In [123…

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection \
import train_test_split
import seaborn as sns

#import prettytable as pt
```

In [123…

```
url = r"https://archive.ics.uci.edu/ml/" \
    + r"machine-learning-databases/iris/iris.data"
data = pd.read_csv(url, names=[ "sepal -length", "sepal -width", "petal -length
"Class"])

#data.to_csv("iris_data.csv")
```

Question# 1.1 download IRIS dataset, remove Setosa flowers and assign labels 0 to to Versicolor and 1 to Virginica.

In [124…

```
a=list(range(0,50))
data.drop(index=a,inplace=True)
label=[]
#print(data.index)
for i in range(len(data)):
    if data["Class"][i+50]=="Iris-versicolor":
        label.append(0)
    elif data["Class"][i+50]=="Iris-virginica":
        label.append(1)
#print(label)
data["label"]=label
Q5_data= pd.read_csv(url, names=[ "sepal -length", "sepal -width", "petal -leng
"Class"])
Q5_data.drop(index=a,inplace=True)
label=[]
#print(data.index)
for i in range(len(Q5_data)):
    if Q5_data["Class"][i+50]=="Iris-versicolor":
        label.append(0)
    elif Q5_data["Class"][i+50]=="Iris-virginica":
        label.append(1)
#print(label)
Q5_data["label"]=label

# data["Class"]=data["Class"].replace("Iris-versicolor",0)
# data["Class"]=data["Class"].replace("Iris-virginica",1)
#data.to_csv("iris_data1.csv")
```

Question#1.2 for each label and feature compute statistical averages (from training set!) and put them in the following table:

In [124…

```
#versicolor_mean=data['petal -length'].loc[data['label'] == 0].mean()
mean_0=[]
mean_0.append(data.loc[(data["label"]==0),:]["petal -length"].mean())
```

```
mean_0.append(data.loc[(data["label"]==0),:]["petal -width"].mean())
mean_0.append(data.loc[(data["label"]==0),:]["sepal -length"].mean())
mean_0.append(data.loc[(data["label"]==0),:]["sepal -width"].mean())
sd_0=[]
sd_0.append(data.loc[(data["label"]==0),:]["petal -length"].std())
sd_0.append(data.loc[(data["label"]==0),:]["petal -width"].std())
sd_0.append(data.loc[(data["label"]==0),:]["sepal -length"].std())
sd_0.append(data.loc[(data["label"]==0),:]["sepal -width"].std())
mean_1=[]
mean_1.append(data.loc[(data["label"]==1),:]["petal -length"].mean())
mean_1.append(data.loc[(data["label"]==1),:]["petal -width"].mean())
mean_1.append(data.loc[(data["label"]==1),:]["sepal -length"].mean())
mean_1.append(data.loc[(data["label"]==1),:]["sepal -width"].mean())
sd_1=[]
sd_1.append(data.loc[(data["label"]==1),:]["petal -length"].std())
sd_1.append(data.loc[(data["label"]==1),:]["petal -width"].std())
sd_1.append(data.loc[(data["label"]==1),:]["sepal -length"].std())
sd_1.append(data.loc[(data["label"]==1),:]["sepal -width"].std())
mean_all=[]
mean_all.append(data["petal -length"].mean())
mean_all.append(data["petal -width"].mean())
mean_all.append(data["sepal -length"].mean())
mean_all.append(data["sepal -width"].mean())
sd_all=[]
sd_all.append(data.loc[(data["label"]==1),:]["petal -length"].std())
sd_all.append(data.loc[(data["label"]==1),:]["petal -width"].std())
sd_all.append(data.loc[(data["label"]==1),:]["sepal -length"].std())
sd_all.append(data.loc[(data["label"]==1),:]["sepal -width"].std())
Q1_d={"Feature":pd.Series(["Petal Lengh","Petal Width","Sepal Lengh","Sepal Wic
      "μ0":pd.Series(mean_0),
      "σ0":pd.Series(sd_0),
      "μ1":pd.Series(mean_1),
      "σ1":pd.Series(sd_1),
      "μall":pd.Series(mean_all),
      "σall":pd.Series(sd_all)}
Q1_df=pd.DataFrame(Q1_d)
print(Q1_df)
```

```
       Feature     μ0        σ0     μ1        σ1   μall      σall
0  Petal Lengh  4.260  0.469911  5.552  0.551895  4.906  0.551895
1  Petal Width  1.326  0.197753  2.026  0.274650  1.676  0.274650
2  Sepal Lengh  5.936  0.516171  6.588  0.635880  6.262  0.635880
3  Sepal Width  2.770  0.313798  2.974  0.322497  2.872  0.322497
```

Question# 1.3 for each class, compute the correlation matrix for your 4 features. Which features have the highest and lowest cor– relations?

In [124…

```
corrM=Q1_df.corr()
print(corrM)
```

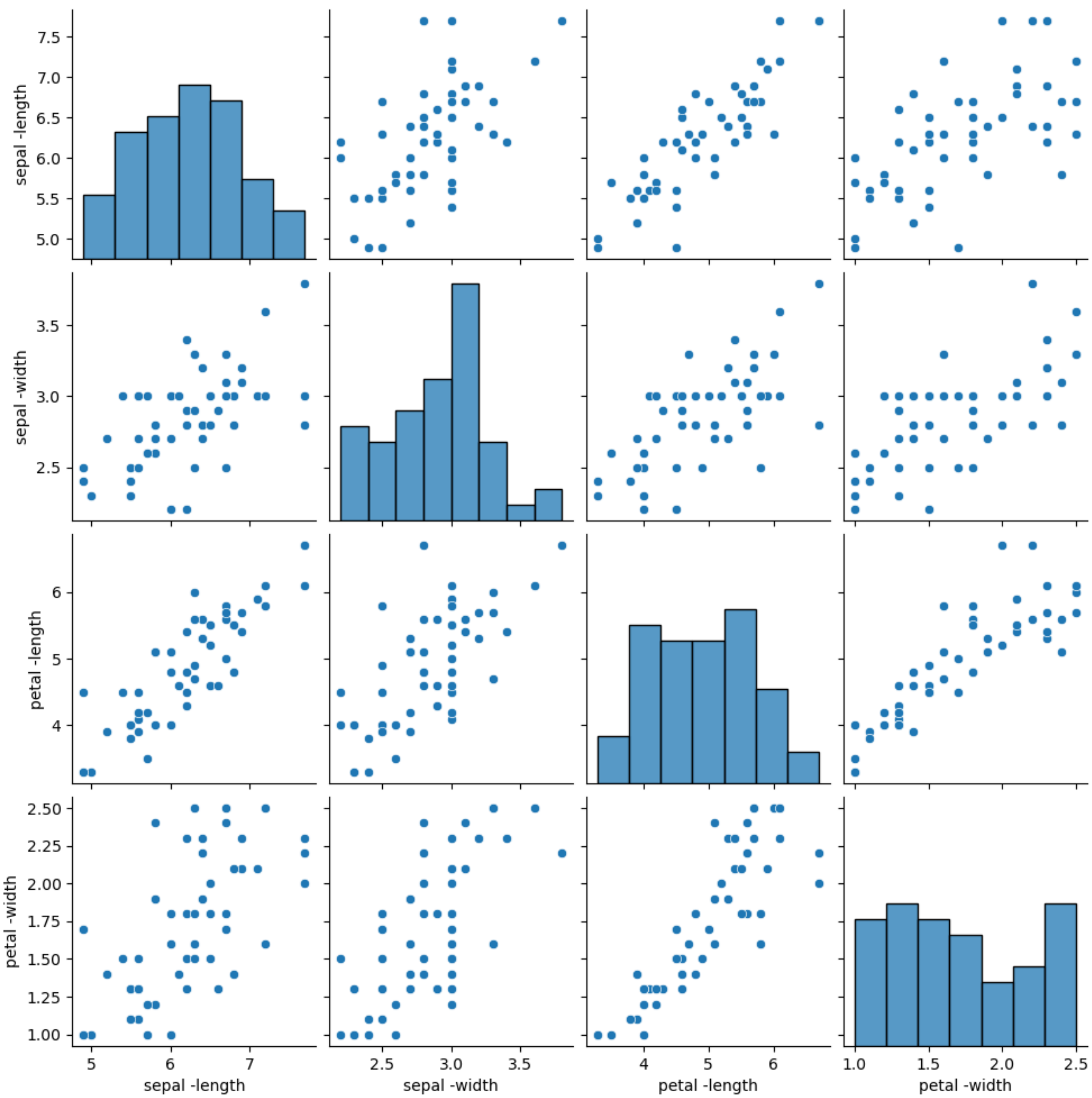
```
            μ0        σ0        μ1        σ1      μall      σall
μ0    1.000000  0.975090  0.979489  0.967863  0.994450  0.967863
σ0    0.975090  1.000000  0.987055  0.974510  0.986369  0.974510
μ1    0.979489  0.987055  1.000000  0.997539  0.995253  0.997539
σ1    0.967863  0.974510  0.997539  1.000000  0.988352  1.000000
μall  0.994450  0.986369  0.995253  0.988352  1.000000  0.988352
σall  0.967863  0.974510  0.997539  1.000000  0.988352  1.000000
```

Question#4. discuss your findings

Question#2.1generate histograms of pairwise relationships for a training set (include these histograms in submitted homework). X rain. You can use ”pairplot” method of the seaborn package:

In [124…

```
X = data[["sepal -length","sepal -width","petal -length","petal -width"]]
y = data["label"]
X_train,X_test,y_train,y_test=train_test_split(X, y, train_size=0.5)
features = ["sepal -length", "sepal -width",
"petal -length", "petal -width"]
pair_plot = sns.pairplot(X_train[features])
plt.show()
```



Question#2.2 examine the histograms and for each feature design a simple classifier (”weak learner”) for labels. Your classifier can only consist of simple comparison using that single feature. For example,

In [124…

```
from socket import TCP_NOTSENT_LOWAT

X_test["sepal_length_label"]=X_test["sepal -length"].apply(lambda x: 1 if x>dat
X_test["sepal_width_label"]=X_test["sepal -width"].apply(lambda x: 1 if x>data[
X_test["petal -length_label"]=X_test["petal -length"].apply(lambda x: 1 if x>da
X_test["petal -width_label"]=X_test["petal -width"].apply(lambda x: 1 if x>data
X_test.loc[:,"Ture_lable"]=y_test


#Ture Positive
TP_pl=X_test.loc[(X_test["petal -length_label"]==1)&(X_test["Ture_lable"]==1),:
TP_pw=X_test.loc[(X_test["petal -width_label"]==1)&(X_test["Ture_lable"]==1),:]
TP_sl=X_test.loc[(X_test["sepal_length_label"]==1)&(X_test["Ture_lable"]==1),:]
TP_sw=X_test.loc[(X_test["sepal_width_label"]==1)&(X_test["Ture_lable"]==1),:][

#False positive
FP_pl=X_test.loc[(X_test["petal -length_label"]==1)&(X_test["Ture_lable"]==0),:
FP_pw=X_test.loc[(X_test["petal -width_label"]==1)&(X_test["Ture_lable"]==0),:]
FP_sl=X_test.loc[(X_test["sepal_length_label"]==1)&(X_test["Ture_lable"]==0),:]
FP_sw=X_test.loc[(X_test["sepal_width_label"]==1)&(X_test["Ture_lable"]==0),:][

#Ture Negative
TN_pl=X_test.loc[(X_test["petal -length_label"]==0)&(X_test["Ture_lable"]==0),:
TN_pw=X_test.loc[(X_test["petal -width_label"]==0)&(X_test["Ture_lable"]==0),:]
TN_sl=X_test.loc[(X_test["sepal_length_label"]==0)&(X_test["Ture_lable"]==0),:]
TN_sw=X_test.loc[(X_test["sepal_width_label"]==0)&(X_test["Ture_lable"]==0),:][

#False Negative
FN_pl=X_test.loc[(X_test["petal -length_label"]==0)&(X_test["Ture_lable"]==1),:
FN_pw=X_test.loc[(X_test["petal -width_label"]==0)&(X_test["Ture_lable"]==1),:]
FN_sl=X_test.loc[(X_test["sepal_length_label"]==0)&(X_test["Ture_lable"]==1),:]
FN_sw=X_test.loc[(X_test["sepal_width_label"]==0)&(X_test["Ture_lable"]==1),:][

#Accuracy
ACC_pl=(TN_pl+TP_pl)/50
ACC_pw=(TN_pw+TP_pw)/50
ACC_sl=(TN_sl+TP_sl)/50
ACC_sw=(TN_sw+TP_sw)/50
#X_test['TP_pl'] = np.where((X_test['petal -length_label'] == 1)  & (X_test['Tu
#X_test.to_csv("x_test.csv")
Q2_d={"Classifier":pd.Series(["Petal Lengh","Petal Width","Sepal Lengh","Sepal 
      "TP":pd.Series([TP_pl,TP_pw,TP_sl,TP_sw]),
      "TN":pd.Series([TN_pl,TN_pw,TN_sl,TN_sw]),
      "FP":pd.Series([FP_pl,FP_pw,FP_sl,FP_sw]),
      "FN":pd.Series([FN_pl,FN_pw,FN_sl,FN_sw]),
      "ACC":pd.Series([ACC_pl,ACC_pw,ACC_sl,ACC_sw])}
Q2_df=pd.DataFrame(Q2_d)


print(Q2_df)
```

	Classifier	TP	TN	FP	FN	ACC
0	Petal Lengh	22	25	0	3	0.94
1	Petal Width	22	24	1	3	0.92
2	Sepal Lengh	14	18	7	11	0.64
3	Sepal Width	13	16	9	12	0.58

Question#2.3 discuss your findings and rank your ”weak” learners by ac– curacy (from most accurate to least accurate)

In [ ]:

Question#3.1 For each such ensemble classifier, split data into training and test. Apply your classifiers on testing data, compute confusion matrix and summarize the results in a table below (note that no training is done, we are just combining the ”weak” learners).

In [124…

```
data["sepal_length_label"]=data["sepal -length"].apply(lambda x: 1 if x>data["s
data["sepal_width_label"]=data["sepal -width"].apply(lambda x: 1 if x>data["sep
data["petal -length_label"]=data["petal -length"].apply(lambda x: 1 if x>data['
data["petal -width_label"]=data["petal -width"].apply(lambda x: 1 if x>data["pe

Q3_1_2_3=[]
for i in range(len(data)):
    if (data["sepal_length_label"][i+50]+data["sepal_width_label"][i+50]+data['
        Q3_1_2_3.append(1)
    else:
        Q3_1_2_3.append(0)
data["Q3_1_2_3"]=Q3_1_2_3

Q3_1_2_4=[]
for i in range(len(data)):
    if (data["sepal_length_label"][i+50]+data["sepal_width_label"][i+50]+data['
        Q3_1_2_4.append(1)
    else:
        Q3_1_2_4.append(0)
data["Q3_1_2_4"]=Q3_1_2_4

Q3_1_3_4=[]
for i in range(len(data)):
    if (data["sepal_length_label"][i+50]+data["petal -length_label"][i+50]+data
        Q3_1_3_4.append(1)
    else:
        Q3_1_3_4.append(0)
data["Q3_1_3_4"]=Q3_1_3_4

Q3_2_3_4=[]
for i in range(len(data)):
    if (data["sepal_width_label"][i+50]+data["petal -length_label"][i+50]+data[
        Q3_2_3_4.append(1)
    else:
        Q3_2_3_4.append(0)
data["Q3_2_3_4"]=Q3_2_3_4
#data.to_csv("Q3.csv")
```

```
#print(data)
```

In [124…

```
X3_1 = data[["sepal -length","sepal -width","petal -length","petal -width","Q3_
y3_1 = data["label"]
X3_1_train,X3_1_test,y3_1_train,y3_1_test=train_test_split(X3_1, y3_1, train_si
X3_1_test.loc[:,"Ture_lable"]=y3_1_test
X3_1_test.to_csv("Q3.csv")
TP_Q3_1_2_3=X3_1_test.loc[(X3_1_test["Q3_1_2_3"]==1)&(X3_1_test["Ture_lable"]==
FP_Q3_1_2_3=X3_1_test.loc[(X3_1_test["Q3_1_2_3"]==1)&(X3_1_test["Ture_lable"]==
TN_Q3_1_2_3=X3_1_test.loc[(X3_1_test["Q3_1_2_3"]==0)&(X3_1_test["Ture_lable"]==
FN_Q3_1_2_3=X3_1_test.loc[(X3_1_test["Q3_1_2_3"]==0)&(X3_1_test["Ture_lable"]==
ACC_Q3_1_2_3=(TN_Q3_1_2_3+TP_Q3_1_2_3)/50
# (TP_Q3_1_2_3,FP_Q3_1_2_3,TN_Q3_1_2_3,FN_Q3_1_2_3)
TP_Q3_1_2_4=X3_1_test.loc[(X3_1_test["Q3_1_2_4"]==1)&(X3_1_test["Ture_lable"]==
FP_Q3_1_2_4=X3_1_test.loc[(X3_1_test["Q3_1_2_4"]==1)&(X3_1_test["Ture_lable"]==
TN_Q3_1_2_4=X3_1_test.loc[(X3_1_test["Q3_1_2_4"]==0)&(X3_1_test["Ture_lable"]==
FN_Q3_1_2_4=X3_1_test.loc[(X3_1_test["Q3_1_2_4"]==0)&(X3_1_test["Ture_lable"]==
ACC_Q3_1_2_4=(TN_Q3_1_2_4+TP_Q3_1_2_4)/50
#print(TP_Q3_1_2_3,X3_1_test["Ture_lable"].sum())
TP_Q3_1_3_4=X3_1_test.loc[(X3_1_test["Q3_1_3_4"]==1)&(X3_1_test["Ture_lable"]==
FP_Q3_1_3_4=X3_1_test.loc[(X3_1_test["Q3_1_3_4"]==1)&(X3_1_test["Ture_lable"]==
TN_Q3_1_3_4=X3_1_test.loc[(X3_1_test["Q3_1_3_4"]==0)&(X3_1_test["Ture_lable"]==
FN_Q3_1_3_4=X3_1_test.loc[(X3_1_test["Q3_1_3_4"]==0)&(X3_1_test["Ture_lable"]==
ACC_Q3_1_3_4=(TN_Q3_1_3_4+TP_Q3_1_3_4)/50

TP_Q3_2_3_4=X3_1_test.loc[(X3_1_test["Q3_2_3_4"]==1)&(X3_1_test["Ture_lable"]==
FP_Q3_2_3_4=X3_1_test.loc[(X3_1_test["Q3_2_3_4"]==1)&(X3_1_test["Ture_lable"]==
TN_Q3_2_3_4=X3_1_test.loc[(X3_1_test["Q3_2_3_4"]==0)&(X3_1_test["Ture_lable"]==
FN_Q3_2_3_4=X3_1_test.loc[(X3_1_test["Q3_2_3_4"]==0)&(X3_1_test["Ture_lable"]==
ACC_Q3_2_3_4=(TN_Q3_2_3_4+TP_Q3_2_3_4)/50

Q3_d={"Classifier":pd.Series(["(1),(2),(3)","(1),(2),(4)","(1),(3),(4)","(2),(3
      "TP":pd.Series([TP_Q3_1_2_3,TP_Q3_1_2_4,TP_Q3_1_3_4,TP_Q3_2_3_4]),
      "TN":pd.Series([TN_Q3_1_2_3,TN_Q3_1_2_4,TN_Q3_1_3_4,FP_Q3_2_3_4]),
      "FP":pd.Series([FP_Q3_1_2_3,FP_Q3_1_2_4,FP_Q3_1_3_4,FN_Q3_2_3_4]),
      "FN":pd.Series([FN_Q3_1_2_3,FN_Q3_1_2_4,FN_Q3_1_3_4,FN_Q3_2_3_4]),
      "ACC":pd.Series([ACC_Q3_1_2_3,ACC_Q3_1_2_4,ACC_Q3_1_3_4,ACC_Q3_2_3_4])}
Q3_df=pd.DataFrame(Q3_d)
print(Q3_df)
```

```
    Classifier  TP  TN  FP  FN   ACC
0  (1),(2),(3)  21  18   3   8  0.78
1  (1),(2),(4)  22  18   3   7  0.80
2  (1),(3),(4)  24  21   0   5  0.90
3  (2),(3),(4)  25   0   4   4  0.92
```

Question# 3.2 discuss your findings and rank your ensembles learners by accuracy (from most accurate to least accurate

Question# 3.3 compare ”weak learners” and ensemble results.

Question#4.1 you design 4 such density-based classfiers, one for each of the 4 features. For each classifier, compute the confusion matrix (from a testing set! as before) and summarize them in a table below

In [124…

```
from scipy.stats import norm
Q4_X = data[["sepal -length","sepal -width","petal -length","petal -width","lab
Q4_y = data["label"]
Q4_X_train,Q4_X_test,Q4_y_train,Q4_y_test=train_test_split(Q4_X, Q4_y, train_si
#print(Q4_X_train)
Q4_1_mu_sl=Q4_X_train["sepal -length"].loc[Q4_X_train['label'] == 1].mean()
Q4_0_mu_sl=Q4_X_train["sepal -length"].loc[Q4_X_train['label'] == 0].mean()
Q4_1_mu_sw=Q4_X_train["sepal -width"].loc[Q4_X_train['label'] == 1].mean()
Q4_0_mu_sw=Q4_X_train["sepal -width"].loc[Q4_X_train['label'] == 0].mean()
Q4_1_mu_pl=Q4_X_train["petal -length"].loc[Q4_X_train['label'] == 1].mean()
Q4_0_mu_pl=Q4_X_train["petal -length"].loc[Q4_X_train['label'] == 0].mean()
Q4_1_mu_pw=Q4_X_train["petal -width"].loc[Q4_X_train['label'] == 1].mean()
Q4_0_mu_pw=Q4_X_train["petal -width"].loc[Q4_X_train['label'] == 0].mean()
Q4_1_std_sl=Q4_X_train["sepal -length"].loc[Q4_X_train['label'] == 1].std()
Q4_0_std_sl=Q4_X_train["sepal -length"].loc[Q4_X_train['label'] == 0].std()
Q4_1_std_sw=Q4_X_train["sepal -width"].loc[Q4_X_train['label'] == 1].std()
Q4_0_std_sw=Q4_X_train["sepal -width"].loc[Q4_X_train['label'] == 0].std()
Q4_1_std_pl=Q4_X_train["petal -length"].loc[Q4_X_train['label'] == 1].std()
Q4_0_std_pl=Q4_X_train["petal -length"].loc[Q4_X_train['label'] == 0].std()
Q4_1_std_pw=Q4_X_train["petal -width"].loc[Q4_X_train['label'] == 1].std()
Q4_0_std_pw=Q4_X_train["petal -width"].loc[Q4_X_train['label'] == 0].std()

#print(Q4_X_test,"\n",Q4_X_test.iloc[[0],[1]])
Q4_petal_length=[]
for i in range(len(Q4_X_test)):
    P_0=norm.pdf((Q4_X_test.iloc[[i],[2]] - Q4_0_mu_pl)/Q4_0_std_pl)
    P_1=norm.pdf((Q4_X_test.iloc[[i],[2]] - Q4_1_mu_pl)/Q4_1_std_pl)
    if P_0>P_1:
        Q4_petal_length.append(0)
    else:
        Q4_petal_length.append(1)
Q4_X_test["pl_label"]=Q4_petal_length

Q4_petal_width=[]
for i in range(len(Q4_X_test)):
    P_0=norm.pdf((Q4_X_test.iloc[[i],[3]] - Q4_0_mu_pw)/Q4_0_std_pw)
    P_1=norm.pdf((Q4_X_test.iloc[[i],[3]] - Q4_1_mu_pw)/Q4_1_std_pw)
    if P_0>P_1:
        Q4_petal_width.append(0)
    else:
        Q4_petal_width.append(1)
Q4_X_test["pw_label"]=Q4_petal_width

Q4_sepal_length=[]
for i in range(len(Q4_X_test)):
    P_0=norm.pdf((Q4_X_test.iloc[[i],[0]] - Q4_0_mu_sl)/Q4_0_std_sl)
    P_1=norm.pdf((Q4_X_test.iloc[[i],[0]] - Q4_1_mu_sl)/Q4_1_std_sl)
    if P_0>P_1:
        Q4_sepal_length.append(0)
    else:
        Q4_sepal_length.append(1)
Q4_X_test["sl_label"]=Q4_sepal_length
```

```
Q4_sepal_width=[]
for i in range(len(Q4_X_test)):
    P_0=norm.pdf((Q4_X_test.iloc[[i],[1]] - Q4_0_mu_sw)/Q4_0_std_sw)
    P_1=norm.pdf((Q4_X_test.iloc[[i],[1]] - Q4_1_mu_sw)/Q4_1_std_sw)
    if P_0>P_1:
        Q4_sepal_width.append(0)
    else:
        Q4_sepal_width.append(1)
Q4_X_test["sw_label"]=Q4_sepal_width
Q4_X_test.to_csv("Q4.csv")
#print(Q4_X_test)
#Ture Positive
Q4_TP_pl=Q4_X_test.loc[(Q4_X_test["pl_label"]==1)&(Q4_X_test["label"]==1),:]["l
Q4_TP_pw=Q4_X_test.loc[(Q4_X_test["pw_label"]==1)&(Q4_X_test["label"]==1),:]["l
Q4_TP_sl=Q4_X_test.loc[(Q4_X_test["sl_label"]==1)&(Q4_X_test["label"]==1),:]["l
Q4_TP_sw=Q4_X_test.loc[(Q4_X_test["sw_label"]==1)&(Q4_X_test["label"]==1),:]["l


#False Positive
Q4_FP_pl=Q4_X_test.loc[(Q4_X_test["pl_label"]==1)&(Q4_X_test["label"]==0),:]["l
Q4_FP_pw=Q4_X_test.loc[(Q4_X_test["pw_label"]==1)&(Q4_X_test["label"]==0),:]["l
Q4_FP_sl=Q4_X_test.loc[(Q4_X_test["sl_label"]==1)&(Q4_X_test["label"]==0),:]["l
Q4_FP_sw=Q4_X_test.loc[(Q4_X_test["sw_label"]==1)&(Q4_X_test["label"]==0),:]["l


#True Negative
Q4_TN_pl=Q4_X_test.loc[(Q4_X_test["pl_label"]==0)&(Q4_X_test["label"]==0),:]["l
Q4_TN_pw=Q4_X_test.loc[(Q4_X_test["pw_label"]==0)&(Q4_X_test["label"]==0),:]["l
Q4_TN_sl=Q4_X_test.loc[(Q4_X_test["sl_label"]==0)&(Q4_X_test["label"]==0),:]["l
Q4_TN_sw=Q4_X_test.loc[(Q4_X_test["sw_label"]==0)&(Q4_X_test["label"]==0),:]["l

#False Negative
Q4_FN_pl=Q4_X_test.loc[(Q4_X_test["pl_label"]==0)&(Q4_X_test["label"]==0),:]["l
Q4_FN_pw=Q4_X_test.loc[(Q4_X_test["pw_label"]==0)&(Q4_X_test["label"]==0),:]["l
Q4_FN_sl=Q4_X_test.loc[(Q4_X_test["sl_label"]==0)&(Q4_X_test["label"]==0),:]["l
Q4_FN_sw=Q4_X_test.loc[(Q4_X_test["sw_label"]==0)&(Q4_X_test["label"]==0),:]["l
#Accuracy
Q4_ACC_pl=(Q4_TN_pl+Q4_TP_pl)/50
Q4_ACC_pw=(Q4_TN_pw+Q4_TP_pw)/50
Q4_ACC_sl=(Q4_TN_sl+Q4_TP_sl)/50
Q4_ACC_sw=(Q4_TN_sw+Q4_TP_sw)/50

Q4_d={"Classifier":pd.Series(["(1) Petal Lengh","(2) Petal Width","(3) Sepal Le
      "TP":pd.Series([Q4_TP_pl,Q4_TP_pw,Q4_FP_sl,Q4_FP_sw]),
      "TN":pd.Series([Q4_TN_pl,Q4_TN_pw,Q4_TN_sl,Q4_TN_sw]),
      "FP":pd.Series([Q4_FP_pl,Q4_FP_pw,Q4_FP_sl,Q4_FP_sw]),
      "FN":pd.Series([Q4_FN_pl,Q4_FN_pw,Q4_FN_sl,Q4_FN_sw]),
      "ACC":pd.Series([Q4_ACC_pl,Q4_ACC_pw,Q4_ACC_sl,Q4_ACC_sw])}
Q4_df=pd.DataFrame(Q4_d)
print(Q4_df)
```

```
        Classifier  TP  TN  FP  FN   ACC
0  (1) Petal Lengh  21  26   2  26  0.94
1  (2) Petal Width  21  27   1  27  0.96
2  (3) Sepal Lengh   5  23   5  23  0.86
3  (4) Sepal Width  11  17  11  17  0.68
```

Question#4.2 discuss your findings and rank your density-based ” weak” learners by accuracy (from most accurate to least accurate

In [ ]:

Question#5.1 For each such ensemble classifier, compute confusion matrix (on testing data!) and summarize the results in a table below

In [124…

```
Q5_1_mu_sl=data["sepal -length"].loc[data['label'] == 1].mean()
Q5_0_mu_sl=data["sepal -length"].loc[data['label'] == 0].mean()
Q5_1_mu_sw=data["sepal -width"].loc[data['label'] == 1].mean()
Q5_0_mu_sw=data["sepal -width"].loc[data['label'] == 0].mean()
Q5_1_mu_pl=data["petal -length"].loc[data['label'] == 1].mean()
Q5_0_mu_pl=data["petal -length"].loc[data['label'] == 0].mean()
Q5_1_mu_pw=data["petal -width"].loc[data['label'] == 1].mean()
Q5_0_mu_pw=data["petal -width"].loc[data['label'] == 0].mean()
Q5_1_std_sl=data["sepal -length"].loc[data['label'] == 1].std()
Q5_0_std_sl=data["sepal -length"].loc[data['label'] == 0].std()
Q5_1_std_sw=data["sepal -width"].loc[data['label'] == 1].std()
Q5_0_std_sw=data["sepal -width"].loc[data['label'] == 0].std()
Q5_1_std_pl=data["petal -length"].loc[data['label'] == 1].std()
Q5_0_std_pl=data["petal -length"].loc[data['label'] == 0].std()
Q5_1_std_pw=data["petal -width"].loc[data['label'] == 1].std()
Q5_0_std_pw=data["petal -width"].loc[data['label'] == 0].std()

Q5_petal_length=[]
for i in range(len(Q5_data)):
    P_0=norm.pdf((Q5_data.iloc[[i],[2]] - Q5_0_mu_pl)/Q5_0_std_pl)
    P_1=norm.pdf((Q5_data.iloc[[i],[2]] - Q5_1_mu_pl)/Q5_1_std_pl)
    if P_0>P_1:
        Q5_petal_length.append(0)
    else:
        Q5_petal_length.append(1)
Q5_data["pl_label"]=Q5_petal_length

Q5_petal_width=[]
for i in range(len(Q5_data)):
    P_0=norm.pdf((Q5_data.iloc[[i],[3]] - Q5_0_mu_pw)/Q5_0_std_pw)
    P_1=norm.pdf((Q5_data.iloc[[i],[3]] - Q5_1_mu_pw)/Q5_1_std_pw)
    if P_0>P_1:
        Q5_petal_width.append(0)
    else:
        Q5_petal_width.append(1)
Q5_data["pw_label"]=Q5_petal_width

Q5_sepal_length=[]
for i in range(len(Q5_data)):
    P_0=norm.pdf((Q5_data.iloc[[i],[0]] - Q5_0_mu_sl)/Q5_0_std_sl)
    P_1=norm.pdf((Q5_data.iloc[[i],[0]] - Q5_1_mu_sl)/Q5_1_std_sl)
    if P_0>P_1:
        Q5_sepal_length.append(0)
    else:
        Q5_sepal_length.append(1)
Q5_data["sl_label"]=Q5_sepal_length

Q5_sepal_width=[]
for i in range(len(Q5_data)):
    P_0=norm.pdf((Q5_data.iloc[[i],[1]] - Q5_0_mu_sw)/Q5_0_std_sw)
    P_1=norm.pdf((Q5_data.iloc[[i],[1]] - Q5_1_mu_sw)/Q5_1_std_sw)
```

```
    if P_0>P_1:
        Q5_sepal_width.append(0)
    else:
        Q5_sepal_width.append(1)
Q5_data["sw_label"]=Q5_sepal_width


######################
Q5_data["sepal_length_label"]=Q5_data["sepal -length"].apply(lambda x: 1 if x>d
Q5_data["sepal_width_label"]=Q5_data["sepal -width"].apply(lambda x: 1 if x>dat
Q5_data["petal -length_label"]=Q5_data["petal -length"].apply(lambda x: 1 if x>
Q5_data["petal -width_label"]=Q5_data["petal -width"].apply(lambda x: 1 if x>da

Q5_1_2_3=[]
for i in range(len(Q5_data)):
    if (Q5_data["sepal_length_label"][i+50]+Q5_data["sepal_width_label"][i+50]+
        Q5_1_2_3.append(1)
    else:
        Q5_1_2_3.append(0)
Q5_data["Q3_1_2_3"]=Q5_1_2_3

Q5_1_2_4=[]
for i in range(len(Q5_data)):
    if (Q5_data["sepal_length_label"][i+50]+Q5_data["sepal_width_label"][i+50]+
        Q5_1_2_4.append(1)
    else:
        Q5_1_2_4.append(0)
Q5_data["Q3_1_2_4"]=Q5_1_2_4

Q5_1_3_4=[]
for i in range(len(Q5_data)):
    if (Q5_data["sepal_length_label"][i+50]+Q5_data["petal -length_label"][i+50
        Q5_1_3_4.append(1)
    else:
        Q5_1_3_4.append(0)
Q5_data["Q3_1_3_4"]=Q5_1_3_4

Q5_2_3_4=[]
for i in range(len(Q5_data)):
    if (Q5_data["sepal_width_label"][i+50]+Q5_data["petal -length_label"][i+50]
        Q5_2_3_4.append(1)
    else:
        Q5_2_3_4.append(0)
Q5_data["Q3_2_3_4"]=Q5_2_3_4

######################

X5_1 = Q5_data[["sepal -length","sepal -width","petal -length","petal -width","
y5_1 = Q5_data["label"]
X5_1_train,X5_1_test,y5_1_train,y5_1_test=train_test_split(X5_1, y5_1, train_si
X5_1_test.loc[:,"Ture_lable"]=y5_1_test
X5_1_test.to_csv("Q3.csv")
TP_Q5_1_2_3=X5_1_test.loc[(X5_1_test["Q3_1_2_3"]==1)&(X5_1_test["Ture_lable"]==
FP_Q5_1_2_3=X5_1_test.loc[(X5_1_test["Q3_1_2_3"]==1)&(X5_1_test["Ture_lable"]==
TN_Q5_1_2_3=X5_1_test.loc[(X5_1_test["Q3_1_2_3"]==0)&(X5_1_test["Ture_lable"]==
FN_Q5_1_2_3=X5_1_test.loc[(X5_1_test["Q3_1_2_3"]==0)&(X5_1_test["Ture_lable"]==
ACC_Q5_1_2_3=(TN_Q5_1_2_3+TP_Q5_1_2_3)/50
# (TP_Q3_1_2_3,FP_Q3_1_2_3,TN_Q3_1_2_3,FN_Q3_1_2_3)
TP_Q5_1_2_4=X5_1_test.loc[(X5_1_test["Q3_1_2_4"]==1)&(X5_1_test["Ture_lable"]==
FP_Q5_1_2_4=X5_1_test.loc[(X5_1_test["Q3_1_2_4"]==1)&(X5_1_test["Ture_lable"]==
```

```
TN_Q5_1_2_4=X5_1_test.loc[(X5_1_test["Q3_1_2_4"]==0)&(X5_1_test["Ture_lable"]==
FN_Q5_1_2_4=X5_1_test.loc[(X5_1_test["Q3_1_2_4"]==0)&(X5_1_test["Ture_lable"]==
ACC_Q5_1_2_4=(TN_Q5_1_2_4+TP_Q5_1_2_4)/50
#print(TP_Q3_1_2_3,X3_1_test["Ture_lable"].sum())
TP_Q5_1_3_4=X5_1_test.loc[(X5_1_test["Q3_1_3_4"]==1)&(X5_1_test["Ture_lable"]==
FP_Q5_1_3_4=X5_1_test.loc[(X5_1_test["Q3_1_3_4"]==1)&(X5_1_test["Ture_lable"]==
TN_Q5_1_3_4=X5_1_test.loc[(X5_1_test["Q3_1_3_4"]==0)&(X5_1_test["Ture_lable"]==
FN_Q5_1_3_4=X5_1_test.loc[(X5_1_test["Q3_1_3_4"]==0)&(X5_1_test["Ture_lable"]==
ACC_Q5_1_3_4=(TN_Q5_1_3_4+TP_Q5_1_3_4)/50

TP_Q5_2_3_4=X5_1_test.loc[(X5_1_test["Q3_2_3_4"]==1)&(X5_1_test["Ture_lable"]==
FP_Q5_2_3_4=X5_1_test.loc[(X5_1_test["Q3_2_3_4"]==1)&(X5_1_test["Ture_lable"]==
TN_Q5_2_3_4=X5_1_test.loc[(X5_1_test["Q3_2_3_4"]==0)&(X5_1_test["Ture_lable"]==
FN_Q5_2_3_4=X5_1_test.loc[(X5_1_test["Q3_2_3_4"]==0)&(X5_1_test["Ture_lable"]==
ACC_Q5_2_3_4=(TN_Q5_2_3_4+TP_Q5_2_3_4)/50


Q5_d={"Classifier":pd.Series(["(1),(2),(3)","(1),(2),(4)","(1),(3),(4)","(2),(3
      "TP":pd.Series([TP_Q5_1_2_3,TP_Q5_1_2_4,TP_Q5_1_3_4,TP_Q5_2_3_4]),
      "TN":pd.Series([TN_Q5_1_2_3,TN_Q5_1_2_4,TN_Q5_1_3_4,FP_Q5_2_3_4]),
      "FP":pd.Series([FP_Q5_1_2_3,FP_Q5_1_2_4,FP_Q5_1_3_4,FN_Q5_2_3_4]),
      "FN":pd.Series([FN_Q5_1_2_3,FN_Q5_1_2_4,FN_Q5_1_3_4,FN_Q5_2_3_4]),
      "ACC":pd.Series([ACC_Q5_1_2_3,ACC_Q5_1_2_4,ACC_Q5_1_3_4,ACC_Q5_2_3_4])}
Q5_df=pd.DataFrame(Q5_d)
print(Q5_df)
```

```
    Classifier  TP  TN  FP  FN   ACC
0  (1),(2),(3)  15  22   5   8  0.74
1  (1),(2),(4)  17  21   6   6  0.76
2  (1),(3),(4)  18  26   1   5  0.88
3  (2),(3),(4)  20   2   3   3  0.90
```

5.2 discuss your findings and rank your ensembles learners by accuracy (from most accurate to least accurate)

Question#5.3 compare ”weak learners” and ensemble results.

Question#1. give a quick summary on comparing classifiers in Method I and Method II