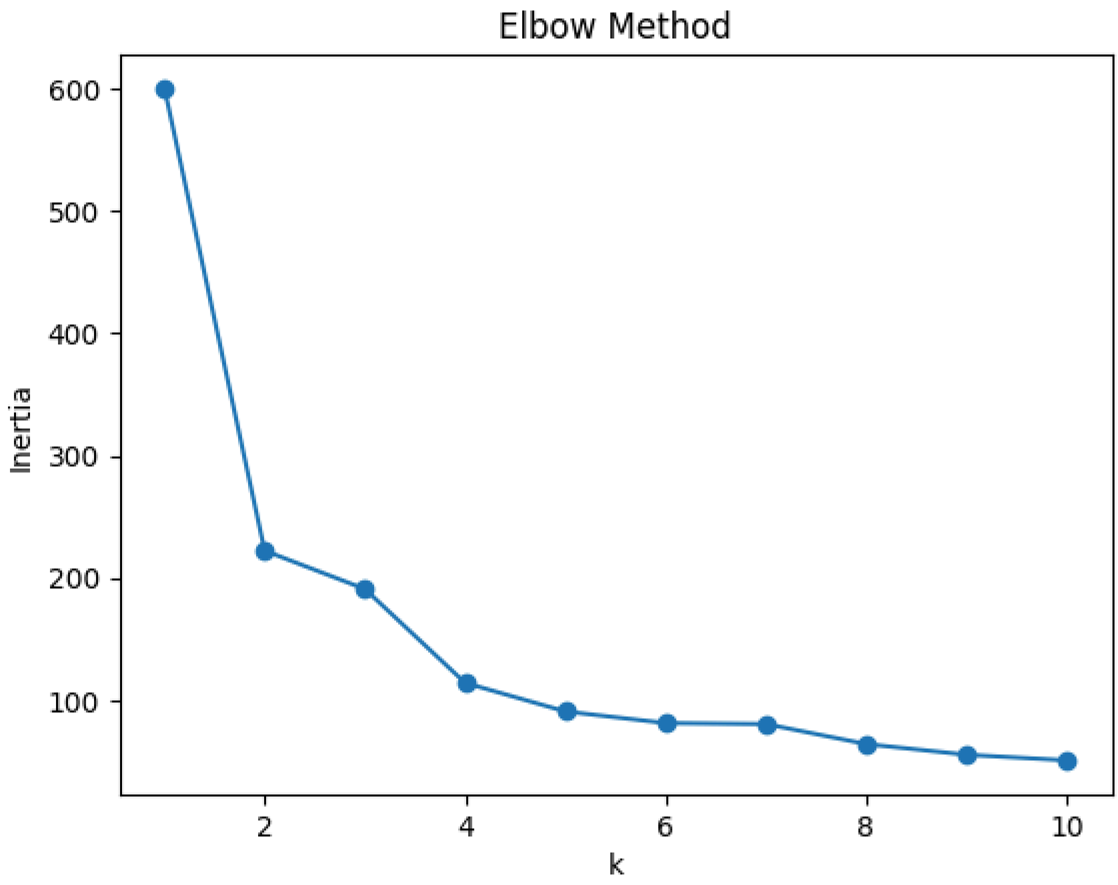
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.datasets import load_iris
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans, SpectralClustering
from sklearn.metrics import silhouette_score
from sklearn.decomposition import PCA
```

```
data = load_iris()
X = pd.DataFrame(data.data, columns=data.feature_names)

scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

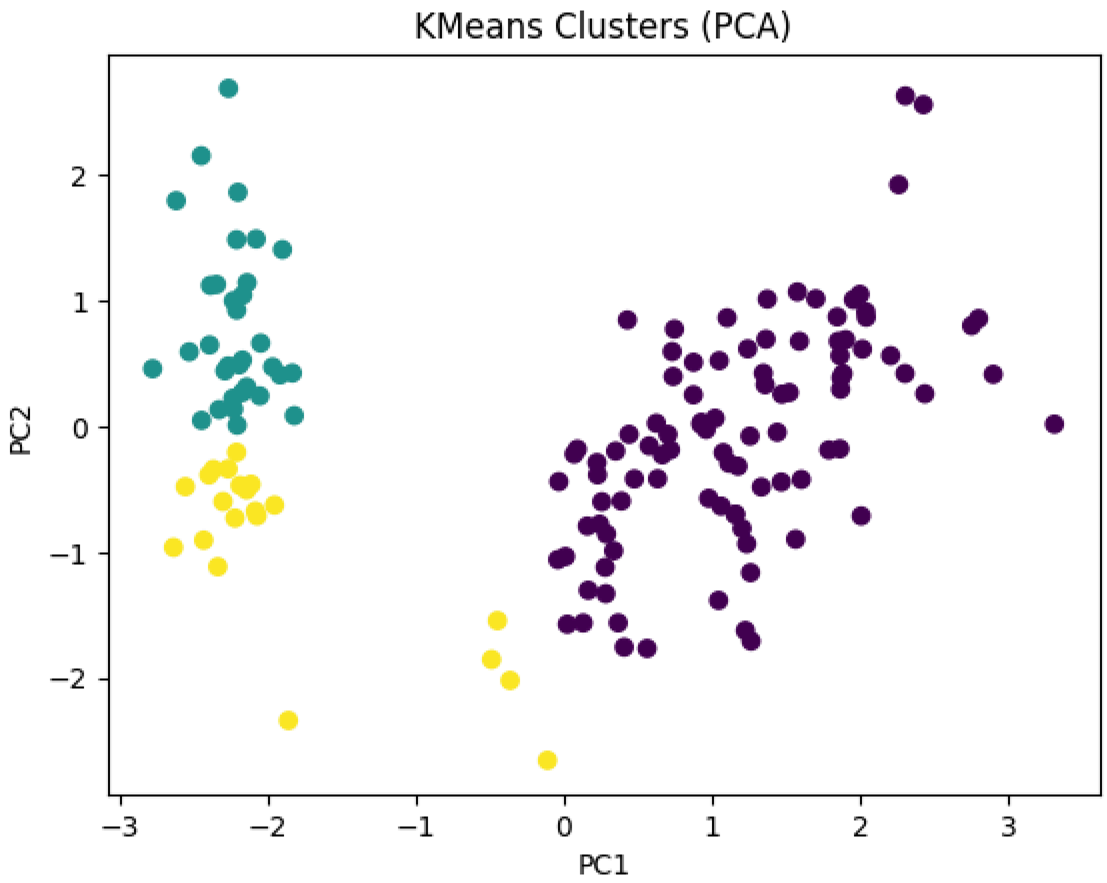
```
inertia = []
K_range = range(1, 11)
for k in K_range:
    km = KMeans(n_clusters=k, random_state=42)
    km.fit(X_scaled)
    inertia.append(km.inertia_)

plt.plot(K_range, inertia, marker='o')
plt.xlabel('k')
plt.ylabel('Inertia')
plt.title('Elbow Method')
plt.show()
```



```
k_best = 3
kmeans = KMeans(n_clusters=k_best, random_state=42)
labels_kmeans = kmeans.fit_predict(X_scaled)

score_kmeans = silhouette_score(X_scaled, labels_kmeans)
print("KMeans Silhouette Score:", round(score_kmeans, 3))
```

```
KMeans Silhouette Score: 0.48
```

```
pca = PCA(n_components=2)
X_pca = pca.fit_transform(X_scaled)

plt.scatter(X_pca[:, 0], X_pca[:, 1], c=labels_kmeans, cmap='viridis')
plt.title('KMeans Clusters (PCA)')
plt.xlabel('PC1')
plt.ylabel('PC2')
plt.show()
```



```
n_samples = X_scaled.shape[0]
n_runs = 10
base_labels = []

for i in range(n_runs):
    k = np.random.choice([2, 3, 4])
    km = KMeans(n_clusters=k, random_state=i)
    labels = km.fit_predict(X_scaled)
    base_labels.append(labels)
```

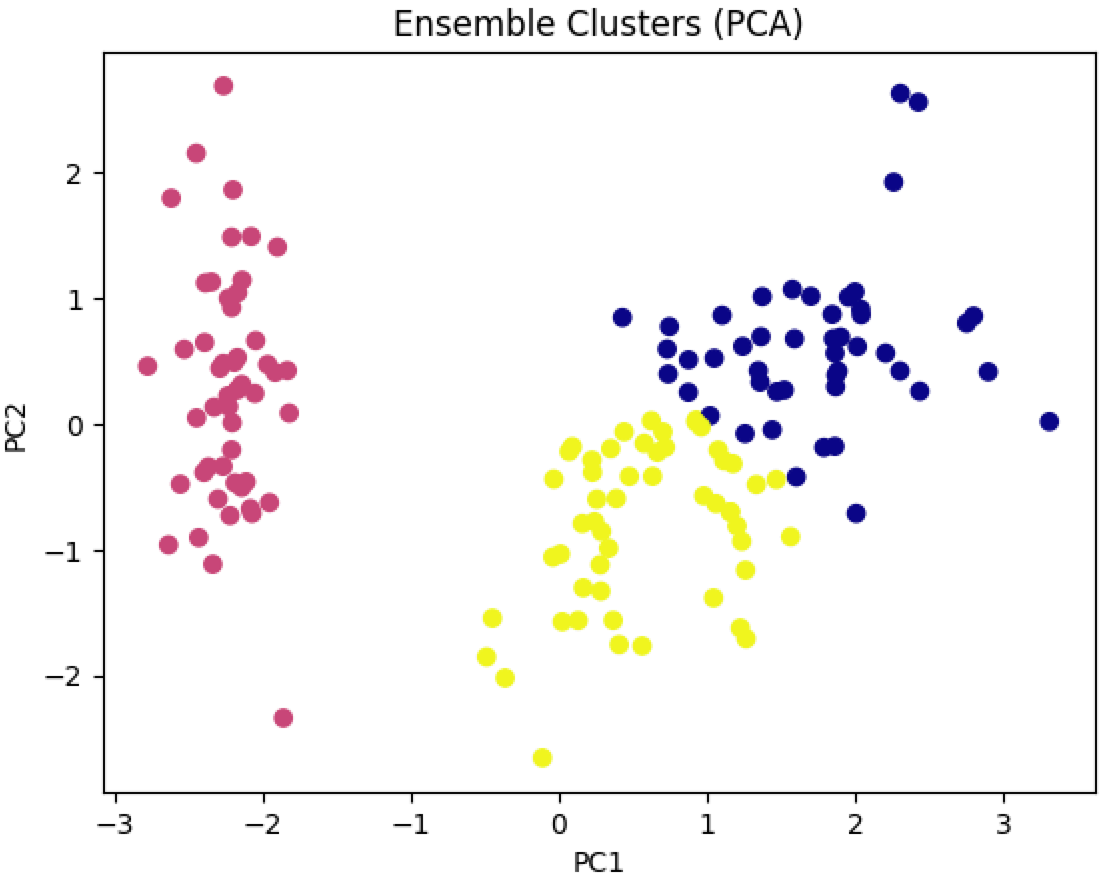
```
co_matrix = np.zeros((n_samples, n_samples))

for labels in base_labels:
    for i in range(n_samples):
        for j in range(n_samples):
            if labels[i] == labels[j]:
                co_matrix[i, j] += 1

co_matrix /= n_runs
```

```
spectral = SpectralClustering(n_clusters=k_best, affinity='precomputed', random_s
labels_ensemble = spectral.fit_predict(co_matrix)
```

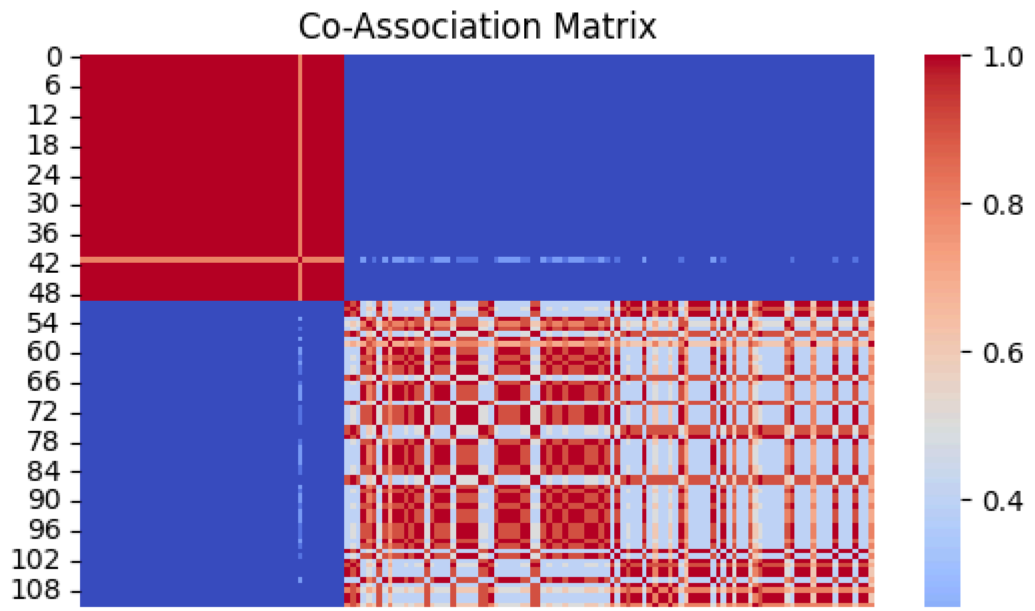
```
score_ensemble = silhouette_score(X_scaled, labels_ensemble)
print("Ensemble Silhouette Score:", round(score_ensemble, 3))
```

```
Ensemble Silhouette Score: 0.46
```

```
plt.scatter(X_pca[:, 0], X_pca[:, 1], c=labels_ensemble, cmap='plasma')
plt.title('Ensemble Clusters (PCA)')
plt.xlabel('PC1')
plt.ylabel('PC2')
plt.show()
```



```
import seaborn as sns
sns.heatmap(co_matrix, cmap='coolwarm')
plt.title('Co-Association Matrix')
plt.show()
```


Co-Association Matrix
0
6
12
18
24
30
36
42
48
54
60
66
72
78
84
90
96
102
108
1.0
0.8
0.6
0.4