Capstone Project – 4
Unsupervised ML
"Netflix Movies and TV Shows Clustering"

Presented By :
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Points of Discussion

1. Problem Statement
2. Data Description
3. Data Preparation and Cleaning
4. EDA (Exploratory Data Analysis)
5. Hypothesis Testing
6. Textual Data Preprocessing
7. Dimensionality Reduction
8. Model Implementation
9. Recommender System
10. Conclusion

1. Problem Statement

This dataset consists of **tv shows** and **movies** available on **Netflix** as of **2019**. The dataset is collected from Flixable which is a third-party Netflix search engine.

In 2018, they released an interesting **report** which shows that the **number of TV shows** on Netflix has nearly **tripled since 2010**. The streaming service's **number of movies** has **decreased** by more than **2,000 titles** since **2010**, while its number of TV shows has nearly tripled. It will be interesting to explore what all other insights can be obtained from the same dataset.

In this project, required to do:

- **Exploratory Data Analysis**.
- Understanding what type **content** is available in **different countries**.
- Is **Netflix** has increasingly **focusing** on **TV** rather than movies in **recent years**.
- Clustering **similar content** by matching **text-based features**.

2. Data Description

The dataset contains movies and tv shows information like title, cast, director, release year, rating, duration etc.

The features of the dataset are :

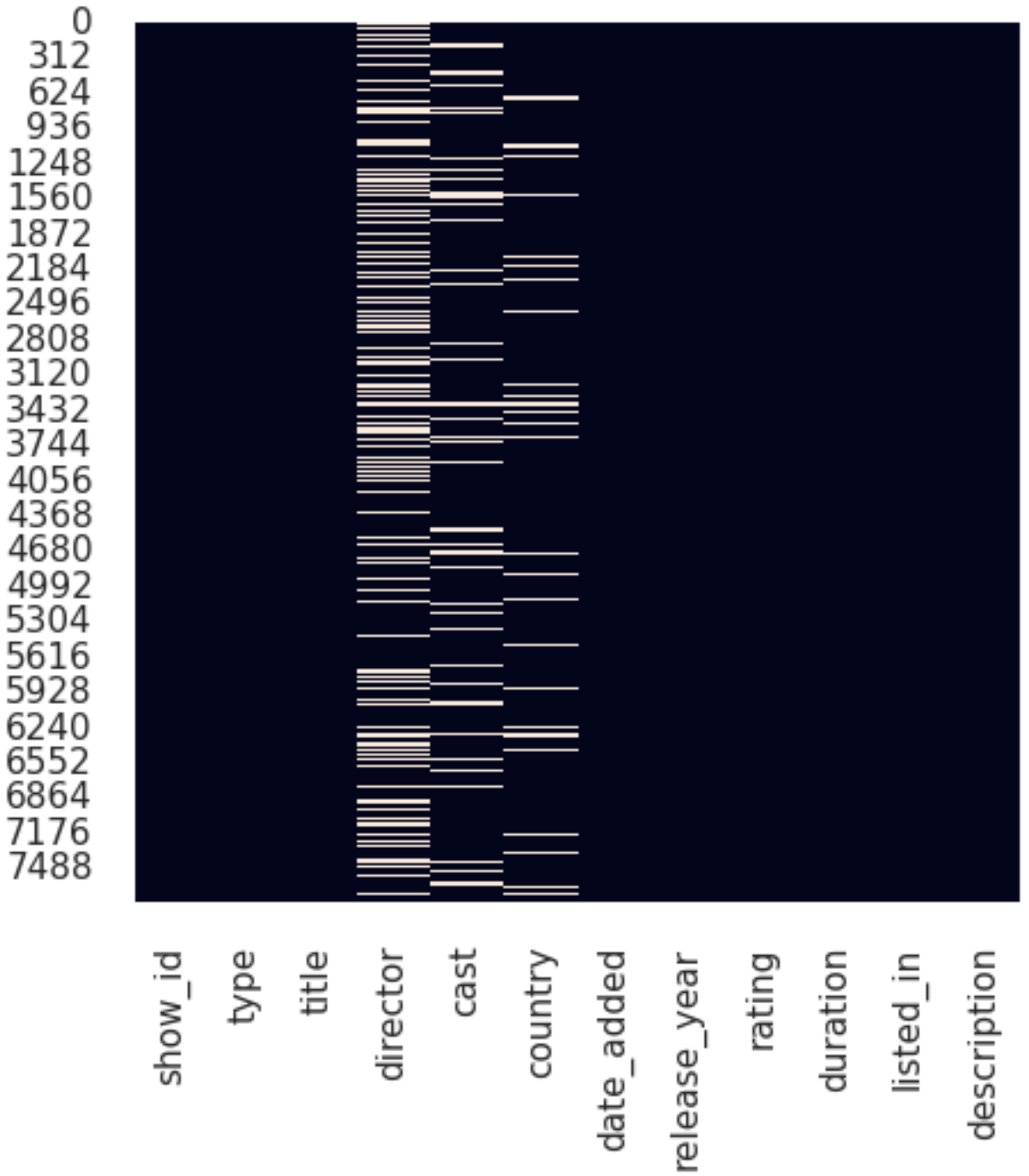
- **show_id**: Unique Id number for all the listed rows
- **type**: denotes type of show namely TV Show or Movie
- **title**: title of the movie
- **director**: Name of director/directors
- **cast**: lists the cast of the movie
- **country**: country of the production house
- **date_added**: the date the show was added
- **release_year**: year of the release of the show
- **rating**: show ratings
- **duration**: duration of the show
- **listed_in**: the genre of the show
- **description**: summary/ description of the movie

3. EDA (Exploratory Data Analysis)

Missing Values

```
# Missing Values/Null Values Count
df.isnull().sum()
```

```
show_id          0
type             0
title            0
director      2389
cast           718
country        507
date_added      10
release_year     0
rating           7
duration         0
listed_in        0
description      0
dtype: int64
```



4. Data Preparation and Cleaning

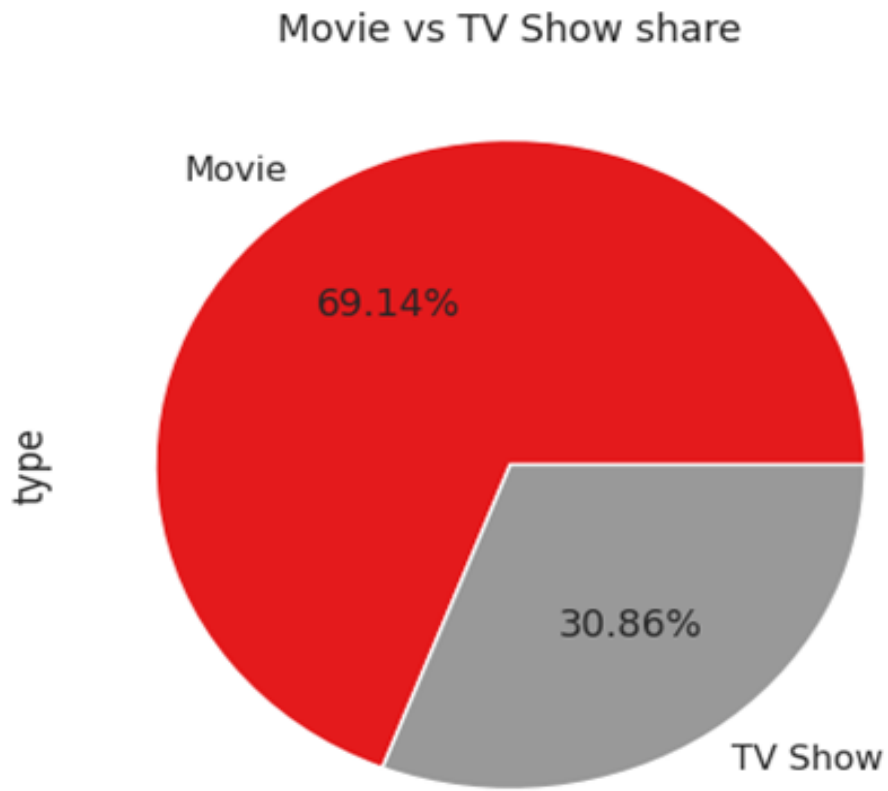
To make the data analysis ready i have done the following:

- Filled missing values of **cast** with **Not available**.
- Filled missing values of **country** with **Not Known**.
- Dropped rows of **date_added** missing values.
- Dropped rows of **ratings** missing values.
- Dropped the entire column of **director** as it had much number of missing values, we can not do that so we replaced the null values of director with **Unknown.**

MOVIE VS TV SHOW SHARE

Types of shows available in Netflix is not even with high count for TV shows.

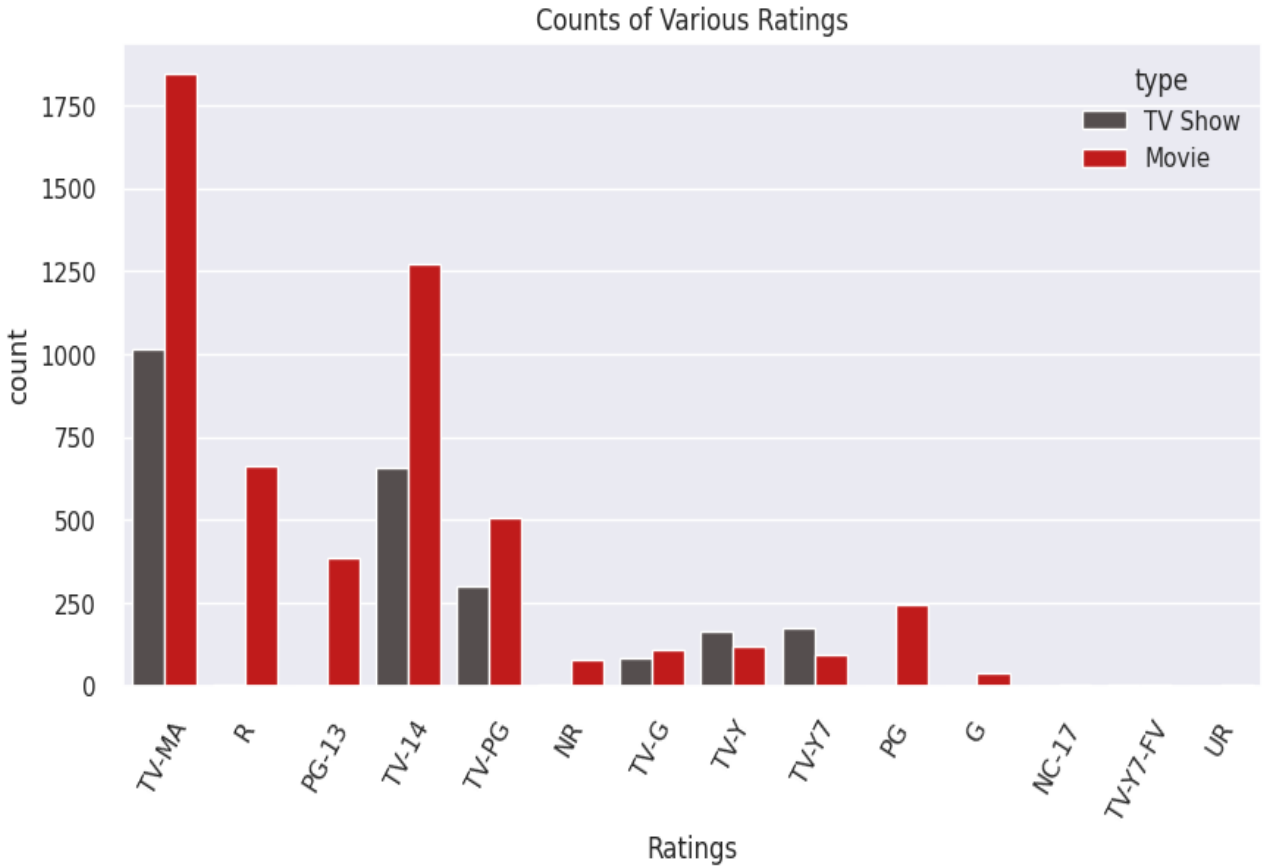
69.14% of the data belongs to Movies and 30.86% of the data for TV shows.



VARIOUS RATINGS COUNT

Little Kids	Older Kids	Teens	Mature
G, TV-Y, TV-G	PG, TV-Y7, TV-Y7-FV, TV-PG	PG-13, TV-14	R, NC-17, TV-MA

- **TV-MA** tops the charts, indicating that **mature content** is **more popular** on **Netflix**.
- This popularity is followed by **TV-14** and **TV-PG**, which are Shows focused on **Teens** and **Older kids**.
- Very few titles with a rating **NC-17** exist. It can be understood since this type of content is purely for the audience **above 17**.



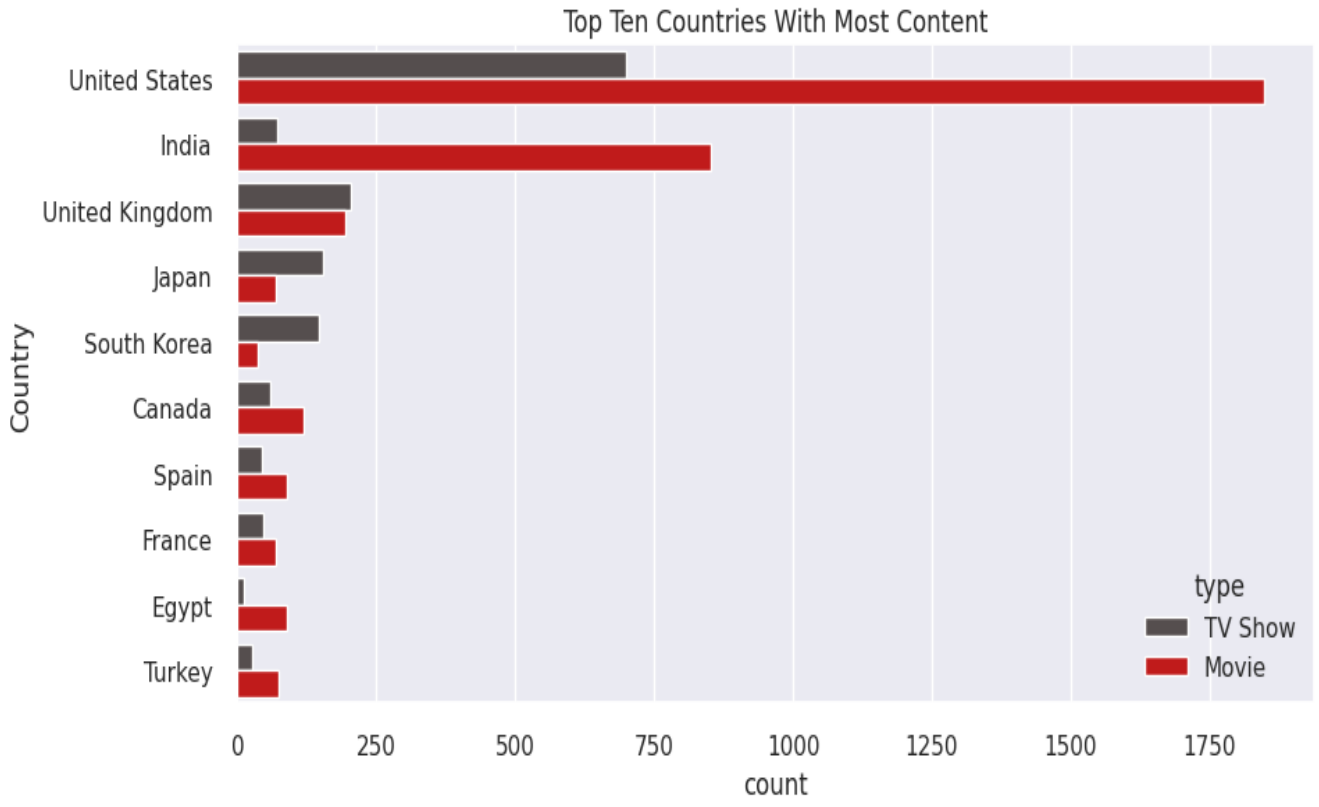
Each Rating Counts for Different Types of Shows:

rating	type	
G	Movie	39
NC-17	Movie	3
NR	Movie	79
	TV Show	4
PG	Movie	247
PG-13	Movie	386
R	Movie	663
	TV Show	2
TV-14	Movie	1272
	TV Show	656
TV-G	Movie	111
	TV Show	83
TV-MA	Movie	1845
	TV Show	1016
TV-PG	Movie	505
	TV Show	299
TV-Y	Movie	117
	TV Show	162
TV-Y7	Movie	95
	TV Show	175
TV-Y7-FV	Movie	5
	TV Show	1
UR	Movie	5

dtype: int64

TOP 10 COUNTRIES WITH MOST CONTENT

- The **United States** is a **leading producer** of both types of shows (**Movies** and **TV Shows**), this makes sense since **Netflix is a US company**.
- The **influence** of **Bollywood** in **India** explains the type of content available, and perhaps the **main focus** of this industry is **Movies** and **not TV Shows**.
- **TV Shows** are **more frequent** in **South Korea**, which explains the **KDrama** culture nowadays.



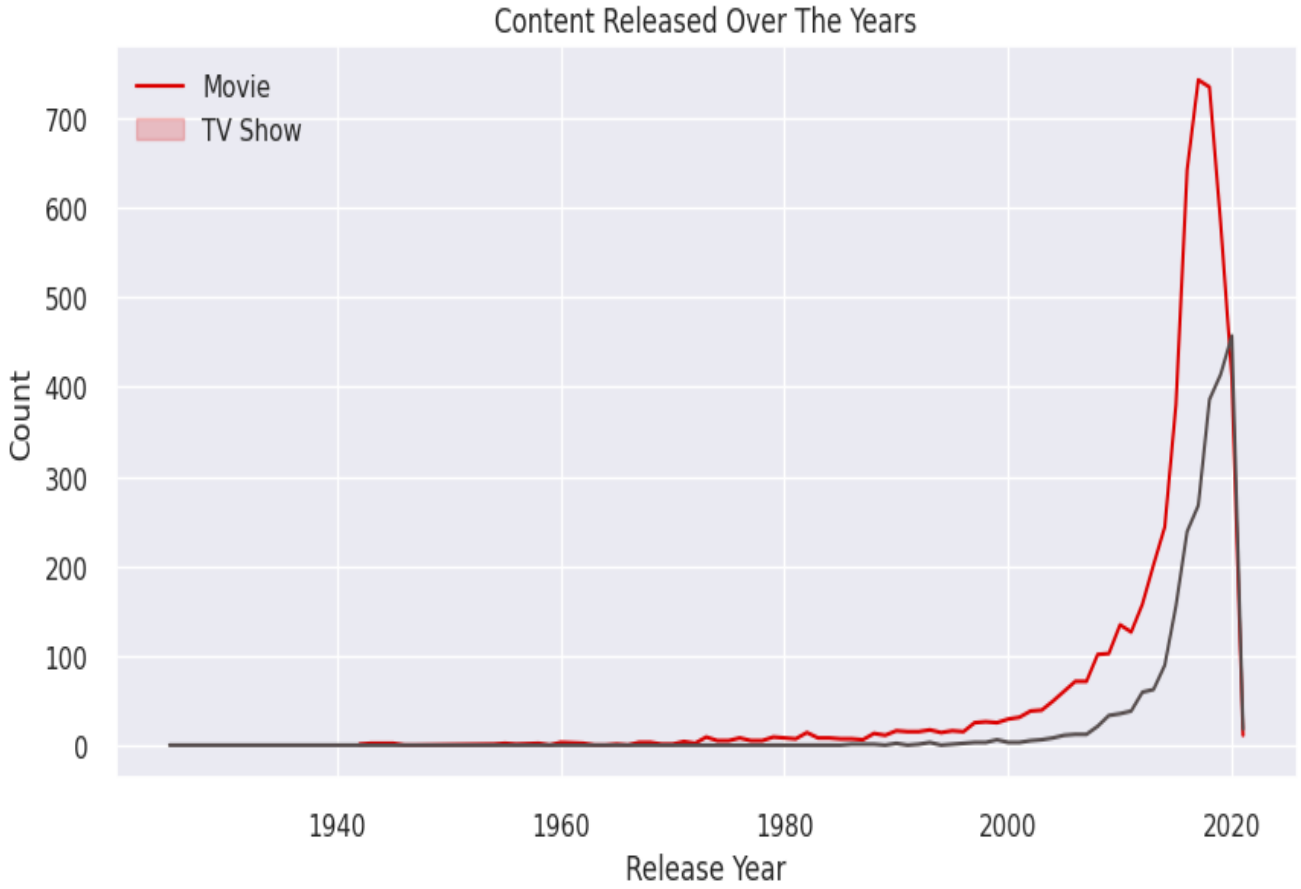
Number of Shows Produced by Top 10 Countries:

type	country	
Movie	United States	1847
	India	852
	United Kingdom	193
	Canada	118
	Egypt	89
	Spain	89
	Turkey	73
	Philippines	70
	France	69
	Japan	69
TV Show	United States	699
	United Kingdom	203
	Japan	155
	South Korea	147
	India	71
	Taiwan	68
	Canada	59
	France	46
	Spain	45
	Australia	44

Name: country, dtype: int64

CONTENT RELEASED OVER THE YEARS

- Growth in the number of **movies** on Netflix is **much higher** than **tv shows**.
- **Most of the content** available was released between **2010** and **2020**.
- **Highest** number of **movies** got released in **2017** & **2018** and **tv shows** got released in **2019** & **2020**.
- Very few movies, and tv shows got released before the year **2010** and in **2021**. It is due to very little data collected from the year **2021**.



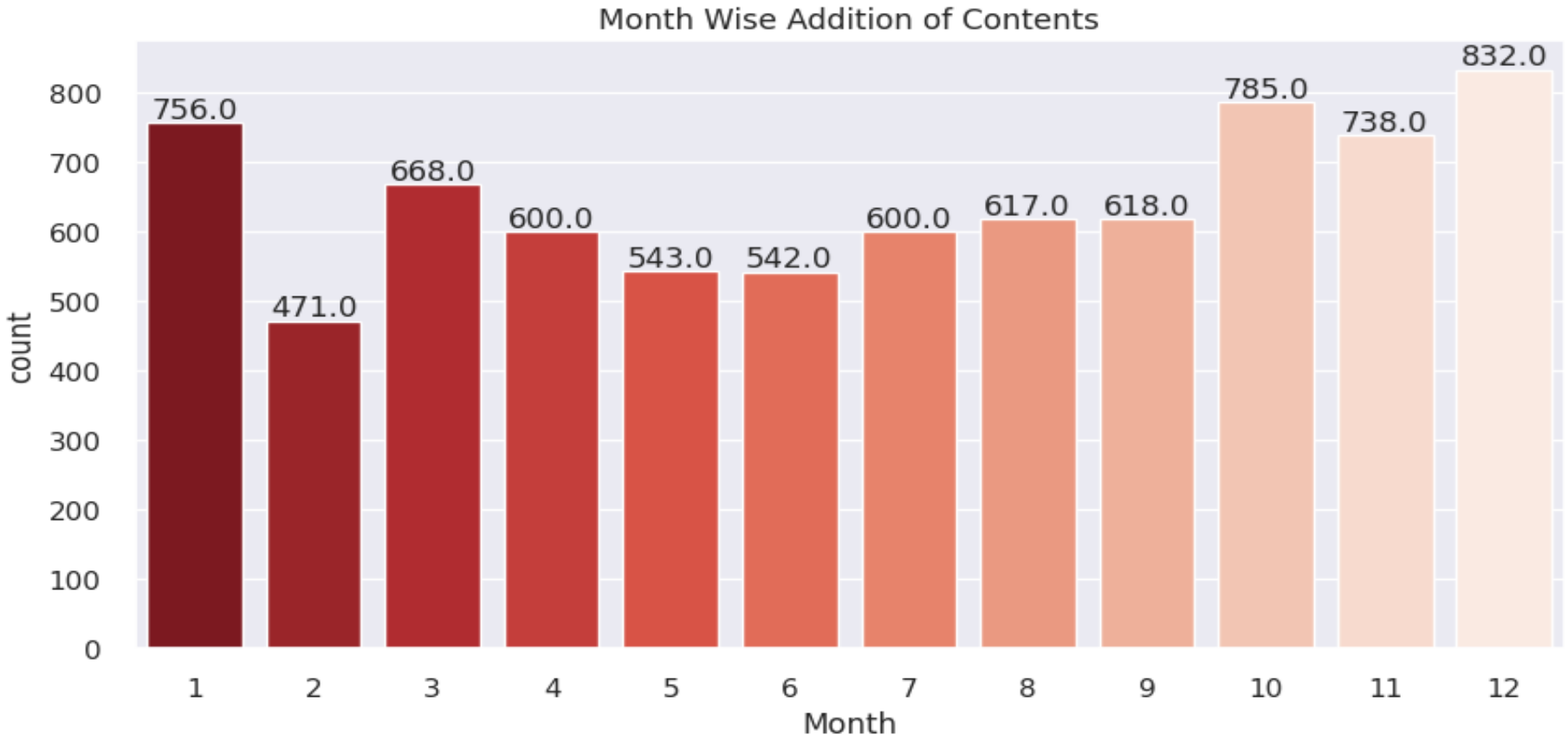
Number of Shows Released in Each Year:

type	release_year	
Movie	2017	742
	2018	734
	2016	642
	2019	582
	2020	411
	2015	380
	2014	244
	2013	202
	2012	158
	2010	135
TV Show	2020	457
	2019	414
	2018	386
	2017	268
	2016	239
	2015	156
	2014	90
	2013	63
	2012	60
	2011	39

Name: release_year, dtype: int64

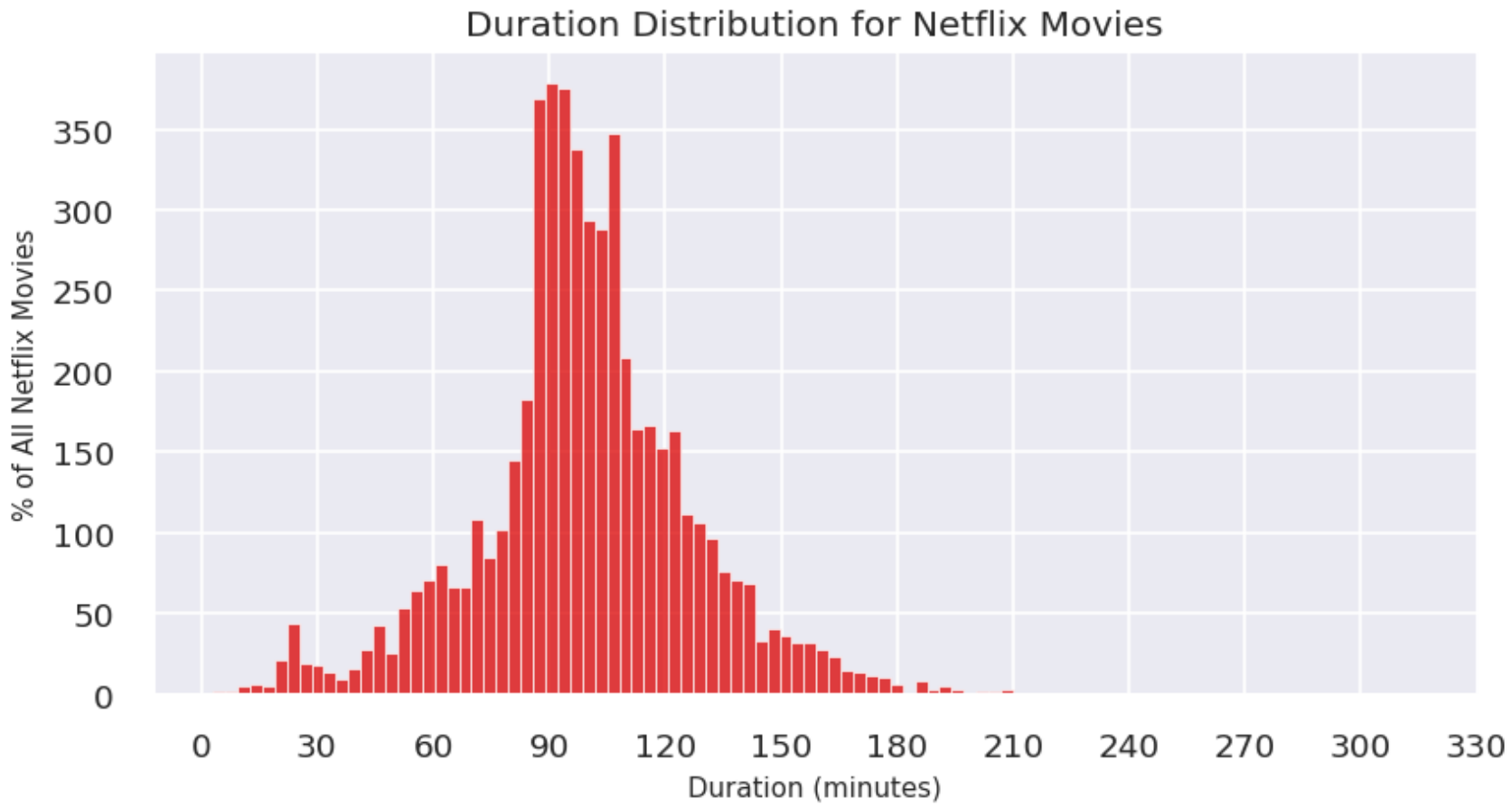
CONTENT ADDED OVER THE MONTHS

- **October**, **November**, **December**, and **January** are months in which many tv shows and movies get **uploaded** to the platform.
- It might be **due to** the **winter**, as in these months people may **stay at home** and watch **tv shows** and **movies** in their free time.



NETFLIX MOVIES DURATION

- **Most number of movies** on the Netflix platform are last for **90** to **120 minutes**.
- Very **few movies** are of **length** more than **200 minutes**.



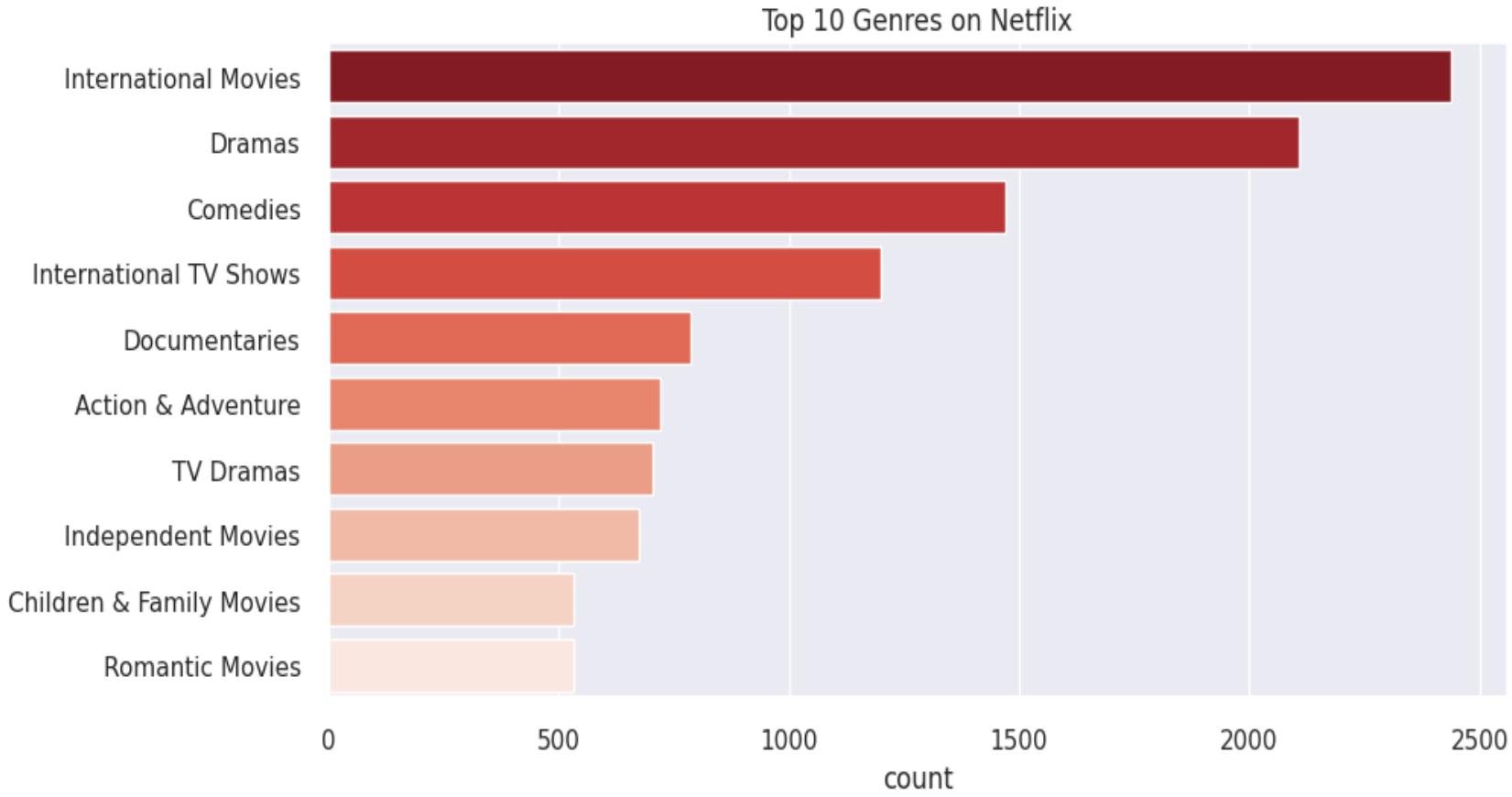
MOST USED WORDS IN SHOWS TITLE

- Most **repeated words** in **title** include **Christmas**, **Love**, **World**, **Man**, and **Story**.
- We saw that most of the movies and tv shows **got added** during the **winters**, which tells why **Christmas** appeared many times in the titles.

Most Used Words In Shows Title

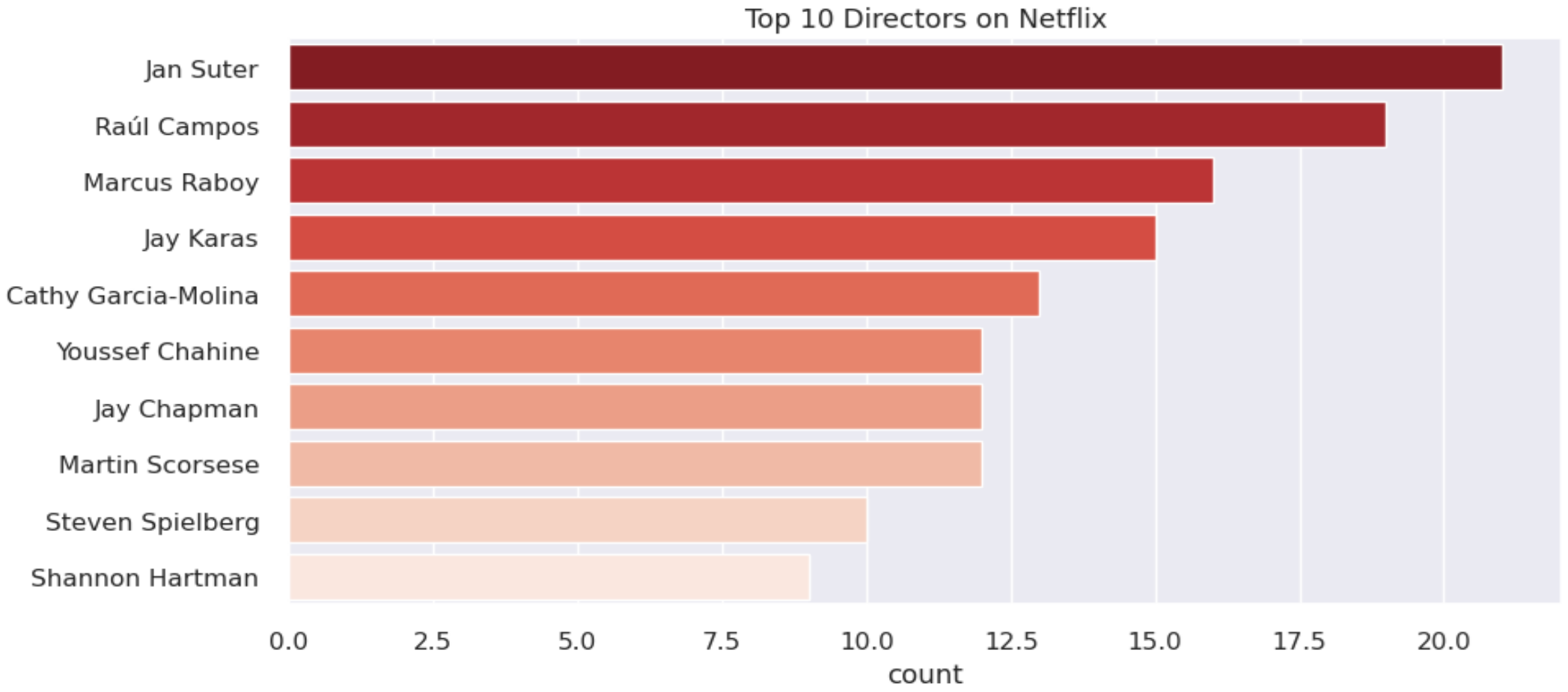
TOP 10 GENRES

- In terms of genres, **international movies** takes the cake surprisingly followed by **dramas** and **comedies**.
- Even though the **United States** has the **most content** available, it looks like **Netflix** has decided to **release** a ton of **international movies**.



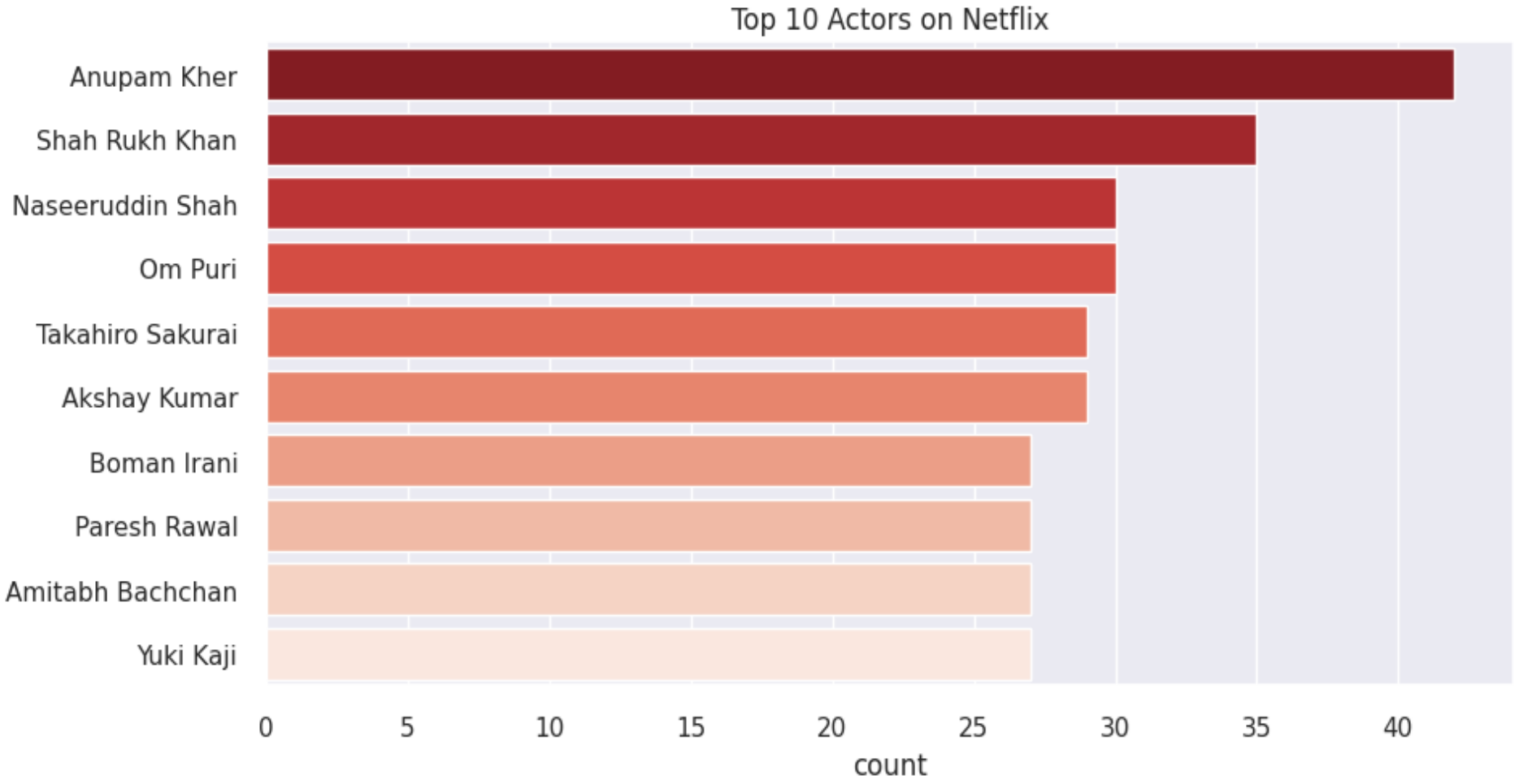
TOP 10 DIRECTORS

- **Jan Suter**, **Raúl Campos**, **Marcus Raboy**, **Jay Karas**, **Cathy Garcia-Molina** are the **top 5 directors** which highest number of movies and tv shows are available in netflix.
- As we stated previously regarding the top genres, it's no surprise that the **most popular directors** on **Netflix** with the most titles are **mainly international** as well.



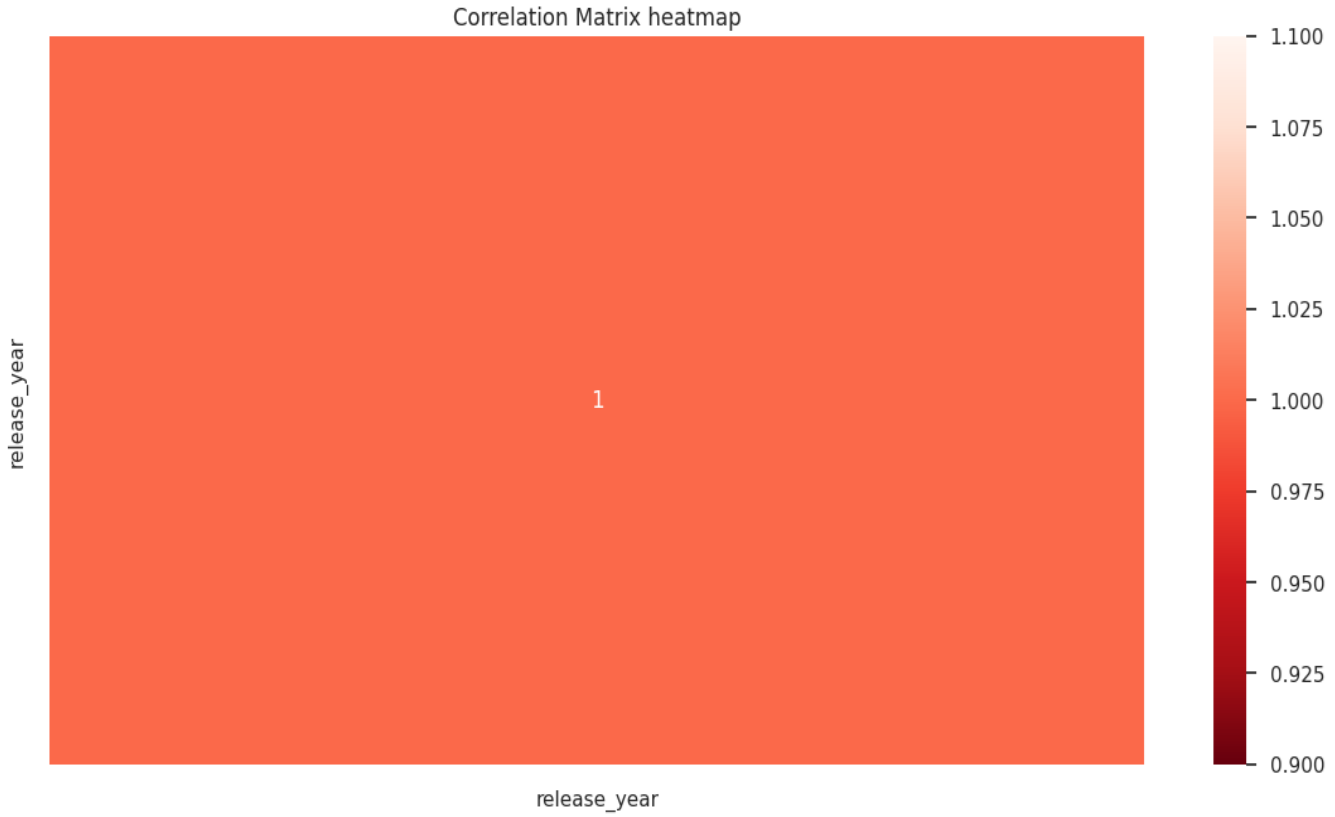
TOP 10 ACTORS

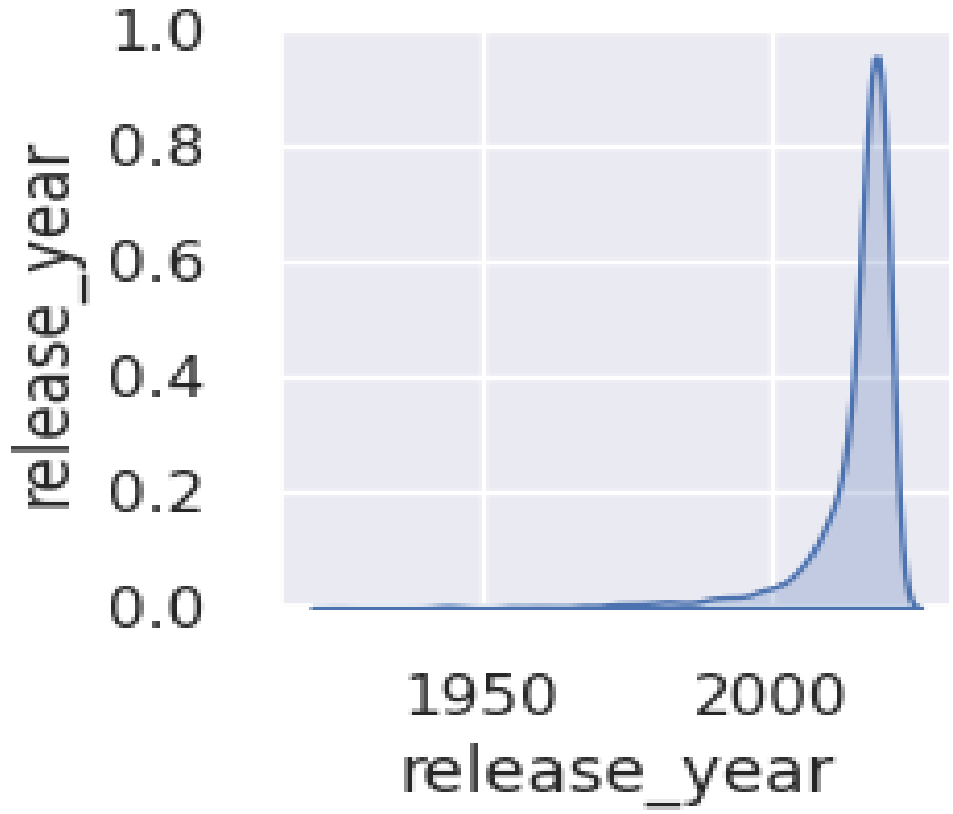
- The **actors** in the **top ten list** of **most numbers tv shows** and **movies** are from **India**.
- **Anupam Kher** and **Shah Rukh Khan** have **30 above content** alone in **netflix**.



CORRELATION HEATMAP & PAIR PLOT

- Since there is **only one value** in **dataframe** of **integer type**, we are unable to visualize the **correlation matrix heatmap** and **pair plot** as well.





5. Hypothesis Testing

HYPOTHESIS TESTING - 1

AVERAGE NUMBER OF MOVIES ON NETFLIX IN UNITED STATES IS HIGHER THAN THE MOVIES ON NETFLIX IN INDIA

- I selected the **two-sample t-test** for this analysis as it is suitable for **comparing** the **means** of **two independent samples**.
- By applying this test, I was able to calculate the **p-value** and **determine** if there is a **significant difference** in the number of movies **between** the **two countries**.

Null hypothesis: $H_o : \mu_{unitedstates} = \mu_{india}$

Alternate hypothesis: $H_1 : \mu_{unitedstates} \neq \mu_{india}$

Test Type: Two-sample t-test

```
Since p-value (0.0079015610234886 38) is less than 0.05, we reject null hypothesis.
Hence, There is a significant difference in average number of movies produced by the 'United States' and 'India'.
```

HYPOTHESIS TESTING - 2

NUMBER OF MOVIES AVAILABLE ON NETFLIX IS GREATER THAN THE NUMBER OF TV SHOWS AVAILABLE ON NETFLIX

- The two sample z-test is used to determine if there is a significant difference between two categorical variables.
- In this case, I wanted to test if there was a significant difference between the number of movies and tv shows available on Netflix.

Null hypothesis: $H_o : \mu_{movie} = \mu_{tvshow}$

Alternate hypothesis: $H_1 : \mu_{movie} \neq \mu_{tvshow}$

Test Type: Two sample z-test

```
Since p-value (0.0) is less than 0.05, we reject null hypothesis.
Hence, There is a significant difference in number of 'movies' and 'TV shows' available on Netflix.
```

6. TEXTUAL DATA

- **Transforming text into a clean and consistent form**

WORK PROCESS

- 1. TOKENIZATION
- Replacing sensitive data with unique identification symbols

- 2. TEXT REMOVAL
- Removing punctuation, numbers, stop words etc.

- 3. STEMMING
- Reducing words to their base form (root form)

- 4. LEMMATIZATION
- Grouping together words with their root form

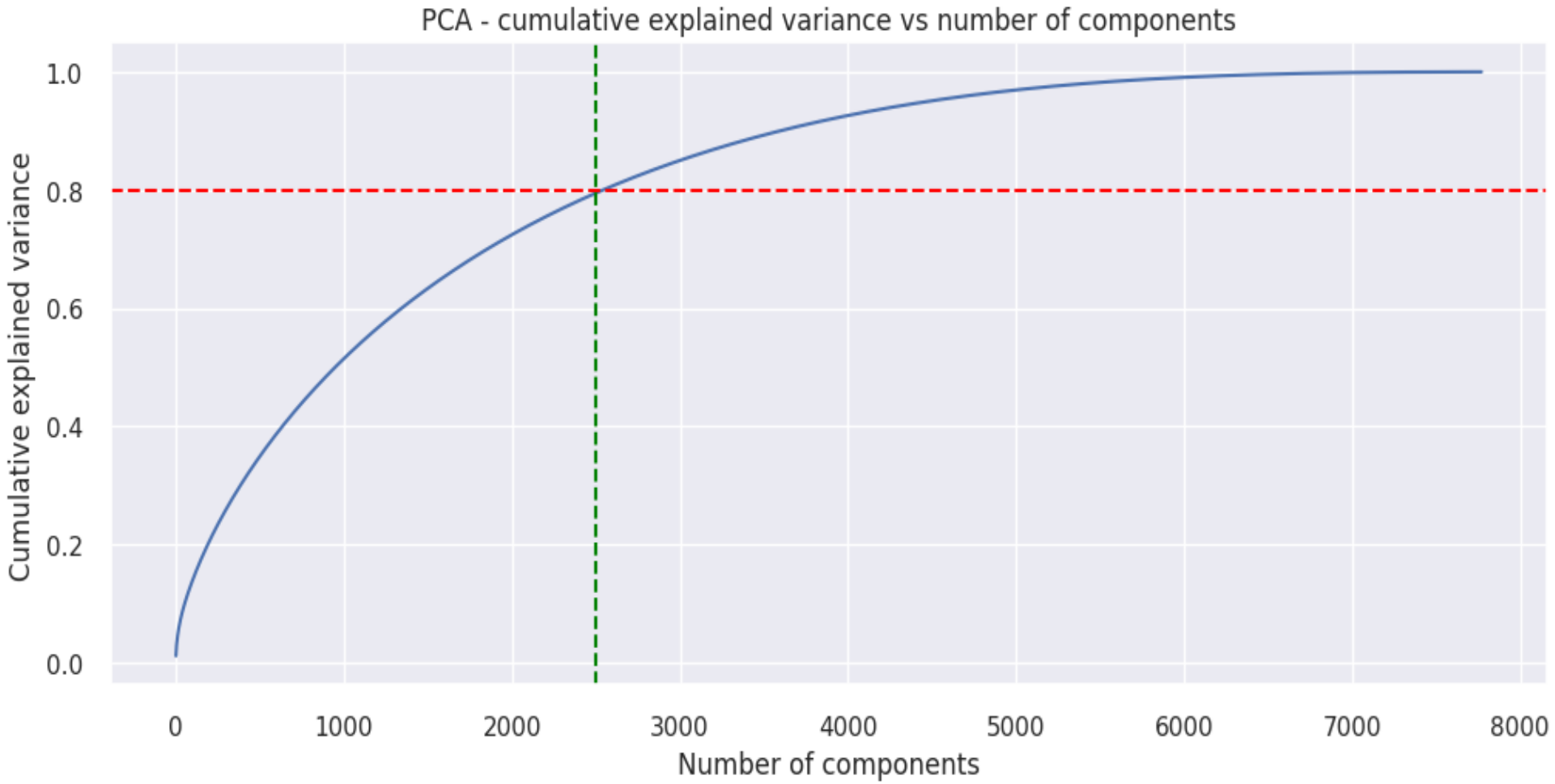
- 5. POS TAGGING
- Process of finding the sequence of tags

7. DIMENSIONALITY REDUCTION

- Reducing the feature set’s dimension

DIMENSIONALITY REDUCTION

- **Principal Component Analysis** (**PCA**) was used to **reduce** the **dimensionality** of data.
- Captured more than **80%** of the **variance** by **reducing** the **components** to **2500**.

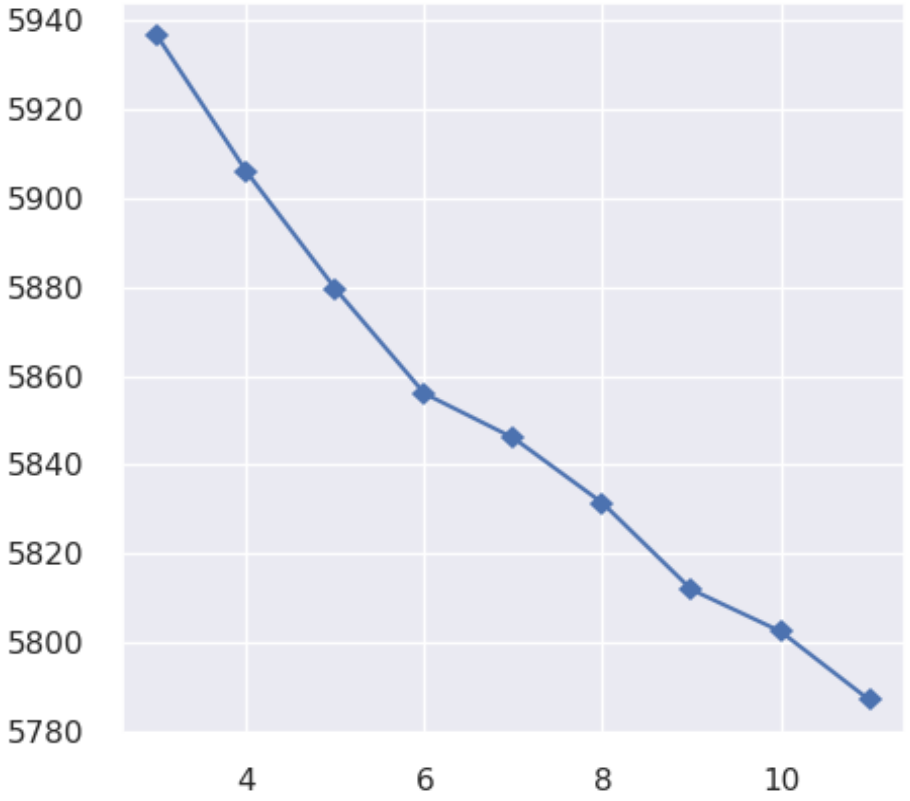


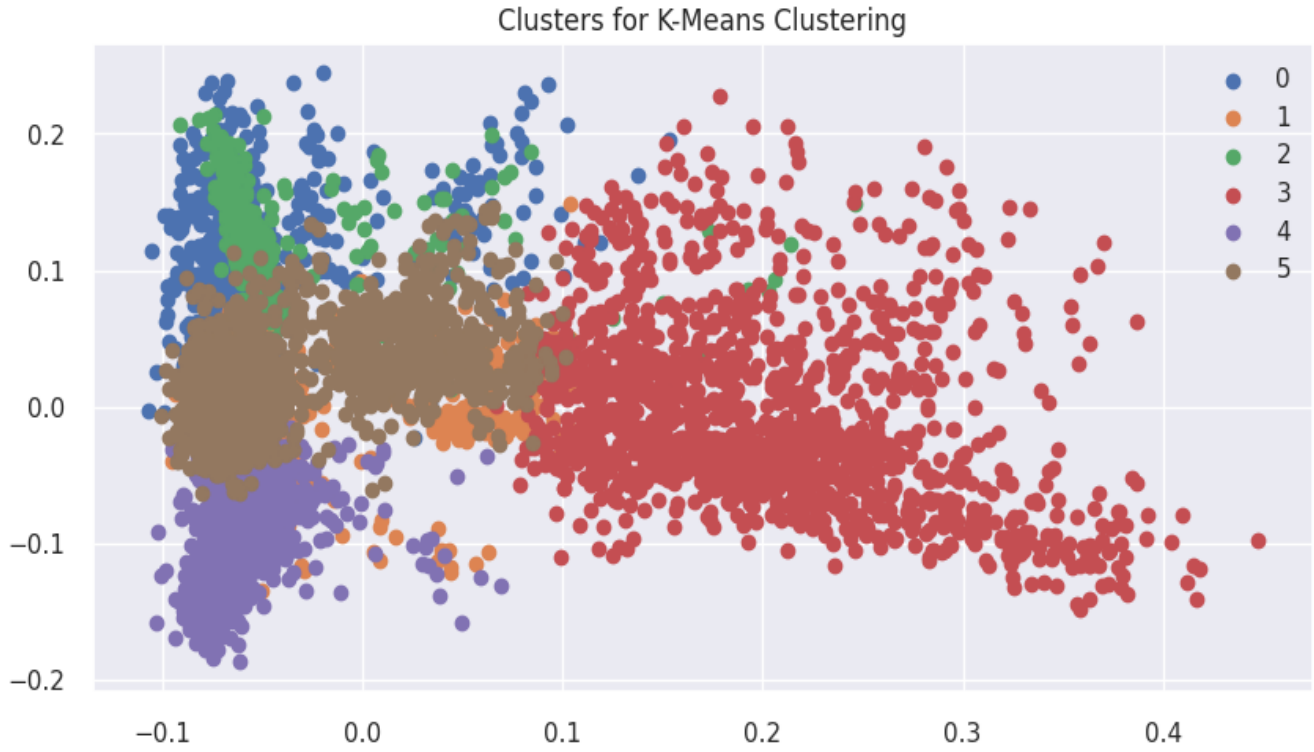
8. MODEL IMPLEMENTATION

- Train ML Algorithms to get best model

K-MEANS CLUSTERING

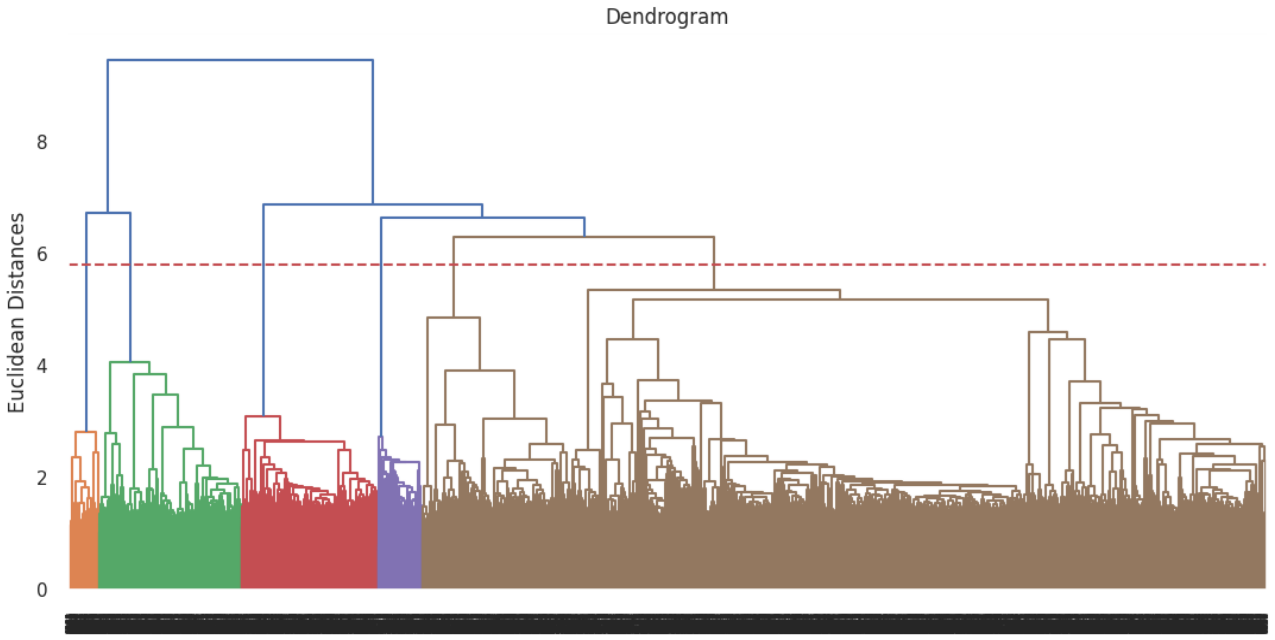
- **K-means** is a **centroid-based** clustering algorithm, where we **calculate** the **distance** between **each data point** and a **centroid** to assign it to a cluster.
- Here **optimal number** of **clusters** is **6** by using the **elbow method**.

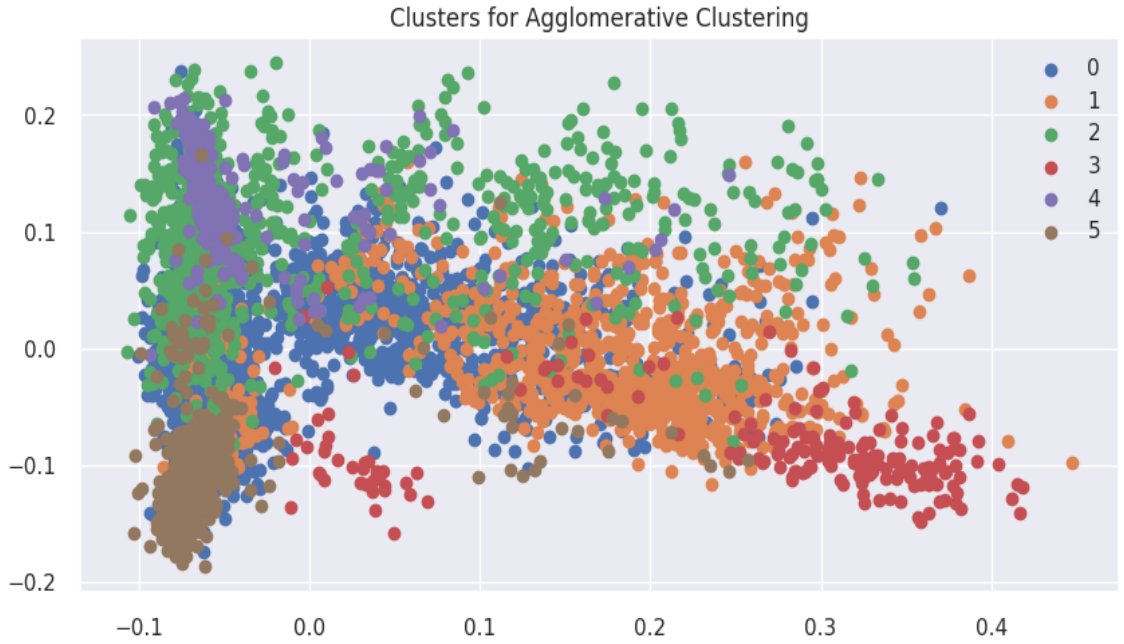




HIERARCHICAL CLUSTERING

- From **dendrogram** we get the **optimal number** of **clusters** is **6**.
- Used **agglomerative clustering** here, which is a type of **hierarchical clustering algorithm**. It helps us to **divides** the **population** into **several clusters**.





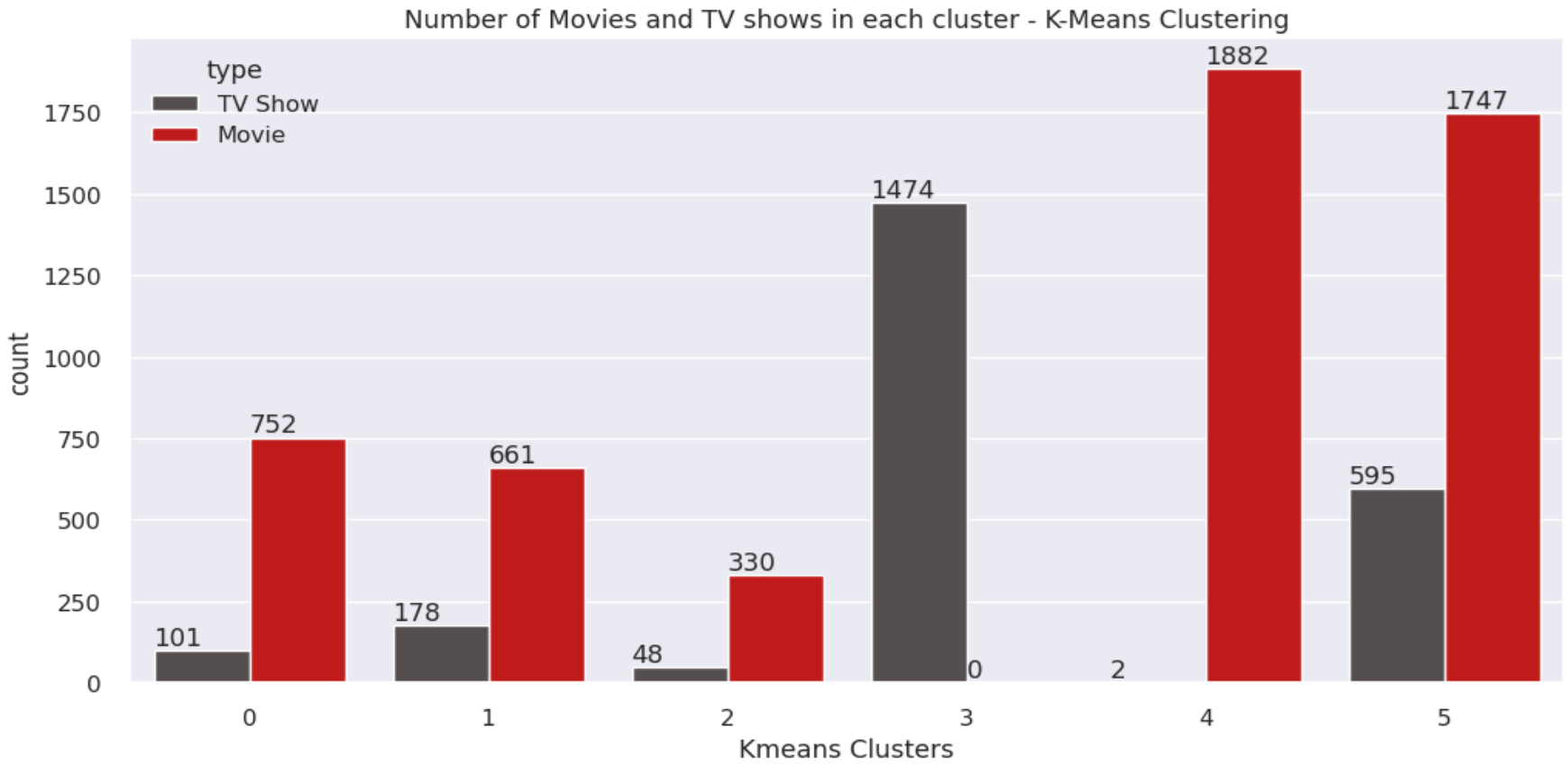
SILHOUETTE SCORE FOR CLUSTERING

- **Silhouette score** is **highest** for the **cluster 5**, so the **optimal number** of **clusters** will be **5**.
- **Silhouette score** is a metric used to calculate the goodness of a clustering technique. Its value ranges from **-1** to **1**.

```
For n_clusters = 2, silhouette score is 0.0083
For n_clusters = 3, silhouette score is 0.0107
For n_clusters = 4, silhouette score is 0.0117
For n_clusters = 5, silhouette score is 0.0131
For n_clusters = 6, silhouette score is 0.0105
For n_clusters = 7, silhouette score is 0.0091
For n_clusters = 8, silhouette score is 0.0101
For n_clusters = 9, silhouette score is 0.0102
For n_clusters = 10, silhouette score is 0.0121
For n_clusters = 11, silhouette score is 0.0100
For n_clusters = 12, silhouette score is 0.0116
For n_clusters = 13, silhouette score is 0.0112
For n_clusters = 14, silhouette score is 0.0125
```

FINAL PREDICTION MODEL

- Selected **K-Mean Clustering model** as the **best model** for our data.
- The clusters are **well divided** in this model and through this cluster we can **know** what **type of data** is in **which cluster**.



TOPIC MODELING

- Used **topic modeling** instead of feature importance and model explainability.
- We can get **topic wise feature importance**. **Assume** that the **clusters** are **topics**.
- Used **CountVectorizer** process for **Vectorization of data** and **Latent Dirichlet Allocation** for **building a topic**.

TOPIC MODELING

The most **important features**, which we are get from each **topics**:

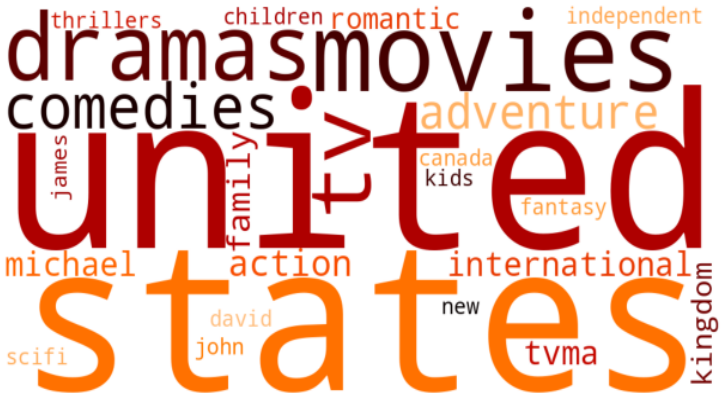
```
Topic 0:
tv united states tvma shows

Topic 1:
movies dramas international united states

Topic 2:
movies international japan anime dramas

Topic 3:
united states movies dramas tv

Topic 4:
tv shows international tvma united

Topic 5:
movies international india dramas comedies
```

WORDCLOUD FOR OTHER TOPICS

Most Important Features in Topic 1

Most Important Features in Topic 2

Most Important Features in Topic 3



Most Important Features in Topic 4

Most Important Features in Topic 5

RECOMMENDER SYSTEM

TOP 10 RECOMMENDED MOVIES/ TV SHOWS

- **Content-based recommender system** on the basis of **cosine similarity score**.

```
# Testing Recommender System on a Indian Movie
recommend('Zindagi Na Milegi Dobara')
```

```
------------------------------------------------------------
Since you liked 'Zindagi Na Milegi Dobara', you may also like:
------------------------------------------------------------
Dev.D
Zero
Katha
Shanghai
Waiting
Saath Saath
Cycle
Raajneeti
Luck by Chance
Jagga Jasoos
```

```
# Testing Recommender System on a International Movie
recommend('Avengers: Infinity War')
```

```
------------------------------------------------------------
Since you liked 'Avengers: Infinity War', you may also like:
------------------------------------------------------------
Thor: Ragnarok
Mark Gatiss: A Study in Sherlock
Her
Marco Polo: One Hundred Eyes
Penguins of Madagascar: The Movie
Walk with Me
War Horse
Chef
Legion
Hail, Caesar!
```

```
# Testing Recommender System on a Korean TV Show
recommend('What in the World Happened?')
```

```
------------------------------------------------------------
Since you liked 'What in the World Happened?', you may also like:
------------------------------------------------------------
Hymn of Death
Dear My Friends
Hi Bye, Mama!
Secret Affair
Rookie Historian Goo Hae-Ryung
My Mister
Magic Phone
Mr. Sunshine
Man to Man
Love Alarm
```

```
# Testing Recommender System on a Content, Which is Not Listed in Netflix Dataset
recommend('Avenger')
```

```
Didn't find any matches for 'Avenger'. Browse other popular TV shows and movies.
```

Conclusion

- Analysis revealed that Netflix has a **greater number** of **movies** than **TV shows**.
- Clustering **TV shows** and **movies** based on their similarities and differences, created a **content-based recommender system** that recommends **top 10 shows** to users based on their **viewing history**.

Thank You AlmaBetter!!!