In [ ]:
```
#Data exploration:
from sklearn import datasets
data = datasets.load_iris(return_X_y=False,as_frame=True)
print(data.data.head())
features_name=data.feature_names
```

```
   sepal length (cm)  sepal width (cm)  petal length (cm)  petal width (cm)
0                5.1               3.5                1.4               0.2
1                4.9               3.0                1.4               0.2
2                4.7               3.2                1.3               0.2
3                4.6               3.1                1.5               0.2
4                5.0               3.6                1.4               0.2
```

In [ ]:
```
#statistical analysis
features=data.data
classes=data.target_names
target=data.target
Iris=features.copy()
Iris['target']=target
Iris.describe()
```

Out[ ]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target
count	150.000000	150.000000	150.000000	150.000000	150.000000
mean	5.843333	3.057333	3.758000	1.199333	1.000000
std	0.828066	0.435866	1.765298	0.762238	0.819232
min	4.300000	2.000000	1.000000	0.100000	0.000000
25%	5.100000	2.800000	1.600000	0.300000	0.000000
50%	5.800000	3.000000	4.350000	1.300000	1.000000
75%	6.400000	3.300000	5.100000	1.800000	2.000000
max	7.900000	4.400000	6.900000	2.500000	2.000000

In [ ]:
```
#explore 3 classes
classes
```

Out[ ]:
```
array(['setosa', 'versicolor', 'virginica'], dtype='<U10')
```

In [ ]:
```
features_name
```

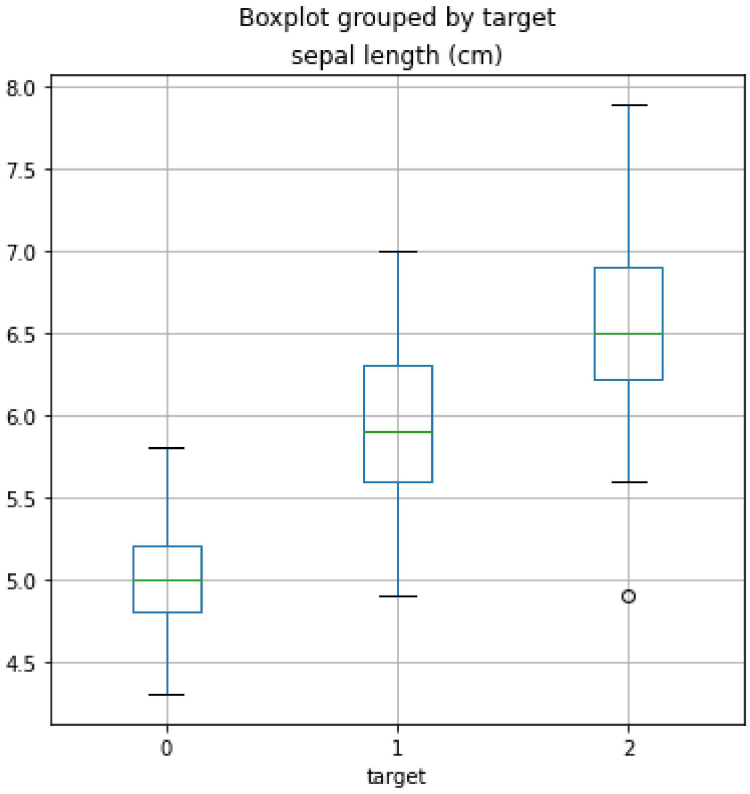
Out[ ]:
```
['sepal length (cm)',
 'sepal width (cm)',
 'petal length (cm)',
 'petal width (cm)']
```

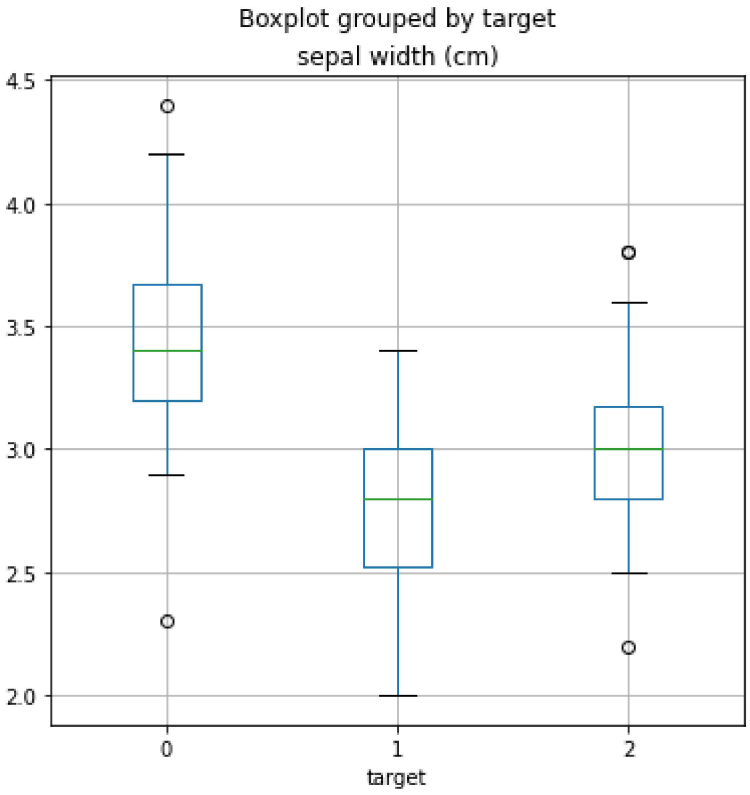
In [ ]:
```
Iris.info()
```

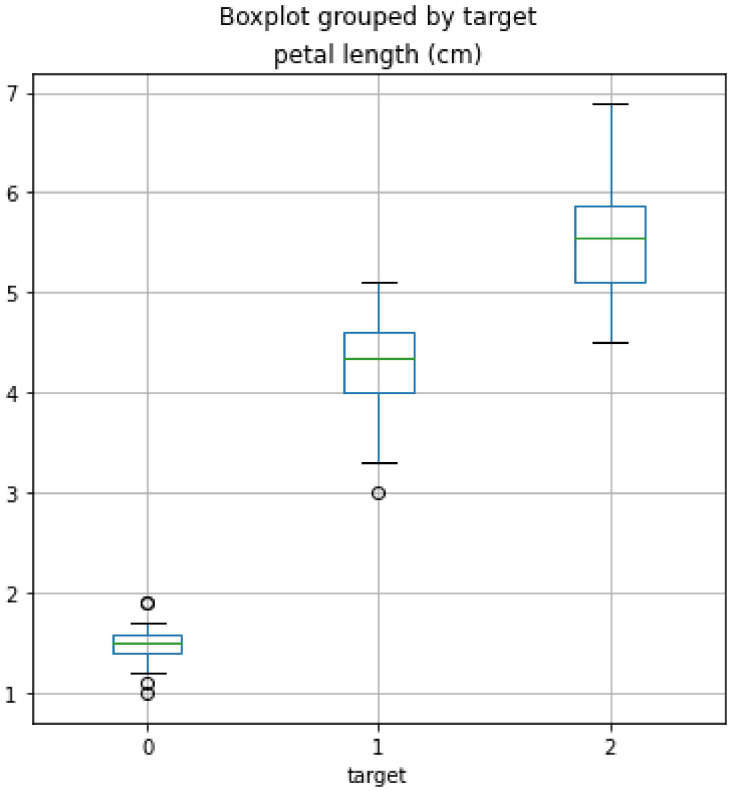
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   sepal length (cm)  150 non-null    float64
 1   sepal width (cm)   150 non-null    float64
 2   petal length (cm)  150 non-null    float64
 3   petal width (cm)   150 non-null    float64
 4   target             150 non-null    int32  
dtypes: float64(4), int32(1)
memory usage: 5.4 KB
```

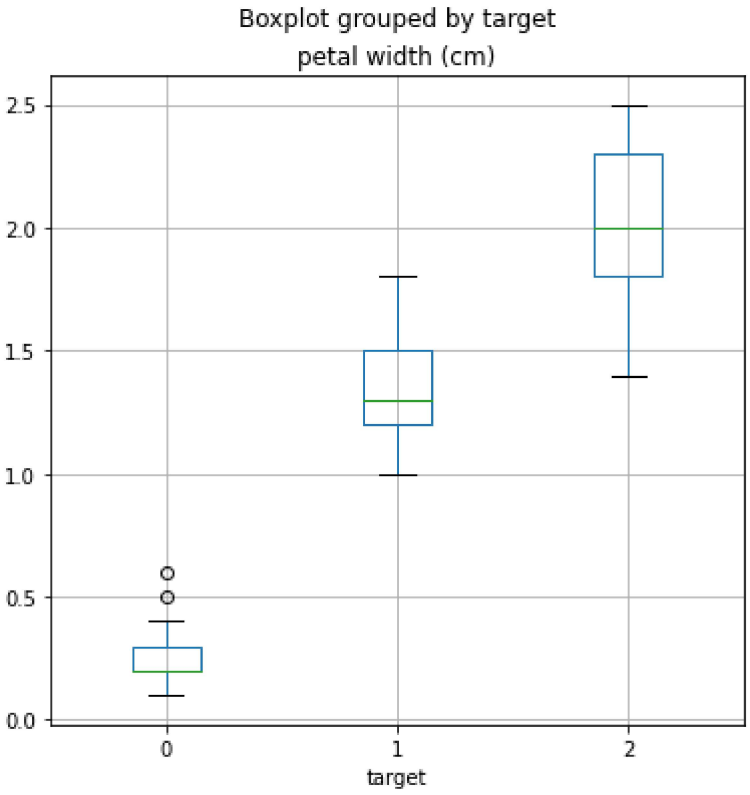
In [ ]:

```
#plot each feature among the 3 categorical classes:
from matplotlib import pyplot as plt
#print(Iris.head())
for col in features_name:
    Iris.boxplot(column=col,by='target', figsize=(6,6))
    plt.title(col)
    plt.show()
```




Boxplot grouped by target
sepal width (cm)
4.5
4.0
3.5
3.0
2.5
2.0
0
1
2
target


Boxplot grouped by target
petal length (cm)
7
6
5
4
3
2
1
0
1
2
target



In [ ]:
```
#check data imbalanced:
Iris.groupby('target').count()
```

Out[ ]:

target	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)
0	50	50	50	50
1	50	50	50	50
2	50	50	50	50

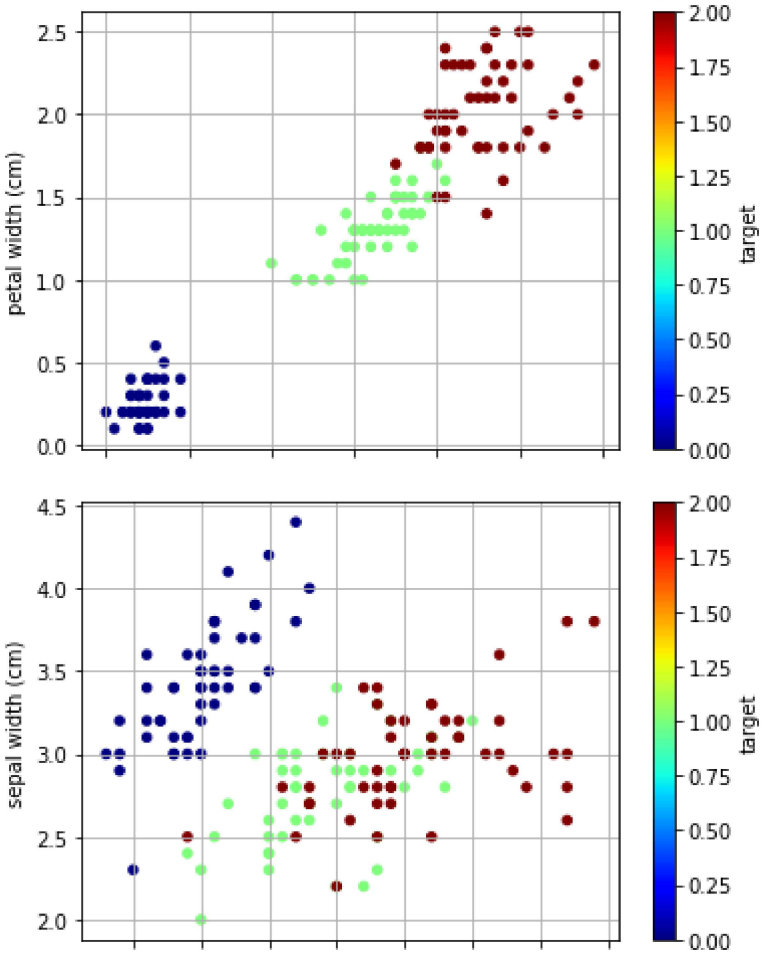
In [ ]:
```
#check data Imbalanced
Iris['target'].value_counts()
```

Out[ ]:
```
0    50
1    50
2    50
Name: target, dtype: int64
```

In [ ]:
```
Iris.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 150 entries, 0 to 149
Data columns (total 5 columns):
 #   Column             Non-Null Count  Dtype  
---  ------             --------------  -----  
 0   sepal length (cm)  150 non-null    float64
 1   sepal width (cm)   150 non-null    float64
 2   petal length (cm)  150 non-null    float64
 3   petal width (cm)   150 non-null    float64
 4   target             150 non-null    int32  
dtypes: float64(4), int32(1)
memory usage: 5.4 KB
```

In [ ]:
```
#represent the dataset for each class clustering :
Iris.plot(kind='scatter',x='petal length (cm)',y='petal width (cm)',grid=True,c='targe
plt.show()
Iris.plot(kind='scatter',x='sepal length (cm)',y='sepal width (cm)',grid=True,c='targe
plt.show()
```



In [ ]:
```
#split the data for training and testing
from sklearn.model_selection import train_test_split
X=features
y=target
Xtrain,Xtest,ytrain,ytest=train_test_split( X,y, test_size=0.2,random_state=42,shuffle
Xtrain.shape
```

Out[ ]:
```
(120, 4)
```

```
Xtest.shape
```

In [ ]:

Out[ ]:
```
(30, 4)
```

In [ ]:
```
from sklearn.linear_model import SGDClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import LinearSVC
from sklearn.svm import SVC
from sklearn.ensemble import VotingClassifier
clf={
    'SGDClassifier':SGDClassifier(random_state=42,alpha=.01,max_iter=2000,tol=.0001,lo
    'KNeighborsClassifier':KNeighborsClassifier(n_neighbors=3),
    'DecisionTreeClassifier':DecisionTreeClassifier(random_state=42,max_features=3),
    'RandomForestClassifier':RandomForestClassifier(random_state=42,max_features=3),
    'LinearSVC':LinearSVC(random_state=42,max_iter=2000,multi_class="crammer_singer",C
    'SVC':  SVC(C=3,max_iter=2000),
    #'VotingClassifier':VotingClassifier()
}
```

In [ ]:
```
#calculate the score for multible models and find the best estimator:
from sklearn.model_selection import cross_val_score
import numpy as np
results=[]
for key in clf.keys():
    score=cross_val_score(clf[key], Xtrain, ytrain, scoring="accuracy", cv=3)
    results.append((key,score.mean()*100))
print('models scores:',results)
best_model_idx=np.array(results)[:,1].argmax()
print('best model:',results[best_model_idx][0],results[best_model_idx][1].round(1))
```

```
models scores: [('SGDClassifier', 94.16666666666667), ('KNeighborsClassifier', 95.0),
('DecisionTreeClassifier', 93.33333333333333), ('RandomForestClassifier', 95.0), ('Li
nearSVC', 97.5), ('SVC', 95.0)]
best model: LinearSVC 97.5
```

```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
```

In [ ]:
```
#test the linear svc on test dataset
score=cross_val_score(clf['LinearSVC'], Xtest, ytest, scoring="accuracy", cv=3)
score.mean()
```

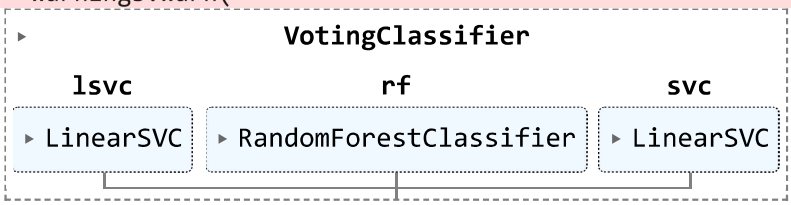
```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
```

Out[ ]:
```
1.0
```

In [ ]:
```
#try the voting classifier model for the highest 3 models :
eclf = VotingClassifier([("lsvc", clf['LinearSVC']), ("rf", clf['RandomForestClassifie
     ("svc", clf['LinearSVC'])])
eclf.fit(Xtrain, ytrain)
```

```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
```

Out[ ]:



In [ ]:
```
eclf.get_params()
```

Out[ ]:
```
{'estimators': [('lsvc',
   LinearSVC(C=3, max_iter=2000, multi_class='crammer_singer', random_state=42)),
  ('rf', RandomForestClassifier(max_features=3, random_state=42)),
  ('svc',
   LinearSVC(C=3, max_iter=2000, multi_class='crammer_singer', random_state=42))],
 'flatten_transform': True,
 'n_jobs': None,
 'verbose': False,
 'voting': 'hard',
 'weights': None,
 'lsvc': LinearSVC(C=3, max_iter=2000, multi_class='crammer_singer', random_state=4
2),
 'rf': RandomForestClassifier(max_features=3, random_state=42),
 'svc': LinearSVC(C=3, max_iter=2000, multi_class='crammer_singer', random_state=42),
 'lsvc__C': 3,
 'lsvc__class_weight': None,
 'lsvc__dual': True,
 'lsvc__fit_intercept': True,
 'lsvc__intercept_scaling': 1,
 'lsvc__loss': 'squared_hinge',
 'lsvc__max_iter': 2000,
 'lsvc__multi_class': 'crammer_singer',
 'lsvc__penalty': 'l2',
 'lsvc__random_state': 42,
 'lsvc__tol': 0.0001,
 'lsvc__verbose': 0,
 'rf__bootstrap': True,
 'rf__ccp_alpha': 0.0,
 'rf__class_weight': None,
 'rf__criterion': 'gini',
 'rf__max_depth': None,
 'rf__max_features': 3,
 'rf__max_leaf_nodes': None,
 'rf__max_samples': None,
 'rf__min_impurity_decrease': 0.0,
 'rf__min_samples_leaf': 1,
 'rf__min_samples_split': 2,
 'rf__min_weight_fraction_leaf': 0.0,
 'rf__n_estimators': 100,
 'rf__n_jobs': None,
 'rf__oob_score': False,
 'rf__random_state': 42,
 'rf__verbose': 0,
 'rf__warm_start': False,
 'svc__C': 3,
 'svc__class_weight': None,
 'svc__dual': True,
 'svc__fit_intercept': True,
 'svc__intercept_scaling': 1,
 'svc__loss': 'squared_hinge',
 'svc__max_iter': 2000,
 'svc__multi_class': 'crammer_singer',
 'svc__penalty': 'l2',
 'svc__random_state': 42,
 'svc__tol': 0.0001,
 'svc__verbose': 0}
```

In [ ]:
```
#find the score(accuracy)
score=cross_val_score(eclf,Xtrain,ytrain,scoring='accuracy',cv=3)
```

```python
accuracy=score.mean()*100
print('accuracy percentage:',accuracy)
```

```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
accuracy percentage: 97.5
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
```

In [ ]:

```python
#find confusuin matrix for the three classes

from sklearn.model_selection import cross_val_predict
from sklearn.metrics import confusion_matrix


ytrain_pred = cross_val_predict(eclf, Xtrain, ytrain, cv=3)
cm = confusion_matrix(ytrain, ytrain_pred)
cm
```

```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
```

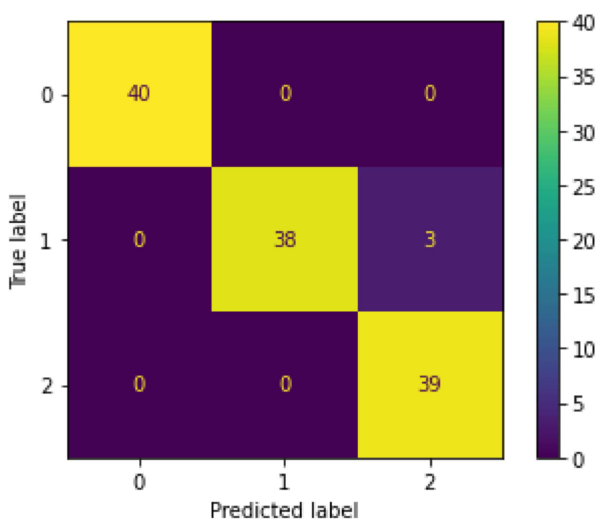
Out[ ]:

```
array([[40,  0,  0],
       [ 0, 38,  3],
       [ 0,  0, 39]], dtype=int64)
```

In [ ]:

```
#plot confusuin matrix for the three classes
from sklearn.metrics import ConfusionMatrixDisplay

ConfusionMatrixDisplay.from_predictions(ytrain, ytrain_pred)
plt.show()
```



In [ ]:

```
#precision
from sklearn.metrics import precision_score, recall_score

precision_score(ytrain, ytrain_pred,average='macro')
```

Out[ ]:

```
0.9761904761904763
```

In [ ]:

```
#recall
```

```
recall_score(ytrain, ytrain_pred,average='macro')
```

Out[ ]: 0.975609756097561

In [ ]:
```
#find f1score:
from sklearn.metrics import f1_score

f1_score(ytrain, ytrain_pred,average='macro')
```

Out[ ]: 0.9749960931395533

In [ ]:
```
#find the Classification report and scoring details for each class:
from sklearn.metrics import classification_report,confusion_matrix,multilabel_confusic
import pandas as pd
report=classification_report(ytrain, ytrain_pred,target_names=data.target_names,output
df = pd.DataFrame.from_dict(report)
df
```

Out[ ]:

	setosa	versicolor	virginica	accuracy	macro avg	weighted avg
precision	1.0	1.000000	0.928571	0.975	0.976190	0.976786
recall	1.0	0.926829	1.000000	0.975	0.975610	0.975000
f1-score	1.0	0.962025	0.962963	0.975	0.974996	0.974988
support	40.0	41.000000	39.000000	0.975	120.000000	120.000000

In [ ]:
```
#test the model on dataset:
score=cross_val_score(eclf,Xtest,ytest,scoring='accuracy',cv=3)
accuracy=score.mean()*100
print('accuracy percentage:',accuracy)
```

```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
accuracy percentage: 100.0
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
```

In [ ]:

```python
#plot confusuin matrix for the three classes
from sklearn.metrics import ConfusionMatrixDisplay
ytest_pred = cross_val_predict(eclf, Xtest, ytest, cv=3)
cm = confusion_matrix(ytest, ytest_pred)
cm
ConfusionMatrixDisplay.from_predictions(ytest, ytest_pred)
plt.show()
```

```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
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  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
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  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_
base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number o
f iterations.
  warnings.warn(
```

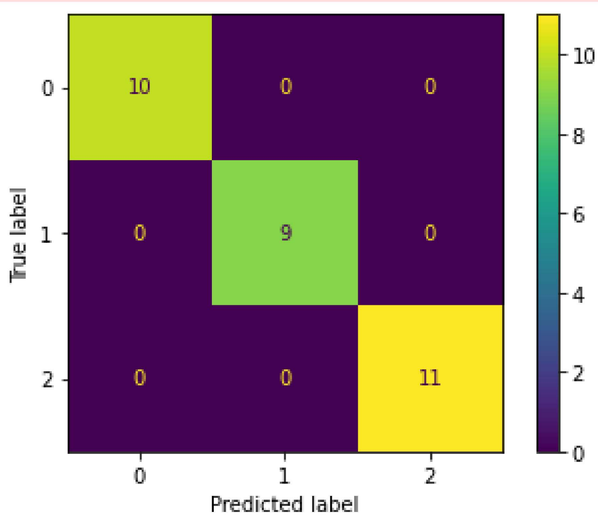

In [ ]:

```python
#train the best model in the whole data  and Save the final Model:
import joblib

final_model=eclf.fit(features,target)

joblib.dump(final_model,'clf_final_model.pkl')
```

```
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  warnings.warn(
c:\Users\user\AppData\Local\Programs\Python\Python310\lib\site-packages\sklearn\svm\_base.py:1225: ConvergenceWarning: Liblinear failed to converge, increase the number of iterations.
  warnings.warn(
```

Out[ ]:
```
['clf_final_model.pkl']
```

In [ ]:
```
#load the model for prediction
final_model=joblib.load('clf_final_model.pkl')
new_data=features.iloc[:5]
predictions=final_model.predict(new_data)
predictions
```

Out[ ]:
```
array([0, 0, 0, 0, 0])
```

In [ ]:
```
target.iloc[:5]
```

Out[ ]:
```
0    0
1    0
2    0
3    0
4    0
Name: target, dtype: int32
```

In [ ]:
```
#perfect!! :)
```

In [ ]:
```

```