```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
     Drive already mounted at /content/gdrive; to attempt to forcibly remount, call drive.mou
```

```
import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split, cross_val_score
from sklearn.tree import DecisionTreeClassifier, export_text, export_graphviz
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.neighbors import KNeighborsClassifier
from sklearn.preprocessing import MinMaxScaler
from sklearn.metrics import classification_report
import pydotplus
from IPython.display import Image
from sklearn.model_selection import cross_val_score
from sklearn.naive_bayes import GaussianNB
from sklearn.neighbors import KNeighborsClassifier
import seaborn as sns
```

Q5.Use Naive bayes, K-nearest, and Decision tree classification algorithms and build classifiers.Divide the data set into training and test set. Compare the accuracy of the different classifiers under the following situations:

5.1 a) Training set=75% Test set=25% b) Training set=66.6%(2/3rd of total),Test set=33.3%

5.2 Training set is chosen by i) hold out method ii) Randomsubsampling iii) Cross-Validation. Compare the accuracy of the classifiers obtained.

5.3 Data is scaled to standard format.

```
import sklearn
from sklearn.datasets import *
dir(sklearn.datasets)
```

```
     ['__all__',
      '__builtins__',
      '__cached__',
      '__doc__',
      '__file__',
      '__loader__',
      '__name__',
      '__package__',
      '__path__',
      '__spec__',
      '_base',
      '_california_housing',
      '_covtype',
      '_kddcup99',
      '_lfw',
      '_olivetti_faces',
      '_openml',
      '_rcv1',
      '_samples_generator',
      '_species_distributions',
      '_svmlight_format_fast',
      '_svmlight_format_io',
      '_twenty_newsgroups',
      'clear_data_home',
      'dump_svmlight_file',
      'fetch_20newsgroups',
      'fetch_20newsgroups_vectorized',
      'fetch_california_housing',
      'fetch_covtype',
      'fetch_kddcup99',
      'fetch_lfw_pairs',
      'fetch_lfw_people',
      'fetch_olivetti_faces',
      'fetch_openml',
      'fetch_rcv1',
      'fetch_species_distributions',
      'get_data_home',
      'load_boston',
      'load_breast_cancer',
      'load_diabetes',
      'load_digits',
      'load_files',
      'load_iris',
      'load_linnerud',
      'load_sample_image',
      'load_sample_images',
      'load_svmlight_file',
      'load_svmlight_files',
      'load_wine',
      'make_biclusters',
      'make_blobs',
      'make_checkerboard',
      'make_circles',
      'make_classification',
      'make_friedman1',
      'make_friedman2',
      'make_friedman3',
      'make_gaussian_quantiles',
      'make_hastie_10_2',
```

```
iris=load_iris()
iris.keys()
```

```
dict_keys(['data', 'target', 'target_names', 'DESCR', 'feature_names', 'filename'])
```

```
print(iris.filename)
print(iris.feature_names)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/datasets/data/iris.csv
['sepal length (cm)', 'sepal width (cm)', 'petal length (cm)', 'petal width (cm)']
```

```
iris=pd.read_csv('/content/gdrive/MyDrive/iris.csv')
print(iris)
#preproces=True;
preproces=False;
```

```
     sepal_length  sepal_width  petal_length  petal_width    species
0             5.1          3.5           1.4          0.2     setosa
1             4.9          3.0           1.4          0.2     setosa
2             4.7          3.2           1.3          0.2     setosa
3             4.6          3.1           1.5          0.2     setosa
4             5.0          3.6           1.4          0.2     setosa
..            ...          ...           ...          ...        ...
145           6.7          3.0           5.2          2.3  virginica
146           6.3          2.5           5.0          1.9  virginica
147           6.5          3.0           5.2          2.0  virginica
148           6.2          3.4           5.4          2.3  virginica
149           5.9          3.0           5.1          1.8  virginica

[150 rows x 5 columns]
```

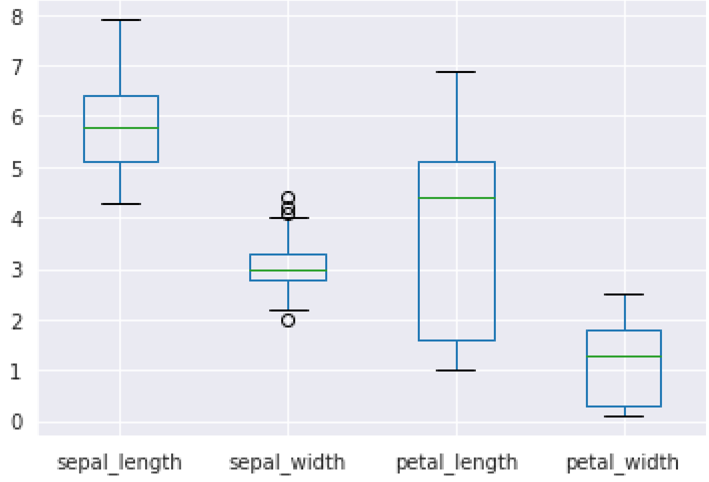
```
iris=iris.drop_duplicates()

#missing_values = iris.isnull().sum()
#print(missing_values)

#df = pd.DataFrame(iris)
#print(df)
#duplicate_Row = iris[df.duplicated()]
```

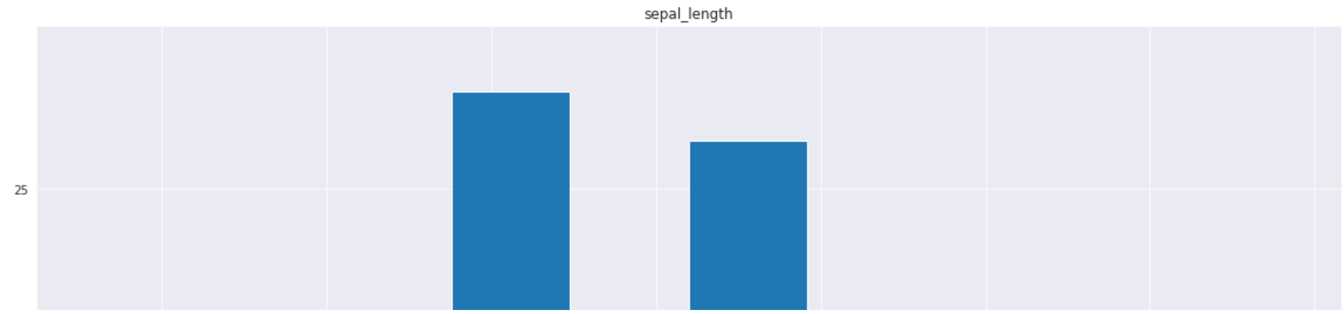
```
iris.boxplot()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8df1e31c10>
```



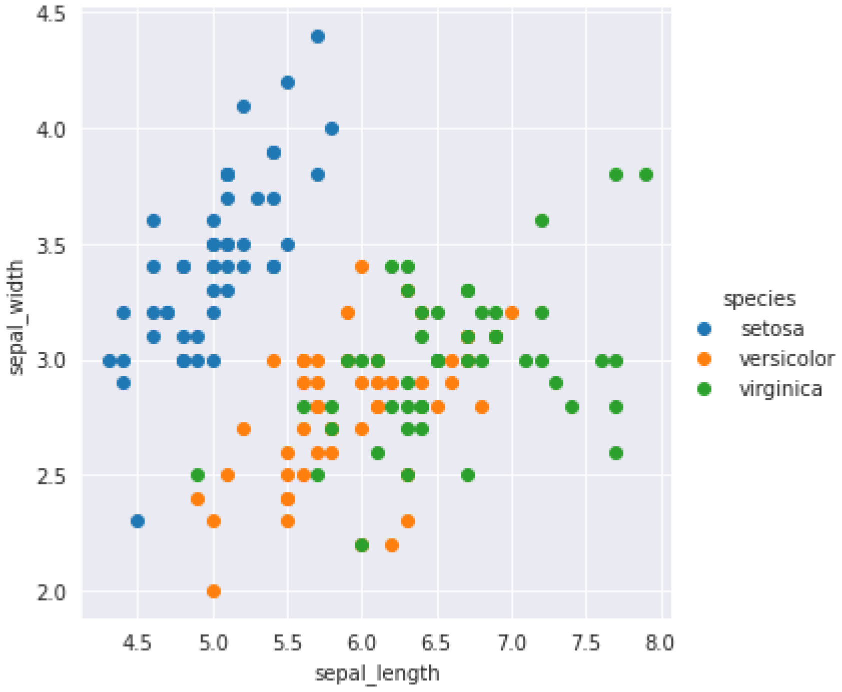
```
from matplotlib import pyplot as plt
```

```
import matplotlib.pyplot as plt
plt.figure(figsize = [20, 100])
for i in range(0,iris.shape[1]-1):
  column=iris.columns[i]
  plt.subplot(4, 1, i+1)
  plt.title(column)
  plt.hist(iris[column])
```

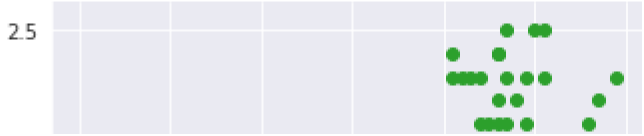


```
sns.set_style("darkgrid")
sns.FacetGrid(iris, hue ="species", height = 5).map(plt.scatter, 'sepal_length', 'sepal_width
```

```
<seaborn.axisgrid.FacetGrid at 0x7f8de4316c50>
```



```
sns.set_style("darkgrid")
sns.FacetGrid(iris, hue ="species", height = 5).map(plt.scatter, 'petal_length', 'petal_width
<seaborn.axisgrid.FacetGrid at 0x7f8de4085150>
```



```
iris.describe()
```

| | sepal_length | sepal_width | petal_length | petal_width |
|---|---|---|---|---|
| **count** | 147.000000 | 147.000000 | 147.000000 | 147.000000 |
| **mean** | 5.856463 | 3.055782 | 3.780272 | 1.208844 |
| **std** | 0.829100 | 0.437009 | 1.759111 | 0.757874 |
| **min** | 4.300000 | 2.000000 | 1.000000 | 0.100000 |
| **25%** | 5.100000 | 2.800000 | 1.600000 | 0.300000 |
| **50%** | 5.800000 | 3.000000 | 4.400000 | 1.300000 |
| **75%** | 6.400000 | 3.300000 | 5.100000 | 1.800000 |
| **max** | 7.900000 | 4.400000 | 6.900000 | 2.500000 |

```
X=iris.values[:,:-1]
Y=iris.values[:,-1]
```

```
print(X.shape)
print(Y.shape)
```

```
(147, 4)
(147,)
```

```
classLabels=np.unique(Y)
classLabels
```

```
array(['setosa', 'versicolor', 'virginica'], dtype=object)
```

```
iris['species'].value_counts()
```

```
versicolor    50
virginica     49
setosa        48
Name: species, dtype: int64
```

```
if preproces == True :
  X=preprocessing.scale(X)
else:
  X=X
print(X)
```

```
[[5.1 3.5 1.4 0.2]
 [4.9 3.0 1.4 0.2]
 [4.7 3.2 1.3 0.2]
 [4.6 3.1 1.5 0.2]
 [5.0 3.6 1.4 0.2]
 [5.4 3.9 1.7 0.4]
 [4.6 3.4 1.4 0.3]
 [5.0 3.4 1.5 0.2]
 [4.4 2.9 1.4 0.2]
 [4.9 3.1 1.5 0.1]
 [5.4 3.7 1.5 0.2]
 [4.8 3.4 1.6 0.2]
 [4.8 3.0 1.4 0.1]
 [4.3 3.0 1.1 0.1]
 [5.8 4.0 1.2 0.2]
 [5.7 4.4 1.5 0.4]
 [5.4 3.9 1.3 0.4]
 [5.1 3.5 1.4 0.3]
 [5.7 3.8 1.7 0.3]
 [5.1 3.8 1.5 0.3]
 [5.4 3.4 1.7 0.2]
 [5.1 3.7 1.5 0.4]
 [4.6 3.6 1.0 0.2]
 [5.1 3.3 1.7 0.5]
 [4.8 3.4 1.9 0.2]
 [5.0 3.0 1.6 0.2]
 [5.0 3.4 1.6 0.4]
 [5.2 3.5 1.5 0.2]
 [5.2 3.4 1.4 0.2]
 [4.7 3.2 1.6 0.2]
 [4.8 3.1 1.6 0.2]
 [5.4 3.4 1.5 0.4]
 [5.2 4.1 1.5 0.1]
 [5.5 4.2 1.4 0.2]
 [5.0 3.2 1.2 0.2]
 [5.5 3.5 1.3 0.2]
 [4.4 3.0 1.3 0.2]
 [5.1 3.4 1.5 0.2]
 [5.0 3.5 1.3 0.3]
 [4.5 2.3 1.3 0.3]
 [4.4 3.2 1.3 0.2]
 [5.0 3.5 1.6 0.6]
 [5.1 3.8 1.9 0.4]
 [4.8 3.0 1.4 0.3]
 [5.1 3.8 1.6 0.2]
 [4.6 3.2 1.4 0.2]
 [5.3 3.7 1.5 0.2]
 [5.0 3.3 1.4 0.2]
 [7.0 3.2 4.7 1.4]
 [6.4 3.2 4.5 1.5]
 [6.9 3.1 4.9 1.5]
 [5.5 2.3 4.0 1.3]
 [6.5 2.8 4.6 1.5]
 [5.7 2.8 4.5 1.3]
 [6.3 3.3 4.7 1.6]
 [4.9 2.4 3.3 1.0]
```

```
     [6.6 2.9 4.6 1.3]
     [5.2 2.7 3.9 1.4]
     [5.0 2.0 3.5 1.0]]
```

```
test_val = 0.25
X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=test_val)
```

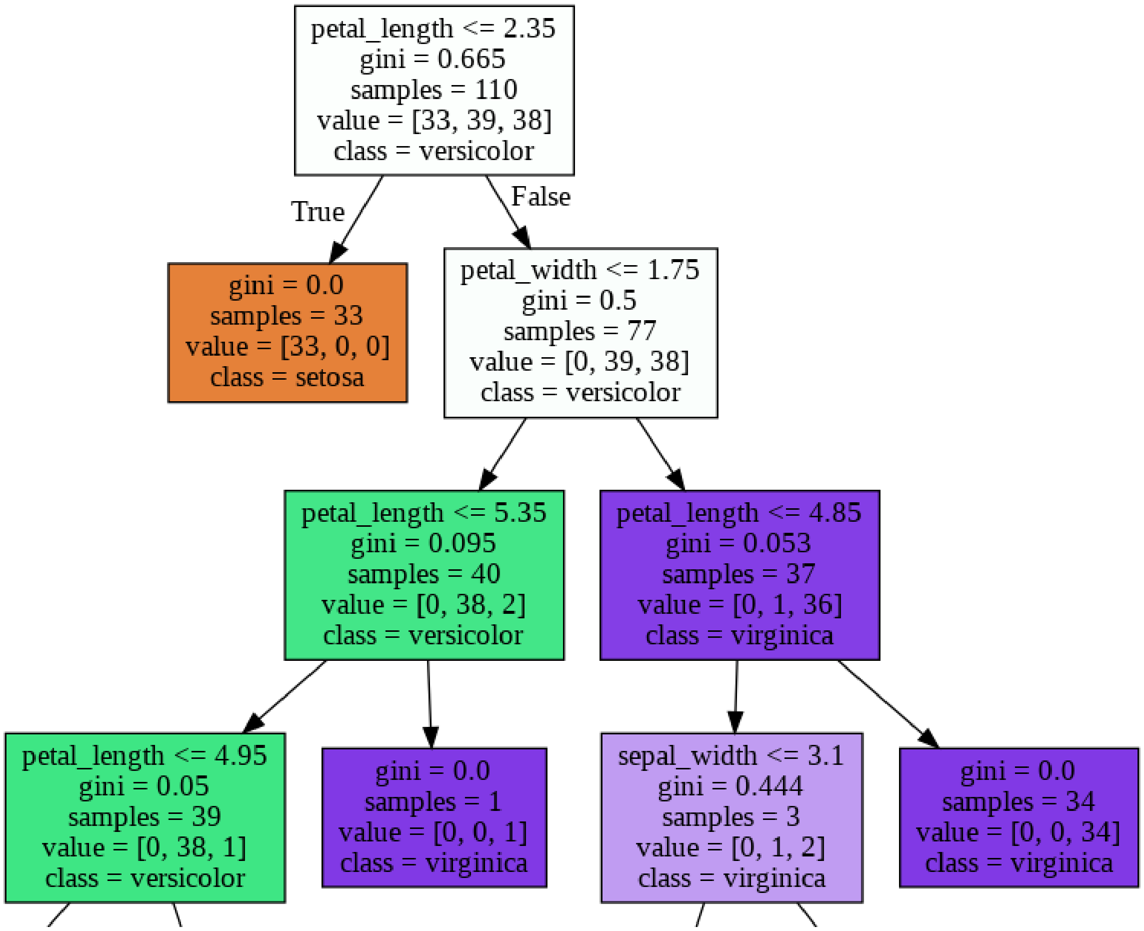
```
print(X_train.shape)
print(X_test.shape)
print(Y_train.shape)
print(Y_test.shape)
```

```
    (110, 4)
    (37, 4)
    (110,)
    (37,)
```

```
#help(DecisionTreeClassifier())
```

```
DTclassifer = DecisionTreeClassifier().fit(X_train,Y_train)
```

```
dot_data=export_graphviz(DTclassifer, feature_names=iris.columns[:-1], class_names=classLabel
graph=pydotplus.graph_from_dot_data(dot_data)
Image(graph.create_png())
```



```
print(Y_test)
Y_predict=DTclassifer.predict(X_test)
print(Y_predict)
```

```
['versicolor' 'setosa' 'virginica' 'setosa' 'versicolor' 'virginica'
 'versicolor' 'virginica' 'setosa' 'setosa' 'virginica' 'virginica'
 'setosa' 'versicolor' 'versicolor' 'setosa' 'versicolor' 'versicolor'
 'setosa' 'setosa' 'setosa' 'setosa' 'virginica' 'virginica' 'versicolor'
 'versicolor' 'setosa' 'setosa' 'versicolor' 'setosa' 'virginica'
 'virginica' 'virginica' 'setosa' 'versicolor' 'setosa' 'virginica']
['versicolor' 'setosa' 'virginica' 'setosa' 'versicolor' 'virginica'
 'versicolor' 'virginica' 'setosa' 'setosa' 'virginica' 'versicolor'
 'setosa' 'versicolor' 'versicolor' 'setosa' 'versicolor' 'versicolor'
 'setosa' 'setosa' 'setosa' 'setosa' 'virginica' 'virginica' 'versicolor'
 'versicolor' 'setosa' 'setosa' 'versicolor' 'setosa' 'virginica'
 'virginica' 'virginica' 'setosa' 'versicolor' 'setosa' 'versicolor']
```

```
accuracy_score(Y_test, Y_predict)
```

```
0.9459459459459459
```

```
conf=confusion_matrix(Y_test, Y_predict)
conf
```

```
array([[15,  0,  0],
       [ 0, 11,  0],
            [ 0,  2,  9]])
```

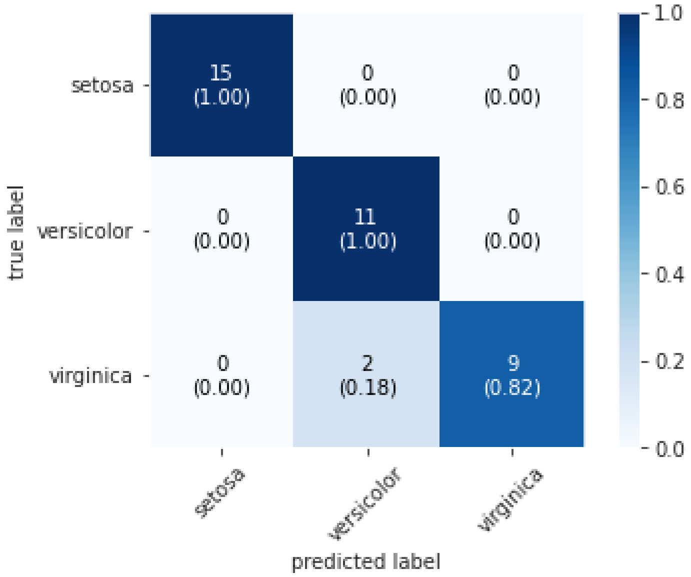
```
!pip install mlxtend --upgrade --no-deps
```

```
     Requirement already up-to-date: mlxtend in /usr/local/lib/python3.7/dist-packages (0.18
```

```
#import mlxtend
#help(mlxtend)
```

```
from mlxtend.plotting import plot_confusion_matrix
plot_confusion_matrix(conf_mat=conf, colorbar=True, show_absolute=True, show_normed=True, cla
```

```
     (<Figure size 432x288 with 2 Axes>,
      <matplotlib.axes._subplots.AxesSubplot at 0x7f8de426b710>)
```

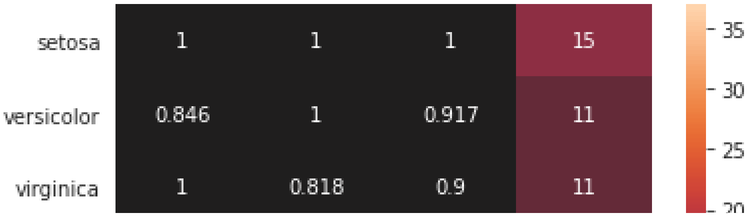


```
clf_report=classification_report(Y_test, Y_predict, target_names=classLabels, digits=5, outpu
print(clf_report)
```

```
     {'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 15}, 'versicol
```

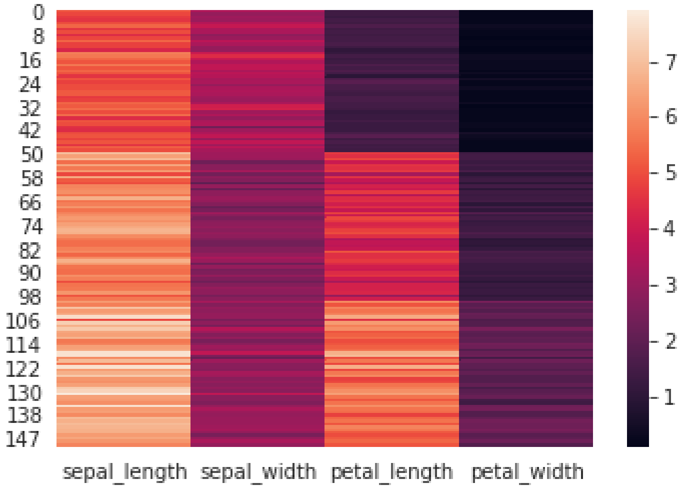
```
sns.heatmap(pd.DataFrame(clf_report).T, annot=True, fmt='.3g',center=True)#.T is for transpos
                                                                          #.3g is used to dis
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8de41ddc10>
```



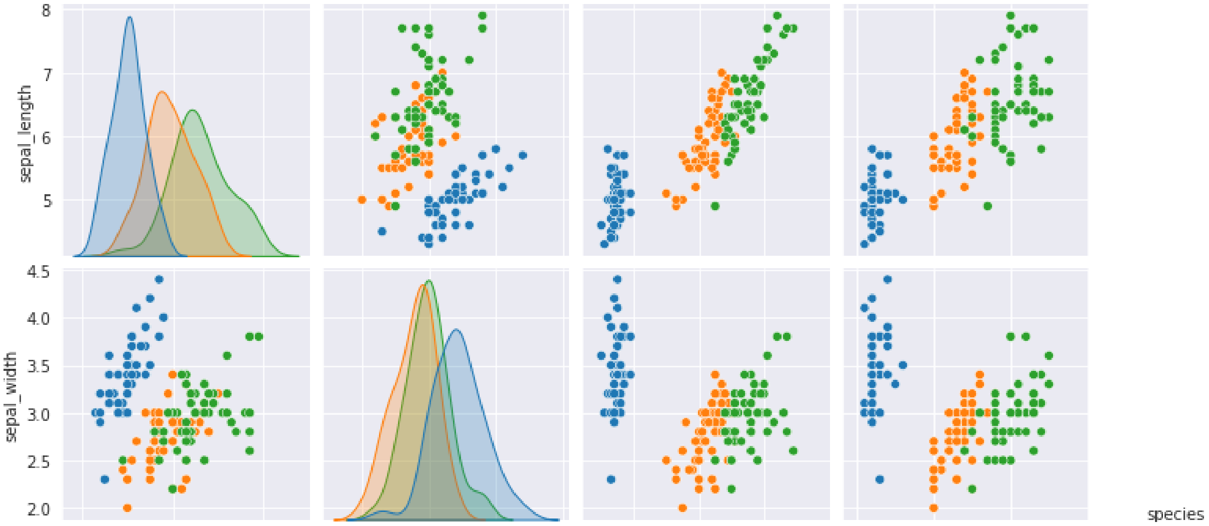
```
sns.heatmap(iris.iloc[: ,:-1 ])
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8de3ff5050>
```



```
sns.pairplot(iris,hue='species')
```

```
<seaborn.axisgrid.PairGrid at 0x7f8de461f710>
```



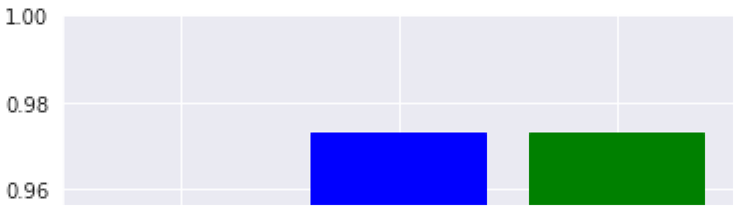
```
def compareClassifiers1(split_ratio):
  X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=split_ratio)
  clf = DecisionTreeClassifier(criterion='gini')
  clf=clf.fit(X_train,Y_train)
  Y_pred=clf.predict(X_test)
  a1=accuracy_score(Y_test,Y_pred)
  print("Accuracy in decision tree base classifier:")
  print(a1)
  print("confusion matrix is:")
  confuss_mat=confusion_matrix(Y_test,Y_pred)
  print(confuss_mat)
  print("classification report:")
  clf_report=classification_report(Y_test, Y_pred, target_names=classLabels,digits=4,output_d
  print(clf_report)

  #KNN
  X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=split_ratio)
  clf = KNeighborsClassifier(n_neighbors=4)
  clf=clf.fit(X_train,Y_train)
  Y_pred=clf.predict(X_test)
  a2=accuracy_score(Y_test,Y_pred)
  print("Accuracy in KNN base classifier:")
  print(a2)
  print("confusion matrix is:")
  confuss_mat=confusion_matrix(Y_test,Y_pred)
  print(confuss_mat)
  print("classification report:")
  clf_report=classification_report(Y_test, Y_pred, target_names=classLabels,digits=4,output_d
  print(clf_report)

  #Naive bayes
  X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=split_ratio)
  clf = GaussianNB()
  clf=clf.fit(X_train,Y_train)
  Y_pred=clf.predict(X_test)
  a3=accuracy_score(Y_test,Y_pred)
  print("Accuracy in naive bayes base classifier:")
  print(a1)
  print("confusion matrix is:")
  confuss_mat=confusion_matrix(Y_test,Y_pred)
  print(confuss_mat)
  print("classification report:")
  clf_report=classification_report(Y_test, Y_pred, target_names=classLabels,digits=4,output_d
  print(clf_report)
  return a1,a2,a3
a=compareClassifiers1(test_val)
```

```
Accuracy in decision tree base classifier:
0.918918918918919
confusion matrix is:
[[ 9  0  0]
 [ 0  9  3]
 [ 0  0 16]]
classification report:
{'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 9}, 'versicolor
Accuracy in KNN base classifier:
0.972972972972973
confusion matrix is:
[[ 7  0  0]
 [ 0 11  0]
 [ 0  1 18]]
classification report:
{'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 7}, 'versicolor
Accuracy in naive bayes base classifier:
0.918918918918919
confusion matrix is:
[[17  0  0]
 [ 0 13  0]
 [ 0  1  6]]
classification report:
{'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 17}, 'versicolo
```

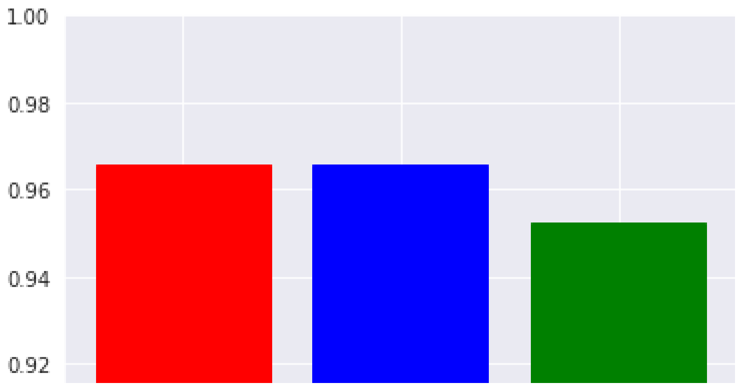
```
l = ['DT', 'KNN', 'NB']
plt.ylim(0.9,1.0)
barlist=plt.bar(l,a)
barlist[0].set_color('r')
barlist[1].set_color('b')
barlist[2].set_color('g')
plt.show()
```



```
k=10  # 3 for vertebrate dataset
def compareClassifiers2(k):
  score=cross_val_score(DecisionTreeClassifier(),X,Y,cv=k)
  print(" K fold cross verlidation for Decision tree: ")
  print(score)
  s1=score.mean()
  print(s1)
  score=cross_val_score( KNeighborsClassifier(),X,Y,cv=k)
  print(" K fold cross verlidation for k-nearest neighbors: ")
  print(score)
  s2=score.mean()
  print(s2)
  score=cross_val_score( GaussianNB(),X,Y,cv=k)
  print(" K fold cross verlidation for naive bayes: ")
  print(score)
  s3=score.mean()
  print(s3)
  return s1,s2,s3
s=compareClassifiers2(12)
```

```
 K fold cross verlidation for Decision tree: 
[1.         0.92307692 1.         1.         0.83333333 1.
 0.91666667 0.91666667 1.         1.         1.         1.        ]
0.9658119658119659
 K fold cross verlidation for k-nearest neighbors: 
[1.         0.92307692 1.         1.         0.91666667 0.91666667
 0.91666667 0.91666667 1.         1.         1.         1.        ]
0.9658119658119658
 K fold cross verlidation for naive bayes: 
[0.92307692 0.92307692 1.         1.         0.83333333 1.
 0.91666667 1.         0.83333333 1.         1.         1.        ]
0.952457264957265
```

```
#sns.histplot(data=s)
l = ['DT', 'KNN', 'NB']
plt.ylim(0.9,1.0)
barlist=plt.bar(l,s)
barlist[0].set_color('r')
barlist[1].set_color('b')
barlist[2].set_color('g')
plt.show()
```



```
numTimes=10

accuracy=list()
for i in range(numTimes):
  X_train, X_test, Y_train, Y_test = train_test_split(X,Y,test_size=test_val)
  DTclassifer = DecisionTreeClassifier(criterion="entropy").fit(X_train,Y_train)
  Y_predict=DTclassifer.predict(X_test)
  accuracy.append(accuracy_score(Y_test, Y_predict))
print(sum(accuracy)/numTimes)
```

```
     0.9351351351351352
```

```
k=10
scores=cross_val_score(DecisionTreeClassifier(),X,Y,cv=k)
print(scores,scores.mean())
```

```
     [1.         0.93333333 1.         0.93333333 0.93333333 0.86666667
      0.93333333 0.92857143 1.         1.        ] 0.9528571428571428
```

```
test_val1 =(1/3)
X_train1, X_test1, Y_train1, Y_test1 = train_test_split(X,Y,test_size=test_val)
```

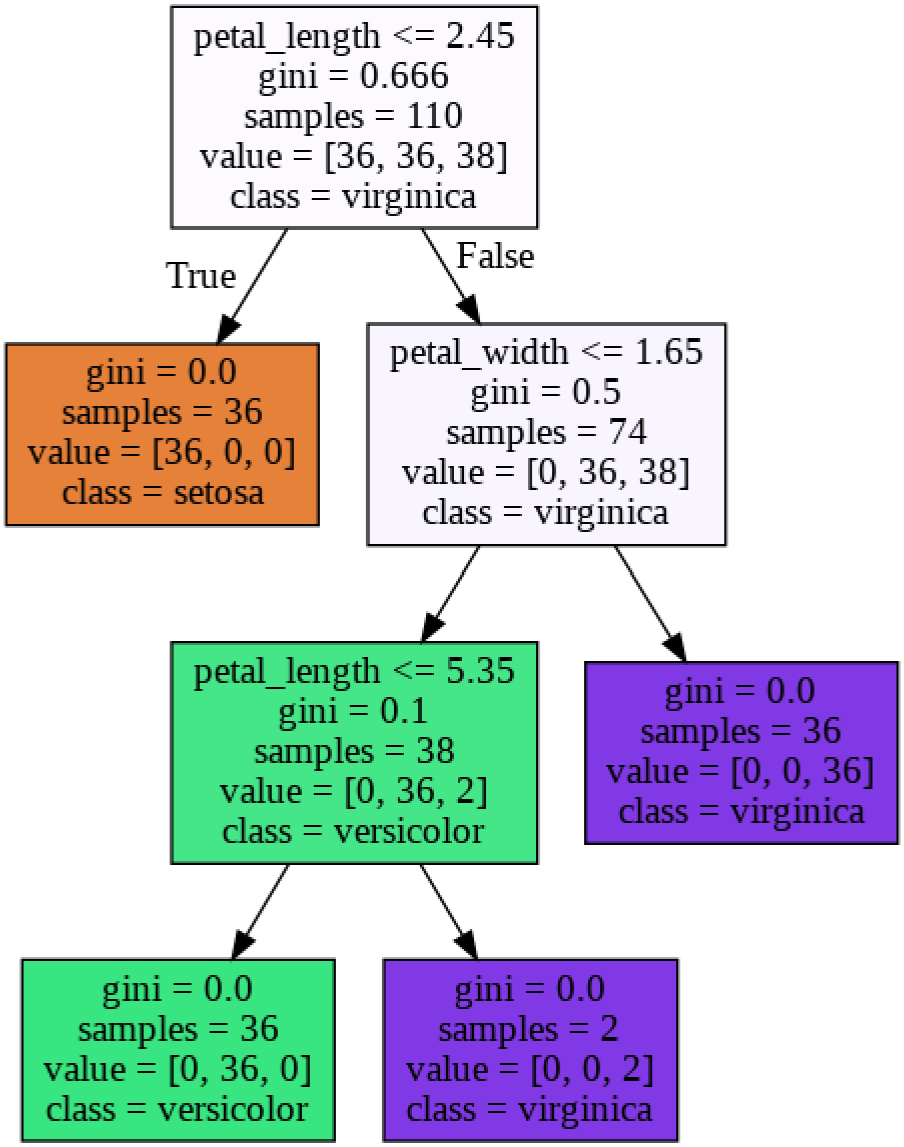
```
print(X_train1.shape)
print(X_test1.shape)
print(Y_train1.shape)
print(Y_test1.shape)
```

```
     (110, 4)
     (37, 4)
     (110,)
     (37,)
```

```
#help(DecisionTreeClassifier())
```

```
DTclassifer = DecisionTreeClassifier().fit(X_train1,Y_train1)
```

```
dot_data1=export_graphviz(DTclassifer, feature_names=iris.columns[:-1], class_names=classLabe
graph1=pydotplus.graph_from_dot_data(dot_data1)
Image(graph1.create_png())
```



```
print(Y_test1)
Y_predict1=DTclassifer.predict(X_test1)
print(Y_predict1)
```

```
['virginica' 'versicolor' 'setosa' 'virginica' 'setosa' 'virginica'
 'versicolor' 'versicolor' 'setosa' 'setosa' 'virginica' 'setosa'
 'versicolor' 'virginica' 'setosa' 'virginica' 'versicolor' 'versicolor'
 'setosa' 'virginica' 'virginica' 'versicolor' 'versicolor' 'virginica'
 'versicolor' 'virginica' 'versicolor' 'setosa' 'setosa' 'setosa'
 'versicolor' 'versicolor' 'versicolor' 'setosa' 'setosa' 'versicolor'
 'virginica']
['versicolor' 'versicolor' 'setosa' 'versicolor' 'setosa' 'virginica'
 'versicolor' 'versicolor' 'setosa' 'setosa' 'virginica' 'setosa'
 'versicolor' 'virginica' 'setosa' 'virginica' 'versicolor' 'versicolor'
 'setosa' 'virginica' 'virginica' 'versicolor' 'versicolor' 'virginica'
 'versicolor' 'virginica' 'versicolor' 'setosa' 'setosa' 'setosa'
 'versicolor' 'virginica' 'virginica' 'setosa' 'setosa' 'versicolor'
 'virginica']
```

```
accuracy_score(Y_test1, Y_predict1)
```

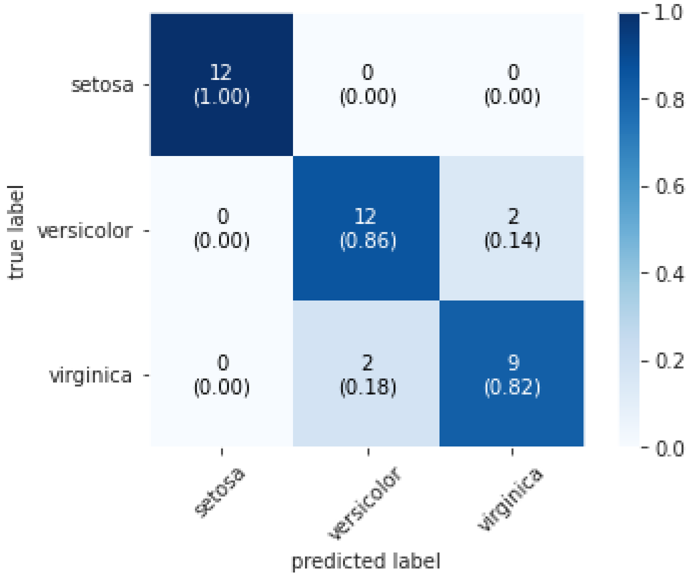
```
0.8918918918918919
```

```
conf1=confusion_matrix(Y_test1, Y_predict1)
conf1
```

```
array([[12,  0,  0],
       [ 0, 12,  2],
       [ 0,  2,  9]])
```

```
from mlxtend.plotting import plot_confusion_matrix
plot_confusion_matrix(conf_mat=conf1, colorbar=True, show_absolute=True, show_normed=True, cl
```

```
(<Figure size 432x288 with 2 Axes>,
 <matplotlib.axes._subplots.AxesSubplot at 0x7f8de3776ed0>)
```

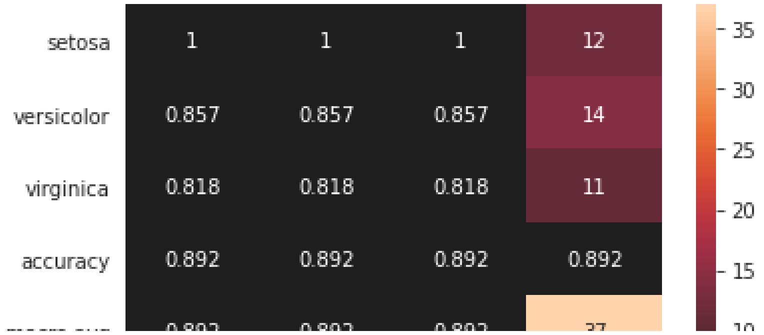


```
clf_report1=classification_report(Y_test1, Y_predict1, target_names=classLabels, digits=5, ou
print(clf_report1)
```

```
{'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 12}, 'versicolo
```

```
import seaborn as sns
sns.heatmap(pd.DataFrame(clf_report1).T, annot=True, fmt='.3g',center=True)#.T is for transpo
                                                                            #.3g is used to dis
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f8de372f610>
```



```
numTimes=10

accuracy=list()
for i in range(numTimes):
  X_train1, X_test1, Y_train1, Y_test1 = train_test_split(X,Y,test_size=test_val)
  DTclassifer = DecisionTreeClassifier(criterion="entropy").fit(X_train1,Y_train1)
  Y_predict1=DTclassifer.predict(X_test1)
  accuracy.append(accuracy_score(Y_test1, Y_predict1))
print(sum(accuracy)/numTimes)
```

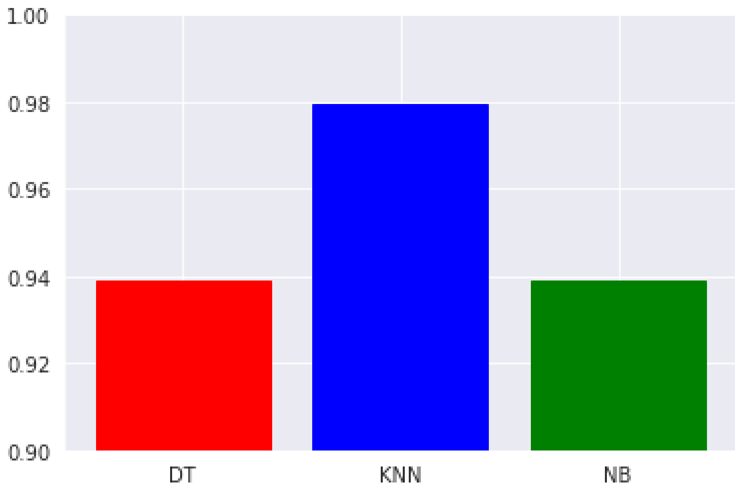
```
0.9621621621621623
```

```
a1=compareClassifiers1(test_val1)
```

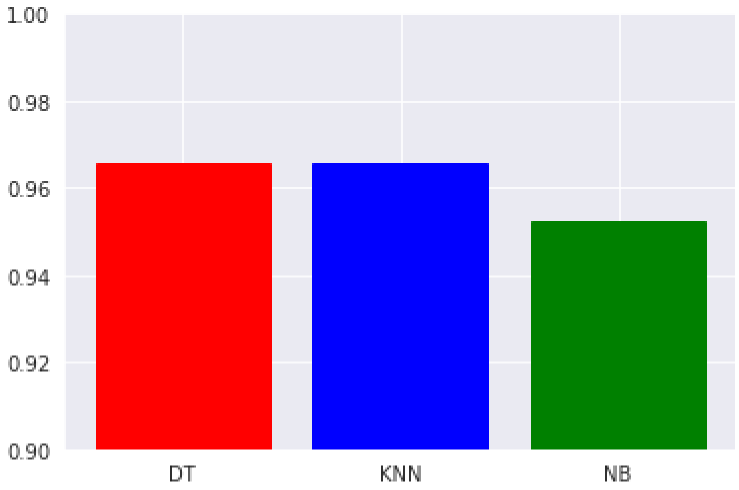
```
Accuracy in decision tree base classifier:
0.9387755102040817
confusion matrix is:
[[16  0  0]
 [ 0 14  2]
 [ 0  1 16]]
classification report:
{'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 16}, 'versicolo
Accuracy in KNN base classifier:
0.9795918367346939
confusion matrix is:
[[17  0  0]
 [ 0 16  0]
 [ 0  1 15]]
classification report:
{'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 17}, 'versicolo
Accuracy in naive bayes base classifier:
0.9387755102040817
confusion matrix is:
[[16  0  0]
 [ 0 10  1]
 [ 0  2 20]]
classification report:
{'setosa': {'precision': 1.0, 'recall': 1.0, 'f1-score': 1.0, 'support': 16}, 'versicolo
```

```
l = ['DT', 'KNN', 'NB']
plt.ylim(0.9,1.0)
```

```
barlist=plt.bar(l,a1)
barlist[0].set_color('r')
barlist[1].set_color('b')
barlist[2].set_color('g')
plt.show()
```



```
#sns.histplot(data=s)
l = ['DT', 'KNN', 'NB']
plt.ylim(0.9,1.0)
barlist=plt.bar(l,s)
barlist[0].set_color('r')
barlist[1].set_color('b')
barlist[2].set_color('g')
plt.show()
```



## VERTIBRATE DATASET

```
vertibrate=pd.read_csv('/content/gdrive/MyDrive/vertebrate.csv')
preproces=True
print(vertibrate)
```

```
             Name  Warm-blooded  Gives Birth  ...  Has Legs  Hibernates       Class
0           human             1            1  ...         1           0     mammals
1          python             0            0  ...         0           1    reptiles
2          salmon             0            0  ...         0           0      fishes
3           whale             1            1  ...         0           0     mammals
4            frog             0            0  ...         1           1  amphibians
5          komodo             0            0  ...         1           0    reptiles
6             bat             1            1  ...         1           1     mammals
7          pigeon             1            0  ...         1           0       birds
8             cat             1            1  ...         1           0     mammals
9   leopard shark             0            1  ...         0           0      fishes
10         turtle             0            0  ...         1           0    reptiles
11        penguin             1            0  ...         1           0       birds
12      porcupine             1            1  ...         1           1     mammals
13            eel             0            0  ...         0           0      fishes
14     salamander             0            0  ...         1           1  amphibians

[15 rows x 8 columns]
```

```
vertibrate=vertibrate.drop_duplicates()
```