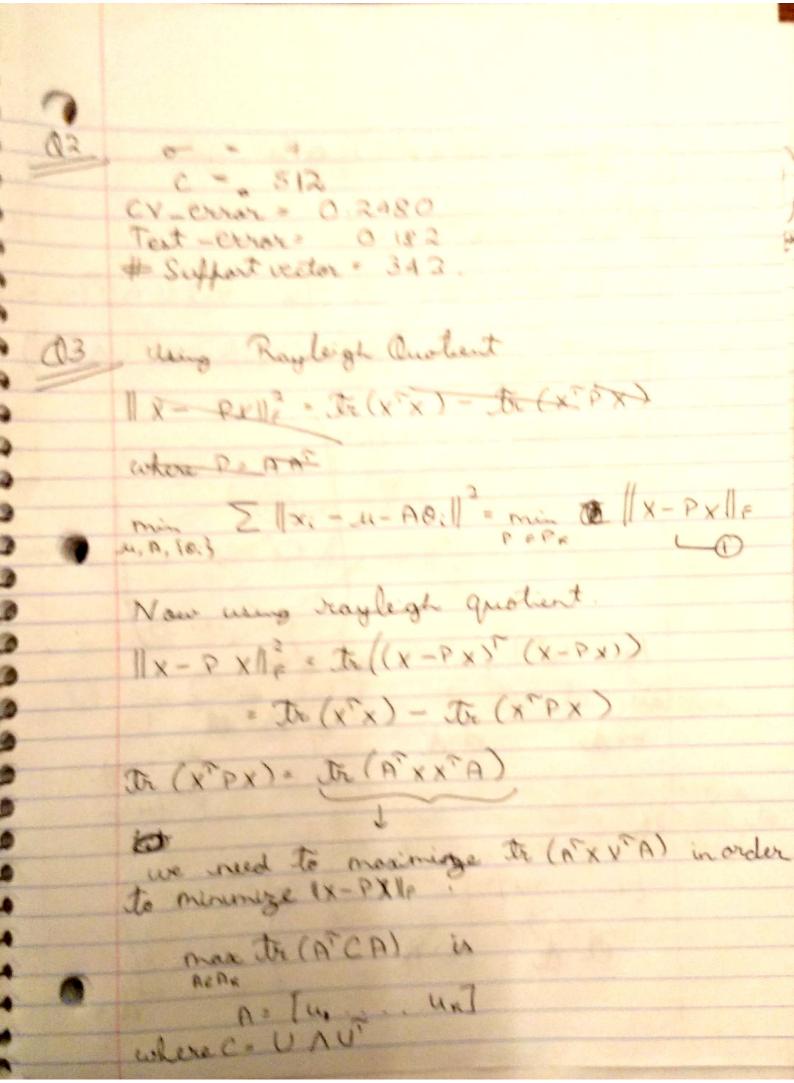
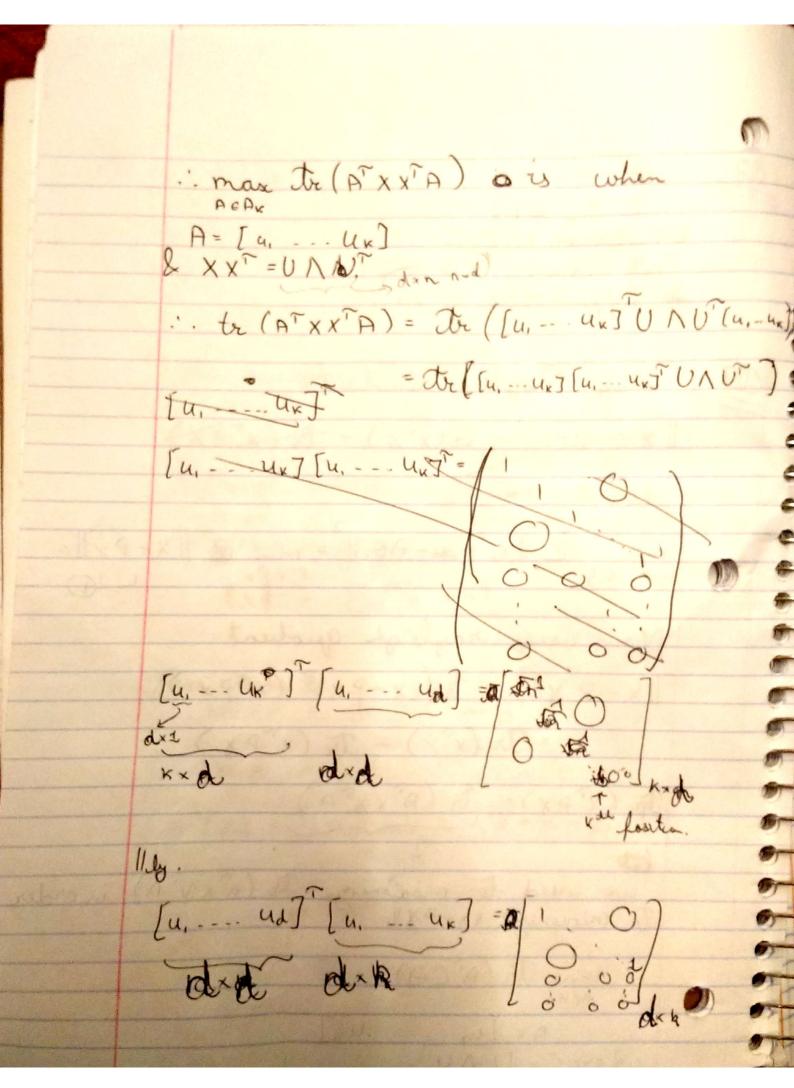
(I) For margin errors, 5 = 1 - y: (w* x: +b*) $y: (w^{r}X_{i} + b^{*}) = 1 - 3i$ $w^{r}X_{i} = = (1 - 3i)/9i - 5i$ The eq. of hyperflone is $y_i(w^{\tau} \times +b) = 1$ $ie \ w^{\tau} \times +b - /y_i = 0$ Both of these hyperflanes: We know dustance of a foint(2) from a hyperplane in (w'x+b) is given by 121 = W = + bt IIwII Here z is \$i ... w Xi = 1-5i - b

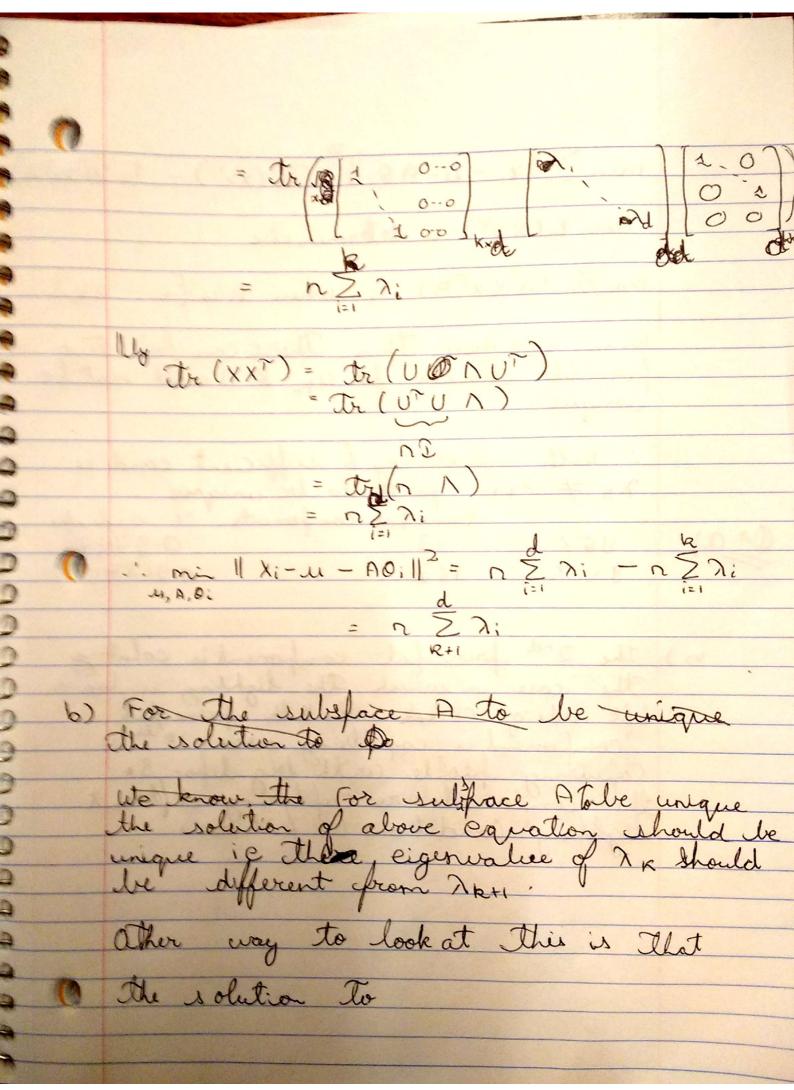
Yi & b = b - /yi :. | rl = | (y- 3i)/yi - b+b-1/vi | 1rl = [3i/yi] 121 x 31 11will & The constant of frofortionality

= 1/9:111 W11



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min \[\lambda \lambda : \lambda = \text{Tr} (xx^2) - \text{Tr} (A^2 xx^2) \\

Here \ta(x x^2) is deterministic Here telxx) is deterministic Smite (AXXTA) is when A'ce [u, -- uk] When In = Nan then there can be two for while choices for up & A will not be 1 --Solh necessary & sufficient condition in the property of the designe.

Description of the angre.

Desc 4 *** (Da a) the case in which the lighting is lower left and of chelok, the 1th frincipal component is capating in lower component is capating nose, 18th is capating nose, 18th is capating people with big life. So, the components are capturing different lighting conditions is peakeres. 6000

```
clear all;
close all;
clc;
load diabetes scaled.mat;
% Creating test and train data sets
X tr = X(1:500,:);
X \text{ tt} = X(501:end,:);
Y tr = y(1:500);
Y_t = y(501:end);
grid sigma = 2.^(0:5);
grid C = 2.^{(6:11)};
tol = 0.01;
[n, p] = size(X tr);
% Cauchy kernel
cauchy kernel = @(u,v,sigma) (1 + dist2(u, v)/(sigma^2)) .^-1;
num sv = zeros(length(grid sigma), length(grid C));
CV error grid = zeros(length(grid sigma), length(grid C));
for i = 1:length(grid_sigma)
    grid sigma iter = grid sigma(:,i);
    for j = 1:length(grid C)
        grid C iter = grid C(:,j);
            CV error iter = 0;
            for k = 1:5
                ind = (k-1)*100 + 1: k*100;
                X tr iter = X tr;
                X_{tr_iter(ind,:)} = [];
                X_CV_iter = X_tr(ind,:);
                y tr iter = Y tr;
                y tr iter(ind,:) = [];
                y CV iter = Y tr(ind,:);
                kmat tr = cauchy kernel(X tr iter, X tr iter,
grid sigma iter);
                 [alpha, bias] = smo(kmat tr, y tr iter', grid C iter, tol);
                kmat_CV = cauchy_kernel(X_CV_iter, X_tr_iter,
grid sigma iter);
                y pred = sign(kmat CV * (y tr iter .* alpha') + bias);
                CV error iter = 1 - sum((y pred == y CV iter))/100 +
CV error iter;
            CV error grid(i, j) = CV error iter / 5;
    end
end
[min error, ind] = min(CV error grid(:));
[m,n] = ind2sub(size(CV error grid),ind);
sigma opt = grid sigma(m); %4
C \text{ opt} = grid C(n); %512
% Selected parameters: (sigma, C) :: (4, 512)
```

```
% CV error: min_error :: 0.2480
% Final model
kmat_tr = cauchy_kernel(X_tr, X_tr, sigma_opt);
[alpha, bias] = smo(kmat_tr, Y_tr', C_opt, tol);
kmat_tt = cauchy_kernel(X_tt, X_tr, sigma_opt);
y_pred = sign(kmat_tt * (Y_tr .* alpha') + bias);
error_tt = 1 - sum((y_pred == Y_tt))/size(Y_tt, 1);
% test error :: 0.182
500 - sum(alpha == 0);
%number of support vectors :: 342
```

Question 4

```
clear;
clc;
load yalefaces; % loads the 3-d array yalefaces
% for i=1:size(yalefaces, 3)
  x = double(yalefaces(:,:,i));
응
     imagesc(x);
    colormap(gray)
     drawnow
     %pause(.1)
       [U, S, V] = svd(x);
% end
yalefaces mat = double(reshape(yalefaces, [], 2414)');
x mean = mean(yalefaces mat);
x mean mat = ones(size(yalefaces mat))* diag(x mean);
cov_base = yalefaces_mat - x_mean_mat;
cov_mat = (cov_base' * cov_base) ./ 2414;
[U, D] = eig(cov mat);
eig values = sum(D);
[sort eig values, index] = sort(eig values, 'descend');
semilogy(sort eig values)
for i = 1:length(sort eig values)
    var_cap = sum(sort_eig_values(:, 1:i)) / sum(sort_eig_values);
    if var cap >= .95
        break
    end
end
% .95 variation captured: 43
% % dim reduction: .9787
for i = 1:length(sort eig values)
    var cap = sum(sort eig values(:, 1:i)) / sum(sort eig values);
    if var cap >= .99
        break
    end
end
% .99 variation captured: 167
% % dim reduction: .9172
subplot(5,4,1)
```

```
a = reshape(x_mean, 48, 42);
imagesc(a);
colormap(gray)
drawnow

for i = 1:19
    subplot(5, 4, i+1);
    x = reshape(U(:, index(i)), 48, 42);
    imagesc(x);
    colormap(gray)
    drawnow
end
```