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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.metrics
import silhouette_score
```

In [3]:

```
iris = load_iris() X =
iris . data
y_true = iris . target # true labels for comparison
```

In [4]:

```
scaler =      StandardScaler()

X_scaled     = scaler . fit_transform(X)
```

In [5]:

```
silhouette_scores = [] K_range =
range(2, 11)
```

In [7]:

```
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}")
```

```
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
```

In [8]:

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

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

Best number of clusters (k) = 2 In [9]: Out[9]:

```
?                      KMeans
KMeans(n_clusters=2, n_init=10, random_state=42)
```

In [10]:

```
print(cluster_sizes)
```

```
labels =  kmeans_final . labels_ centers =
kmeans_final . cluster_centers_

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

```
print("\nCluster Centers (Standardized Feature Space):") print(pd . DataFrame(centers,
columns=iris . feature_names))
```

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

Cluster Centers (Standardized Feature Space): sepal length (cm)  sepal width (cm)  petal length (cm)  petal
      width (cm)
0                    0.507289      -0.426631       0.652494      0.627447
1                    -1.014579      0.853263       -1.304987     -1.254893
```

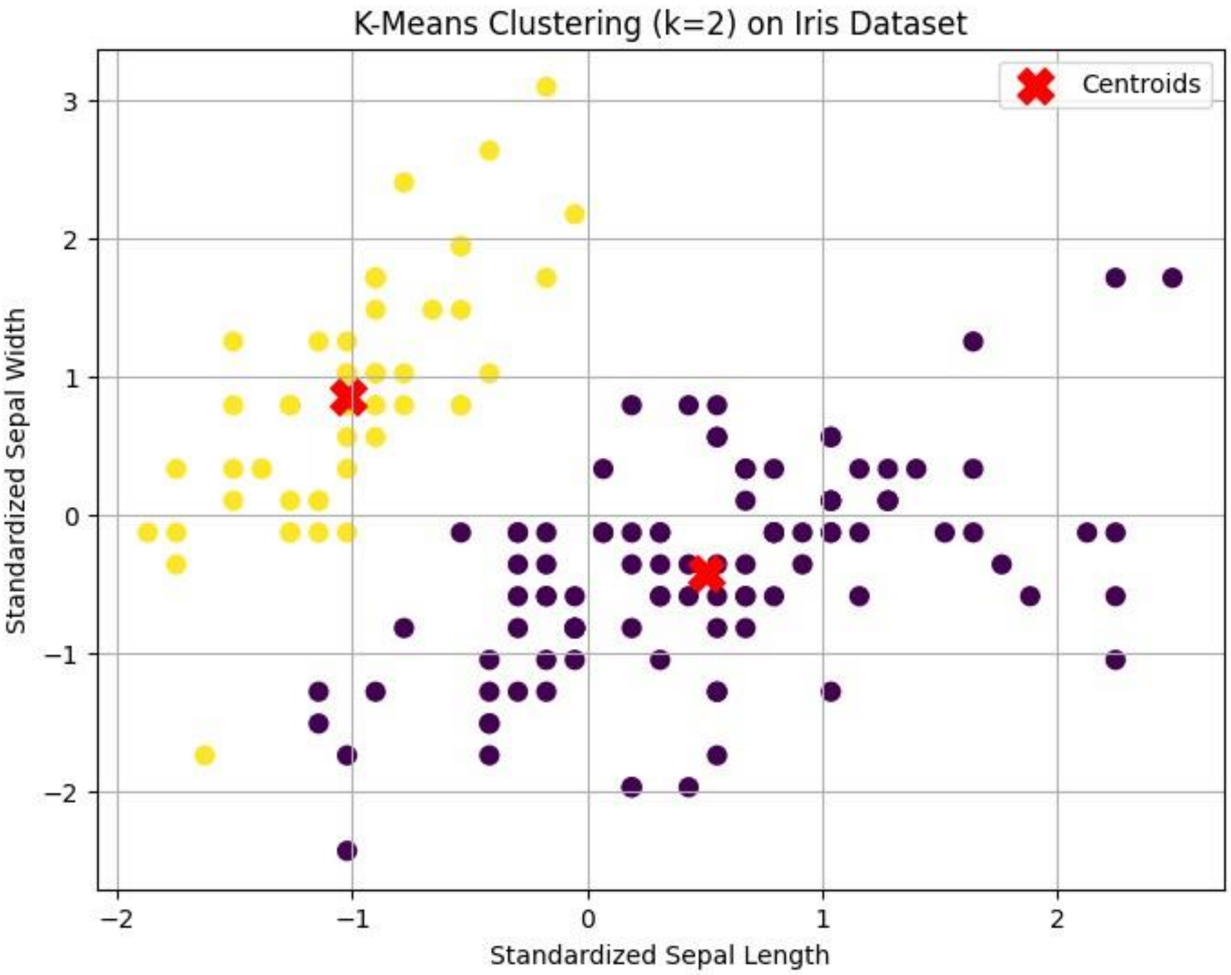
In [11]:

```
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 [12]:

```
plt . figure(figsize=(8, 6)) plt . scatter(X_scaled[:, 0], X_scaled[:, 1], c=labels, cmap='viridis', s=50)
plt . scatter(centers[:, 0], centers[:, 1], c='red', marker='X', s=200, label='C plt . xlabel('Standardized Sepal
Length') plt . ylabel('Standardized Sepal Width')
plt . title(f'K-Means Clustering (k={best_k}) on Iris Dataset')
plt . legend() plt . grid(True)
plt . show()
```



In [13]:

```
print("\nCluster Analysis Complete.")
```

```
Cluster
                              Analysis Complete.
```