PS13

January 24, 2023

1 Decision tree classifier

1.1 Load Iris dataset

[1]:
```
from sklearn.datasets import load_iris
```

[2]:
```
iris = load_iris()
X = iris.data
y = iris.target

print(X.shape)
print(y.shape)
```

```
(150, 4)
(150,)
```

[3]:
```
aa = iris.feature_names

print(aa[1])
```

```
sepal width (cm)
```

[4]:
```
aa = iris.feature_names

string_a = ', '.join(aa)
print(string_a)
#print(iris.DESCR)
#print(iris.filename)
#print(iris)
```

```
sepal length (cm), sepal width (cm), petal length (cm), petal width (cm)
```

[5]:
```
print(iris.feature_names)
```

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

[6]:
```
from sklearn.model_selection import train_test_split
from sklearn.tree import DecisionTreeClassifier
```

[7]:
```
# train-test data split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2)
```

[8]:
```
tree_clf = DecisionTreeClassifier(max_depth=2)

# training
tree_clf.fit(X_train, y_train)
```

[8]:
```
DecisionTreeClassifier(max_depth=2)
```

[9]:
```
# evaluation
test_performance = tree_clf.score(X_test, y_test)
print(test_performance)
```

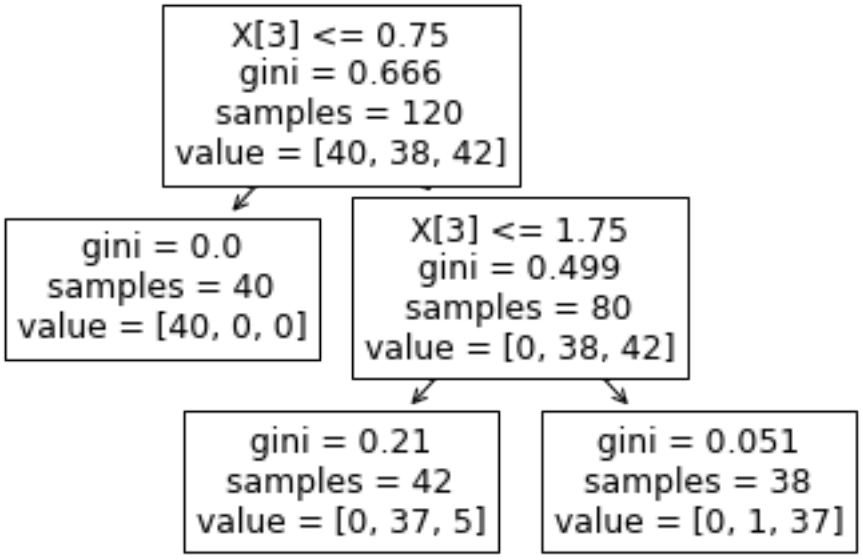
```
1.0
```

1.1.1 Decision tree visualization

[10]:
```
from sklearn.tree import plot_tree
```

[11]:
```
plot_tree(tree_clf)
```

[11]:
```
[Text(0.4, 0.8333333333333334, 'X[3] <= 0.75\ngini = 0.666\nsamples = 120\nvalue
= [40, 38, 42]'),
 Text(0.2, 0.5, 'gini = 0.0\nsamples = 40\nvalue = [40, 0, 0]'),
 Text(0.6, 0.5, 'X[3] <= 1.75\ngini = 0.499\nsamples = 80\nvalue = [0, 38,
42]'),
 Text(0.4, 0.16666666666666666, 'gini = 0.21\nsamples = 42\nvalue = [0, 37,
5]'),
 Text(0.8, 0.16666666666666666, 'gini = 0.051\nsamples = 38\nvalue = [0, 1,
37]')]
```



1.1.2 Feature importance

[12]:
```
aa = tree_clf.feature_importances_
#print(aa)
#print(tree_clf.feature_importances_)

bb = zip(iris.feature_names, tree_clf.feature_importances_)
print(bb)
```

```
<zip object at 0x000002EFD6830640>
```

[13]:
```
for name, score in zip(iris.feature_names, tree_clf.feature_importances_):
    print(name, ': ', score)

print(dict(zip(iris.feature_names, tree_clf.feature_importances_)))
```

```
sepal length (cm) :  0.0
sepal width (cm) :  0.0
petal length (cm) :  0.0
petal width (cm) :  1.0
{'sepal length (cm)': 0.0, 'sepal width (cm)': 0.0, 'petal length (cm)': 0.0,
'petal width (cm)': 1.0}
```

[17]:
```
# increasing order
sorted_idx = tree_clf.feature_importances_.argsort()

print(sorted_idx)
```

```
print(np.asarray(iris.feature_names)[sorted_idx])

# reverse (decreasing order)
#print(tree_clf.feature_importances_.argsort()[::-1])
```

```
[0 1 2 3]
['sepal length (cm)' 'sepal width (cm)' 'petal length (cm)'
 'petal width (cm)']
```

[18]:
```
#sorted_idx = tree_clf.feature_importances_.argsort()[::-1]
#sorted_idx = tree_clf.feature_importances_.argsort()
#print(sorted_idx)
```

[19]:
```
import numpy as np

print(np.asarray(iris.feature_names)[sorted_idx])

bb = np.asarray(iris.feature_names)
cc = iris.feature_names
print(bb[sorted_idx])
```

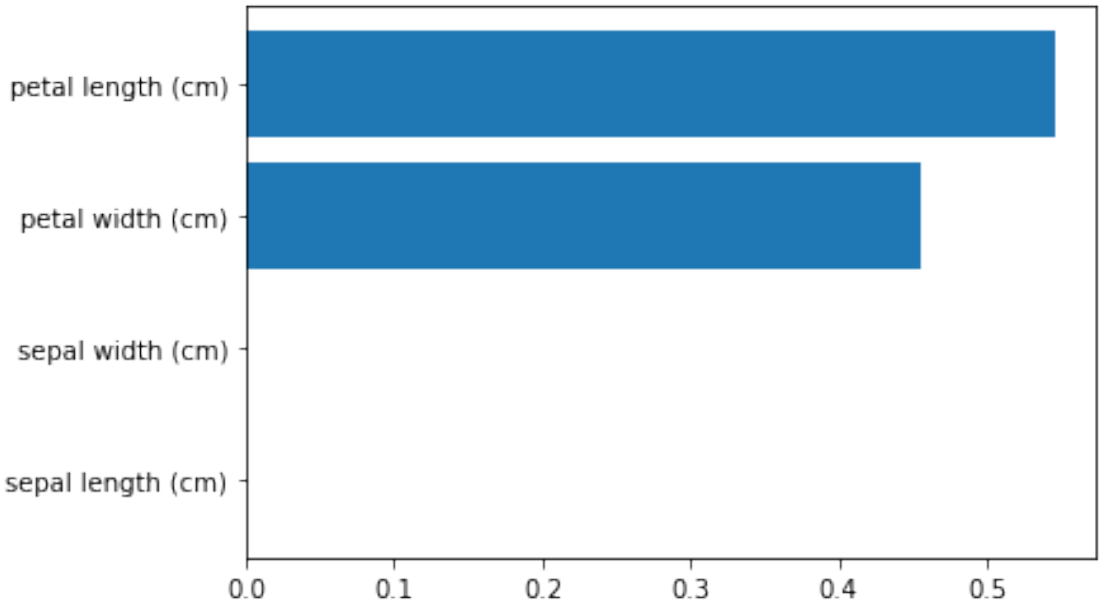
```
['sepal length (cm)' 'sepal width (cm)' 'petal length (cm)'
 'petal width (cm)']
['sepal length (cm)' 'sepal width (cm)' 'petal length (cm)'
 'petal width (cm)']
```

[20]:
```
print(iris.feature_names)
```

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

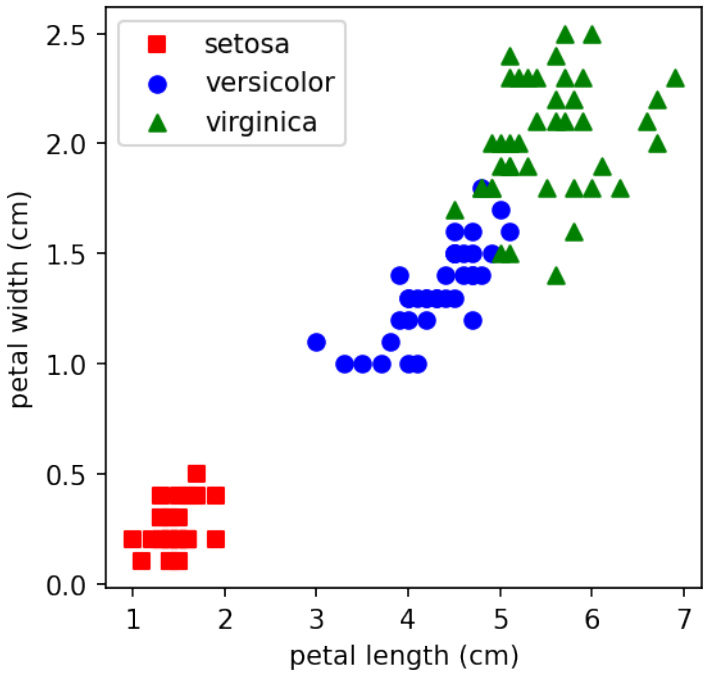
[95]:
```
import matplotlib.pyplot as plt

#plt.barh(np.asarray(iris.feature_names)[sorted_idx][::-1],
#         tree_clf.feature_importances_[sorted_idx][::-1])

plt.barh(np.asarray(iris.feature_names)[sorted_idx],
         tree_clf.feature_importances_[sorted_idx])
```

[95]:
```
<BarContainer object of 4 artists>
```



1.2 Decision Boundary

[21]:
```
import matplotlib.pyplot as plt

X_y_0 = X_train[y_train==0] # setosa
X_y_1 = X_train[y_train==1] # versicolor
X_y_2 = X_train[y_train==2] # virginica

plt.figure(figsize=(4, 4), dpi=150)

plt.scatter(X_y_0[:, 2], X_y_0[:, 3],
            c='red',label='setosa',marker='s')
plt.scatter(X_y_1[:, 2], X_y_1[:, 3],
            c='blue',label='versicolor',marker='o')
plt.scatter(X_y_2[:, 2], X_y_2[:, 3],
            c='green', label='virginica',marker='^')
plt.xlabel(iris.feature_names[2])
plt.ylabel(iris.feature_names[3])
plt.legend()
plt.show()
```



[22]:
```
aa = np.array([1, 2, 3])
bb = np.array([4, 5, 6])

cc = np.c_[aa.reshape(-1,1), bb.reshape(-1,1)]
print(cc)
```

```
[[1 4]
 [2 5]
 [3 6]]
```

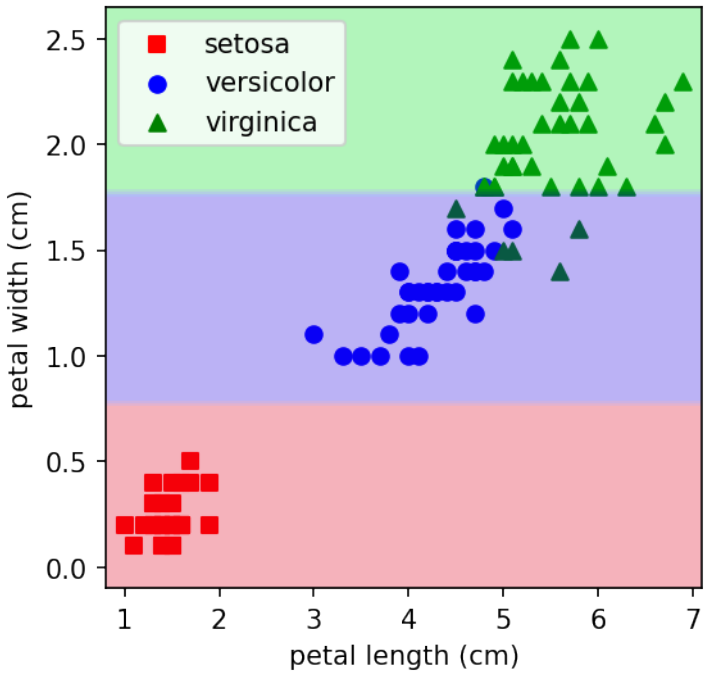
[23]:
```
zz_min, zz_max = X_train[:, 2].min() - 0.2, X_train[:, 2].max() + 0.2
ww_min, ww_max = X_train[:, 3].min() - 0.2, X_train[:, 3].max() + 0.2


zz = np.arange(zz_min, zz_max, 0.05)
ww = np.arange(ww_min, ww_max, 0.05)

zz, ww = np.meshgrid(zz, ww, indexing='ij')

print(zz)
print(ww)
```

```
[[0.8  0.8  0.8  … 0.8  0.8  0.8 ]
 [0.85 0.85 0.85 … 0.85 0.85 0.85]
 [0.9  0.9  0.9  … 0.9  0.9  0.9 ]
```

```
 …
 [7.   7.   7.   … 7.   7.   7.  ]
 [7.05 7.05 7.05 … 7.05 7.05 7.05]
 [7.1  7.1  7.1  … 7.1  7.1  7.1 ]]
[[-0.1  -0.05  0.   …  2.55  2.6   2.65]
 [-0.1  -0.05  0.   …  2.55  2.6   2.65]
 [-0.1  -0.05  0.   …  2.55  2.6   2.65]
 …
 [-0.1  -0.05  0.   …  2.55  2.6   2.65]
 [-0.1  -0.05  0.   …  2.55  2.6   2.65]
 [-0.1  -0.05  0.   …  2.55  2.6   2.65]]
```

[24]:
```
from matplotlib.colors import LinearSegmentedColormap
import numpy as np

plt.figure(figsize=(4, 4), dpi=150)
plt.scatter(X_y_0[:, 2], X_y_0[:, 3],
            c='red',label='setosa',marker='s')
plt.scatter(X_y_1[:, 2], X_y_1[:, 3],
            c='blue',label='versicolor',marker='o')
plt.scatter(X_y_2[:, 2], X_y_2[:, 3],
            c='green', label='virginica',marker='^')
plt.xlabel(iris.feature_names[2])
plt.ylabel(iris.feature_names[3])
plt.legend()

# Draw a decision boundary
colors = [(1, 0, 0), (0, 0, 1), (0, 1, 0)]

zz_min, zz_max = X_train[:, 2].min() - 0.2, X_train[:, 2].max() + 0.2
ww_min, ww_max = X_train[:, 3].min() - 0.2, X_train[:, 3].max() + 0.2

# xx: sepal length, yy: sepal width, ww: petal width, zz: petal length
zz, ww = np.meshgrid(np.arange(zz_min, zz_max, 0.05),
                     np.arange(ww_min, ww_max, 0.05),indexing='ij')
xx = np.zeros_like(zz)
yy = np.zeros_like(zz)

#Z = tree_clf.predict(np.c_[xx.ravel().reshape(-1, 1),
#                           yy.ravel().reshape(-1, 1),
#                           zz.ravel().reshape(-1, 1),
#                           ww.ravel().reshape(-1, 1)])
Z = tree_clf.predict(np.c_[xx.reshape(-1, 1),
                           yy.reshape(-1, 1),
                           zz.reshape(-1, 1),
                           ww.reshape(-1, 1)])
```

```
Z = Z.reshape(zz.shape)

plt.contourf(zz, ww, Z,
             cmap=LinearSegmentedColormap.from_list('rgb', colors),
             alpha=0.3)
plt.show()
```



[ ]:

[ ]: