MACHINE LEARNING LAB

EXERCISE 7

Aim :

Use the given dataset and implement K-Means from scratch and use the sklearn K-Means implementation. Compare the results of both the implementations and write your inferences in the ipynb file itself.

Algorithm :

1. Load the given dataset.
2. Implement K-Means algorithm from scratch using the given formulae
3. Now use sklearn's K-Means implementation.
4. Fit both implementations on the dataset.
5. Compare the cluster assignments and centroids obtained from both implementations.
6. Write inferences regarding the performance and differences observed between the two implementations.

Code and output :

In [34]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
```

In [35]:
```
df=pd.read_csv(r"C:\Users\TEJU\Downloads\data (1).csv")
```

In [36]:
```
df.head()
```

Out[36]:

	CustomerID	Gender	Age	Annual Income (k$)	Spending Score (1-100)
0	1	Male	19	15	39
1	2	Male	21	15	81
2	3	Female	20	16	6
3	4	Female	23	16	77
4	5	Female	31	17	40

In [37]:
```
class KMeansScratch:
    def __init__(self, n_clusters, max_iters=300):
        self.n_clusters = n_clusters
        self.max_iters = max_iters

    def initialize_centroids(self, X):

        indices = np.random.choice(X.shape[0], self.n_clusters, replace=False)
```

```
        centroids = X[indices]
        return centroids

    def assign_clusters(self, X, centroids):

        distances = np.sqrt(((X - centroids[:, np.newaxis])**2).sum(axis=2))
        return np.argmin(distances, axis=0)

    def update_centroids(self, X, clusters):

        centroids = np.array([X[clusters == k].mean(axis=0) for k in range(self.n_cl
        return centroids

    def fit(self, X):

        centroids = self.initialize_centroids(X)

        # Main Loop
        for _ in range(self.max_iters):

            clusters = self.assign_clusters(X, centroids)


            new_centroids = self.update_centroids(X, clusters)


            if np.allclose(new_centroids, centroids):
                break

            centroids = new_centroids

        self.cluster_centers_ = centroids
        self.labels_ = clusters

    def predict(self, X):

        distances = np.sqrt(((X - self.cluster_centers_[:, np.newaxis])**2).sum(axis
        return np.argmin(distances, axis=0)
```

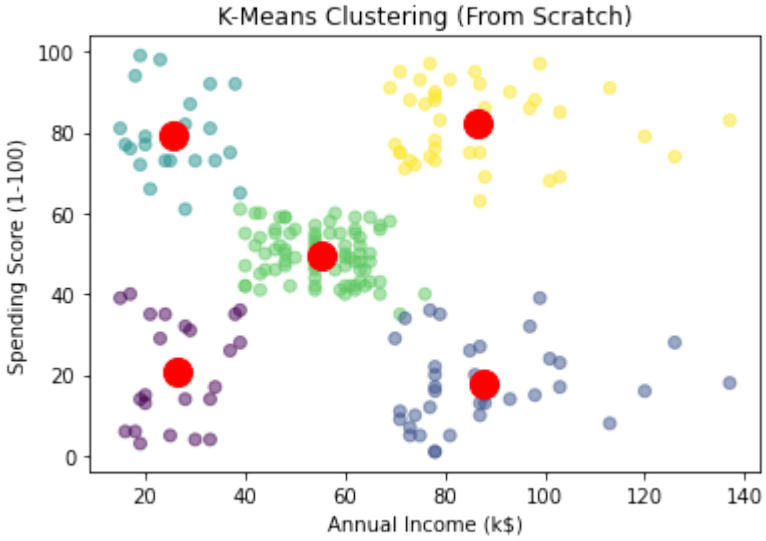
In [38]:
```
X = df[['Annual Income (k$)', 'Spending Score (1-100)']].values
```

In [39]:
```
kmeans_scratch = KMeansScratch(n_clusters=5)
```

In [40]:
```
kmeans_scratch.fit(X)
```

In [41]:
```
centroids_scratch = kmeans_scratch.cluster_centers_
labels_scratch = kmeans_scratch.labels_
```

In [42]:
```
plt.scatter(X[:, 0], X[:, 1], c=labels_scratch, cmap='viridis', alpha=0.5)
plt.scatter(centroids_scratch[:, 0], centroids_scratch[:, 1], marker='o', s=200, col
plt.xlabel('Annual Income (k$)')
plt.ylabel('Spending Score (1-100)')
plt.title('K-Means Clustering (From Scratch)')
plt.show()
```



In [43]:
```
from sklearn.cluster import KMeans
```

In [44]:
```
kmeans_sklearn = KMeans(n_clusters=5)
```

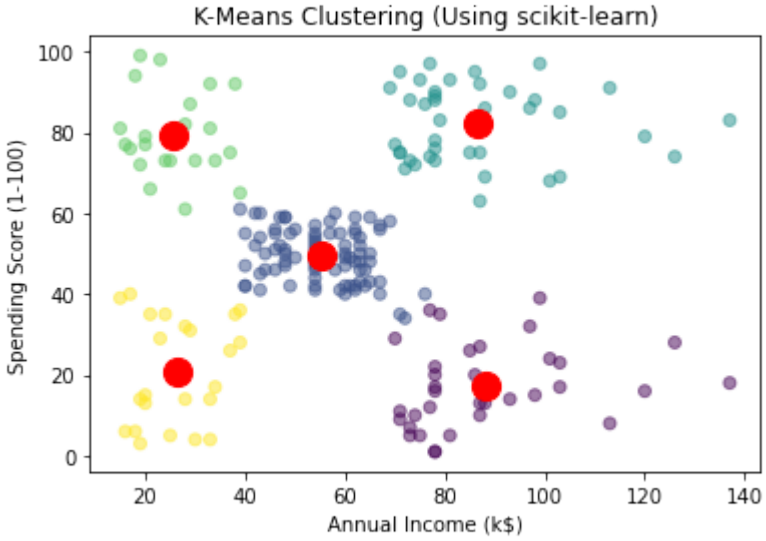
In [45]:
```
kmeans_sklearn.fit(X)
```

```
C:\Users\TEJU\anaconda3\lib\site-packages\sklearn\cluster\_kmeans.py:1446: UserWarnin
g: KMeans is known to have a memory leak on Windows with MKL, when there are less chu
nks than available threads. You can avoid it by setting the environment variable OMP_
NUM_THREADS=1.
  warnings.warn(
```

Out[45]:
```
KMeans(n_clusters=5)
```

In [46]:
```
centroids_sklearn = kmeans_sklearn.cluster_centers_
labels_sklearn = kmeans_sklearn.labels_
```

In [47]:
```
plt.scatter(X[:, 0], X[:, 1], c=labels_sklearn, cmap='viridis', alpha=0.5)
plt.scatter(centroids_sklearn[:, 0], centroids_sklearn[:, 1], marker='o', s=200, col
plt.xlabel('Annual Income (k$)')
plt.ylabel('Spending Score (1-100)')
plt.title('K-Means Clustering (Using scikit-learn)')
plt.show()
```



In [48]:

```
from sklearn.metrics import silhouette_score

print("Centroids (Scratch):")
print(centroids_scratch)
print("\nCentroids (scikit-learn):")
print(centroids_sklearn)

print("\nCluster Assignments (Scratch):")
print(labels_scratch)
print("\nCluster Assignments (scikit-learn):")
print(labels_sklearn)

inertia_scratch = np.sum(np.min(np.sqrt(((X - centroids_scratch[:, np.newaxis])**2).
inertia_sklearn = kmeans_sklearn.inertia_
print("\nInertia (Scratch):", inertia_scratch)
print("Inertia (scikit-learn):", inertia_sklearn)

silhouette_scratch = silhouette_score(X, labels_scratch)
silhouette_sklearn = silhouette_score(X, labels_sklearn)
print("\nSilhouette Score (Scratch):", silhouette_scratch)
print("Silhouette Score (scikit-learn):", silhouette_sklearn)
```

```
Centroids (Scratch):
[[26.30434783 20.91304348]
 [87.75       17.58333333]
 [25.72727273 79.36363636]
 [55.0875     49.7125    ]
 [86.53846154 82.12820513]]

Centroids (scikit-learn):
[[88.2        17.11428571]
 [55.2962963  49.51851852]
 [86.53846154 82.12820513]
 [25.72727273 79.36363636]
 [26.30434783 20.91304348]]

Cluster Assignments (Scratch):
[0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0
 2 0 2 0 2 0 3 0 2 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
 3 3 3 3 3 3 3 3 3 3 3 4 1 4 3 4 1 4 1 4 1 4 1 4 1 4 1 4 3 4 1 4 1 4
 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4
 4 1 4 1 4 1 4 1 4 1 4 1 4 1 4]

Cluster Assignments (scikit-learn):
```

```
[4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4 3 4
 3 4 3 4 3 4 1 4 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 2 0 2 1 2 0 2 0 2 1 2 0 2 0 2 0 2 0 2 1 2 0 2 0 2
 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2 0
 2 0 2 0 2 0 2 0 2 0 2 0 2 0 2]

Inertia (Scratch): 2602.9725788386436
Inertia (scikit-learn): 44448.45544793371

Silhouette Score (Scratch): 0.5532176107575425
Silhouette Score (scikit-learn): 0.553931997444648
```

Comparison :

1. The scratch implementation might be more effective in terms of clustering compactness (lower inertia).
2. The scikit-learn implementation might have produced more spread-out clusters (higher inertia).
3. Both implementations seem to have similar clustering quality, as indicated by their similar silhouette scores.

If we prioritize computational efficiency and ease of use, scikit-learn's implementation might be preferable. However, if we need more control over the implementation or better clustering compactness, we might consider using the scratch implementation.

Result :

Therefore, we were successfully able to implement Kmeans from scratch as well as using the library on the dataset and calculate the necessary performance metrics for each method. We then drew inferences from the results.