Assignment Report #3

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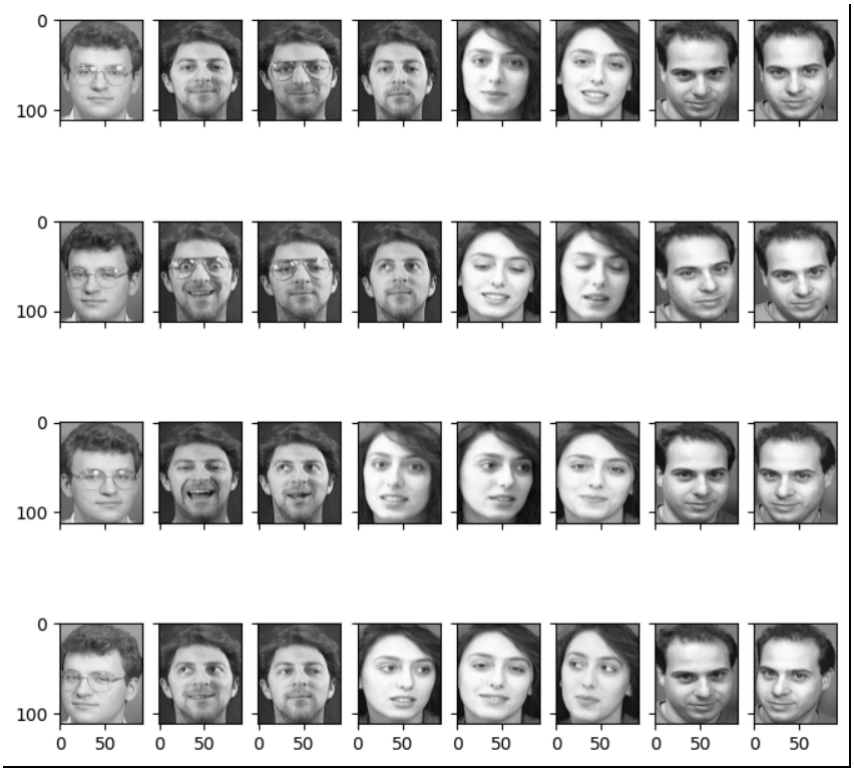
Due date: *September 1, 2023*

There are 40 classes and totally 400 pictures in the dataset:

Some Images of dataset before splitting



1) Splitting the data into train and test (Odd images for training and even images for testing)

Xtrain shape: (200, 10304)
Ytrain shape: (200, 1)
Xtest shape: (200, 10304)
Ytest shape: (200, 1).

By using PCA algorithm to compute projection matrix and defining alphas=(0.8,0.85,0.9,0.95) we came out with these accuracies for each alpha:

0.1. The Classification report:
. For alpha with number –>0.8
(Accuracy found to be 0.93)

accuracy for alpha = 0.8

	precision	recall	f1-score	support
1	1.00	0.60	0.75	5
2	0.71	1.00	0.83	5
3	0.83	1.00	0.91	5
4	1.00	1.00	1.00	5
5	0.62	1.00	0.77	5
6	1.00	1.00	1.00	5
7	0.71	1.00	0.83	5
8	1.00	1.00	1.00	5
9	1.00	1.00	1.00	5
10	1.00	0.80	0.89	5
11	1.00	1.00	1.00	5
12	1.00	1.00	1.00	5
13	1.00	1.00	1.00	5
14	1.00	1.00	1.00	5
15	0.83	1.00	0.91	5
16	0.83	1.00	0.91	5
17	1.00	1.00	1.00	5
18	1.00	1.00	1.00	5
19	1.00	0.80	0.89	5
20	1.00	0.80	0.89	5
21	0.83	1.00	0.91	5
22	1.00	1.00	1.00	5
23	1.00	1.00	1.00	5
24	1.00	1.00	1.00	5
25	1.00	1.00	1.00	5
26	1.00	1.00	1.00	5
27	1.00	1.00	1.00	5
28	1.00	1.00	1.00	5
29	1.00	1.00	1.00	5
30	1.00	1.00	1.00	5
31	1.00	0.80	0.89	5
32	1.00	0.80	0.89	5
32	1.00	0.80	0.89	5
33	1.00	1.00	1.00	5
34	1.00	1.00	1.00	5
35	1.00	0.60	0.75	5
36	0.75	0.60	0.67	5
37	1.00	1.00	1.00	5
38	0.83	1.00	0.91	5
39	1.00	1.00	1.00	5
40	0.67	0.40	0.50	5
accuracy			0.93	200
macro avg	0.94	0.93	0.93	200
weighted avg	0.94	0.93	0.93	200

0.2. The Classification report:

. For alpha with number –>0.85
(Accuracy found to be 0.94)

accuracy for alpha = 0.85

	precision	recall	f1-score	support
1	1.00	0.60	0.75	5
2	1.00	1.00	1.00	5
3	0.83	1.00	0.91	5
4	1.00	1.00	1.00	5
5	0.62	1.00	0.77	5
6	1.00	1.00	1.00	5
7	0.71	1.00	0.83	5
8	1.00	1.00	1.00	5
9	1.00	1.00	1.00	5
10	1.00	0.80	0.89	5
11	1.00	1.00	1.00	5
12	1.00	1.00	1.00	5
13	1.00	1.00	1.00	5
14	1.00	1.00	1.00	5
15	1.00	1.00	1.00	5
16	0.83	1.00	0.91	5
17	1.00	1.00	1.00	5
18	1.00	1.00	1.00	5
19	0.80	0.80	0.80	5
20	1.00	0.80	0.89	5
21	0.83	1.00	0.91	5
22	1.00	1.00	1.00	5
23	1.00	1.00	1.00	5
24	1.00	1.00	1.00	5
25	1.00	1.00	1.00	5
26	1.00	1.00	1.00	5
27	1.00	1.00	1.00	5
28	1.00	1.00	1.00	5
29	1.00	1.00	1.00	5
30	1.00	1.00	1.00	5
31	1.00	0.80	0.89	5
32	1.00	1.00	1.00	5
33	1.00	1.00	1.00	5
34	1.00	1.00	1.00	5
35	1.00	0.80	0.89	5
36	0.75	0.60	0.67	5
37	1.00	1.00	1.00	5
38	0.83	1.00	0.91	5
39	1.00	1.00	1.00	5
40	0.67	0.40	0.50	5
accuracy			0.94	200
macro avg	0.95	0.94	0.94	200
weighted avg	0.95	0.94	0.94	200

0.3. The Classification report:
. For alpha with number –>0.9
(Accuracy found to be 0.94)

accuracy for alpha = 0.9

	precision	recall	f1-score	support
1	1.00	0.60	0.75	5
2	0.83	1.00	0.91	5
3	0.83	1.00	0.91	5
4	1.00	1.00	1.00	5
5	0.62	1.00	0.77	5
6	1.00	1.00	1.00	5
7	0.83	1.00	0.91	5
8	0.83	1.00	0.91	5
9	1.00	1.00	1.00	5
10	1.00	0.80	0.89	5
11	1.00	1.00	1.00	5
12	1.00	1.00	1.00	5
13	1.00	1.00	1.00	5
14	1.00	1.00	1.00	5
15	1.00	1.00	1.00	5
16	0.83	1.00	0.91	5
17	1.00	1.00	1.00	5
18	1.00	1.00	1.00	5
19	1.00	0.80	0.89	5
20	1.00	0.80	0.89	5
21	0.83	1.00	0.91	5
22	1.00	1.00	1.00	5
23	1.00	1.00	1.00	5
24	1.00	1.00	1.00	5
25	1.00	1.00	1.00	5
26	1.00	1.00	1.00	5
27	1.00	1.00	1.00	5
28	1.00	1.00	1.00	5
29	1.00	1.00	1.00	5
30	1.00	1.00	1.00	5
31	1.00	0.80	0.89	5
32	1.00	1.00	1.00	5

33	1.00	1.00	1.00	5
34	1.00	1.00	1.00	5
35	1.00	0.80	0.89	5
36	1.00	0.80	0.89	5
37	1.00	1.00	1.00	5
38	0.83	1.00	0.91	5
39	1.00	1.00	1.00	5
40	0.67	0.40	0.50	5
accuracy			0.94	200
macro avg	0.95	0.94	0.94	200
weighted avg	0.95	0.94	0.94	200

0.4. The Classification report:
. For alpha with number –>0.95
(Accuracy found to be 0.94)

accuracy for alpha = 0.95

	precision	recall	f1-score	support
1	1.00	0.60	0.75	5
2	0.71	1.00	0.83	5
3	0.83	1.00	0.91	5
4	1.00	1.00	1.00	5
5	0.62	1.00	0.77	5
6	1.00	1.00	1.00	5
7	0.83	1.00	0.91	5
8	0.83	1.00	0.91	5
9	1.00	1.00	1.00	5
10	1.00	0.80	0.89	5
11	1.00	1.00	1.00	5
12	1.00	1.00	1.00	5
13	1.00	1.00	1.00	5
14	1.00	1.00	1.00	5
15	1.00	1.00	1.00	5
16	0.83	1.00	0.91	5
17	1.00	1.00	1.00	5
18	1.00	1.00	1.00	5
19	1.00	0.80	0.89	5
20	1.00	0.80	0.89	5
21	1.00	1.00	1.00	5
22	1.00	1.00	1.00	5
23	0.83	1.00	0.91	5
24	1.00	1.00	1.00	5
25	1.00	1.00	1.00	5
26	1.00	1.00	1.00	5
27	1.00	1.00	1.00	5
28	1.00	1.00	1.00	5
29	1.00	1.00	1.00	5
30	0.83	1.00	0.91	5
31	1.00	0.80	0.89	5

32	1.00	0.80	0.89	5
33	1.00	1.00	1.00	5
34	1.00	1.00	1.00	5
35	1.00	0.80	0.89	5
36	1.00	0.80	0.89	5
37	1.00	1.00	1.00	5
38	0.80	0.80	0.80	5
39	1.00	1.00	1.00	5
40	0.67	0.40	0.50	5
accuracy			0.94	200
macro avg	0.95	0.93	0.93	200
weighted avg	0.95	0.94	0.93	200

1. Comparison Between Accuracies of Alphas

Number Of Alpha	0.8	0.85	0.9	0.95
Test Accuracy	0.93	0.94	0.945	0.935

We first subtract the vectorized image by the average vector that retrieved from the PCA result. Then we compute the projection of this mean-subtracted vector to each eigenface and take it as the weight for this picture. Afterwards, we compare the weight vector of the picture in question to that of each existing picture and find the one with the KNN distance as the best match. We can see that it indeed can successfully find the closest match in the same class:

Output for some test images :

BONUS PART

2) Splitting the data into train and test (70 percent of images for training and 30 percent of images for testing)

Xtrain shape: (280, 10304)
Ytrain shape: (280, 1)
Xtest shape: (120, 10304)
Ytest shape: (120, 1).

By using PCA algorithm to compute projection matrix and defining alphas=(0.8,0.85,0.9,0.95) we came out with these accuracies for each alpha:

1.1. The Classification report:
. For alpha with number –>0.8
(Accuracy found to be 0.967)

accuracy for alpha with number --> 0.8

	precision	recall	f1-score	support
1	1.00	1.00	1.00	1
2	1.00	1.00	1.00	3
3	1.00	1.00	1.00	3
4	1.00	1.00	1.00	6
5	1.00	1.00	1.00	4
6	1.00	1.00	1.00	2
7	1.00	1.00	1.00	1
8	1.00	1.00	1.00	3
9	1.00	1.00	1.00	3
10	1.00	0.80	0.89	5
11	1.00	1.00	1.00	3
12	1.00	1.00	1.00	4
13	1.00	1.00	1.00	2
14	1.00	1.00	1.00	6
15	0.80	1.00	0.89	4
16	1.00	1.00	1.00	3
17	1.00	1.00	1.00	3
18	1.00	1.00	1.00	3
19	1.00	1.00	1.00	5
20	1.00	1.00	1.00	2
21	1.00	1.00	1.00	3
22	1.00	1.00	1.00	4
23	1.00	1.00	1.00	4
24	1.00	1.00	1.00	2
25	1.00	1.00	1.00	1
26	1.00	1.00	1.00	2
27	1.00	1.00	1.00	5
28	1.00	1.00	1.00	6
29	1.00	1.00	1.00	1
30	1.00	1.00	1.00	4
31	1.00	1.00	1.00	2
32	1.00	1.00	1.00	1
33	1.00	1.00	1.00	2
34	1.00	1.00	1.00	2
35	1.00	0.60	0.75	5
36	1.00	1.00	1.00	1
37	1.00	1.00	1.00	4
38	0.50	1.00	0.67	1
39	1.00	1.00	1.00	4
40	0.00	0.00	0.00	0
accuracy			0.97	120
macro avg	0.96	0.96	0.95	120
weighted avg	0.99	0.97	0.98	120

1.2. The Classification report:
. For alpha with number –>0.85
(Accuracy found to be 0.958)

accuracy for alpha = 0.85

	precision	recall	f1-score	support
1	1.00	1.00	1.00	2
2	1.00	1.00	1.00	2
3	0.75	1.00	0.86	3
4	1.00	1.00	1.00	3
5	1.00	0.40	0.57	5
6	1.00	1.00	1.00	5
7	1.00	1.00	1.00	4
8	1.00	1.00	1.00	1
9	0.80	1.00	0.89	4
10	1.00	1.00	1.00	4
11	1.00	1.00	1.00	3
12	1.00	1.00	1.00	5
13	1.00	1.00	1.00	6
14	1.00	1.00	1.00	3
15	1.00	1.00	1.00	4
16	1.00	1.00	1.00	4
17	1.00	0.80	0.89	5
18	1.00	1.00	1.00	2
20	1.00	1.00	1.00	1
21	1.00	1.00	1.00	2
22	1.00	1.00	1.00	3
23	1.00	1.00	1.00	3
24	1.00	1.00	1.00	3
25	1.00	1.00	1.00	1
26	1.00	1.00	1.00	3
27	1.00	1.00	1.00	3
28	1.00	1.00	1.00	3
29	1.00	1.00	1.00	3
30	1.00	1.00	1.00	2
31	1.00	0.80	0.89	5
32	1.00	1.00	1.00	4
33	1.00	1.00	1.00	1
34	1.00	1.00	1.00	2
35	1.00	1.00	1.00	3
36	1.00	1.00	1.00	4
37	1.00	1.00	1.00	3
38	1.00	1.00	1.00	2
39	1.00	1.00	1.00	3
40	0.25	1.00	0.40	1
accuracy			0.96	120
macro avg	0.97	0.97	0.96	120
weighted avg	0.98	0.96	0.96	120

1.3. The Classification report:

. For alpha with number –>0.9
(Accuracy found to be 0.95)

accuracy for alpha = 0.9

	precision	recall	f1-score	support
1	1.00	1.00	1.00	2
2	1.00	1.00	1.00	2
3	0.75	1.00	0.86	3
4	1.00	1.00	1.00	3
5	1.00	0.40	0.57	5
6	1.00	1.00	1.00	5
7	1.00	1.00	1.00	4
8	1.00	1.00	1.00	1
9	0.80	1.00	0.89	4
10	1.00	1.00	1.00	4
11	1.00	1.00	1.00	3
12	1.00	1.00	1.00	5
13	1.00	1.00	1.00	6
14	1.00	1.00	1.00	3
15	1.00	1.00	1.00	4
16	1.00	1.00	1.00	4
17	0.80	0.80	0.80	5
18	1.00	1.00	1.00	2
20	1.00	1.00	1.00	1
21	1.00	1.00	1.00	2
22	1.00	1.00	1.00	3
23	1.00	1.00	1.00	3
24	1.00	1.00	1.00	3
25	1.00	1.00	1.00	1
26	1.00	1.00	1.00	3
27	1.00	1.00	1.00	3
28	1.00	1.00	1.00	3
29	1.00	1.00	1.00	3
30	1.00	1.00	1.00	2
31	1.00	0.80	0.89	5
32	1.00	1.00	1.00	4
33	1.00	1.00	1.00	1
34	1.00	1.00	1.00	2
35	1.00	1.00	1.00	3
36	1.00	0.75	0.86	4
37	1.00	1.00	1.00	3
38	1.00	1.00	1.00	2
39	1.00	1.00	1.00	3
40	0.25	1.00	0.40	1
accuracy			0.95	120
macro avg	0.96	0.97	0.96	120
weighted avg	0.97	0.95	0.95	120

1.4. The Classification report:
. For alpha with number –>0.95
(Accuracy found to be 0.942)

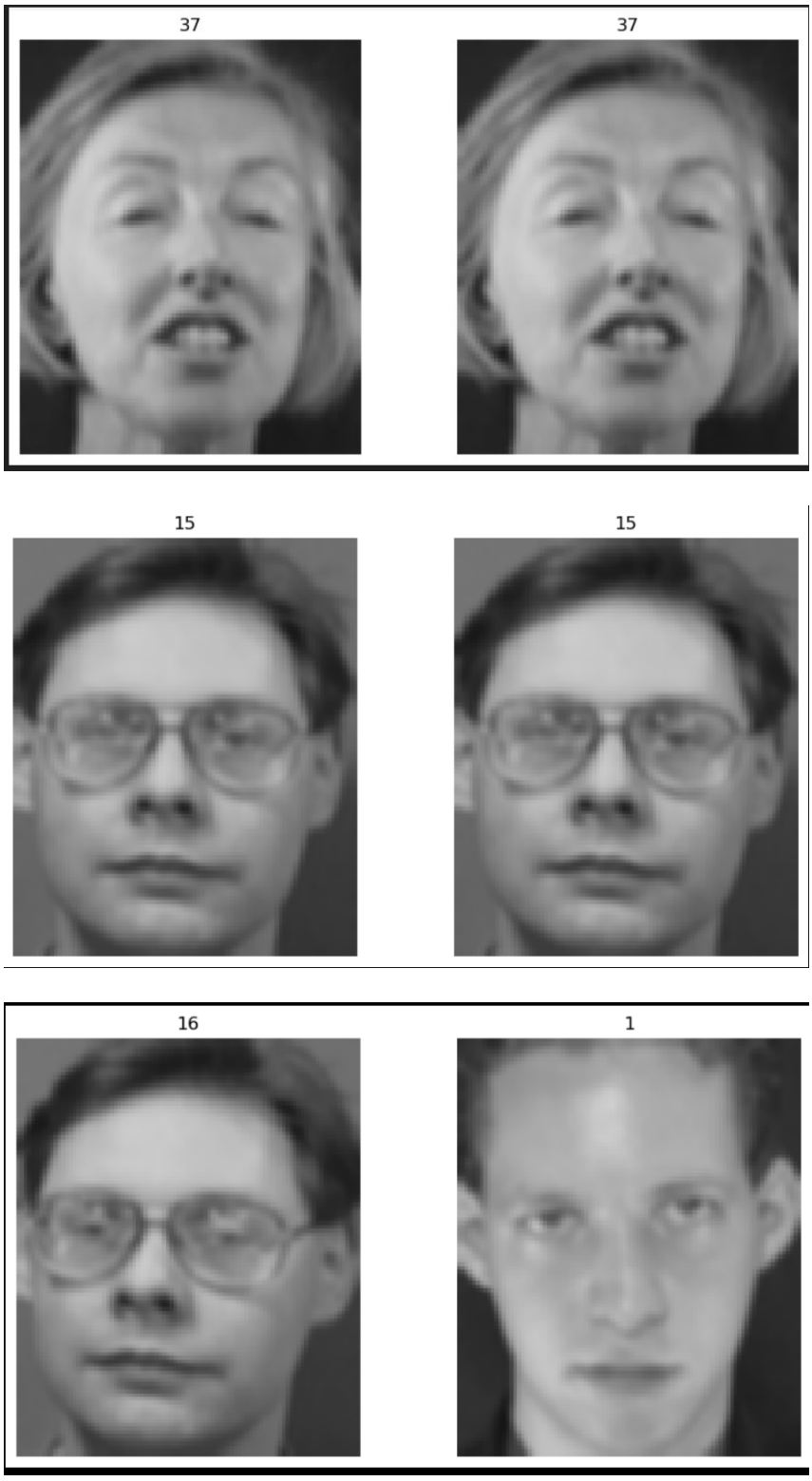
accuracy for alpha = 0.95

	precision	recall	f1-score	support
1	1.00	1.00	1.00	2
2	1.00	1.00	1.00	2
3	0.75	1.00	0.86	3
4	1.00	1.00	1.00	3
5	1.00	0.40	0.57	5
6	1.00	1.00	1.00	5
7	1.00	1.00	1.00	4
8	1.00	1.00	1.00	1
9	0.80	1.00	0.89	4
10	1.00	1.00	1.00	4
11	1.00	1.00	1.00	3
12	1.00	1.00	1.00	5
13	1.00	1.00	1.00	6
14	1.00	1.00	1.00	3
15	1.00	1.00	1.00	4
16	1.00	1.00	1.00	4
17	0.80	0.80	0.80	5
18	1.00	1.00	1.00	2
20	1.00	1.00	1.00	1
21	1.00	1.00	1.00	2
22	1.00	1.00	1.00	3
23	1.00	1.00	1.00	3
24	1.00	1.00	1.00	3
25	1.00	1.00	1.00	1
26	1.00	1.00	1.00	3
27	1.00	1.00	1.00	3
28	1.00	1.00	1.00	3
29	1.00	1.00	1.00	3
30	0.67	1.00	0.80	2
31	1.00	0.60	0.75	5
32	1.00	1.00	1.00	4
33	1.00	1.00	1.00	1
34	1.00	1.00	1.00	2
35	1.00	1.00	1.00	3
36	1.00	0.75	0.86	4
37	1.00	1.00	1.00	3
38	1.00	1.00	1.00	2
39	1.00	1.00	1.00	3
40	0.25	1.00	0.40	1
accuracy			0.94	120
macro avg	0.96	0.96	0.95	120
weighted avg	0.97	0.94	0.94	120

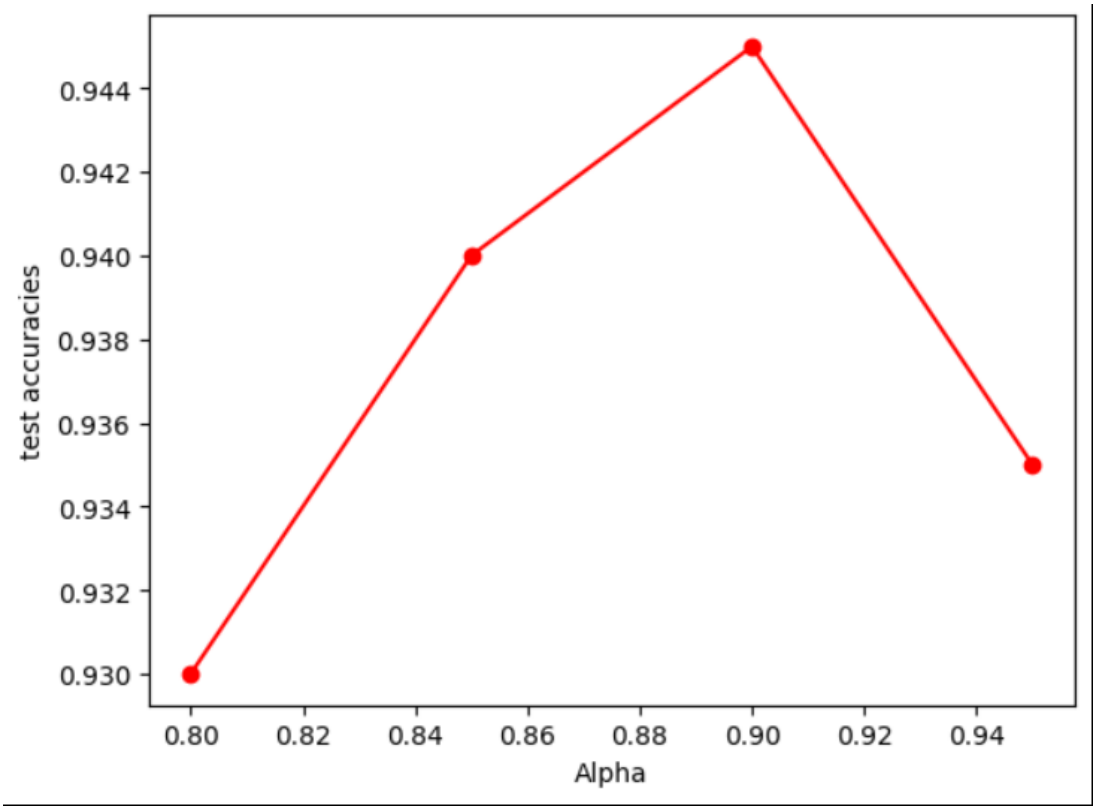
2. Comparison Between Accuracies of Alphas

Number Of Alpha	0.8	0.85	0.9	0.95
Test Accuracy	0.9667	0.9583	0.95	0.94167

Output for some test images :



Next figure is Relation between Alpha and classification accuracy



As shown in previous figure as the value of Alpha increases the test accuracy increases until it reaches a certain value then accuracy
starts to decrease.