Q3

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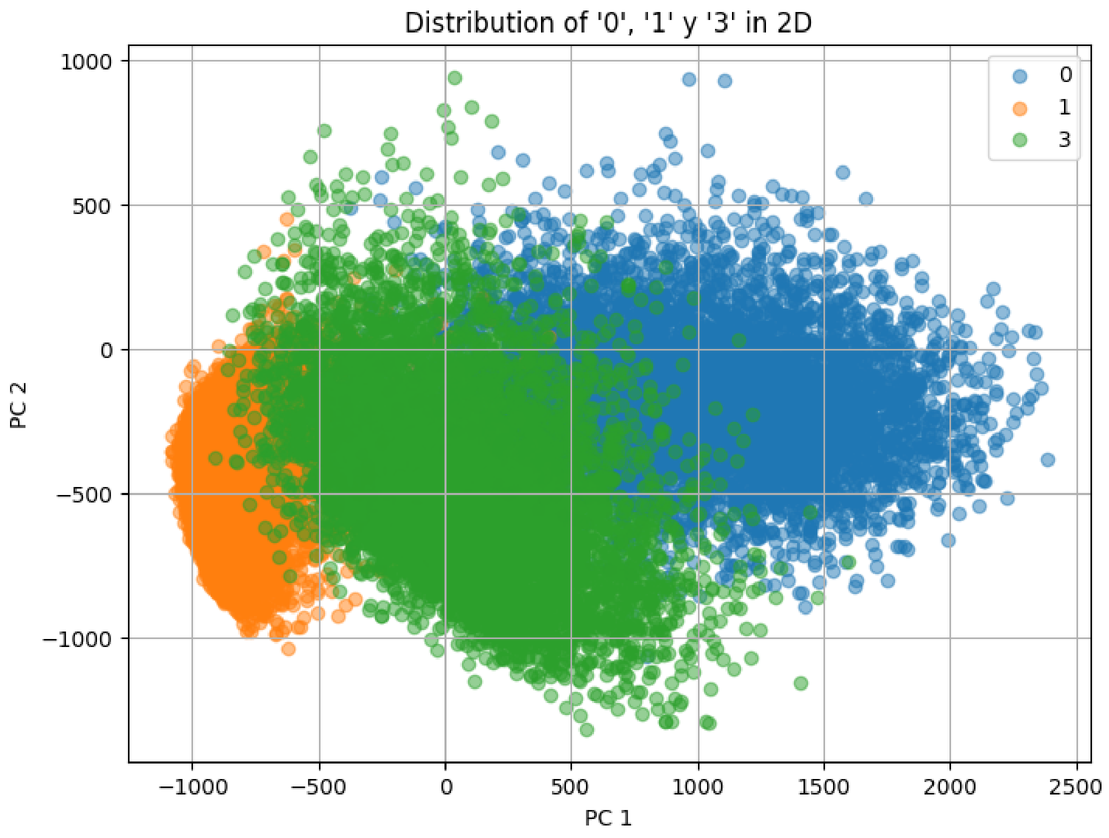
```
[ ]: # Name: Carlos Sanchez
     # Student ID: 21111910
```

1 Question 3

1.1 Part 2

```
[ ]: # Import useful libraries. Feel free to use sklearn.
     from sklearn.datasets import fetch_openml
     import warnings
     warnings.filterwarnings("ignore")


     # Load MNIST dataset.
     X, y = fetch_openml("mnist_784", version=1, return_X_y=True, as_frame=False)
```

```
[ ]: # Conduct PCA to reduce the dimensionality of X.
     from sklearn.decomposition import PCA
     import numpy as np
     import matplotlib.pyplot as plt

     pca = PCA(n_components=2)
     X_reduced = pca.fit_transform(X)

     # Visualize the data distribution of digits '0', '1' and '3' in a 2D scatter␣
      ↪plot.
     digit_mask = np.isin(y, ['0', '1', '3'])
     X_filtered = X_reduced[digit_mask]
     y_filtered = y[digit_mask]

     plt.figure(figsize=(8, 6))
     for digit in np.unique(y_filtered):
         plt.scatter(X_filtered[y_filtered == digit, 0], X_filtered[y_filtered ==␣
      ↪digit, 1], label=digit, alpha=0.5)
     plt.title("Distribution of '0', '1' y '3' in 2D")
     plt.xlabel("PC 1")
     plt.ylabel("PC 2")
     plt.legend()
     plt.grid(True)
     plt.show()
```



We can clearly see that the points corresponding to the value 3 can be located between the cluster of points representing 0 and the cluster of points representing 1.

To print an image of a value 3 from only the points of 0 and 1, it could work if we first find the centroids of the clusters for each value(0 and 1), and then we try to give a weight for the values of each centroid. Then, id we add this values with each weight, we could get an image that represents a 3.

In the following code, I have tried various values for both weights, and the ones that make the output to be as close as posible to 3 are w0 = 0.4 and w1 = 0.6. The output image is the following.

```
[ ]: # Generate an image of digit '3' using 2D representations of digits '0' and '1'.
     X_0 = X_reduced[y == '0']
     X_1 = X_reduced[y == '1']

     centroid_0 = np.mean(X_0, axis=0)
     centroid_1 = np.mean(X_1, axis=0)
```

```
weight_0 = 0.4
weight_1 = 0.6
generated_image = weight_0 * centroid_0 + weight_1 * centroid_1

plt.figure(figsize=(4, 4))
plt.imshow(pca.inverse_transform(generated_image).reshape(28, 28), cmap='gray')
plt.title("Generated image of '3'")
plt.axis('off')
plt.show()
```

Generated image of '3'