Contents


```
% Assignment 3 Question 3
% CH22B007 Ojas Phadake

clc; clear; close all;
cell_all = struct2table(dir("yalefacespng"));
cell_all = cell_all.name;

matrix = zeros(243, 320, 90); % This will contain all the images
vector_matrix = zeros(77760, 90);% This will contain all the reshaped images in vector form
for i=1:90
    matrix(:, :, i) = imread('yalefacespng/' + string(cell_all(i+2)));
    vector_matrix(:, i) = reshape(matrix(:, :, i), 77760, 1);
end

% In case an image is to be seen, firstly convert it to unint8 and then
% display the reshaped image in size 243 * 320
```

Part 1. Norm Images

```
vector_norms = vector_matrix(:, 6:6:90); % All normal images
classified_person = zeros(90, 1);
image_num = 1:1:90; image_num = image_num';
true_person_num = floor((image_num-1)/6) + 1;
result = [];
correct_count = 0;

for i=1:90
    % The norm images will be 6*i kind amongst the above dataset
    % After that, use a for loop from 1:15 to check the distances
    dist = zeros(15, 1);
    for j=1:15
        dist(j) = norm(vector_norms(:, j) - vector_matrix(:, i));
    end
    classified_person(i) = find(dist == min(dist, [], "all"));
        if classified_person(i) == true_person_num(i)
            result = [result; "YES"];
            correct_count = correct_count + 1;
        else
            result = [result; "NO"];
        end
end

to_show = table(image_num, true_person_num, classified_person, result);
disp("The following table contains the Image number, Correct label of person, Classified estimate and Result");
disp(to_show)
disp("The number of images obtained correctly by comparing with the norm images is: " + correct_count);
disp("--------------------------------------------------------------------------")
```

```
The following table contains the Image number, Correct label of person, Classified estimate and Result
    image_num    true_person_num    classified_person    result
    _________    _______________    _________________    ______

        1              1                  1              "YES"
        2              1                  1              "YES"
        3              1                  1              "YES"
        4              1                 12              "NO"
        5              1                  2              "NO"
        6              1                  1              "YES"
        7              2                  2              "YES"
        8              2                  2              "YES"
        9              2                  2              "YES"
       10              2                  2              "YES"
       11              2                  2              "YES"
       12              2                  2              "YES"
       13              3                 13              "NO"
       14              3                  3              "YES"
       15              3                  3              "YES"
       16              3                 12              "NO"
       17              3                  3              "YES"
       18              3                  3              "YES"
       19              4                  4              "YES"
       20              4                  4              "YES"
       21              4                  4              "YES"
       22              4                  2              "NO"
       23              4                  4              "YES"
       24              4                  4              "YES"
```

25	5	5	"YES"
26	5	5	"YES"
27	5	5	"YES"
28	5	12	"NO"
29	5	5	"YES"
30	5	5	"YES"
31	6	14	"NO"
32	6	6	"YES"
33	6	6	"YES"
34	6	12	"NO"
35	6	6	"YES"
36	6	6	"YES"
37	7	10	"NO"
38	7	7	"YES"
39	7	7	"YES"
40	7	12	"NO"
41	7	7	"YES"
42	7	7	"YES"
43	8	8	"YES"
44	8	8	"YES"
45	8	8	"YES"
46	8	12	"NO"
47	8	10	"NO"
48	8	8	"YES"
49	9	3	"NO"
50	9	5	"NO"
51	9	9	"YES"
52	9	12	"NO"
53	9	9	"YES"
54	9	9	"YES"
55	10	1	"NO"
56	10	1	"NO"
57	10	10	"YES"
58	10	2	"NO"
59	10	10	"YES"
60	10	10	"YES"
61	11	11	"YES"
62	11	11	"YES"
63	11	11	"YES"
64	11	11	"YES"
65	11	11	"YES"
66	11	11	"YES"
67	12	5	"NO"
68	12	2	"NO"
69	12	5	"NO"
70	12	12	"YES"
71	12	12	"YES"
72	12	12	"YES"
73	13	7	"NO"
74	13	13	"YES"
75	13	13	"YES"
76	13	12	"NO"
77	13	13	"YES"
78	13	13	"YES"
79	14	14	"YES"
80	14	14	"YES"
81	14	14	"YES"
82	14	11	"NO"
83	14	14	"YES"
84	14	14	"YES"
85	15	15	"YES"
86	15	10	"NO"
87	15	15	"YES"
88	15	12	"NO"
89	15	10	"NO"
90	15	15	"YES"

```
The number of images obtained correctly by comparing with the norm images is: 63
--------------------------------------------------------------------------------
```

Part 2. First Principle Component

B - First Principal Component use to make image

```
PC_comp = zeros(77760, 15);
variance_arr = zeros(15, 1);

for i=1:15
    Z = vector_matrix(:, ((6*i) - 5):(6*i));
    Z_s = Z - mean(Z, 1);
    S_zs = cov(Z_s);
    [V, D] = eig(S_zs);
    D = sort(diag(D), 'descend');
    variance_arr(i) = D(1)/sum(D, "all");
    PC_comp(:, i) = Z*((V(:, end)).^2); % This contains the first PC of every person as each column
end
```

```
disp("We multiply by ((V(:, end)).^2) so that condition of orthogonality is " + ...
    "maintained, and also to obtain weights between 0 and 1, so that the " + ...
    "resulting number also lies in between 0 and 255")

% imshow((reshape(uint8(PC_comp(:, 2)), 243, 320)))

classified_person = zeros(90, 1);
image_num = (1:1:90)';
result = [];
correct_count = 0;

for i=1:90

    dist = zeros(15, 1);
    for j = 1:15
        dist(j) = norm(PC_comp(:, j) - vector_matrix(:, i));
    end
    est_person_img = find(dist == min(dist, [], 'all')); % Minimum index is found
        if est_person_img == true_person_num(i)
            result = [result; "YES"];
            correct_count = correct_count + 1;
        else
            result = [result; "NO"];
        end
end

to_show = table(image_num, true_person_num, result);
disp("The following table contains the Image number, Correct label of person, Classified estimate and Result");
disp(to_show)
disp("The number of images obtained correctly by comparing with the first PC is: " + correct_count);
disp("--------------------------------------------------------------------------")
```

```
We multiply by ((V(:, end)).^2) so that condition of orthogonality is maintained, and also to obtain weights between 0 and 1, so that the resulting number also lies
The following table contains the Image number, Correct label of person, Classified estimate and Result
    image_num    true_person_num    result
    _________    _______________    ______

        1              1           "YES"
        2              1           "YES"
        3              1           "YES"
        4              1           "NO"
        5              1           "YES"
        6              1           "YES"
        7              2           "YES"
        8              2           "YES"
        9              2           "YES"
       10              2           "YES"
       11              2           "YES"
       12              2           "YES"
       13              3           "YES"
       14              3           "YES"
       15              3           "YES"
       16              3           "NO"
       17              3           "YES"
       18              3           "YES"
       19              4           "YES"
       20              4           "YES"
       21              4           "YES"
       22              4           "NO"
       23              4           "YES"
       24              4           "YES"
       25              5           "YES"
       26              5           "YES"
       27              5           "YES"
       28              5           "NO"
       29              5           "YES"
       30              5           "YES"
       31              6           "NO"
       32              6           "YES"
       33              6           "YES"
       34              6           "NO"
       35              6           "YES"
       36              6           "YES"
       37              7           "YES"
       38              7           "YES"
       39              7           "YES"
       40              7           "NO"
       41              7           "YES"
       42              7           "YES"
       43              8           "YES"
       44              8           "YES"
       45              8           "YES"
       46              8           "NO"
       47              8           "YES"
       48              8           "YES"
```

```
   49              9          "YES"
   50              9          "YES"
   51              9          "YES"
   52              9          "NO"
   53              9          "YES"
   54              9          "YES"
   55             10          "YES"
   56             10          "YES"
   57             10          "YES"
   58             10          "NO"
   59             10          "YES"
   60             10          "YES"
   61             11          "YES"
   62             11          "YES"
   63             11          "YES"
   64             11          "YES"
   65             11          "YES"
   66             11          "YES"
   67             12          "NO"
   68             12          "YES"
   69             12          "NO"
   70             12          "YES"
   71             12          "YES"
   72             12          "YES"
   73             13          "YES"
   74             13          "YES"
   75             13          "YES"
   76             13          "NO"
   77             13          "YES"
   78             13          "YES"
   79             14          "YES"
   80             14          "YES"
   81             14          "YES"
   82             14          "NO"
   83             14          "YES"
   84             14          "YES"
   85             15          "YES"
   86             15          "YES"
   87             15          "YES"
   88             15          "NO"
   89             15          "YES"
   90             15          "YES"

The number of images obtained correctly by comparing with the first PC is: 75
--------------------------------------------------------------------------------
```

Part 3. Two Principle Components

```
PC_comp_both = zeros(77760, 30);
variance_arr = zeros(15, 1);

for i=1:15
    Z = vector_matrix(:, ((6*i) - 5):(6*i));
    Z_s = Z - mean(Z, 1);
    S_zs = cov(Z_s);
    [V, D] = eig(S_zs);
    D = sort(diag(D), 'descend');
    variance_arr(i) = (D(1) + D(2))/sum(D, "all");
    PC_comp_both(:, 2*i-1) = Z*((V(:, end)).^2);
    PC_comp_both(:, 2*i) = Z*((V(:, end-1)).^2);
end

classified_person_1 = zeros(90, 1);
classified_person_2 = zeros(90, 1);
image_num = (1:1:90)';
result = [];
correct_count = 0;

for i=1:90

    dist_first = zeros(15, 1);
    dist_second = zeros(15, 1);
    for j = 1:15
        dist_first(j) = norm(PC_comp_both(:, 2*j-1) - vector_matrix(:, i));
        dist_second(j) = norm(PC_comp_both(:, 2*j) - vector_matrix(:, i));
    end
    est_person_img_first = find(dist_first == min(dist_first, [], 'all'));
    est_person_img_second = find(dist_second == min(dist_second, [], 'all'));

    if (est_person_img_first == true_person_num(i)) || (est_person_img_second == true_person_num(i))
        result = [result; "YES"];
        correct_count = correct_count + 1;
    else
        result = [result; "NO"];
    end
    classified_person_1(i) = est_person_img_first;
```

```
    classified_person_2(i) = est_person_img_second;
end

to_show = table(image_num, true_person_num, classified_person_1, classified_person_2, result);
disp("The following table contains the Image number, Correct label of person, Classified estimate by PC1, Classified estimate by PC2 and Result");
disp(to_show)
disp("The number of images obtained correctly by comparing with the first 2 PCs is: " + correct_count);
```

```
The following table contains the Image number, Correct label of person, Classified estimate by PC1, Classified estimate by PC2 and Result
    image_num    true_person_num    classified_person_1    classified_person_2    result
    _________    _______________    ___________________    ___________________    ______

       1              1                  1                     12                "YES"
       2              1                  1                     12                "YES"
       3              1                  1                     10                "YES"
       4              1                 12                      1                "YES"
       5              1                  1                     12                "YES"
       6              1                  1                     12                "YES"
       7              2                  2                     12                "YES"
       8              2                  2                     12                "YES"
       9              2                  2                     12                "YES"
      10              2                  2                      2                "YES"
      11              2                  2                     12                "YES"
      12              2                  2                     12                "YES"
      13              3                  3                     10                "YES"
      14              3                  3                     13                "YES"
      15              3                  3                     10                "YES"
      16              3                 12                      3                "YES"
      17              3                  3                     10                "YES"
      18              3                  3                     10                "YES"
      19              4                  4                     10                "YES"
      20              4                  4                     12                "YES"
      21              4                  4                     12                "YES"
      22              4                 12                      4                "YES"
      23              4                  4                     10                "YES"
      24              4                  4                     12                "YES"
      25              5                  5                     12                "YES"
      26              5                  5                     12                "YES"
      27              5                  5                     12                "YES"
      28              5                 12                      5                "YES"
      29              5                  5                     12                "YES"
      30              5                  5                     12                "YES"
      31              6                 14                      6                "YES"
      32              6                  6                      6                "YES"
      33              6                  6                      6                "YES"
      34              6                 12                      6                "YES"
      35              6                  6                      6                "YES"
      36              6                  6                      6                "YES"
      37              7                  7                     10                "YES"
      38              7                  7                     10                "YES"
      39              7                  7                     10                "YES"
      40              7                 12                      7                "YES"
      41              7                  7                     10                "YES"
      42              7                  7                     10                "YES"
      43              8                  8                     10                "YES"
      44              8                  8                     10                "YES"
      45              8                  8                     10                "YES"
      46              8                 12                      8                "YES"
      47              8                  8                     10                "YES"
      48              8                  8                     10                "YES"
      49              9                  9                      9                "YES"
      50              9                  9                     10                "YES"
      51              9                  9                      9                "YES"
      52              9                 12                      9                "YES"
      53              9                  9                      9                "YES"
      54              9                  9                      9                "YES"
      55             10                 10                     10                "YES"
      56             10                 10                     10                "YES"
      57             10                 10                     10                "YES"
      58             10                  1                     10                "YES"
      59             10                 10                     10                "YES"
      60             10                 10                     10                "YES"
      61             11                 11                     11                "YES"
      62             11                 11                     10                "YES"
      63             11                 11                     12                "YES"
      64             11                 11                     11                "YES"
      65             11                 11                     10                "YES"
      66             11                 11                     12                "YES"
      67             12                  1                     12                "YES"
      68             12                 12                     12                "YES"
      69             12                  5                     12                "YES"
      70             12                 12                      2                "YES"
      71             12                 12                     12                "YES"
      72             12                 12                     12                "YES"
      73             13                 13                     13                "YES"
      74             13                 13                     13                "YES"
```

```
    75          13          13          13          "YES"
    76          13          12          13          "YES"
    77          13          13          13          "YES"
    78          13          13          13          "YES"
    79          14          14          14          "YES"
    80          14          14          14          "YES"
    81          14          14          14          "YES"
    82          14          11          14          "YES"
    83          14          14          14          "YES"
    84          14          14          14          "YES"
    85          15          15          10          "YES"
    86          15          15          10          "YES"
    87          15          15          10          "YES"
    88          15          11          15          "YES"
    89          15          15          10          "YES"
    90          15          15          10          "YES"

  The number of images obtained correctly by comparing with the first 2 PCs is: 90
```

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