## DINESH KUMAR

## LAB 8:ANIMAL CLASSIFICATION USING DECISION TREE

In [3]:
```
import pandas as pd
```

In [4]:
```
#STEP 1:
```

In [5]:
```
df=pd.read_csv("animal.csv")
df.head()
```

Out[5]:

|  | Toothed | hair | breathes | legs | species |
|---|---|---|---|---|---|
| **0** | True | True | True | True | Mammal |
| **1** | True | True | True | True | Mammal |
| **2** | True | False | True | False | Reptile |
| **3** | False | True | True | True | Mammal |
| **4** | True | True | True | True | Mammal |

In [6]:
```
#STEP 2:
```

In [7]:
```
from sklearn.tree import DecisionTreeClassifier
```

In [8]:
```
DT=DecisionTreeClassifier(criterion='entropy')
```

In [9]:
```
from sklearn.model_selection import train_test_split
```

In [10]:
```
x=df.drop("species",axis=1)
y=df['species']
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.33)
```

In [11]:

```
x
```

Out[11]:

|   | Toothed | hair | breathes | legs |
|---|---|---|---|---|
| **0** | True | True | True | True |
| **1** | True | True | True | True |
| **2** | True | False | True | False |
| **3** | False | True | True | True |
| **4** | True | True | True | True |
| **5** | True | True | True | True |
| **6** | True | False | False | False |
| **7** | True | False | True | False |
| **8** | True | True | True | True |
| **9** | False | False | True | True |

In [12]:

```
y
```

Out[12]:

```
0     Mammal
1     Mammal
2    Reptile
3     Mammal
4     Mammal
5     Mammal
6    Reptile
7    Reptile
8     Mammal
9    Reptile
Name: species, dtype: object
```

In [13]:

```
DT.fit(x_train,y_train)
```

Out[13]:

```
DecisionTreeClassifier(criterion='entropy')
```

In [14]:

```
y_pred=DT.predict(x_test)
```

In [15]:

```
from sklearn.metrics import accuracy_score as acs
```

In [16]:

```
acc=acs(y_test,y_pred)
```

In [17]:

```
acc
```

Out[17]:

```
1.0
```

In [18]:
```
from sklearn.metrics import classification_report
```

In [19]:
```
cr=classification_report(y_pred,y_test)
cr
```

Out[19]:
```
'              precision    recall  f1-score   support\n\n      Mammal
1.00      1.00      1.00         3\n     Reptile       1.00      1.00
1.00         1\n\n    accuracy                           1.00         4\n
macro avg       1.00      1.00      1.00         4\nweighted avg       1.00
1.00      1.00         4\n'
```

In [20]:
```
from sklearn.tree import export_graphviz
from sklearn import tree
```

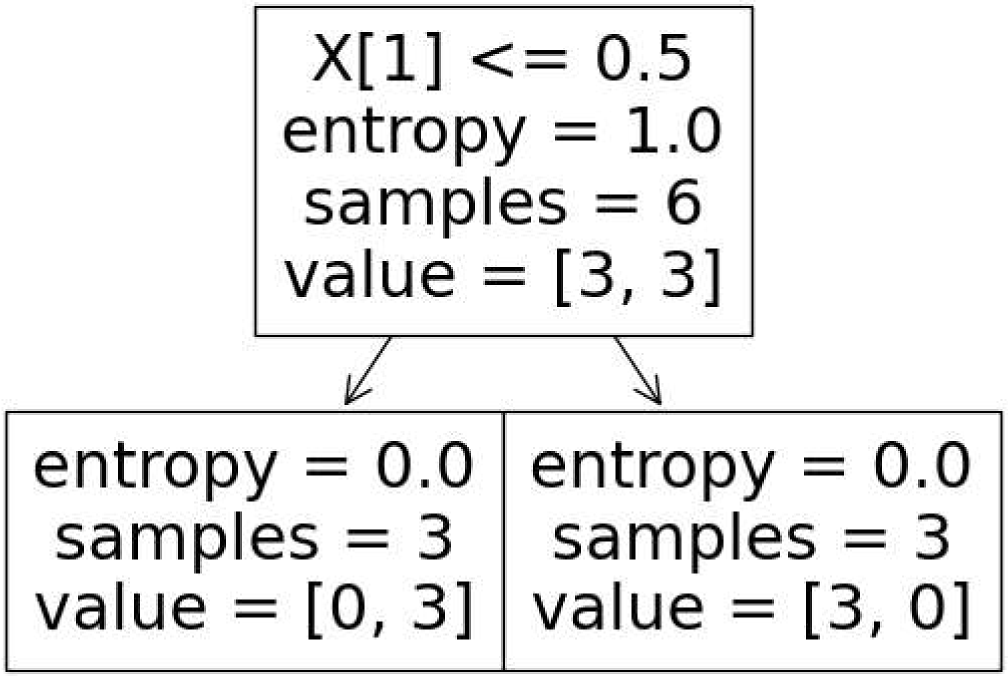
In [21]:
```
with open("tree1.dot",'w')as f:
    f=tree.export_graphviz(DT,out_file=f,max_depth=4,impurity=False,feature_n
```

In [22]:
```
!type tree1.dot
```

```
digraph Tree {
node [shape=box, style="filled", color="black", fontname="helvetica"] ;
edge [fontname="helvetica"] ;
0 [label="hair <= 0.5\nsamples = 6\nvalue = [3, 3]\nclass = Reptile", fillco
lor="#ffffff"] ;
1 [label="samples = 3\nvalue = [0, 3]\nclass = Mammal", fillcolor="#399de5"]
;
0 -> 1 [labeldistance=2.5, labelangle=45, headlabel="True"] ;
2 [label="samples = 3\nvalue = [3, 0]\nclass = Reptile", fillcolor="#e5813
9"] ;
0 -> 2 [labeldistance=2.5, labelangle=-45, headlabel="False"] ;
}
```

In [23]:
```
tree.plot_tree(DT)
```

Out[23]:
```
[Text(0.5, 0.75, 'X[1] <= 0.5\nentropy = 1.0\nsamples = 6\nvalue = [3, 3]'),
 Text(0.25, 0.25, 'entropy = 0.0\nsamples = 3\nvalue = [0, 3]'),
 Text(0.75, 0.25, 'entropy = 0.0\nsamples = 3\nvalue = [3, 0]')]
```



In [24]:
```
#STEP 3:
```

In [25]:
```
test=pd.read_csv("animaltest.csv")
test
```

Out[25]:

| | Toothed | hair | breathes | legs |
|---|---|---|---|---|
| 0 | False | False | True | False |
| 1 | False | True | True | True |
| 2 | True | False | True | True |

In [26]:
```
#STEP 4:
```

In [27]:
```
DT
```

Out[27]:
```
DecisionTreeClassifier(criterion='entropy')
```

In [28]:
```
y_pred=DT.predict(test)
```

In [29]:
```
y_pred
```

Out[29]:
```
array(['Reptile', 'Mammal', 'Reptile'], dtype=object)
```

In [30]:
```
#STEP 5:
```

In [31]:
```
DTC=DecisionTreeClassifier(criterion='gini')
```

In [32]:
```
DTC.fit(x,y)
```

Out[32]:
```
DecisionTreeClassifier()
```

In [33]:
```
y_pred1=DTC.predict(test)
```

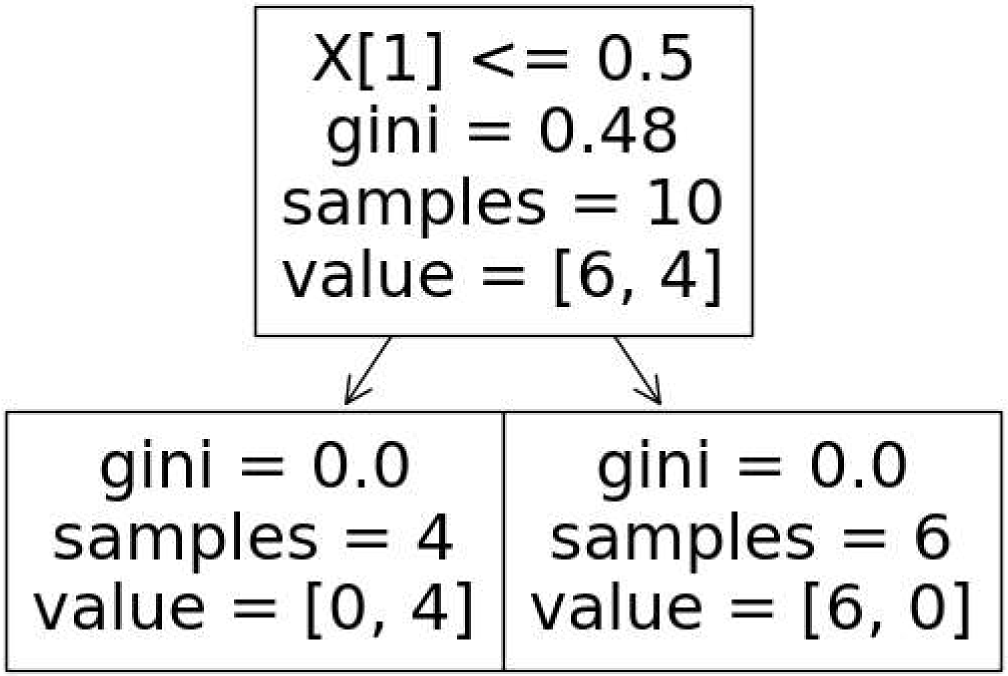
In [34]:
```
y_pred1
```

Out[34]:
```
array(['Reptile', 'Mammal', 'Reptile'], dtype=object)
```

In [35]:
```
with open("tree2.dot",'w')as f:
    f=tree.export_graphviz(DT,out_file=f,max_depth=4,impurity=False,feature_n
```

In [36]:
```
tree.plot_tree(DTC)
```

Out[36]:
```
[Text(0.5, 0.75, 'X[1] <= 0.5\ngini = 0.48\nsamples = 10\nvalue = [6, 4]'),
 Text(0.25, 0.25, 'gini = 0.0\nsamples = 4\nvalue = [0, 4]'),
 Text(0.75, 0.25, 'gini = 0.0\nsamples = 6\nvalue = [6, 0]')]
```



In [37]:
```
#STEP 6:
```

In [38]:
```
zoo=pd.read_csv("zoo.data")
```

In [39]:
```
zoo.head()
```

Out[39]:

| | aardvark | 1 | 0 | 0.1 | 1.1 | 0.2 | 0.3 | 1.2 | 1.3 | 1.4 | 1.5 | 0.4 | 0.5 | 4 | 0.6 | 0.7 | 1.6 | 1.7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | antelope | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 4 | 1 | 0 | 1 | 1 |
| **1** | bass | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 4 |
| **2** | bear | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 1 |
| **3** | boar | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 4 | 1 | 0 | 1 | 1 |
| **4** | buffalo | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 4 | 1 | 0 | 1 | 1 |

In [40]:
```
X=zoo.drop(['aardvark','1.7'],axis=1)
```

In [41]:
```
y=zoo['1.7'].values
```

In [42]:
```
X1_train, X1_test, y1_train, y1_test = train_test_split(X, y, test_size=0.33,
zoo_entropy = DecisionTreeClassifier(criterion ="entropy")
zoo_entropy.fit(X1_train,y1_train)
```

Out[42]:
```
DecisionTreeClassifier(criterion='entropy')
```

In [43]:
```
y1_pred = zoo_entropy.predict(X1_test)
```

In [44]:
```
train_acc=zoo_entropy.predict(X1_train)
train_acc
```

Out[44]:
```
array([1, 5, 1, 1, 2, 1, 1, 4, 3, 2, 6, 1, 2, 4, 2, 6, 1, 4, 4, 1, 1, 1,
       6, 4, 1, 6, 7, 2, 1, 1, 2, 3, 4, 2, 7, 7, 3, 2, 6, 1, 1, 7, 1, 2,
       2, 4, 2, 5, 4, 4, 1, 6, 1, 2, 7, 5, 2, 6, 2, 1, 1, 1, 6, 1, 1, 1,
       1], dtype=int64)
```

In [45]:
```
test_acc=zoo_entropy.predict(X1_test)
test_acc
```

Out[45]:
```
array([1, 2, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1, 2, 7, 4, 1, 2, 5, 4, 1, 1, 5,
       1, 1, 7, 1, 4, 2, 2, 7, 4, 7, 3], dtype=int64)
```

In [46]:
```
print("Train Accuracy:", acs(y1_train, zoo_entropy.predict(X1_train)))
print("Test Accuracy:", acs(y1_test, zoo_entropy.predict(X1_test)))
```

```
Train Accuracy: 1.0
Test Accuracy: 0.9090909090909091
```

In [47]:
```
acc = acs(y1_test, y1_pred)
print("Accuracy score :",acc)
```

```
Accuracy score : 0.9090909090909091
```

In [48]:

```
clf_report= classification_report(y1_test, y1_pred)
print("Classification report: ",clf_report)
```

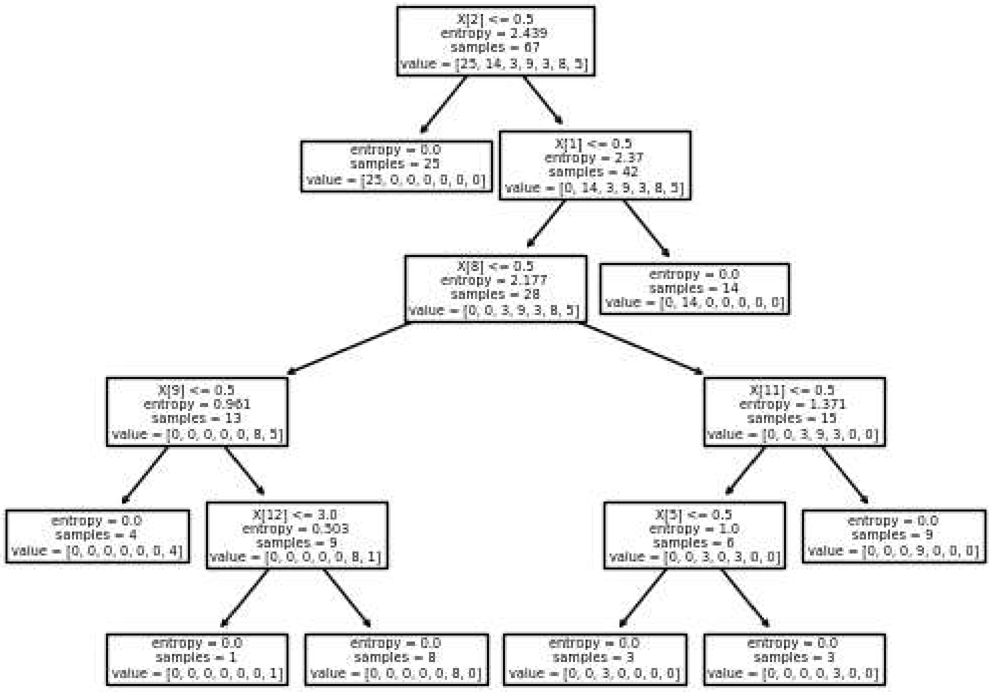
```
Classification report:                precision    recall  f1-score   suppor
t

           1       0.88      0.93      0.90        15
           2       1.00      1.00      1.00         6
           3       1.00      0.50      0.67         2
           4       1.00      1.00      1.00         4
           5       0.50      1.00      0.67         1
           7       1.00      0.80      0.89         5

    accuracy                           0.91        33
   macro avg       0.90      0.87      0.85        33
weighted avg       0.93      0.91      0.91        33
```

```
In [49]: tree.plot_tree(zoo_entropy)
```

```
Out[49]: [Text(0.5, 0.9166666666666666, 'X[2] <= 0.5\nentropy = 2.439\nsamples = 67\n
         value = [25, 14, 3, 9, 3, 8, 5]'),
          Text(0.4, 0.75, 'entropy = 0.0\nsamples = 25\nvalue = [25, 0, 0, 0, 0, 0,
         0]'),
          Text(0.6, 0.75, 'X[1] <= 0.5\nentropy = 2.37\nsamples = 42\nvalue = [0, 14,
         3, 9, 3, 8, 5]'),
          Text(0.5, 0.5833333333333334, 'X[8] <= 0.5\nentropy = 2.177\nsamples = 28\n
         value = [0, 0, 3, 9, 3, 8, 5]'),
          Text(0.2, 0.4166666666666667, 'X[9] <= 0.5\nentropy = 0.961\nsamples = 13\n
         value = [0, 0, 0, 0, 0, 8, 5]'),
          Text(0.1, 0.25, 'entropy = 0.0\nsamples = 4\nvalue = [0, 0, 0, 0, 0, 0,
         4]'),
          Text(0.3, 0.25, 'X[12] <= 3.0\nentropy = 0.503\nsamples = 9\nvalue = [0, 0,
         0, 0, 0, 8, 1]'),
          Text(0.2, 0.08333333333333333, 'entropy = 0.0\nsamples = 1\nvalue = [0, 0,
         0, 0, 0, 0, 1]'),
          Text(0.4, 0.08333333333333333, 'entropy = 0.0\nsamples = 8\nvalue = [0, 0,
         0, 0, 0, 8, 0]'),
          Text(0.8, 0.4166666666666667, 'X[11] <= 0.5\nentropy = 1.371\nsamples = 15
         \nvalue = [0, 0, 3, 9, 3, 0, 0]'),
          Text(0.7, 0.25, 'X[5] <= 0.5\nentropy = 1.0\nsamples = 6\nvalue = [0, 0, 3,
         0, 3, 0, 0]'),
          Text(0.6, 0.08333333333333333, 'entropy = 0.0\nsamples = 3\nvalue = [0, 0,
         3, 0, 0, 0, 0]'),
          Text(0.8, 0.08333333333333333, 'entropy = 0.0\nsamples = 3\nvalue = [0, 0,
         0, 0, 3, 0, 0]'),
          Text(0.9, 0.25, 'entropy = 0.0\nsamples = 9\nvalue = [0, 0, 0, 9, 0, 0,
         0]'),
          Text(0.7, 0.5833333333333334, 'entropy = 0.0\nsamples = 14\nvalue = [0, 14,
         0, 0, 0, 0, 0]')]
```



```
In [50]: X2_train, X2_test, y2_train, y2_test = train_test_split(X, y, test_size=0.33,
         zoo2_entropy = DecisionTreeClassifier(criterion ="gini")
         zoo2_entropy.fit(X2_train,y2_train)

Out[50]: DecisionTreeClassifier()
```

```
In [51]: y2_pred = zoo2_entropy.predict(X2_test)
```

```
In [52]: train_acc=zoo2_entropy.predict(X2_train)
         train_acc

Out[52]: array([1, 5, 1, 1, 2, 1, 1, 4, 3, 2, 6, 1, 2, 4, 2, 6, 1, 4, 4, 1, 1, 1,
                6, 4, 1, 6, 7, 2, 1, 1, 2, 3, 4, 2, 7, 7, 3, 2, 6, 1, 1, 7, 1, 2,
                2, 4, 2, 5, 4, 4, 1, 6, 1, 2, 7, 5, 2, 6, 2, 1, 1, 1, 6, 1, 1, 1,
                1], dtype=int64)
```

```
In [53]: test_acc=zoo2_entropy.predict(X2_train)
         test_acc

Out[53]: array([1, 5, 1, 1, 2, 1, 1, 4, 3, 2, 6, 1, 2, 4, 2, 6, 1, 4, 4, 1, 1, 1,
                6, 4, 1, 6, 7, 2, 1, 1, 2, 3, 4, 2, 7, 7, 3, 2, 6, 1, 1, 7, 1, 2,
                2, 4, 2, 5, 4, 4, 1, 6, 1, 2, 7, 5, 2, 6, 2, 1, 1, 1, 6, 1, 1, 1,
                1], dtype=int64)
```

```
In [54]: print("Train Accuracy:", acs(y2_train, zoo2_entropy.predict(X2_train)))
         print("Test Accuracy:", acs(y2_test, zoo2_entropy.predict(X2_test)))

         Train Accuracy: 1.0
         Test Accuracy: 0.9090909090909091
```

```
In [55]: acc = acs(y2_test, y2_pred)
         print("Accuracy score :",acc)

         Accuracy score : 0.9090909090909091
```

In [56]:
```
clf_report= classification_report(y2_test, y2_pred)
print("Classification report: ",clf_report)
```

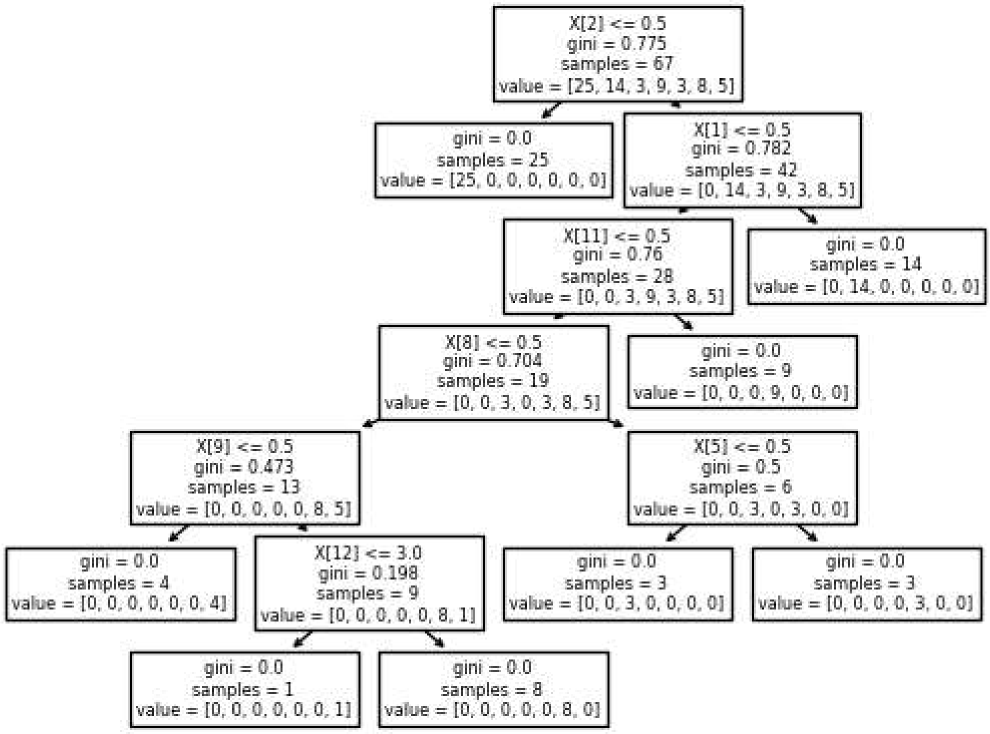
```
Classification report:                precision    recall  f1-score   suppor
t

           1       0.88      0.93      0.90        15
           2       1.00      1.00      1.00         6
           3       1.00      0.50      0.67         2
           4       1.00      1.00      1.00         4
           5       0.50      1.00      0.67         1
           7       1.00      0.80      0.89         5

    accuracy                           0.91        33
   macro avg       0.90      0.87      0.85        33
weighted avg       0.93      0.91      0.91        33
```

```
In [57]: tree.plot_tree(zoo2_entropy)
```

```
Out[57]: [Text(0.625, 0.9285714285714286, 'X[2] <= 0.5\ngini = 0.775\nsamples = 67\nv
alue = [25, 14, 3, 9, 3, 8, 5]'),
 Text(0.5, 0.7857142857142857, 'gini = 0.0\nsamples = 25\nvalue = [25, 0, 0,
0, 0, 0, 0]'),
 Text(0.75, 0.7857142857142857, 'X[1] <= 0.5\ngini = 0.782\nsamples = 42\nva
lue = [0, 14, 3, 9, 3, 8, 5]'),
 Text(0.625, 0.6428571428571429, 'X[11] <= 0.5\ngini = 0.76\nsamples = 28\nv
alue = [0, 0, 3, 9, 3, 8, 5]'),
 Text(0.5, 0.5, 'X[8] <= 0.5\ngini = 0.704\nsamples = 19\nvalue = [0, 0, 3,
0, 3, 8, 5]'),
 Text(0.25, 0.35714285714285715, 'X[9] <= 0.5\ngini = 0.473\nsamples = 13\nv
alue = [0, 0, 0, 0, 0, 8, 5]'),
 Text(0.125, 0.21428571428571427, 'gini = 0.0\nsamples = 4\nvalue = [0, 0,
0, 0, 0, 0, 4]'),
 Text(0.375, 0.21428571428571427, 'X[12] <= 3.0\ngini = 0.198\nsamples = 9\n
value = [0, 0, 0, 0, 0, 8, 1]'),
 Text(0.25, 0.07142857142857142, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0,
0, 0, 0, 1]'),
 Text(0.5, 0.07142857142857142, 'gini = 0.0\nsamples = 8\nvalue = [0, 0, 0,
0, 0, 8, 0]'),
 Text(0.75, 0.35714285714285715, 'X[5] <= 0.5\ngini = 0.5\nsamples = 6\nvalu
e = [0, 0, 3, 0, 3, 0, 0]'),
 Text(0.625, 0.21428571428571427, 'gini = 0.0\nsamples = 3\nvalue = [0, 0,
3, 0, 0, 0, 0]'),
 Text(0.875, 0.21428571428571427, 'gini = 0.0\nsamples = 3\nvalue = [0, 0,
0, 0, 3, 0, 0]'),
 Text(0.75, 0.5, 'gini = 0.0\nsamples = 9\nvalue = [0, 0, 0, 9, 0, 0, 0]'),
 Text(0.875, 0.6428571428571429, 'gini = 0.0\nsamples = 14\nvalue = [0, 14,
0, 0, 0, 0, 0]')]
```


X[2] <= 0.5
gini = 0.775
samples = 67
value = [25, 14, 3, 9, 3, 8, 5]
gini = 0.0
samples = 25
value = [25, 0, 0, 0, 0, 0, 0]
X[1] <= 0.5
gini = 0.782
samples = 42
value = [0, 14, 3, 9, 3, 8, 5]
X[11] <= 0.5
gini = 0.76
samples = 28
value = [0, 0, 3, 9, 3, 8, 5]
gini = 0.0
samples = 14
value = [0, 14, 0, 0, 0, 0, 0]
X[8] <= 0.5
gini = 0.704
samples = 19
value = [0, 0, 3, 0, 3, 8, 5]
gini = 0.0
samples = 9
value = [0, 0, 0, 9, 0, 0, 0]
X[9] <= 0.5
gini = 0.473
samples = 13
value = [0, 0, 0, 0, 0, 8, 5]
X[5] <= 0.5
gini = 0.5
samples = 6
value = [0, 0, 3, 0, 3, 0, 0]
gini = 0.0
samples = 4
value = [0, 0, 0, 0, 0, 0, 4]
X[12] <= 3.0
gini = 0.198
samples = 9
value = [0, 0, 0, 0, 0, 8, 1]
gini = 0.0
samples = 3
value = [0, 0, 3, 0, 0, 0, 0]
gini = 0.0
samples = 3
value = [0, 0, 0, 0, 3, 0, 0]
gini = 0.0
samples = 1
value = [0, 0, 0, 0, 0, 0, 1]
gini = 0.0
samples = 8
value = [0, 0, 0, 0, 0, 8, 0]