

Given Data

```
file = unzip('/MATLAB Drive/yalefaces.zip');  
df=file(1:90);
```

Image Vectors

```
all_img = zeros(243,320,90);  
vectorized_img = zeros(77760,90);  
for i = 1:90  
    I =imread(df{i});  
    all_img(:,:,i) = I;  
    vectorized_img(:,i) = reshape(I,1,[]);  
end
```

Normal Image Vectors

```
normal_img_vectors = zeros(77760,15);  
for i = 1:15  
    normal_img_vectors(:,i) = vectorized_img(:,6*i);  
end
```

A

```
cnt=0;  
for i = 1:90  
    curr_img = vectorized_img(:,i);  
    d = Inf;  
    index =i;  
    for j = 1 : 15  
        v = curr_img - normal_img_vectors(:,j);  
        if d >= norm(v)  
            index=j;  
            d = norm(v);  
        end  
    end  
    % index cross checking  
    if 6*index - i <= 5 && 6*index - i >=0  
        fprintf('%d Yes\n', i);  
        cnt = cnt+1;  
    else  
        fprintf('%d No\n', i);  
    end  
end  
end
```

```
1 Yes  
2 Yes  
3 Yes  
4 No  
5 No
```

6 Yes
7 Yes
8 Yes
9 Yes
10 Yes
11 Yes
12 Yes
13 No
14 Yes
15 Yes
16 No
17 Yes
18 Yes
19 Yes
20 Yes
21 Yes
22 No
23 Yes
24 Yes
25 Yes
26 Yes
27 Yes
28 No
29 Yes
30 Yes
31 No
32 Yes
33 Yes
34 No
35 Yes
36 Yes
37 No
38 Yes
39 Yes
40 No
41 Yes
42 Yes
43 Yes
44 Yes
45 Yes
46 No
47 No
48 Yes
49 No
50 No
51 Yes
52 No
53 Yes
54 Yes
55 No
56 No
57 Yes
58 No
59 Yes
60 Yes
61 Yes
62 Yes
63 Yes
64 Yes
65 Yes
66 Yes
67 No
68 No
69 No

```

70 Yes
71 Yes
72 Yes
73 No
74 Yes
75 Yes
76 No
77 Yes
78 Yes
79 Yes
80 Yes
81 Yes
82 No
83 Yes
84 Yes
85 Yes
86 No
87 Yes
88 No
89 No
90 Yes

```

```
disp(['The normal image classifier :'])
```

```
The normal image classifier :
```

```
cnt
```

```
cnt = 63
```

B

```
pcs = zeros(77760,15)
```

```

pcs = 77760x15
    0     0     0     0     0     0     0     0     0     0     0     0     0 ...
    0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0
    0     0     0     0     0     0     0     0     0     0     0     0     0
    :
    :

```

```

for i = 1:15
    cd = vectorized_img(:,6*i-5:6*i);
    cd_sf = cd - mean(cd,1);
    c = cov(cd_sf);
    [e v] = eig(c);
    eval = diag(v);
    [~,ind] = sort(eval);
    new_data = cd*e(:,ind(6));
    new_data_rec= rescale(new_data,0,255);
    pcs(:,i) = new_data_rec;
end

```

```
pcs
```

```
pcs = 77760x15
 115.0706  113.1425  127.5477  129.4189  110.2082  111.6888  127.3599  128.4888 ...
 255.0000  239.8999  255.0000  255.0000  253.3127  241.6530  255.0000  255.0000
 255.0000  252.7023  255.0000  255.0000  255.0000  255.0000  255.0000  255.0000
 255.0000  255.0000  255.0000  255.0000  255.0000  255.0000  255.0000  255.0000
 255.0000  255.0000  255.0000  255.0000  255.0000  255.0000  255.0000  255.0000
 255.0000  255.0000  255.0000  255.0000  255.0000  249.7864  255.0000  255.0000
 255.0000  255.0000  255.0000  255.0000  255.0000  212.5798  255.0000  255.0000
 255.0000  255.0000  255.0000  255.0000  255.0000  222.1669  255.0000  255.0000
 255.0000  255.0000  255.0000  255.0000  255.0000  245.7935  255.0000  255.0000
 255.0000  255.0000  255.0000  255.0000  255.0000  254.1883  255.0000  255.0000
  ⋮
```

```
B = reshape(pcs(:,1),[243,320]);
B =uint8(B);
imshow(B)
```



```
cnt=0;
idx = zeros(90,1);
for i =1:90
    curr_img = vectorized_img(:,i);
    d = Inf;
    index =i;
    for j = 1 : 15
        v = curr_img - pcs(:,j);
        if d >= norm(v)
```

```

        index=j;
        d = norm(v);
    end
end
% index cross checking
if 6*index - i <= 5 && 6*index - i >=0
    fprintf('%d  Yes\n', i);
    cnt = cnt+1;
    idx(i)=1;
else
    fprintf('%d  No\n', i);
end
end

```

```

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

```

```
47 Yes
48 Yes
49 Yes
50 Yes
51 Yes
52 No
53 Yes
54 Yes
55 Yes
56 Yes
57 Yes
58 No
59 Yes
60 Yes
61 Yes
62 Yes
63 Yes
64 Yes
65 Yes
66 Yes
67 No
68 Yes
69 No
70 Yes
71 Yes
72 Yes
73 Yes
74 Yes
75 Yes
76 No
77 Yes
78 Yes
79 Yes
80 Yes
81 Yes
82 Yes
83 Yes
84 Yes
85 Yes
86 Yes
87 Yes
88 No
89 Yes
90 Yes
```

```
disp(['Classification with 1 rep. image :'])
```

```
Classification with 1 rep. image :
```

```
cnt
```

```
cnt = 76
```

C

```
pcs2 = zeros(77760,15);
for i = 1:15
    cd = vectorized_img(:,6*i-5:6*i);
    cd_sf = cd - mean(cd,1);
    c = cov(cd_sf);
    [e v] = eig(c);
```

```

eval = diag(v);
[~,ind] = sort(eval);
new_data = cd*(e(:,ind(5))+ e(:,ind(6)));
new_data_rec= rescale(new_data,0,255);
pcs2(:,i) = new_data_rec;
end
pcs2

```

```

pcs2 = 77760x15
    96.3478    109.0976    122.3422    118.8471     93.6104    113.5731    112.8257    112.0121 ...
    217.8103    206.1546    215.1518    211.0361    208.9911    173.9626    206.1240    202.1891
    217.8103    220.5893    215.1518    211.0361    211.0081    185.7797    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    185.7797    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    185.7797    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    181.1593    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    148.4990    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    157.0336    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    177.7378    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    184.9638    206.1240    202.1891
    :
    :

```

```

pcs2

```

```

pcs2 = 77760x15
    96.3478    109.0976    122.3422    118.8471     93.6104    113.5731    112.8257    112.0121 ...
    217.8103    206.1546    215.1518    211.0361    208.9911    173.9626    206.1240    202.1891
    217.8103    220.5893    215.1518    211.0361    211.0081    185.7797    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    185.7797    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    185.7797    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    181.1593    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    148.4990    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    157.0336    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    177.7378    206.1240    202.1891
    217.8103    223.1495    215.1518    211.0361    211.0081    184.9638    206.1240    202.1891
    :
    :

```

```

B = reshape(pcs2(:,1),[243,320]);
B =uint8(B);
imshow(B)

```



```
cnt=0;
for i = 1:90
    curr_img = vectorized_img(:,i);
    d = Inf;
    index =i;
    for j = 1 : 15
        v = curr_img - pcs2(:,j);
        if d >= norm(v)
            index=j;
            d = norm(v);
        end
    end
    % index cross checking
    if 6*index - i <= 5 && 6*index - i >=0
        fprintf('%d Yes\n', i);
        cnt = cnt+1;
        idx(i)=1;
    else
        fprintf('%d No\n', i);
    end
end
end
```

```
1 Yes
2 Yes
3 Yes
```


4 No
5 No
6 Yes
7 Yes
8 Yes
9 Yes
10 No
11 Yes
12 Yes
13 No
14 Yes
15 Yes
16 No
17 Yes
18 Yes
19 Yes
20 Yes
21 Yes
22 No
23 Yes
24 Yes
25 Yes
26 Yes
27 Yes
28 No
29 Yes
30 Yes
31 No
32 Yes
33 Yes
34 No
35 Yes
36 Yes
37 No
38 Yes
39 Yes
40 No
41 Yes
42 Yes
43 Yes
44 Yes
45 Yes
46 No
47 No
48 Yes
49 No
50 No
51 Yes
52 No
53 Yes
54 Yes
55 No
56 No
57 Yes
58 No
59 Yes
60 Yes
61 Yes
62 Yes
63 Yes
64 Yes
65 Yes
66 Yes

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67 No
68 No
69 No
70 Yes
71 Yes
72 Yes
73 Yes
74 Yes
75 Yes
76 No
77 Yes
78 Yes
79 Yes
80 Yes
81 Yes
82 No
83 Yes
84 Yes
85 Yes
86 Yes
87 Yes
88 No
89 Yes
90 No
```

```
disp(['Classification with 2 rep. images : '])
```

```
Classification with 2 rep. images :
```

```
cnt
```

```
cnt = 64
```

```
cnt_t=0;
for i=1:90
    if idx(i) == 1
        cnt_t = cnt_t+1;
    end
end
disp(['Unique classfications :'])
```

```
Unique classfications :
```

```
cnt_t
```

```
cnt_t = 76
```

Conclusion: In this question increasing the number of principal components does not necessarily mean that we will be able to classify more images correctly because effectively, we are obtaining a resultant image from 6 images belonging to a subject. This can improve the classification of one image as well and can reduce the classification accuracy of another image, as the number of principal components increases.