Problem 1: The K Means Clustering Method

(a)

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In [1]: import numpy as np
import matplotlib.pyplot as plt
from sklearn.datasets import load_iris
from collections import Counter
from sklearn import datasets
from sklearn.decomposition import PCA
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis


np.random.seed(42)

def euclidean_distance(a, b):
    return np.linalg.norm(a - b, axis=1)

def manhattan_distance(a, b):
    return np.sum(np.abs(a - b), axis=1)

def chebyshev_distance(a, b):
    return np.max(np.abs(a - b), axis=1)


iris = load_iris()
x = iris.data
y = iris.target
feature_names = iris.feature_names
target_names = iris.target_names


def k_means(x, K, distance_metric='euclidean', max_iters=100):
    centroids = x[np.random.choice(range(len(x)), K, replace=False)]

    for _ in range(max_iters):
        if distance_metric == 'euclidean':
            distances = np.array([euclidean_distance(x, centroid) for cen
        elif distance_metric == 'manhattan':
            distances = np.array([manhattan_distance(x, centroid) for cen
        elif distance_metric == 'chebyshev':
            distances = np.array([chebyshev_distance(x, centroid) for cen

        cluster_labels = np.argmin(distances, axis=0)

        new_centroids = np.array([x[cluster_labels == k].mean(axis=0) for

        if np.allclose(centroids, new_centroids):
            break
        centroids = new_centroids

    return cluster_labels, centroids
```

(b) & (c) combined

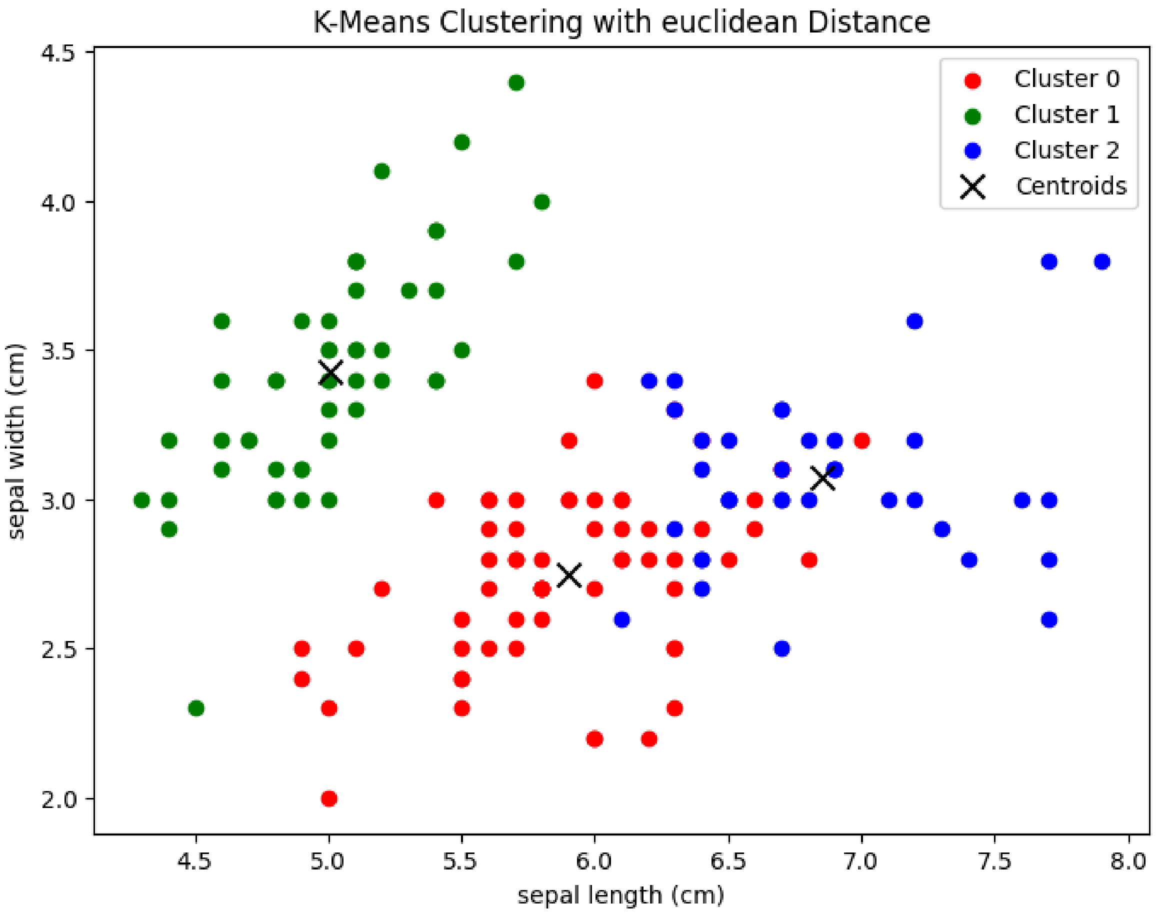
```
In [2]: K = 3
        distance_metrics = ['euclidean', 'manhattan', 'chebyshev']

        for metric in distance_metrics:
            cluster_labels, centroids = k_means(x, K, distance_metric=metric)

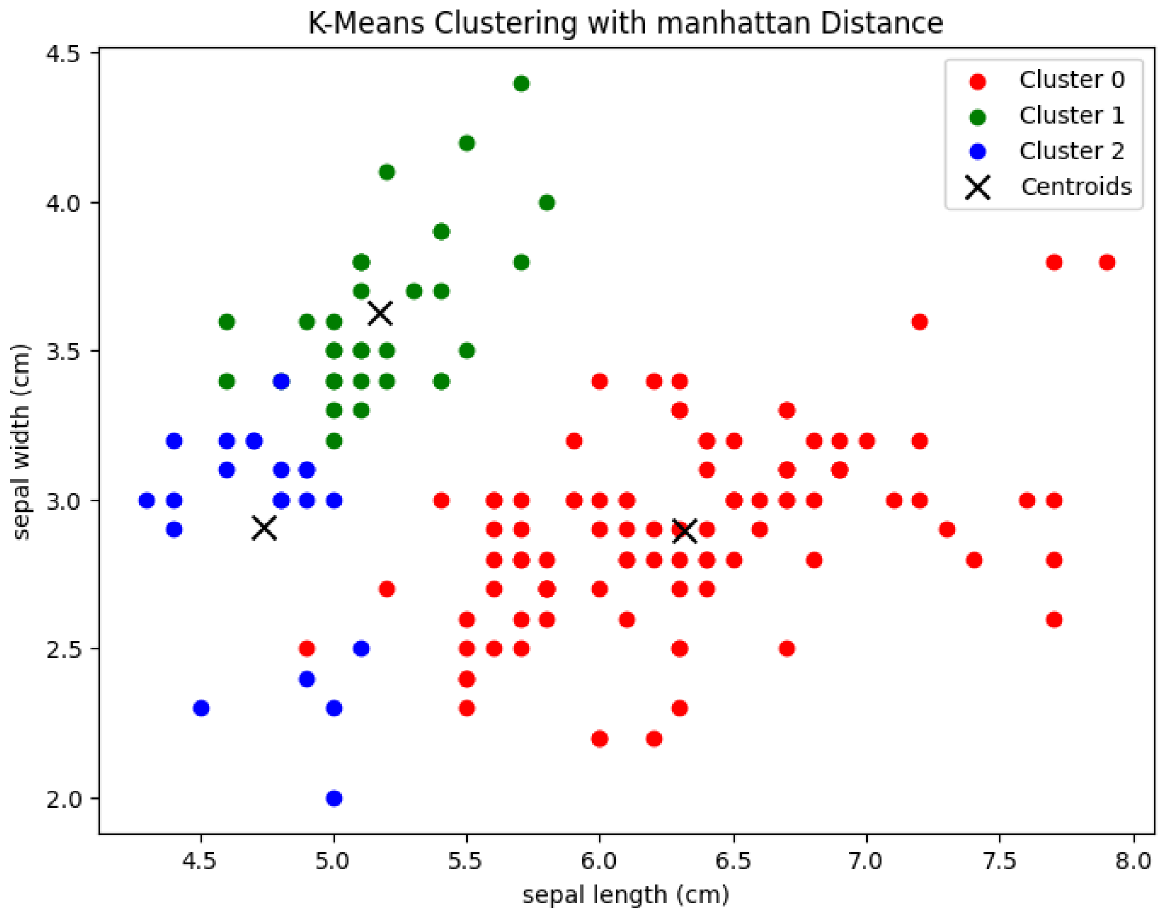
            plt.figure(figsize=(8, 6))
            colors = ['r', 'g', 'b']
            for k in range(K):
                cluster = x[cluster_labels == k]
                plt.scatter(cluster[:, 0], cluster[:, 1], c=colors[k], label=f'Cl

            plt.scatter(centroids[:, 0], centroids[:, 1], s=100, c='black', marke
            plt.title(f'K-Means Clustering with {metric} Distance')
            plt.xlabel(feature_names[0])
            plt.ylabel(feature_names[1])
            plt.legend()
            plt.show()

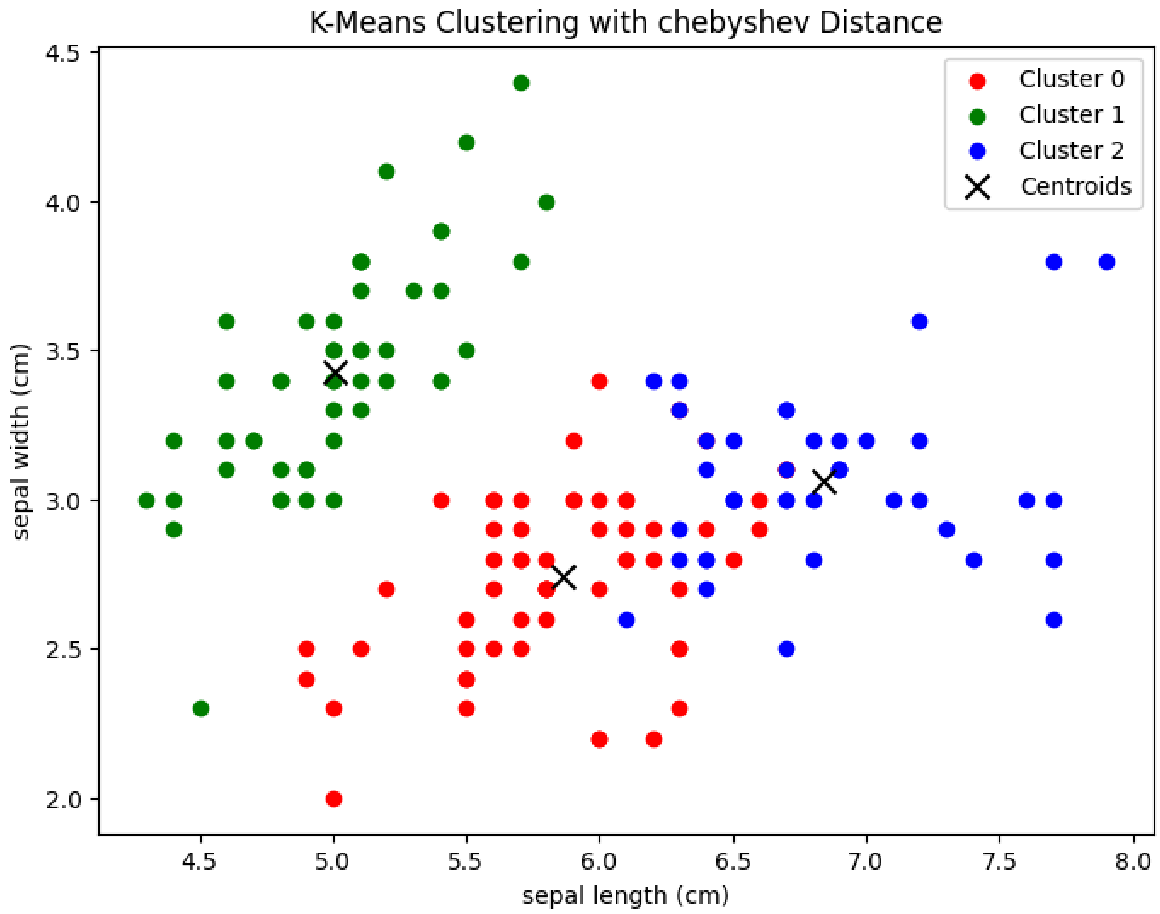
            label_mapping = {}
            for k in range(K):
                true_labels = y[cluster_labels == k]
                if len(true_labels) == 0:
                    continue
                most_common = Counter(true_labels).most_common(1)[0][0]
                label_mapping[k] = most_common
            predicted_labels = np.array([label_mapping[label] for label in cluste
            accuracy = np.mean(predicted_labels == y)
            print(f'Accuracy with {metric} distance: {accuracy:.4f}')
```



```
Accuracy with euclidean distance: 0.8933
```



```
Accuracy with manhattan distance: 0.6667
```



```
Accuracy with chebyshev distance: 0.8867
```

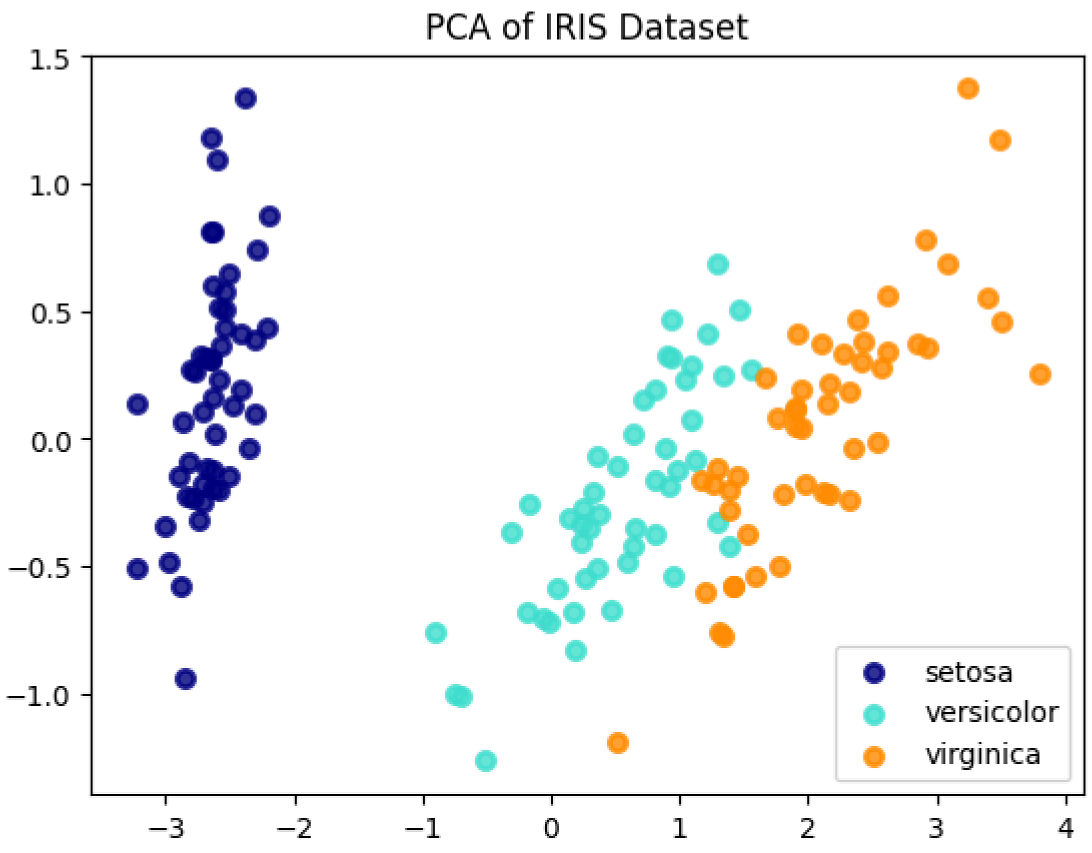
Problem 2: The PCA Method

In [3]:
```
pca = PCA(n_components=2)
x_r = pca.fit_transform(x)

print("Explained variance ratio (first two components):", pca.explained_v
plt.figure()
colors = ["navy", "turquoise", "darkorange"]
lw = 2

for color, i, target_name in zip(colors, [0, 1, 2], target_names):
    plt.scatter(
        x_r[y == i, 0],
        x_r[y == i, 1],
        color=color,
        alpha=0.8,
        lw=lw,
        label=target_name
    )
plt.legend()
plt.title("PCA of IRIS Dataset")
plt.show()
```

```
Explained variance ratio (first two components): [0.92461872 0.05306648]
```


PCA of IRIS Dataset
setosa
versicolor
virginica