```python
import torch
import numpy as np
from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_score
from sklearn.preprocessing import StandardScaler

tensor_features = torch.load("/content/stacked_tensor_3.pt")

flattened_data = tensor_features.view(tensor_features.size(0), -
1).numpy()

scaler = StandardScaler()
normalized_data = scaler.fit_transform(flattened_data)

wcss = []
silhouette_scores = []

num_clusters_range = range(2, 25)

for num_clusters in num_clusters_range:
    kmeans = KMeans(n_clusters=num_clusters, random_state=42)
    clusters = kmeans.fit_predict(normalized_data)
    wcss.append(kmeans.inertia_)
    silhouette_avg = silhouette_score(normalized_data, clusters)
    silhouette_scores.append(silhouette_avg)
    print(f"For n_clusters = {num_clusters}, the average
silhouette_score is : {silhouette_avg}")
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(

For n_clusters = 2, the average silhouette_score is :
0.7061271071434021

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(

For n_clusters = 3, the average silhouette_score is :
0.8409109711647034

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
```

```
For n_clusters = 4, the average silhouette_score is :
0.8875818252563477

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(

For n_clusters = 5, the average silhouette_score is :
0.9462693929672241

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(

For n_clusters = 6, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (7). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 7, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (8). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 8, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
```

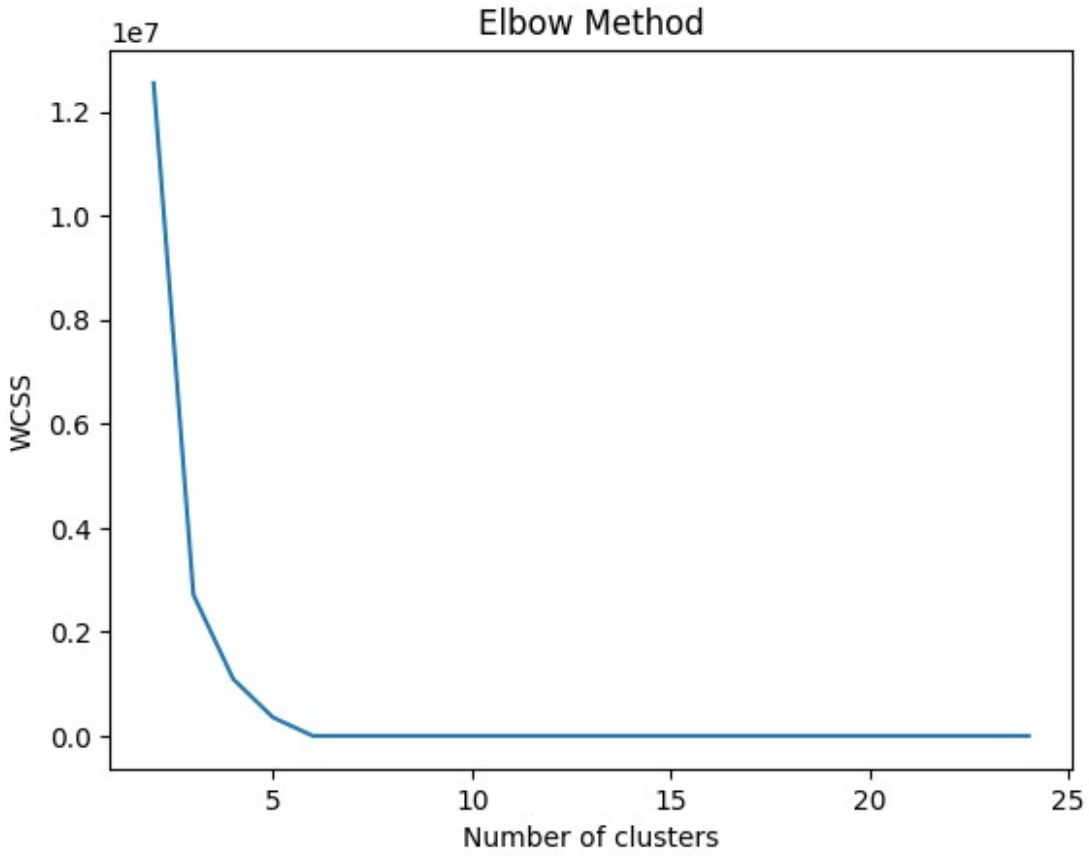
```
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (9). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 9, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (10). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 10, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (11). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 11, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (12). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 12, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
```

```
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (13). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 13, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (14). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 14, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (15). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 15, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (16). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 16, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
```

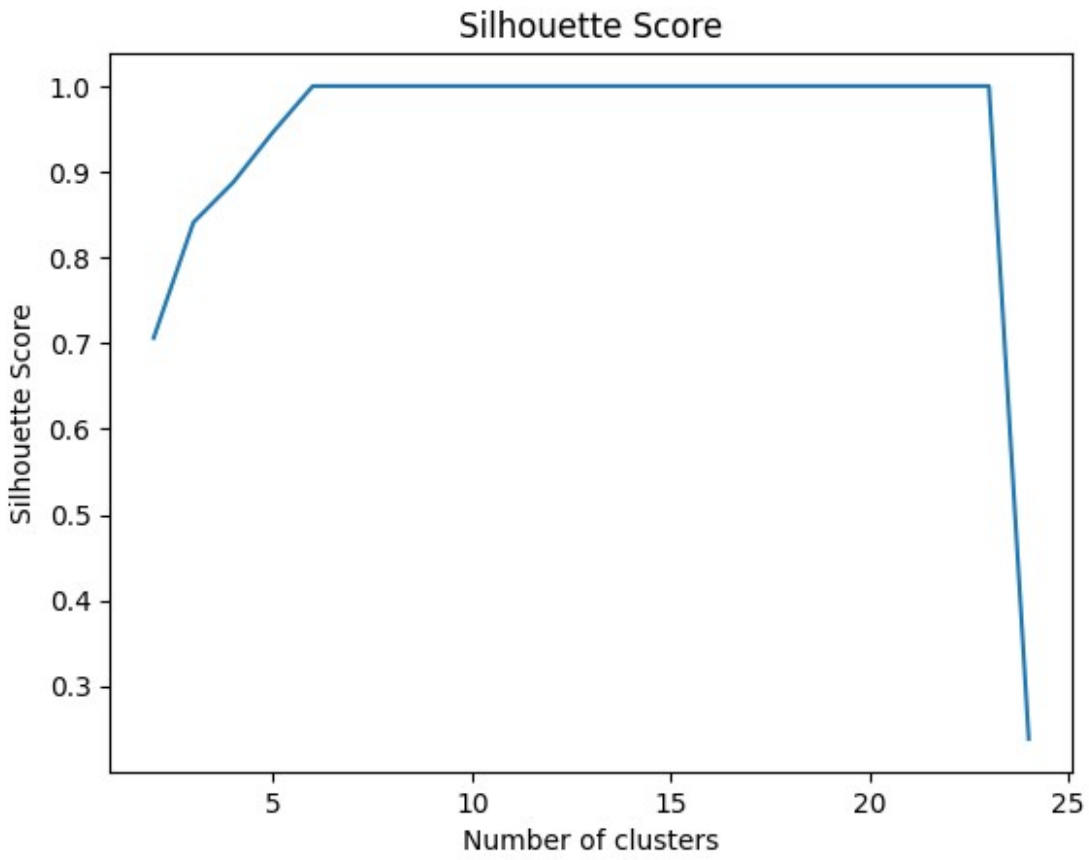
```
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (17). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 17, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (18). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 18, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (19). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 19, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (20). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 20, the average silhouette_score is :
0.9999996423721313
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (21). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 21, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (22). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 22, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (6) found smaller
than n_clusters (23). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 23, the average silhouette_score is :
0.9999996423721313

/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/_kmeans.py:103
3: ConvergenceWarning: Number of distinct clusters (9) found smaller
than n_clusters (24). Possibly due to duplicate points in X.
  return self.fit(X, sample_weight=sample_weight).labels_

For n_clusters = 24, the average silhouette_score is :
0.2384926825761795
```

```
import torch
import numpy as np
from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_score
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt

# Plot Elbow Method
plt.plot(num_clusters_range, wcss)
plt.title('Elbow Method')
plt.xlabel('Number of clusters')
plt.ylabel('WCSS')
plt.show()
```




```
# Plot Silhouette Score
plt.plot(num_clusters_range, silhouette_scores)
plt.title('Silhouette Score')
plt.xlabel('Number of clusters')
plt.ylabel('Silhouette Score')
plt.show()
```




```
num_clusters = 4

kmeans = KMeans(n_clusters=num_clusters, random_state=42)

clusters = kmeans.fit_predict(normalized_data)
```

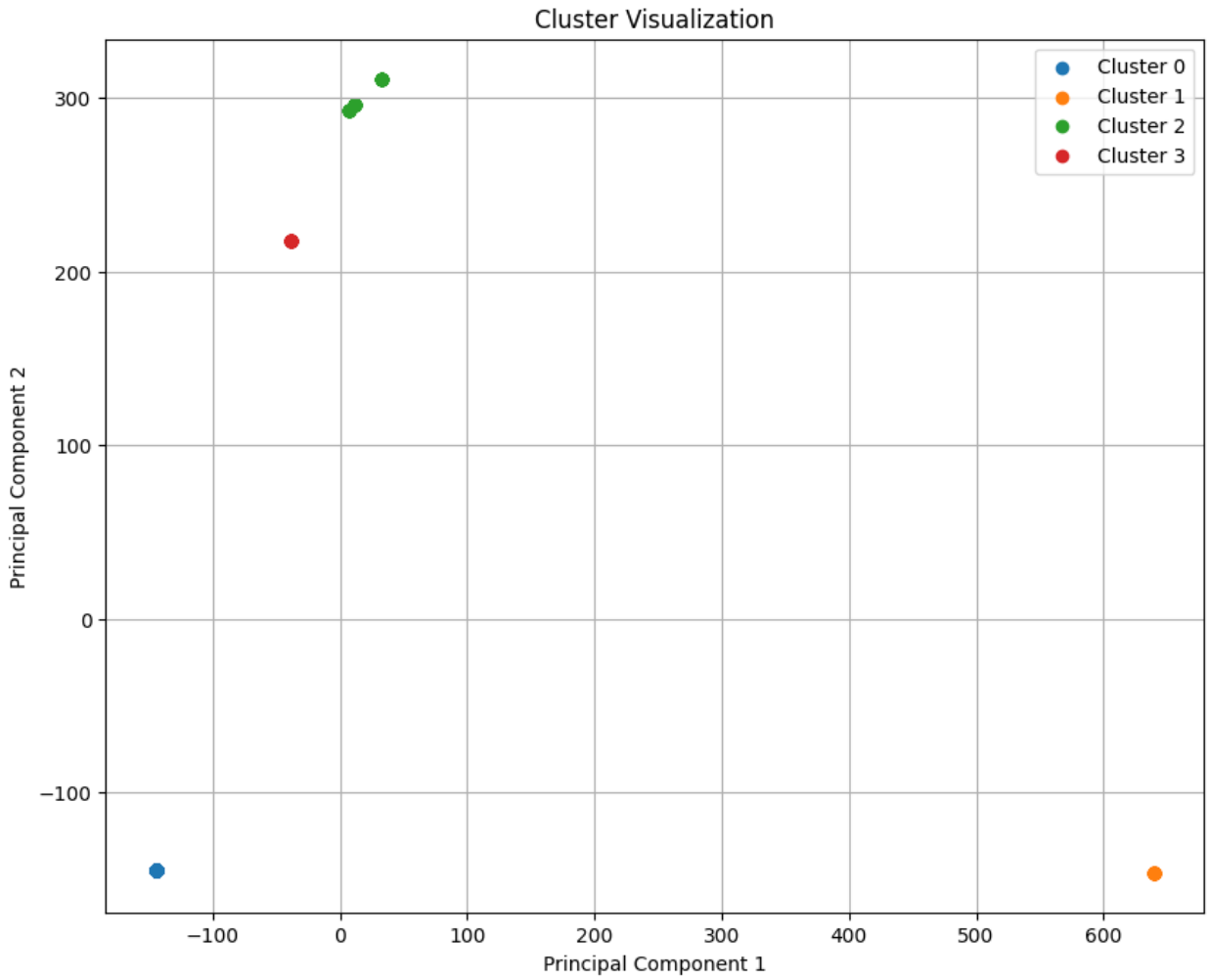
```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
```

```
silhouette_avg = silhouette_score(normalized_data, clusters)
print(f"Silhouette Score: {silhouette_avg}")
```

```
Silhouette Score: 0.8875818252563477
```

```
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
pca = PCA(n_components=2)
reduced_data = pca.fit_transform(normalized_data)

plt.figure(figsize=(10, 8))
for cluster_label in range(num_clusters):
```

```
    cluster_points = reduced_data[clusters == cluster_label]
    plt.scatter(cluster_points[:, 0], cluster_points[:, 1],
label=f'Cluster {cluster_label}')
plt.title('Cluster Visualization')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend()
plt.grid(True)
plt.show()
```




```
import matplotlib.pyplot as plt
from sklearn.manifold import TSNE
from sklearn.metrics import silhouette_samples
import seaborn as sns
import pandas as pd

tsne = TSNE(n_components=2, random_state=42)
tsne_data = tsne.fit_transform(normalized_data)
```

```
plt.figure(figsize=(10, 8))
sns.scatterplot(x=tsne_data[:, 0], y=tsne_data[:, 1], hue=clusters,
palette='Set1', legend='full')
plt.title('t-SNE Visualization of Clusters')
plt.xlabel('t-SNE Component 1')
plt.ylabel('t-SNE Component 2')
plt.show()
```