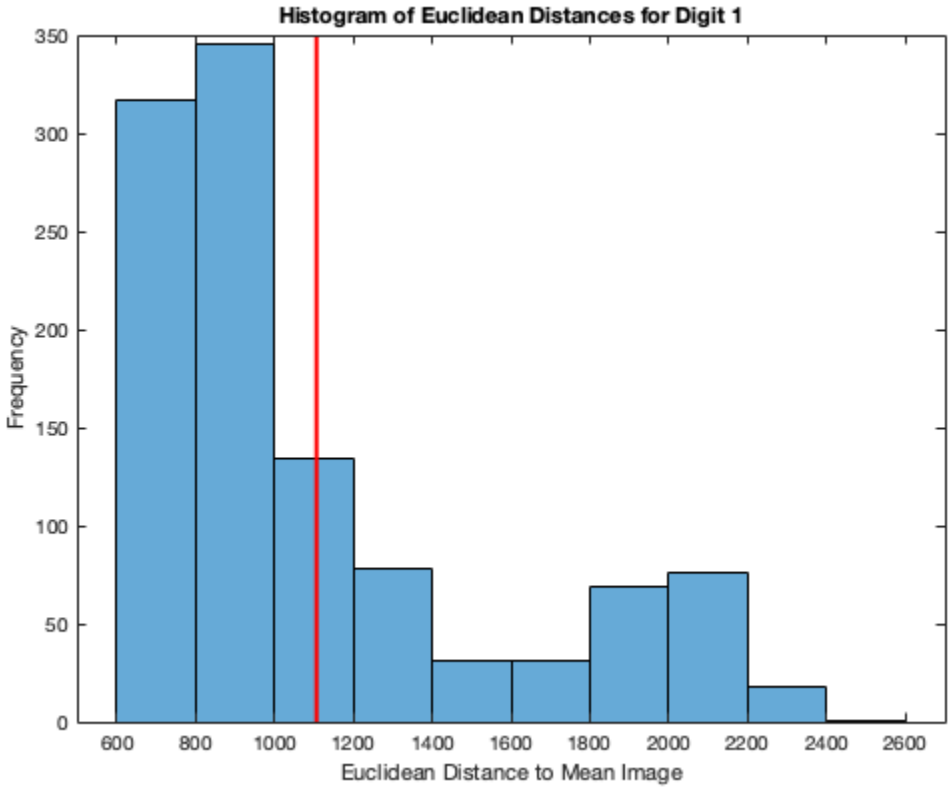
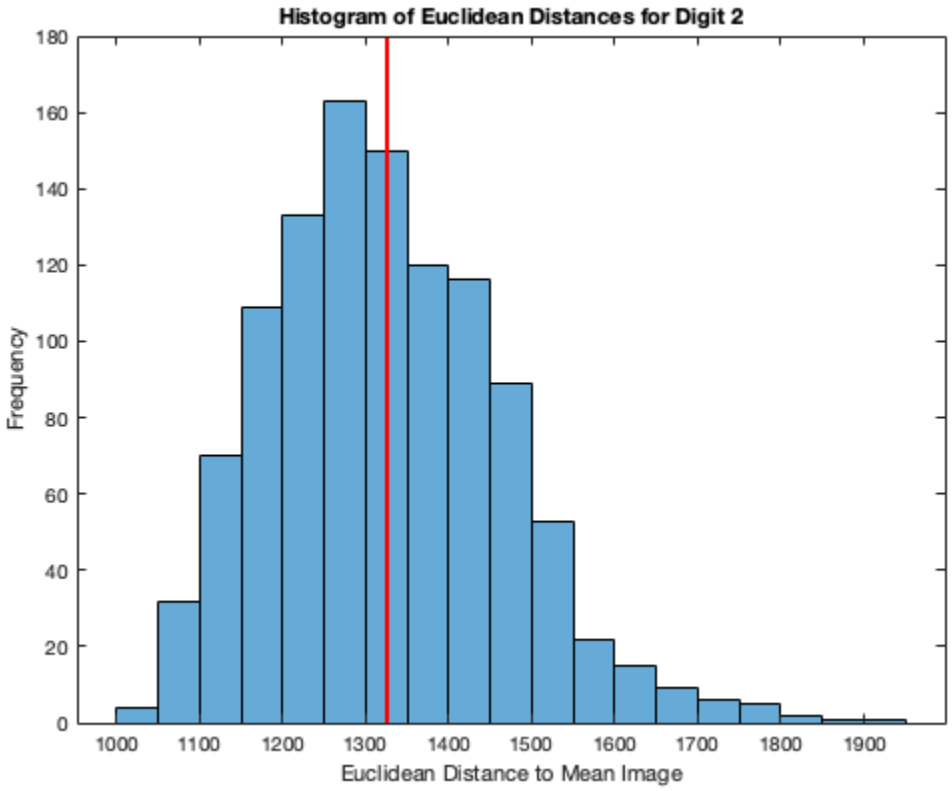
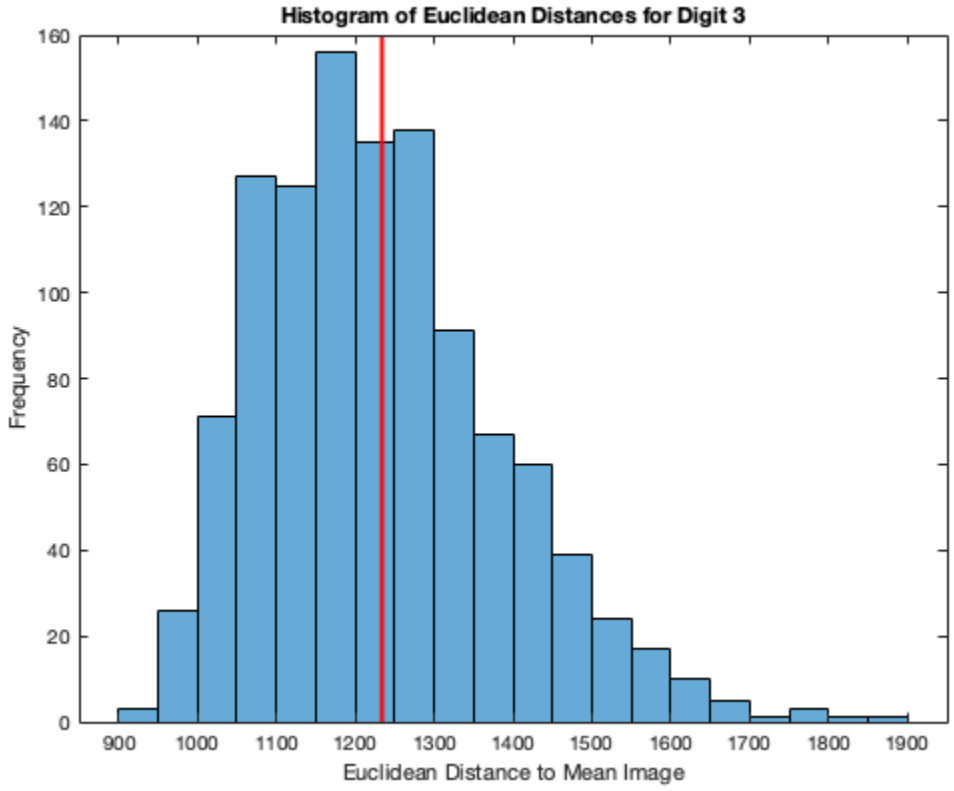
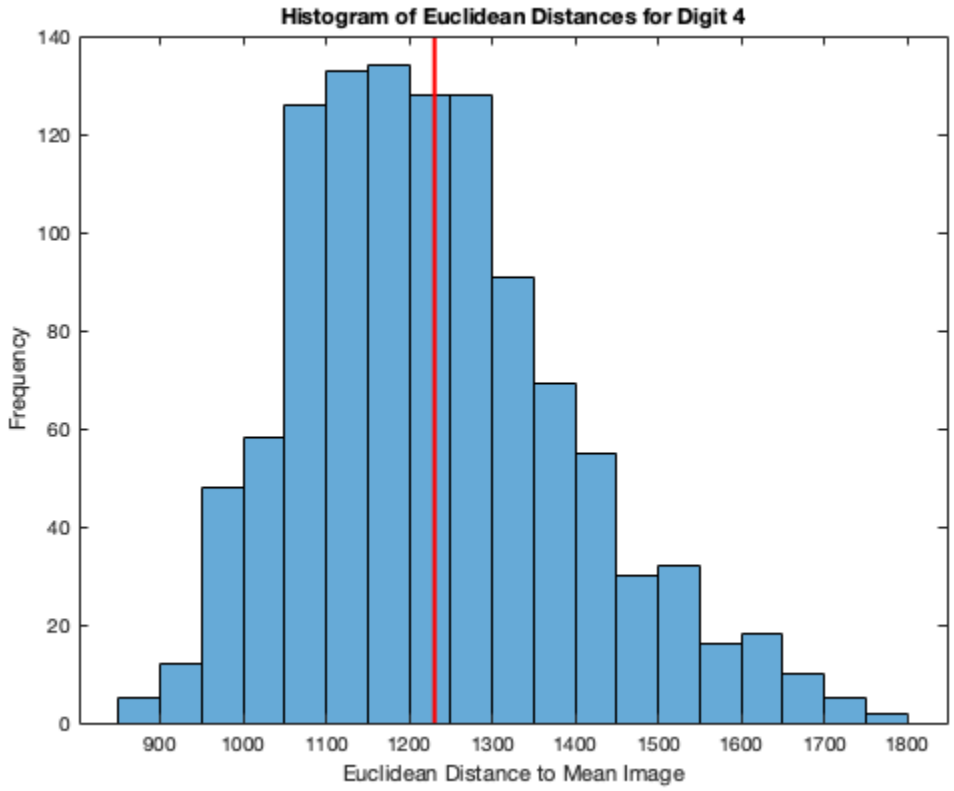
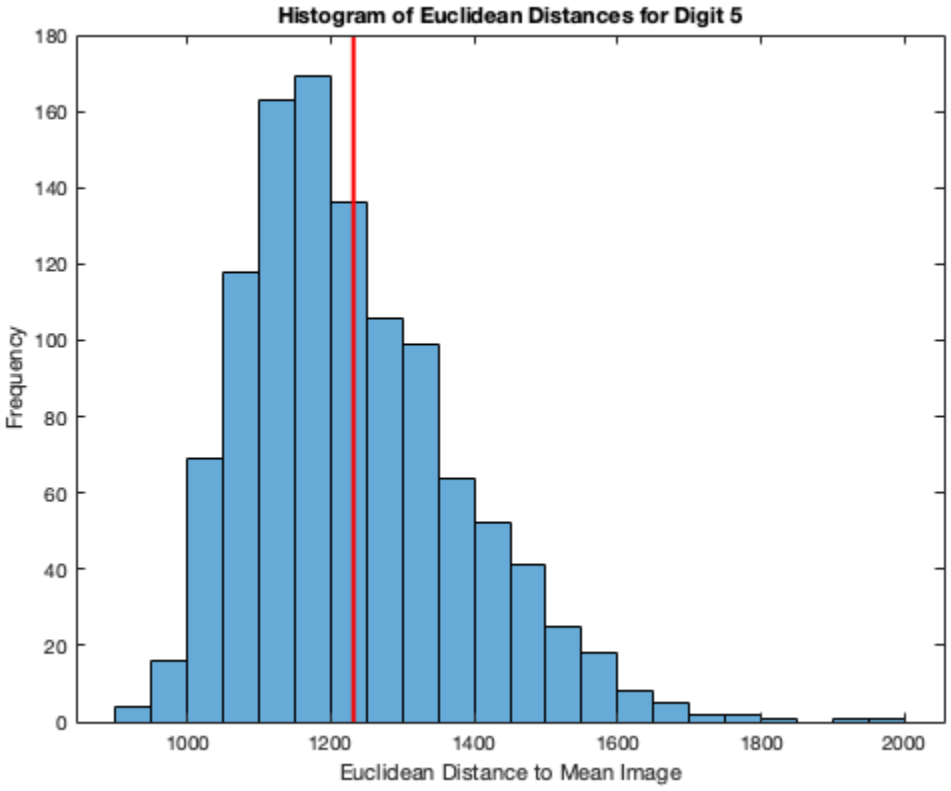
```
clear;
clc;
close all;
load('usps_all.mat');

% Compute distances and display histograms
for i = 1:10
    distances = zeros(1, size(data, 2)); % Initialize distance array
    sample_mean = mean(data(:, :, i), 2); % Mean vector of the class

    % Compute Euclidean distance from the mean for each image in the class
    for j = 1:size(data, 2)
    % Ensure both the image data and the sample mean are of type double
        distances(j) = norm(double(data(:, j, i)) - double(sample_mean));
    end

    % Calculate the mean of the distances
    meanDistance = mean(distances);

    % Plot histogram of distances
    figure; % Create new figure for each histogram
    histogram(distances);
    hold on;
    % Plot a vertical line representing the mean distance
    yLimits = ylim; % Get the current y-axis limits
    line([meanDistance meanDistance], yLimits, 'Color', 'red', 'LineWidth',
2);
    title(['Histogram of Euclidean Distances for Digit ', num2str(mod(i,
10))]);
    xlabel('Euclidean Distance to Mean Image');
    ylabel('Frequency');
    hold off;
end
```

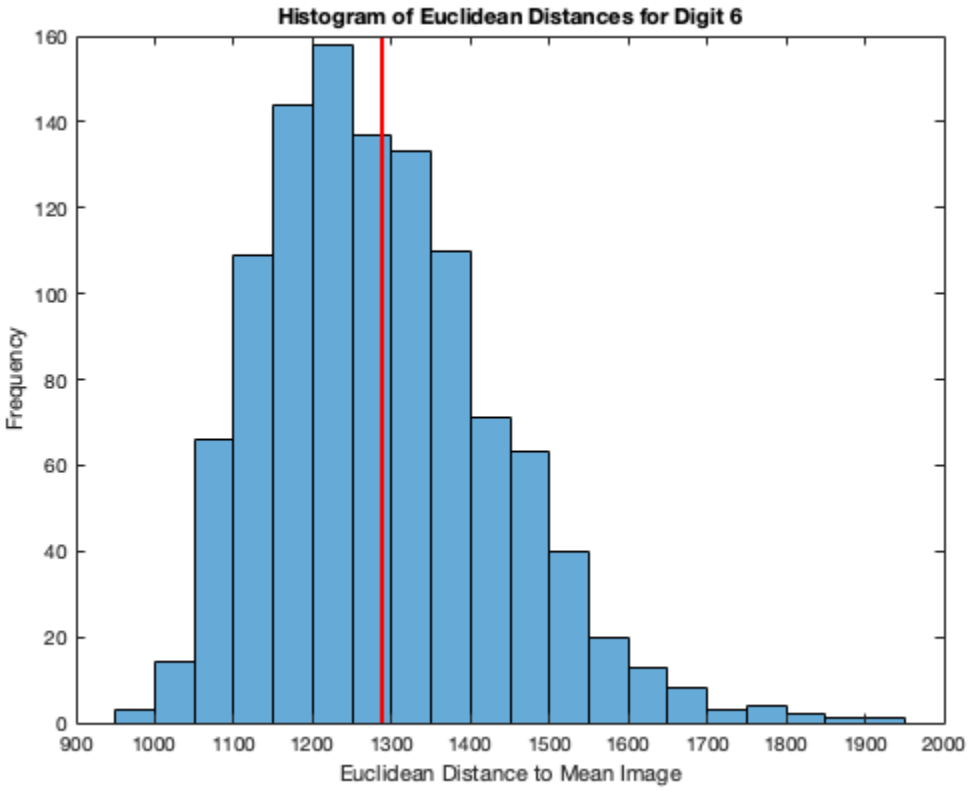

Histogram of Euclidean Distances for Digit 1
Frequency
Euclidean Distance to Mean Image
0
50
100
150
200
250
300
350
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600

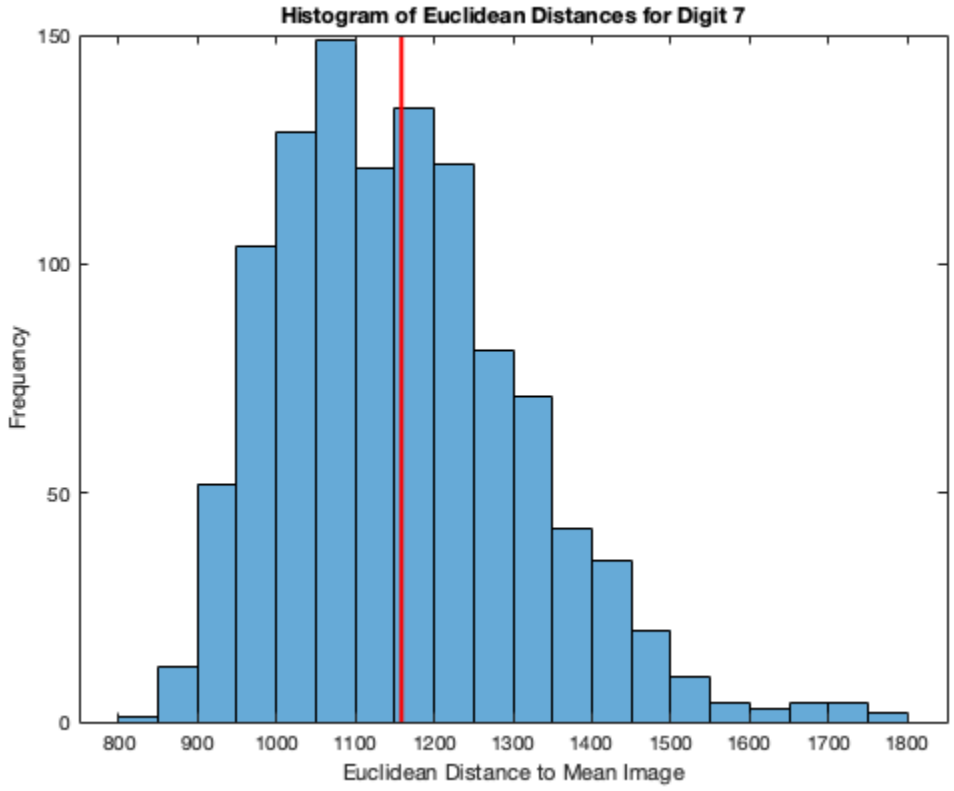

Histogram of Euclidean Distances for Digit 2
Frequency
Euclidean Distance to Mean Image
0
20
40
60
80
100
120
140
160
180
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

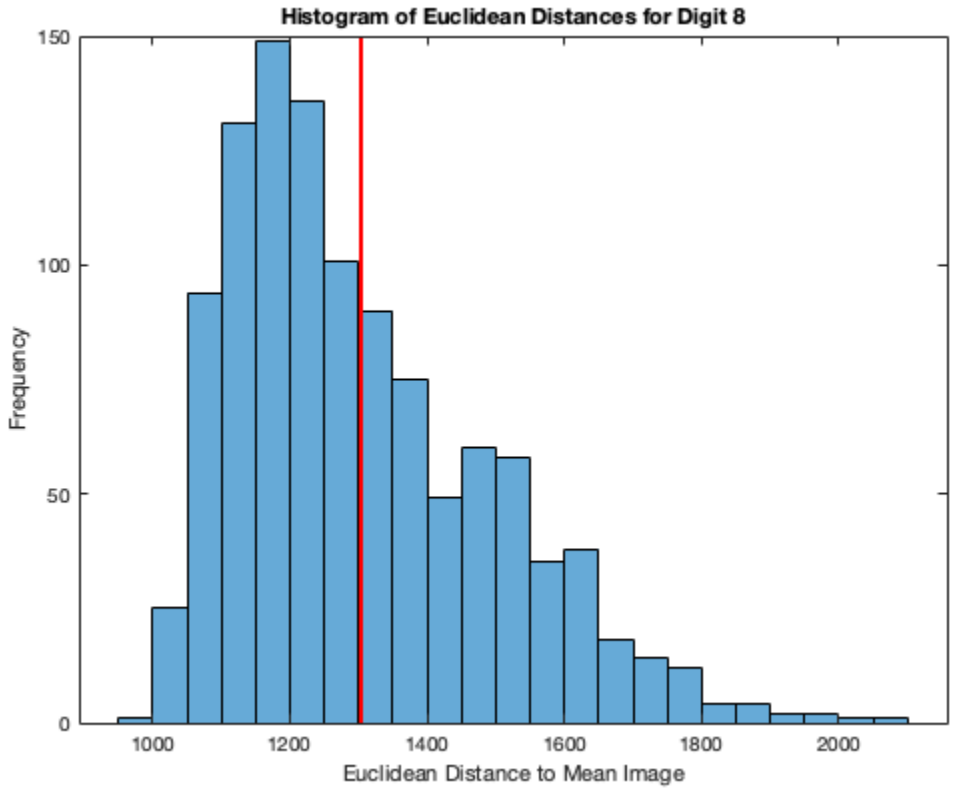

Histogram of Euclidean Distances for Digit 3
Frequency
Euclidean Distance to Mean Image
0
20
40
60
80
100
120
140
160
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900

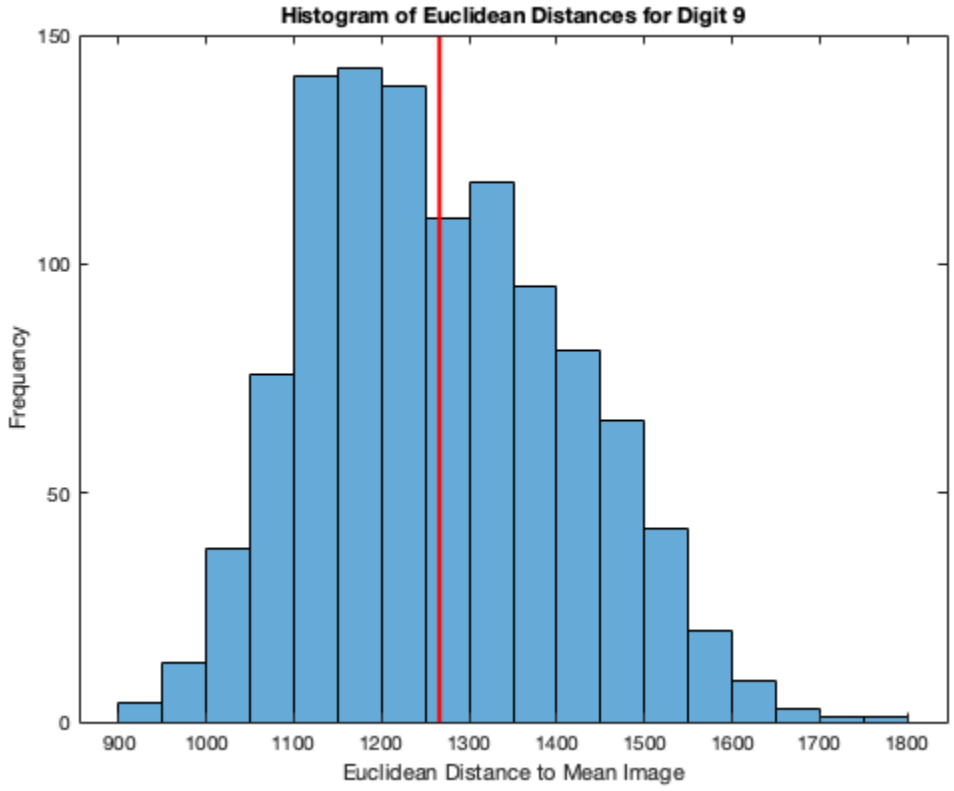

Histogram of Euclidean Distances for Digit 4
Frequency
Euclidean Distance to Mean Image
0
20
40
60
80
100
120
140
900
1000
1100
1200
1300
1400
1500
1600
1700
1800

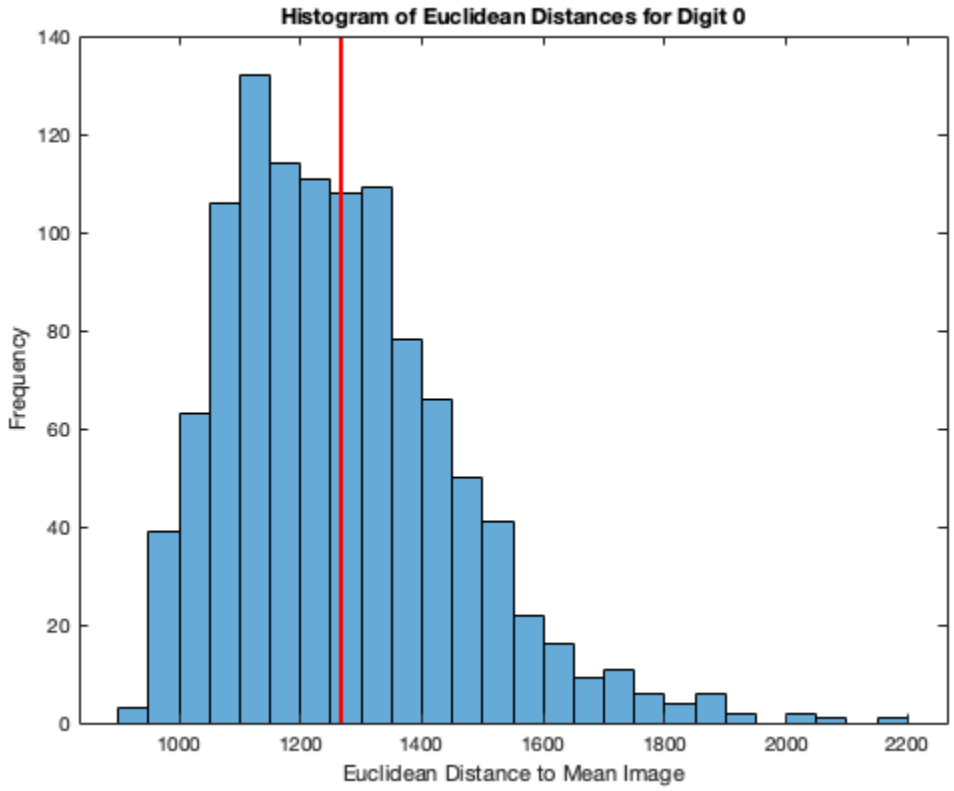

Histogram of Euclidean Distances for Digit 5
Frequency
Euclidean Distance to Mean Image
0
20
40
60
80
100
120
140
160
180
1000
1200
1400
1600
1800
2000


Histogram of Euclidean Distances for Digit 6
Frequency
Euclidean Distance to Mean Image
0
20
40
60
80
100
120
140
160
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000


Histogram of Euclidean Distances for Digit 7
Frequency
Euclidean Distance to Mean Image
0
50
100
150
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800


Histogram of Euclidean Distances for Digit 8
Frequency
Euclidean Distance to Mean Image
0
50
100
150
1000
1200
1400
1600
1800
2000


Histogram of Euclidean Distances for Digit 9
Frequency
Euclidean Distance to Mean Image
0
50
100
150
900
1000
1100
1200
1300
1400
1500
1600
1700
1800


Histogram of Euclidean Distances for Digit 0
Frequency
Euclidean Distance to Mean Image
0
20
40
60
80
100
120
140
1000
1200
1400
1600
1800
2000
2200

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```
clear;
clc;
close all;
load('usps_all.mat'); % Load the dataset

average_distances = zeros(1, 10); % Initialize array to store average
distances for each class

% Compute distances, display histograms, and calculate average distances
for i = 1:10
    distances = zeros(1, size(data, 2)); % Initialize distance array
    sample_mean = mean(data(:, :, i), 2); % Mean vector of the class

    % Compute Euclidean distance from the mean for each image in the class
    for j = 1:size(data, 2)
        distances(j) = norm(double(data(:, j, i)) - double(sample_mean));
    end

    % Calculate the average distance for the current class
    average_distances(i) = mean(distances);

end

% Display the average distances
disp('Average distances from the sample mean image to the vectors in the same
class:');
for i = 1:10
    fprintf('Digit %d: %f\n', mod(i, 10), average_distances(i));
end
```

```
Average distances from the sample mean image to the vectors in the same class:
Digit 1: 1107.250098
Digit 2: 1325.916908
Digit 3: 1234.219900
Digit 4: 1230.648937
Digit 5: 1231.721912
Digit 6: 1288.068328
Digit 7: 1158.781621
Digit 8: 1303.130699
Digit 9: 1265.921626
Digit 0: 1266.779951
```

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```
clear;
clc;
close all;
load('usps_all.mat'); % Load the dataset

% Number of nearest neighbors
K = 20;

% Loop through each digit class
for i = 1:10
    % Calculate the mean image for the current class
    sample_mean = mean(data(:, :, i), 2);

    % Initialize matrix to store distances and their indices
    distances = zeros(100, 1); % There are 100 images to consider

    % Compute Euclidean distance from the mean for the first 100 images in
the class
    for j = 1:100
        distances(j) = norm(double(data(:, j, i)) - double(sample_mean));
    end

    % Find the indices of the 20 nearest neighbors
    [~, sortedIndices] = sort(distances, 'ascend');
    nearestNeighborIndices = sortedIndices(1:K);

    % Display the indices of the 20 nearest neighbors
    fprintf('20 Nearest Neighbors for Digit %d: ', mod(i, 10));
    disp(nearestNeighborIndices');
end
```

```
20 Nearest Neighbors for Digit 1:   Columns 1 through 13

    50    41    96    33    30    11    17    88    87    89    14     6   100

  Columns 14 through 20

    53    48    47    80    32    65    73

20 Nearest Neighbors for Digit 2:   Columns 1 through 13

    96    37    82    55    66    54    14    60    73    44    65    78     3

  Columns 14 through 20

     8    22    59    33    32    98    90

20 Nearest Neighbors for Digit 3:   Columns 1 through 13

   100    60    16    36    26    99    39    61    23     6    15    90    35

  Columns 14 through 20
```

```
    81    64    10    43    46     8    65

20 Nearest Neighbors for Digit 4:   Columns 1 through 13

    46    34    95    72    32    45     5    91    78    68     7    49    76

  Columns 14 through 20

    82    64    25    19    58    29    60

20 Nearest Neighbors for Digit 5:   Columns 1 through 13

    40    37    95    46    58    28    71    57    63    47    62    74    67

  Columns 14 through 20

    27    84    44     8    93    17    31

20 Nearest Neighbors for Digit 6:   Columns 1 through 13

    23     4    80    24    84    88    60    47    63    54    25    92    40

  Columns 14 through 20

    58    38    71    72     6    22    33

20 Nearest Neighbors for Digit 7:   Columns 1 through 13

    84    51    12    39    20    67    35    69     6    34    64    22    66

  Columns 14 through 20

    86    50    40    65    95    49    87

20 Nearest Neighbors for Digit 8:   Columns 1 through 13

    76    94     2    27    34    75    41    22    56    52    85    97    72

  Columns 14 through 20

     3    84     8    93    90    19    28

20 Nearest Neighbors for Digit 9:   Columns 1 through 13

    49    48    22    23    21    63    12    17    90    89    10    59    56

  Columns 14 through 20

    64    98    11    13    99    94    53

20 Nearest Neighbors for Digit 0:   Columns 1 through 13

    18    91    81    15    35    62    73    90    19    11     8    37    31
```

```
  Columns 14 through 20

    46    99    27    32    12    61    84
```

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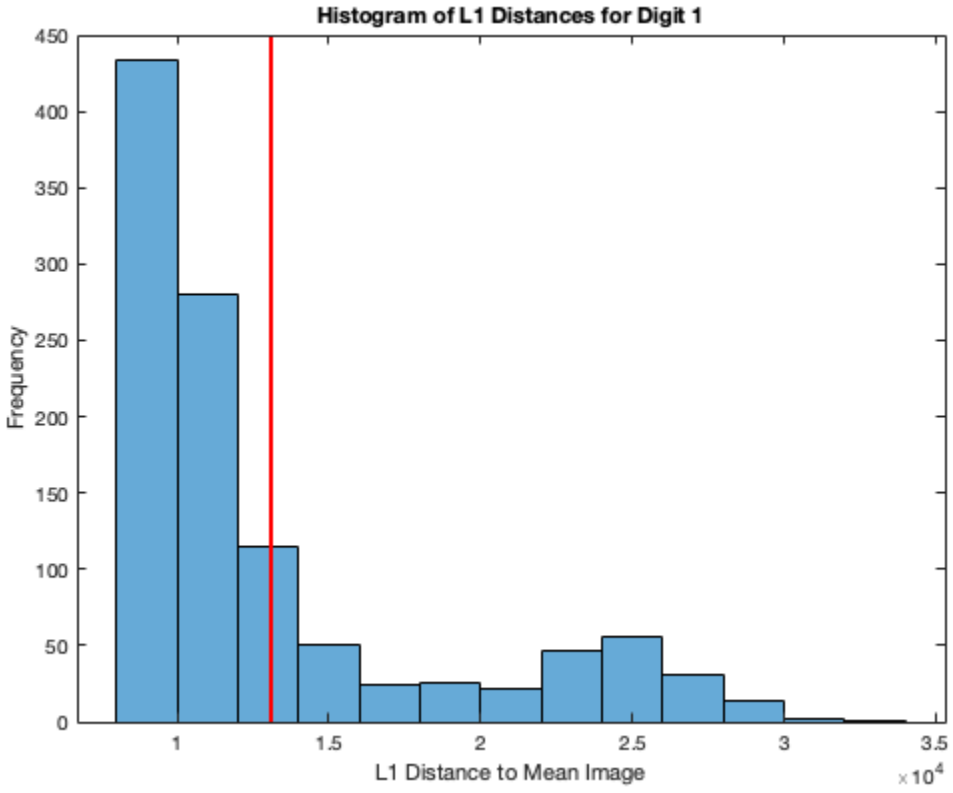
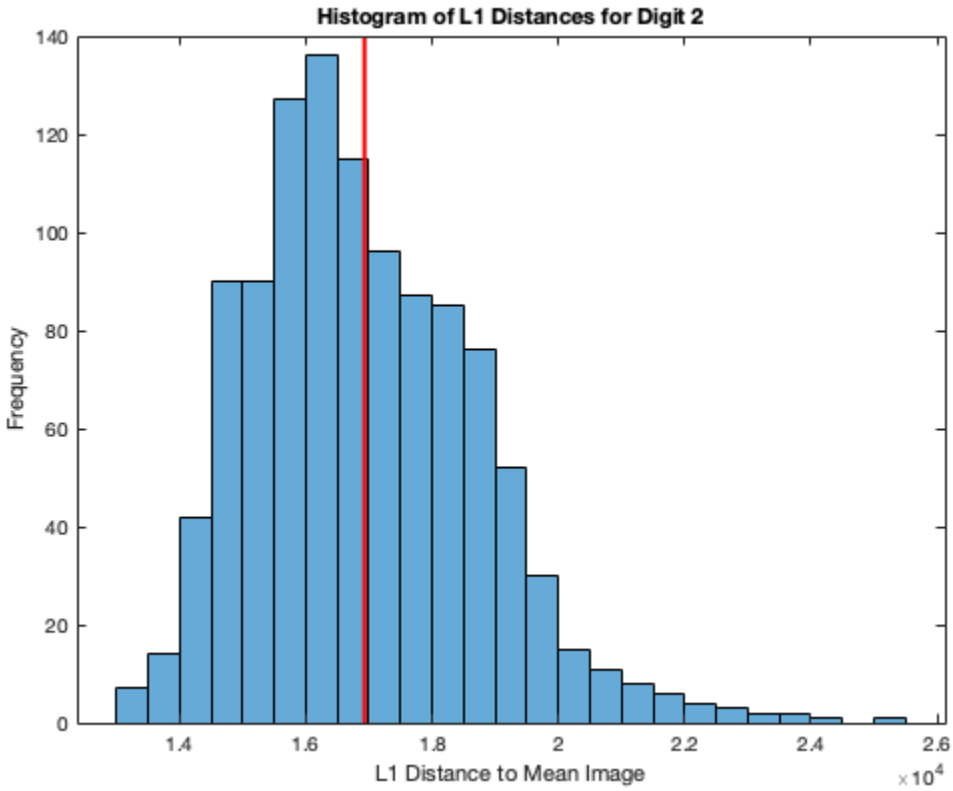
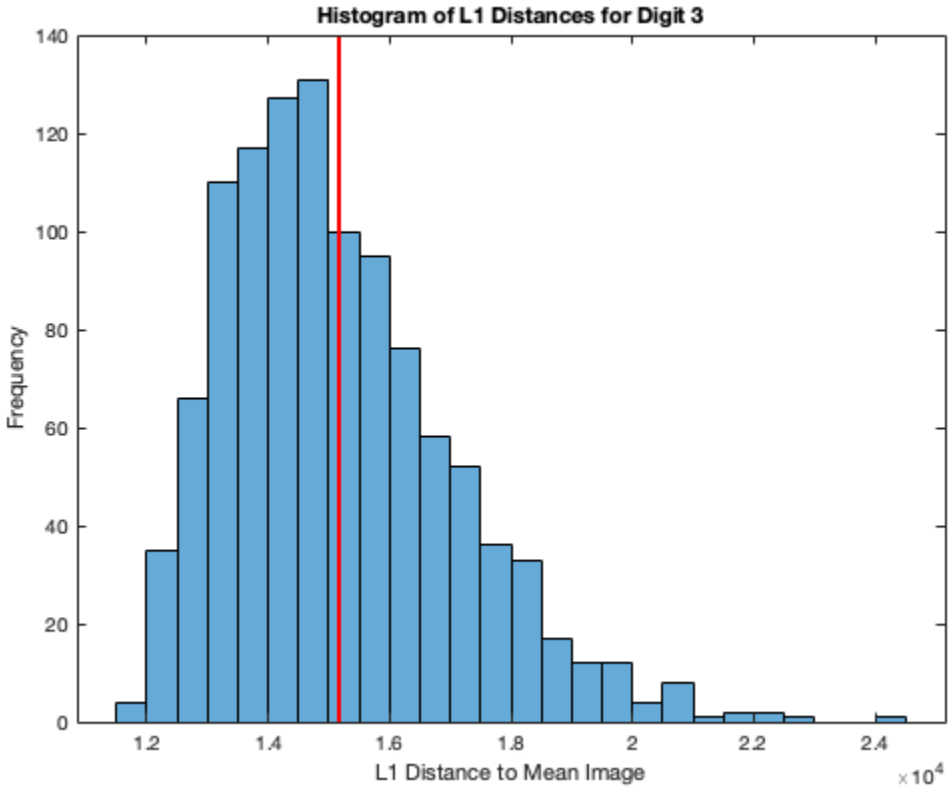
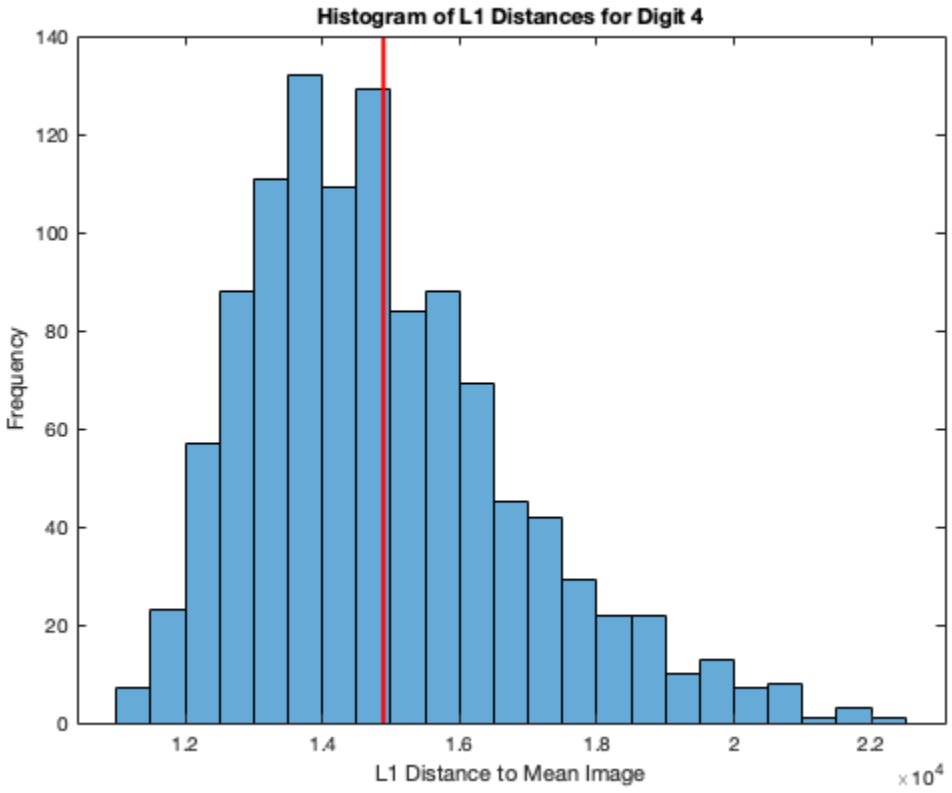
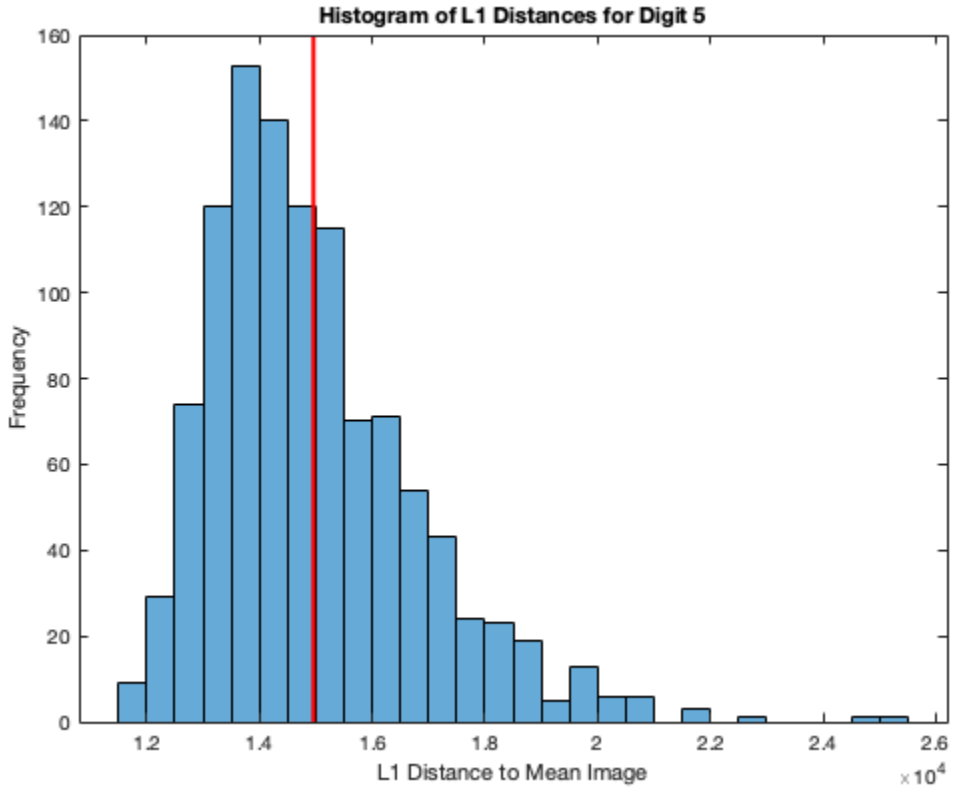
```
clear;
clc;
close all;
load('usps_all.mat'); % Load the dataset

% Compute distances using L1 norm and display histograms
for i = 1:10
    distances = zeros(1, size(data, 2)); % Initialize distance array
    sample_mean = mean(data(:, :, i), 2); % Mean vector of the class

    % Compute L1 distance from the mean for each image in the class
    for j = 1:size(data, 2)
        distances(j) = sum(abs(double(data(:, j, i)) - double(sample_mean)));
    end

    % Calculate the mean of the distances
    meanDistance = mean(distances);

    % Plot histogram of distances
    figure; % Create new figure for each histogram
    histogram(distances);
    hold on;

    % Plot a vertical line representing the mean distance
    yLimits = ylim; % Get the current y-axis limits
    line([meanDistance meanDistance], yLimits, 'Color', 'red', 'LineWidth',
2);
    title(['Histogram of L1 Distances for Digit ', num2str(mod(i, 10))]);
    xlabel('L1 Distance to Mean Image');
    ylabel('Frequency');
    hold off;
end
```

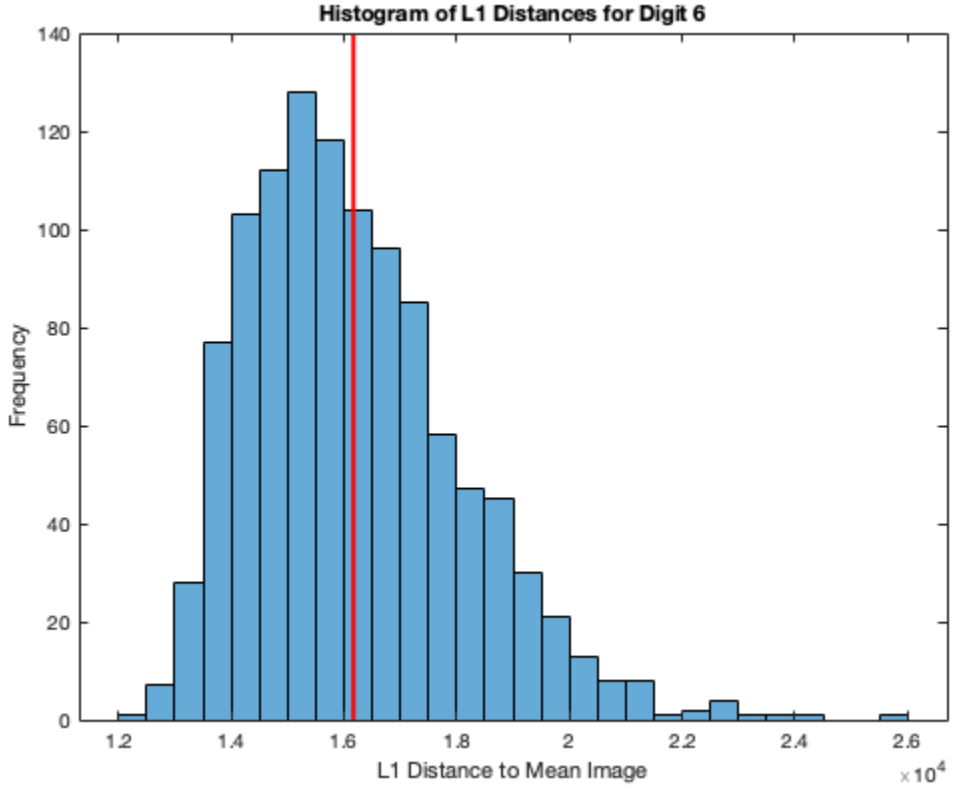

Histogram of L1 Distances for Digit 1
Frequency
L1 Distance to Mean Image
×10^4
0
50
100
150
200
250
300
350
400
450
1
1.5
2
2.5
3
3.5

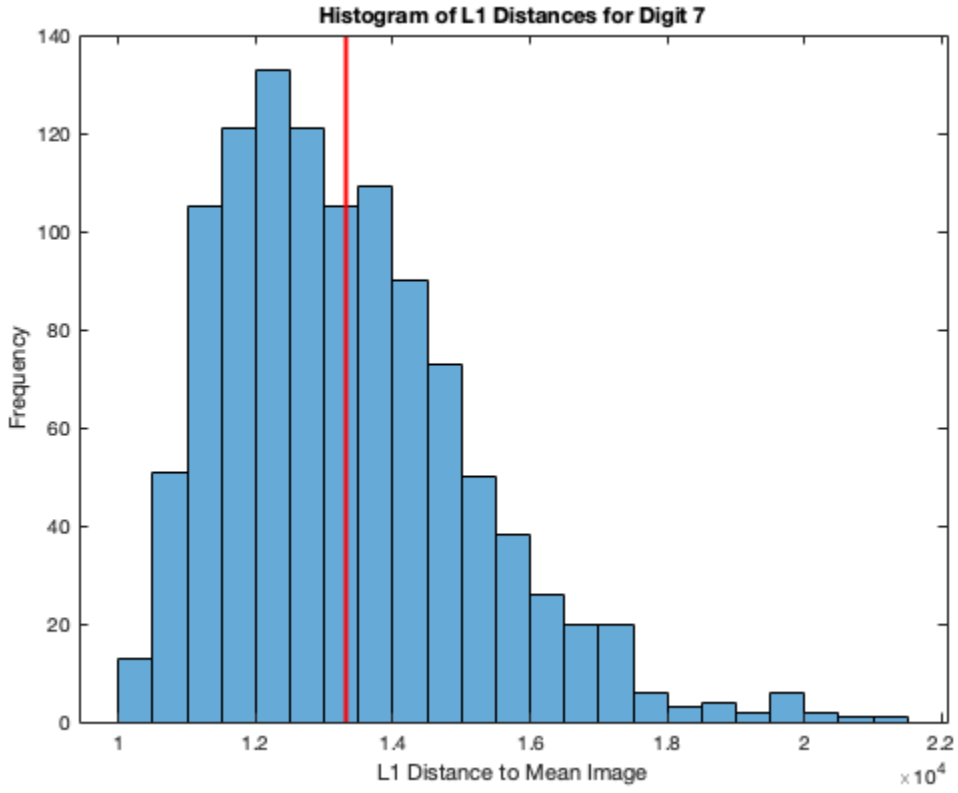

Histogram of L1 Distances for Digit 2
Frequency
L1 Distance to Mean Image
×10^4
0
20
40
60
80
100
120
140
1.4
1.6
1.8
2
2.2
2.4
2.6

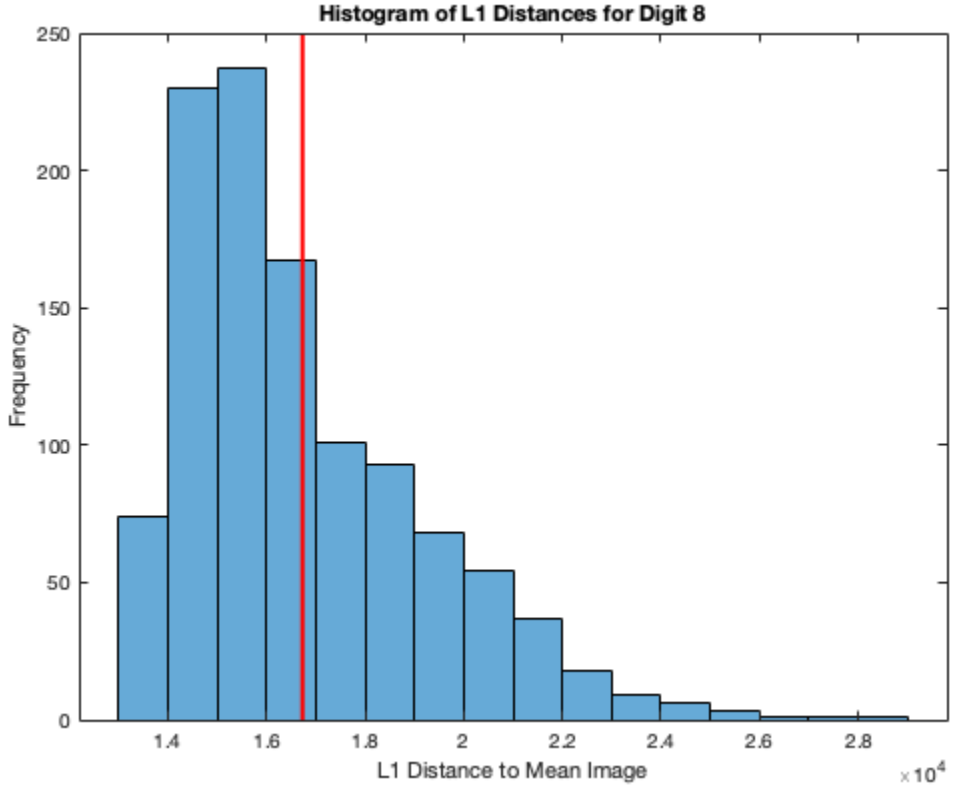

Histogram of L1 Distances for Digit 3
Frequency
L1 Distance to Mean Image
×10^4
0
20
40
60
80
100
120
140
1.2
1.4
1.6
1.8
2
2.2
2.4

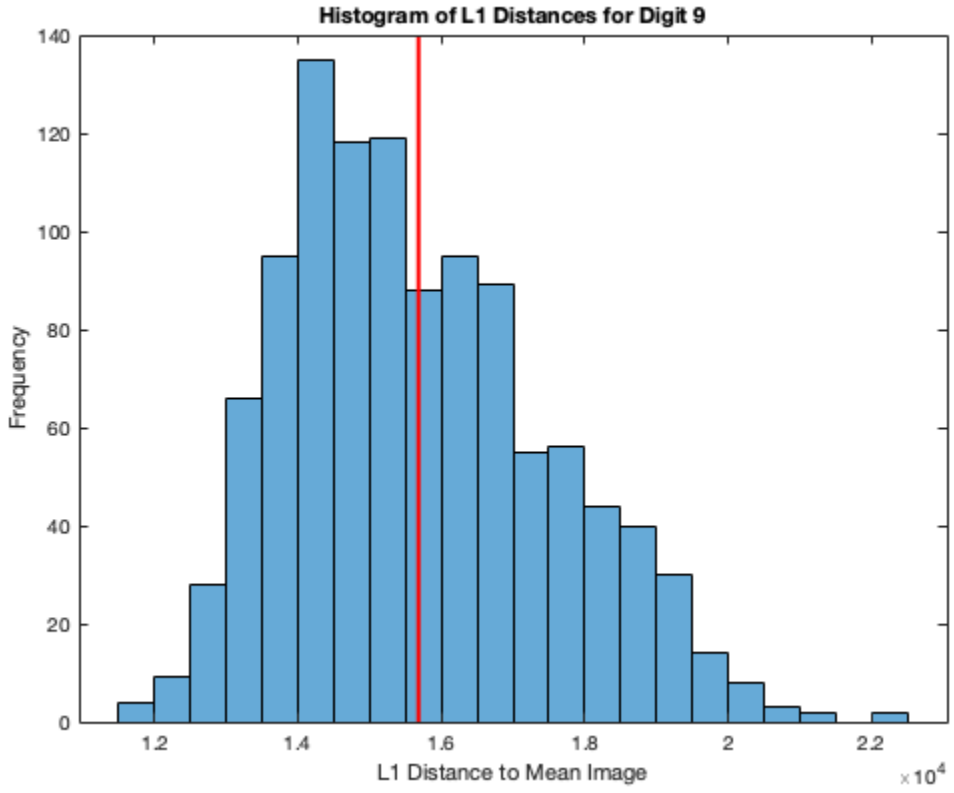

Histogram of L1 Distances for Digit 4
Frequency
L1 Distance to Mean Image
×10^4
0
20
40
60
80
100
120
140
1.2
1.4
1.6
1.8
2
2.2

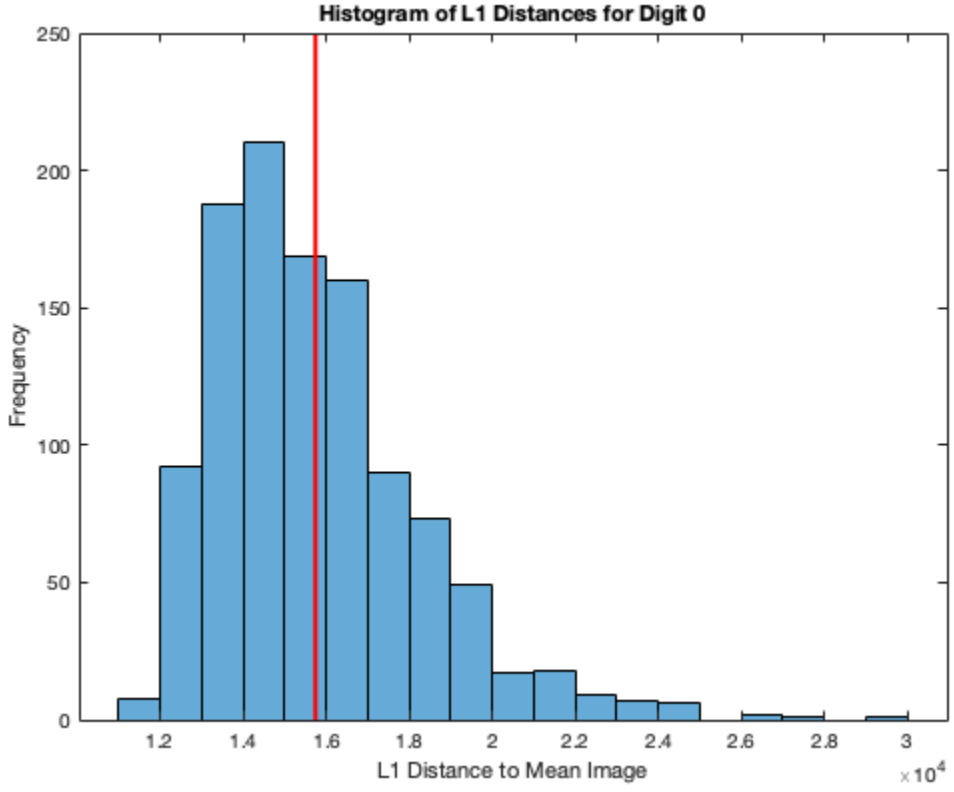

Histogram of L1 Distances for Digit 5
Frequency
L1 Distance to Mean Image
×10^4


Histogram of L1 Distances for Digit 6
Frequency
L1 Distance to Mean Image
×10^4


Histogram of L1 Distances for Digit 7
Frequency
L1 Distance to Mean Image
×10^4


Histogram of L1 Distances for Digit 8
Frequency
L1 Distance to Mean Image
×10^4


Histogram of L1 Distances for Digit 9
Frequency
L1 Distance to Mean Image
×10^4


Histogram of L1 Distances for Digit 0
Frequency
L1 Distance to Mean Image
×10^4

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```
clear;
clc;
close all;
load('usps_all.mat'); % Load the dataset

% Number of nearest neighbors
K = 20;

% Loop through each digit class
for i = 1:10
    % Calculate the mean image for the current class
    sample_mean = mean(data(:, :, i), 2);

    % Initialize matrix to store distances and their indices
    distances = zeros(100, 1); % There are 100 images to consider

    % Compute Manhattan distance (L1 norm) from the mean for the first 100
images in the class
    for j = 1:100
        distances(j) = sum(abs(double(data(:, j, i)) - double(sample_mean)));
    end

    % Find the indices of the 20 nearest neighbors
    [~, sortedIndices] = sort(distances, 'ascend');
    nearestNeighborIndices = sortedIndices(1:K);

    % Display the indices of the 20 nearest neighbors
    fprintf('20 Nearest Neighbors for Digit %d (L1 Norm): ', mod(i, 10));
    disp(nearestNeighborIndices');
end
```

```
20 Nearest Neighbors for Digit 1 (L1 Norm):   Columns 1 through 13

    50    33    41    96    30    11    17    88    87    89    14     6    48

  Columns 14 through 20

    32    80    53   100    65    47    73

20 Nearest Neighbors for Digit 2 (L1 Norm):   Columns 1 through 13

    96    37    82    55    60    54    66    14     3    44    73    65    78

  Columns 14 through 20

     8    59    98    33    32    22    21

20 Nearest Neighbors for Digit 3 (L1 Norm):   Columns 1 through 13

    36   100    26    16    60    99    15    61    90     6    23    39    35

  Columns 14 through 20
```

```
    43    81    10    78     8    64    65

20 Nearest Neighbors for Digit 4 (L1 Norm):   Columns 1 through 13

    46    34    95    72    45    32    91     5    78    49    68    82    64

  Columns 14 through 20

    76    51     7    60    26    29    19

20 Nearest Neighbors for Digit 5 (L1 Norm):   Columns 1 through 13

    37    40    58    28    63    74    84    71    95    27    67    46    93

  Columns 14 through 20

    57     2    17    97    47    41    79

20 Nearest Neighbors for Digit 6 (L1 Norm):   Columns 1 through 13

    23     4    80    84    60    24    88    47    54    25    92    63     2

  Columns 14 through 20

     6    71    58    38    40    72    33

20 Nearest Neighbors for Digit 7 (L1 Norm):   Columns 1 through 13

    84    51    12    39    67    35    20    22    69    34     6    66    87

  Columns 14 through 20

    64    65    95     1    50    15    86

20 Nearest Neighbors for Digit 8 (L1 Norm):   Columns 1 through 13

    76    94    27    56     2    97    75    41    85    52     3    34    22

  Columns 14 through 20

    84    45    98    28    69    72    19

20 Nearest Neighbors for Digit 9 (L1 Norm):   Columns 1 through 13

    49    48    22    23    21    12    89    63    17    10    90    59    13

  Columns 14 through 20

    53    99    56    98    64    78    94

20 Nearest Neighbors for Digit 0 (L1 Norm):   Columns 1 through 13

    18    91    81    15    35    90    62    11    73    19    31     8    99
```

```
  Columns 14 through 20

    37    46    27    32    12    61    84
```

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