

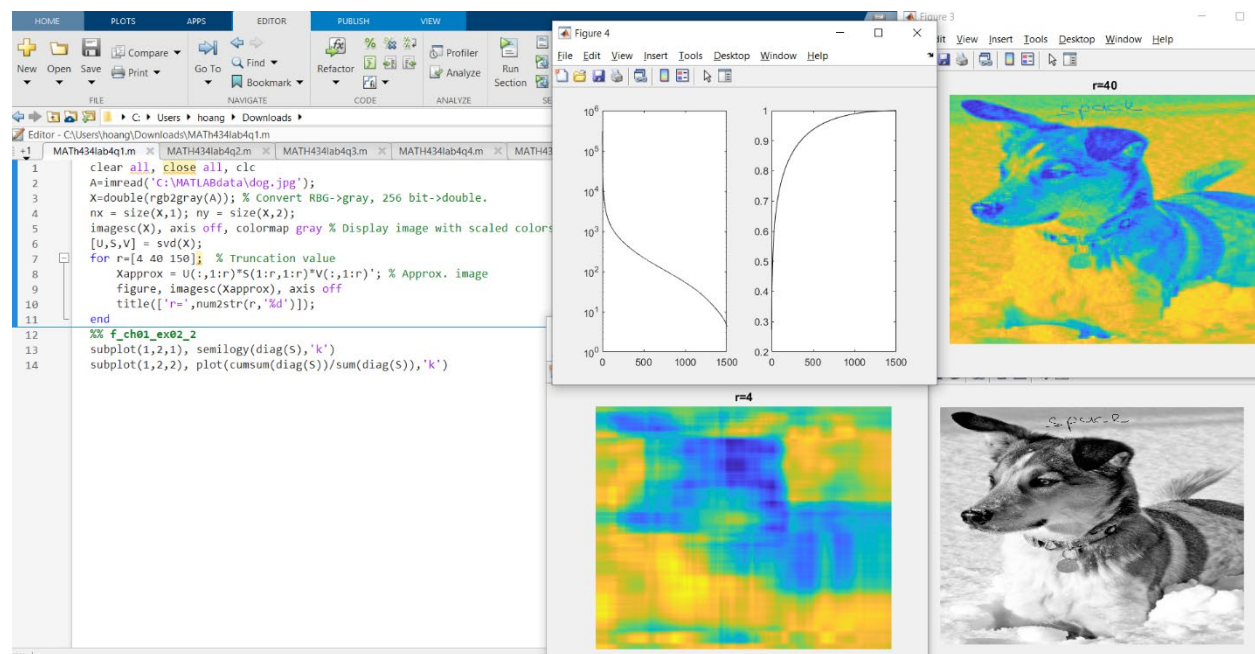
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MATH434

Lab4

1.

a.



b.

The smallest  $r$  value when the five-letter word is readable is 40.

c.

This PC > Local Disk (C:) > MATLABdata

Name	Date	Type	Size	Tags
allFaces	11/11/2022 7:09 PM	MATLAB Data	55,769 KB	
dog	11/11/2022 11:15 AM	JPG File	362 KB	
housing	11/11/2022 11:10 AM	DATA File	48 KB	
newdog1r150	11/11/2022 9:04 PM	PNG File	265 KB	
newdog2r4	11/11/2022 9:05 PM	PNG File	219 KB	
newdog3r40	11/11/2022 9:05 PM	PNG File	327 KB	

d.

The new images look pretty much the same as the original beside the size is reducing.

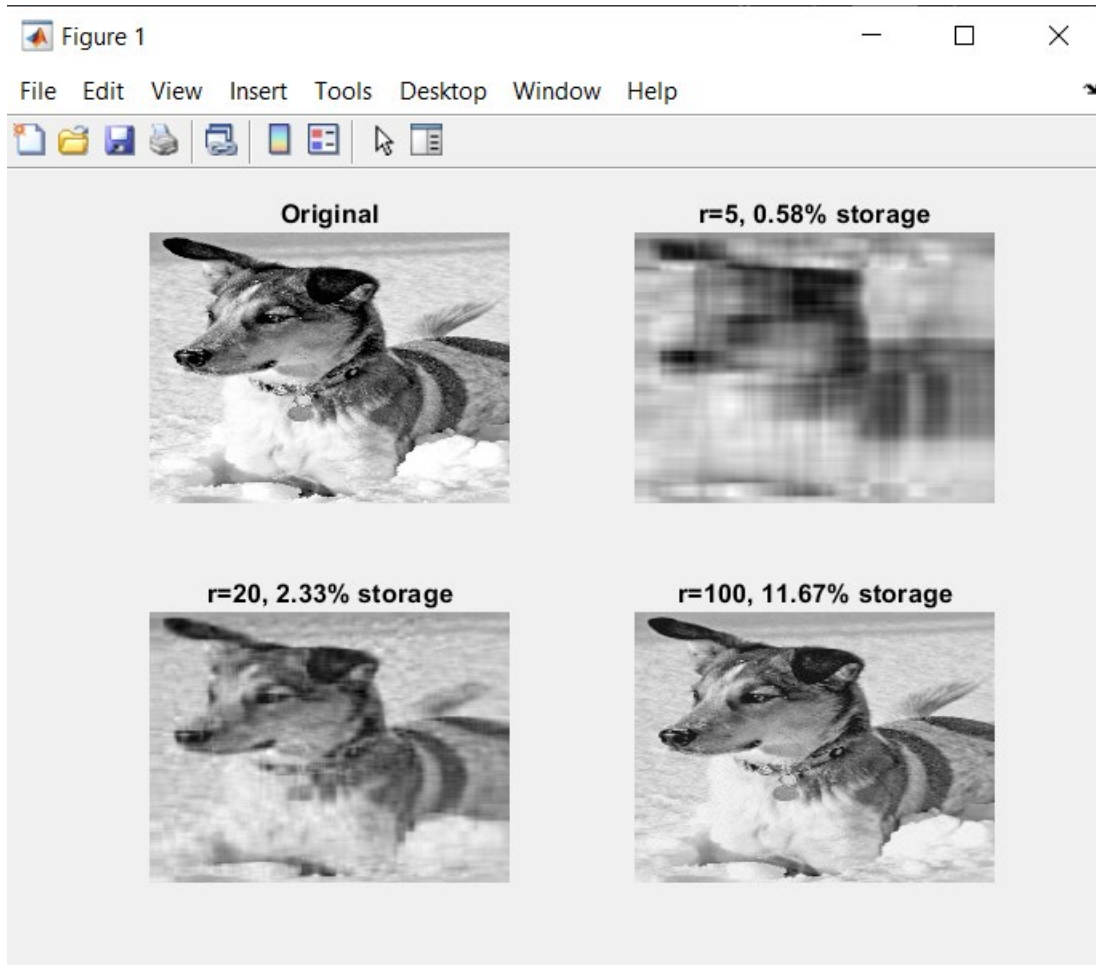
e.

```

Z = 10 + peaks; %10 + z - coordinate of the peaks function
surf(Z) %display surface of Z
hold on %hold on
imagesc(Z) %print image Z|

```

2.



Original: original image of the dog.

$r = 5$ , 0.58% storage: using 5 SVD, only capture 0.58% of variance, hence image is blurry.

$r = 20$ , 2.33% storage: using 20 SVD, capture 2.33% of variance, hence image still blurry but can see it is a dog.

$r = 100$ , 11.67% storage: using 100 SVD, capture 11.67% of variance, the image is clear but not clear as the original. With only 11.67% of data, the original image can be decomposed and saving more storage which lower the cost.

3.

```

1 clear all, close all, clc
2 %load hald; % Load Portland Cement dataset
3 % a
4 A = rand(8000,10000);
5 % b
6 b = rand(1,10000)';
7 [U,S,V] = svd(A,'econ');
8 % c
9 x = V*inv(S)*U.'*b; % Solve Ax=b using the SVD
10
11 % plot(b,'k','LineWidth',2); hold on % Plot data
12
13 m = pinv(A); %% Alternative 2 (pinv)
14 x_appro = m.*b;
15 % d
16 % Print first 5 elts of x
17 first_5_elts_of_x = x(1:5);
18 % Print entries (1,1) and (1,2) of the pseudoinverse of A
19 entries_11 = m(1,1);
20 entries_12 = m(1,2);
21 % e
22 % Compute the residual error
23 residual_error = norm(x - x_appro);
24
25
26
27

```

```

first_5_elts_of_x =
    1.0e-03 *
    0.5964    -0.2167    0.2491    0.1818   -0.0102

entries_11 =
    6.7750e-04

entries_12 =
   -2.1685e-04

residual_error =
    0

fx >>

```

My laptop takes 4min to compute this data. I'm not sure if the residual error is correct.

4.

It provides 2 model of multiple regression. The left is unsorted data and the right sorted by home value. The 2<sup>nd</sup> figure showing significance of factors contribute to the regression.

Method have been implemented in the following code is multiple regression.

5.

It provides a model of noisy cloud of data.

Method have been implemented in the following code is PCA. It generates that the first 3 standard deviation ellipsoids (red) and 2 SV vectors (green). It captures most of the data.

Nice code!

6.

It provides 2 figures. Figure 1 is the singular values and figure 2 is the clustering of samples that are normal and those that have cancer in the first three principal component coordinates.

Method have been implemented in the following code is SVD and PCA.

7.

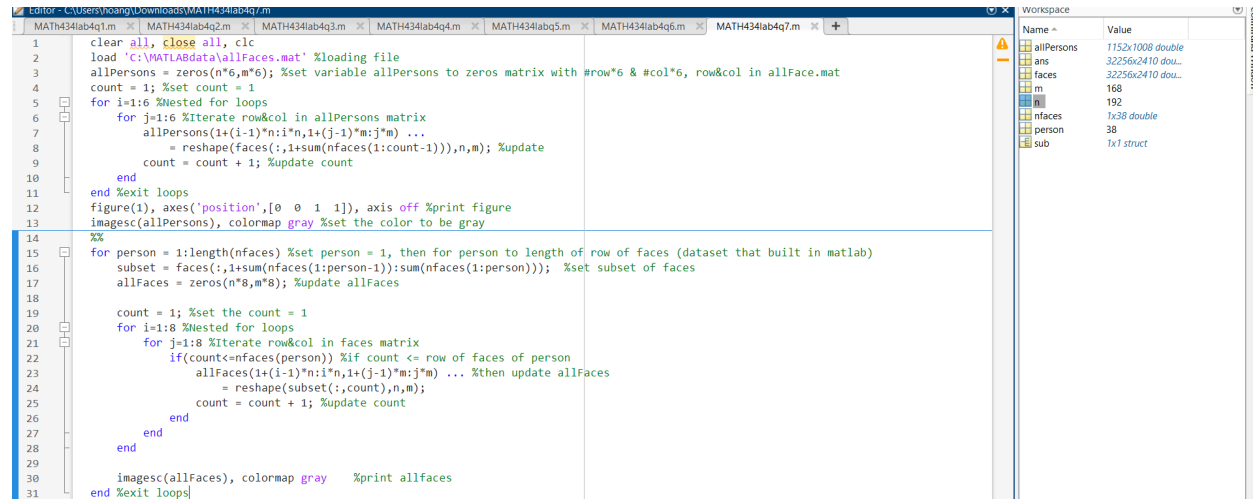
a.

It generates 64 different images of a face under different light conditions.

b.

Method have been implemented in the following code is SVD and PCA, where U are the eigenfaces. It generates 64 different images of a face under different light conditions. i.e., a large column vector with  $192 \times 168 = 32256$  elts.

c.



```

1 clear all, close all, clc
2 load 'C:\MATLABdata\allFaces.mat' %loading file
3 allPersons = zeros(n*6,m*6); %set variable allPersons to zeros matrix with #row*6 & #col*6, row&col in allFace.mat
4 count = 1; %set count = 1
5 for i=1:6 %Nested for loops
6     for j=1:6 %Iterate row&col in allPersons matrix
7         allPersons(i+(i-1)*n:1*n,i+(j-1)*m:j*m) ...
8             = reshape(faces(:,1+sum(nfaces(1:count-1))),n,m); %update
9         count = count + 1; %update count
10    end
11 end %exit loops
12 figure(1), axes('position',[0 0 1 1]), axis off %print figure
13 imagesc(allPersons), colormap gray %set the color to be gray
14 %%
15 for person = 1:length(nfaces) %set person = 1, then for person to length of row of faces (dataset that built in matlab)
16     subset = faces(1,1+sum(nfaces(1:person-1)):sum(nfaces(1:person))); %set subset of faces
17     allFaces = zeros(n*8,m*8); %update allFaces
18
19     count = 1; %set the count = 1
20     for i=1:8 %Nested for loops
21         for j=1:8 %Iterate row&col in faces matrix
22             if(count<=nfaces(person)) %if count <= row of faces of person
23                 allFaces(i+(i-1)*n:1*n,i+(j-1)*m:j*m) ... %then update allFaces
24                     = reshape(subset(:,count),n,m);
25                 count = count + 1; %update count
26             end
27         end
28     end
29
30 imagesc(allFaces), colormap gray %print allfaces
31 end %exit loops

```

8.

a.

Figure x value from -2500 to 500 and y value from -4000 to 4000 with red rectangle and black diamond

b.

Projection of all images from two individuals onto the 5<sup>th</sup> and 6<sup>th</sup> PCA modes. Project images of the first individual are indicated with black diamond, and projected images of the second individual are indicated with red triangles.

9.

a.

Figure a, show the underlying low-rank signal. Figure b, show the signal with noise. Figure c, truncate using optimal hard threshold. Figure d, truncate using 90% energy criterion.

b.

Method have been implemented in the following code is truncation when using SVD.

10.

a.

Figure a, show the data consisting of ones with a squares sub-block of zeros. Figure c, show its SVD spectrum. Figure b, show if rotate the image by 10 degrees. Figure d, the SVD spectrum becomes significantly more complex.

b.

Method have been implemented in the following code is alignment when using SVD.