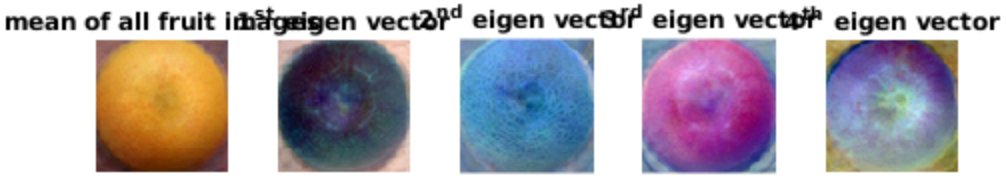
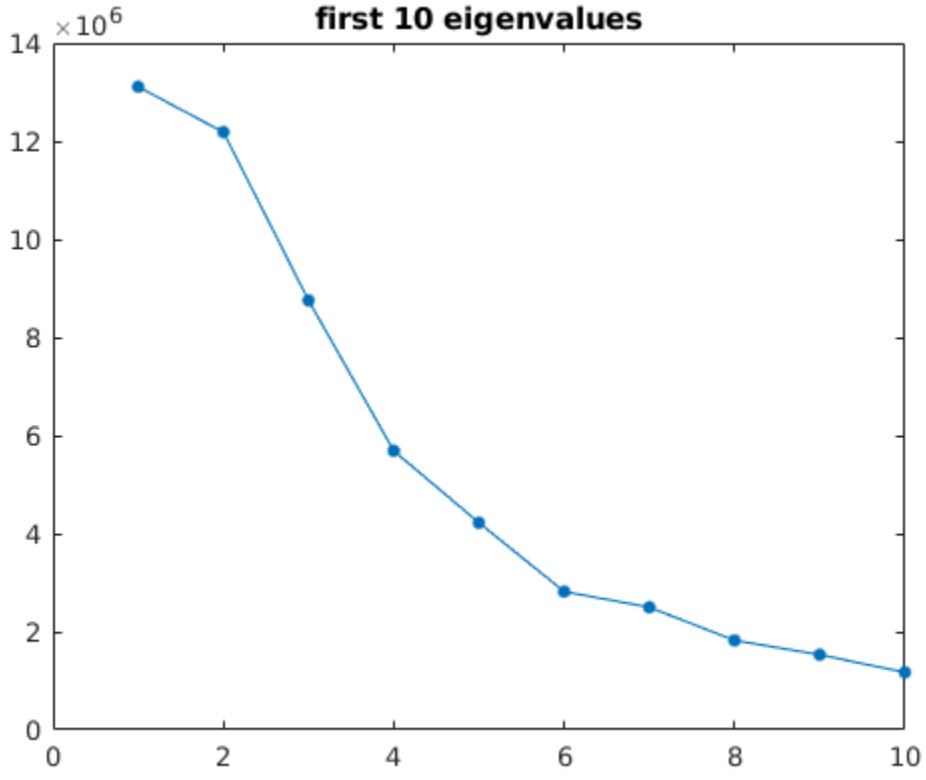
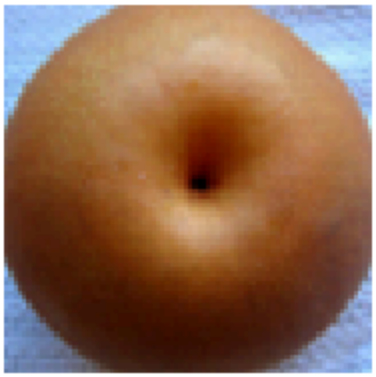
```
% Load images
%directory in which files are stored, Change if the path differs
Dir = "data_fruit/";
% list all png files in the AllImages variable
AllImages = dir(fullfile(Dir,"*.png"));
% number of images
num_images = length(AllImages);
%vector to store the images
I = zeros([19200 , num_images],"double");
for i = 1:num_images    % get the name of ith image
    image = fullfile(Dir,AllImages(i).name);
    %read the ith image
    im = imread(image);
    %reshape the image into a single vector and append it into the I
 matrix
    % while reshaping, the image is reshaped into a column vector
    I(:,i) = reshape(im,[19200, 1]);
end
% I contains each image as a column.


% PCA
me = (sum(I,2)/size(I,2)); %mean
I = I - me; %origin shifted to mean
%calculate the covariance matrix. Note that the covariance matrix for
 distribution is estimated using its MLE estimate
co = I*I' / size(I,2);
[u, s] = eigs(co,4); % u=eigen vectors, diag(s)= eigenvalues. Since we
 need only 4 maximum eigen values, we use eigs(co,4)


%Show the images of mean and the eigenvectors
figure
subplot(1,5,1),imshow(rescale(reshape(me,[80, 80, 3])))
title("mean of all fruit images")
subplot(1,5,2), imshow(rescale(reshape(u(:,1),[80, 80, 3])))
title("1^{st} eigen vector")
subplot(1,5,3), imshow(rescale(reshape(u(:,2),[80, 80, 3])))
title("2^{nd} eigen vector")
subplot(1,5,4), imshow(rescale(reshape(u(:,3),[80, 80, 3])))
title("3^{rd} eigen vector")
subplot(1,5,5), imshow(rescale(reshape(u(:,4),[80, 80, 3])))
title("4^{th} eigen vector")


% Plot of first ten eigen-values
D = eigs(co,10); %calculate the first 10 eigen values, returns in
 sorted order only
figure %plot
plot(D,"Marker",".","MarkerSize",15)
title("first 10 eigenvalues")
```

```
%Projections
%The closest representation will be the projection of the image on the
 vector space formed by the four eigen vectors as proved in the report
weights = u' * I; % dot product of the image on the smaller space
re_I = u*weights+me; %the reconstruction is simply weights *
 eigen_vector + mean.
% Plotting the reconstructed images and original images
for i=1:num_images
    figure
    subplot(1,2,1), imshow(rescale(reshape(I(:,i)+me,[80,
 80,3]))) %original image, We subtracted mean so have to add back
    title("Original Image for "+num2str(i) + " image")
    subplot(1,2,2), imshow(rescale(reshape(re_I(:,i),[80,
 80,3]))) %the reconstructed images
    title("Reconstructed Image for "+num2str(i) + " image")
end


%Random Fruits from normal distribution
%seed the random number generator
rng(4)
figure
for i=1:3
%     % get weights for the four eigenvectors.
%     %To notice difference, weights must be comparable to the norm of
 mean
%     % So it is multiplied by the norm of mean
%     % (randn + 0.1) is used to increase the scale a bit
    w = randn(4,1)*(rand+0.1)*norm(me);
%     % construct the image of fruit from the weights
    new_image = u*w+me;
%     %display the image
    subplot(1,3,i), imshow(rescale(reshape(new_image,[80, 80,3])))
    title("randomly generated image "+num2str(i))
end
```


mean of all fruit images
1st eigen vector
2nd eigen vector
3rd eigen vector
4th eigen vector


first 10 eigenvalues
×10^6
14
12
10
8
6
4
2
0
0
2
4
6
8
10

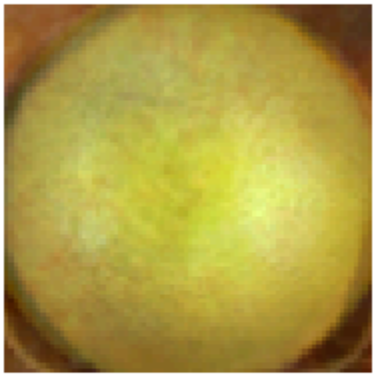
Original Image for 1 image



Reconstructed Image for 1 image

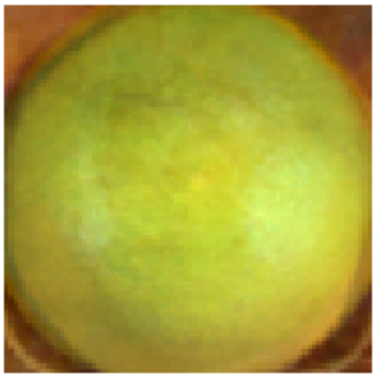
Original Image for 2 image

Reconstructed Image for 2 image

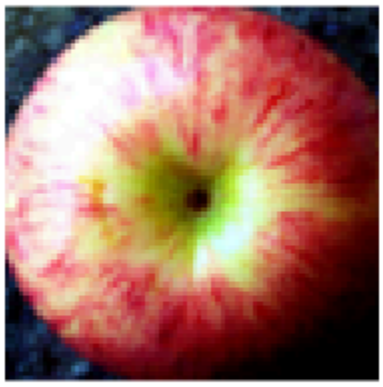


Original Image for 3 image

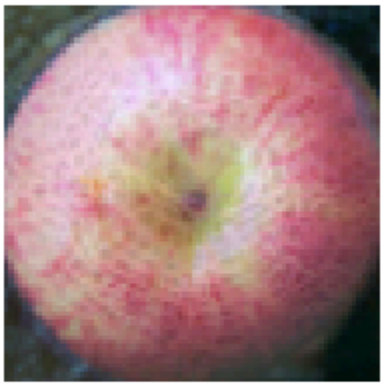
Reconstructed Image for 3 image



Original Image for 4 image



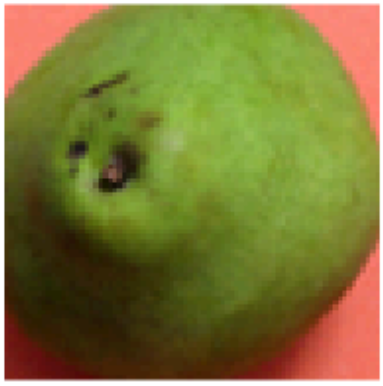
Reconstructed Image for 4 image



Original Image for 5 image

Reconstructed Image for 5 image

Original Image for 6 image



Reconstructed Image for 6 image

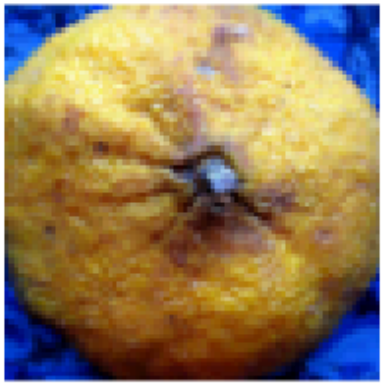
Original Image for 7 image

Reconstructed Image for 7 image

Original Image for 8 image

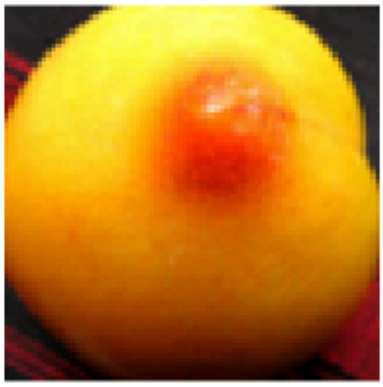
Reconstructed Image for 8 image

Original Image for 9 image



Reconstructed Image for 9 image

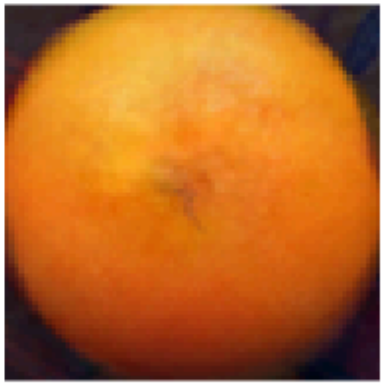
Original Image for 10 image



Reconstructed Image for 10 image

Original Image for 11 image

Reconstructed Image for 11 image



Original Image for 12 image

Reconstructed Image for 12 image

Original Image for 13 image

Reconstructed Image for 13 image

Original Image for 14 image

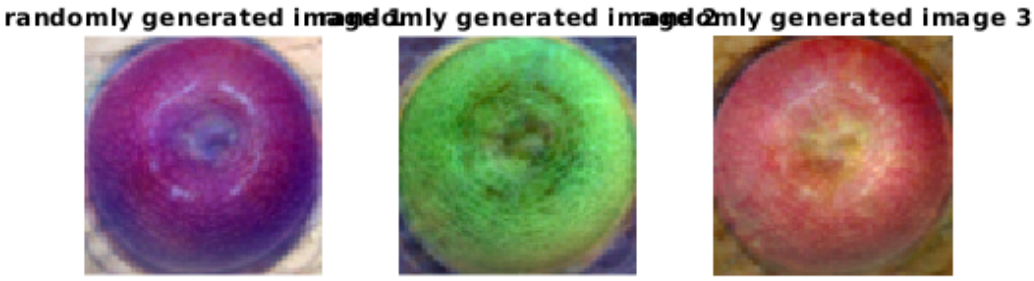
Reconstructed Image for 14 image

Original Image for 15 image

Reconstructed Image for 15 image

Original Image for 16 image

Reconstructed Image for 16 image



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