Homework 1
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Problem 1

CODE:

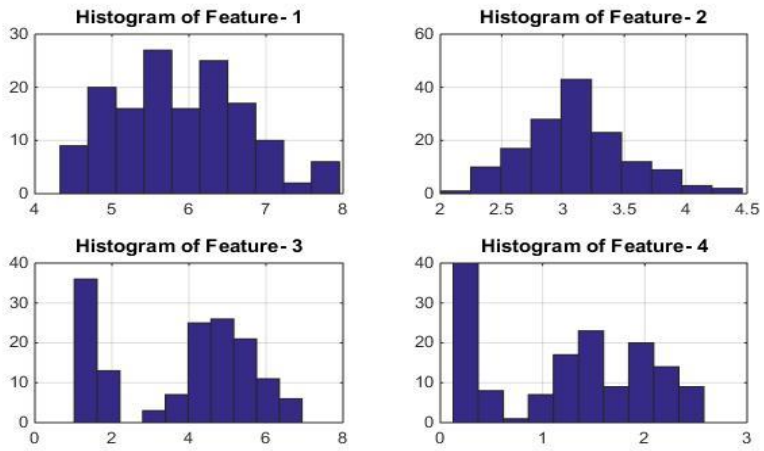
```
clear all;
%old=cd('C:\Users\DEBATRI\Desktop\HW1\data');  % cd to the data
folder
DATA=load('data/iris.txt');                     % read data from
text
%cd(old);                                       % cd back to old
directory

x=DATA(:,1:end-1);                              % features
y=DATA(:,end);                                  % classes

whos;                                           % show current variables
in memory and sizes

no_of_features = size(x,2);                     % get no of features
i.e. equal to num of columns
no_of_data = size(x,1);                         % get no of data points
i.e. equal to the no of rows

%size(x)
MEAN =zeros(4,1);
VAR=zeros(4,1);

for i=1:no_of_features
     subplot(2,2,i);
     hist(x(:,i));
     MEAN(i,1)=mean(x(:,i));
     VAR(i,1)=var(x(:,i));
end
STD=VAR.^(1/2);
%NORMAL=zeros(size(x));
ONES=ones(no_of_data,1);


for i=1:no_of_features
     x(:,i)=(x(:,i)-ONES.*MEAN(i,1));
     x(:,i)=x(:,i)./STD(i,1);
end
%STD=zeros(4,1);
```

```
figure;

subplot(3,1,1);
gscatter(x(:,1),x(:,2),y(:,1),'bgr','xo+');
xlabel('feature1');
ylabel('feature2');
subplot(3,1,2);
gscatter(x(:,1),x(:,3),y(:,1),'bgr','xo+');
xlabel('feature1');
ylabel('feature3');
subplot(3,1,3)
gscatter(x(:,1),x(:,4),y(:,1),'bgr','xo+');
xlabel('feature1');
ylabel('feature4');
%title('Scatter Plot')
```

(a)

```
no_of_features = size(x,2); (ANS : 4)                    % get no of features
i.e.                                                  equal to num of columns
no_of_data = size(x,1);  (ANS: 148)                     % get no of data
points i.e.                                           equal to the no of
rows
```

(b)
Histogram



(c)
Computing Mean, Variance and Standard Deviation

```
MEAN =zeros(4,1);
VAR=zeros(4,1);

for i=1:no_of_features
    subplot(2,2,i);
```

```
    hist(x(:,i));
    MEAN(i,1)=mean(x(:,i));
    VAR(i,1)=var(x(:,i));
end
STD=VAR.^(1/2);
%NORMAL=zeros(size(x));
```

ANS:

```
MEAN =
[5.90010376418919
3.09893091689189
3.81955484054054
1.25255548459459]
```

```
VAR=
[0.699283896094493
0.191645469728850
3.09764638598857
0.579652210531846]
```

```
STD_DEV=
[0.836231963090680
0.437773308607149
1.76001317778833
0.761348941374351]
```

(e)

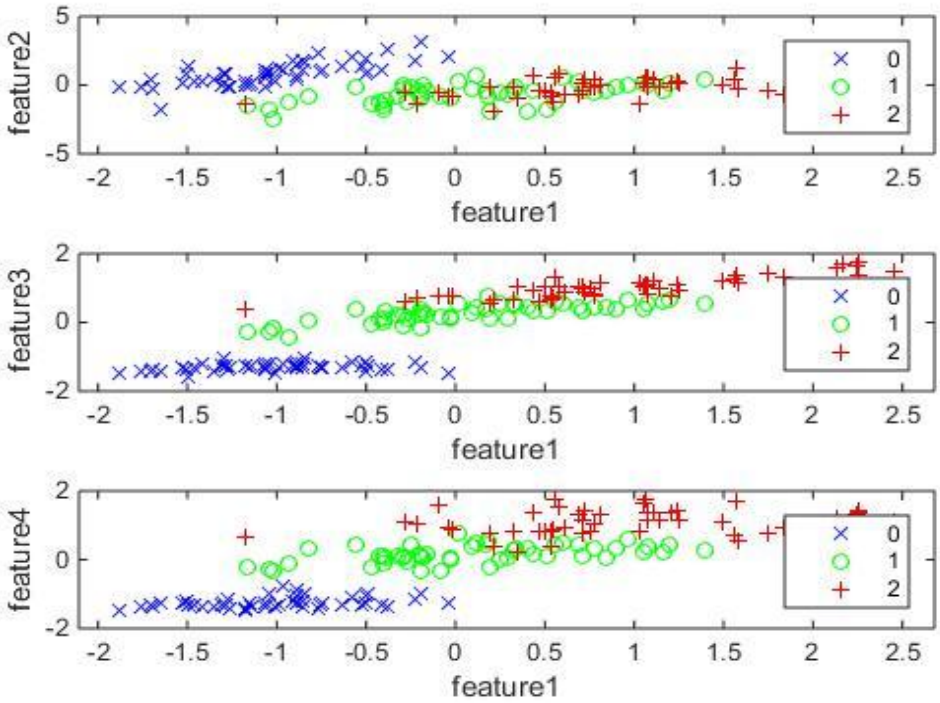
Normalize Data

```
ONES=ones(no_of_data,1);
for i=1:no_of_features
    x(:,i)=(x(:,i)-ONES.*MEAN(i,1));
    x(:,i)=x(:,i)./STD(i,1);
end
```

(f)

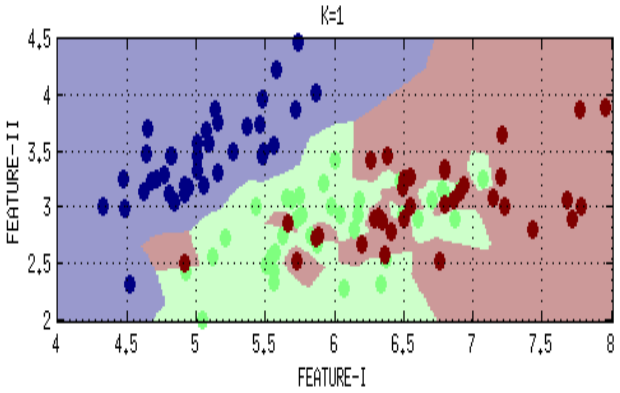
Scatter Plot

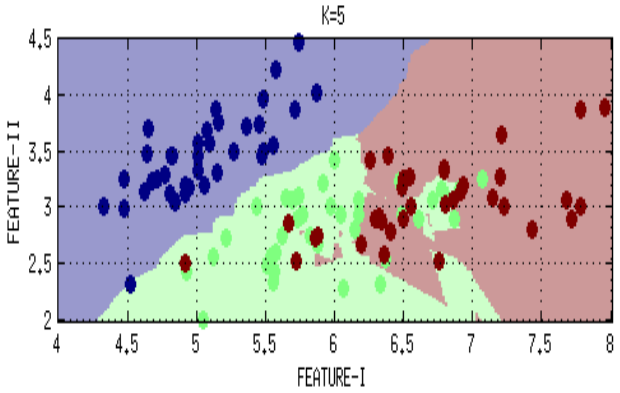
```
subplot(3,1,1);
gscatter(x(:,1),x(:,2),y(:,1),'bgr','xo+');
xlabel('feature1');
ylabel('feature2');
subplot(3,1,2);
gscatter(x(:,1),x(:,3),y(:,1),'bgr','xo+');
xlabel('feature1');
ylabel('feature3');
subplot(3,1,3)
gscatter(x(:,1),x(:,4),y(:,1),'bgr','xo+');
xlabel('feature1');
```

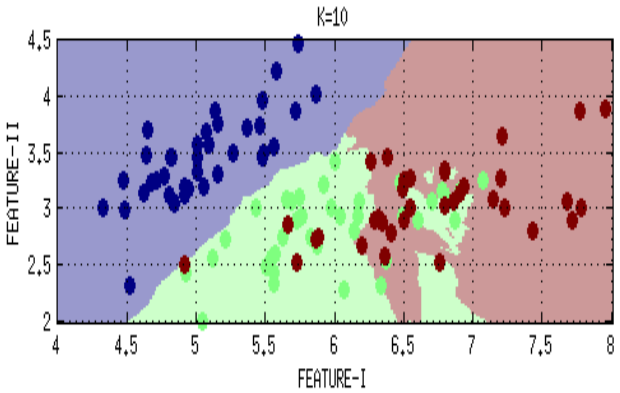

feature2
feature1
0
1
2
feature3
feature1
0
1
2
feature4
feature1
0
1
2

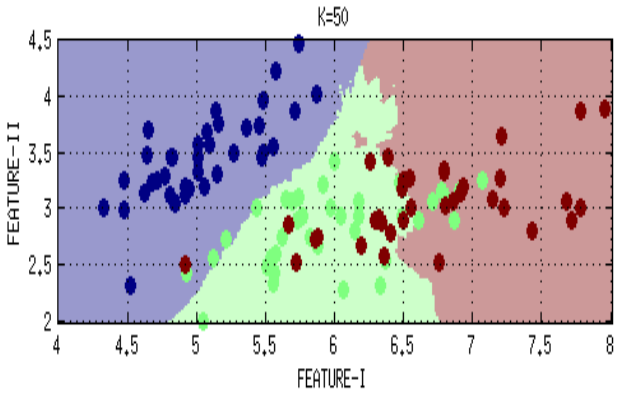
Problem 2

```
%% Problem- 2(a)
j=1;
for K=[10, 50, 100, 200]

knn = knnClassify( Xtr, Ytr, K );
YteHat = predict( knn, Xte );

subplot(2,2,j)
plotClassify2D( knn, Xtr, Ytr );
j=j+1;
end
```



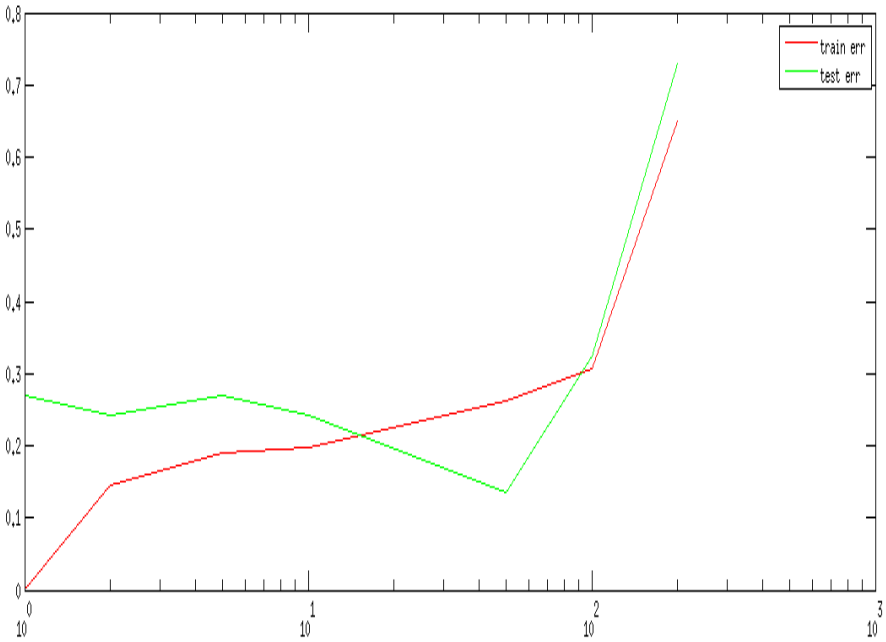







```
%% Problem- 2(b)
%K=[1,2,5,10,50,100,200];
i=1;
for K=[1,2,5,10,50,100,200];
model = knnClassify( Xtr, Ytr, K );
Yhat = predict( model, Xtr );

%model = knnClassify( Xtr, Ytr, K );
Yhat_test = predict( model, Xte );

errTrain(i) = mean(Yhat~=Ytr);
errTest(i) =  mean(Yhat_test~=Yte);
```

```
i=i+1;
end

K=[1,2,5,10,50,100,200];
semilogx(K,errTrain,'r');
hold on;
semilogx(K,errTest,'g');
```



I would recommend K around 15 as the Test Error is less.

PROBLEM - 4

```
clear all;

iris=load('data/iris.txt');

y=iris(:,end);
x=iris(:,1:2);
[x, y] = shuffleData(x,y);
[Xtr,Xte ,Ytr, Yte] = splitData(x,y, .75);

%% 4(a)
m=1;
n=1;
```

```
p=1;
for i=1:length(Xtr(:,1))
 if(Ytr(i)==0)
      Zero(m,:)=Xtr(i,:);
      m=m+1;
 elseif(Ytr(i)==1)
      One(n,:)= Xtr(i,:);
      n=n+1;
      elseif(Ytr(i)==2)
      Two(p,:)= Xtr(i,:);
      p=p+1;
  end
end

MEAN(:,:,1)=mean(Zero);
MEAN(:,:,2)=mean(One);
MEAN(:,:,3)=mean(Two);
%COV=zeros(2,2,3);
COV(:,:,1)=cov(Zero);
COV(:,:,2)=cov(One);
COV(:,:,3)=cov(Two);
```

ANS:

Mean

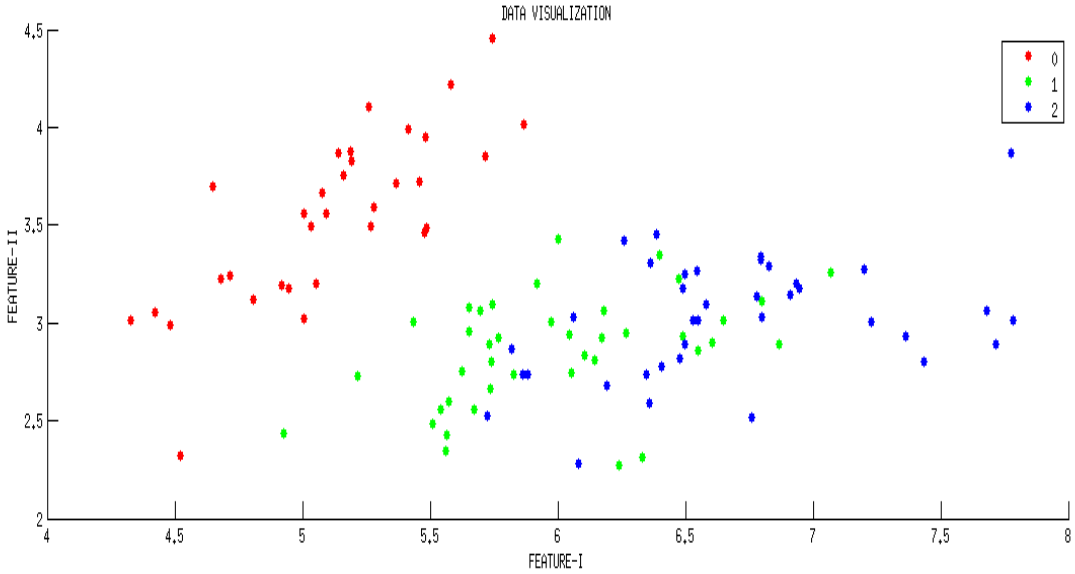
```
Feature-I
     5.0441     3.4936
Feature-II
     5.9886     2.8439
Feature-III
     6.6531     3.0034
```

COV MATRIX

```
Feature-I
     0.1460     0.1154
     0.1154     0.1648
Feature-II
     0.2939     0.1082
     0.1082     0.1077
Feature-III
     0.3364     0.0725
     0.0725     0.0898
```

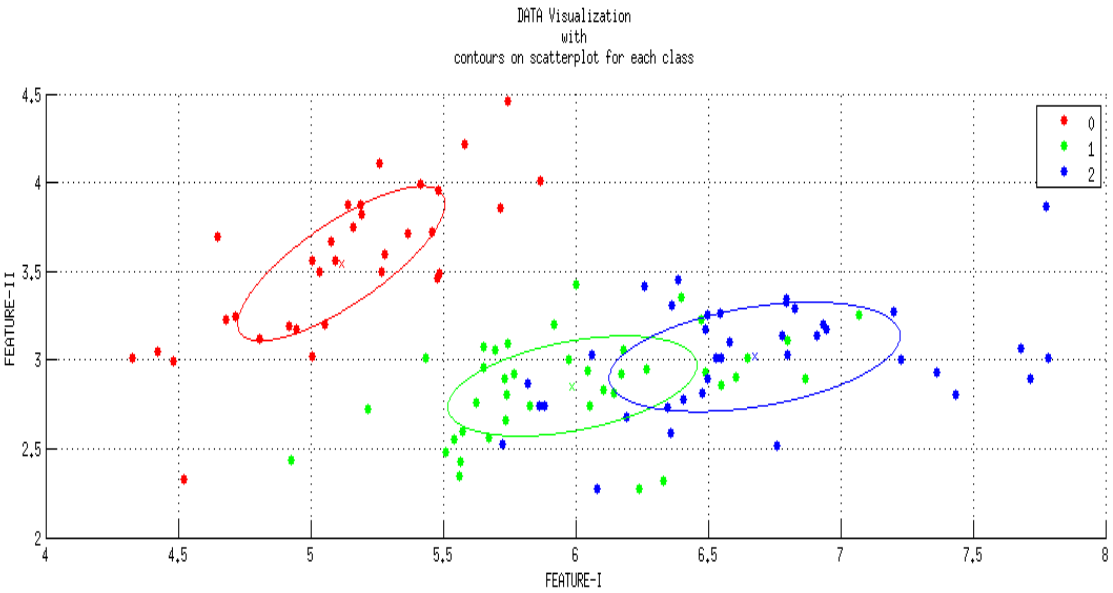
%% 4(b)

```
group=Ytr;
figure;
gscatter(Xtr(:,1),Xtr(:,2),group)
```



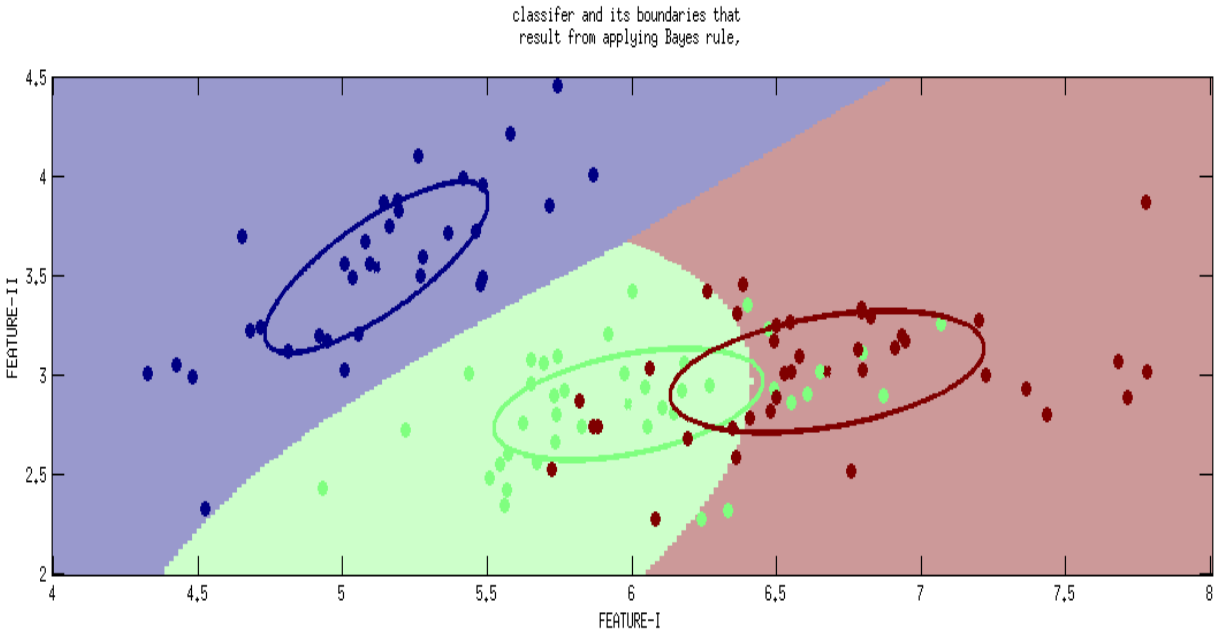
%% 4(c)

```
figure;
gscatter(Xtr(:,1),Xtr(:,2),group)
hold on;
plotGauss2D(MEAN(:,:,1),COV(:,:,1),'-r');
plotGauss2D(MEAN(:,:,2),COV(:,:,2),'-g');
plotGauss2D(MEAN(:,:,3),COV(:,:,3),'-b');
```



%% 4(d)

```
bc = gaussBayesClassify( Xtr, Ytr );
figure;
plotClassify2D(bc, Xtr, Ytr);
```



%% 4(e)

```
%old =cd('')
Yhat = predict( bc, Xtr );
errTrain = mean(Yhat~=Ytr);
Yhat_test=predict(bc,Xte);
errTest=mean(Yhat_test~=Yte);

ANS:
errTrain = 0.18
errTest= 0.1892
```

%% 4(f)

```
iris=load('data/iris.txt');

y=iris(:,end);
x=iris(:,1:end-1);
[x, y] = shuffleData(x,y);
```

```
[Xtr,Xte ,Ytr, Yte] = splitData(x,y, .60);

bc = gaussBayesClassify( Xtr, Ytr );
Yhat = predict( bc, Xtr );
errTrain_all = mean(Yhat~=Ytr);
Yhat_test=predict(bc,Xte);
errTest_all=mean(Yhat_test~=Yte);
```

ANS:

```
errTrain-using all features= 0.011235955056180
errTest-using all Features = 0.033898305084746
```

Problem - 3 (HW #1 - ML) (CS 273A)

(a)

- $P(y) \; \forall y \in \{-1, 1\}$

$$P(y=1) = \frac{\sum_{\forall i : y^{(i)}=1} y_i}{\sum_{\forall i} 1} = 0.4$$

$$P(y=-1) = \frac{6}{10} = 0.6.$$

-

	$y=-1$				$y=1$			
Feature	0's	1's	$P(x_i=1/y)$	$P(x_i=0/y)$	0's	1's	$P(x_i=1/y)$	$P(x_i=0/y)$
x_1	3	3	0.5	0.5	1	3	0.75	0.25
x_2	1	5	0.83	0.17	4	0	0	1
x_3	2	4	0.67	0.33	1	3	0.75	0.25
x_4	1	5	0.83	0.17	2	2	0.5	0.5
x_5	4	2	0.33	0.67	3	1	0.25	0.75

(b) Naive Bayes

<i> $\therefore \quad P(y=1 / x=\langle 0,0,0,0,0 \rangle)$

$= P(y=1) \times P(x_1=0/y=1) \times P(x_2=0/y=1) \ldots P(x_5=0/y=1).$

$= 0.4 \times 0.25 \times 1 \times 0.25 \times 0.5 \times 0.75$

$= 0.009$

$P(y=-1/x=\langle 0,0,0,0,0 \rangle)$

$= 0.6 \times 0.5 \times 0.17 \times 0.33 \times 0.17 \times 0.67$

$= 0.002.$

$\therefore$ The class chosen is $y=1$.

(ii) $P(Y=1 \mid x=(1\,1\,0\,1\,0))$

$= 0.4 \times 0.75 \times 0 \times 0.25 \times 0.5 \times 0.75 = 0$.

$P(Y=-1 \mid x=(1\,1\,0\,1\,0))$

$= 0.6 \times 0.5 \times 0.83 \times 0.33 \times 0.83 \times 0.67$

$= 0.046$.

∴ ~~the~~ chosen class is $y = -1$.

(c) $P(Y=1 \mid \underline{x} = \langle 1,1,0,1,0 \rangle)$

$= 0$

(d) 5 features (binary) ∴ we have 2^{32} parameters but 10 data points

∴ Bayes classifier would overfit.