Machine learning algorithms for classification and regression on iris in Python

In [173…

```
# load necessary libraries for data import, reshaping and visualization

import seaborn as sns
import matplotlib.pyplot as plt
from sklearn import datasets
import pandas as pd
import numpy as np

# Convert 'iris.data' numpy array to 'iris.dataframe' pandas dataframe
# complete the iris dataset by adding species
iris = datasets.load_iris()
iris = pd.DataFrame(
    data= np.c_[iris['data'], iris['target']],
    columns= iris['feature_names'] + ['target']
    )

species = []

for i in range(len(iris['target'])):
    if iris['target'][i] == 0:
        species.append("setosa")
    elif iris['target'][i] == 1:
        species.append('versicolor')
    else:
        species.append('virginica')

iris['species'] = species
iris
```

Out[173]:

	sepal length (cm)	sepal width (cm)	petal length (cm)	petal width (cm)	target	species
0	5.1	3.5	1.4	0.2	0.0	setosa
1	4.9	3.0	1.4	0.2	0.0	setosa
2	4.7	3.2	1.3	0.2	0.0	setosa
3	4.6	3.1	1.5	0.2	0.0	setosa
4	5.0	3.6	1.4	0.2	0.0	setosa
...	...	...	...	...	...	...
145	6.7	3.0	5.2	2.3	2.0	virginica
146	6.3	2.5	5.0	1.9	2.0	virginica
147	6.5	3.0	5.2	2.0	2.0	virginica
148	6.2	3.4	5.4	2.3	2.0	virginica
149	5.9	3.0	5.1	1.8	2.0	virginica

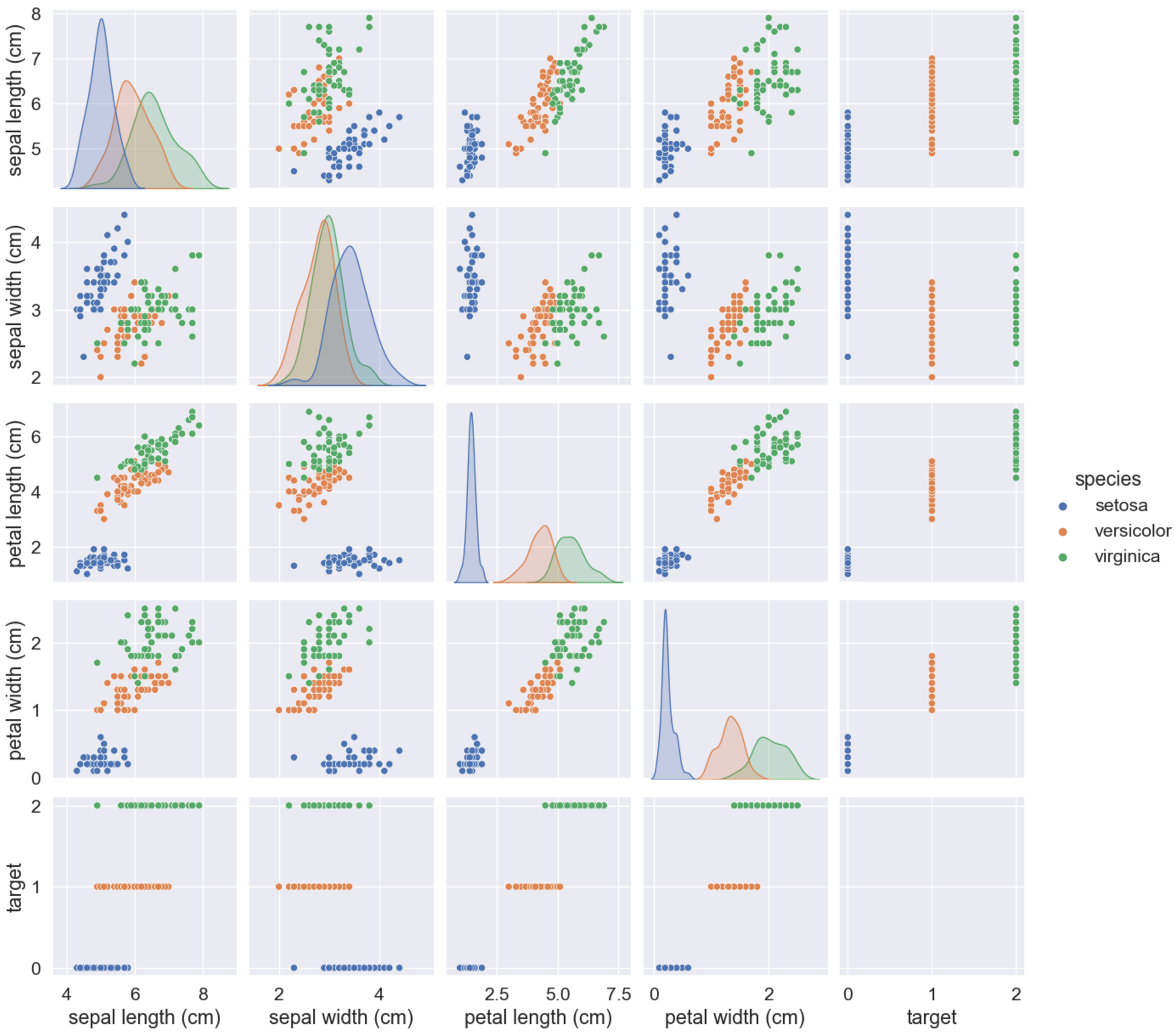
150 rows × 6 columns

1. Visualization

In [174…

```
plt.figure(figsize=(6,3))
sns.pairplot(iris, hue='species')
plt.show()
```

```
<Figure size 600x300 with 0 Axes>
```



2. splitting the dataset into training and test sets

In [177…

```
X = iris.iloc[:, 0:4]
y = iris.iloc[:, 4]
class_names = iris.iloc[:, 5]

from sklearn.model_selection import train_test_split
import random

random.seed(2023)
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=40, train_s
```

2.1 Saving a copy of the different datasets in .csv files

In [178…

```
# save a copy of the datasets in .csv
iris.to_csv('C:/Users/julia/OneDrive/Desktop/github/24. Machine learning toolbox Py
```

```
iris.to_csv('C:/Users/julia/OneDrive/Desktop/github/24. Machine learning toolbox Py
          index = False)

iris.to_csv('C:/Users/julia/OneDrive/Desktop/github/24. Machine learning toolbox Py
          index = False)
```

3. Some metrics

TP = true positive, TN = true negative, FP = false positive, FN = false negative

\vspace{10} \noindent Accuracy. The number of samples correctly classified out of all the samples present in the (test) set.

$$Accuracy = \frac{TP + TN}{(TP + TN + FP + FN)}$$

\vspace{10} \noindent Precision (for the positive class). The number of samples actually belonging to the positive class out of all the samples that were predicted to be of the positive class by the model.

$$Precision = \frac{TP}{(TP + FP)}$$

\vspace{10} \noindent Recall (for the positive class). The number of samples predicted correctly to be belonging to the positive class out of all the samples that actually belong to the positive class.

$$Recall = \frac{TP}{(TP + NP)}$$

\vspace{10} \noindent F1-Score (for the positive class). The harmonic mean of the precision and recall scores obtained for the positive class.

$$F1 - score = \frac{2 * Precision * Recall}{(Precision + Recall)}$$

1. Naive Bayes classifier

1.1 train the model

In [179…

```
from sklearn.naive_bayes import GaussianNB

# create a Gaussian RF classifier
nb_model = GaussianNB()

# fit the model to the iris dataset
nb_model.fit(X_train,y_train)

# make predictions on test set
y_pred_nb = nb_model.predict(X_test)
```

1.2 Confusion matrix

Now that we have predictions, we can compute a confusion matrix and the accuracy of our trained NB classifier on the testing set.

In [180…

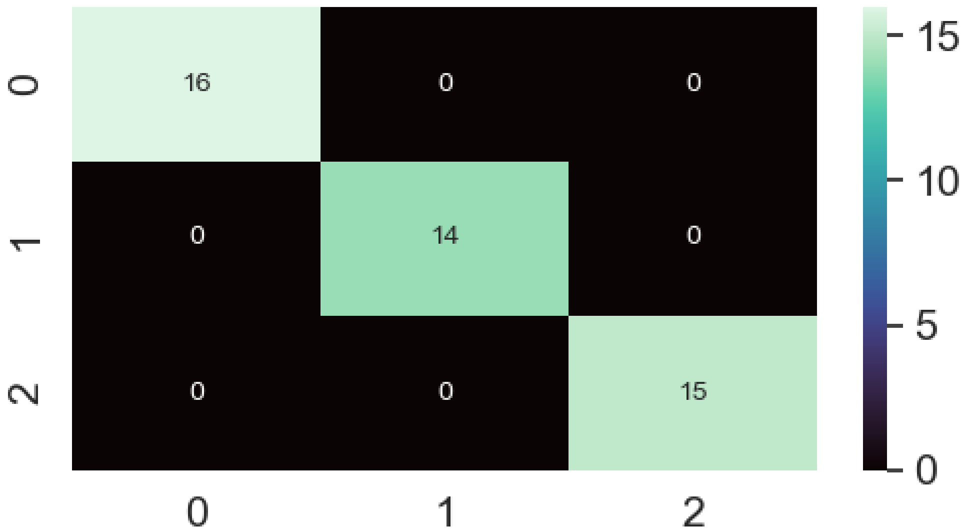
```
from sklearn.metrics import confusion_matrix

cm_nb = confusion_matrix(y_test, y_pred_nb)
cm_nb

df_cm_nb = pd.DataFrame(cm_nb, range(len(class_names.unique())), range(len(class_na

plt.figure(figsize=(6,3))
sns.set(font_scale=1.4) # for label size
sns.heatmap(df_cm_nb, annot=True, annot_kws={"size": 10}, cmap = sns.color_palette

plt.show()
```



1.3 Accuracy of the Naive Bayes classifier

In [181…

```
from sklearn.metrics import accuracy_score, precision_score,recall_score, f1_score

accuracy_test_nb = round(accuracy_score(y_test, y_pred_nb)* 100, 2)
accuracy_train_nb = round(nb_model.score(X_train, y_train)* 100, 2)
precision_nb = precision_score(y_test, y_pred_nb,average = 'micro')
recall_nb =  recall_score(y_test, y_pred_nb, average = 'micro')
f1_nb = f1_score(y_test,y_pred_nb,average = 'micro')

print("Accuracy testing: %.3f"  % accuracy_test_nb)
print("Accuracy training: %.3f" % accuracy_train_nb)
print('precision_NB : %.3f' %precision_nb)
print('recall_NB: %.3f' %recall_nb)
print('f1-score_NB : %.3f' %f1_nb)
```

```
Accuracy testing: 100.000
Accuracy training: 95.240
precision_NB : 1.000
recall_NB: 1.000
f1-score_NB : 1.000
```

2. Random forest classifier

2.1 train the model

In [182…

```
from sklearn.ensemble import RandomForestClassifier

# create a Gaussian RF classifier
rf_model = RandomForestClassifier(n_estimators=1000)

# fit the model to the iris dataset
rf_model.fit(X_train,y_train)

# make predictions on test set
y_pred_rf = rf_model.predict(X_test)
```

2.2 Confusion matrix and accuracy

Now that we have predictions, we can compute a confusion matrix and the accuracy of our trained RF classifier on the testing set.

In [183…

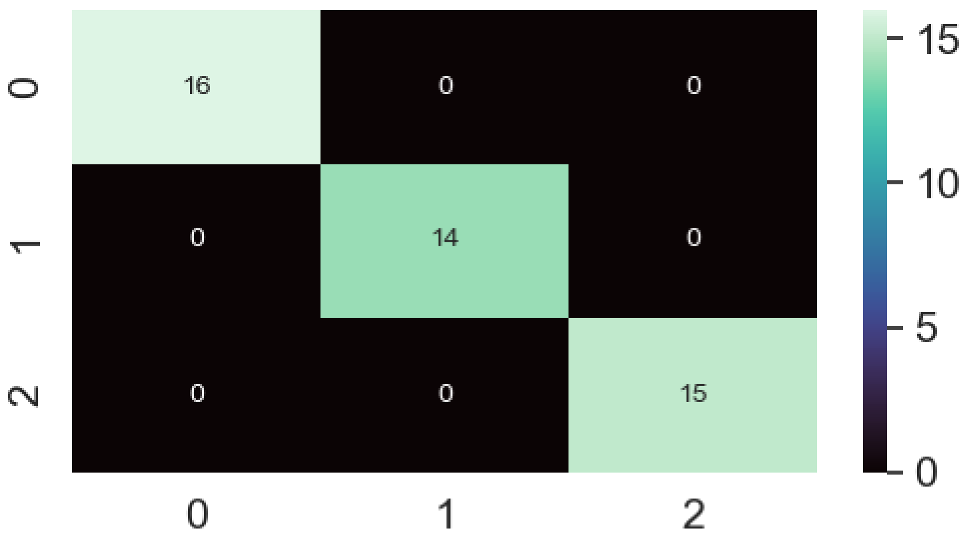
```
from sklearn.metrics import confusion_matrix

cm_rf = confusion_matrix(y_test, y_pred_rf)
cm_rf

df_cm_rf = pd.DataFrame(cm_rf, range(len(class_names.unique())), range(len(class_n

plt.figure(figsize=(6,3))
sns.set(font_scale=1.4) # for label size
sns.heatmap(df_cm_rf, annot=True, annot_kws={"size": 10}, cmap = sns.color_palette

plt.show()
```



2.3 Accuracy of the Random forest classifier

In [184…

```
from sklearn.metrics import accuracy_score, precision_score,recall_score, f1_score

accuracy_test_rf = round(accuracy_score(y_test, y_pred_rf)* 100, 2)
accuracy_train_rf = round(rf_model.score(X_train, y_train)* 100, 2)
precision_rf = precision_score(y_test, y_pred_rf,average = 'micro')
recall_rf =  recall_score(y_test, y_pred_rf, average = 'micro')
f1_rf = f1_score(y_test,y_pred_rf,average = 'micro')

print("Accuracy testing: %.3f"  % accuracy_test_rf)
print("Accuracy training: %.3f" % accuracy_train_rf)
print('precision_rf : %.3f' %precision_rf)
```

```
print('recall_rf: %.3f' %recall_rf)
print('f1-score_rf : %.3f' %f1_rf)
```

```
Accuracy testing: 100.000
Accuracy training: 100.000
precision_rf : 1.000
recall_rf: 1.000
f1-score_rf : 1.000
```

3. Multinomial Logistic Regression classifier

3.1 train the model

In [185…

```
from sklearn.linear_model import  LogisticRegression

# create a Logistic regresion model
lr_model = LogisticRegression(solver= 'lbfgs', max_iter=400, multi_class = 'multin

# fit the model to the iris dataset
lr_model.fit(X_train, y_train)

# make predictions on test set
y_pred_lr = lr_model.predict(X_test)
```

3.2 Confusion matrix and accuracy

Now that we have predictions, we can compute a confusion matrix and the accuracy of our trained SVM classifier on the testing set.

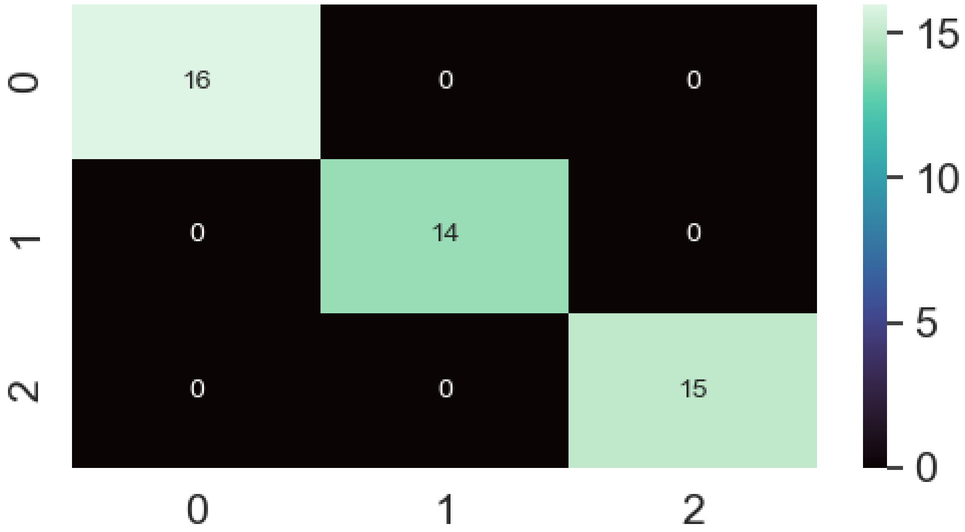
In [186…

```
from sklearn.metrics import confusion_matrix
cm_lr = confusion_matrix(y_test, y_pred_lr)
cm_lr

df_cm_lr = pd.DataFrame(cm_lr, range(len(class_names.unique())), range(len(class_n

plt.figure(figsize=(6,3))
sns.set(font_scale=1.4) # for label size
sns.heatmap(df_cm_lr, annot=True, annot_kws={"size": 10}, cmap = sns.color_palette

plt.show()
```



3.3 Accuracy of the Multinomial Logistic Regression classifier

In [215…

```
from sklearn.metrics import accuracy_score, precision_score,recall_score, f1_score

accuracy_test_lr = round(accuracy_score(y_test, y_pred_lr)* 100, 2)
accuracy_train_lr = round(lr_model.score(X_train, y_train)* 100, 2)
precision_lr = precision_score(y_test, y_pred_lr,average = 'micro')
recall_lr =  recall_score(y_test, y_pred_lr, average = 'micro')
f1_lr = f1_score(y_test,y_pred_lr,average = 'micro')

print("Accuracy testing: %.3f"  % accuracy_test_lr)
print("Accuracy training: %.3f" % accuracy_train_lr)
print('precision_lr : %.3f' %precision_lr)
print('recall_lr: %.3f' %recall_lr)
print('f1-score_lr : %.3f' %f1_lr)
```

```
Accuracy testing: 100.000
Accuracy training: 98.100
precision_lr : 1.000
recall_lr: 1.000
f1-score_lr : 1.000
```

4. Support Vector Machines classifier

4.1 train the model

In [188…

```
from sklearn.svm import SVC

# create a SVM model
svm_model = SVC(kernel = 'linear', random_state = 0)

# fit the model to the iris dataset
svm_model.fit(X_train, y_train)

# make predictions on test set
y_pred_svm = svm_model.predict(X_test)
```

4.2 Confusion matrix and accuracy

Now that we have predictions, we can compute a confusion matrix and the accuracy of our trained SVM classifier on the testing set.

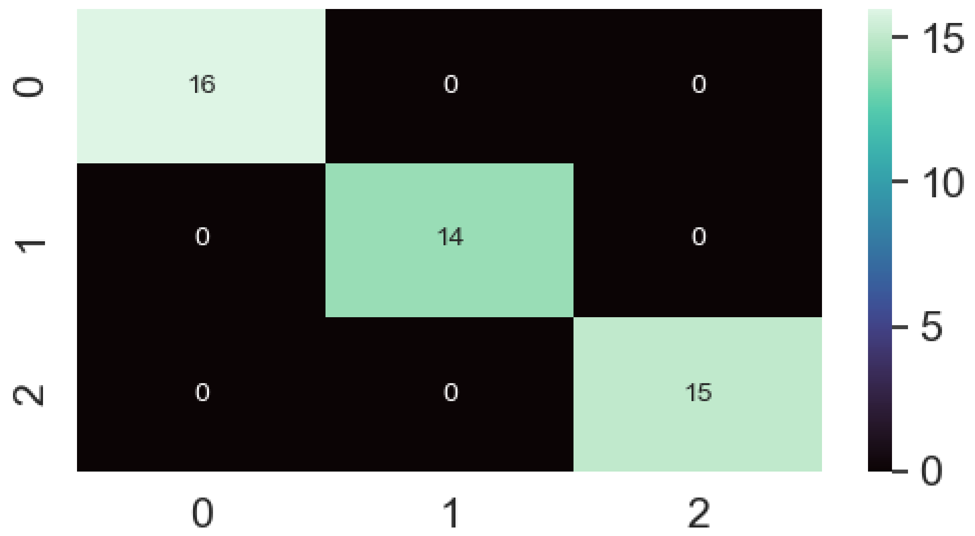
In [189…

```
from sklearn.metrics import confusion_matrix
cm_svm = confusion_matrix(y_test, y_pred_svm)
cm_svm

df_cm_svm = pd.DataFrame(cm_svm, range(len(class_names.unique())), range(len(class_

plt.figure(figsize=(6,3))
sns.set(font_scale=1.4) # for label size
sns.heatmap(df_cm_svm, annot=True, annot_kws={"size": 10}, cmap = sns.color_palett

plt.show()
```



4.3 Accuracy of the SVM classifier

In [190…

```
from sklearn.metrics import accuracy_score, precision_score,recall_score, f1_score

accuracy_test_svm = round(accuracy_score(y_test, y_pred_svm)* 100, 2)
accuracy_train_svm = round(svm_model.score(X_train, y_train)* 100, 2)
precision_svm = precision_score(y_test, y_pred_svm,average = 'micro')
recall_svm =  recall_score(y_test, y_pred_svm, average = 'micro')
f1_svm = f1_score(y_test,y_pred_svm,average = 'micro')

print("Accuracy testing: %.3f"  % accuracy_test_svm)
print("Accuracy training: %.3f" % accuracy_train_svm)
print('precision_svm : %.3f' %precision_svm)
print('recall_svm: %.3f' %recall_svm)
print('f1-score_svm : %.3f' %f1_svm)
```

```
Accuracy testing: 100.000
Accuracy training: 97.140
precision_svm : 1.000
recall_svm: 1.000
f1-score_svm : 1.000
```

5. K-Nearest Neighbors classifier

5.1 train the model

In [198…
```
from sklearn.neighbors import KNeighborsClassifier

# create a KNN model
knn_model = KNeighborsClassifier(n_neighbors = 5, weights = 'distance')

# fit the model to the iris dataset
knn_model.fit(X_train, y_train)

# make predictions on test set
y_pred_knn = knn_model.predict(X_test)
```

Out[198]:
```
array([0., 1., 2., 2., 1., 2., 1., 1., 1., 0., 1., 0., 0., 2., 1., 2., 2.,
       2., 1., 1., 2., 2., 1., 0., 1., 0., 0., 2., 0., 1., 1., 0., 0., 0.,
       0., 2., 0., 0., 2., 0., 0., 1., 2., 2., 2.])
```

5.2 Confusion matrix

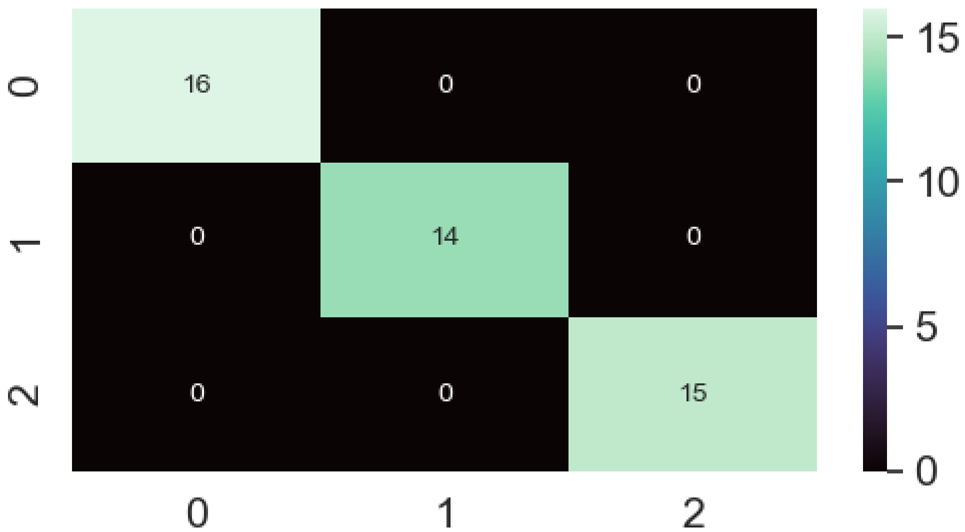
Now that we have predictions, we can compute a confusion matrix and the accuracy of our trained KNN classifier on the testing set.

In [192…
```
from sklearn.metrics import confusion_matrix
cm_knn = confusion_matrix(y_test, y_pred_knn)
cm_knn

df_cm_knn = pd.DataFrame(cm_knn, range(len(class_names.unique())), range(len(class_

plt.figure(figsize=(6,3))
sns.set(font_scale=1.4) # for label size
sns.heatmap(df_cm_knn, annot=True, annot_kws={"size": 10}, cmap = sns.color_palett

plt.show()
```



5.3 Accuracy of the KNN classifier

In [193…
```
from sklearn.metrics import accuracy_score, precision_score,recall_score, f1_score

accuracy_test_knn = round(accuracy_score(y_test, y_pred_knn)* 100, 2)
accuracy_train_knn = round(knn_model.score(X_train, y_train)* 100, 2)
precision_knn = precision_score(y_test, y_pred_knn,average = 'micro')
recall_knn =  recall_score(y_test, y_pred_knn, average = 'micro')
f1_knn = f1_score(y_test,y_pred_knn,average = 'micro')
```

```
print("Accuracy testing: %.3f"  % accuracy_test_knn)
print("Accuracy training: %.3f" % accuracy_train_knn)
print('precision_knn : %.3f' %precision_knn)
print('recall_knn: %.3f' %recall_knn)
print('f1-score_knn : %.3f' %f1_knn)
```

```
Accuracy testing: 100.000
Accuracy training: 100.000
precision_knn : 1.000
recall_knn: 1.000
f1-score_knn : 1.000
```

6. Neural Network (MLP) classifier

6.1 train the model

In [199…

```
from sklearn.neural_network import MLPClassifier

mlp_model = MLPClassifier(hidden_layer_sizes=(10, 5), max_iter=1000)
# fit the model to the iris dataset
mlp_model.fit(X_train, y_train)

# make predictions on test set
y_pred_mlp = mlp_model.predict(X_test)
```

6.2 Confusion matrix

Now that we have predictions, we can compute a confusion matrix and the accuracy of our trained MLP classifier on the testing set.

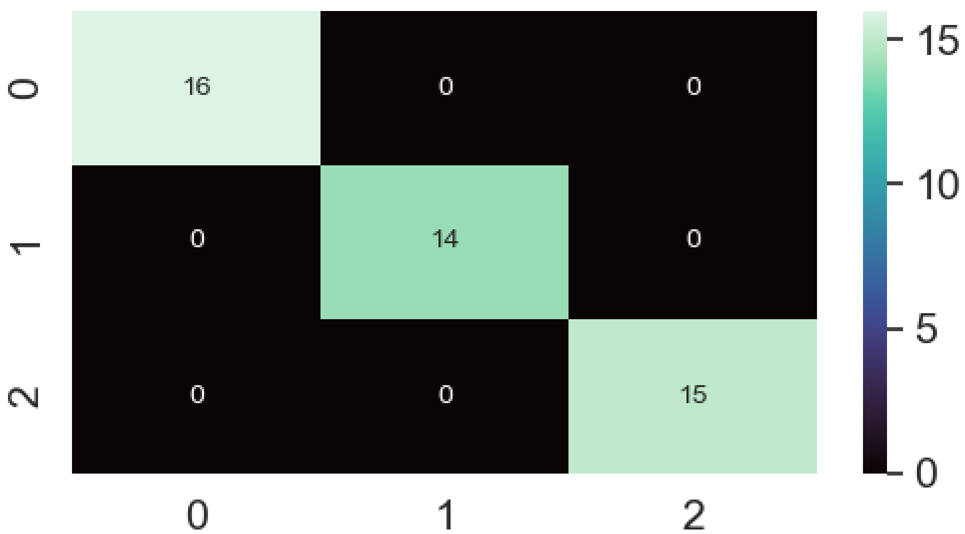
In [201…

```
from sklearn.metrics import confusion_matrix
cm_mlp = confusion_matrix(y_test, y_pred_mlp)
cm_mlp

df_cm_mlp = pd.DataFrame(cm_mlp, range(len(class_names.unique())), range(len(class_

plt.figure(figsize=(6,3))
sns.set(font_scale=1.4) # for label size
sns.heatmap(df_cm_mlp, annot=True, annot_kws={"size": 10}, cmap = sns.color_palett

plt.show()
```



6.3 Accuracy of the MLP classifier

In [204...

```
from sklearn.metrics import accuracy_score, precision_score,recall_score, f1_score

accuracy_test_mlp = round(accuracy_score(y_test, y_pred_mlp)* 100, 2)
accuracy_train_mlp = round(knn_model.score(X_train, y_train)* 100, 2)
precision_mlp = precision_score(y_test, y_pred_mlp,average = 'micro')
recall_mlp =  recall_score(y_test, y_pred_mlp, average = 'micro')
f1_mlp = f1_score(y_test,y_pred_mlp,average = 'micro')

print("Accuracy testing: %.3f"  % accuracy_test_mlp)
print("Accuracy training: %.3f" % accuracy_train_mlp)
print('precision_mlp : %.3f' %precision_mlp)
print('recall_mlp: %.3f' %recall_mlp)
print('f1-score_mlp : %.3f' %f1_mlp)
```

```
Accuracy testing: 100.000
Accuracy training: 100.000
precision_mlp : 1.000
recall_mlp: 1.000
f1-score_mlp : 1.000
```

7. XGboost classifier

7.1 train the model

In [212...

```
import sys
!{sys.executable} -m pip install xgboost
from xgboost import XGBClassifier

xgb_model = XGBClassifier(n_estimators=100, learning_rate= 0.3)
# fit the model to the iris dataset
xgb_model.fit(X_train, y_train)

# make predictions on test set
y_pred_xgb = xgb_model.predict(X_test)
```

```
Requirement already satisfied: xgboost in c:\users\julia\.conda\new\lib\site-packa
ges (1.7.4)
Requirement already satisfied: scipy in c:\users\julia\.conda\new\lib\site-package
s (from xgboost) (1.9.1)
Requirement already satisfied: numpy in c:\users\julia\.conda\new\lib\site-package
s (from xgboost) (1.21.5)
```

7.2 Confusion matrix

Now that we have predictions, we can compute a confusion matrix and the accuracy of our trained XGboost classifier on the testing set.

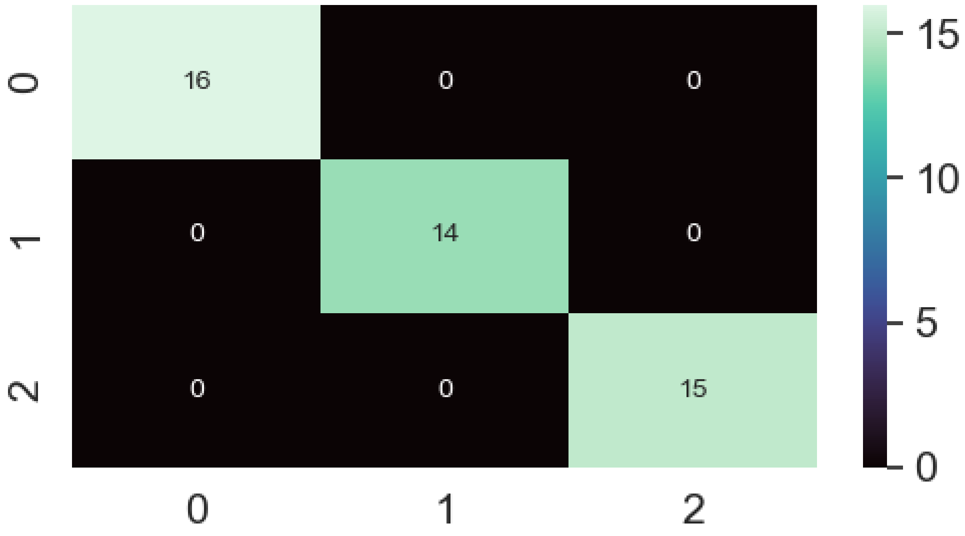
In [213...

```
from sklearn.metrics import confusion_matrix
cm_xgb = confusion_matrix(y_test, y_pred_xgb)
cm_xgb

df_cm_xgb = pd.DataFrame(cm_xgb, range(len(class_names.unique())), range(len(class_

plt.figure(figsize=(6,3))
sns.set(font_scale=1.4) # for label size
sns.heatmap(df_cm_xgb, annot=True, annot_kws={"size": 10}, cmap = sns.color_palett
```

```
plt.show()
```



7.3 Accuracy of the XGboost classifier

In [214…

```
from sklearn.metrics import accuracy_score, precision_score,recall_score, f1_score

accuracy_test_xgb = round(accuracy_score(y_test, y_pred_xgb)* 100, 2)
accuracy_train_xgb = round(knn_model.score(X_train, y_train)* 100, 2)
precision_xgb = precision_score(y_test, y_pred_xgb,average = 'micro')
recall_xgb =  recall_score(y_test, y_pred_xgb, average = 'micro')
f1_xgb = f1_score(y_test,y_pred_xgb,average = 'micro')

print("Accuracy testing: %.3f"  % accuracy_test_xgb)
print("Accuracy training: %.3f" % accuracy_train_xgb)
print('precision_xgb : %.3f' %precision_xgb)
print('recall_xgb: %.3f' %recall_xgb)
print('f1-score_xgb : %.3f' %f1_xgb)
```

```
Accuracy testing: 100.000
Accuracy training: 100.000
precision_xgb : 1.000
recall_xgb: 1.000
f1-score_xgb : 1.000
```

In [ ]: