dm-project

May 14, 2024

0.1 Importing libraries

[275]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns


from sklearn.preprocessing import MinMaxScaler
from sklearn_extra.cluster import KMedoids
from sklearn.metrics import silhouette_score
from scipy.cluster.hierarchy import dendrogram, linkage
from sklearn.cluster import AgglomerativeClustering
from sklearn.decomposition import PCA
```

0.2 Reading Dataset

[276]:
```
# Read the dataset into a pandas DataFrame
df = pd.read_csv('netflix_titles.csv')

# Set pandas display options to show all columns without truncation
pd.set_option('display.max_columns', None)
pd.set_option('display.width', None)

# Choose how many rows to display
num_rows_to_display = 5 # Change this to the desired number of rows

# Display the DataFrame
display(df.iloc[:num_rows_to_display, :12])
```

```
  show_id     type                  title         director  \
0      s1    Movie   Dick Johnson Is Dead  Kirsten Johnson
1      s2  TV Show          Blood & Water              NaN
2      s3  TV Show              Ganglands  Julien Leclercq
3      s4  TV Show  Jailbirds New Orleans              NaN
4      s5  TV Show           Kota Factory              NaN

                                                cast        country  \
```

```
0                                                NaN  United States
1  Ama Qamata, Khosi Ngema, Gail Mabalane, Thaban…   South Africa
2  Sami Bouajila, Tracy Gotoas, Samuel Jouy, Nabi…            NaN
3                                                NaN            NaN
4  Mayur More, Jitendra Kumar, Ranjan Raj, Alam K…          India

  date_added  release_year rating   duration  \
0  25-Sep-21          2020  PG-13     90 min
1  24-Sep-21          2021  TV-MA  2 Seasons
2  24-Sep-21          2021  TV-MA   1 Season
3  24-Sep-21          2021  TV-MA   1 Season
4  24-Sep-21          2021  TV-MA  2 Seasons

                                        listed_in  \
0                                   Documentaries
1    International TV Shows, TV Dramas, TV Mysteries
2  Crime TV Shows, International TV Shows, TV Act…
3                             Docuseries, Reality TV
4  International TV Shows, Romantic TV Shows, TV …

                                         description
0  As her father nears the end of his life, filmm…
1  After crossing paths at a party, a Cape Town t…
2  To protect his family from a powerful drug lor…
3  Feuds, flirtations and toilet talk go down amo…
4  In a city of coaching centers known to train I…
```

0.3 Identify columns with missing values

[277]:
```
missing_values = df.isnull().sum()
print("Columns with missing values:\n")
print(missing_values[missing_values > 0])
```

```
Columns with missing values:

director    480
cast        152
country     360
dtype: int64
```

0.4 Remove unnecessary columns with many missing values

[278]:
```
df_cleaned = df.dropna(axis=1, thresh=len(df) * 0.9)  # Drop columns with more
 ↪than 90% missing values

# Check the remaining missing values
missing_values_cleaned = df_cleaned.isnull().sum()
```

```
print("Remaining missing values after removing unnecessary columns:\n")
print(missing_values_cleaned[missing_values_cleaned > 0])
```

```
Remaining missing values after removing unnecessary columns:

Series([], dtype: int64)
```

[279]:
```
df_cleaned
```

[279]:
```
     show_id     type                         title date_added  release_year  \
0         s1    Movie        Dick Johnson Is Dead  25-Sep-21          2020
1         s2  TV Show                Blood & Water  24-Sep-21          2021
…       …       …                           …         …             …
1497   s1498    Movie        Hello, Love, Goodbye  24-Dec-20          2019
1498   s1499    Movie  The History of Future Folk  23-Dec-20          2012

     rating   duration                                          listed_in  \
0     PG-13     90 min                                       Documentaries
1     TV-MA  2 Seasons   International TV Shows, TV Dramas, TV Mysteries
…      …         …                                                  …
1497  TV-14    117 min     Dramas, International Movies, Romantic Movies
1498  TV-14     85 min  Action & Adventure, Comedies, Independent Movies

                                           description
0     As her father nears the end of his life, filmm…
1     After crossing paths at a party, a Cape Town t…
…                                                   …
1497  In Hong Kong, the lives of two overseas Filipi…
1498  An alien ordered to colonize Earth abandons hi…

[1499 rows x 9 columns]
```

0.5 Min-Max scaling

[280]:
```
# Select numerical columns for scaling
numerical_columns = df_cleaned.select_dtypes(include=['int64', 'float64']).
 ↪columns

# Perform Min-Max scaling on numerical columns using .loc
scaler = MinMaxScaler()
df_cleaned.loc[:, numerical_columns] = scaler.fit_transform(df_cleaned.loc[:,␣
 ↪numerical_columns])

# Display the first few rows of the cleaned and scaled DataFrame
display(df_cleaned.head())
```

```
C:\Users\imoaz\AppData\Local\Temp\ipykernel_2736\174888871.py:6: FutureWarning:
```

```
Setting an item of incompatible dtype is deprecated and will raise in a future
error of pandas. Value '[0.98684211 1.         1.         … 0.96052632
0.97368421 0.88157895]' has dtype incompatible with int64, please explicitly
cast to a compatible dtype first.
  df_cleaned.loc[:, numerical_columns] = scaler.fit_transform(df_cleaned.loc[:,
numerical_columns])
```

	show_id	type	title	date_added	release_year	rating	duration	listed_in	description
0	s1	Movie	Dick Johnson Is Dead	25-Sep-21	0.986842	PG-13	90 min	Documentaries	As her father nears the end of his life, filmm…
1	s2	TV Show	Blood & Water	24-Sep-21	1.000000	TV-MA	2 Seasons	International TV Shows, TV Dramas, TV Mysteries	After crossing paths at a party, a Cape Town t…
2	s3	TV Show	Ganglands	24-Sep-21	1.000000	TV-MA	1 Season	Crime TV Shows, International TV Shows, TV Act…	To protect his family from a powerful drug lor…
3	s4	TV Show	Jailbirds New Orleans	24-Sep-21	1.000000	TV-MA	1 Season	Docuseries, Reality TV	Feuds, flirtations and toilet talk go down amo…
4	s5	TV Show	Kota Factory	24-Sep-21	1.000000	TV-MA	2 Seasons	International TV Shows, Romantic TV Shows, TV …	In a city of coaching centers known to train I…

0.6 One-hot encoding

[281]:
```
# Set display options to limit the number of rows and columns shown
pd.set_option('display.max_rows', 5)  # Adjust as needed
pd.set_option('display.max_columns', 10)  # Adjust as needed

# Perform one-hot encoding on categorical columns
df_encoded = pd.get_dummies(df_cleaned)

# Display the first few rows of the encoded DataFrame
display(df_encoded.head())
```

	release_year	show_id_s1	show_id_s10	show_id_s100	show_id_s1000	…
0	0.986842	True	False	False	False	…
1	1.000000	False	False	False	False	…
2	1.000000	False	False	False	False	…
3	1.000000	False	False	False	False	…
4	1.000000	False	False	False	False	…

```
  description_Yılmaz Erdoğan's lauded stage play traces the life of wunderkind␣
 ↪Gülseren as she navigates social and political change.  \
0                                                   False
1                                                   False
2                                                   False
3                                                   False
4                                                   False

  description_Zack Snyder and his "Army of the Dead" team dive into the film's␣
 ↪wild stunts, groundbreaking effects and the evolution of the zombie genre.  \
0                                                   False
1                                                   False
2                                                   False
3                                                   False
4                                                   False

  description_Zack and Miri make and star in an adult film to bring in easy␣
 ↪money. But their unspoken feelings for each other might threaten the whole␣
 ↪enterprise.  \
0                                                   False
1                                                   False
2                                                   False
3                                                   False
4                                                   False

  description_Zig, an island-bound hyena, will do anything to get his paws on␣
 ↪Marina the mermaid, but her devoted pal Sharko always comes to her rescue in␣
 ↪time.  \
0                                                   False
1                                                   False
2                                                   False
3                                                   False
4                                                   False

  description_"Last Chance U" hits the hardwood in East Los Angeles as a coach␣
 ↪with strong convictions leads young men who hope to fulfill major college␣
 ↪potential.
0                                                   False
1                                                   False
2                                                   False
3                                                   False
4                                                   False

[5 rows x 5178 columns]
```

0.7 Dataset summary after cleaning

[342]:
```
summary_stats = df_encoded.describe()
print("Summary Statistics after cleaning:")
summary_stats
```

```
Summary Statistics after cleaning:
```

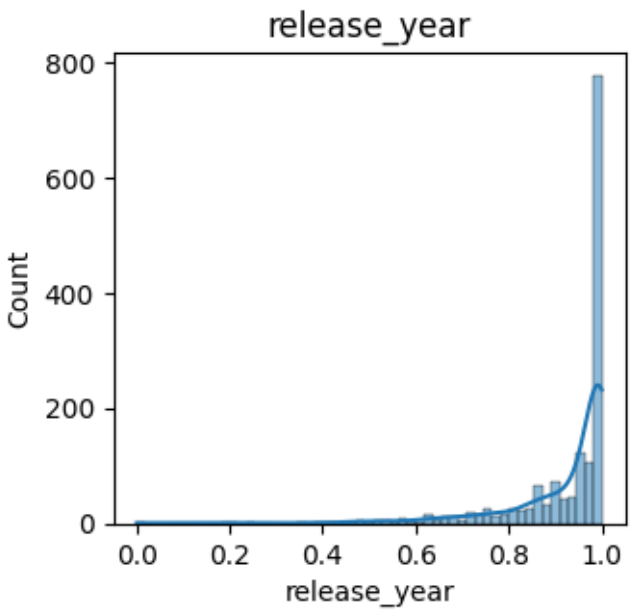
[342]:

	release_year
count	1499.00000
mean	0.92876
…	…
75%	1.00000
max	1.00000

[8 rows x 1 columns]

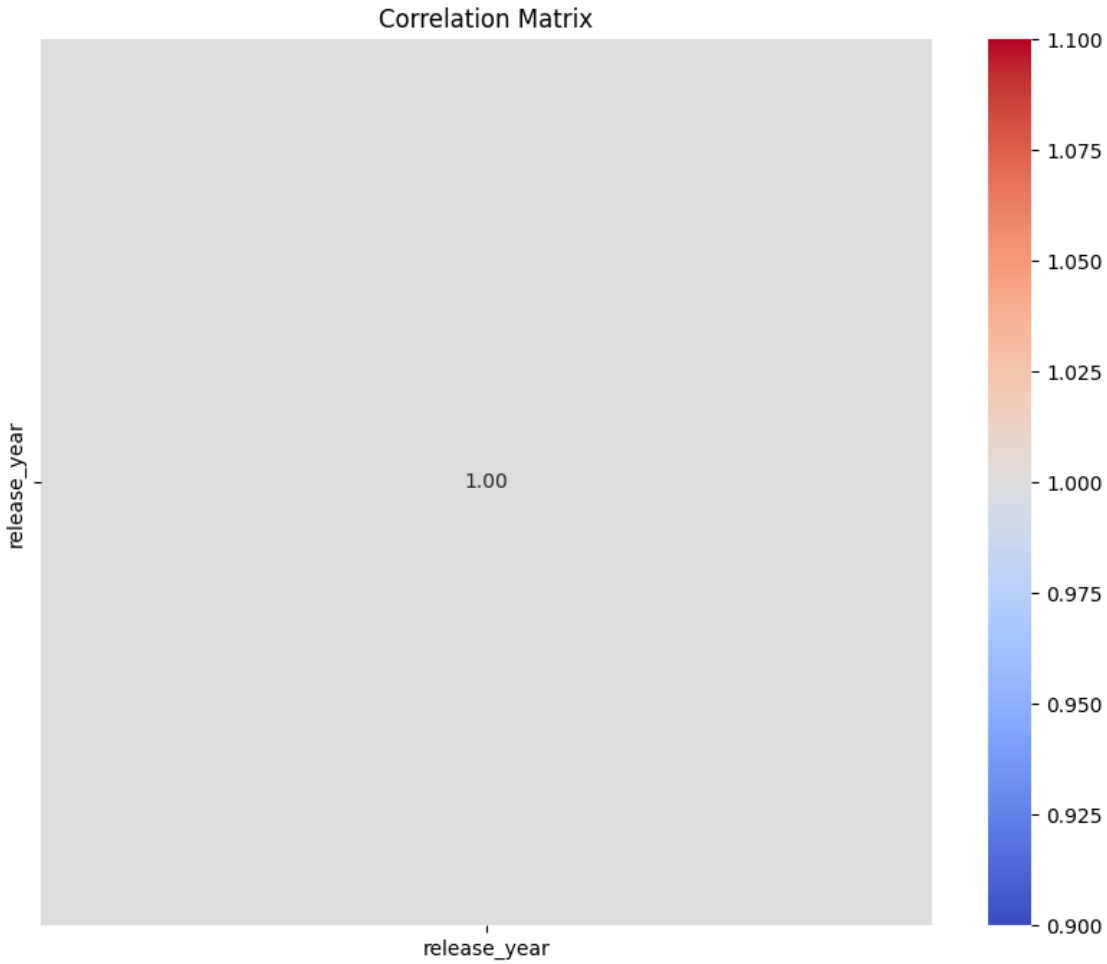
0.8 Data Distributions (Numerical Features)

[343]:
```
numerical_columns = df_encoded.select_dtypes(include=['int64', 'float64']).
 ↪columns
df_numerical = df_encoded[numerical_columns]

plt.figure(figsize=(12, 6))
for i, column in enumerate(numerical_columns):
    plt.subplot(2, 4, i + 1)
    sns.histplot(df_numerical[column], kde=True)
    plt.title(column)
plt.tight_layout()
plt.show()
```



0.9 Correlation Analysis

[344]:
```
correlation_matrix = df_numerical.corr()
plt.figure(figsize=(10, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title('Correlation Matrix')
plt.show()
```



0.10 Categorical Variables

[345]:
```
categorical_columns = df_encoded.select_dtypes(include=['uint8']).columns
plt.figure(figsize=(15, 6))
for i, column in enumerate(categorical_columns):
    plt.subplot(2, 4, i + 1)
    sns.countplot(x=column, data=df_encoded)
    plt.title(column)
    plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

```
<Figure size 1500x600 with 0 Axes>
```

0.11 10 Most important features

[346]:
```
# Calculate the frequency of each binary feature
binary_feature_counts = df_encoded.sum(axis=0)

# Sort the features by frequency in descending order
binary_feature_counts_sorted = binary_feature_counts.
 ↪sort_values(ascending=False)

# Display the top 10 most important features
print("Top 10 most important features:")

binary_feature_counts_sorted.head()
```

```
Top 10 most important features:
```

[346]:
```
release_year    1392.210526
type_Movie       984.000000
type_TV Show     515.000000
rating_TV-MA     500.000000
rating_TV-14     331.000000
dtype: float64
```

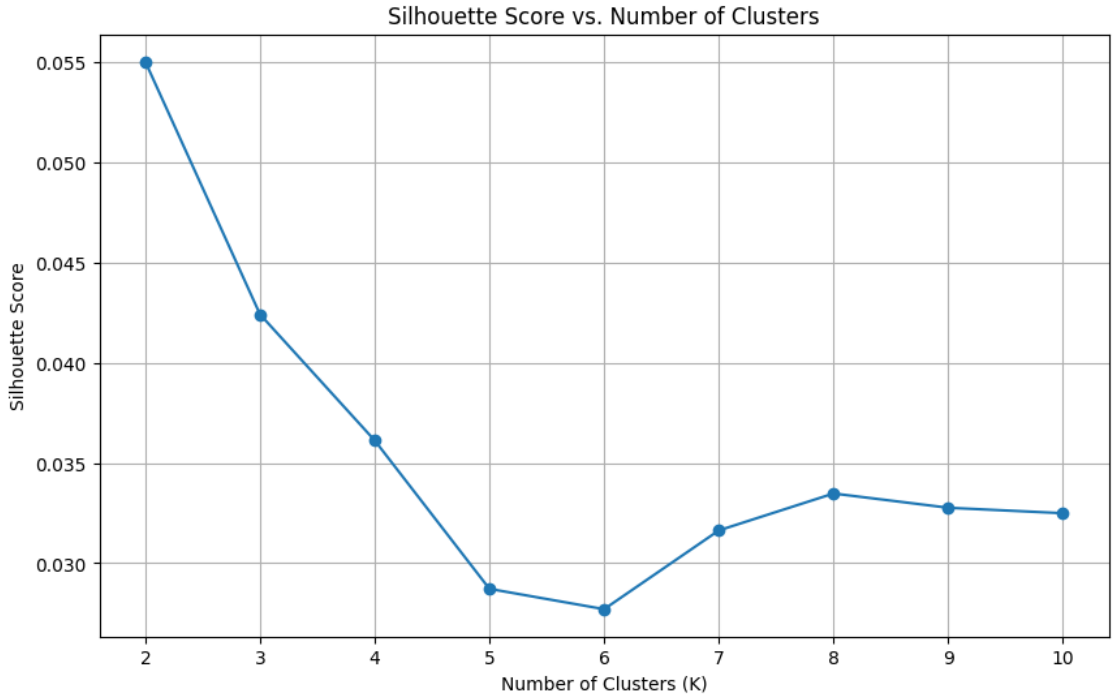
1 KMedoid Clustering

1.1 Determinig optimal number of clusters

[347]:
```
# Choose a range of K values
k_values = range(2, 11)  # You can adjust the range as needed

# Initialize lists to store silhouette scores for each K
silhouette_scores = []

# Perform K-medoids clustering for each K
for k in k_values:
    # Initialize K-medoids model
    kmedoids = KMedoids(n_clusters=k, random_state=42)

    # Fit the model to the encoded DataFrame
    kmedoids.fit(df_encoded)

    # Predict cluster labels
    cluster_labels = kmedoids.labels_

    # Compute silhouette score
    silhouette_avg = silhouette_score(df_encoded, cluster_labels)
    silhouette_scores.append(silhouette_avg)
```

1.2 Silhouette scores for each K

[348]:
```
plt.figure(figsize=(10, 6))
plt.plot(k_values, silhouette_scores, marker='o', linestyle='-')
plt.title('Silhouette Score vs. Number of Clusters')
plt.xlabel('Number of Clusters (K)')
plt.ylabel('Silhouette Score')
plt.xticks(k_values)
plt.grid(True)
plt.show()
```



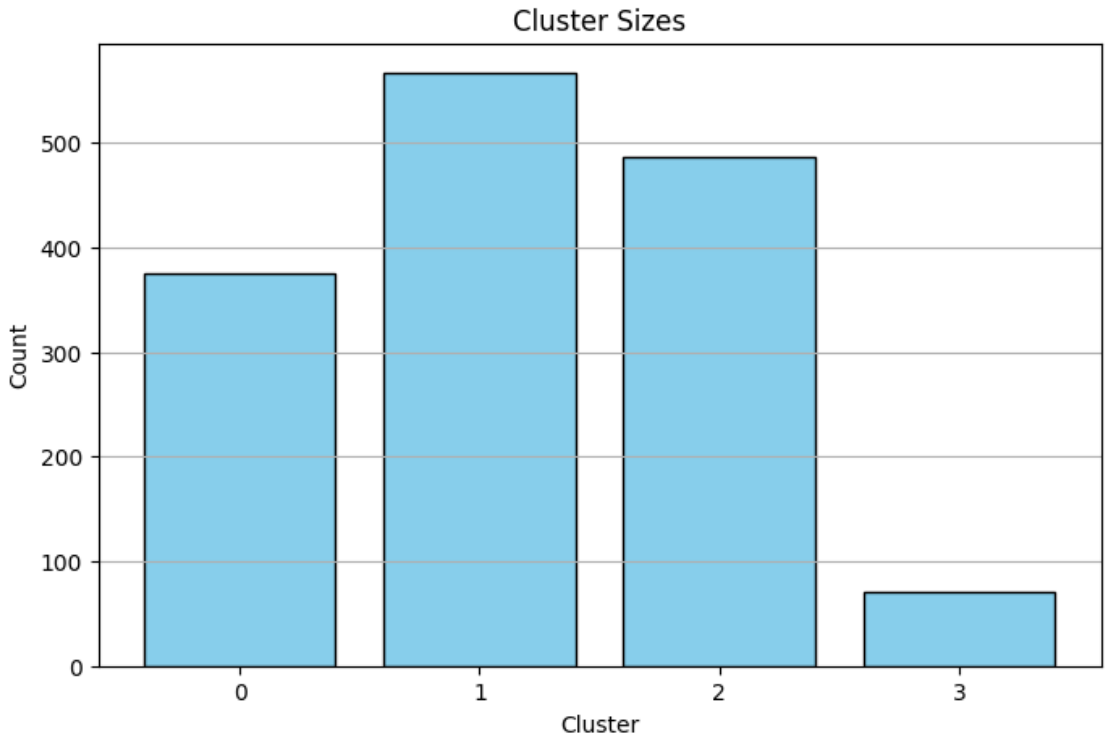
1.3 Fitting the K-medoids model

[349]:
```
# Choose the optimal number of clusters (K)
optimal_k = 4  # Adjust as needed based on the silhouette score plot

# Initialize K-medoids model with the optimal number of clusters
kmedoids = KMedoids(n_clusters=optimal_k, random_state=42)

# Fit the model to the encoded DataFrame
kmedoids.fit(df_encoded)

# Predict cluster labels
cluster_labels = kmedoids.labels_
```

```
# Compute silhouette score
silhouette_avg = silhouette_score(df_encoded, cluster_labels)
print(f'Silhouette Score for {optimal_k} clusters: {silhouette_avg}')
```

```
Silhouette Score for 4 clusters: 0.036128118186691774
```

[350]:
```
# Plot cluster sizes
plt.figure(figsize=(8, 5))
plt.hist(cluster_labels, bins=np.arange(optimal_k + 1) - 0.5, rwidth=0.8,␣
 ↪color='skyblue', edgecolor='black')
plt.title('Cluster Sizes')
plt.xlabel('Cluster')
plt.ylabel('Count')
plt.xticks(range(optimal_k))
plt.grid(axis='y')
plt.show()
```

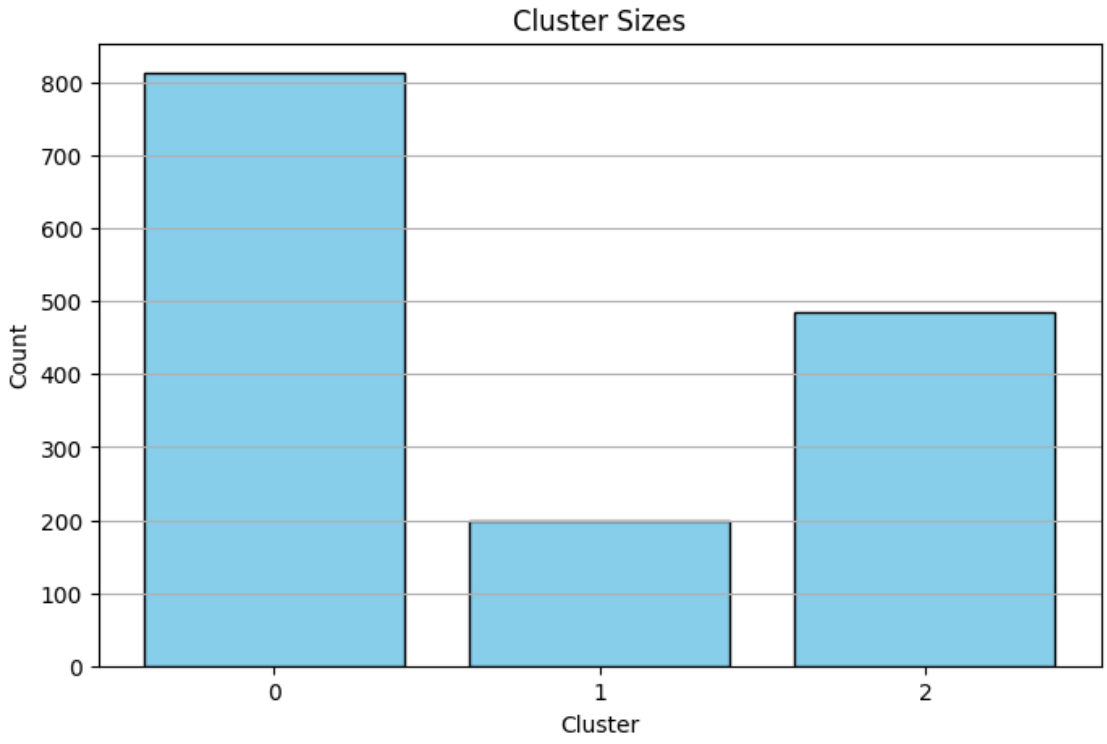


[351]:
```
# Choose the optimal number of clusters (K)
optimal_k = 3  # Adjust as needed based on the silhouette score plot

# Initialize K-medoids model with the optimal number of clusters
kmedoids = KMedoids(n_clusters=optimal_k, random_state=42)
```

```
# Fit the model to the encoded DataFrame
kmedoids.fit(df_encoded)

# Predict cluster labels
cluster_labels = kmedoids.labels_

# Compute silhouette score
silhouette_avg = silhouette_score(df_encoded, cluster_labels)
print(f'Silhouette Score for {optimal_k} clusters: {silhouette_avg}')
```

```
Silhouette Score for 3 clusters: 0.04242481642128724
```

[352]:
```
# Plot cluster sizes
plt.figure(figsize=(8, 5))
plt.hist(cluster_labels, bins=np.arange(optimal_k + 1) - 0.5, rwidth=0.8,␣
 ↪color='skyblue', edgecolor='black')
plt.title('Cluster Sizes')
plt.xlabel('Cluster')
plt.ylabel('Count')
plt.xticks(range(optimal_k))
plt.grid(axis='y')
plt.show()
```



[353]:
```
# Calculate silhouette score for K-medoids clustering
silhouette_kmedoids = silhouette_score(df_encoded, cluster_labels)
print(f'Silhouette Score for K-medoids clustering: {silhouette_kmedoids}')
```

```
Silhouette Score for K-medoids clustering: 0.04242481642128724
```

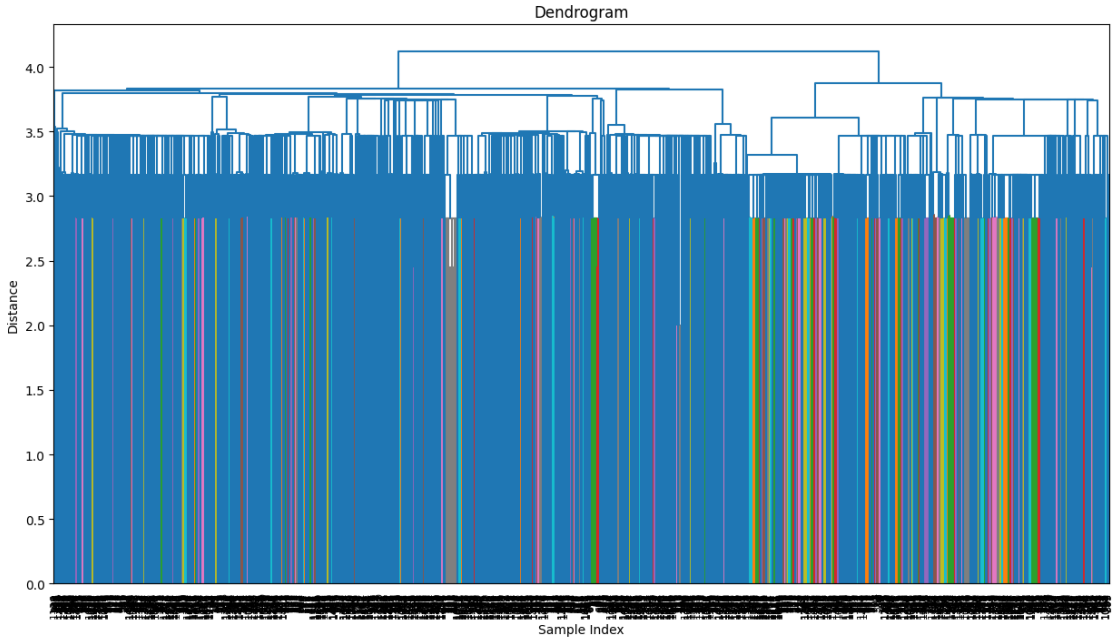
1.4 Hierarchical clustering

1.5 Silhouette Score

[354]:
```
# Calculate silhouette score for hierarchical clustering
# Since we haven't explicitly performed hierarchical clustering, we need to do␣
 ↪so first
# Let's use agglomerative clustering for hierarchical clustering


# Specify the number of clusters based on the dendrogram analysis or any other␣
 ↪criteria
# For demonstration purposes, let's choose 4 clusters
num_clusters_hierarchical = 4

# Initialize AgglomerativeClustering model
agg_clustering = AgglomerativeClustering(n_clusters=num_clusters_hierarchical)

# Fit the model to the encoded DataFrame
cluster_labels_hierarchical = agg_clustering.fit_predict(df_encoded)

# Calculate silhouette score for hierarchical clustering
silhouette_hierarchical = silhouette_score(df_encoded,␣
 ↪cluster_labels_hierarchical)
print(f'Silhouette Score for hierarchical clustering:␣
 ↪{silhouette_hierarchical}')
```

```
Silhouette Score for hierarchical clustering: 0.05371318582541217
```

[355]:
```
# Compute the linkage matrix using complete linkage
linkage_matrix = linkage(df_encoded, method='complete')

# Plot the dendrogram
plt.figure(figsize=(15, 8))
dendrogram(linkage_matrix, leaf_rotation=90, leaf_font_size=8)
plt.title('Dendrogram')
plt.xlabel('Sample Index')
plt.ylabel('Distance')
plt.show()
```



1.5.1 Evaluation of two clustering

[356]:
```
# Comparison of Silhouette Scores
print(f'Silhouette Score for K-medoids clustering: {silhouette_kmedoids}')
print(f'Silhouette Score for hierarchical clustering:␣
 ↪{silhouette_hierarchical}')
```

```
Silhouette Score for K-medoids clustering: 0.04242481642128724
Silhouette Score for hierarchical clustering: 0.05371318582541217
```

1.6 Principal Component Analysis

[357]:
```
# Reduce dimensionality using PCA
pca = PCA(n_components=2)
pca_result = pca.fit_transform(df_encoded)

# Plot clusters in the reduced feature space
plt.figure(figsize=(10, 6))
for cluster in np.unique(cluster_labels_hierarchical):
    plt.scatter(pca_result[cluster_labels_hierarchical == cluster, 0],
                pca_result[cluster_labels_hierarchical == cluster, 1],
                label=f'Cluster {cluster}', alpha=0.5)
plt.title('Hierarchical Clustering Results (PCA)')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend()
```

```
plt.grid(True)
plt.show()
```