ECE 442 Lab 3

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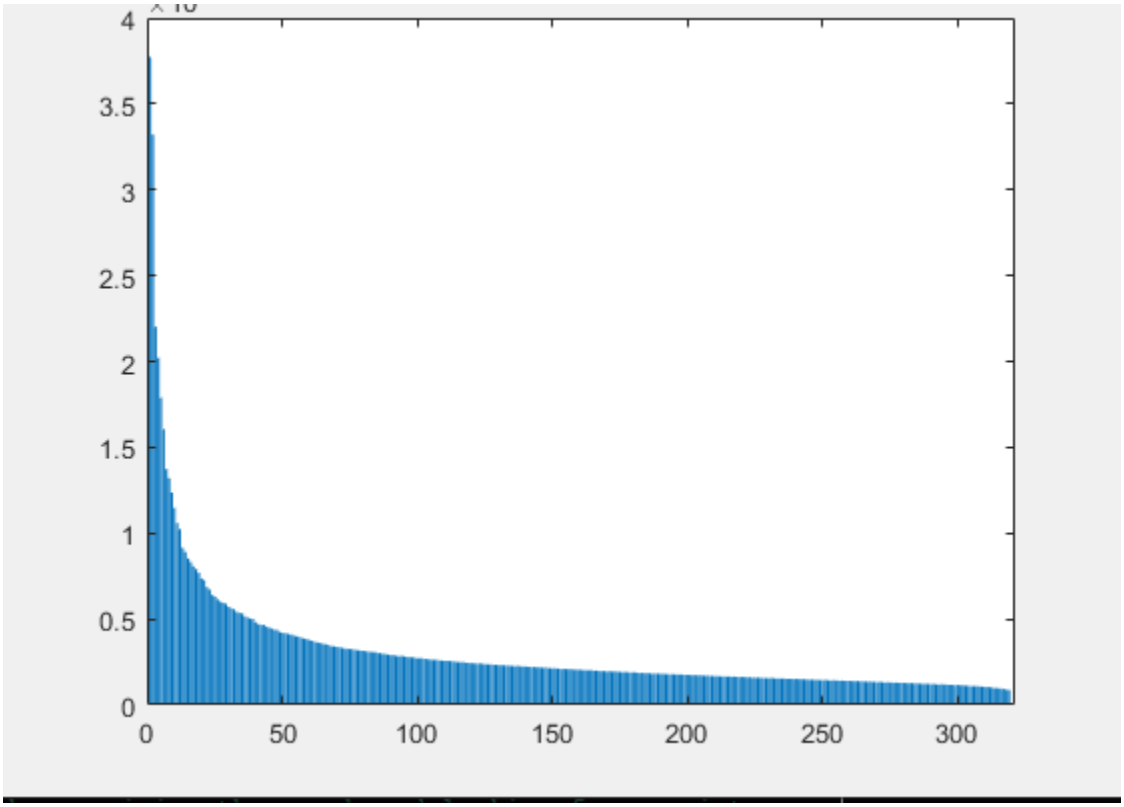
1. See below for the graph of the eigenvalues listed in descending order.



I would choose K by examining the graph and looking for a point near where the graph starts to flatten out. This point is where I would get K from.

2. The Euclidean distance from $W_{arctichare}$ and W_{mean} =

```
hare
    9.8414e+03
```

For the first test image (I used the 11th image) we have:

```
test1
    5.2579e+03
```

As we can see, the Euclidean distance to the arctichare image is much larger than to the test image.

3. 6000 was chosen as the threshold to allow for some space between the largest of the Euclidean distances in case the images tested were still lower on the spectrum.

```
test2
    4.4070e+03

test3
    4.9585e+03

test4
    5.5326e+03

Threshold: 6000
```

4. the images do not resemble their original images at all however, they do resemble eachother. This is likely due to the fact that the weights for both the 1st and 40th image set are very similar and we are using the same values for V and E[X].
   See below for the two images (also see the lab folder for Q4_1strecon.bmp and Q4_40threcon.bmp).

Figure 4: reconstruction using $W_{p\ mean\ 1}$

Figure 3: original image of 1st person

Figure 2: reconstruction using $W_{p\ mean\ 40}$

Figure 1: original image of 40th person

   Comparing figure 4 and figure 3, we see that the two images have similar mouths, similar eye placement, and similar orientation when looking at the camera.
   Comparing figure 2 and figure 1, we see that the two images have similar hairlines and similar collars.
5. See below for the label's of each test image.
   Note: these may not be in the exact order from 1 to 40 as they way MATLAB reads the folders means that the images are not saved in the order from 1 to 40.

```
  1.0e+03 *

Columns 1 through 13

   5.3962    6.4154    5.0677    5.6607    5.1348    4.7057    4.7185    4.6386    3.5721    3.6418    5.1064    4.8773    3.3484

Columns 14 through 26

   3.1818    3.7349    4.6676    4.5291    4.6219    5.1655    4.4207    4.8947    4.4619    4.0313    4.3529    4.8531    4.6905

Columns 27 through 39

   3.8048    3.6665    5.1159    4.9211    3.9157    4.3644    5.1136    5.1681    4.2713    4.2809    4.8456    4.2105    4.4139

Columns 40 through 52

   3.9420    5.9166    4.3474    4.2835    5.4096    4.0284    3.8327    3.9899    4.0534    5.1592    4.7860    4.5558    4.8716

Columns 53 through 65

   5.6424    4.6422    5.3825    5.2638    4.6943    4.9491    3.9937    3.7835    4.7392    4.5967    3.8208    4.6305    4.7940

Columns 66 through 78

   5.2666    4.3187    3.7954    4.8285    4.7347    4.2684    4.4204    5.0632    5.4485    4.0924    4.1639    5.2130    4.9191

Columns 79 through 80

   4.5847    4.5300

>>
```

6. See below for the accuracies using KNN with K = 1.

```
Q6 KNN
   1.0e+03 *

  Columns 1 through 13

    5.3964    6.4154    5.0676    5.6608    5.1343    4.7059    4.7170    4.6370    3.5721    3.6417    5.1071    4.8788    3.3487

  Columns 14 through 26

    3.1819    3.7319    4.6691    4.5291    4.6220    5.1654    4.4202    4.8938    4.4604    4.0313    4.3540    4.8524    4.6874

  Columns 27 through 39

    3.8040    3.6651    5.1199    4.9184    3.9153    4.3654    5.1105    5.1657    4.2711    4.2773    4.8458    4.2108    4.4142

  Columns 40 through 52

    3.9433    5.9145    4.3494    4.2837    5.4094    4.0278    3.8327    3.9902    4.0534    5.1592    4.7860    4.5551    4.8705

  Columns 53 through 65

    5.6399    4.6415    5.3832    5.2648    4.6940    4.9491    3.9937    3.7838    4.7362    4.5968    3.8185    4.6308    4.7937

  Columns 66 through 78

    5.2667    4.3188    3.7956    4.8285    4.7338    4.2682    4.4197    5.0618    5.4385    4.0908    4.1623    5.2108    4.9201

  Columns 79 through 80

    4.5730    4.5300

>>
```

The labels for each image in KNN seem to be slightly less accurate (the distance to the closest image from the test image is slightly farther); however, this is with K = 1. If we were to use a larger value for K, I would expect to see a more accurate prediction for KNN as opposed to PCA for face classification, and as such, I would prefer to use KNN to classify images.

7. All images below are only a sample of the full vector

```
1.0e+03 *

 3.1621
-0.4579
-1.4203
-1.9592
 0.0493
-0.7531
-0.6484
 1.4218
 0.0423
 0.7899
```

Figure 7: Weight vector of my test image.

```
1.0e+03 *

 7.0912
 1.0925
 0.1702
-0.4861
-4.8493
 1.8142
-0.8567
 1.8879
 1.6465
 0.0911
```

Figure 5: Weight vector of arctichare image

```
1.0e-13 *

-0.3766
-0.3766
-0.3766
-0.3766
-0.3766
-0.3766
-0.3766
-0.3766
-0.3766
-0.3766
```

Figure 6: W_{mean}

Comparing figure 5 and figure 7, we can see that for the most part the arctichare image has a weight vector that is larger than my own test image. This fits with the idea that face images have a lower threshold than other images, which was explored earlier in the lab.

Figure 8: My test image

Figure 9: Closest image to my test image

Looking at figures 8 and 9 we can see some similarities between my own image and the image that the KNN algorithm finds closest to it. Both images have similar facial hair styles, similar eyebrows, same gender, and similar head shape. However, the algorithm does find that the closest image to my test image is older in age and has glasses. It may detect similar ears due to the fact that my test image has a headset on which may seem like more pronounced ears.

8. This was tested using the image myTest that was also used in the previous question (question 7). Looking at the outputs of the KNN algorithm, but using K = 3, K= 5, and K = 7 we can see that the most common number (the mode of the K nearest neighbours) is 47 for all values of K. This would suggest that the closest training image to my test image (and therefore the predicted image) is image 47. Looking at the K nearest neighbours in the image below, we can see that the values become more random with higher values of K. This would seem to suggest that K = 3 is the most accurate as we get 2 instances of 47 from this value of K, whereas, we get no more instance of image 47 from any higher values of K. Based on this we could say that K = 3 is the best value for K for this training set.
   Note: image 47 is the 7th image of the 14th training set (folder s14) and is the same image that was determined to be the closest image to my test image in question 7.

```
Closest image to my test image
    "Knn3: 47"    "Knn3: 66"    "Knn3: 47"

    "Knn5: 47"    "Knn5: 66"    "Knn5: 47"    "Knn5: 86"    "Knn5: 309"

    "Knn7: 47"    "Knn7: 66"    "Knn7: 47"    "Knn7: 86"    "Knn7: 309"    "Knn7: 158"    "Knn7: 288"

Mode of Knn3: 47
Mode of Knn5: 47
Mode of Knn7: 47
```