```
clear all
%{
%% 2.1
% Plot of W
n = 1000;
p = 2;
mu = 0;
sigma = 1;
W = normrnd(mu,sigma,p,n);
%{
figure()
plot(W(1,:),W(2,:),'.')
title('scatter plots for W')
%}
% Plot of W
Rx = [2,-1.2;-1.2,1];
[E,gamma] = eig(Rx);
Xtilde = gamma^(0.5) * W;
%{
figure()
plot(Xtilde(1,:),Xtilde(2,:),'.')
axis('equal')
title('scatter plots for Xtilde')
%}
X = E*Xtilde;
%{
figure()
plot(X(1,:),X(2,:),'.')
axis('equal')
title('scatter plots for X')
%}
%% 2.2
miu_head = mean(X,2);
Z = X - miu_head;
R_head = 1/(n-1) * (Z*Z.');

[E,gamma] = eig(R_head);
Xtilde = E.' * X;
figure()
plot(Xtilde(1,:),Xtilde(2,:),'.')
axis('equal')
title('scatter plots for Xtilde')

W = gamma^(-0.5) * E.' * X;
figure()
plot(W(1,:),W(2,:),'.')
axis('equal')
title('scatter plots for W')
```

```
miu_W = mean(W,2);
Z_W = W - miu_W;
R_W = 1/(n-1) * (Z_W*Z_W.');
%}
%% 4.1
run('./training_data/read_data.m')

miu_head = mean(X,2);
Z = X - miu_head;
[U S V] = svd(Z,0);
%{
for i=1:12
  img=reshape(U(:,(i)),64,64);
  figure(1); subplot(4,3,i); imagesc(img);
  axis('image'); colormap(gray(256));
end
%}
Y = U(:,1:10).' * Z(:,1:4);
%{
figure()
for i = 1:4
    plot(1:10,Y(:,i))
    hold on
end
legend('a','b','c','d')
%}
%{
figure()
img=reshape(X(:,1),64,64);
imagesc(img);
axis('image'); colormap(gray(256));
%}
%{
m = [1,5,10,15,20,30];
figure()
for i=1:length(m)
    subplot(3,2,i)
    Xre = U(:,1:m(i)) * U(:,1:m(i)).' * Z(:,1);
    Xre = Xre + miu_head;
    img=reshape(Xre,64,64);
    imagesc(img);
    axis('image');
    title(['m = ',num2str(m(i))])
    colormap(gray(256));
end
%}
```

```
%% 5.1
empty_cell=cell(26,2);
params=cell2struct(empty_cell,{'M','R'},2);
% trans. to a lower dimension
A = U(:,1:10);
Y = A.' * Z;
% store the mean and covariance
Rwc = zeros(10,10);
for k = 1:26
    params(k).M = mean(Y(:,k:26:end),2);
    %params(k).R = (Y(:,k:26:end)-params(k).M)*(Y(:,k:26:end)-params(k).M).' / (12-1);
    params(k).R = eye(10);
    % params(k).R =
    % diag(diag((Y(:,k:26:end)-params(k).M)*(Y(:,k:26:end)-params(k).M).' /
    % (12-1))); % Sigma k
    %{
    % Bk = Rwc
    for i = 1:10
        for j = 1:10
            Rwc(i,j) = Rwc(i,j) + params(k).R(i,j);
        end
    end
    %}
end
%{
for k = 1:26
    params(k).R = Rwc / 26;
    % params(k).R = diag(diag(params(k).R)); % find the diag. of Rwc
end
%}
% transfer the test data into matrix
[rowX,colX] = size(X);
test_data = zeros(rowX,length(datachar));
i = 1;
for ch = datachar
    im_name = sprintf('./test_data/veranda/%s.tif',ch);
    test_data(:,i) = reshape(imread(im_name),rowX,1);
    i = i + 1;
end
% reduce the dimension of test data
y = A.' * (test_data-miu_head);
% test the classifier
k_star = zeros(26,length(datachar));
kmin_ind = zeros(1,26);
for i = 1:length(datachar) % traverse through the Input
    yi = y(:,i);
    for j = 1:26 % traverse through the data in the STRUCTURE
        k_star(j,i) = (yi-params(j).M).' * (params(j).R)^-1 * (yi-params(j).M) + log(det(params(j)↙
```

```
R));
    end
    [kmin,ind] = min(k_star(:,i));
    kmin_ind(i) = ind;
end
% show the output of the classifier
for i = 1:26
    output(i) = datachar(kmin_ind(i));
end
```