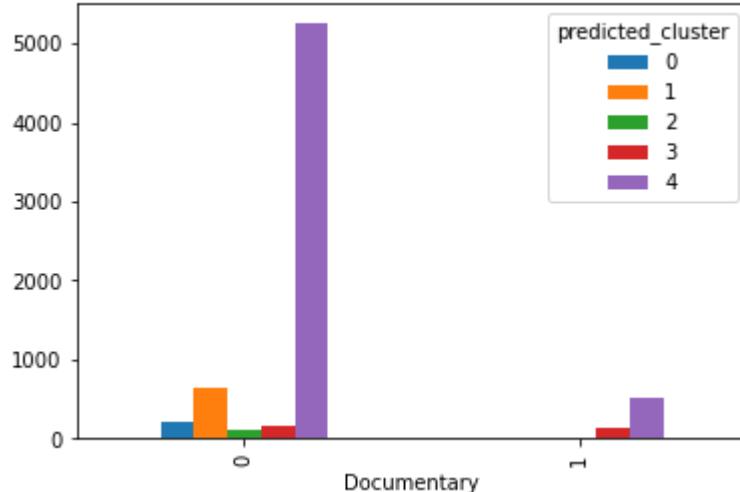
predicted_cluster	0	1	2	3	4
Sport					
0	202	634	107	287	5612
1	7	28	2	6	161
predicted_cluster	0	1	2	3	4
Sport					
0	0.966507	0.957704	0.981651	0.979522	0.972112
1	0.033493	0.042296	0.018349	0.020478	0.027888

Sport



predicted_cluster	0	1	2	3	4
Documentary					
0	207	643	102	157	5247
1	2	19	7	136	526
predicted_cluster	0	1	2	3	4
Documentary					
0	0.990431	0.971299	0.93578	0.535836	0.908886
1	0.009569	0.028701	0.06422	0.464164	0.091114

Documentary



predicted_cluster 0 1 2 3 4

Musical

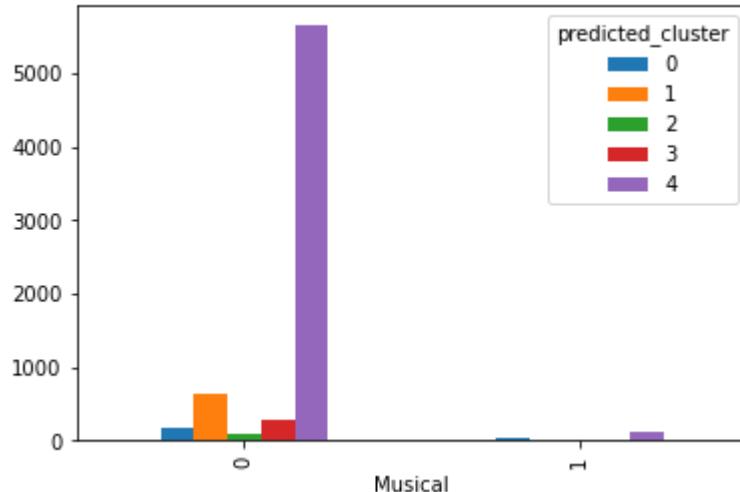
	0	1	2	3	4
0	179	638	101	282	5642
1	30	24	8	11	131

predicted_cluster 0 1 2 3 4

Musical

	0	1	2	3	4
0	0.856459	0.963746	0.926606	0.962457	0.977308
1	0.143541	0.036254	0.073394	0.037543	0.022692

Musical



predicted_cluster 0 1 2 3 4

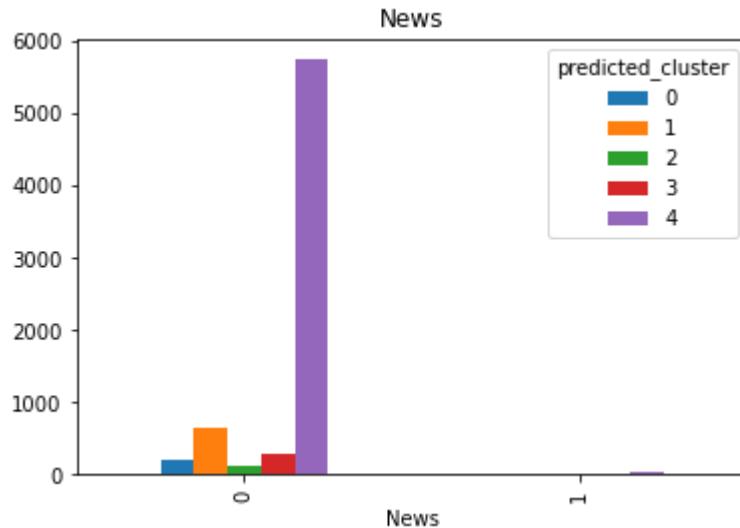
News

	0	1	2	3	4
0	209	660	109	293	5746
1	0	2	0	0	27

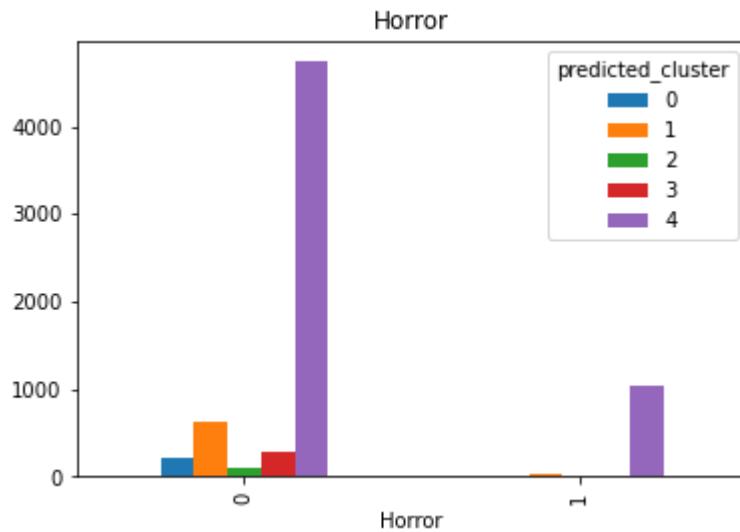
predicted_cluster 0 1 2 3 4

News

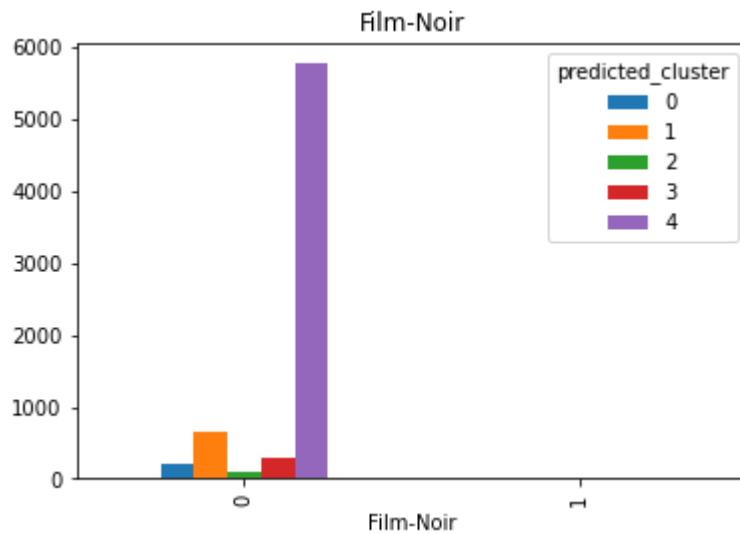
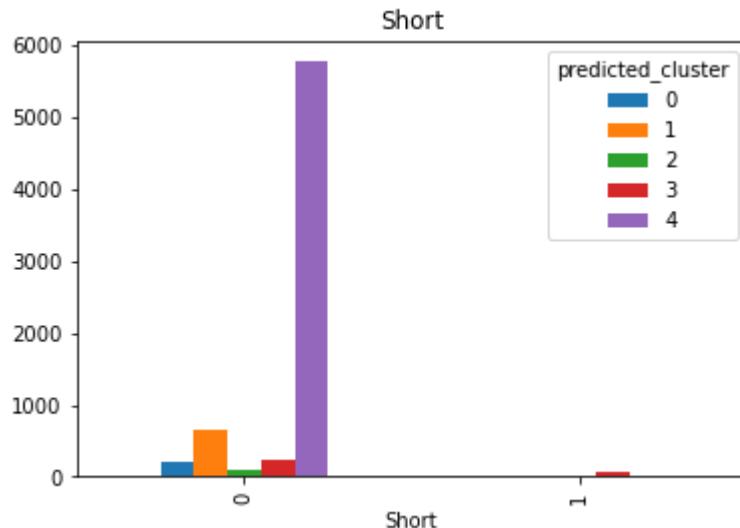
	0	1	2	3	4
0	1.0	0.996979	1.0	1.0	0.995323
1	0.0	0.003021	0.0	0.0	0.004677



predicted_cluster	0	1	2	3	4
Horror					
0	205	635	100	293	4737
1	4	27	9	0	1036
predicted_cluster	0	1	2	3	4
Horror					
0	0.980861	0.959215	0.917431	1.0	0.820544
1	0.019139	0.040785	0.082569	0.0	0.179456

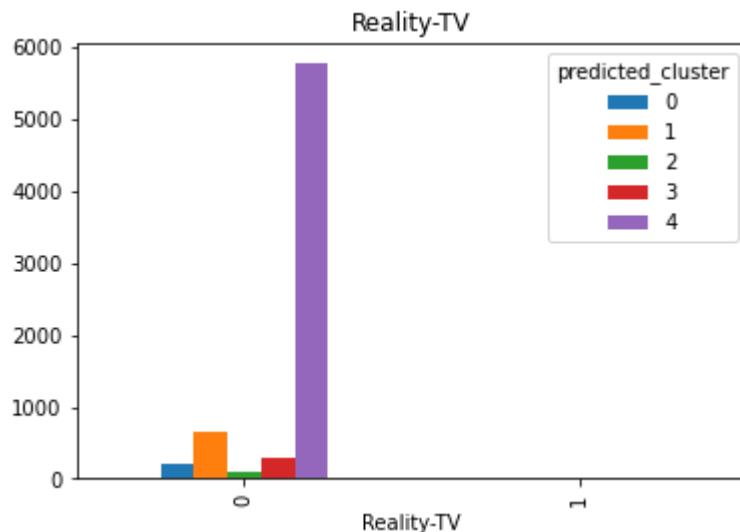


predicted_cluster	0	1	2	3	4
Short					
0	209	662	107	222	5773
1	0	0	2	71	0
predicted_cluster	0	1	2	3	4
Short					
0	1.0	1.0	0.981651	0.757679	1.0
1	0.0	0.0	0.018349	0.242321	0.0

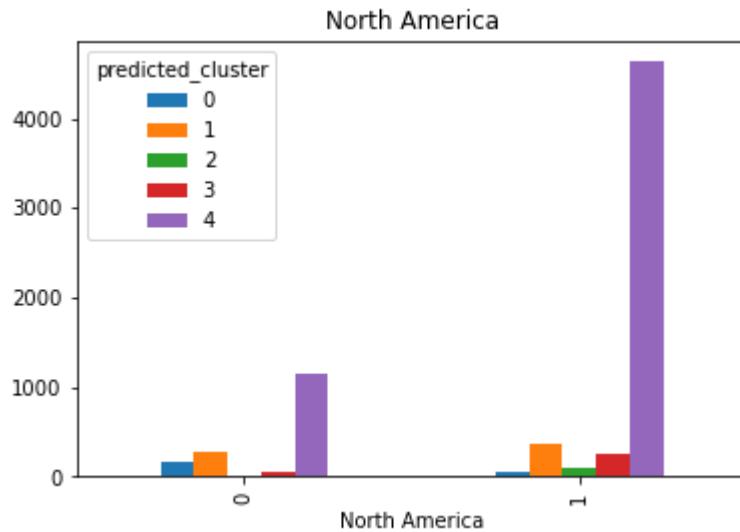


Reality-TV

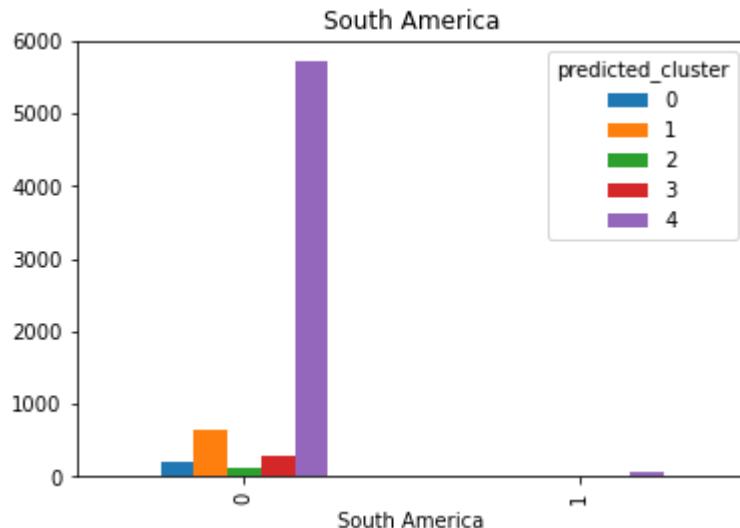
predicted_cluster	0	1	2	3	4
Reality-TV	1.0	1.0	1.0	1.0	0.999827
1	0.0	0.0	0.0	0.0	0.000173



predicted_cluster	0	1	2	3	4
0	162	287	8	48	1142
1	47	375	101	245	4631
predicted_cluster	0	1	2	3	4
0	0.77512	0.433535	0.073394	0.163823	0.197817
1	0.22488	0.566465	0.926606	0.836177	0.802183



predicted_cluster	0	1	2	3	4
0	162	287	8	48	1142
1	47	375	101	245	4631
predicted_cluster	0	1	2	3	4
0	0.77512	0.433535	0.073394	0.163823	0.197817
1	0.22488	0.566465	0.926606	0.836177	0.802183

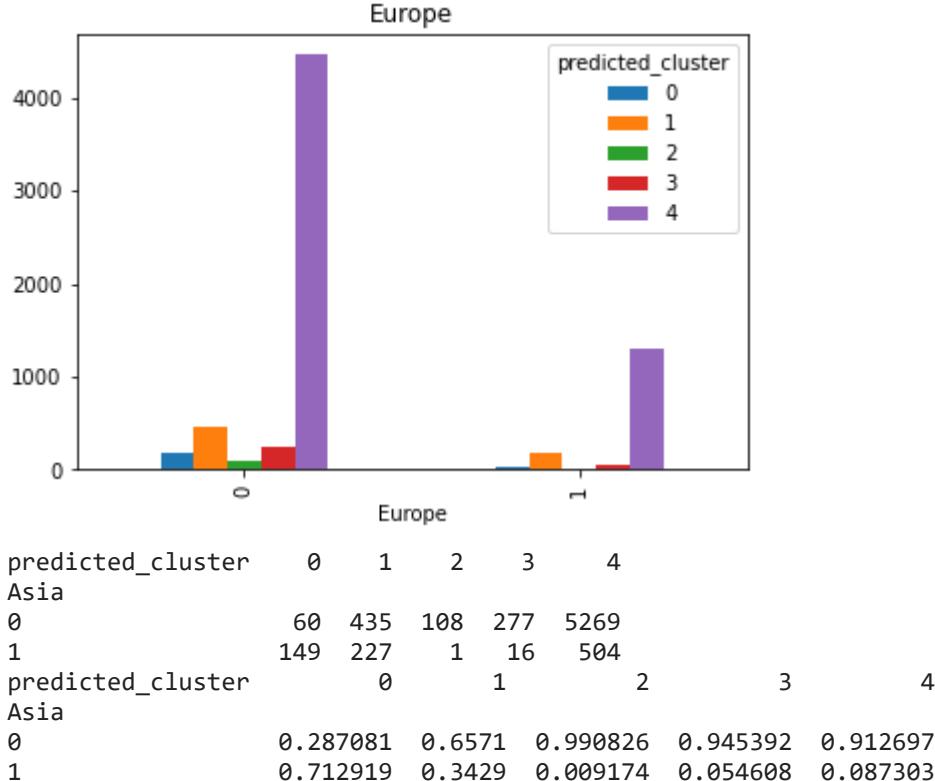


Europe

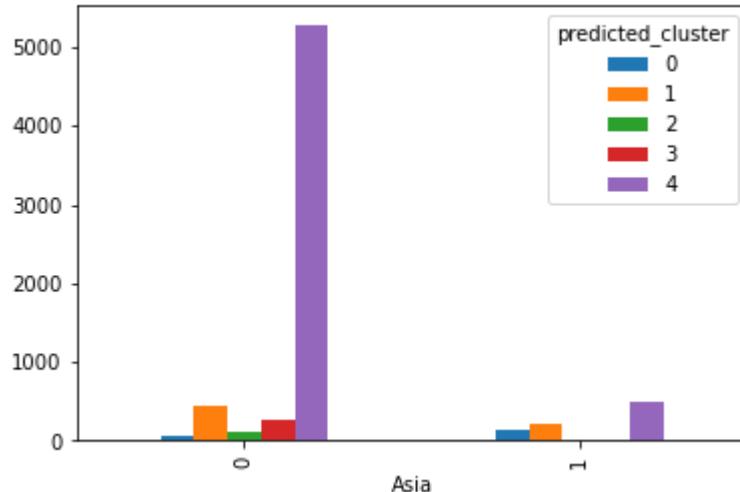
predicted_cluster	0	1	2	3	4
0	179	472	100	244	4464
1	30	190	9	49	1309

Asia

predicted_cluster	0	1	2	3	4
0	0.856459	0.712991	0.917431	0.832765	0.773255
1	0.143541	0.287009	0.082569	0.167235	0.226745

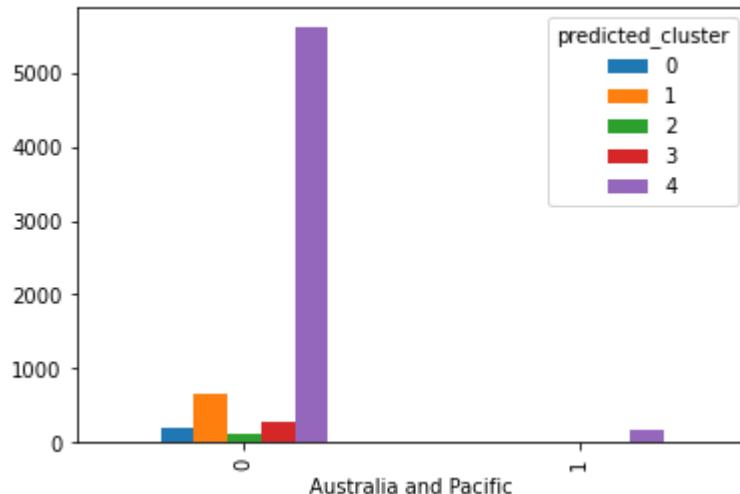


Asia

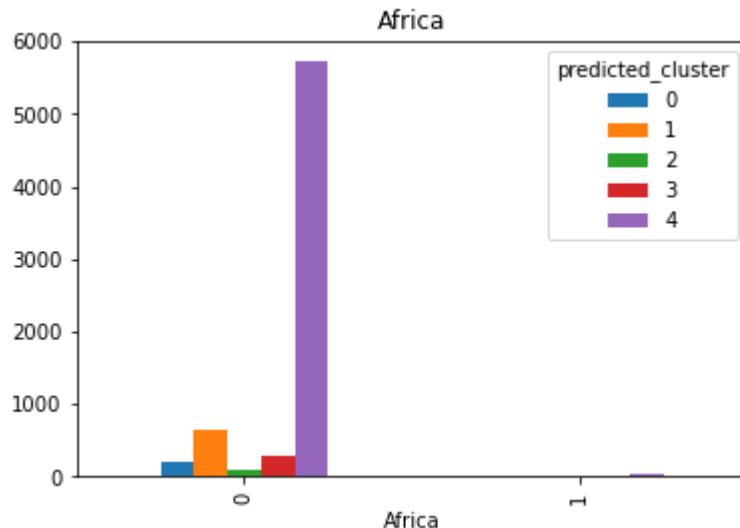


predicted_cluster	0	1	2	3	4	
Australia and Pacific	207	650	109	293	5602	
0	2	12	0	0	171	
predicted_cluster	0	1	2	3	4	
Australia and Pacific	0.990431	0.981873	1.0	1.0	0.970379	
0	0.009569	0.018127	0.0	0.0	0.029621	

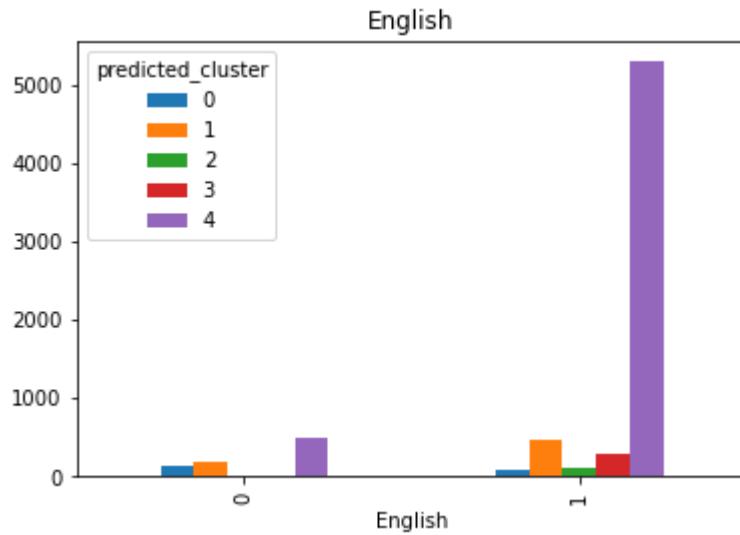
Australia and Pacific



predicted_cluster	0	1	2	3	4	
Africa	209	654	108	293	5720	
0	0	8	1	0	53	
predicted_cluster	0	1	2	3	4	
Africa	1.0	0.987915	0.990826	1.0	0.990819	
0	0.0	0.012085	0.009174	0.0	0.009181	

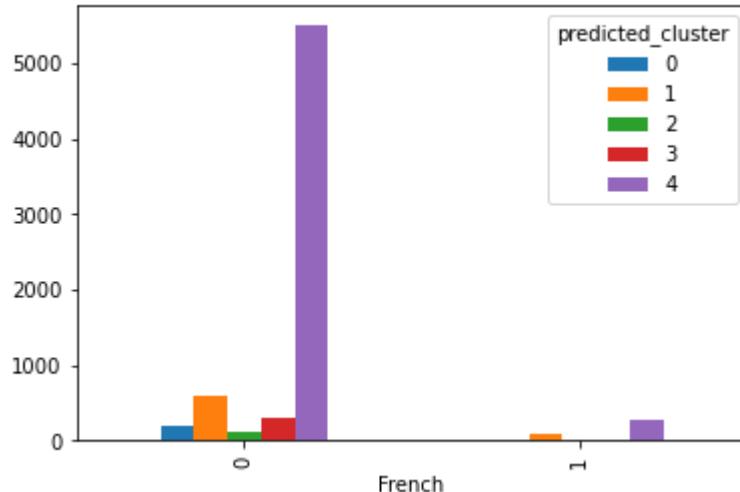


predicted_cluster	0	1	2	3	4
English	0.607656	0.296073	0.036697	0.040956	0.084531
1	0.392344	0.703927	0.963303	0.959044	0.915469



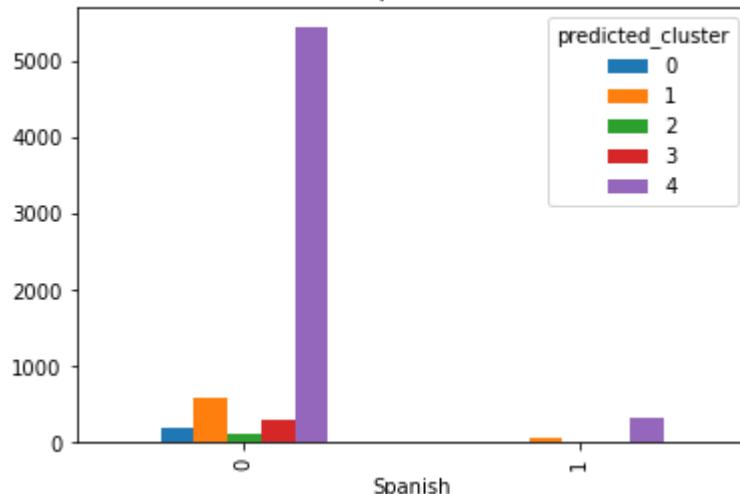
predicted_cluster	0	1	2	3	4
French	0.899522	0.882175	0.963303	0.989761	0.951845
1	0.100478	0.117825	0.036697	0.010239	0.048155

French

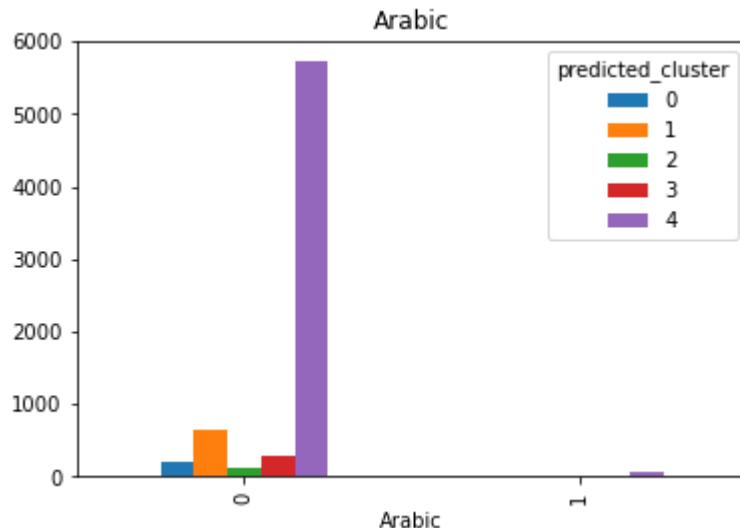


predicted_cluster	0	1	2	3	4
Spanish					
0	200	599	107	291	5440
1	9	63	2	2	333
predicted_cluster	0	1	2	3	4
Spanish					
0	0.956938	0.904834	0.981651	0.993174	0.942318
1	0.043062	0.095166	0.018349	0.006826	0.057682

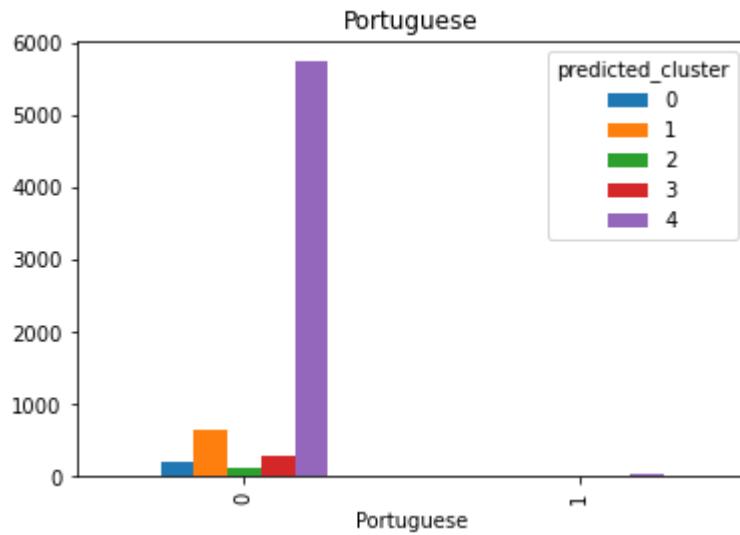
Spanish



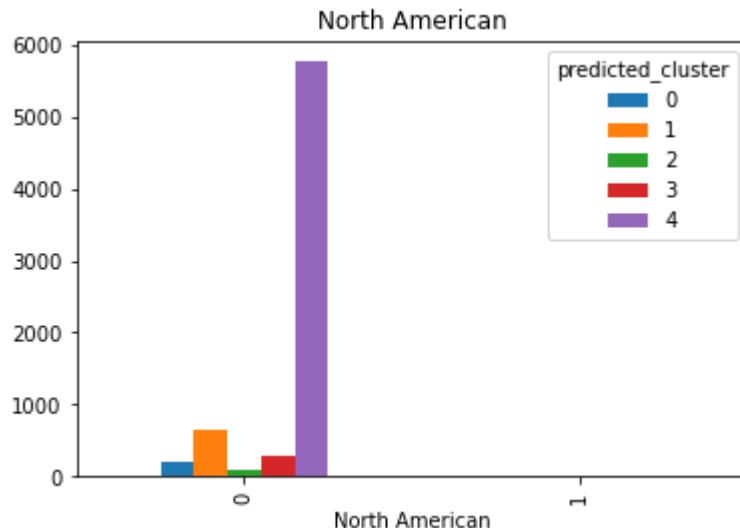
predicted_cluster	0	1	2	3	4
Arabic					
0	207	651	109	290	5718
1	2	11	0	3	55
predicted_cluster	0	1	2	3	4
Arabic					
0	0.990431	0.983384	1.0	0.989761	0.990473
1	0.009569	0.016616	0.0	0.010239	0.009527



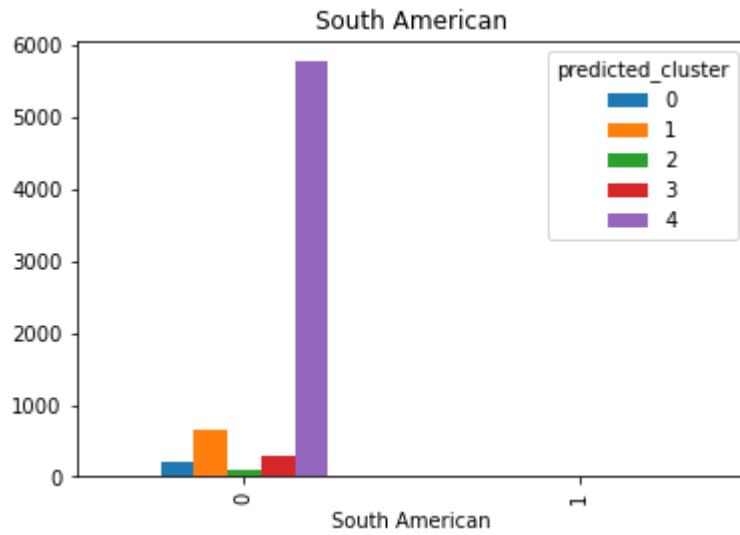
predicted_cluster	0	1	2	3	4
Portuguese	208	654	109	292	5742
1	1	8	0	1	31
predicted_cluster	0	1	2	3	4
Portuguese	0	1	2	3	4
0	0.995215	0.987915	1.0	0.996587	0.99463
1	0.004785	0.012085	0.0	0.003413	0.00537



predicted_cluster	0	1	2	3	4
North American	209	659	109	293	5758
1	0	3	0	0	15
predicted_cluster	0	1	2	3	4
North American	0	1	2	3	4
0	1.0	0.995468	1.0	1.0	0.997402
1	0.0	0.004532	0.0	0.0	0.002598

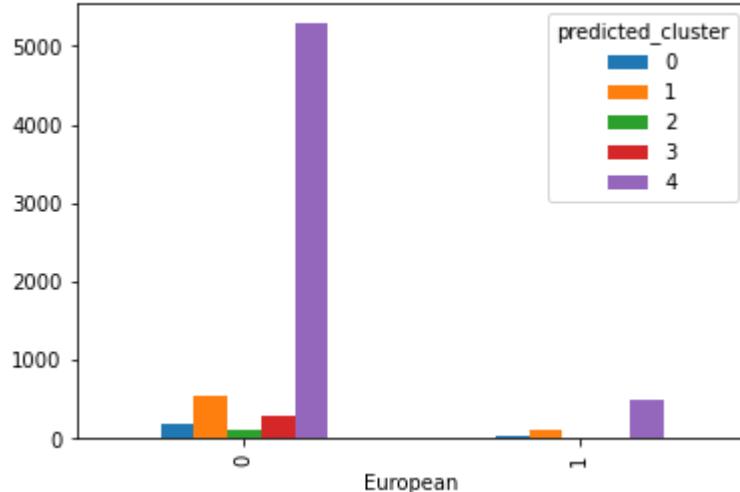


predicted_cluster	0	1	2	3	4
South American	209	660	109	293	5770
1	0	2	0	0	3
predicted_cluster	0	1	2	3	4
South American	0	1	2	3	4
0	1.0	0.996979	1.0	1.0	0.99948
1	0.0	0.003021	0.0	0.0	0.00052



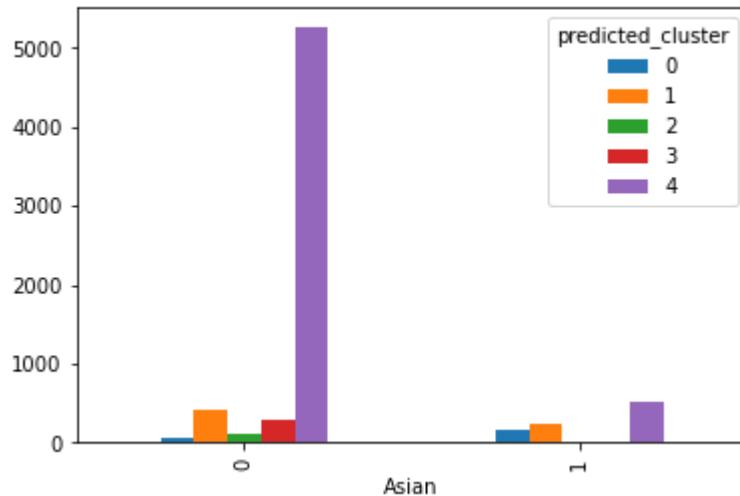
predicted_cluster	0	1	2	3	4
European	177	542	104	281	5283
1	32	120	5	12	490
predicted_cluster	0	1	2	3	4
European	0	1	2	3	4
0	0.84689	0.818731	0.954128	0.959044	0.915122
1	0.15311	0.181269	0.045872	0.040956	0.084878

European

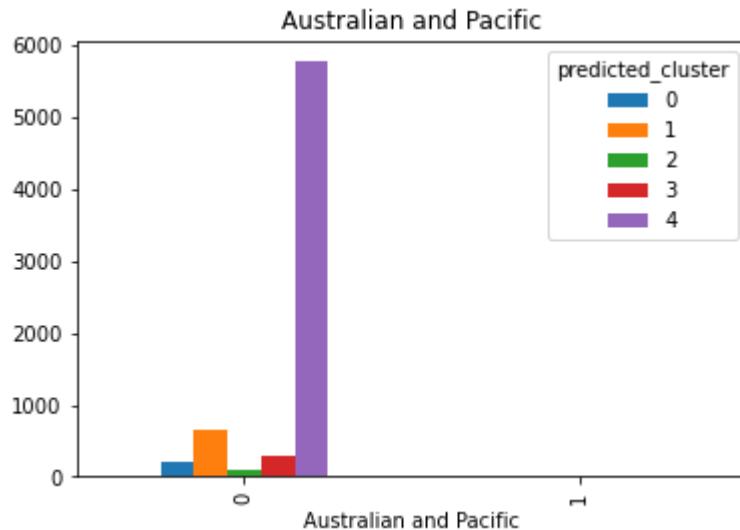


predicted_cluster	0	1	2	3	4
Asian	52	420	108	282	5257
1	157	242	1	11	516
predicted_cluster	0	1	2	3	4
Asian	0.248804	0.634441	0.990826	0.962457	0.910618
1	0.751196	0.365559	0.009174	0.037543	0.089382

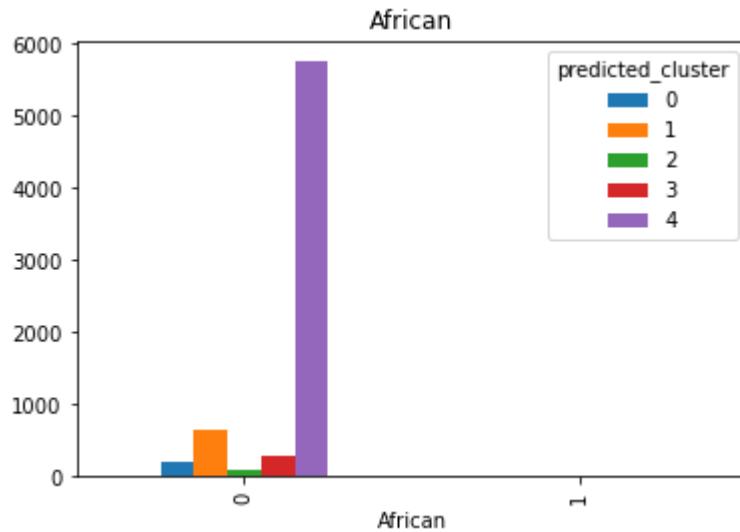
Asian



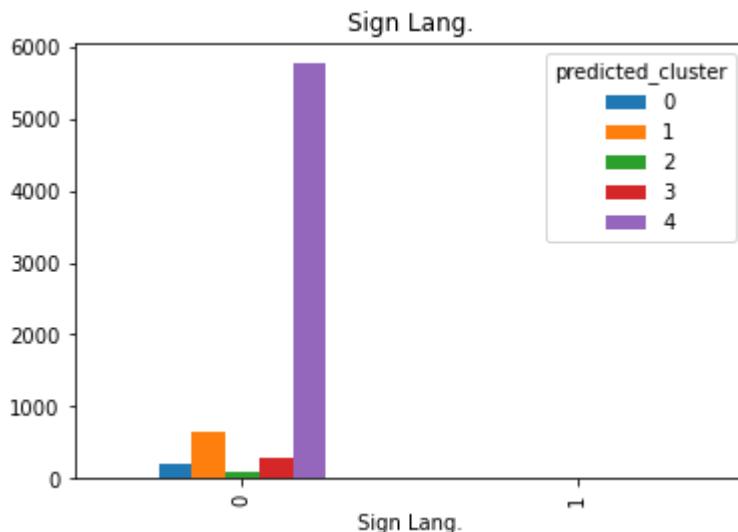
predicted_cluster	0	1	2	3	4
Australian and Pacific	209	659	109	292	5765
1	0	3	0	1	8
predicted_cluster	0	1	2	3	4
Australian and Pacific	1.0	0.995468	1.0	0.996587	0.998614
1	0.0	0.004532	0.0	0.003413	0.001386



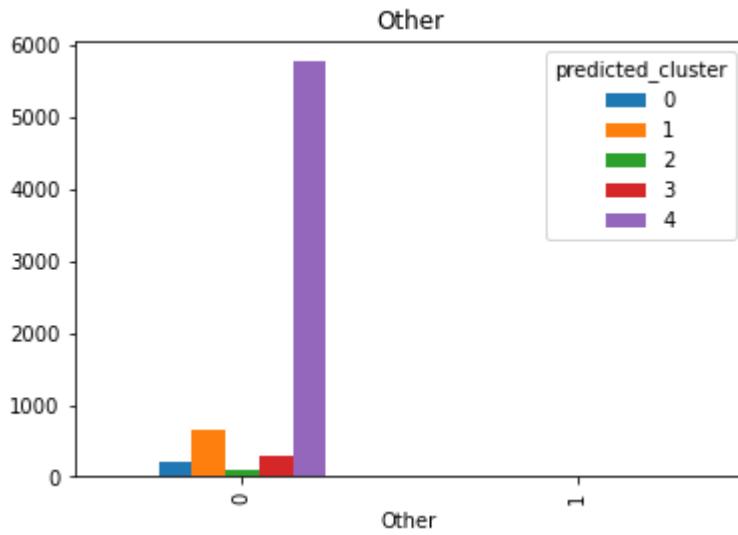
predicted_cluster	0	1	2	3	4
African	207	657	109	293	5753
1	2	5	0	0	20
predicted_cluster	0	1	2	3	4
African	0.990431	0.992447	1.0	1.0	0.996536
1	0.009569	0.007553	0.0	0.0	0.003464



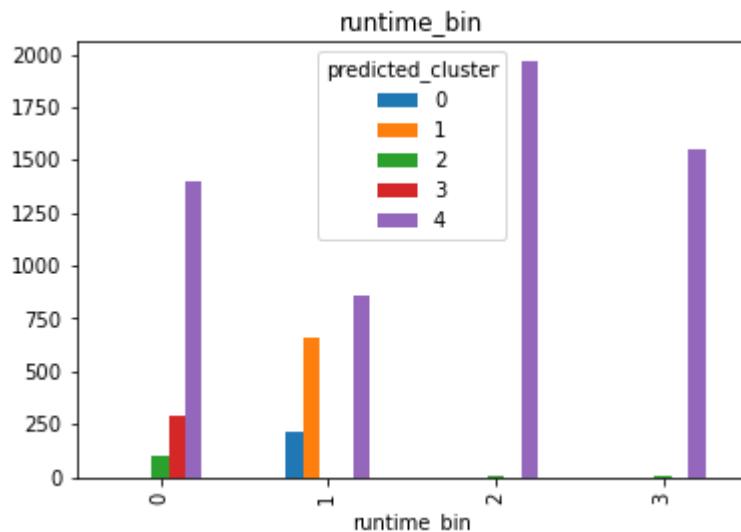
predicted_cluster	0	1	2	3	4
Sign Lang.	207	658	108	289	5758
1	2	4	1	4	15
predicted_cluster	0	1	2	3	4
Sign Lang.	0.990431	0.993958	0.990826	0.986348	0.997402
1	0.009569	0.006042	0.009174	0.013652	0.002598



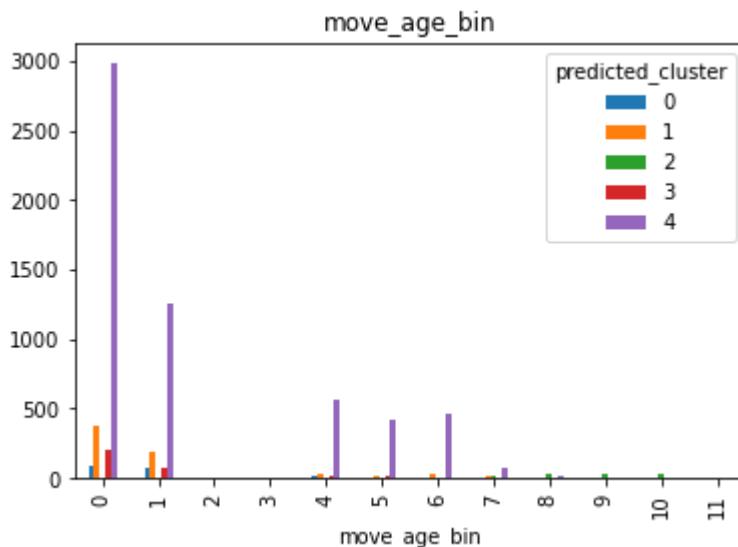
predicted_cluster	0	1	2	3	4
Other	208	661	108	290	5767
1	1	1	1	3	6
predicted_cluster	0	1	2	3	4
Other	0.995215	0.998489	0.990826	0.989761	0.998961
1	0.004785	0.001511	0.009174	0.010239	0.001039



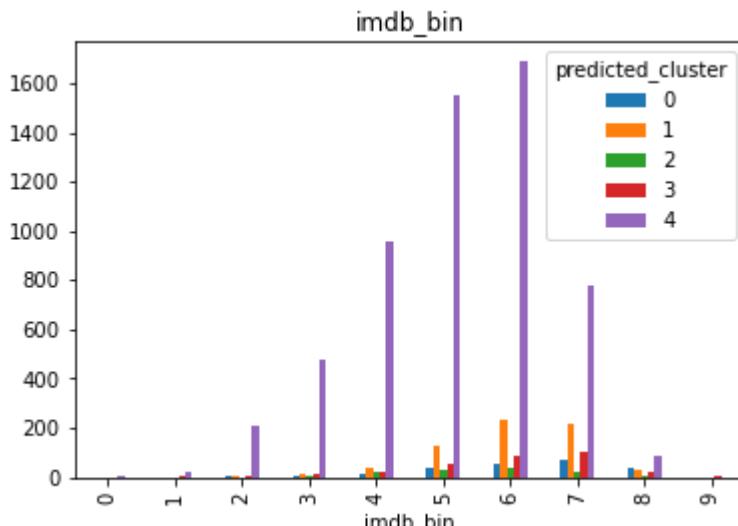
predicted_cluster	0	1	2	3	4
runtime_bin	0	0	97	293	1396
0	0	0	97	293	1396
1	209	662	0	0	863
2	0	0	6	0	1964
3	0	0	6	0	1550
predicted_cluster	0	1	2	3	4
runtime_bin	0.0	0.0	0.889908	1.0	0.241815
0	0.0	0.0	0.889908	1.0	0.241815
1	1.0	1.0	0.000000	0.0	0.149489
2	0.0	0.0	0.055046	0.0	0.340204
3	0.0	0.0	0.055046	0.0	0.268491



predicted_cluster	0	1	2	3	4
move_age_bin					
0	92	371	0	198	2982
1	78	188	0	70	1253
2	1	0	1	0	0
3	0	0	1	0	0
4	22	28	0	10	567
5	5	23	0	11	417
6	6	24	1	3	470
7	3	19	10	1	68
8	1	0	30	0	14
9	0	7	31	0	2
10	1	0	33	0	0
11	0	2	2	0	0
predicted_cluster	0	1	2	3	4
move_age_bin					
0	0.440191	0.560423	0.000000	0.675768	0.516543
1	0.373206	0.283988	0.000000	0.238908	0.217045
2	0.004785	0.000000	0.009174	0.000000	0.000000
3	0.000000	0.000000	0.009174	0.000000	0.000000
4	0.105263	0.042296	0.000000	0.034130	0.098216
5	0.023923	0.034743	0.000000	0.037543	0.072233
6	0.028708	0.036254	0.009174	0.010239	0.081413
7	0.014354	0.028701	0.091743	0.003413	0.011779
8	0.004785	0.000000	0.275229	0.000000	0.002425
9	0.000000	0.010574	0.284404	0.000000	0.000346
10	0.004785	0.000000	0.302752	0.000000	0.000000
11	0.000000	0.003021	0.018349	0.000000	0.000000



predicted_cluster	0	1	2	3	4
imdb_bin					
0	0	0	0	0	1
1	0	0	0	1	21
2	2	7	0	2	204
3	3	15	5	9	475
4	13	39	18	17	959
5	35	123	29	57	1557
6	57	229	35	85	1688
7	66	220	20	99	779
8	33	29	2	22	89
9	0	0	0	1	0
predicted_cluster	0	1	2	3	4
imdb_bin					
0	0.000000	0.000000	0.000000	0.000000	0.000173
1	0.000000	0.000000	0.000000	0.003413	0.003638
2	0.009569	0.010574	0.000000	0.006826	0.035337
3	0.014354	0.022659	0.045872	0.030717	0.082280
4	0.062201	0.058912	0.165138	0.058020	0.166118
5	0.167464	0.185801	0.266055	0.194539	0.269704
6	0.272727	0.345921	0.321101	0.290102	0.292396
7	0.315789	0.332326	0.183486	0.337884	0.134939
8	0.157895	0.043807	0.018349	0.075085	0.015417
9	0.000000	0.000000	0.000000	0.003413	0.000000

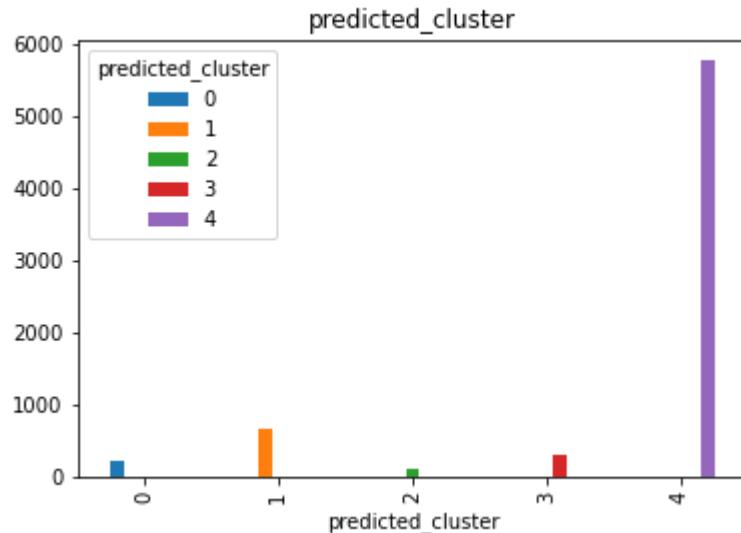


predicted_cluster	0	1	2	3	4
predicted_cluster	209	0	0	0	0

```

1          0  662    0    0    0
2          0    0  109    0    0
3          0    0    0  293    0
4          0    0    0    0 5773
predicted_cluster  0    1    2    3    4
predicted_cluster
0          1.0  0.0  0.0  0.0  0.0
1          0.0  1.0  0.0  0.0  0.0
2          0.0  0.0  1.0  0.0  0.0
3          0.0  0.0  0.0  1.0  0.0
4          0.0  0.0  0.0  0.0  1.0

```



In [64]:

```

# KModes plots
km = KModes(n_clusters=5,random_state=1000)
cluster_labels = km.fit_predict(mdf_cat)
mdf_cat['predicted_cluster']=cluster_labels

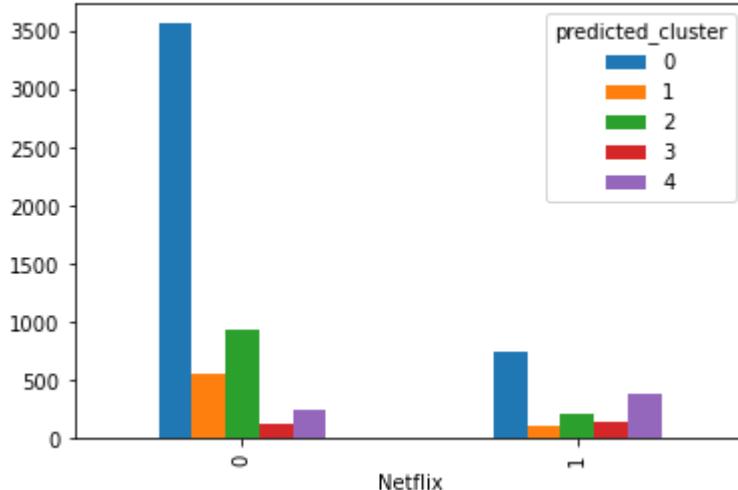
for i in mdf_cat.columns:
    ctab = pd.crosstab(mdf_cat[i], mdf_cat['predicted_cluster'])
    print(ctab)
    print(ctab / ctab.sum())
    ctab.plot.bar()
    plt.title('{}'.format(i))
    plt.xlabel(i)
    plt.show()

# ctab = pd.crosstab(mdf_cat['Netflix'], mdf_cat['predicted_cluster'])
# print(ctab)
# print(ctab / ctab.sum())
# ctab.plot.bar()

```

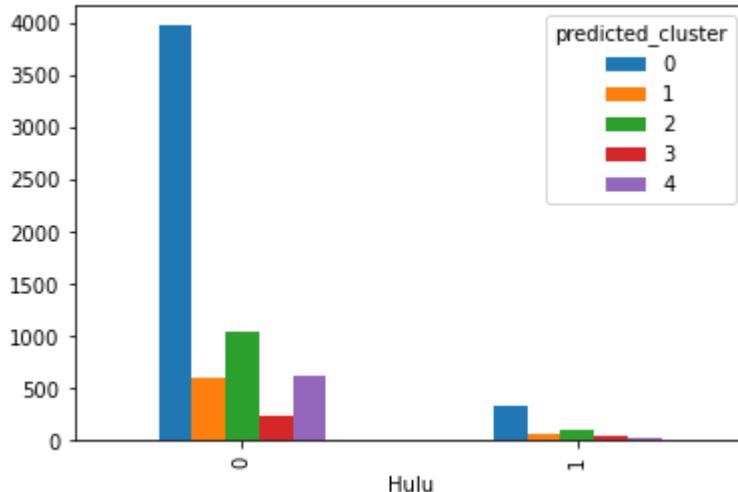
predicted_cluster	0	1	2	3	4
Netflix					
0	3567	552	930	131	257
1	745	113	216	151	384
predicted_cluster	0	1	2	3	4
Netflix					
0	0.827226	0.830075	0.811518	0.464539	0.400936
1	0.172774	0.169925	0.188482	0.535461	0.599064

Netflix

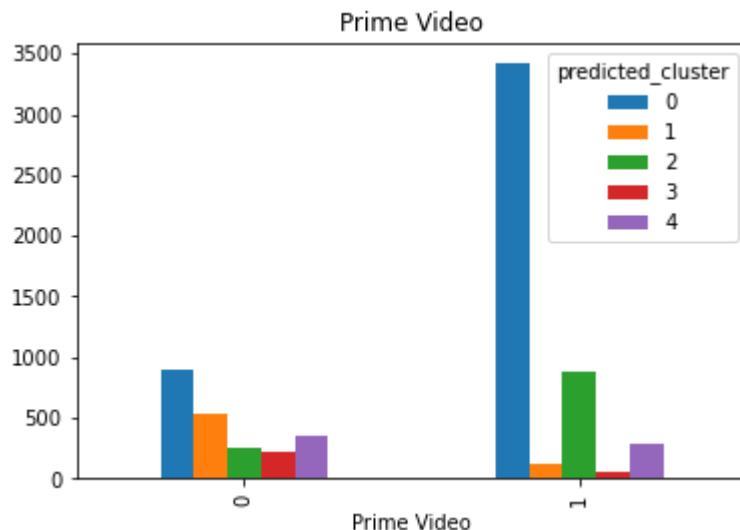


	predicted_cluster	0	1	2	3	4
Hulu	0	3978	603	1039	244	615
	1	334	62	107	38	26
	predicted_cluster	0	1	2	3	4
Hulu	0	0.922542	0.906767	0.906632	0.865248	0.959438
	1	0.077458	0.093233	0.093368	0.134752	0.040562

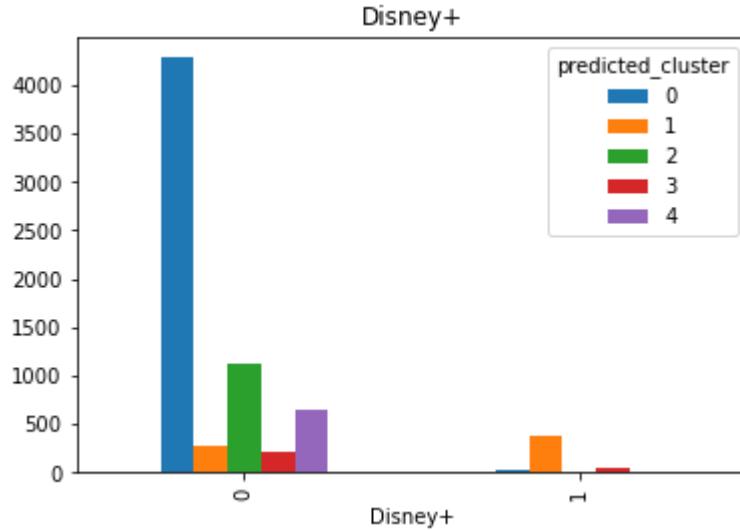
Hulu



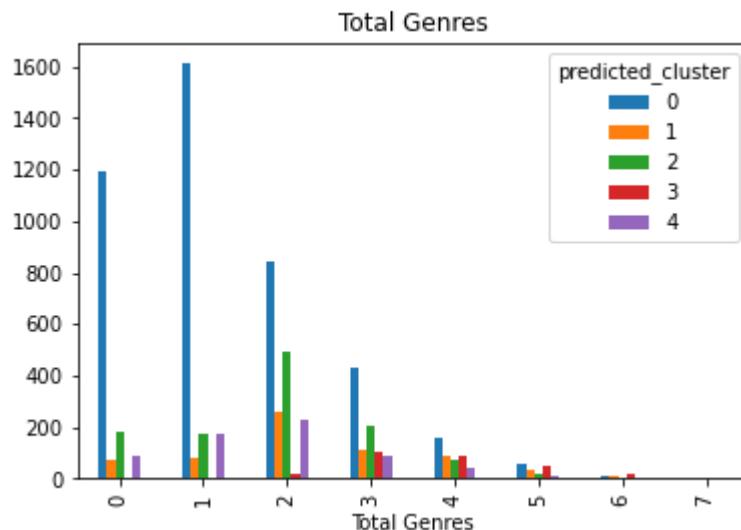
	predicted_cluster	0	1	2	3	4
Prime Video	0	896	543	262	228	356
	1	3416	122	884	54	285
	predicted_cluster	0	1	2	3	4
Prime Video	0	0.207792	0.816541	0.228621	0.808511	0.555382
	1	0.792208	0.183459	0.771379	0.191489	0.444618



predicted_cluster	0	1	2	3	4
Disney+					
0	4281	282	1131	223	640
1	31	383	15	59	1
predicted_cluster	0	1	2	3	4
Disney+					
0	0.992811	0.42406	0.986911	0.79078	0.99844
1	0.007189	0.57594	0.013089	0.20922	0.00156

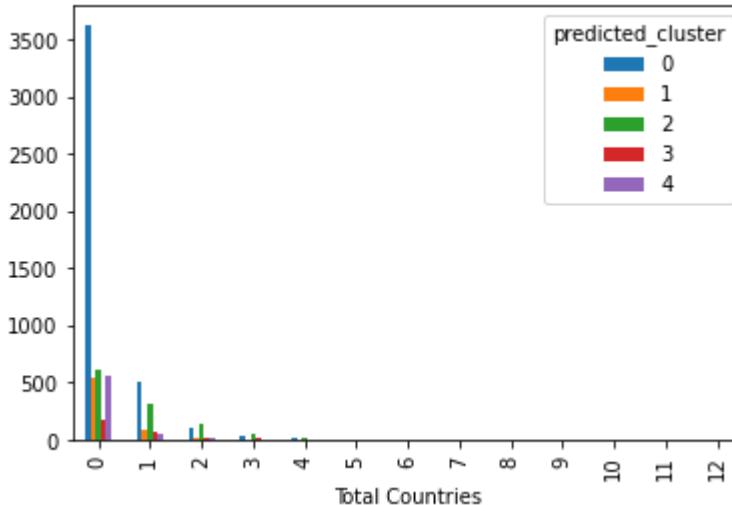


predicted_cluster	0	1	2	3	4
Total Genres					
0	1194	74	184	0	90
1	1610	83	173	4	178
2	846	256	495	15	232
3	433	115	202	104	87
4	158	92	71	85	43
5	58	35	15	48	9
6	9	9	5	19	2
7	4	1	1	7	0
predicted_cluster	0	1	2	3	4
Total Genres					
0	0.276902	0.111278	0.160558	0.000000	0.140406
1	0.373377	0.124812	0.150960	0.014184	0.277691
2	0.196197	0.384962	0.431937	0.053191	0.361934
3	0.100417	0.172932	0.176265	0.368794	0.135725
4	0.036642	0.138346	0.061955	0.301418	0.067083
5	0.013451	0.052632	0.013089	0.170213	0.014041
6	0.002087	0.013534	0.004363	0.067376	0.003120
7	0.000928	0.001504	0.000873	0.024823	0.000000



predicted_cluster	0	1	2	3	4
Total Countries					
0	3623	548	612	175	564
1	515	90	317	67	52
2	112	16	133	22	17
3	44	6	47	11	3
4	10	3	22	3	2
5	4	0	8	2	3
6	3	0	3	2	0
7	0	1	0	0	0
8	0	0	2	0	0
9	0	0	1	0	0
10	0	1	0	0	0
11	1	0	0	0	0
12	0	0	1	0	0
predicted_cluster	0	1	2	3	4
Total Countries					
0	0.840213	0.824060	0.534031	0.620567	0.879875
1	0.119434	0.135338	0.276614	0.237589	0.081123
2	0.025974	0.024060	0.116056	0.078014	0.026521
3	0.010204	0.009023	0.041012	0.039007	0.004680
4	0.002319	0.004511	0.019197	0.010638	0.003120
5	0.000928	0.000000	0.006981	0.007092	0.004680
6	0.000696	0.000000	0.002618	0.007092	0.000000
7	0.000000	0.001504	0.000000	0.000000	0.000000
8	0.000000	0.000000	0.001745	0.000000	0.000000
9	0.000000	0.000000	0.000873	0.000000	0.000000
10	0.000000	0.001504	0.000000	0.000000	0.000000
11	0.000232	0.000000	0.000000	0.000000	0.000000
12	0.000000	0.000000	0.000873	0.000000	0.000000

Total Countries



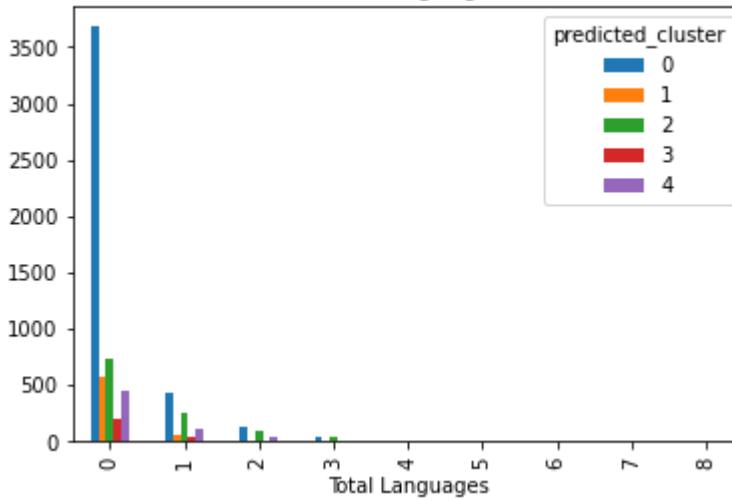
predicted_cluster
Total Languages

	0	1	2	3	4
0	3678	571	736	211	456
1	436	67	250	47	118
2	131	15	101	15	42
3	42	7	40	6	15
4	16	2	14	2	5
5	6	2	2	1	1
6	2	0	2	0	1
7	1	1	1	0	2
8	0	0	0	0	1

predicted_cluster
Total Languages

	0	1	2	3	4
0	0.852968	0.858647	0.642234	0.748227	0.711388
1	0.101113	0.100752	0.218150	0.166667	0.184087
2	0.030380	0.022556	0.088133	0.053191	0.065523
3	0.009740	0.010526	0.034904	0.021277	0.023401
4	0.003711	0.003008	0.012216	0.007092	0.007800
5	0.001391	0.003008	0.001745	0.003546	0.001560
6	0.000464	0.000000	0.001745	0.000000	0.001560
7	0.000232	0.001504	0.000873	0.000000	0.003120
8	0.000000	0.000000	0.000000	0.000000	0.001560

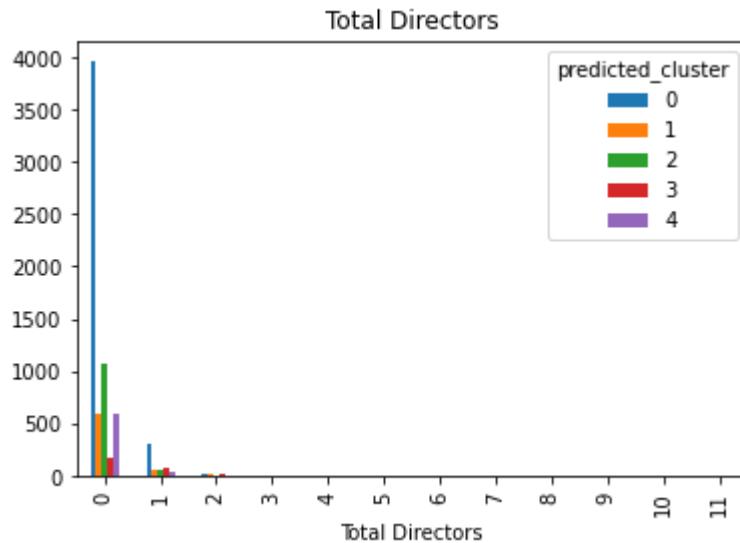
Total Languages



predicted_cluster
Total Directors

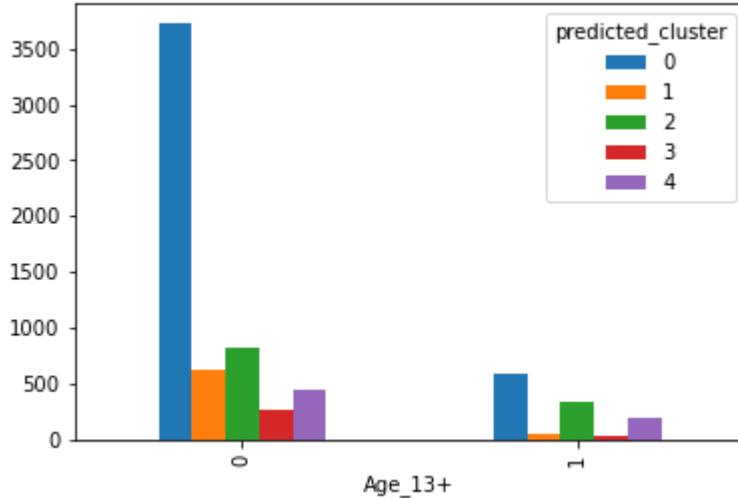
	0	1	2	3	4
0	3961	585	1074	174	597
1	314	58	62	79	36
2	24	12	8	21	4

3	5	3	0	3	2
4	0	3	0	2	1
5	0	1	0	0	0
6	1	2	0	1	0
7	1	1	0	0	0
8	0	0	0	1	0
9	2	0	0	0	1
10	1	0	1	1	0
11	3	0	1	0	0
predicted_cluster	0	1	2	3	4
Total Directors					
0	0.918599	0.879699	0.937173	0.617021	0.931357
1	0.072820	0.087218	0.054101	0.280142	0.056162
2	0.005566	0.018045	0.006981	0.074468	0.006240
3	0.001160	0.004511	0.000000	0.010638	0.003120
4	0.000000	0.004511	0.000000	0.007092	0.001560
5	0.000000	0.001504	0.000000	0.000000	0.000000
6	0.000232	0.003008	0.000000	0.003546	0.000000
7	0.000232	0.001504	0.000000	0.000000	0.000000
8	0.000000	0.000000	0.000000	0.003546	0.000000
9	0.000464	0.000000	0.000000	0.000000	0.001560
10	0.000232	0.000000	0.000873	0.003546	0.000000
11	0.000696	0.000000	0.000873	0.000000	0.000000



predicted_cluster	0	1	2	3	4
<i>Age_13+</i>					
0	3721	617	809	259	448
1	591	48	337	23	193
<i>predicted_cluster</i>					
0	0	1	2	3	4
<i>Age_13+</i>					
0	0.862941	0.92782	0.705934	0.91844	0.698908
1	0.137059	0.07218	0.294066	0.08156	0.301092

Age_13+



predicted_cluster

0 1 2 3 4

Age_16+

0	4114	652	1080	280	615
1	198	13	66	2	26

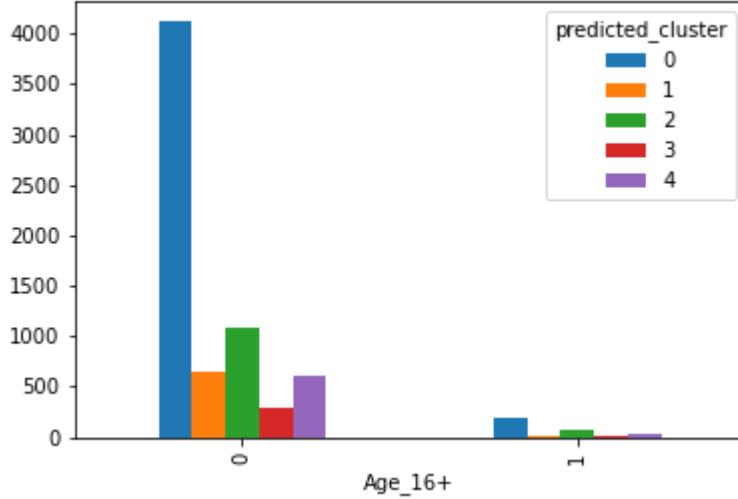
predicted_cluster

0 1 2 3 4

Age_16+

0	0.954082	0.980451	0.942408	0.992908	0.959438
1	0.045918	0.019549	0.057592	0.007092	0.040562

Age_16+



predicted_cluster

0 1 2 3 4

Age_18+

0	1535	662	734	281	471
1	2777	3	412	1	170

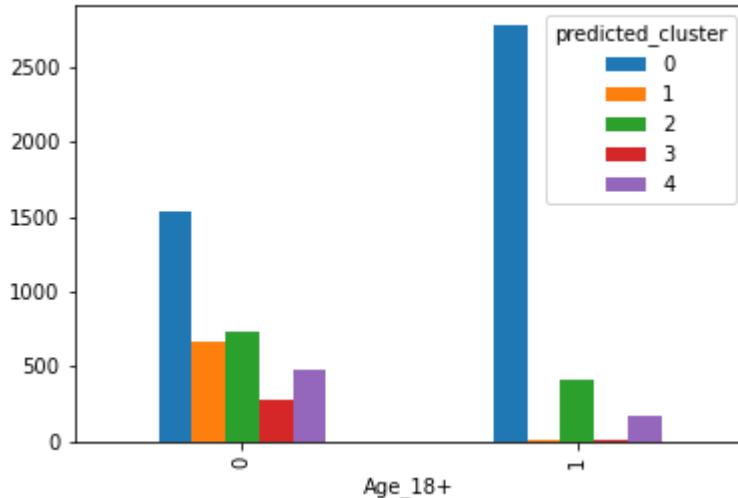
predicted_cluster

0 1 2 3 4

Age_18+

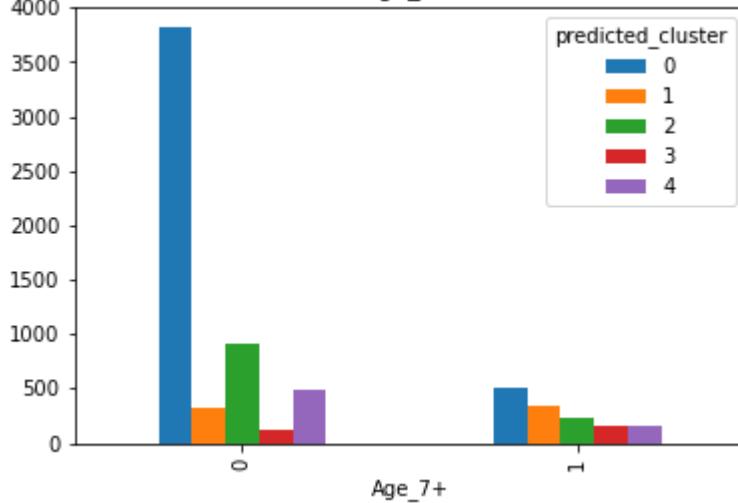
0	0.355983	0.995489	0.640489	0.996454	0.734789
1	0.644017	0.004511	0.359511	0.003546	0.265211

Age_18+

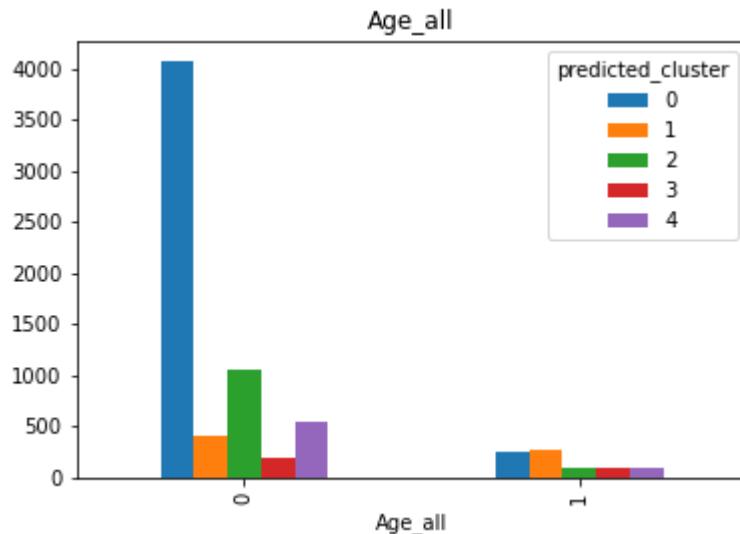


predicted_cluster	0	1	2	3	4
Age_7+	3812	323	913	121	481
1	500	342	233	161	160
predicted_cluster	0	1	2	3	4
Age_7+	0.884045	0.485714	0.796684	0.429078	0.75039
1	0.115955	0.514286	0.203316	0.570922	0.24961

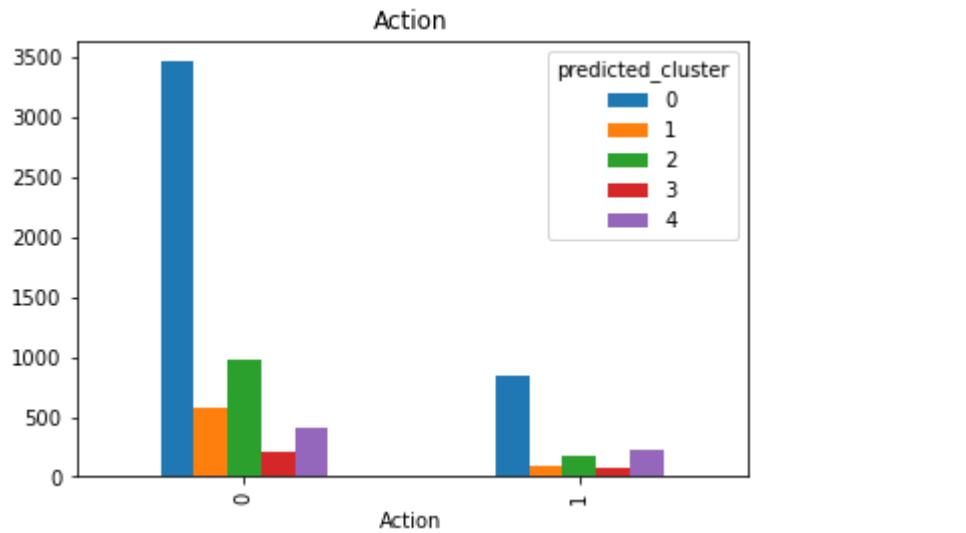
Age_7+



predicted_cluster	0	1	2	3	4
Age_all	4066	406	1048	187	549
1	246	259	98	95	92
predicted_cluster	0	1	2	3	4
Age_all	0.94295	0.610526	0.914485	0.663121	0.856474
1	0.05705	0.389474	0.085515	0.336879	0.143526

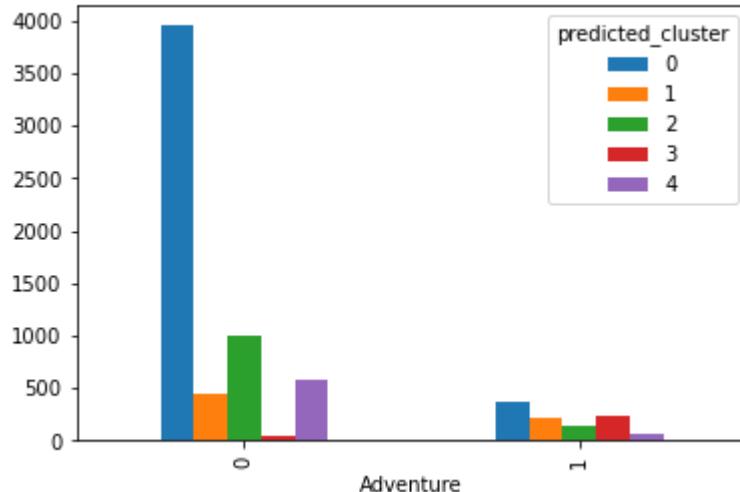


predicted_cluster	0	1	2	3	4
Action	0.802876	0.864662	0.854276	0.758865	0.638066
1	0.197124	0.135338	0.145724	0.241135	0.361934



predicted_cluster	0	1	2	3	4
Adventure	3948	452	998	51	581
1	364	213	148	231	60
predicted_cluster	0	1	2	3	4
Adventure	0.915584	0.679699	0.870855	0.180851	0.906396
1	0.084416	0.320301	0.129145	0.819149	0.093604

Adventure



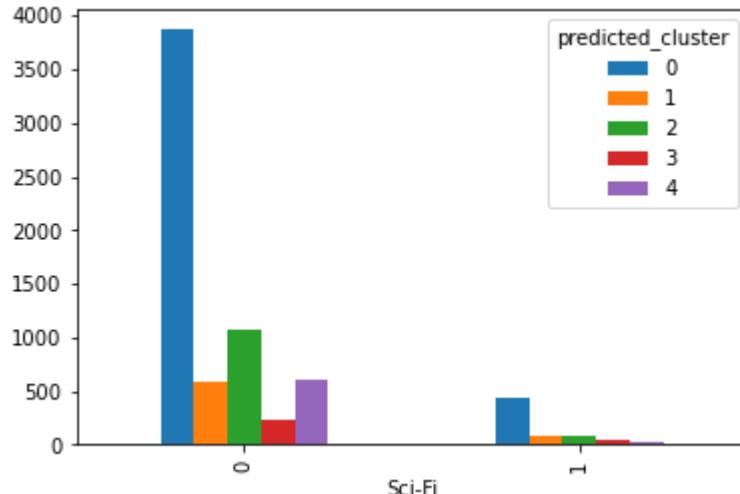
predicted_cluster
Sci-Fi

	0	1	2	3	4
0	3866	581	1072	236	609
1	446	84	74	46	32

predicted_cluster
Sci-Fi

	0	1	2	3	4
0	0.896568	0.873684	0.935428	0.836879	0.950078
1	0.103432	0.126316	0.064572	0.163121	0.049922

Sci-Fi



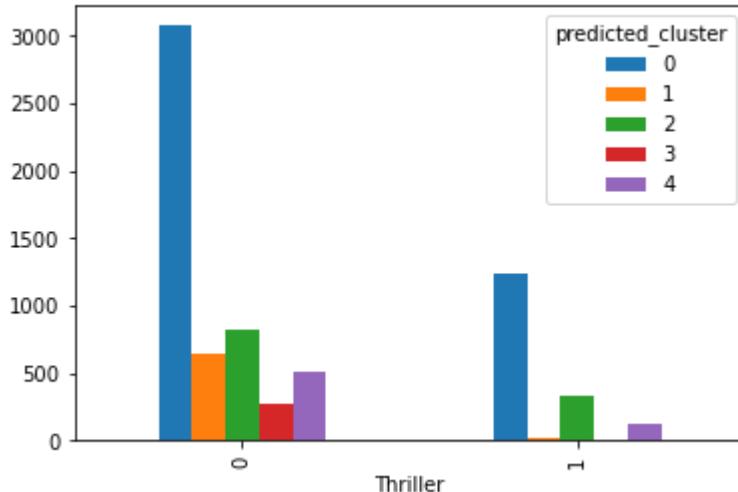
predicted_cluster
Thriller

	0	1	2	3	4
0	3076	643	819	274	510
1	1236	22	327	8	131

predicted_cluster
Thriller

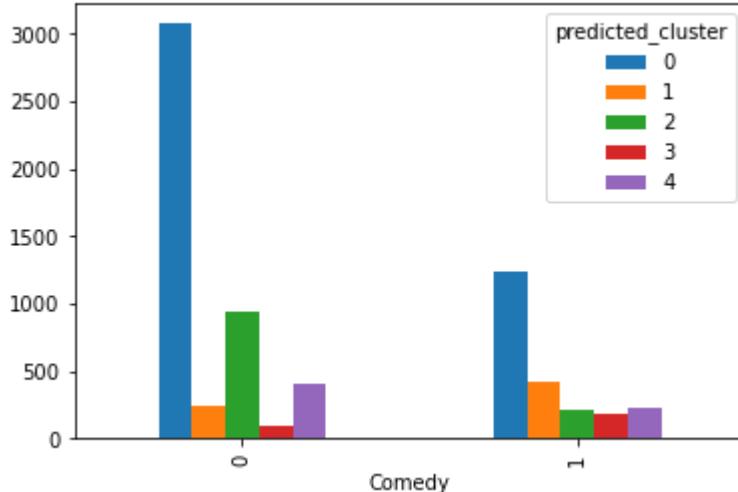
	0	1	2	3	4
0	0.713358	0.966917	0.71466	0.971631	0.795632
1	0.286642	0.033083	0.28534	0.028369	0.204368

Thriller



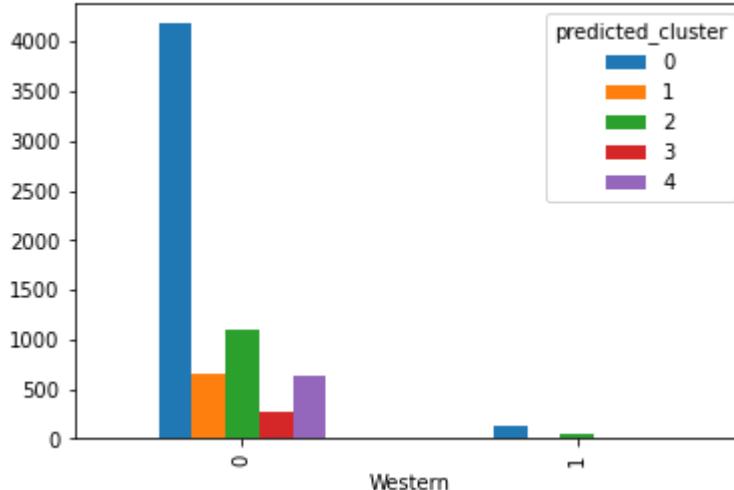
predicted_cluster	0	1	2	3	4
Comedy					
0	3076	238	935	95	411
1	1236	427	211	187	230
predicted_cluster	0	1	2	3	4
Comedy					
0	0.713358	0.357895	0.815881	0.336879	0.641186
1	0.286642	0.642105	0.184119	0.663121	0.358814

Comedy



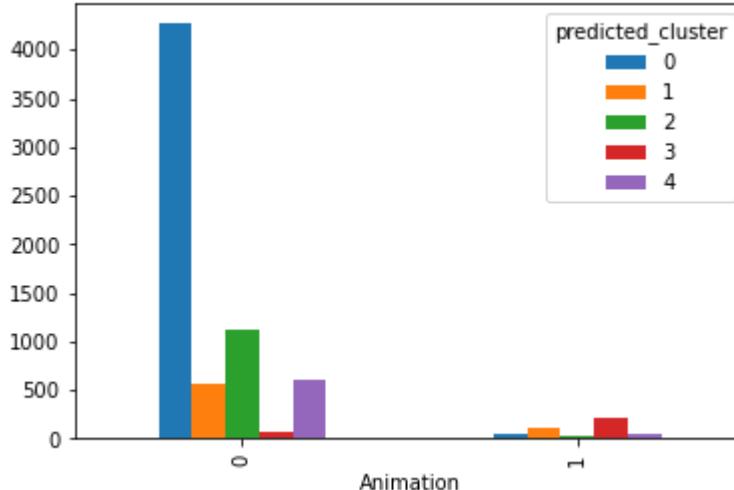
predicted_cluster	0	1	2	3	4
Western					
0	4179	650	1106	277	639
1	133	15	40	5	2
predicted_cluster	0	1	2	3	4
Western					
0	0.969156	0.977444	0.965096	0.98227	0.99688
1	0.030844	0.022556	0.034904	0.01773	0.00312

Western



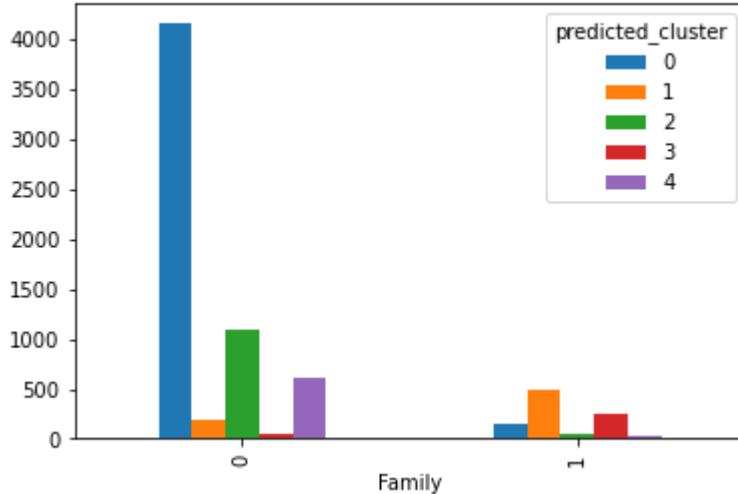
predicted_cluster	0	1	2	3	4
Animation	4266	561	1122	63	597
Family	46	104	24	219	44
predicted_cluster	0	1	2	3	4
Animation	0.989332	0.843609	0.979058	0.223404	0.931357
Family	0.010668	0.156391	0.020942	0.776596	0.068643

Animation



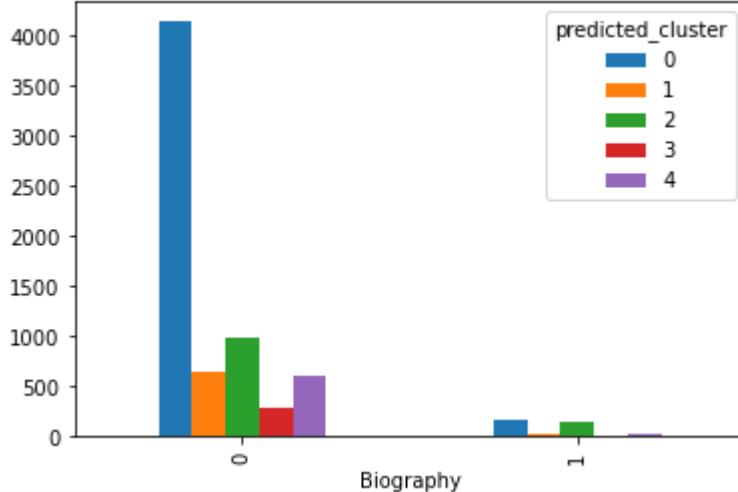
predicted_cluster	0	1	2	3	4
Animation	4266	561	1122	63	597
Family	46	104	24	219	44
predicted_cluster	0	1	2	3	4
Animation	0.989332	0.843609	0.979058	0.223404	0.931357
Family	0.010668	0.156391	0.020942	0.776596	0.068643

Family



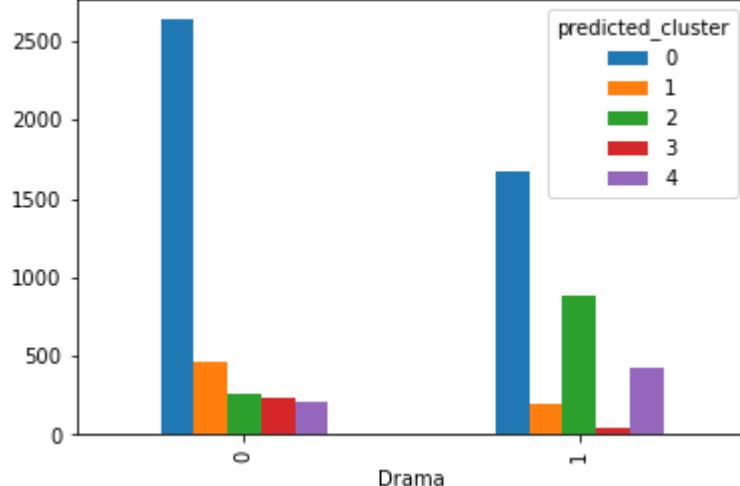
predicted_cluster	0	1	2	3	4
Biography	4141	645	997	281	607
0	171	20	149	1	34
predicted_cluster	0	1	2	3	4
Biography	0.960343	0.969925	0.869983	0.996454	0.946958
1	0.039657	0.030075	0.130017	0.003546	0.053042

Biography



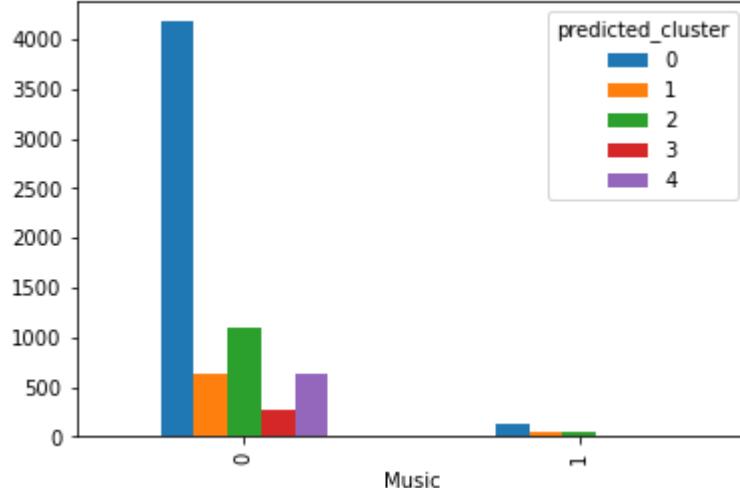
predicted_cluster	0	1	2	3	4
Drama	2635	466	263	239	213
0	1677	199	883	43	428
predicted_cluster	0	1	2	3	4
Drama	0.611085	0.700752	0.229494	0.847518	0.332293
1	0.388915	0.299248	0.770506	0.152482	0.667707

Drama



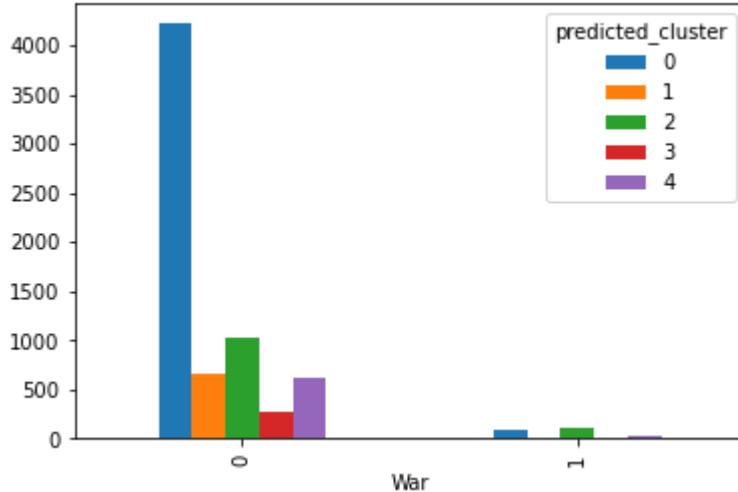
predicted_cluster	0	1	2	3	4
Music					
0	4175	624	1089	275	630
1	137	41	57	7	11
predicted_cluster	0	1	2	3	4
Music					
0	0.968228	0.938346	0.950262	0.975177	0.982839
1	0.031772	0.061654	0.049738	0.024823	0.017161

Music



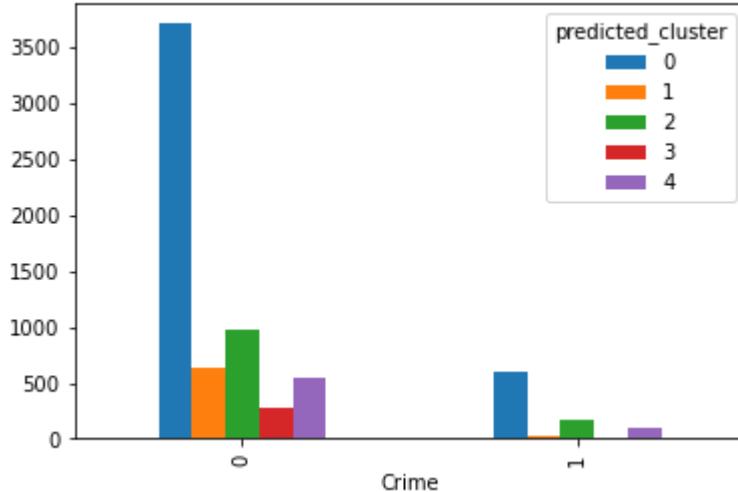
predicted_cluster	0	1	2	3	4
War					
0	4220	660	1036	281	614
1	92	5	110	1	27
predicted_cluster	0	1	2	3	4
War					
0	0.978664	0.992481	0.904014	0.996454	0.957878
1	0.021336	0.007519	0.095986	0.003546	0.042122

War



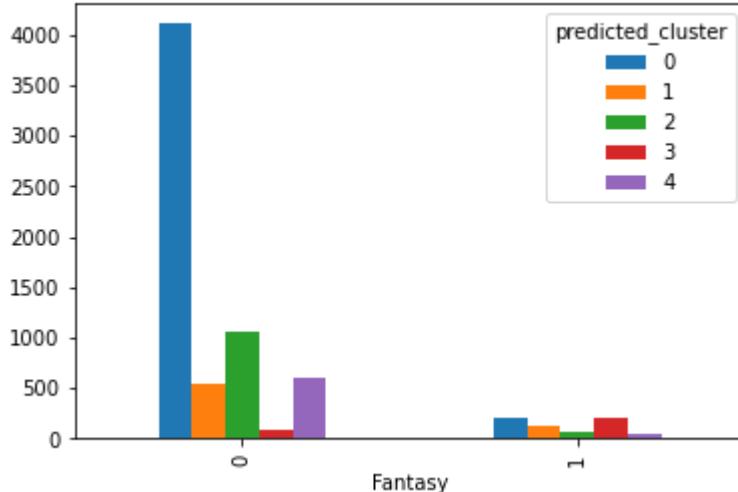
	predicted_cluster	0	1	2	3	4
Crime	predicted_cluster	0	1	2	3	4
0	0	3709	633	976	273	548
1	1	603	32	170	9	93
predicted_cluster	0	1	2	3	4	
Crime	0	0.860158	0.95188	0.851658	0.968085	0.854914
1	1	0.139842	0.04812	0.148342	0.031915	0.145086

Crime



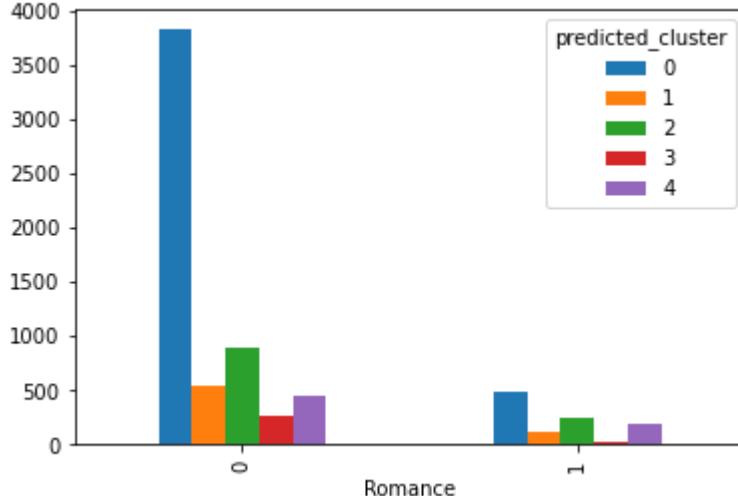
	predicted_cluster	0	1	2	3	4
Fantasy	predicted_cluster	0	1	2	3	4
0	0	4107	534	1069	80	596
1	1	205	131	77	202	45
predicted_cluster	0	1	2	3	4	
Fantasy	0	0.952458	0.803008	0.93281	0.283688	0.929797
1	1	0.047542	0.196992	0.06719	0.716312	0.070203

Fantasy



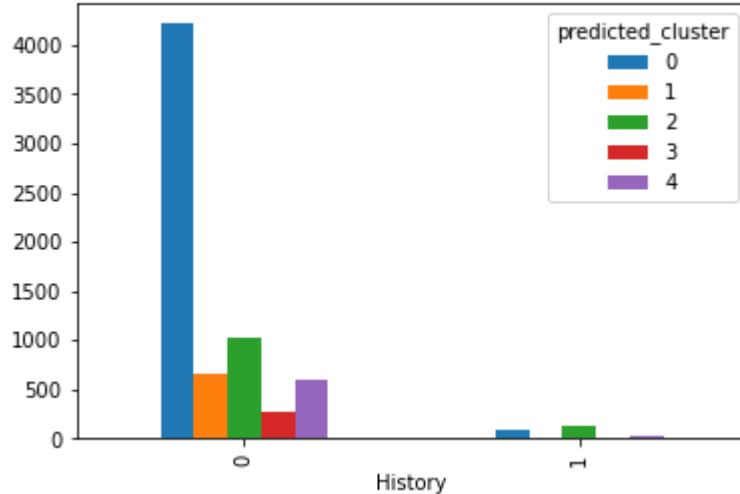
predicted_cluster	0	1	2	3	4
Romance					
0	3821	552	902	260	455
1	491	113	244	22	186
predicted_cluster	0	1	2	3	4
Romance					
0	0.886132	0.830075	0.787086	0.921986	0.709828
1	0.113868	0.169925	0.212914	0.078014	0.290172

Romance



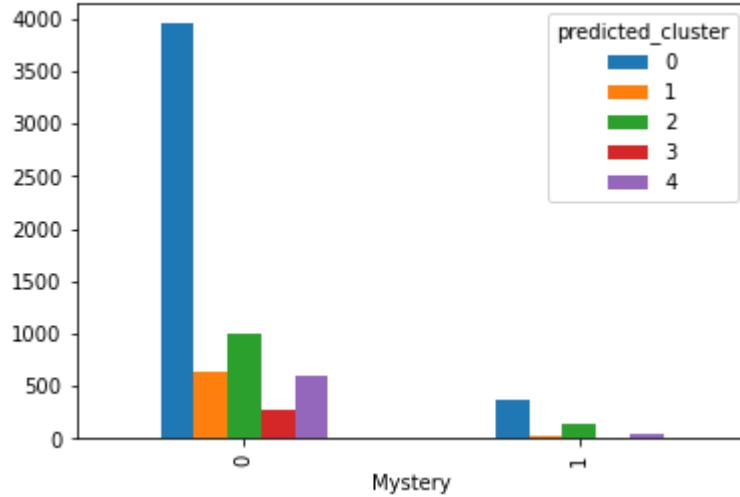
predicted_cluster	0	1	2	3	4
History					
0	4213	657	1021	281	607
1	99	8	125	1	34
predicted_cluster	0	1	2	3	4
History					
0	0.977041	0.98797	0.890925	0.996454	0.946958
1	0.022959	0.01203	0.109075	0.003546	0.053042

History



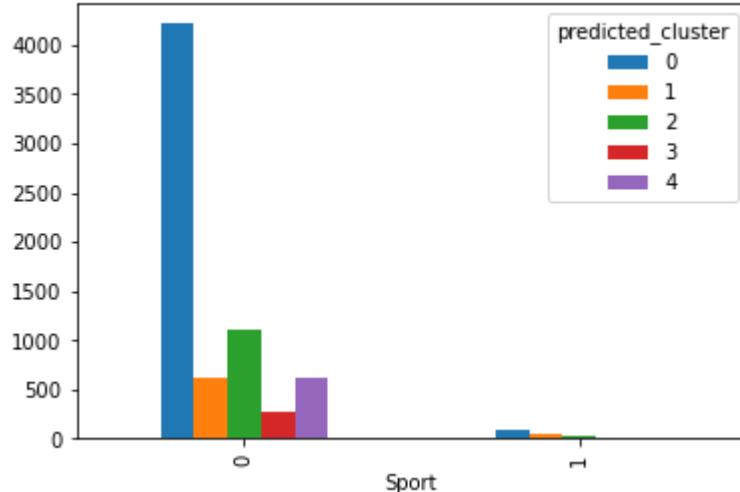
predicted_cluster	0	1	2	3	4
Mystery	3949	639	1002	267	600
1	363	26	144	15	41
predicted_cluster	0	1	2	3	4
Mystery	0.915816	0.960902	0.874346	0.946809	0.936037
1	0.084184	0.039098	0.125654	0.053191	0.063963

Mystery



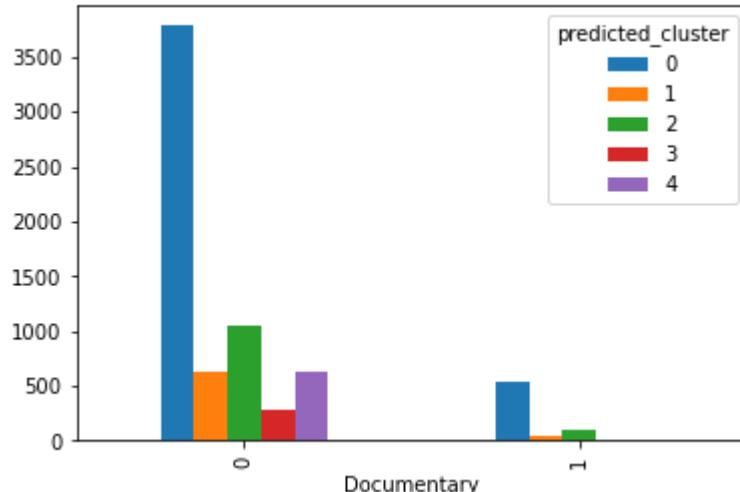
predicted_cluster	0	1	2	3	4
Sport	4215	615	1108	281	623
1	97	50	38	1	18
predicted_cluster	0	1	2	3	4
Sport	0.977505	0.924812	0.966841	0.996454	0.971919
1	0.022495	0.075188	0.033159	0.003546	0.028081

Sport

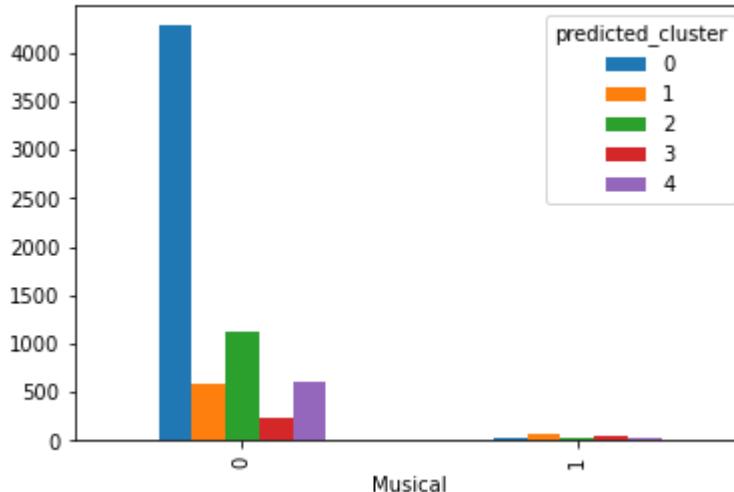


predicted_cluster	0	1	2	3	4
Documentary					
0	3782	624	1040	282	628
1	530	41	106	0	13
predicted_cluster	0	1	2	3	4
Documentary					
0	0.877087	0.938346	0.907504	1.0	0.979719
1	0.122913	0.061654	0.092496	0.0	0.020281

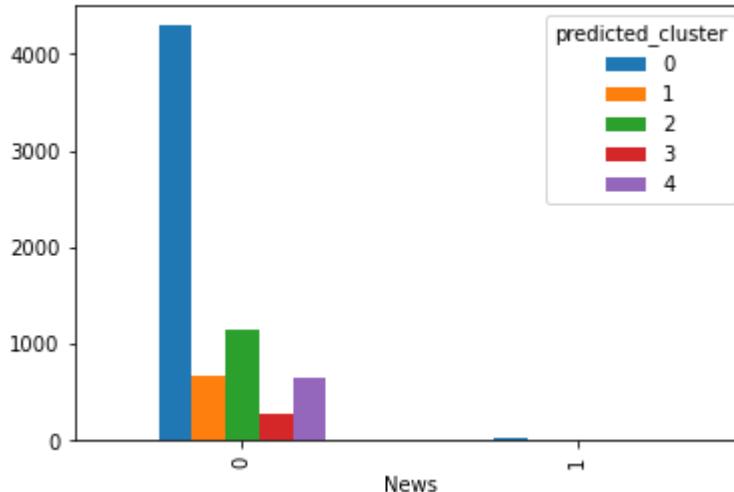
Documentary



predicted_cluster	0	1	2	3	4
Musical					
0	4279	592	1123	239	609
1	33	73	23	43	32
predicted_cluster	0	1	2	3	4
Musical					
0	0.992347	0.890226	0.97993	0.847518	0.950078
1	0.007653	0.109774	0.02007	0.152482	0.049922

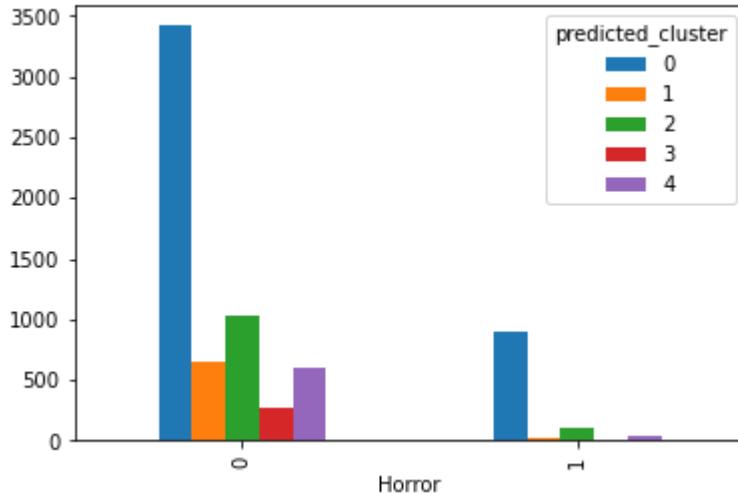
Musical

predicted_cluster	0	1	2	3	4
News	4290	664	1140	282	641
1	22	1	6	0	0
predicted_cluster	0	1	2	3	4
News	0.994898	0.998496	0.994764	1.0	1.0
1	0.005102	0.001504	0.005236	0.0	0.0

News

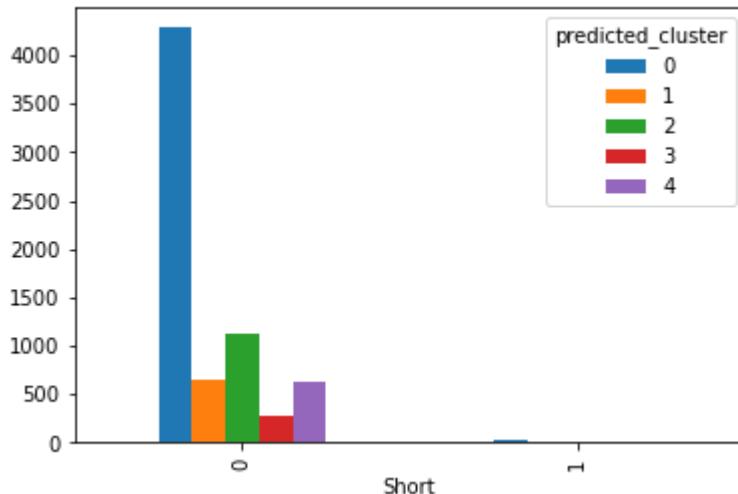
predicted_cluster	0	1	2	3	4
Horror	3417	646	1032	275	600
1	895	19	114	7	41
predicted_cluster	0	1	2	3	4
Horror	0.79244	0.971429	0.900524	0.975177	0.936037
1	0.20756	0.028571	0.099476	0.024823	0.063963

Horror



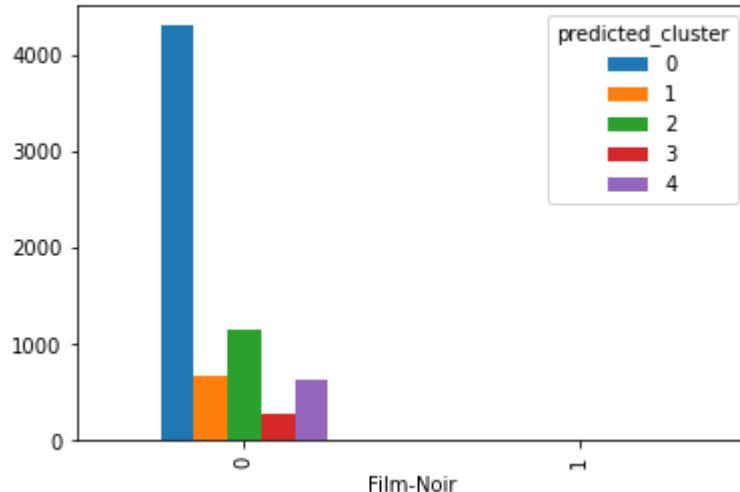
predicted_cluster	0	1	2	3	4
Short	4282	652	1130	270	639
1	30	13	16	12	2
predicted_cluster	0	1	2	3	4
Short	0.993043	0.980451	0.986038	0.957447	0.99688
1	0.006957	0.019549	0.013962	0.042553	0.00312

Short



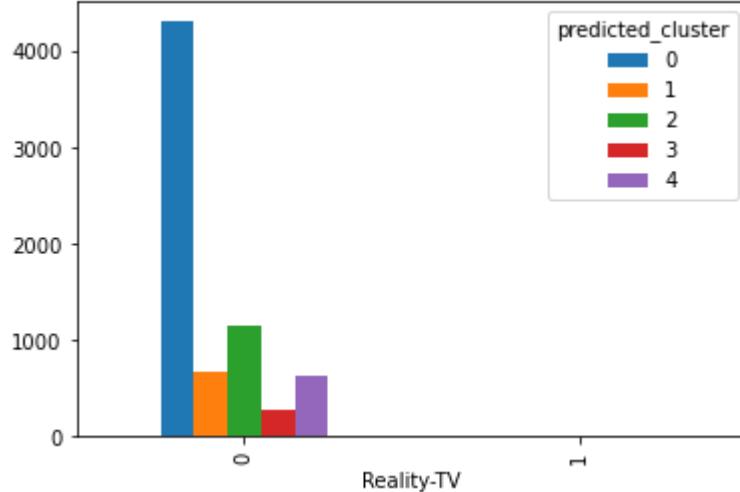
predicted_cluster	0	1	2	3	4
Film-Noir	4306	665	1146	282	641
1	6	0	0	0	0
predicted_cluster	0	1	2	3	4
Film-Noir	0.998609	1.0	1.0	1.0	1.0
1	0.001391	0.0	0.0	0.0	0.0

Film-Noir



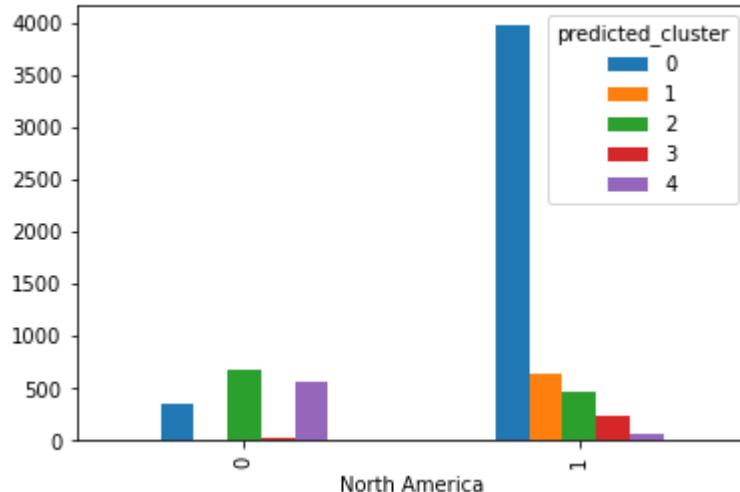
predicted_cluster	0	1	2	3	4
Reality-TV					
0	4311	665	1146	282	641
1	1	0	0	0	0
predicted_cluster	0	1	2	3	4
Reality-TV					
0	0.999768	1.0	1.0	1.0	1.0
1	0.000232	0.0	0.0	0.0	0.0

Reality-TV



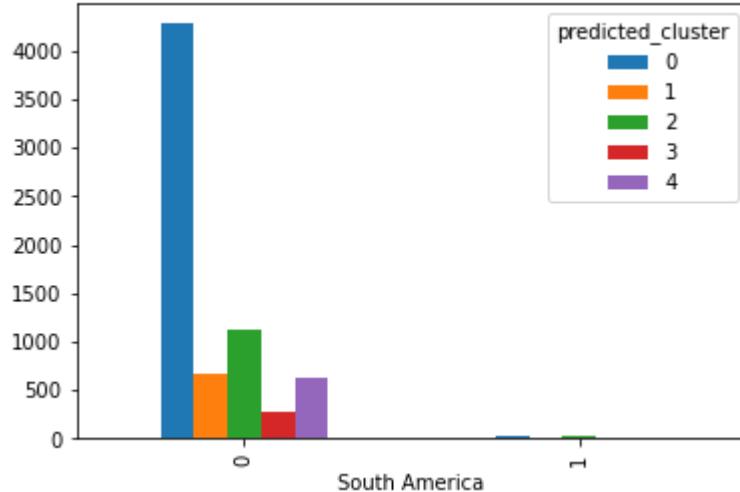
predicted_cluster	0	1	2	3	4
North America					
0	345	17	678	35	572
1	3967	648	468	247	69
predicted_cluster	0	1	2	3	4
North America					
0	0.080009	0.025564	0.591623	0.124113	0.892356
1	0.919991	0.974436	0.408377	0.875887	0.107644

North America



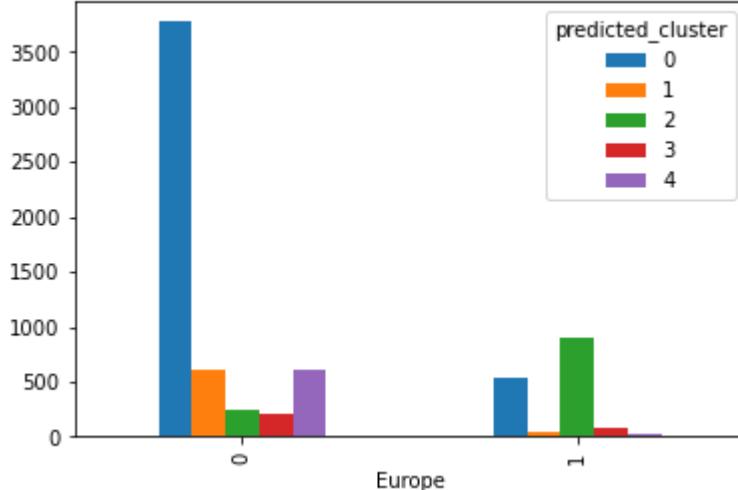
predicted_cluster	0	1	2	3	4
South America					
0	4274	665	1125	280	635
1	38	0	21	2	6
predicted_cluster	0	1	2	3	4
South America					
0	0.991187	1.0	0.981675	0.992908	0.99064
1	0.008813	0.0	0.018325	0.007092	0.00936

South America



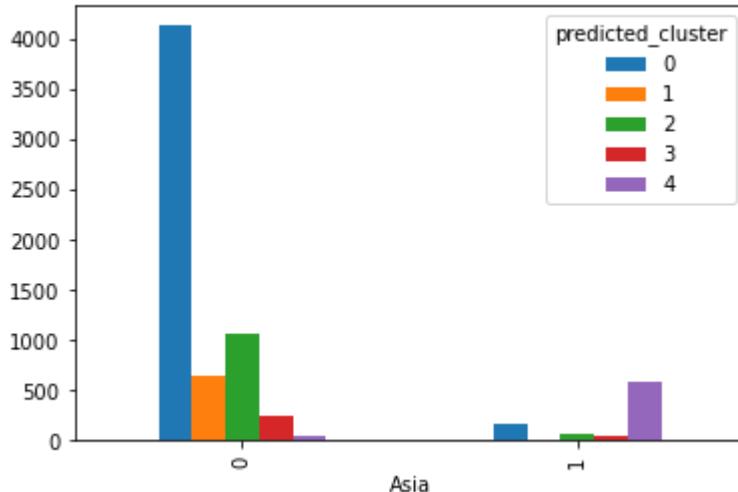
predicted_cluster	0	1	2	3	4
Europe					
0	3774	613	250	206	616
1	538	52	896	76	25
predicted_cluster	0	1	2	3	4
Europe					
0	0.875232	0.921805	0.21815	0.730496	0.960998
1	0.124768	0.078195	0.78185	0.269504	0.039002

Europe

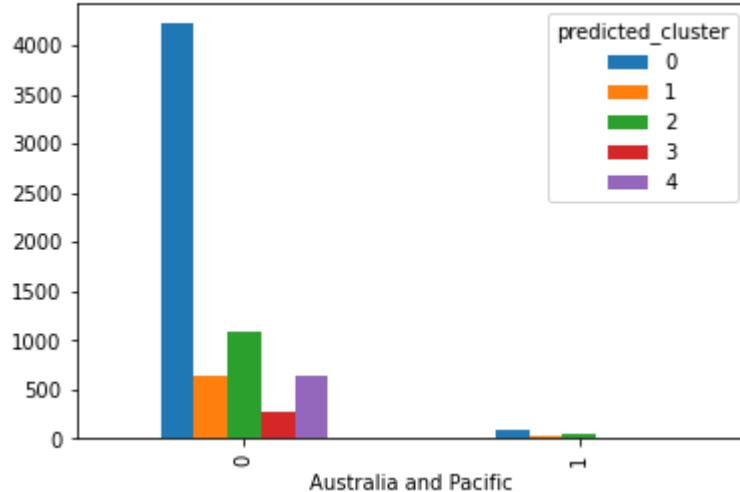


predicted_cluster	0	1	2	3	4
0	4137	650	1072	239	51
1	175	15	74	43	590
predicted_cluster	0	1	2	3	4
0	0.959416	0.977444	0.935428	0.847518	0.079563
1	0.040584	0.022556	0.064572	0.152482	0.920437

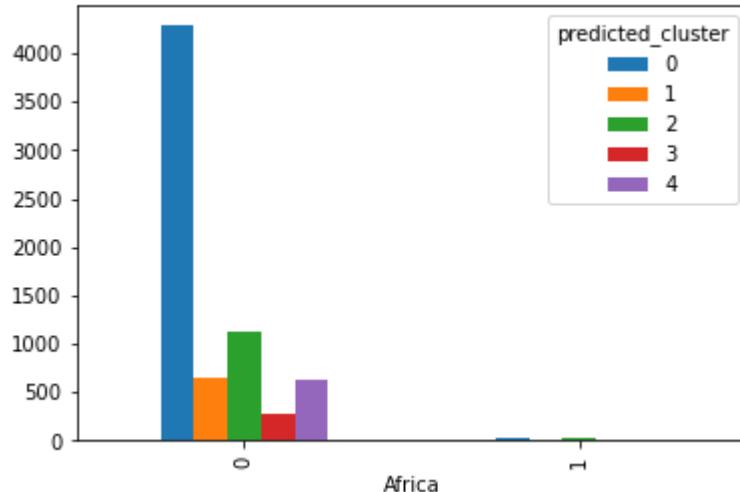
Asia



predicted_cluster	0	1	2	3	4
0	4217	644	1088	275	637
1	95	21	58	7	4
predicted_cluster	0	1	2	3	4
0	0.977968	0.968421	0.949389	0.975177	0.99376
1	0.022032	0.031579	0.050611	0.024823	0.00624

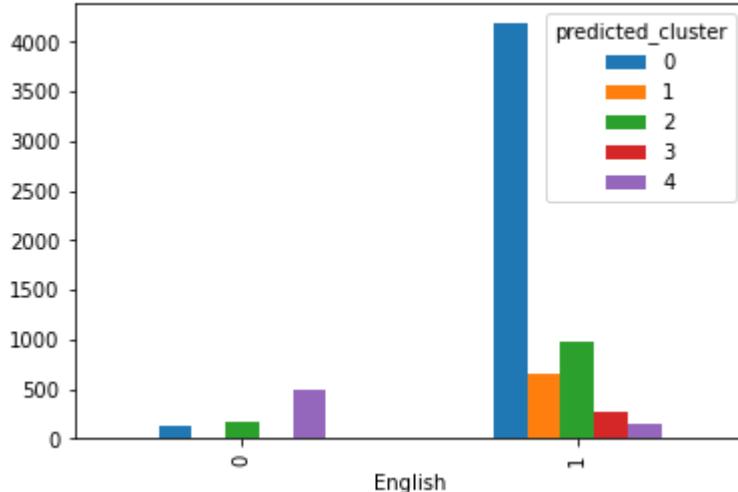
Australia and Pacific

predicted_cluster	0	1	2	3	4
Africa	4282	660	1122	281	639
0	30	5	24	1	2
predicted_cluster	0	1	2	3	4
Africa	0.993043	0.992481	0.979058	0.996454	0.99688
0	0.006957	0.007519	0.020942	0.003546	0.00312

Africa

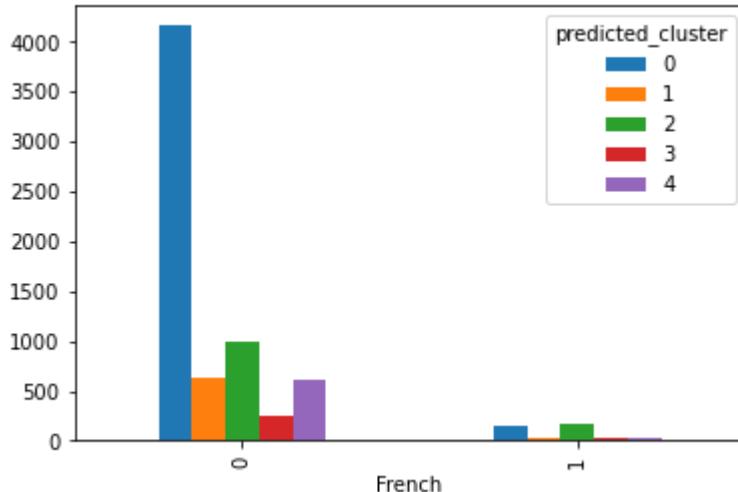
predicted_cluster	0	1	2	3	4
English	129	7	177	17	497
0	4183	658	969	265	144
predicted_cluster	0	1	2	3	4
English	0.029917	0.010526	0.15445	0.060284	0.775351
0	0.970083	0.989474	0.84555	0.939716	0.224649

English



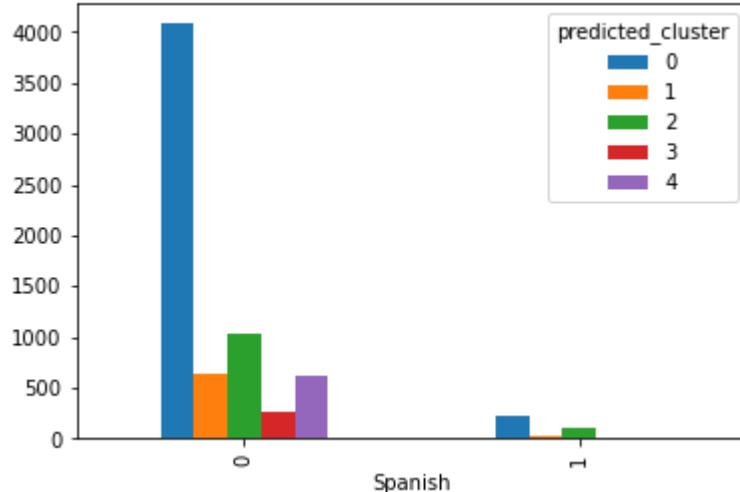
predicted_cluster	0	1	2	3	4
French	4161	641	986	254	620
0	151	24	160	28	21
predicted_cluster	0	1	2	3	4
French	0.964981	0.96391	0.860384	0.900709	0.967239
0	0.035019	0.03609	0.139616	0.099291	0.032761

French



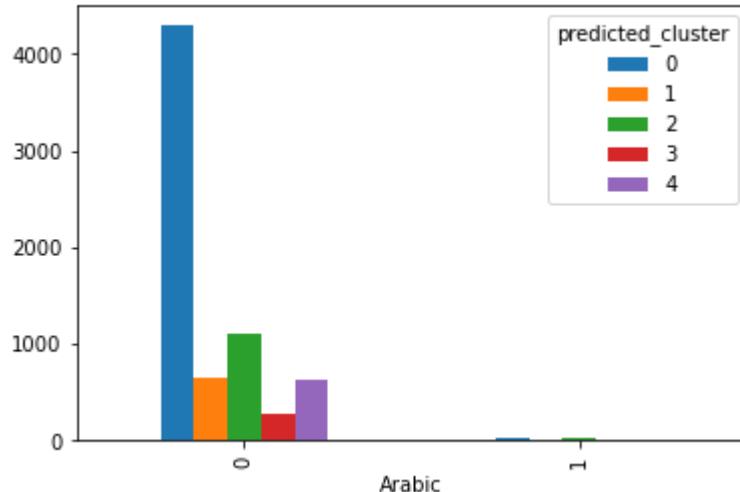
predicted_cluster	0	1	2	3	4
Spanish	4079	636	1032	264	626
0	233	29	114	18	15
predicted_cluster	0	1	2	3	4
Spanish	0.945965	0.956391	0.900524	0.93617	0.976599
0	0.054035	0.043609	0.099476	0.06383	0.023401

Spanish



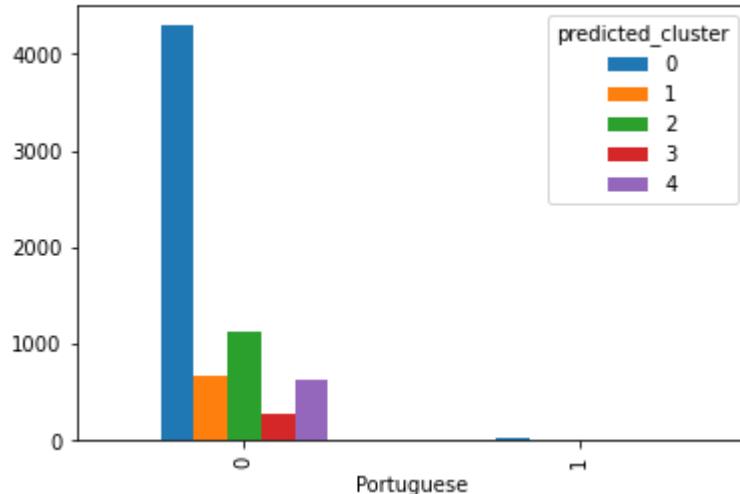
predicted_cluster	0	1	2	3	4
Arabic					
0	4289	661	1113	281	631
1	23	4	33	1	10
predicted_cluster	0	1	2	3	4
Arabic					
0	0.994666	0.993985	0.971204	0.996454	0.984399
1	0.005334	0.006015	0.028796	0.003546	0.015601

Arabic



predicted_cluster	0	1	2	3	4
Portuguese					
0	4292	663	1134	279	637
1	20	2	12	3	4
predicted_cluster	0	1	2	3	4
Portuguese					
0	0.995362	0.996992	0.989529	0.989362	0.99376
1	0.004638	0.003008	0.010471	0.010638	0.00624

Portuguese



predicted_cluster 0 1 2 3 4

North American

0	4299	665	1144	280	640
1	13	0	2	2	1

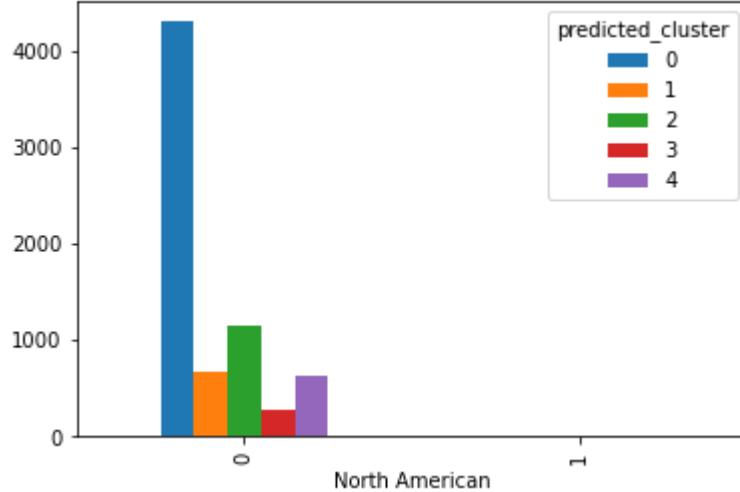
predicted_cluster

0	0	1	2	3	4
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North American

0	0.996985	1.0	0.998255	0.992908	0.99844
1	0.003015	0.0	0.001745	0.007092	0.00156

North American



predicted_cluster 0 1 2 3 4

South American

0	4311	665	1142	282	641
1	1	0	4	0	0

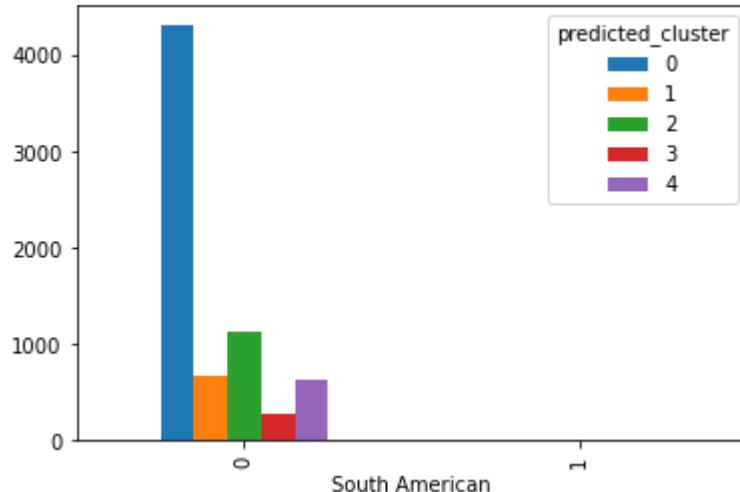
predicted_cluster

0	0	1	2	3	4
---	---	---	---	---	---

South American

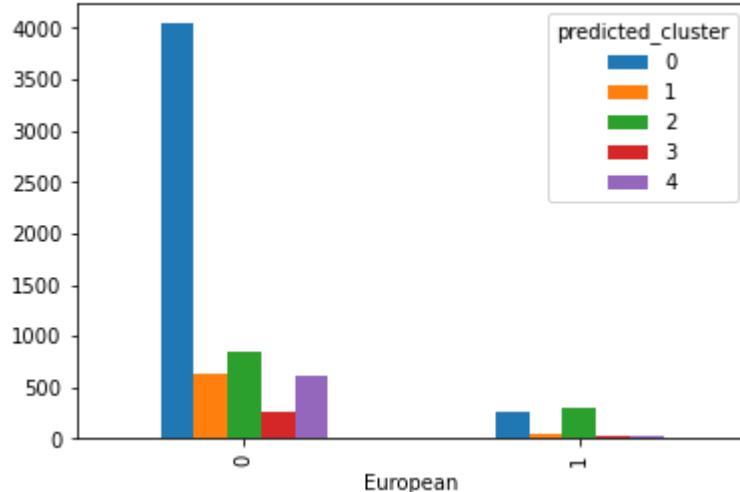
0	0.999768	1.0	0.99651	1.0	1.0
1	0.000232	0.0	0.00349	0.0	0.0

South American



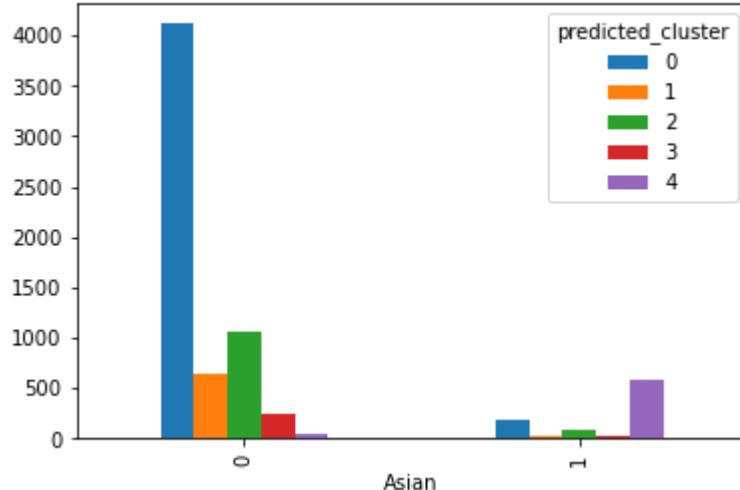
predicted_cluster	0	1	2	3	4
0	4042	625	851	253	616
1	270	40	295	29	25
predicted_cluster	0	1	2	3	4
0	0.937384	0.93985	0.742583	0.897163	0.960998
1	0.062616	0.06015	0.257417	0.102837	0.039002

European



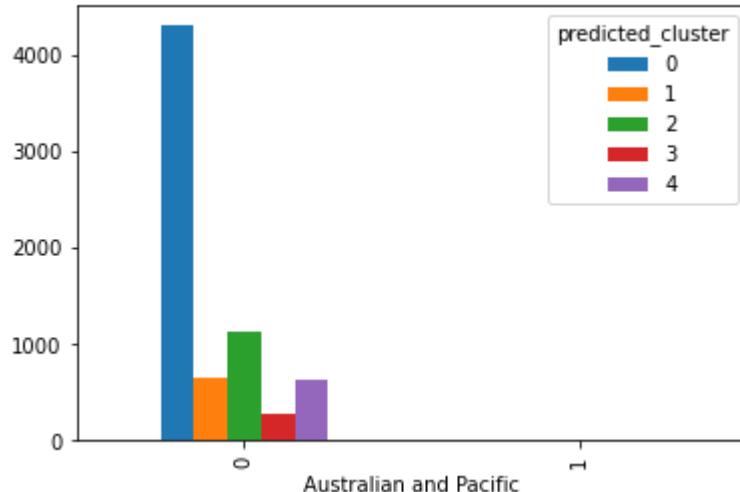
predicted_cluster	0	1	2	3	4
0	4115	644	1059	251	50
1	197	21	87	31	591
predicted_cluster	0	1	2	3	4
0	0.954314	0.968421	0.924084	0.890071	0.078003
1	0.045686	0.031579	0.075916	0.109929	0.921997

Asian



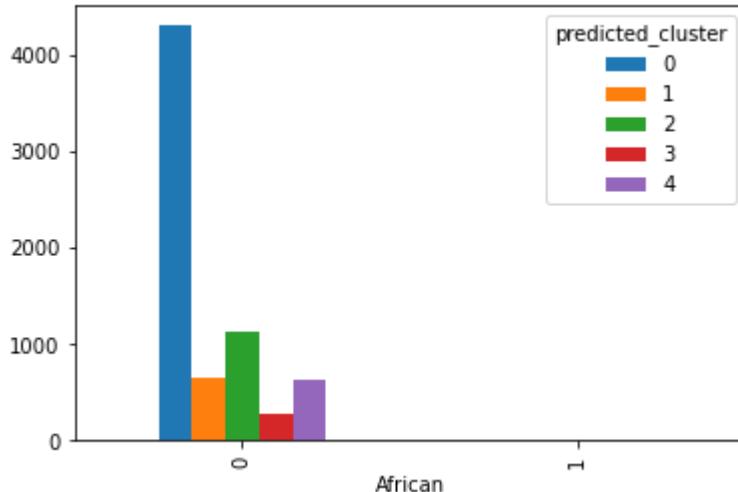
	0	1	2	3	4
Australian and Pacific					
0	4308	664	1140	281	641
1	4	1	6	1	0
	0	1	2	3	4
Australian and Pacific					
0	0.999072	0.998496	0.994764	0.996454	1.0
1	0.000928	0.001504	0.005236	0.003546	0.0

Australian and Pacific



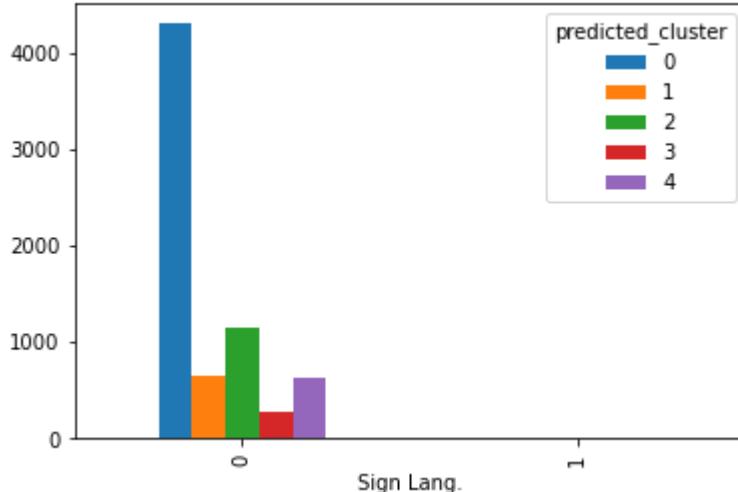
	0	1	2	3	4
African					
0	4304	661	1132	282	640
1	8	4	14	0	1
	0	1	2	3	4
African					
0	0.998145	0.993985	0.987784	1.0	0.99844
1	0.001855	0.006015	0.012216	0.0	0.00156

African



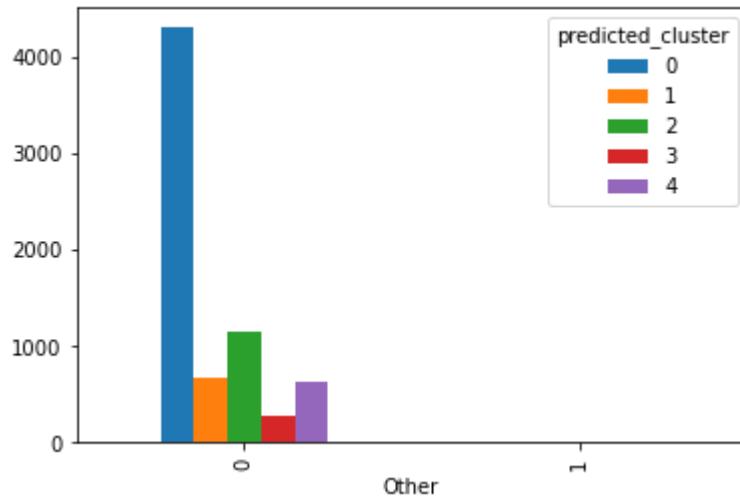
predicted_cluster	0	1	2	3	4
Sign Lang.	4295	661	1142	282	640
0	4295	661	1142	282	640
1	17	4	4	0	1
predicted_cluster	0	1	2	3	4
Sign Lang.	0.996058	0.993985	0.99651	1.0	0.99844
0	0.996058	0.993985	0.99651	1.0	0.99844
1	0.003942	0.006015	0.00349	0.0	0.00156

Sign Lang.



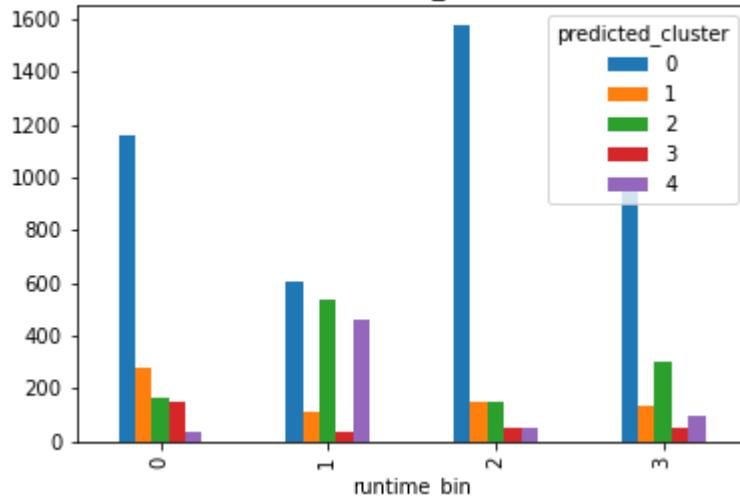
predicted_cluster	0	1	2	3	4
Other	4304	664	1143	282	641
0	4304	664	1143	282	641
1	8	1	3	0	0
predicted_cluster	0	1	2	3	4
Other	0	1	2	3	4
0	0.998145	0.998496	0.997382	1.0	1.0
1	0.001855	0.001504	0.002618	0.0	0.0

Other



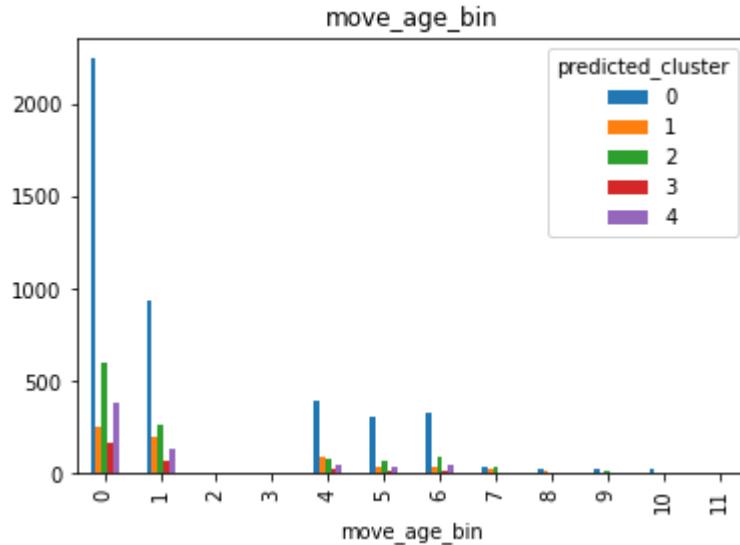
predicted_cluster	0	1	2	3	4
runtime_bin	1158	277	167	147	37
0	601	109	533	32	459
1	1574	148	145	50	53
2	979	131	301	53	92
predicted_cluster	0	1	2	3	4
runtime_bin	0.268553	0.416541	0.145724	0.521277	0.057722
0	0.139378	0.163910	0.465096	0.113475	0.716069
1	0.365028	0.222556	0.126527	0.177305	0.082683
2	0.227041	0.196992	0.262653	0.187943	0.143526

runtime_bin

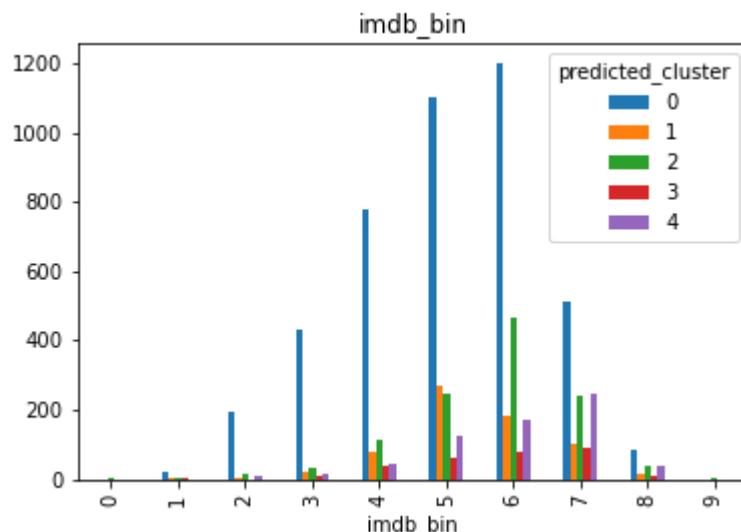


predicted_cluster	0	1	2	3	4
move_age_bin	2248	256	598	159	382
0	932	199	264	65	129
1	1	0	1	0	0
2	0	0	1	0	0
3	390	93	74	28	42
4	308	37	65	10	36
5	323	38	86	8	49
6	38	18	38	5	2
7	25	15	2	2	1
8	22	6	8	4	0
9	24	3	6	1	0
10	1	0	3	0	0
predicted_cluster	0	1	2	3	4
move_age_bin	0	0	0	0	0

0	0.521336	0.384962	0.521815	0.563830	0.595944
1	0.216141	0.299248	0.230366	0.230496	0.201248
2	0.000232	0.000000	0.000873	0.000000	0.000000
3	0.000000	0.000000	0.000873	0.000000	0.000000
4	0.090445	0.139850	0.064572	0.099291	0.065523
5	0.071429	0.055639	0.056719	0.035461	0.056162
6	0.074907	0.057143	0.075044	0.028369	0.076443
7	0.008813	0.027068	0.033159	0.017730	0.003120
8	0.005798	0.022556	0.001745	0.007092	0.001560
9	0.005102	0.009023	0.006981	0.014184	0.000000
10	0.005566	0.004511	0.005236	0.003546	0.000000
11	0.000232	0.000000	0.002618	0.000000	0.000000

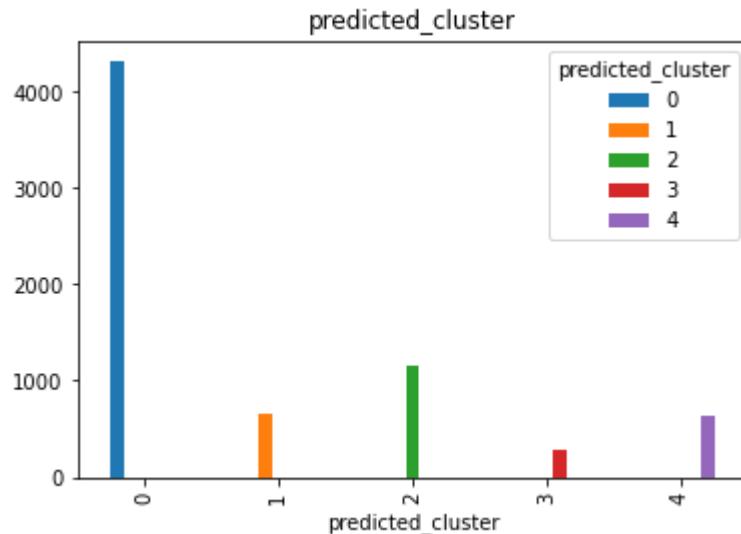


predicted_cluster	0	1	2	3	4
imdb_bin					
0	0	0	1	0	0
1	19	1	1	1	0
2	191	3	15	0	6
3	431	20	33	11	12
4	780	78	110	35	43
5	1101	270	244	63	123
6	1197	180	466	78	173
7	510	100	240	87	247
8	83	13	35	7	37
9	0	0	1	0	0
predicted_cluster	0	1	2	3	4
imdb_bin					
0	0.000000	0.000000	0.000873	0.000000	0.000000
1	0.004406	0.001504	0.000873	0.003546	0.000000
2	0.044295	0.004511	0.013089	0.000000	0.009360
3	0.099954	0.030075	0.028796	0.039007	0.018721
4	0.180891	0.117293	0.095986	0.124113	0.067083
5	0.255334	0.406015	0.212914	0.223404	0.191888
6	0.277597	0.270677	0.406632	0.276596	0.269891
7	0.118275	0.150376	0.209424	0.308511	0.385335
8	0.019249	0.019549	0.030541	0.024823	0.057722
9	0.000000	0.000000	0.000873	0.000000	0.000000



predicted_cluster	0	1	2	3	4
predicted_cluster	0	1	2	3	4
0	4312	0	0	0	0
1	0	665	0	0	0
2	0	0	1146	0	0
3	0	0	0	282	0
4	0	0	0	0	641

predicted_cluster	0	1	2	3	4
predicted_cluster	0	1	2	3	4
0	1.0	0.0	0.0	0.0	0.0
1	0.0	1.0	0.0	0.0	0.0
2	0.0	0.0	1.0	0.0	0.0
3	0.0	0.0	0.0	1.0	0.0
4	0.0	0.0	0.0	0.0	1.0



Description of Clustering Attributes for both Algorithms

Agglomerative Hierarchical Clustering

Highlight Summary

- Cluster 0:
 - Mostly available on Netflix and Prime Video. There are more genres per movie. The movies are mostly available in 1 country and 1-2 languages, and mostly directed by 1 director.
 - Movies in this cluster target the Young/Adolescent/Adult audience. Drama, Romance, and

Action are popular genres. These movies are mostly available in Asia and in Asian languages and some English. All movies are in the Regular-Short (1.5 hours) range. Most movies were made in the last 20 years. Average IMDb ratings in the 6-8 stars range.

- Cluster 1:
 - Mostly available on Netflix and Prime Video. There are more genres per movie. The movies are mostly available in 1 country and 1-2 languages, and mostly directed by 1 director. Movies in this cluster target the Young/Adolescent/Adult audience. Drama, Comedy, and Action are popular genres. These movies are mostly available in North America, Europe, and Asia and in English, European, and Asian languages. All movies are in the Regular-Short (1.5 hours) range. Most movies were made in the last 20 years. Average IMDb ratings in the 6-8 stars range.
- Cluster 2:
 - Mostly available on Prime Video. There are less genres per movie. The movies are mostly available in 1 country and language, and mostly directed by 1 director. Movies in this cluster target the Young/All ages audience. Western, Drama, and Comedy are popular genres. These movies are mostly available in North America and in English. Most movies are in the Short (0-1.5 hours) range. Most movies were made 60-90 years ago. Average IMDb ratings in the 5-7 stars range.
- Cluster 3:
 - Mostly available on Netflix and Prime Video. There are less genres per movie. The movies are mostly available in 1 country and language, and mostly directed by 1 director. Movies in this cluster target the Young/All/Adult audience. Comedy, Documentary, and Short are popular genres. These movies are mostly available in North America and in English. All movies are in the Short (0-1.5 hours) range. Most movies were made in the last 20 years. Average IMDb ratings in the 6-8 stars range.
- Cluster 4:
 - Mostly available on Netflix and Prime Video. There are less genres per movie. The movies are mostly available in 1 country and language, and mostly directed by 1 director. Movies in this cluster target the Adult audience and some younger audiences. Drama, Comedy, and Thriller are popular genres. These movies are mostly available in North America and Europe and in English. There's a wide-range of movie lengths but slightly more in the Regular-Long (1.5-1.75 hours) range. Most movies were made in the last 20 years. Average IMDb ratings in the 5-7 stars range.

Exhaustive Summary

Cluster 0:

- Streaming Platforms
 - Netflix (40.2%), Hulu (2.4%), Prime Video (61.2%), Disney+ (2.9%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (2: 23.4%, 3: 38.8%, 4: 21.1%).
 - Total Countries (1: 89.0%, 2: 7.7%).
 - Total Languages (1: 62.2%, 2: 20.1%).
 - Total Directors (1: 94.3%, 2: 4.3%).
- Age ratings

- All ages (19.1%), 7+ (31.1%), 13+ (25.8%), 16+ (2.4%), 18+ (21.5%).
- Genres
 - Action (34.5%), Adventure (8.6%), Sci-Fi (4.3%), Thriller (20.6%), Comedy (31.1%), Western (1.9%), Animation (0.5%), Family (7.7%), Biography (7.7%), Drama (78.0%), Music (2.9%), War (7.2%), Crime (12.9%), Fantasy (5.7%), Romance (36.8%), History (9.1%), Mystery (4.8%), Sport (3.3%), Documentary (1.0%), Musical (14.4%), News (0%), Horror (1.9%), Short (0%), Film-Noir (0%), Reality TV (0%).
- Available Regions
 - North America (22.5%), South America (0%), Europe (14.4%), Asia (71.3%), Australia & Pacific (1.0%), Africa (0%).
- Available Languages
 - English (39.2%), French (10.0%), Spanish (4.3%), Arabic (1.0%), Portuguese (0.5%), North American (0%), South American (0%), European (15.3%), Asian (75.1%), Australian & Pacific (0%), African (1.0%), Sign Language (1.0%), Other (0.5%).
- Runtime Length
 - Short (0%), Regular-Short (100%), Regular-Long (0%), Long (0%).
- Movie Age
 - 0-10 years (44.0%), 10-20 years (37.3%).
- IMDb rating
 - 6-7 stars (27.3%), 7-8 stars (31.6%).

Cluster 1:

- Streaming Platforms
 - Netflix (41.4%), Hulu (7.9%), Prime Video (51.2%), Disney+ (8.0%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (2: 27.2%, 3: 34.9%, 4: 17.5%).
 - Total Countries (1: 71.3%, 2: 14.4%).
 - Total Languages (1: 63.0%, 2: 19.8%).
 - Total Directors (1: 95.6%, 2: 3.5%).
- Age ratings
 - All ages (9.4%), 7+ (18.6%), 13+ (27.0%), 16+ (2.3%), 18+ (42.7%).
- Genres
 - Action (25.4%), Adventure (13.1%), Sci-Fi (9.4%), Thriller (23.0%), Comedy (28.2%), Western (4.1%), Animation (1.1%), Family (6.5%), Biography (13.3%), Drama (69.3%), Music (3.8%), War (9.4%), Crime (14.8%), Fantasy (6.3%), Romance (24.5%), History (10.4%), Mystery (8.5%), Sport (4.2%), Documentary (2.9%), Musical (3.6%), News (0.3%), Horror (4.1%), Short (0%), Film-Noir (0%), Reality TV (0%).
- Available Regions
 - North America (56.6%), South America (1.2%), Europe (28.7%), Asia (34.3%), Australia & Pacific (1.8%), Africa (1.2%).
- Available Languages
 - English (70.4%), French (11.8%), Spanish (9.5%), Arabic (1.7%), Portuguese (1.2%), North American (0.5%), South American (0.3%), European (18.1%), Asian (36.6%), Australian & Pacific (0.5%), African (0.8%), Sign Language (0.6%), Other (0.2%).

- Runtime Length
 - Short (0%), Regular-Short (100%), Regular-Long (0%), Long (0%).
- Movie Age
 - 0-10 years (56.0%), 10-20 years (28.4%).
- IMDb rating
 - 6-7 stars (34.6%), 7-8 stars (33.2%).

Cluster 2:

- Streaming Platforms
 - Netflix (0%), Hulu (0%), Prime Video (83.5%), Disney+ (16.5%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (1: 14.7%, 2: 25.7%, 3: 24.8%, 4: 18.3%).
 - Total Countries (1: 94.5%, 2: 4.6%).
 - Total Languages (1: 92.7%, 2: 6.4%).
 - Total Directors (1: 86.2%, 2: 7.3%).
- Age ratings
 - All ages (67.0%), 7+ (28.4%), 13+ (3.7%), 16+ (0%), 18+ (0.9%).
- Genres
 - Action (22.0%), Adventure (23.9%), Sci-Fi (7.3%), Thriller (13.8%), Comedy (30.3%), Western (35.8%), Animation (11.0%), Family (22.0%), Biography (1.8%), Drama (34.9%), Music (11.9%), War (3.7%), Crime (10.1%), Fantasy (12.8%), Romance (20.2%), History (1.8%), Mystery (9.2%), Sport (1.8%), Documentary (6.4%), Musical (7.3%), News (0%), Horror (8.3%), Short (1.8%), Film-Noir (2.8%), Reality TV (0%).
- Available Regions
 - North America (92.7%), South America (0%), Europe (8.3%), Asia (0.9%), Australia & Pacific (0%), Africa (0.9%).
- Available Languages
 - English (96.3%), French (3.7%), Spanish (1.8%), Arabic (0%), Portuguese (0%), North American (0%), South American (0%), European (4.6%), Asian (0.9%), Australian & Pacific (0%), African (0%), Sign Language (0.9%), Other (0.9%).
- Runtime Length
 - Short (89.0%), Regular-Short (0%), Regular-Long (5.5%), Long (5.5%).
- Movie Age
 - 60-70 years (27.5%), 70-80 years (28.4%), 80-90 years (30.3%).
- IMDb rating
 - 5-6 stars (26.6%), 6-7 stars (32.1%).

Cluster 3:

- Streaming Platforms
 - Netflix (26.3%), Hulu (4.1%), Prime Video (62.5%), Disney+ (9.9%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (1: 39.6%, 2: 31.4%).
 - Total Countries (1: 90.1%, 2: 8.5%).
 - Total Languages (1: 92.5%, 2: 5.8%).

- Total Directors (1: 83.6%, 2: 14.3%).
- Age ratings
 - All ages (25.3%), 7+ (22.2%), 13+ (10.9%), 16+ (5.5%), 18+ (36.2%).
- Genres
 - Action (6.5%), Adventure (8.5%), Sci-Fi (2.4%), Thriller (3.4%), Comedy (46.4%), Western (0.3%), Animation (19.1%), Family (19.8%), Biography (3.4%), Drama (9.9%), Music (4.8%), War (1.4%), Crime (3.4%), Fantasy (7.2%), Romance (2.0%), History (4.8%), Mystery (1.4%), Sport (2.0%), Documentary (46.4%), Musical (3.8%), News (0%), Horror (0%), Short (24.2%), Film-Noir (0%), Reality TV (0%).
- Available Regions
 - North America (83.6%), South America (0.3%), Europe (16.7%), Asia (5.5%), Australia & Pacific (0%), Africa (0%).
- Available Languages
 - English (95.9%), French (1.0%), Spanish (0.7%), Arabic (1.0%), Portuguese (0.3%), North American (0%), South American (0%), European (4.1%), Asian (3.8%), Australian & Pacific (0.3%), African (0%), Sign Language (1.4%), Other (1.0%).
- Runtime Length
 - Short (100%), Regular-Short (0%), Regular-Long (0%), Long (0%).
- Movie Age
 - 0-10 years (67.6%), 10-20 years (23.9%).
- IMDb rating
 - 6-7 stars (29.0%), 7-8 stars (33.8%).

Cluster 4:

- Streaming Platforms
 - Netflix (20.3%), Hulu (8.6%), Prime Video (69.6%), Disney+ (6.6%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (1: 22.7%, 2: 29.4%, 3: 25.4%).
 - Total Countries (1: 77.9%, 2: 15.6%).
 - Total Languages (1: 82.0%, 2: 12.5%).
 - Total Directors (1: 90.5%, 2: 8.1%).
- Age ratings
 - All ages (9.4%), 7+ (19.3%), 13+ (16.0%), 16+ (4.7%), 18+ (50.7%).
- Genres
 - Action (19.5%), Adventure (14.9%), Sci-Fi (10.3%), Thriller (26.1%), Comedy (32.4%), Western (2.1%), Animation (6.3%), Family (14.4%), Biography (4.5%), Drama (44.0%), Music (3.4%), War (2.6%), Crime (13.2%), Fantasy (9.9%), Romance (13.7%), History (2.8%), Mystery (8.8%), Sport (2.8%), Documentary (9.1%), Musical (2.3%), News (0.5%), Horror (17.9%), Short (0%), Film-Noir (0.1%), Reality TV (0.0%).
- Available Regions
 - North America (80.2%), South America (1.0%), Europe (22.7%), Asia (8.7%), Australia & Pacific (3.0%), Africa (0.9%).
- Available Languages

- English (91.5%), French (4.8%), Spanish (5.8%), Arabic (1.0%), Portuguese (0.5%), North American (0.3%), South American (0.0%), European (8.5%), Asian (8.9%), Australian & Pacific (0.1%), African (0.3%), Sign Language (0.3%), Other (0.1%).
- Runtime Length
 - Short (24.2%), Regular-Short (14.9%), Regular-Long (34.0%), Long (26.8%).
- Movie Age
 - 0-10 years (51.7%), 10-20 years (21.7%).
- IMDb rating
 - 5-6 stars (27.0%), 6-7 stars (29.2%).

KModes Clustering Attributes

Highlight Summary

- Cluster 0:
 - Mostly available on Prime Video. There are less genres per movie. The movies are mostly available in 1 country and language, and mostly directed by 1 director. Movies in this cluster targets Adult audiences 18+. Drama, Thriller, and Comedies are popular genres. These movies are mostly available in North America and in English. There's a wide-range of movie lengths but slightly more in the Regular-Long range (1.5-1.75 hours). Most movies were made in the last 20 years. Average IMDb ratings are in the 5-7 stars range.
- Cluster 1:
 - Mostly available on Disney+. There are more genres per movie. The movies are mostly available in 1 country and language, and mostly directed by 1 director. Movies in this cluster target the Young/All audience. Family, Comedy, and Adventure are popular genres. These movies are mostly available in North America and in English. There's a wide-range of movie lengths but slightly more in the Short range (0-1.5 hours). Most movies were made in the last 20 years. Average IMDb ratings are in the 5-6 stars range.
- Cluster 2:
 - Mostly available on Prime Video. There are more genres per movie. The movies are mostly available in 1-2 countries and languages, and mostly directed by 1 director. Movies in this cluster target the Young/Adolescent/Adult audience. Drama, Thriller, Romance are popular genres. These movies are mostly available in Europe and some in North America, in English and some French. There's a wide-range of movie lengths but slightly more in the Regular-Short (1.5 hours) range. Most movies were made in the last 20 years. Average IMDb ratings in the 6-7 stars range.
- Cluster 3:
 - Mostly available on Netflix. There are more genres per movie. The movies are mostly available in 1-2 countries and 1 language, and mostly directed by 1-2 directors. Movies in this cluster target the Young/All audience. Family, Adventure, Animation are popular genres. These movies are mostly available in North America and a little in Europe, in English and a little French. Most movies are Short (0-1.5 hours) length movies. Most movies were made in the last 20 years. Average IMDb ratings in the 6-8 stars range.
- Cluster 4:

- Mostly available on Netflix and Prime Video. There are less genres per movie. The movies are mostly available in 1 country and language, and mostly directed by 1 director. Movies in this cluster target the Young/Adolescent/Adult audience. Drama, Action, Comedy are popular genres. These movies are mostly available in Asia and in Asian languages and some English. Most movies in the Regular-Short (1.5 hours) range. Most movies were made in the last 20 years. Average IMDb ratings in the 7-8 stars range.

Exhaustive summary

Cluster 0:

- Streaming Platforms
 - Netflix (17.3%), Hulu (7.7%), Prime Video (79.2%), Disney+ (0.7%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (1: 27.7%, 2: 37.3%, 3: 19.6%).
 - Total Countries (1: 84.0%, 2: 11.9%).
 - Total Languages (1: 85.3%, 2: 10.1%).
 - Total Directors (1: 91.9%, 2: 7.3%).
- Age ratings
 - All ages (5.7%), 7+ (11.6%), 13+ (13.7%), 16+ (4.6%), 18+ (64.4%).
- Genres
 - Action (19.7%), Adventure (8.4%), Sci-Fi (10.3%), Thriller (28.7%), Comedy (28.7%), Western (3.1%), Animation (1.1%), Family (3.6%), Biography (4.0%), Drama (38.9%), Music (3.2%), War (2.1%), Crime (14.0%), Fantasy (4.8%), Romance (11.4%), History (2.3%), Mystery (8.4%), Sport (2.2%), Documentary (12.3%), Musical (0.8%), News (0.5%), Horror (20.8%), Short (0.7%), Film-Noir (0.1%), Reality TV (0.0%).
- Available regions
 - North America (92.0%), South America (0.9%), Europe (12.5%), Asia (4.1%), Australia & Pacific (2.2%), Africa (0.7%).
- Available languages
 - English (97.0%), French (3.5%), Spanish (5.4%), Arabic (0.5%), Portuguese (0.5%), North American (0.3%), South American (0.0%), European (6.3%), Asian (4.6%), Australian & Pacific (0.0%), African (0.2%), Sign Language (0.4%), Other (0.2%).
- Runtime length
 - Short (26.9%), Regular-Short (13.9%), Regular-Long (36.5%), Long (22.7%).
- Movie age
 - 0-10 years (52.1%), 10-20 years (21.6%).
- IMDb rating
 - 5-6 stars (25.5%), 6-7 stars (27.8%).

Cluster 1:

- Streaming Platforms
 - Netflix (17.0%), Hulu (9.3%), Prime Video (18.3%), Disney+ (57.6%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (3: 38.5%, 4: 17.3%).

- Total Countries (1: 82.4%, 2: 13.5%).
- Total Languages (1: 85.9%, 2: 10.1%).
- Total Directors (1: 88.0%, 2: 8.7%).
- Age ratings
 - All ages (38.9%), 7+ (51.4%), 13+ (7.2%), 16+ (2.0%), 18+ (0.5%).
- Genres
 - Action (13.5%), Adventure (32.0%), Sci-Fi (12.6%), Thriller (3.3%), Comedy (64.2%), Western (2.6%), Animation (15.6%), Family (72.5%), Biography (3.0%), Drama (29.9%), Music (6.2%), War (0.8%), Crime (4.8%), Fantasy (19.7%), Romance (17.0%), History (1.2%), Mystery (3.9%), Sport (7.5%), Documentary (6.2%), Musical (11.0%), News (0.2%), Horror (2.9%), Short (2.0%), Film-Noir (0%), Reality TV (0%).
- Available regions
 - North America (97.4%), South America (0%), Europe (7.8%), Asia (2.3%), Australia & Pacific (3.2%), Africa (0.8%).
- Available languages
 - English (98.9%), French (3.6%), Spanish (4.4%), Arabic (0.6%), Portuguese (0.3%), North American (0%), South American (0%), European (6.0%), Asian (3.2%), Australian & Pacific (0.2%), African (0.6%), Sign Language (0.6%), Other (0.2%).
- Runtime length
 - Short (41.7%), Regular-Short (16.4%), Regular-Long (22.6%), Long (19.7%).
- Movie age
 - 0-10 years (38.5%), 10-20 years (29.9%).
- IMDb rating
 - 5-6 stars (40.6%), 6-7 stars (27.1%).

Cluster 2:

- Streaming Platforms
 - Netflix (18.8%), Hulu (9.3%), Prime Video (77.1%), Disney+ (1.3%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (1: 16.1%, 2: 15.1%, 3: 43.2%, 4: 17.6%).
 - Total Countries (1: 53.4%, 2: 27.7%).
 - Total Languages (1: 64.2%, 2: 21.8%).
 - Total Directors (1: 93.7%, 2: 5.4%).
- Age ratings
 - All ages (8.6%), 7+ (20.3%), 13+ (29.4%), 16+ (5.8%), 18+ (36.0%).
- Genres
 - Action (14.6%), Adventure (12.9%), Sci-Fi (6.5%), Thriller (28.5%), Comedy (18.4%), Western (3.5%), Animation (2.1%), Family (5.1%), Biography (13.0%), Drama (77.1%), Music (5.0%), War (9.6%), Crime (14.8%), Fantasy (6.7%), Romance (21.3%), History (10.9%), Mystery (12.6%), Sport (3.3%), Documentary (9.2%), Musical (2.0%), News (0.5%), Horror (9.9%), Short (1.4%), Film-Noir (0%), Reality TV (0%).
- Available regions
 - North America (40.8%), South America (1.8%), Europe (78.2%), Asia (6.5%), Australia & Pacific (5.1%), Africa (2.1%).

- Available languages
 - English (84.6%), French (14.0%), Spanish (9.9%), Arabic (2.9%), Portuguese (1.0%), North American (0.2%), South American (0.3%), European (25.7%), Asian (7.6%), Australian & Pacific (0.5%), African (1.2%), Sign Language (0.3%), Other (0.3%).
- Runtime length
 - Short (14.6%), Regular-Short (46.5%), Regular-Long (12.7%), Long (26.3%).
- Movie age
 - 0-10 years (52.2%), 10-20 years (23.0%).
- IMDb rating
 - 5-6 stars (21.3%), 6-7 stars (40.7%), 7-8 stars (20.9%).

Cluster 3:

- Streaming Platforms
 - Netflix (53.5%), Hulu (13.5%), Prime Video (19.1%), Disney+ (20.9%).
- Total Genres, Countries, Languages, and Directors
 - Total Genres (4: 36.9%, 5: 30.1%, 6: 17.0%).
 - Total Countries (1: 62.1%, 2: 23.8%).
 - Total Languages (1: 74.8%, 2: 16.7%).
 - Total Directors (1: 61.7%, 2: 28.0%).
- Age ratings
 - All ages (33.7%), 7+ (57.1%), 13+ (8.2%), 16+ (7.1%), 18+ (0.4%).
- Genres
 - Action (24.1%), Adventure (81.9%), Sci-Fi (16.3%), Thriller (2.8%), Comedy (66.3%), Western (1.8%), Animation (77.7%), Family (86.2%), Biography (0.4%), Drama (15.2%), Music (2.5%), War (0.4%), Crime (3.2%), Fantasy (71.6%), Romance (7.8%), History (0.4%), Mystery (5.3%), Sport (0.4%), Documentary (0%), Musical (15.2%), News (0%), Horror (2.5%), Short (4.3%), Film-Noir (0%), Reality TV (0%).
- Available regions
 - North America (87.6%), South America (0.7%), Europe (27.0%), Asia (15.2%), Australia & Pacific (2.5%), Africa (0.4%).
- Available languages
 - English (94.0%), French (9.9%), Spanish (6.4%), Arabic (0.4%), Portuguese (1.1%), North American (0.7%), South American (0%), European (10.3%), Asian (11.0%), Australian & Pacific (0.4%), African (0%), Sign Language (0%), Other (0%).
- Runtime length
 - Short (52.1%), Regular-Short (11.3%), Regular-Long (17.7%), Long (18.8%).
- Movie age
 - 0-10 years (56.4%), 10-20 years (23.0%).
- IMDb rating
 - 6-7 stars (27.7%), 7-8 stars (30.9%).

Cluster 4:

- Streaming Platforms
 - Netflix (59.9%), Hulu (4.1%), Prime Video (44.5%), Disney+ (0.2%).

- Total Genres, Countries, Languages, and Directors
 - Total Genres (2: 27.8%, 3: 36.2%).
 - Total Countries (1: 88.0%, 2: 8.1%).
 - Total Languages (1: 71.1%, 2: 18.4%).
 - Total Directors (1: 93.1%, 2: 5.6%).
- Age ratings
 - All ages (14.4%), 7+ (25.0%), 13+ (30.1%), 16+ (4.1%), 18+ (26.5%).
- Genres
 - Action (36.2%), Adventure (9.4%), Sci-Fi (5.0%), Thriller (20.4%), Comedy (35.9%), Western (0.3%), Animation (6.9%), Family (5.8%), Biography (5.3%), Drama (66.8%), Music (1.7%), War (4.2%), Crime (14.5%), Fantasy (7.0%), Romance (29.0%), History (5.3%), Mystery (6.4%), Sport (2.8%), Documentary (2.0%), Musical (5.0%), News (0%), Horror (6.4%), Short (0.3%), Film-Noir (0%), Reality TV (0%).
- Available regions
 - North America (10.8%), South America (0.9%), Europe (3.9%), Asia (92.0%), Australia & Pacific (0.6%), Africa (0.3%).
- Available languages
 - English (22.5%), French (3.3%), Spanish (2.3%), Arabic (1.6%), Portuguese (0.6%), North American (0.2%), South American (0%), European (3.9%), Asian (92.2%), Australian & Pacific (0%), African (0.2%), Sign Language (0.2%), Other (0%).
- Runtime length
 - Short (5.8%), Regular-Short (71.6%), Regular-Long (8.3%), Long (14.4%).
- Movie age
 - 0-10 years (59.6%), 10-20 years (20.1%).
- IMDb rating
 - 6-7 stars (27.0%), 7-8 stars (38.5%).

Cluster Distances

Since this dataset did not include pre-assigned class labels, the cluster distances/other cluster metrics were used to ascertain the accuracy of the algorithm.

```
In [65]: ag = AgglomerativeClustering(n_clusters= 5, affinity='euclidean', linkage='complete')
Y_pred = ag.fit_predict(hierarch_df)
dm = pdist(hierarch_df, metric='euclidean')
Z = linkage(dm, method='complete')
coph = cophenet(Z)
print(np.corrcoef(dm,coph))
print(silhouette_score(hierarch_df, Y_pred))

[[1.          0.79536613]
 [0.79536613 1.          ]
 0.35948131901912683]
```

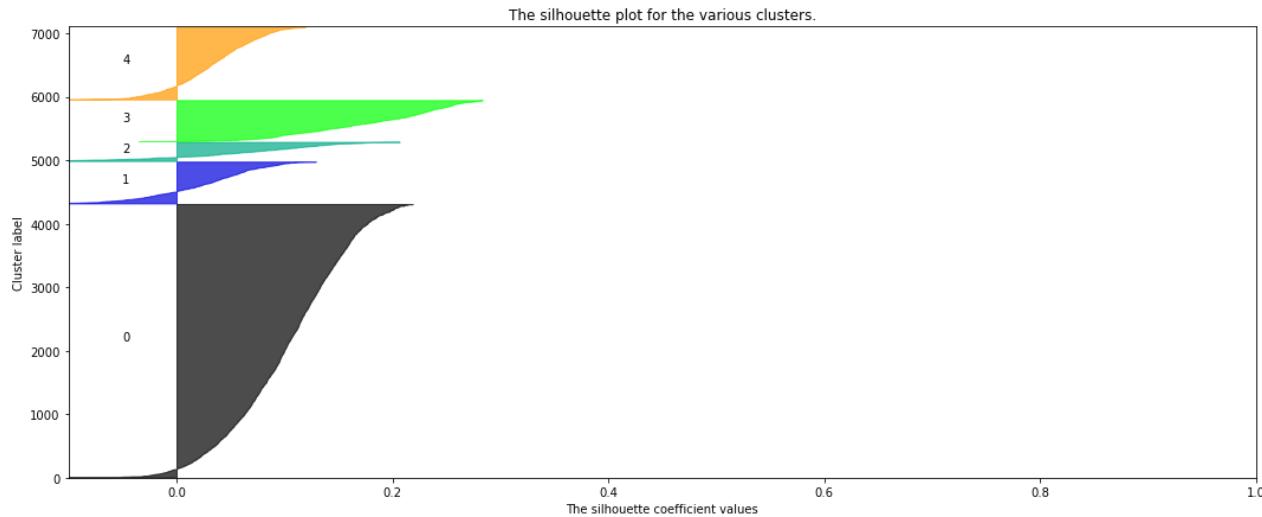
To start, the first algorithm analyzed for the cluster distances was the agglomerative hierarchical clustering with complete linkage. Since this method is hierarchical clustering, the cophenetic correlation coefficient can be used to determine whether or not the clustering is better for the given dataset. In fact, the euclidean distance matrix was calculated for the given dataset and the

cophenetic distances were given using the complete linkage function. Lastly, finding the correlation between the two distance matrices yielded the correlation matrix above. It is apparent that the value outputted from the correlation matrix is quite close to 1, hinting that the dendrogram preserves the pairwise distances of the original dataset. Additionally, the average silhouette score of the complete linkage with 5 clusters yielded a value of about 0.35, hinting that the clusters are more cohesive and well separated. This can also be used as a metric to evaluate the cluster distances as more well separated and cohesive clusters means there is larger cluster distances.

In [66]:

```
km = KModes(n_clusters=5, random_state=1000)
cluster_labels = km.fit_predict(mdf_cat)
silhouette_avg = silhouette_score(mdf_cat, cluster_labels)
print(silhouette_avg)
create_silhouette_plot(mdf_cat, cluster_labels)
```

0.08905031089544016



Unfortunately for k-modes, there does not seem to be a cophenetic correlation coefficient metric that can be used for this unsupervised learning method. Instead, it is better to look at the average silhouette score as well as the silhouette plot, once again. From the average silhouette score, the values is very close to about 0.1. This hints that there is a very average/mediocre amount of cohesion and separation among clusters in the dataset. Hence, the cluster distances among clusters must be on the smaller end of the spectrum as less separation and cohesion makes clusters overlap with one another.

7. Analysis Summary

Algorithm Comparison Summary

In [67]:

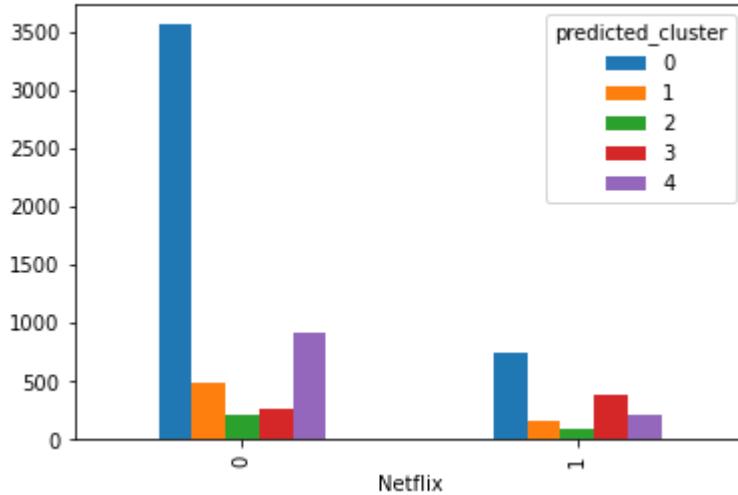
```
# KModes plots
km = KModes(n_clusters=5, random_state=1000)
cluster_labels = km.fit_predict(mdf_cat)
mdf_cat['predicted_cluster']=cluster_labels

for i in mdf_cat.columns:
    ctab = pd.crosstab(mdf_cat[i], mdf_cat['predicted_cluster'])
    print(ctab)
    print(ctab / ctab.sum())
```

```
ctab.plot.bar()
plt.title('{}'.format(i))
plt.xlabel(i)
plt.show()
```

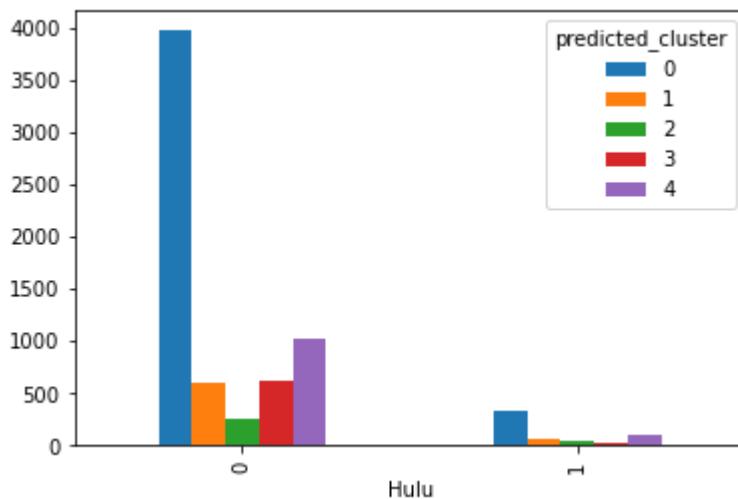
predicted_cluster	0	1	2	3	4
Netflix					
0	3558	491	209	257	922
1	743	167	92	391	216
predicted_cluster	0	1	2	3	4
Netflix					
0	0.827249	0.746201	0.694352	0.396605	0.810193
1	0.172751	0.253799	0.305648	0.603395	0.189807

Netflix



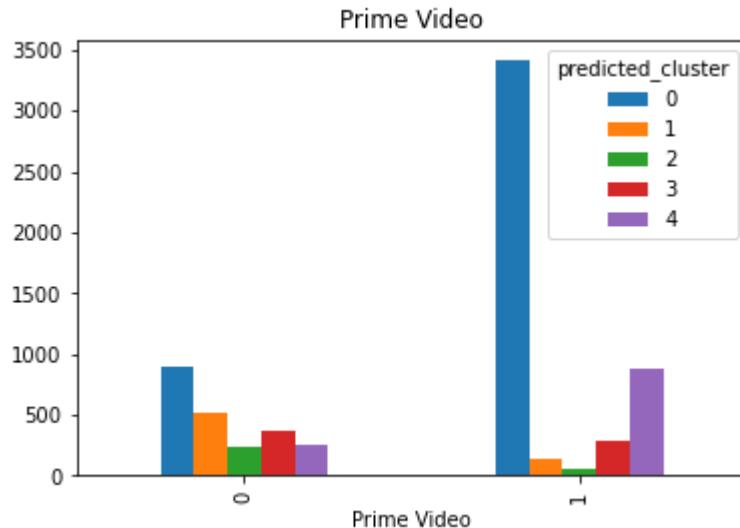
predicted_cluster	0	1	2	3	4
Hulu					
0	3970	594	260	622	1033
1	331	64	41	26	105
predicted_cluster	0	1	2	3	4
Hulu					
0	0.923041	0.902736	0.863787	0.959877	0.907733
1	0.076959	0.097264	0.136213	0.040123	0.092267

Hulu

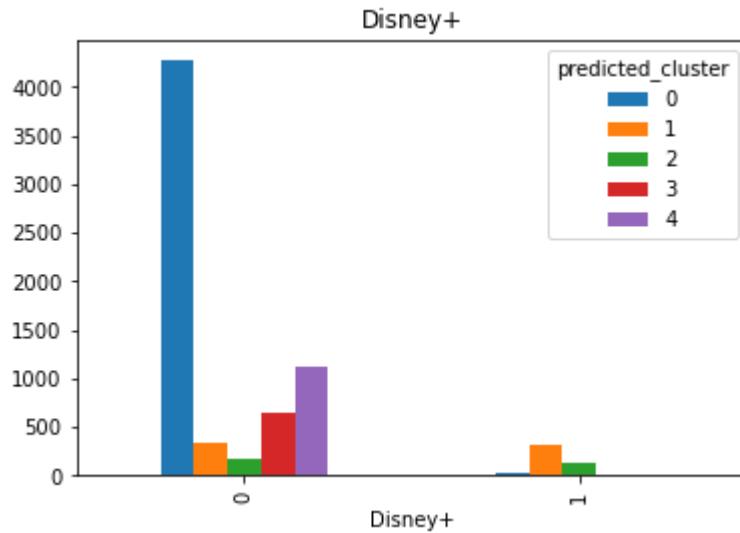


predicted_cluster	0	1	2	3	4
Prime Video					
0	891	525	245	363	261
1	3410	133	56	285	877
predicted_cluster	0	1	2	3	4
Prime Video					

0	0.207161	0.797872	0.813953	0.560185	0.22935
1	0.792839	0.202128	0.186047	0.439815	0.77065

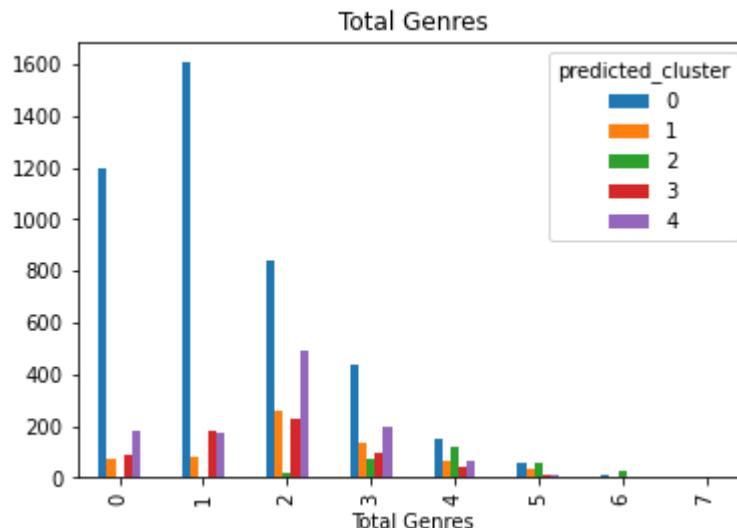


predicted_cluster	0	1	2	3	4
Disney+					
0	4271	343	172	647	1124
1	30	315	129	1	14
predicted_cluster	0	1	2	3	4
Disney+					
0	0.993025	0.521277	0.571429	0.998457	0.987698
1	0.006975	0.478723	0.428571	0.001543	0.012302



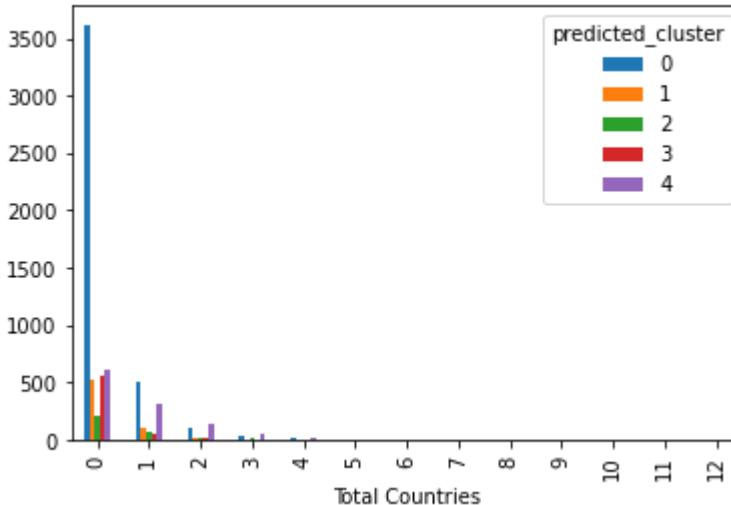
predicted_cluster	0	1	2	3	4
Total Genres					
0	1194	74	0	90	184
1	1606	83	6	180	173
2	843	259	16	232	494
3	434	138	76	93	200
4	154	66	119	42	68
5	58	31	54	9	13
6	9	5	23	2	5
7	3	2	7	0	1
predicted_cluster	0	1	2	3	4
Total Genres					
0	0.277610	0.112462	0.000000	0.138889	0.161687
1	0.373402	0.126140	0.019934	0.277778	0.152021
2	0.196001	0.393617	0.053156	0.358025	0.434095
3	0.100907	0.209726	0.252492	0.143519	0.175747
4	0.035806	0.100304	0.395349	0.064815	0.059754
5	0.013485	0.047112	0.179402	0.013889	0.011424

6	0.002093	0.007599	0.076412	0.003086	0.004394
7	0.000698	0.003040	0.023256	0.000000	0.000879



predicted_cluster	0	1	2	3	4
Total Countries					
0	3615	527	204	568	608
1	512	98	65	52	314
2	112	21	18	17	132
3	44	5	11	4	47
4	10	4	1	3	22
5	4	1	1	3	8
6	3	1	0	1	3
7	0	0	1	0	0
8	0	0	0	0	2
9	0	0	0	0	1
10	0	1	0	0	0
11	1	0	0	0	0
12	0	0	0	0	1
predicted_cluster	0	1	2	3	4
Total Countries					
0	0.840502	0.800912	0.677741	0.876543	0.534271
1	0.119042	0.148936	0.215947	0.080247	0.275923
2	0.026040	0.031915	0.059801	0.026235	0.115993
3	0.010230	0.007599	0.036545	0.006173	0.041301
4	0.002325	0.006079	0.003322	0.004630	0.019332
5	0.000930	0.001520	0.003322	0.004630	0.007030
6	0.000698	0.001520	0.000000	0.001543	0.002636
7	0.000000	0.000000	0.003322	0.000000	0.000000
8	0.000000	0.000000	0.000000	0.000000	0.001757
9	0.000000	0.000000	0.000000	0.000000	0.000879
10	0.000000	0.001520	0.000000	0.000000	0.000000
11	0.000233	0.000000	0.000000	0.000000	0.000000
12	0.000000	0.000000	0.000000	0.000000	0.000879

Total Countries



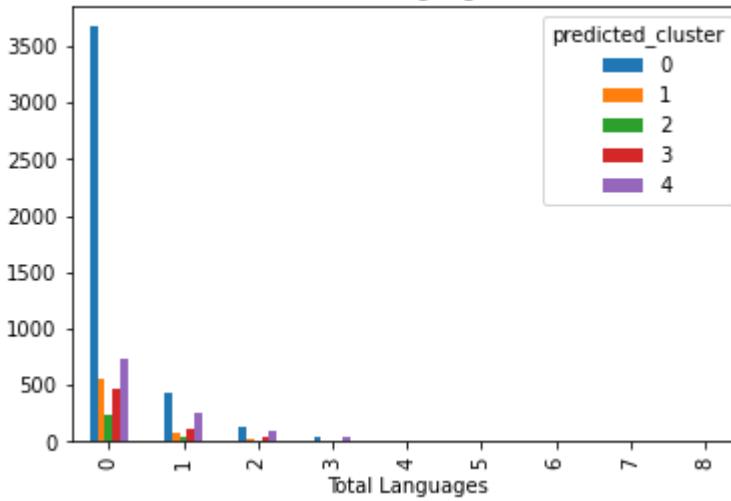
predicted_cluster
Total Languages

	0	1	2	3	4
0	3671	552	238	460	731
1	434	75	41	120	248
2	129	18	13	43	101
3	42	7	6	15	40
4	16	3	2	5	13
5	6	2	1	1	2
6	2	0	0	1	2
7	1	1	0	2	1
8	0	0	0	1	0

predicted_cluster
Total Languages

	0	1	2	3	4
0	0.853522	0.838906	0.790698	0.709877	0.642355
1	0.100907	0.113982	0.136213	0.185185	0.217926
2	0.029993	0.027356	0.043189	0.066358	0.088752
3	0.009765	0.010638	0.019934	0.023148	0.035149
4	0.003720	0.004559	0.006645	0.007716	0.011424
5	0.001395	0.003040	0.003322	0.001543	0.001757
6	0.000465	0.000000	0.000000	0.001543	0.001757
7	0.000233	0.001520	0.000000	0.003086	0.000879
8	0.000000	0.000000	0.000000	0.001543	0.000000

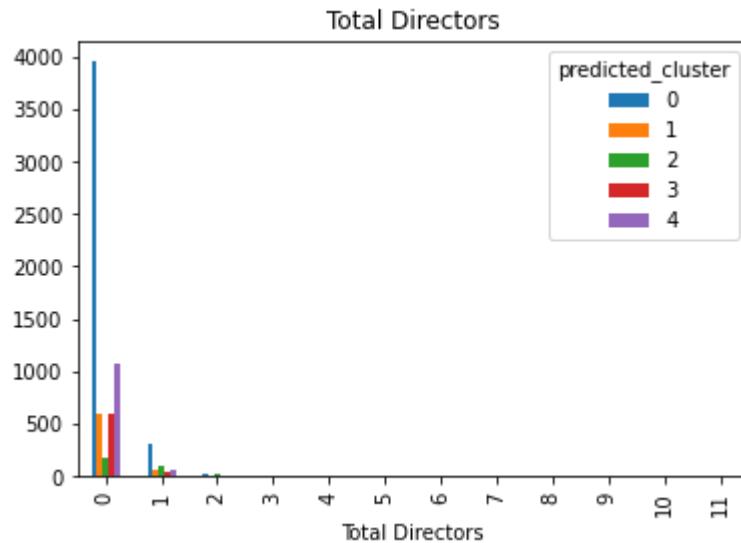
Total Languages



predicted_cluster
Total Directors

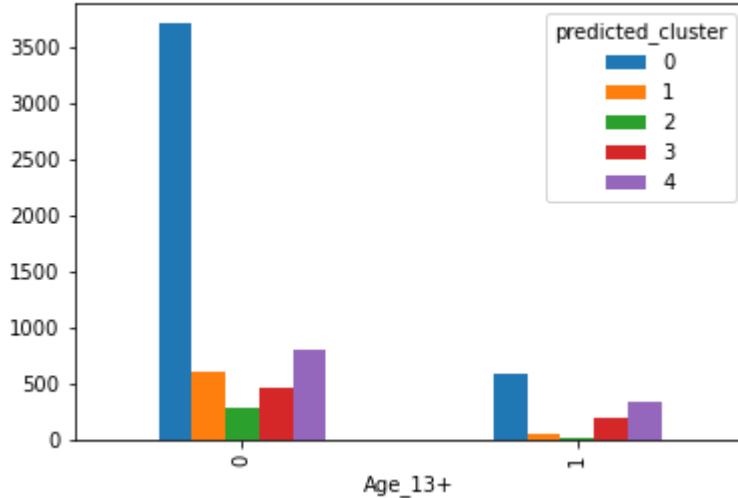
	0	1	2	3	4
0	3955	592	175	602	1067
1	309	52	91	36	61
2	24	9	23	5	8

3	5	2	4	2	0
4	0	2	3	1	0
5	0	0	1	0	0
6	1	0	3	0	0
7	1	1	0	0	0
8	0	0	0	1	0
9	2	0	0	1	0
10	1	0	1	0	1
11	3	0	0	0	1
predicted_cluster	0	1	2	3	4
Total Directors					
0	0.919554	0.899696	0.581395	0.929012	0.937610
1	0.071844	0.079027	0.302326	0.055556	0.053603
2	0.005580	0.013678	0.076412	0.007716	0.007030
3	0.001163	0.003040	0.013289	0.003086	0.000000
4	0.000000	0.003040	0.009967	0.001543	0.000000
5	0.000000	0.000000	0.003322	0.000000	0.000000
6	0.000233	0.000000	0.009967	0.000000	0.000000
7	0.000233	0.001520	0.000000	0.000000	0.000000
8	0.000000	0.000000	0.000000	0.001543	0.000000
9	0.000465	0.000000	0.000000	0.001543	0.000000
10	0.000233	0.000000	0.003322	0.000000	0.000879
11	0.000698	0.000000	0.000000	0.000000	0.000879



predicted_cluster	0	1	2	3	4
<i>Age_13+</i>					
0	3710	605	286	452	801
1	591	53	15	196	337
<i>Age_13+</i>					
predicted_cluster	0	1	2	3	4
0	0.86259	0.919453	0.950166	0.697531	0.703866
1	0.13741	0.080547	0.049834	0.302469	0.296134

Age_13+



predicted_cluster

0 1 2 3 4

Age_16+

0	4103	645	299	622	1072
1	198	13	2	26	66

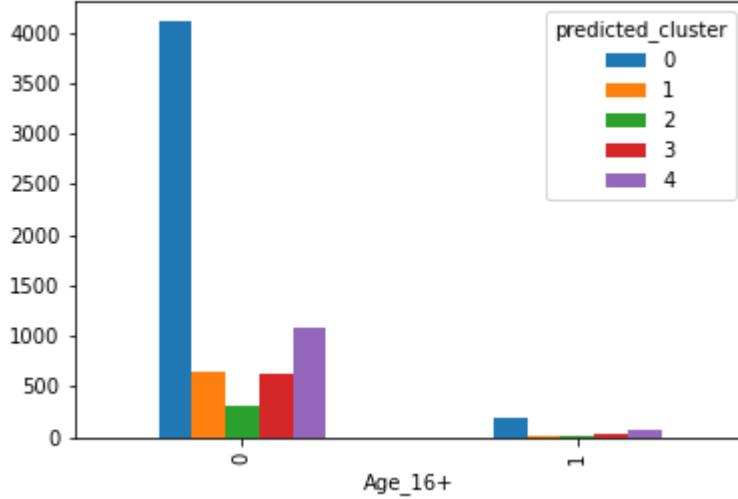
predicted_cluster

0 1 2

Age_16+

0	0.953964	0.980243	0.993355	0.959877	0.942004
1	0.046036	0.019757	0.006645	0.040123	0.057996

Age_16+



predicted_cluster

0 1 2 3 4

Age_18+

0	1524	655	300	478	726
1	2777	3	1	170	412

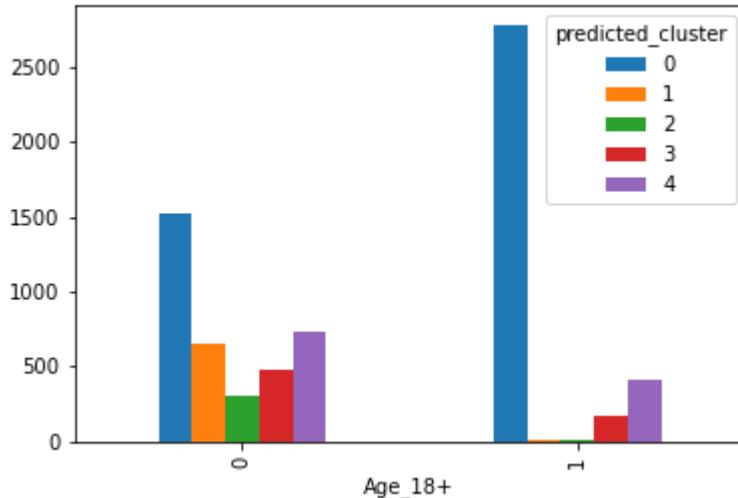
predicted_cluster

0 1 2

Age_18+

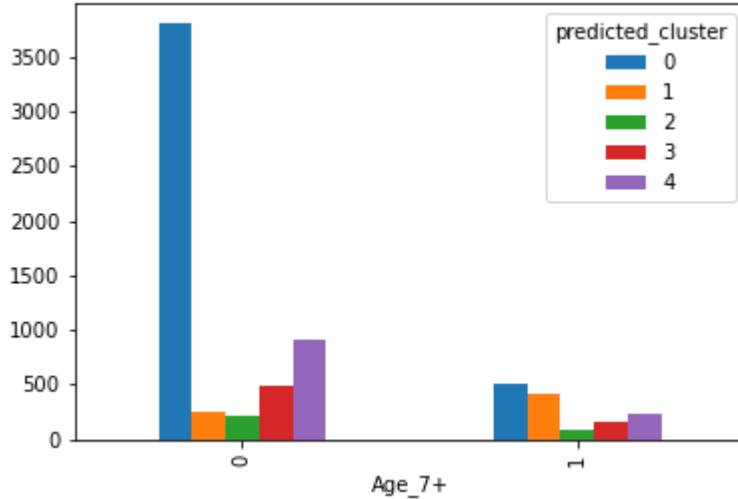
0	0.354336	0.995441	0.996678	0.737654	0.637961
1	0.645664	0.004559	0.003322	0.262346	0.362039

Age_18+

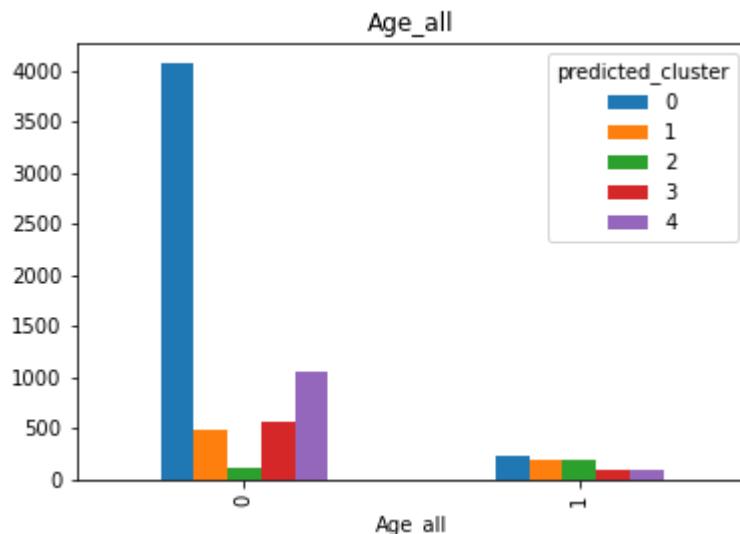


predicted_cluster	0	1	2	3	4
Age_7+	3800	251	211	483	905
1	501	407	90	165	233
predicted_cluster	0	1	2	3	4
Age_7+	0.883515	0.381459	0.700997	0.74537	0.795255
1	0.116485	0.618541	0.299003	0.25463	0.204745

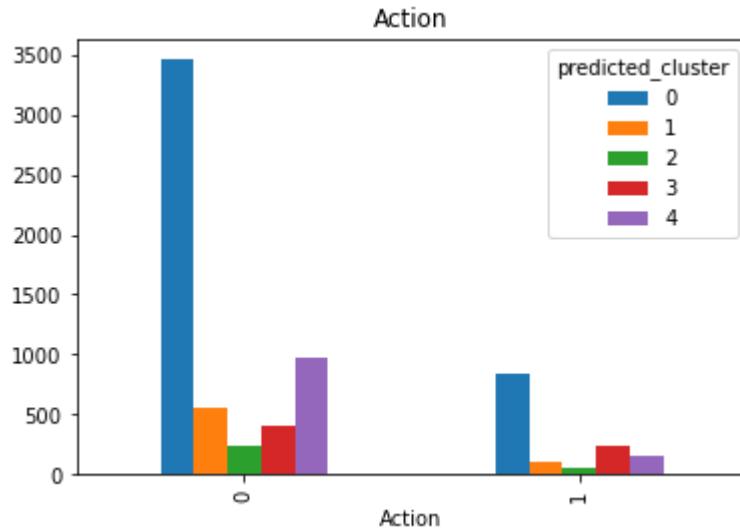
Age_7+



predicted_cluster	0	1	2	3	4
Age_all	4067	476	108	557	1048
1	234	182	193	91	90
predicted_cluster	0	1	2	3	4
Age_all	0.945594	0.723404	0.358804	0.859568	0.920914
1	0.054406	0.276596	0.641196	0.140432	0.079086

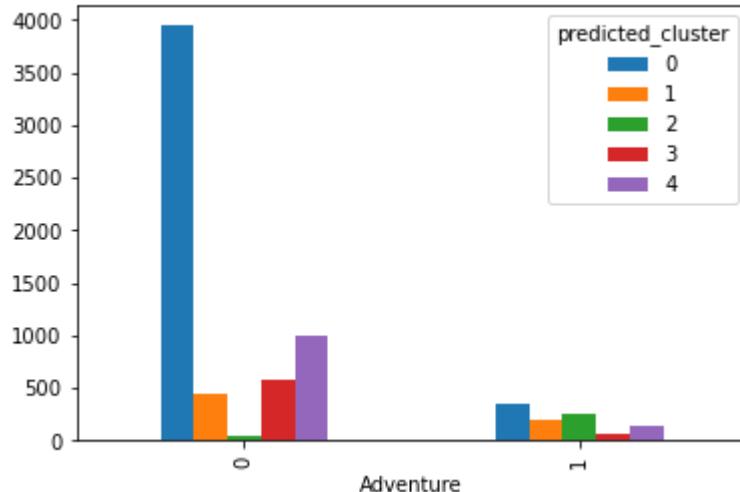


predicted_cluster	0	1	2	3	4
Action	0.803069	0.841945	0.817276	0.634259	0.855888
1	0.196931	0.158055	0.182724	0.365741	0.144112



predicted_cluster	0	1	2	3	4
Adventure	3942	454	51	586	997
1	359	204	250	62	141
predicted_cluster	0	1	2	3	4
Adventure	0.916531	0.68997	0.169435	0.904321	0.876098
1	0.083469	0.31003	0.830565	0.095679	0.123902

Adventure



predicted_cluster

Sci-Fi

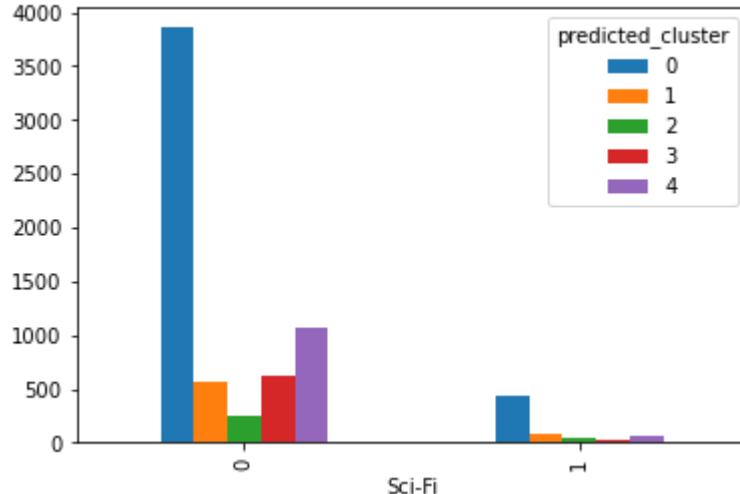
	0	1	2	3	4
0	3856	570	257	616	1065
1	445	88	44	32	73

predicted_cluster

Sci-Fi

	0	1	2	3	4
0	0.896536	0.866261	0.853821	0.950617	0.935852
1	0.103464	0.133739	0.146179	0.049383	0.064148

Sci-Fi



predicted_cluster

Thriller

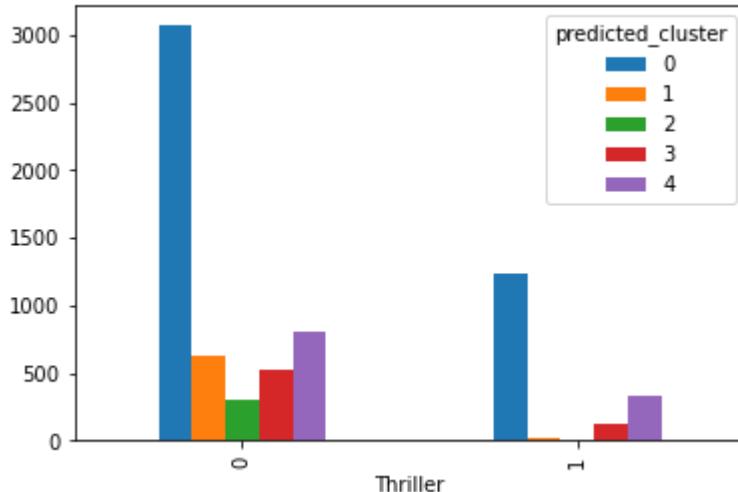
	0	1	2	3	4
0	3065	633	295	517	812
1	1236	25	6	131	326

predicted_cluster

Thriller

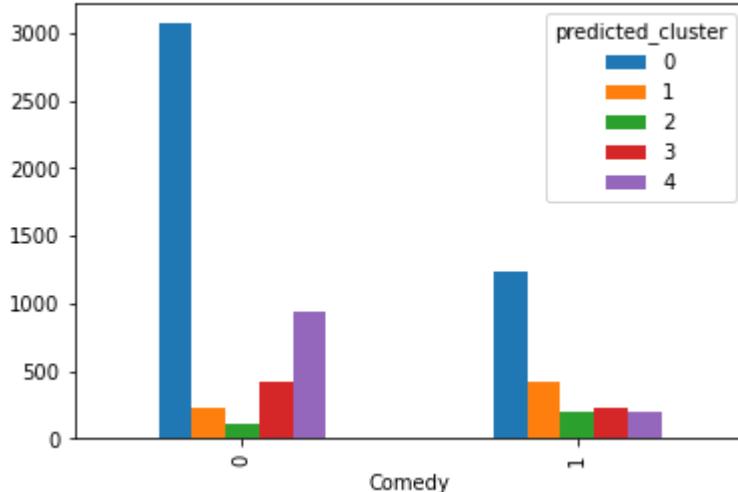
	0	1	2	3	4
0	0.712625	0.962006	0.980066	0.79784	0.713533
1	0.287375	0.037994	0.019934	0.20216	0.286467

Thriller



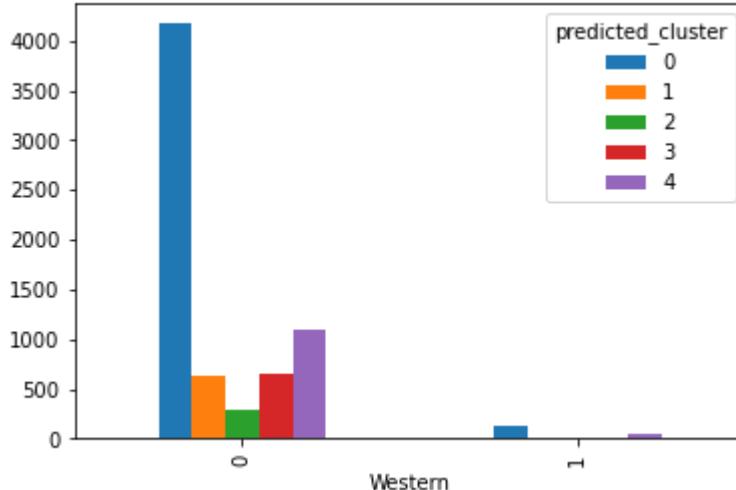
predicted_cluster	0	1	2	3	4
Comedy					
0	3067	234	107	415	932
1	1234	424	194	233	206
predicted_cluster	0	1	2	3	4
Comedy					
0	0.71309	0.355623	0.355482	0.640432	0.818981
1	0.28691	0.644377	0.644518	0.359568	0.181019

Comedy



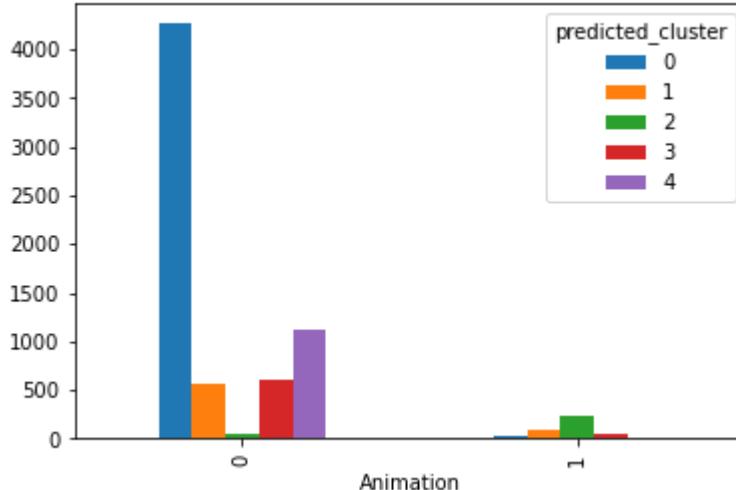
predicted_cluster	0	1	2	3	4
Western					
0	4170	642	295	646	1098
1	131	16	6	2	40
predicted_cluster	0	1	2	3	4
Western					
0	0.969542	0.975684	0.980066	0.996914	0.964851
1	0.030458	0.024316	0.019934	0.003086	0.035149

Western



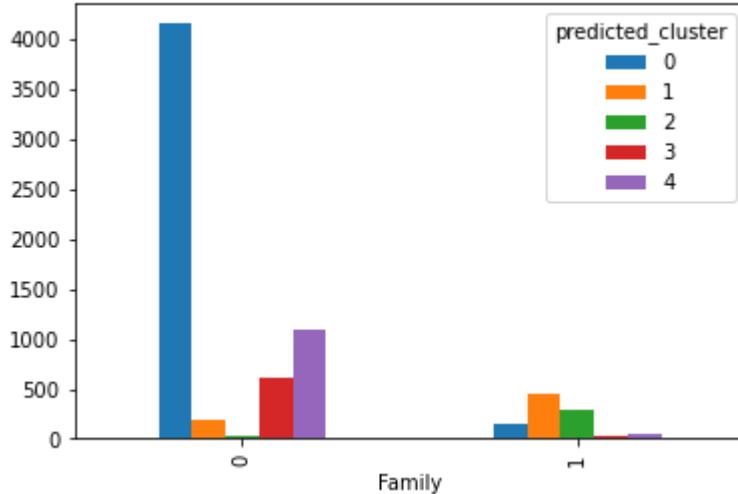
predicted_cluster	0	1	2	3	4
Animation	4263	571	57	599	1119
1	38	87	244	49	19
predicted_cluster	0	1	2	3	4
Animation	0.991165	0.867781	0.189369	0.924383	0.983304
0	0.008835	0.132219	0.810631	0.075617	0.016696

Animation



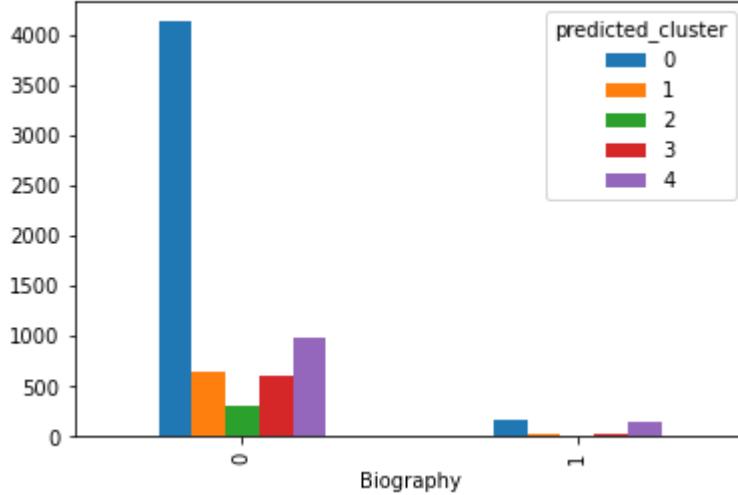
predicted_cluster	0	1	2	3	4
Family	4157	199	19	610	1087
1	144	459	282	38	51
predicted_cluster	0	1	2	3	4
Family	0.966519	0.302432	0.063123	0.941358	0.955185
0	0.033481	0.697568	0.936877	0.058642	0.044815

Family



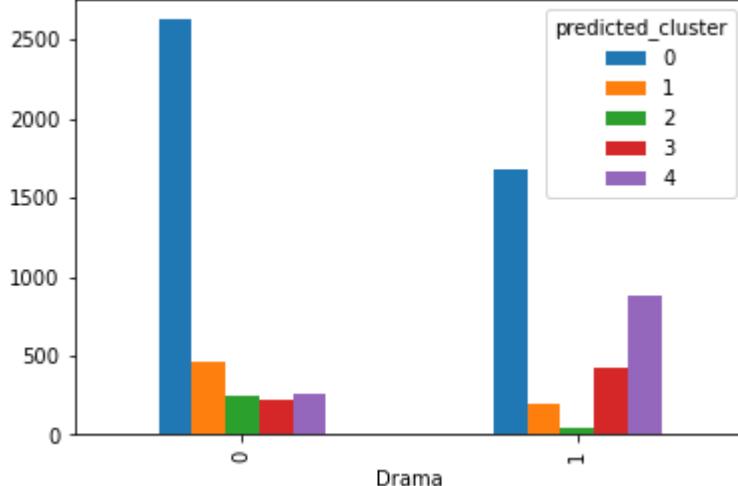
predicted_cluster	0	1	2	3	4
Biography					
0	4130	638	300	614	989
1	171	20	1	34	149
predicted_cluster	0	1	2	3	4
Biography					
0	0.960242	0.969605	0.996678	0.947531	0.869069
1	0.039758	0.030395	0.003322	0.052469	0.130931

Biography



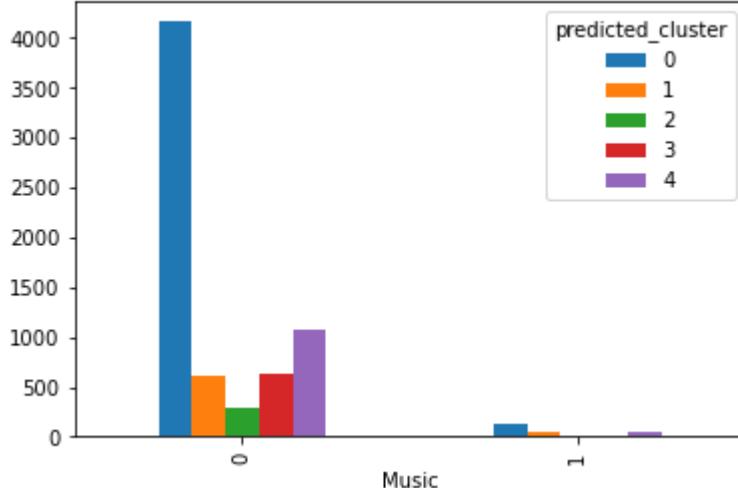
predicted_cluster	0	1	2	3	4
Drama					
0	2626	463	252	218	257
1	1675	195	49	430	881
predicted_cluster	0	1	2	3	4
Drama					
0	0.610556	0.703647	0.837209	0.33642	0.225835
1	0.389444	0.296353	0.162791	0.66358	0.774165

Drama



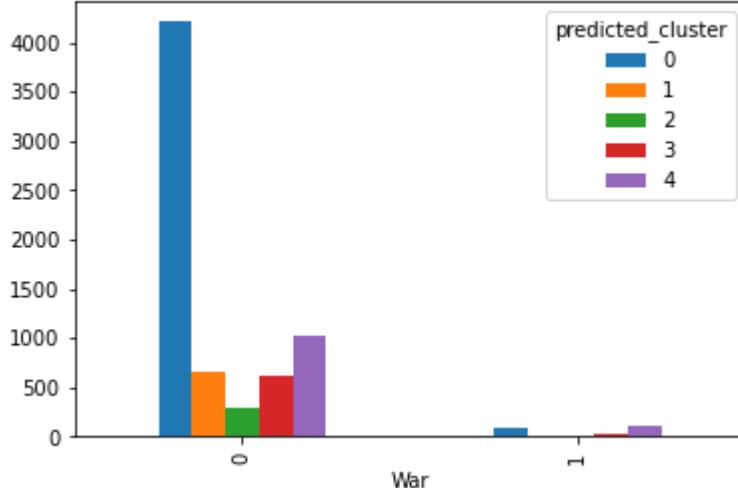
predicted_cluster	0	1	2	3	4
Music	4164	618	293	637	1081
War	137	40	8	11	57
predicted_cluster	0	1	2	3	4
Music	0.968147	0.93921	0.973422	0.983025	0.949912
War	0.031853	0.06079	0.026578	0.016975	0.050088

Music



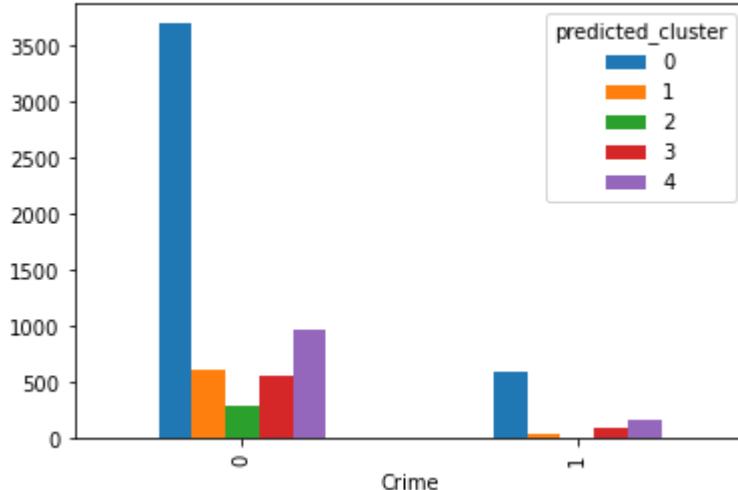
predicted_cluster	0	1	2	3	4
Music	4209	654	300	620	1028
War	92	4	1	28	110
predicted_cluster	0	1	2	3	4
Music	0.97861	0.993921	0.996678	0.95679	0.903339
War	0.02139	0.006079	0.003322	0.04321	0.096661

War



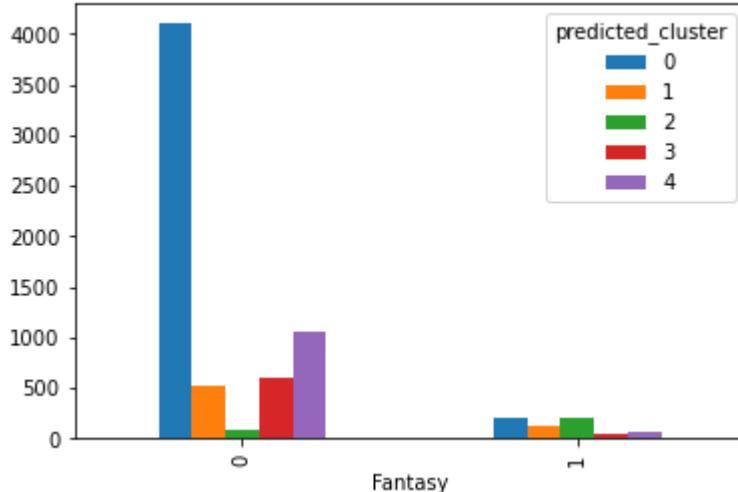
predicted_cluster	0	1	2	3	4
Crime	3699	623	294	555	968
Fantasy	602	35	7	93	170
predicted_cluster	0	1	2	3	4
Crime	0.860033	0.946809	0.976744	0.856481	0.850615
Fantasy	0.139967	0.053191	0.023256	0.143519	0.149385

Crime



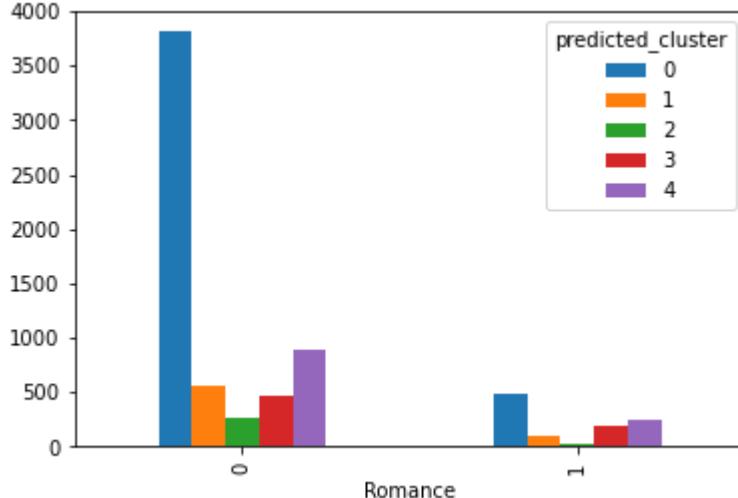
predicted_cluster	0	1	2	3	4
Crime	3699	623	294	555	968
Fantasy	602	35	7	93	170
predicted_cluster	0	1	2	3	4
Crime	0.860033	0.946809	0.976744	0.856481	0.850615
Fantasy	0.139967	0.053191	0.023256	0.143519	0.149385

Fantasy



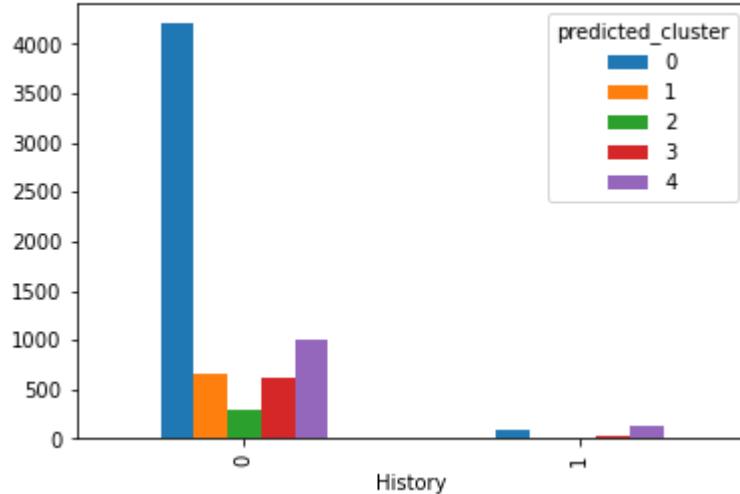
predicted_cluster	0	1	2	3	4
Romance	3811	558	267	460	894
1	490	100	34	188	244
predicted_cluster	0	1	2	3	4
Romance	0.886073	0.848024	0.887043	0.709877	0.785589
1	0.113927	0.151976	0.112957	0.290123	0.214411

Romance



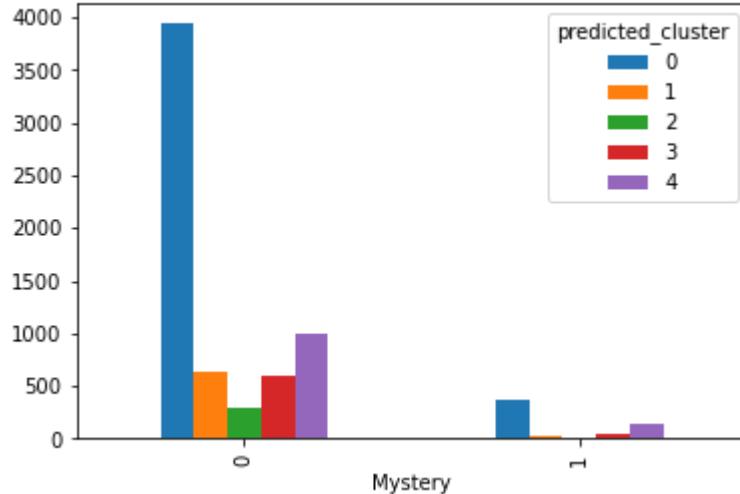
predicted_cluster	0	1	2	3	4
History	4202	650	300	614	1013
1	99	8	1	34	125
predicted_cluster	0	1	2	3	4
History	0.976982	0.987842	0.996678	0.947531	0.890158
1	0.023018	0.012158	0.003322	0.052469	0.109842

History



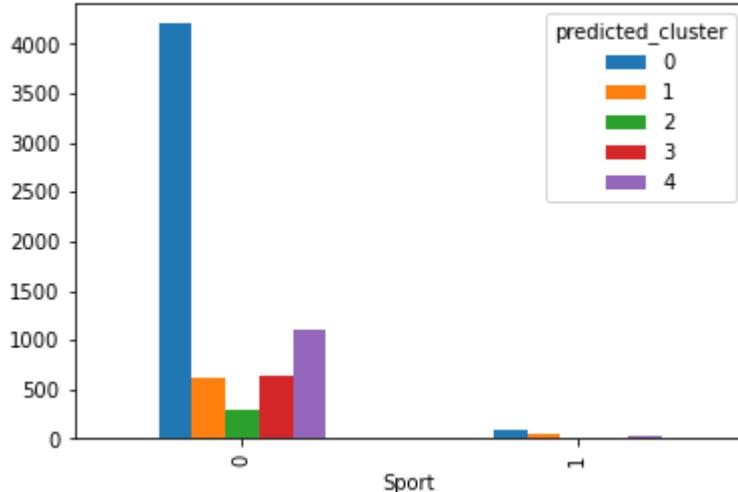
predicted_cluster	0	1	2	3	4
Mystery	3939	632	285	607	994
1	362	26	16	41	144
predicted_cluster	0	1	2	3	4
Mystery	0.915834	0.960486	0.946844	0.936728	0.873462
1	0.084166	0.039514	0.053156	0.063272	0.126538

Mystery



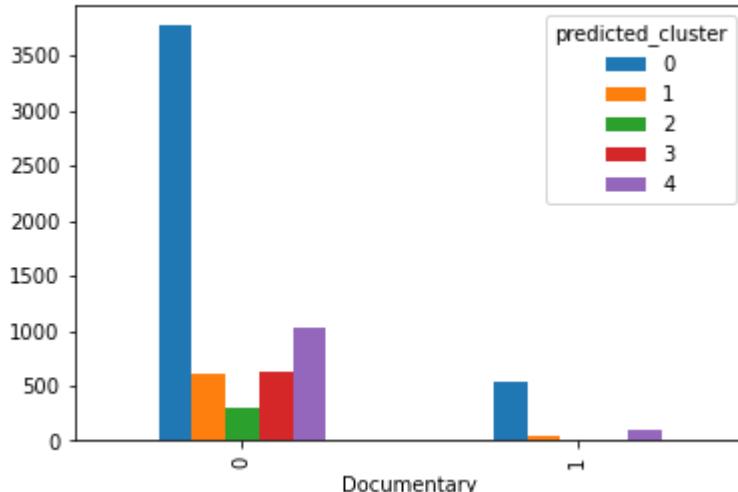
predicted_cluster	0	1	2	3	4
Sport	4204	613	295	630	1100
1	97	45	6	18	38
predicted_cluster	0	1	2	3	4
Sport	0.977447	0.931611	0.980066	0.972222	0.966608
1	0.022553	0.068389	0.019934	0.027778	0.033392

Sport

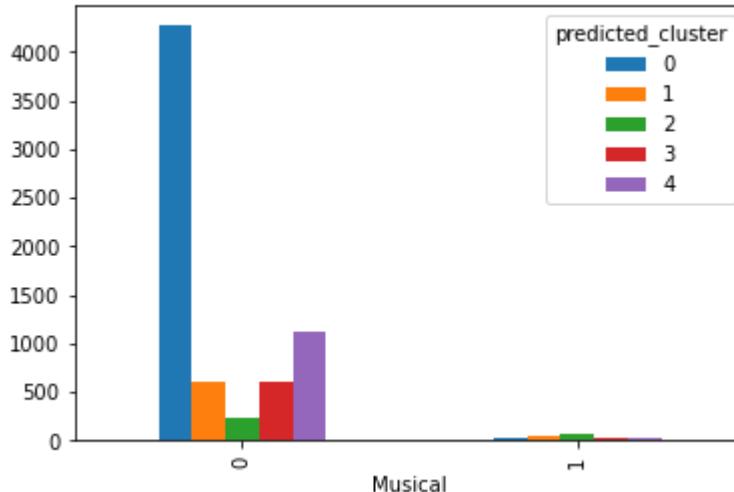


predicted_cluster	0	1	2	3	4
Documentary	3771	617	301	635	1032
1	530	41	0	13	106
predicted_cluster	0	1	2	3	4
Documentary	0.876773	0.93769	1.0	0.979938	0.906854
1	0.123227	0.06231	0.0	0.020062	0.093146

Documentary



predicted_cluster	0	1	2	3	4
Musical	4269	610	231	616	1116
1	32	48	70	32	22
predicted_cluster	0	1	2	3	4
Musical	0.99256	0.927052	0.767442	0.950617	0.980668
1	0.00744	0.072948	0.232558	0.049383	0.019332

Musical

predicted_cluster 0 1 2 3 4

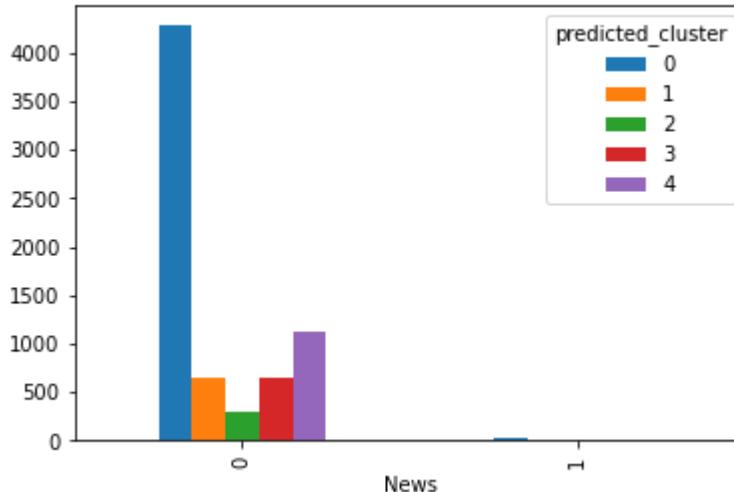
News

0	4279	657	301	648	1132
1	22	1	0	0	6

predicted_cluster 0 1 2 3 4

News

0	0.994885	0.99848	1.0	1.0	0.994728
1	0.005115	0.00152	0.0	0.0	0.005272

News

predicted_cluster 0 1 2 3 4

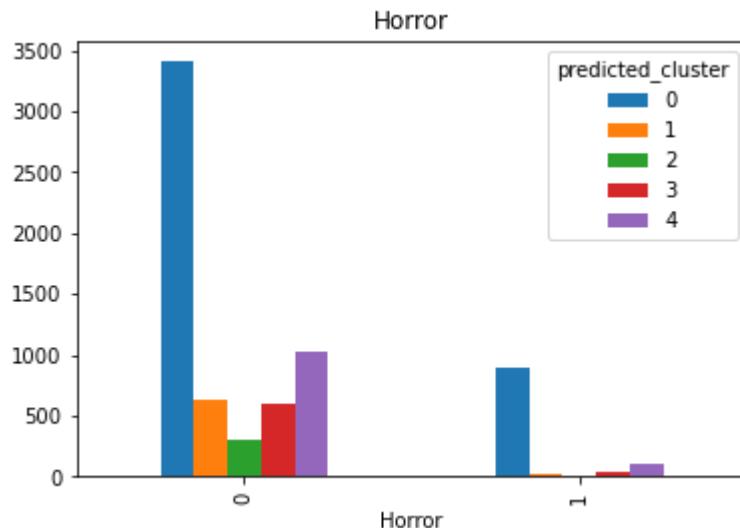
Horror

0	3406	636	296	607	1025
1	895	22	5	41	113

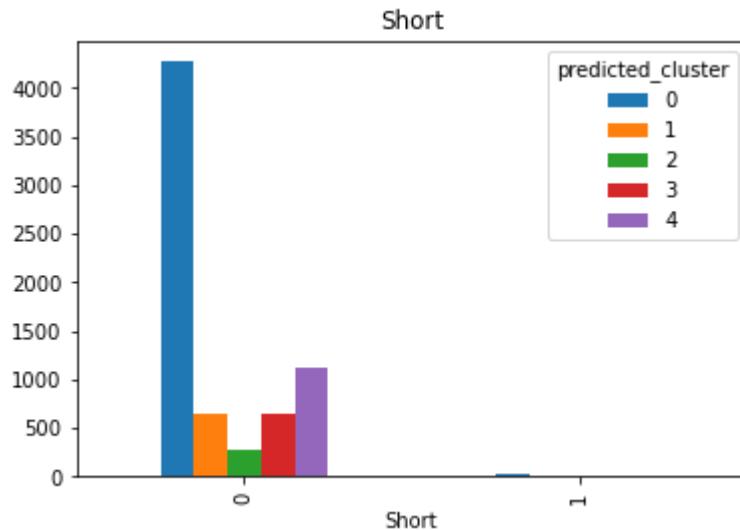
predicted_cluster 0 1 2 3 4

Horror

0	0.791909	0.966565	0.983389	0.936728	0.900703
1	0.208091	0.033435	0.016611	0.063272	0.099297

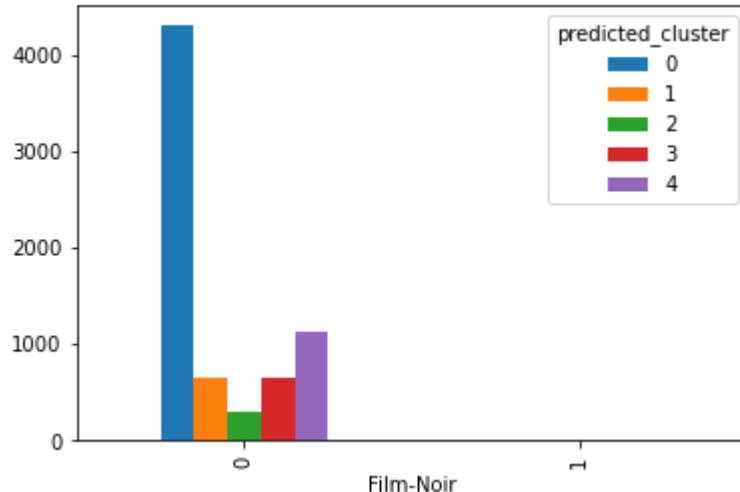


predicted_cluster	0	1	2	3	4
Short					
0	4271	646	286	646	1124
1	30	12	15	2	14
predicted_cluster	0	1	2	3	4
Short					
0	0.993025	0.981763	0.950166	0.996914	0.987698
1	0.006975	0.018237	0.049834	0.003086	0.012302



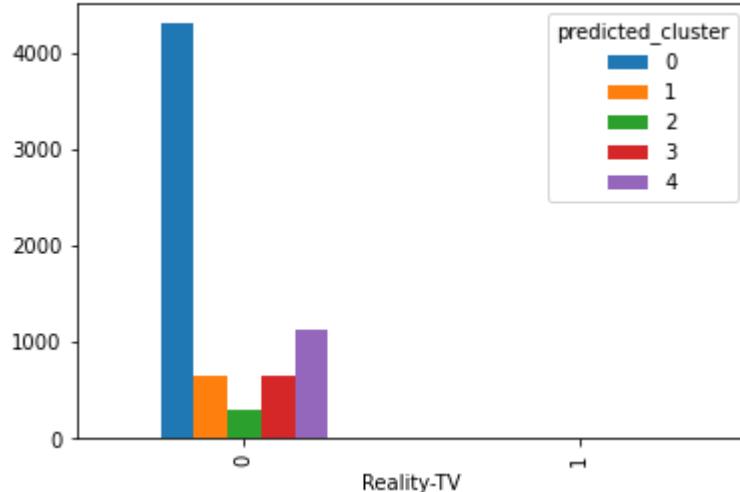
predicted_cluster	0	1	2	3	4
Film-Noir					
0	4295	658	301	648	1138
1	6	0	0	0	0
predicted_cluster	0	1	2	3	4
Film-Noir					
0	0.998605	1.0	1.0	1.0	1.0
1	0.001395	0.0	0.0	0.0	0.0

Film-Noir



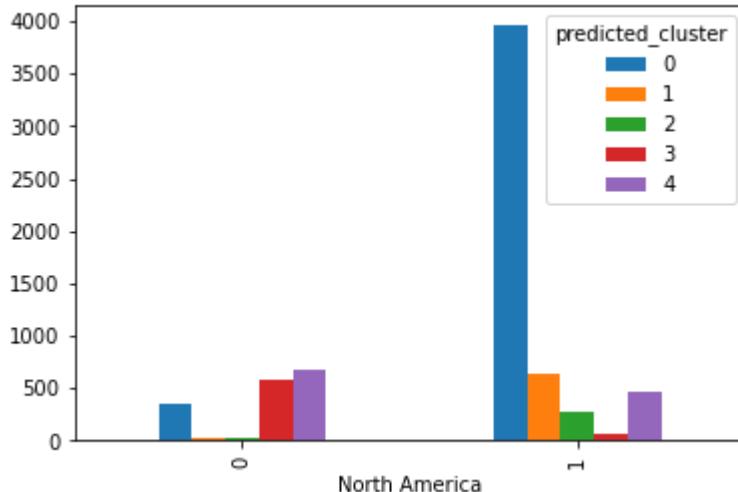
predicted_cluster	0	1	2	3	4
0	4300	658	301	648	1138
1	1	0	0	0	0
predicted_cluster	0	1	2	3	4
0	0.999767	1.0	1.0	1.0	1.0
1	0.000233	0.0	0.0	0.0	0.0

Reality-TV



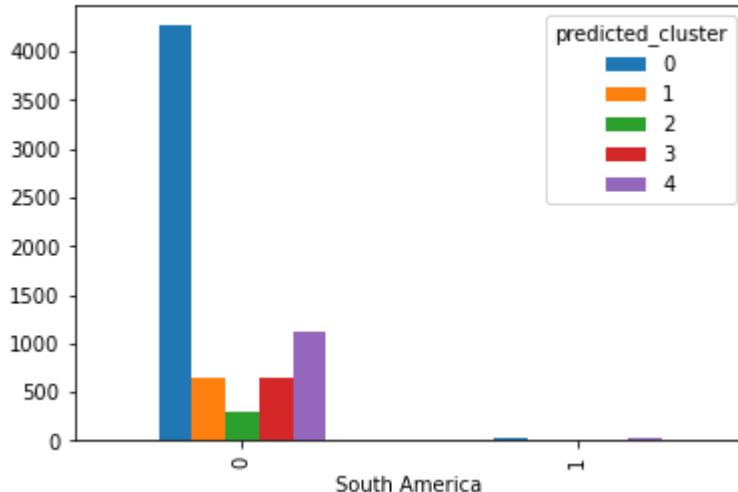
predicted_cluster	0	1	2	3	4
0	345	26	28	575	673
1	3956	632	273	73	465
predicted_cluster	0	1	2	3	4
0	0.080214	0.039514	0.093023	0.887346	0.591388
1	0.919786	0.960486	0.906977	0.112654	0.408612

North America



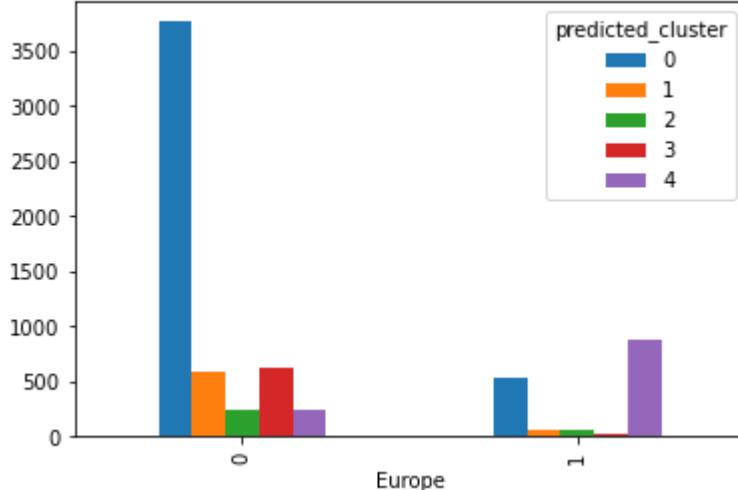
predicted_cluster	0	1	2	3	4
0	4264	657	299	642	1117
1	37	1	2	6	21
predicted_cluster	0	1	2	3	4
0	0.991397	0.99848	0.993355	0.990741	0.981547
1	0.008603	0.00152	0.006645	0.009259	0.018453

South America



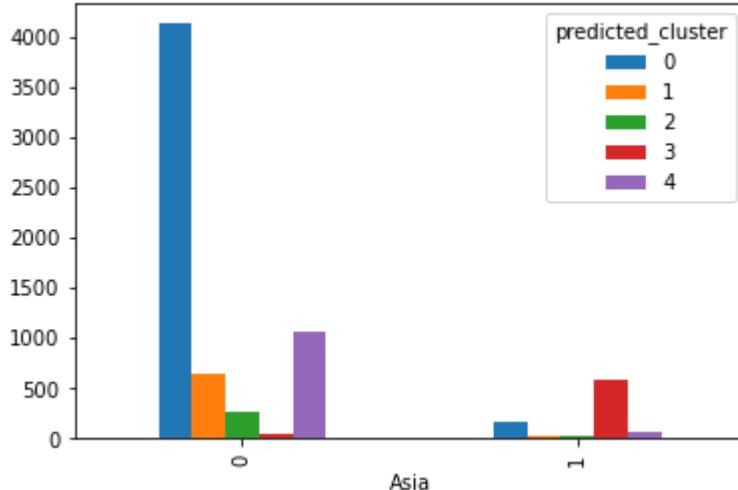
predicted_cluster	0	1	2	3	4
0	3763	588	238	620	250
1	538	70	63	28	888
predicted_cluster	0	1	2	3	4
0	0.874913	0.893617	0.790698	0.95679	0.219684
1	0.125087	0.106383	0.209302	0.04321	0.780316

Europe

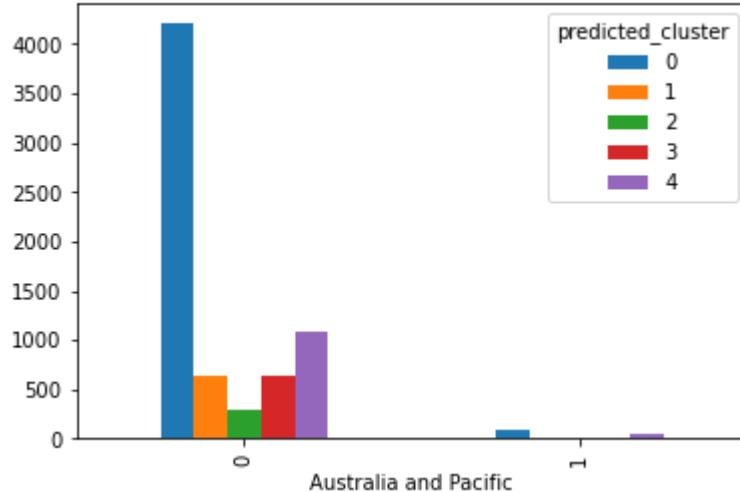


	predicted_cluster	0	1	2	3	4
Asia	0	4126	639	268	52	1064
	1	175	19	33	596	74
	predicted_cluster	0	1	2	3	4
Asia	0	0.959312	0.971125	0.890365	0.080247	0.934974
	1	0.040688	0.028875	0.109635	0.919753	0.065026

Asia



	predicted_cluster	0	1	2	3	4
Australia and Pacific	0	4206	644	285	644	1082
	1	95	14	16	4	56
	predicted_cluster	0	1	2	3	4
Australia and Pacific	0	0.977912	0.978723	0.946844	0.993827	0.950791
	1	0.022088	0.021277	0.053156	0.006173	0.049209

Australia and Pacific

predicted_cluster

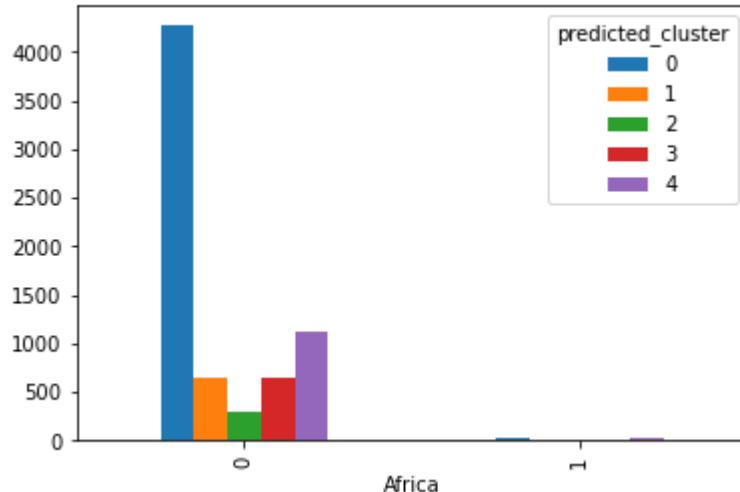
Africa

0	1	2	3	4
4271	652	301	646	1114
30	6	0	2	24

predicted_cluster

Africa

0	1	2	3	4
0.993025	0.990881	1.0	0.996914	0.97891
0.006975	0.009119	0.0	0.003086	0.02109

Africa

predicted_cluster

English

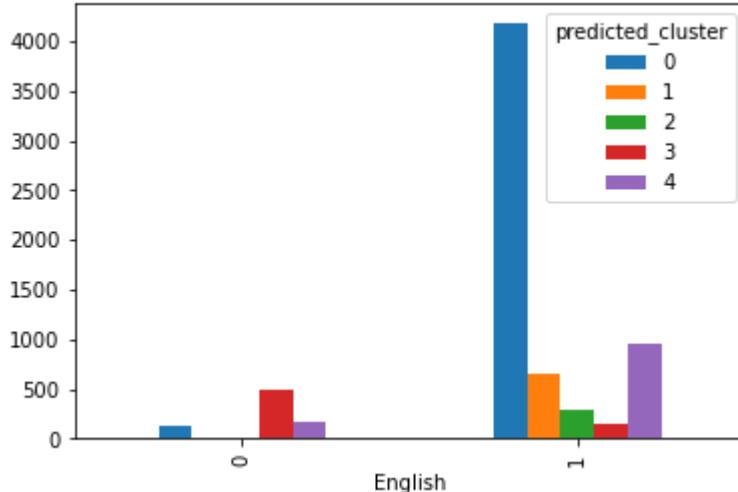
0	1	2	3	4
129	11	14	498	175
4172	647	287	150	963

predicted_cluster

English

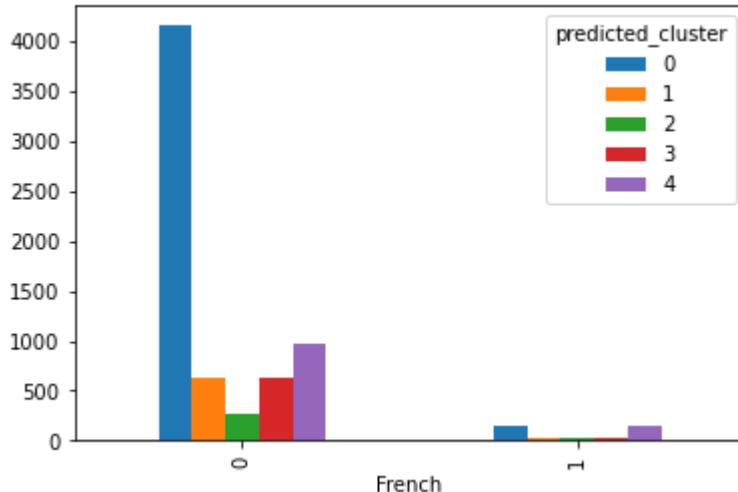
0	1	2	3	4
0.029993	0.016717	0.046512	0.768519	0.153779
0.970007	0.983283	0.953488	0.231481	0.846221

English



predicted_cluster	0	1	2	3	4
French	0.965357	0.954407	0.913621	0.967593	0.86116
1	0.034643	0.045593	0.086379	0.032407	0.13884

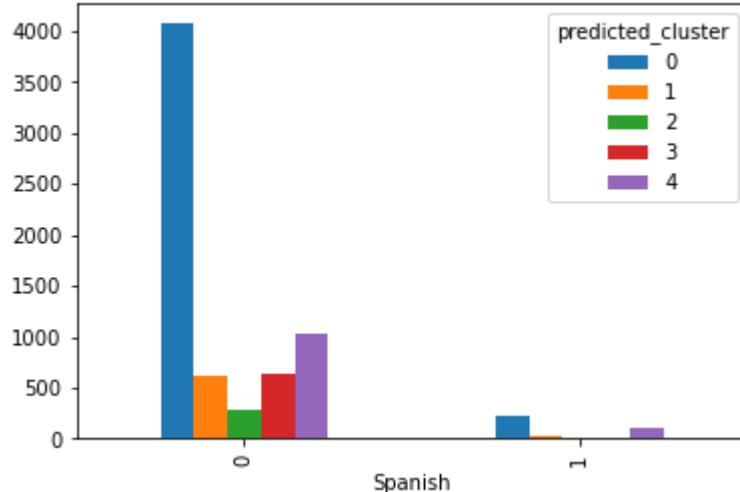
French



predicted_cluster	0	1	2	3	4
Spanish	4069	625	285	633	1025
1	232	33	16	15	113

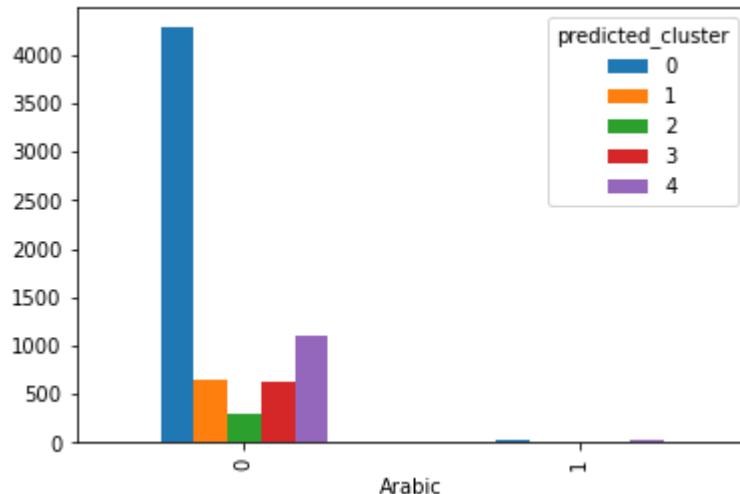
predicted_cluster	0	1	2	3	4
Spanish	0.946059	0.949848	0.946844	0.976852	0.900703
1	0.053941	0.050152	0.053156	0.023148	0.099297

Spanish



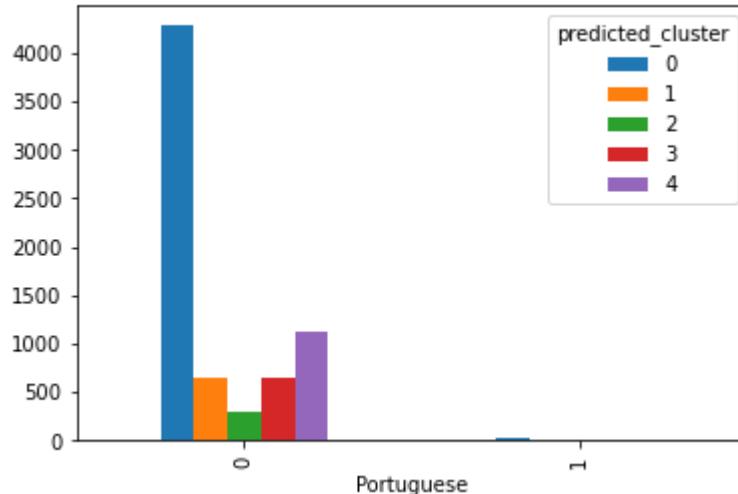
predicted_cluster	0	1	2	3	4
Arabic	4278	656	298	638	1105
1	23	2	3	10	33
predicted_cluster	0	1	2	3	4
Arabic	0.994652	0.99696	0.990033	0.984568	0.971002
1	0.005348	0.00304	0.009967	0.015432	0.028998

Arabic



predicted_cluster	0	1	2	3	4
Portuguese	4281	655	299	644	1126
1	20	3	2	4	12
predicted_cluster	0	1	2	3	4
Portuguese	0.99535	0.995441	0.993355	0.993827	0.989455
1	0.00465	0.004559	0.006645	0.006173	0.010545

Portuguese



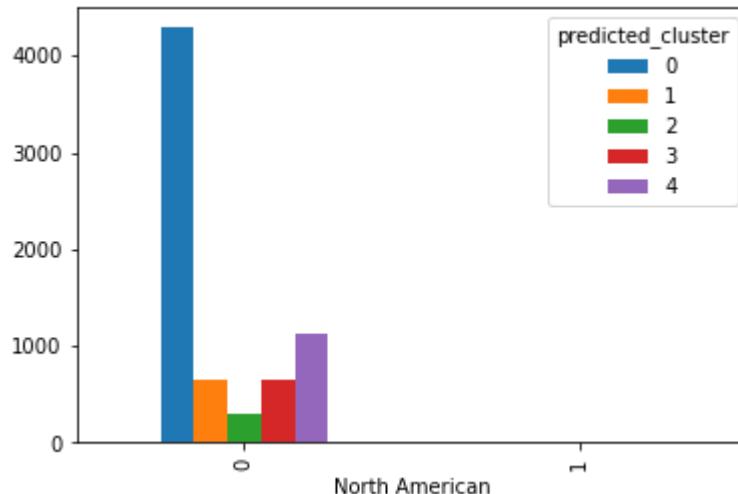
predicted_cluster 0 1 2 3 4
North American

	0	1	2	3	4
0	4288	658	299	647	1136
1	13	0	2	1	2

predicted_cluster 0 1 2 3 4
North American

	0	1	2	3	4
0	0.996977	1.0	0.993355	0.998457	0.998243
1	0.003023	0.0	0.006645	0.001543	0.001757

North American



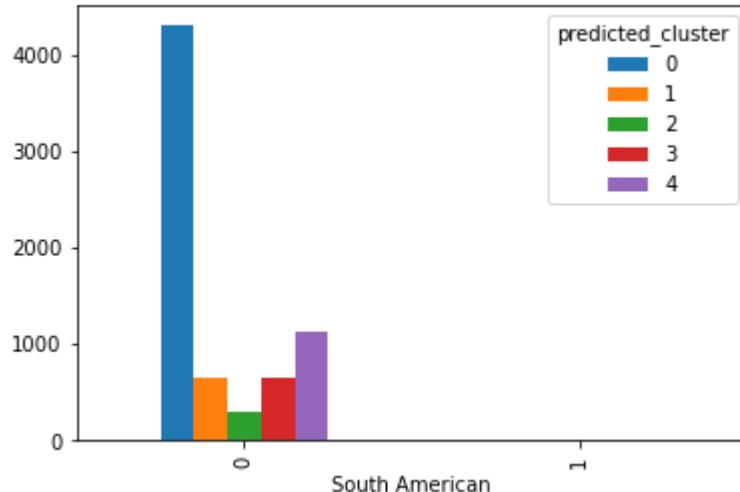
predicted_cluster 0 1 2 3 4
South American

	0	1	2	3	4
0	4300	658	301	648	1134
1	1	0	0	0	4

predicted_cluster 0 1 2 3 4
South American

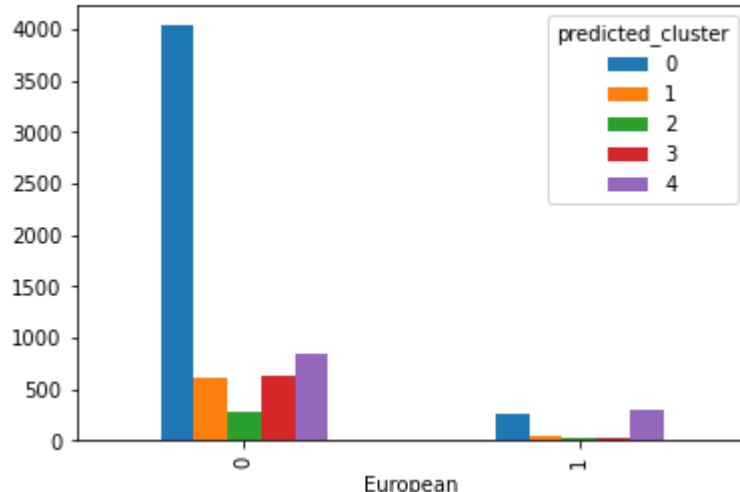
	0	1	2	3	4
0	0.999767	1.0	1.0	1.0	0.996485
1	0.000233	0.0	0.0	0.0	0.003515

South American



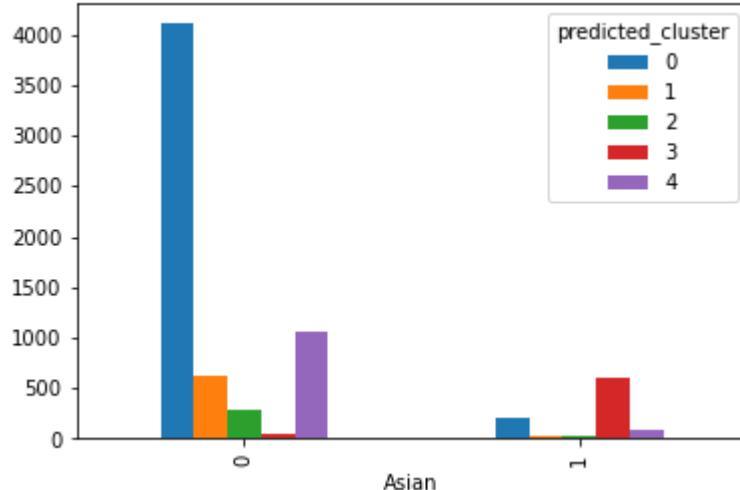
	predicted_cluster	0	1	2	3	4
predicted_cluster	0	0.937689	0.928571	0.913621	0.96142	0.742531
European	0	4033	611	275	623	845
predicted_cluster	1	0.062311	0.071429	0.086379	0.03858	0.257469

European



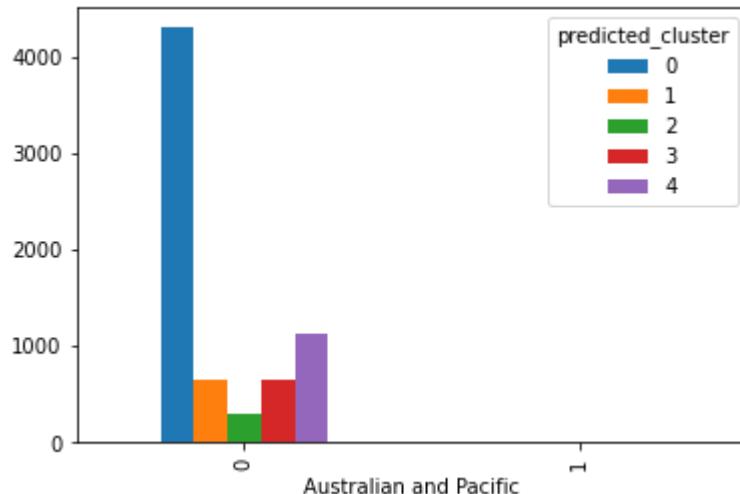
	predicted_cluster	0	1	2	3	4
predicted_cluster	0	0.954197	0.960486	0.92691	0.08179	0.92355
Asian	0	4104	632	279	53	1051
predicted_cluster	1	197	26	22	595	87

Asian



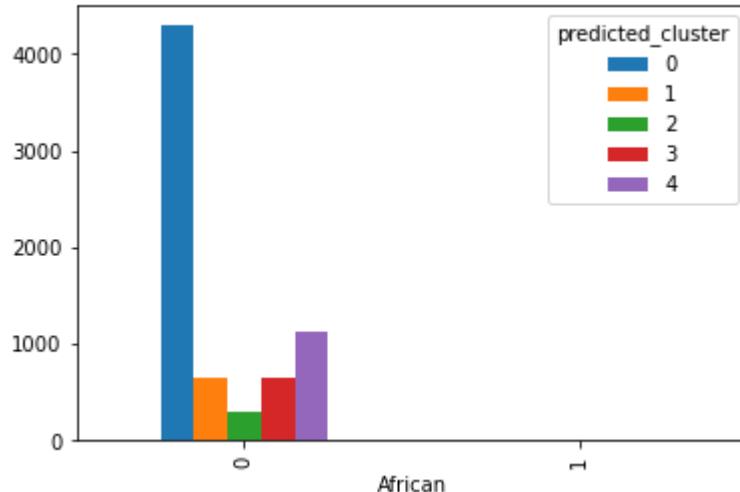
predicted_cluster	0	1	2	3	4
Australian and Pacific					
0	4297	658	299	648	1132
1	4	0	2	0	6
predicted_cluster	0	1	2	3	4
Australian and Pacific					
0	0.99907	1.0	0.993355	1.0	0.994728
1	0.00093	0.0	0.006645	0.0	0.005272

Australian and Pacific



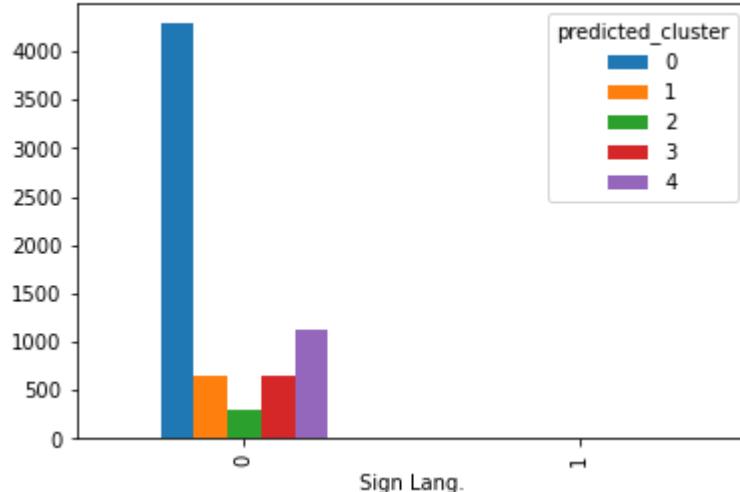
predicted_cluster	0	1	2	3	4
African					
0	4293	654	300	647	1125
1	8	4	1	1	13
predicted_cluster	0	1	2	3	4
African					
0	0.99814	0.993921	0.996678	0.998457	0.988576
1	0.00186	0.006079	0.003322	0.001543	0.011424

African

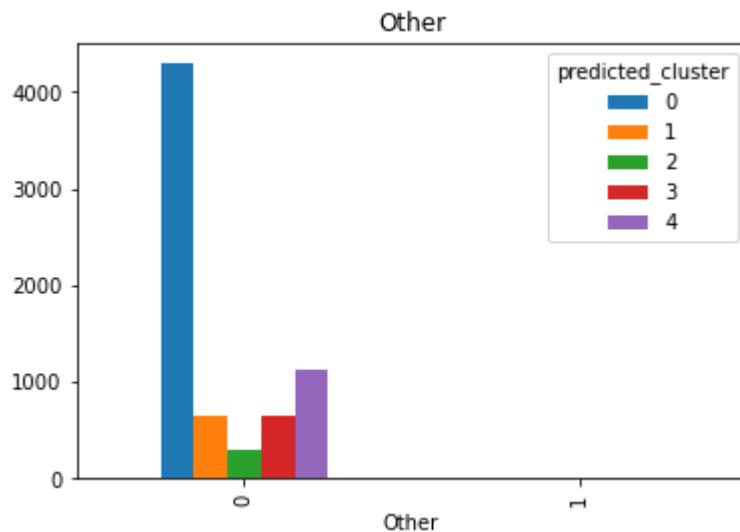


predicted_cluster	0	1	2	3	4
Sign Lang.	0.996047	0.993921	0.996678	0.998457	0.997364
1	0.003953	0.006079	0.003322	0.001543	0.002636

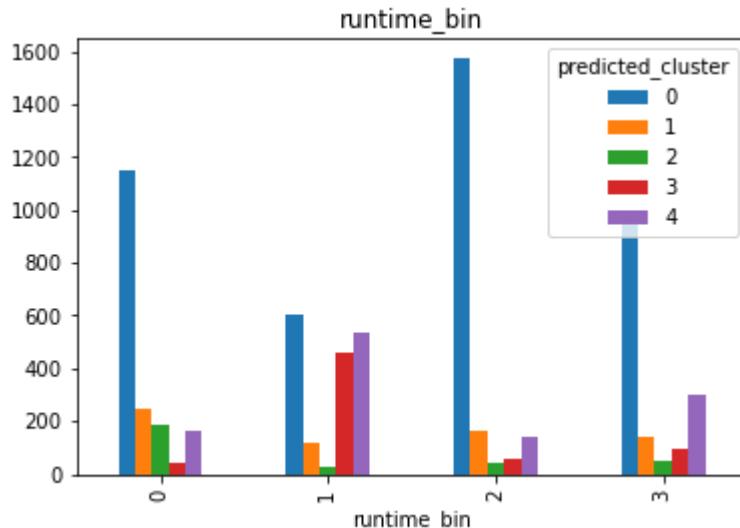
Sign Lang.



predicted_cluster	0	1	2	3	4
Other	0.99814	0.99848	0.996678	1.0	0.998243
1	0.00186	0.00152	0.003322	0.0	0.001757

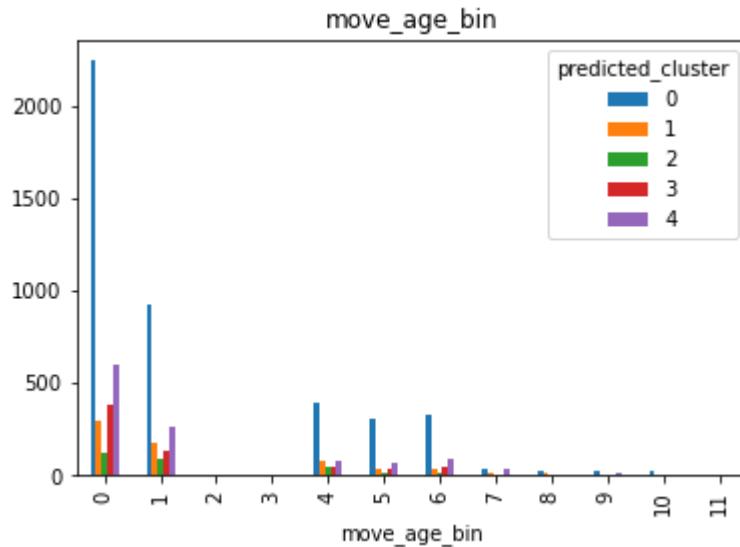


predicted_cluster	0	1	2	3	4
runtime_bin	1150	245	188	39	164
0	1150	245	188	39	164
1	601	115	25	461	532
2	1572	160	40	55	143
3	978	138	48	93	299
predicted_cluster	0	1	2	3	4
runtime_bin	0.267380	0.372340	0.624585	0.060185	0.144112
0	0.267380	0.372340	0.624585	0.060185	0.144112
1	0.139735	0.174772	0.083056	0.711420	0.467487
2	0.365496	0.243161	0.132890	0.084877	0.125659
3	0.227389	0.209726	0.159468	0.143519	0.262742

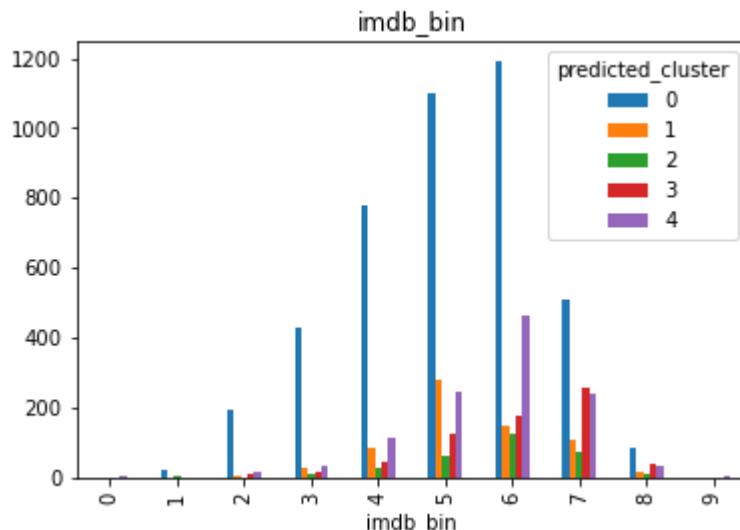


predicted_cluster	0	1	2	3	4
move_age_bin	2244	293	126	386	594
0	2244	293	126	386	594
1	928	180	87	131	263
2	1	0	0	0	1
3	0	0	1	0	0
4	389	81	42	42	73
5	308	34	12	37	65
6	322	33	15	49	85
7	38	17	6	2	38
8	24	12	6	1	2
9	22	6	4	0	8
10	24	2	2	0	6
11	1	0	0	0	3
predicted_cluster	0	1	2	3	4
move_age_bin	0	1	2	3	4

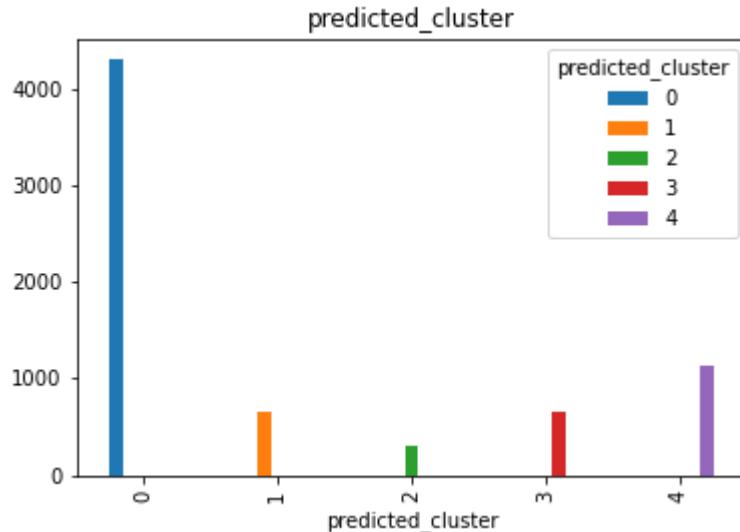
0	0.521739	0.445289	0.418605	0.595679	0.521968
1	0.215764	0.273556	0.289037	0.202160	0.231107
2	0.000233	0.000000	0.000000	0.000000	0.000879
3	0.000000	0.000000	0.003322	0.000000	0.000000
4	0.090444	0.123100	0.139535	0.064815	0.064148
5	0.071611	0.051672	0.039867	0.057099	0.057118
6	0.074866	0.050152	0.049834	0.075617	0.074692
7	0.008835	0.025836	0.019934	0.003086	0.033392
8	0.005580	0.018237	0.019934	0.001543	0.001757
9	0.005115	0.009119	0.013289	0.000000	0.007030
10	0.005580	0.003040	0.006645	0.000000	0.005272
11	0.000233	0.000000	0.000000	0.000000	0.002636



predicted_cluster	0	1	2	3	4
imdb_bin					
0	0	0	0	0	1
1	19	0	3	0	0
2	191	3	0	6	15
3	430	25	7	12	33
4	779	86	28	43	110
5	1099	277	58	124	243
6	1190	145	122	173	464
7	510	109	74	253	238
8	83	13	9	37	33
9	0	0	0	0	1
predicted_cluster	0	1	2	3	4
imdb_bin					
0	0.000000	0.000000	0.000000	0.000000	0.000879
1	0.004418	0.000000	0.009967	0.000000	0.000000
2	0.044408	0.004559	0.000000	0.009259	0.013181
3	0.099977	0.037994	0.023256	0.018519	0.028998
4	0.181121	0.130699	0.093023	0.066358	0.096661
5	0.255522	0.420973	0.192691	0.191358	0.213533
6	0.276680	0.220365	0.405316	0.266975	0.407733
7	0.118577	0.165653	0.245847	0.390432	0.209139
8	0.019298	0.019757	0.029900	0.057099	0.028998
9	0.000000	0.000000	0.000000	0.000000	0.000879



predicted_cluster	0	1	2	3	4
predicted_cluster	0	1	2	3	4
0	4301	0	0	0	0
1	0	658	0	0	0
2	0	0	301	0	0
3	0	0	0	648	0
4	0	0	0	0	1138
predicted_cluster	0	1	2	3	4
predicted_cluster	0	1	2	3	4
0	1.0	0.0	0.0	0.0	0.0
1	0.0	1.0	0.0	0.0	0.0
2	0.0	0.0	1.0	0.0	0.0
3	0.0	0.0	0.0	1.0	0.0
4	0.0	0.0	0.0	0.0	1.0



From the results throughout this report, it is apparent that the k-modes did a much better job in ascertaining groups within the data than that of the agglomerative hierarchical clustering. In terms of the research motivations, there were a lot of insights that needed to be confirmed. Prior to this analysis, there were a lot of relationships that were intuitive and needed to be substantiate with unsupervised learning. For instance, a group that contained the Disney+ streaming service should also like family and animation genres and have age groups that are younger. This specific example was better confirmed by the k-modes clustering than that of the agglomerative hierarchical clustering. The research goals of this project was to understand underlying groups within streaming platforms to better understand how to cater to them. By understanding this, reccomendations, like

different movie genres, can be made to allow for a more enjoyable viewing experience. Overall, the k-modes algorithm better helped reach the research goals of this analysis and provided informative results.

Insights Summary

In conclusion, this project provided a variety of insights on not only the dataset, but also the ways in which unsupervised learning methods can be applied and interpreted. In the beginning of the report, an exploratory data analysis as well as a data processing/cleaning phase was necessary to jumpstart the unsupervised learning analysis. First, many descriptive statistics were calculated for all the numerical data in the dataset. From the output, it was evident that there was a large standard deviation among each feature in the dataset. Additionally, with the creation of dummy variables, the standard deviation was quite unbalanced from feature to feature. To combat this, a scaling/standardizing of the data was completed to ensure a more fair and holistic analysis. Furthermore, some basic pairwise relationships were ascertained to see if there were any correlations between variables of interest. Specifically, there was a strong positive correlation between Disney+ and the Family genre, which makes sense intuitively.

After the preliminary exploratory data analysis, the dataset structure was put under scrutiny. The two dataset, `mdf` and `mdf_cat`, were plotted onto a t-sne plot to discover the shape of each dataset. Unfortunately, both datasets seemed to be encompassed by 1-2 clusters and were approximately spherical in shape. Additionally, there was a large imbalance in the size of the clusters with many clusters overlapping with one another. Because of the shape and type of dataset that was being used, two main clustering algorithms were applied to the dataset: agglomerative hierarchical clustering and k-modes clustering. From further analysis using silhouette scores, dendograms, elbow plots and t-sne plots, it was found that using 5 cluster for the k-modes algorithm and using 5 clusters with complete linkage for the agglomerative hierarchical clustering algorithm provided the most optimal results.

After choosing the final clustering, the separation and cohesion of the clusters were assessed using the silhouette score and plots. From this analysis, it was found that the agglomerative hierarchical clustering had much better separation and cohesion in comparison to that of the k-modes algorithm. However, this does not mean that hierarchical clustering performed better than k-modes. When looking at the cluster attributes, it was apparent that many of the clusterings created by k-modes made sense. In other words, k-modes was much better at identifying streaming platforms as cluster groups, while hierarchical clustering tends to muddle the streaming platforms together. Additionally, some of the cluster in the hierarchical clustering didn't make sense, like having a group that is dominated by both younger and older audiences who watch comedies and documentaries. This doesn't intuitively make sense and it yielded inaccurate results. On the other hand, k-modes provided cluster groups that actually made sense. For instance, there was a Disney+ cluster group that had younger audiences and had adventure, animation and family genre movies. This result intuitively makes sense and is more accurate. Lastly, looking at the cluster distances of each method, it was apparent that the cluster distances of agglomerative hierarchical clustering were smaller than that of k-modes clustering due to the differences in average silhouette scores.

All in all, this clustering analysis provided an insightful analysis on the research motivation and shed light on underlying groups within the streaming platforms dataset, which will help cater and recommend genres to different groups.