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In [1]:
```
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 from
sklearn.decomposition import PCA from
sklearn.metrics import silhouette_score
```

In [2]:
```
iris = load_iris()
X = iris.data
y_true =
iris.target
feature_names = iris.feature_names
```

In [3]:
```
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
```

In [4]:
```
silhouette_scores = []
K_range = range(2, 11)
for k in K_range:
    kmeans = KMeans(n_clusters=k, random_state=42, n_init=10)
    kmeans.fit(X_scaled)
    score = silhouette_score(X_scaled, kmeans.labels_)
    silhouette_scores.append(score)
    print(f"k = {k}, Silhouette Score = {score:.4f}")

best_k = K_range[np.argmax(silhouette_scores)]
print(f"\nBest number of clusters (k) = {best_k}")
```

k = 2, Silhouette Score = 0.5818
k = 3, Silhouette Score = 0.4599 k =
4, Silhouette Score = 0.3869 k = 5,
Silhouette Score = 0.3459 k = 6,
Silhouette Score = 0.3171 k = 7,
Silhouette Score = 0.3202 k = 8,
Silhouette Score = 0.3387 k = 9,
Silhouette Score = 0.3424 k = 10,
Silhouette Score = 0.3518 Best number
of

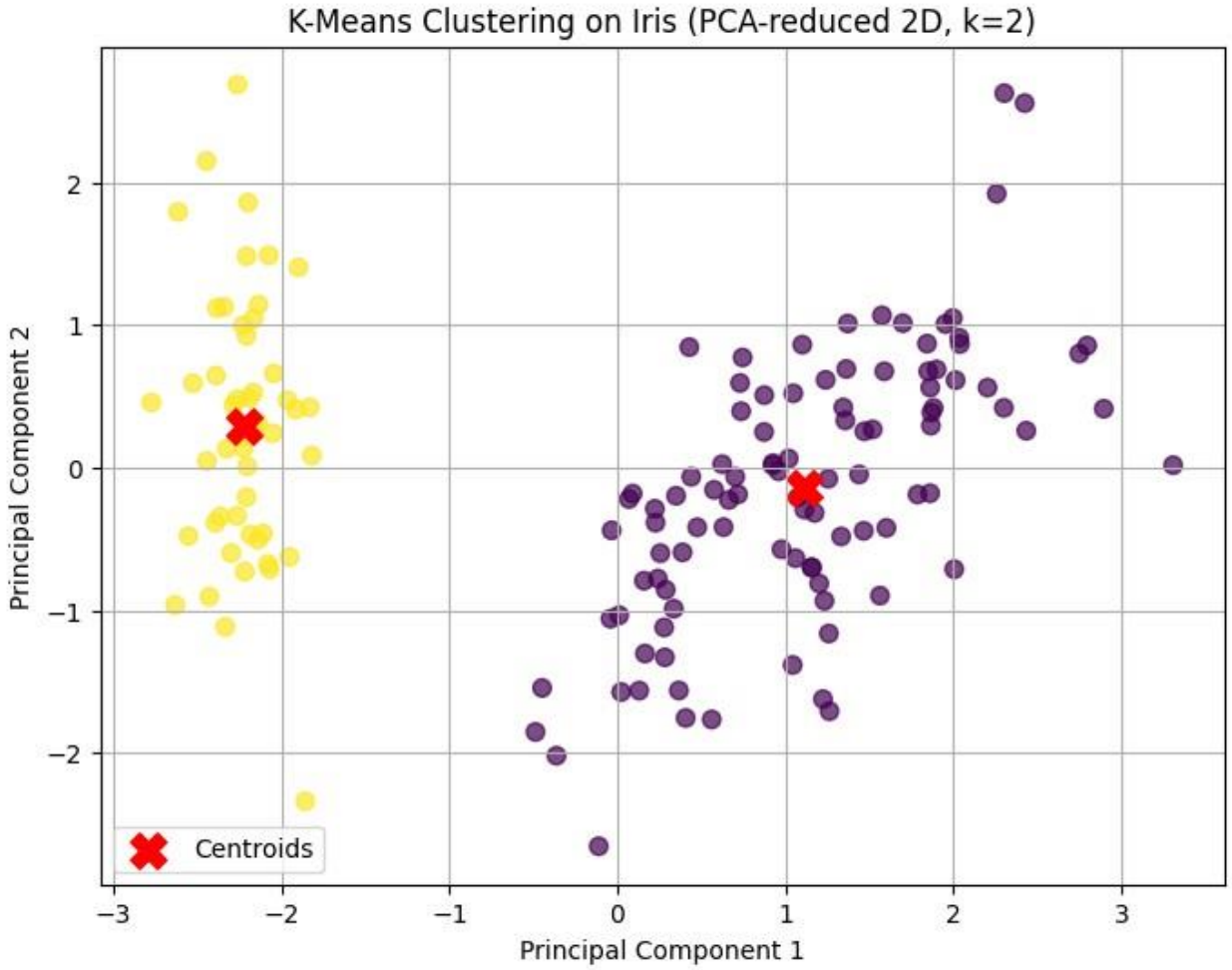
```
kmeans_final = KMeans(n_clusters=best_k, random_state=42,
n_init=10) kmeans_final.fit(X_scaled) labels =
kmeans_final.labels_ centers = kmeans_final.cluster_centers_
```

clusters (k) = 2 In [5]:

In [6]:
```
pca = PCA(n_components=2)
X_pca = pca.fit_transform(X_scaled)
centers_pca = pca.transform(centers)
```

In [7]:
```
plt.figure(figsize=(8, 6))
scatter = plt.scatter(X_pca[:, 0], X_pca[:, 1], c=labels, cmap='viridis', s=50
```

```
plt.scatter(centers_pca[:, 0], centers_pca[:, 1], c='red', marker='X',
s=200,
plt.title(f'K-Means Clustering on Iris (PCA-reduced 2D, k={best_k})')
plt.xlabel('Principal Component 1')
plt.ylabel('Principal Component 2')
plt.legend()
plt.grid(True)
plt.show()
```



In [8]:
```
cluster_sizes =
pd.Series(labels).value_counts().sort_index()
print("\nCluster Sizes:") print(cluster_sizes)
```

```
Cluster Sizes:
0     100
1     50
Name: count, dtype: int64
```

In [9]:
```
comparison = pd.crosstab(labels, y_true, rownames=['Cluster'],
colnames=['True print("\nMapping of Clusters to True Species:")
print(comparison)
```

```
Mapping of Clusters to True Species:
True Species    0    1    2
Cluster
0               0   50   50
1               50   0    0
```

In [10]:
```
iris_df = pd.DataFrame(X, columns=feature_names)
iris_df['Cluster Label'] = labels
iris_df['True Species'] = [iris.target_names[i] for i in y_true]

print("\nSample of Data with Cluster Labels:")
print(iris_df.head())
```

```
Sample of Data with Cluster Labels: sepal length (cm)  sepal width (cm)
   petal length (cm)  petal width (cm)  \
0                5.1               3.5                1.4               0.2
1                4.9               3.0                1.4               0.2
2                4.7               3.2                1.3               0.2
3                4.6               3.1                1.5               0.2
4                5.0               3.6                1.4               0.2

   Cluster Label True Species
0              1       setosa
1              1       setosa
2              1       setosa
3              1       setosa
4              1       setosa
```