B4. Create a program that fits a mixture of Gaussians to a dataset of handwritten digit features and clusters them into distinct groups. Use the Expectation Maximization method to estimate the parameters of the Gaussian mixture model.

In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.mixture import GaussianMixture
from sklearn.datasets import fetch_openml
from sklearn.decomposition import PCA
from sklearn.metrics import accuracy_score, confusion_matrix
from scipy.optimize import linear_sum_assignment
```

In [2]:

```
mnist = fetch_openml('mnist_784', version=1, as_frame=False)
X = mnist.data.astype(np.float32) / 255.0
y = mnist.target.astype(int)
```

In [3]:

```
pca = PCA(n_components=50, random_state=42)
X_reduced = pca.fit_transform(X)
```

In [4]:

```
num_clusters = 10
gmm = GaussianMixture(n_components=num_clusters, covariance_type='full', random_state=42)
gmm.fit(X_reduced)
```

Out[4]:

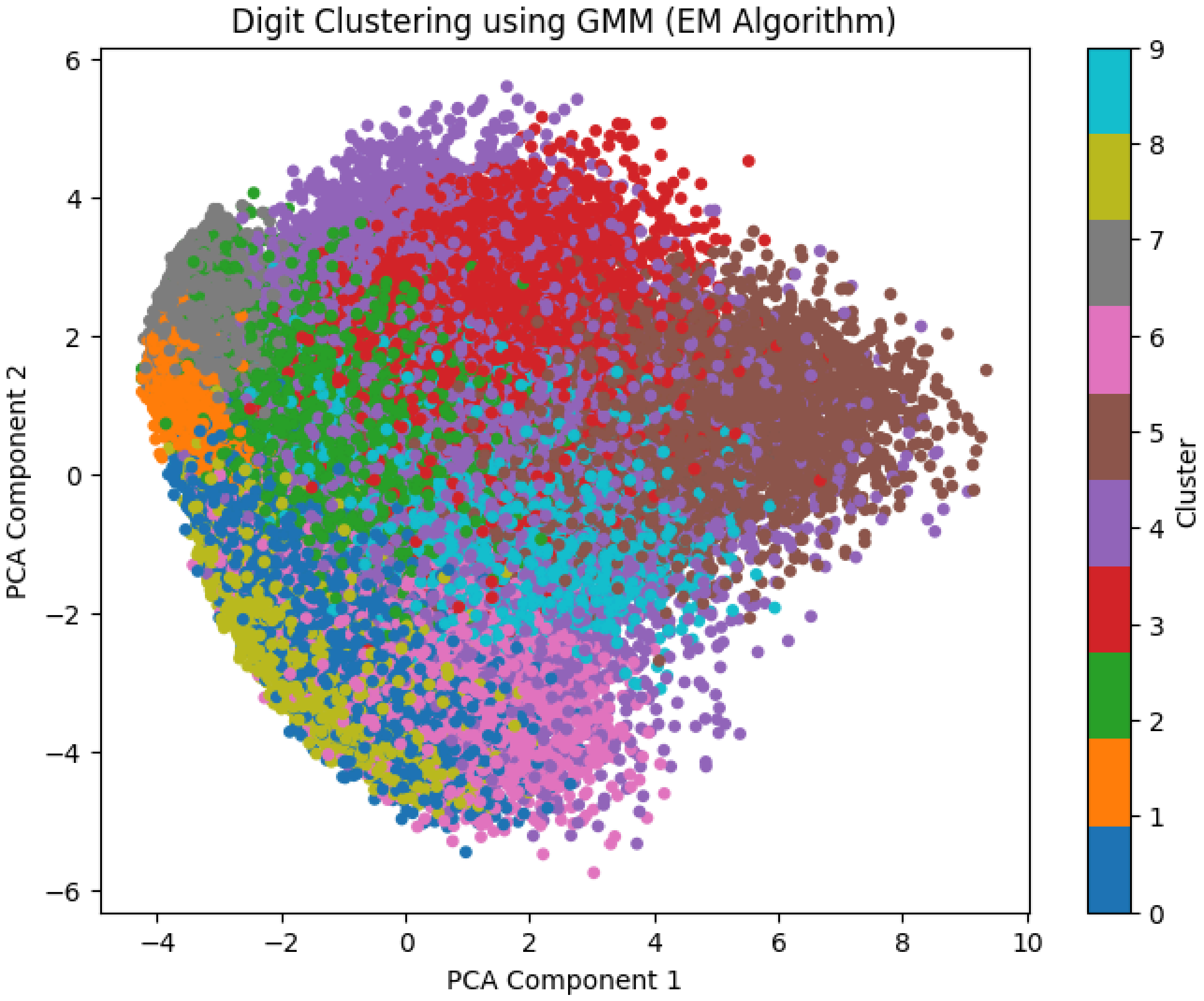
```
▾ GaussianMixture
GaussianMixture(n_components=10, random_state=42)
```

In [9]:

```
clusters = gmm.predict(X_reduced)
```

In [10]:

```
plt.figure(figsize=(8, 6))
plt.scatter(X_reduced[:, 0], X_reduced[:, 1], c=clusters, cmap='tab10', s=15)
plt.title("Digit Clustering using GMM (EM Algorithm)")
plt.xlabel("PCA Component 1")
plt.ylabel("PCA Component 2")
plt.colorbar(label="Cluster")
plt.show()
```



In [11]:

```
def cluster_accuracy(y_true, y_pred):
    cm = confusion_matrix(y_true, y_pred)
    row_ind, col_ind = linear_sum_assignment(-cm)
    accuracy = cm[row_ind, col_ind].sum() / y_true.size
    return accuracy

acc = cluster_accuracy(y, clusters)
print(f"GMM Clustering Accuracy: {acc:.4f}")
```

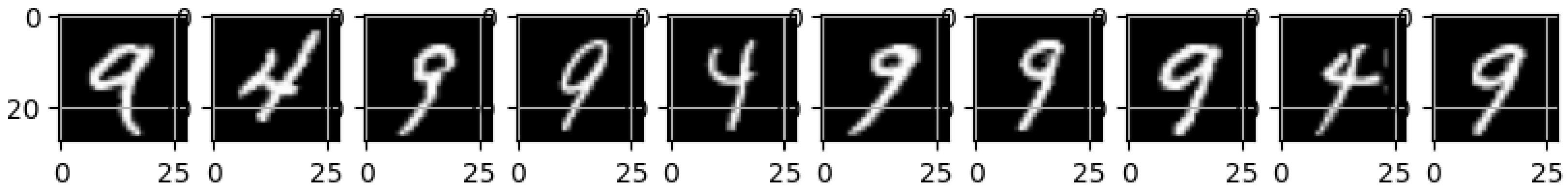
```
GMM Clustering Accuracy: 0.6080
```

In [ ]:

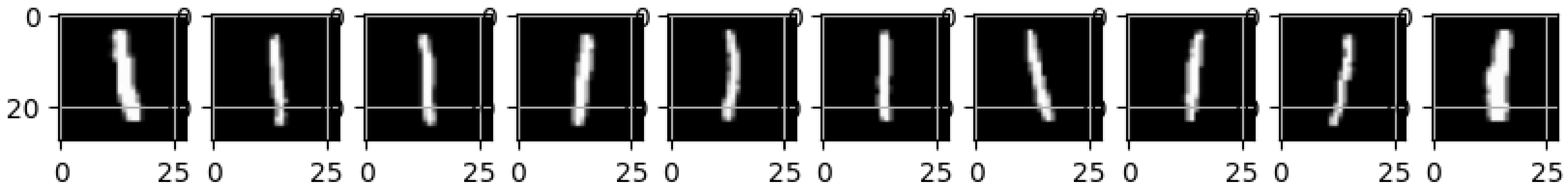
```
#OPTIONAL
def plot_cluster_images(cluster_number, num_samples=10):
    indices = np.where(clusters == cluster_number)[0][:num_samples]
    plt.figure(figsize=(10, 2))
    for i, idx in enumerate(indices):
        plt.subplot(1, num_samples, i+1)
        plt.imshow(X[idx].reshape(28, 28), cmap='gray')
        plt.grid("off")
    plt.suptitle(f"Cluster {cluster_number}")
    plt.show()

for i in range(5):
    plot_cluster_images(i)
```

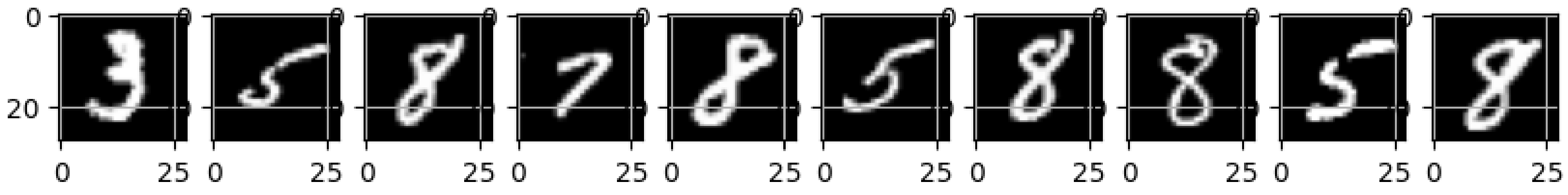
Cluster 0



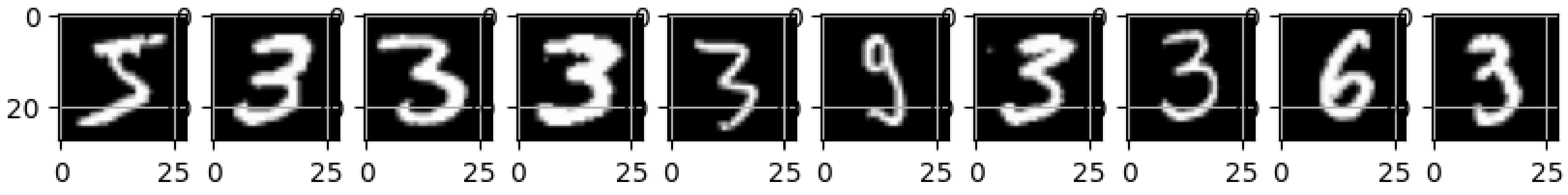
Cluster 1



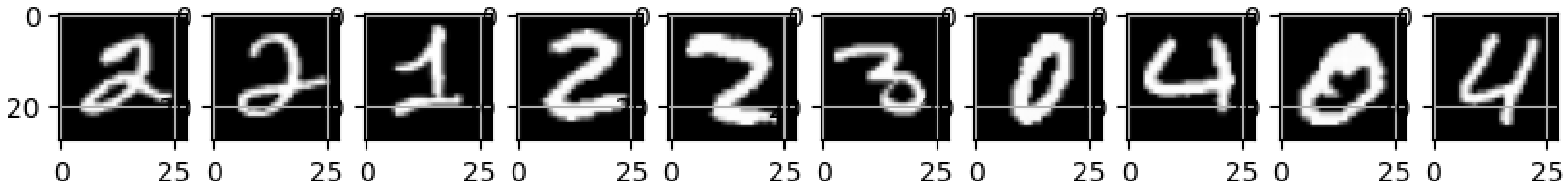
Cluster 2



Cluster 3



Cluster 4



In [ ]: