PML_lab-8_205229118_Mahalakshmi.S

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0.0.1 Lab8. Animal Classification using Decision Trees

Step1. [Create Dataset]

0.0.2 Create the following dataset using Excel and save it as CSV file.

[1]:
```
import pandas as pd
```

[2]:
```
ani=pd.read_csv('animal.csv')
```

[3]:
```
ani.head()
```

[3]:

	Toothed	Hair	Breathes	Legs	Species
0	True	True	True	True	Mammal
1	True	True	True	True	Mammal
2	True	False	True	False	Repite
3	False	True	True	True	Mammal
4	True	True	True	True	Mammal

[4]:
```
ani.shape
```

[4]:
```
(10, 5)
```

[5]:
```
ani.dtypes
```

[5]:
```
Toothed       bool
Hair          bool
Breathes      bool
Legs          bool
Species     object
dtype: object
```

[6]:
```
ani.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 10 entries, 0 to 9
Data columns (total 5 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   Toothed   10 non-null     bool
```

```
 1   Hair      10 non-null     bool
 2   Breathes  10 non-null     bool
 3   Legs      10 non-null     bool
 4   Species   10 non-null     object
dtypes: bool(4), object(1)
memory usage: 248.0+ bytes
```

[7]:
```
ani.dtypes.value_counts()
```

[7]:
```
bool      4
object    1
dtype: int64
```

[8]:
```
ani.columns
```

[8]:
```
Index(['Toothed', 'Hair', 'Breathes', 'Legs', 'Species'], dtype='object')
```

0.0.3 Step2. [Model building using ID3]

Import your data set

[9]:
```
import pandas as pd
from sklearn import tree
import csv
from sklearn.tree import export_graphviz
from sklearn.preprocessing import LabelEncoder
from sklearn.tree import DecisionTreeClassifier
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score,classification_report
from sklearn.metrics import␣
 ↪accuracy_score,confusion_matrix,classification_report,auc,roc_curve,precision_score,recall_
import warnings
warnings.filterwarnings('ignore')
```

Create DT model using 'entropy' criterion

[10]:
```
DecisionTreeClassifier(criterion='entropy')
```

[10]:
```
DecisionTreeClassifier(criterion='entropy')
```

[13]:
```
laben = LabelEncoder()
ani["Label"] = laben.fit_transform(ani["Species"])
ani
```

[13]:

	Toothed	Hair	Breathes	Legs	Species	Label
0	True	True	True	True	Mammal	0
1	True	True	True	True	Mammal	0
2	True	False	True	False	Repite	1
3	False	True	True	True	Mammal	0
4	True	True	True	True	Mammal	0

```
5     True   True      True   True  Mammal      0
6     True  False     False  False  Repite      1
7     True  False      True  False  Repite      1
8     True   True      True   True  Mammal      0
9    False  False      True   True  Repite      1
```

[15]:
```
categories = list(laben.inverse_transform([0,1]))
categories
```

[15]:
```
['Mammal', 'Repite']
```

Perform training and testing

[16]:
```
X = ani.drop(['Label','Species'],axis=1)
```

[17]:
```
y = ani.Label
```

[18]:
```
X
```

[18]:
```
   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
```

[19]:
```
y
```

[19]:
```
0    0
1    0
2    1
3    0
4    0
5    0
6    1
7    1
8    0
9    1
Name: Label, dtype: int32
```

[20]:
```
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.
↪33,random_state=0)
```

[21]:
```
clf = DecisionTreeClassifier(criterion='entropy',max_depth=4, random_state=42)
clf.fit(X_train,y_train)
```

[21]:
```
DecisionTreeClassifier(criterion='entropy', max_depth=4, random_state=42)
```

[22]:
```
y_predict = clf.predict(X_test)
y_predict
```

[22]:
```
array([1, 0, 0, 0])
```

Print accuracy and classification report.

[23]:
```
print("Accuracy of train :",clf.score(X_train,y_train))
print("Accuracy of test  :",clf.score(X_test,y_test))
print('\n')
print(classification_report(y_test,y_predict))
```

```
Accuracy of train : 1.0
Accuracy of test  : 0.75


              precision    recall  f1-score   support

           0       0.67      1.00      0.80         2
           1       1.00      0.50      0.67         2

    accuracy                           0.75         4
   macro avg       0.83      0.75      0.73         4
weighted avg       0.83      0.75      0.73         4
```

Visualize your DT model using graphviz

[24]:
```
with open("tree1.dot", 'w') as f:
    f = tree.export_graphviz(clf,out_file=f,max_depth = 4,impurity =␣
↪False,feature_names = X.columns.values,class_names = categories,filled= True␣
↪)
```

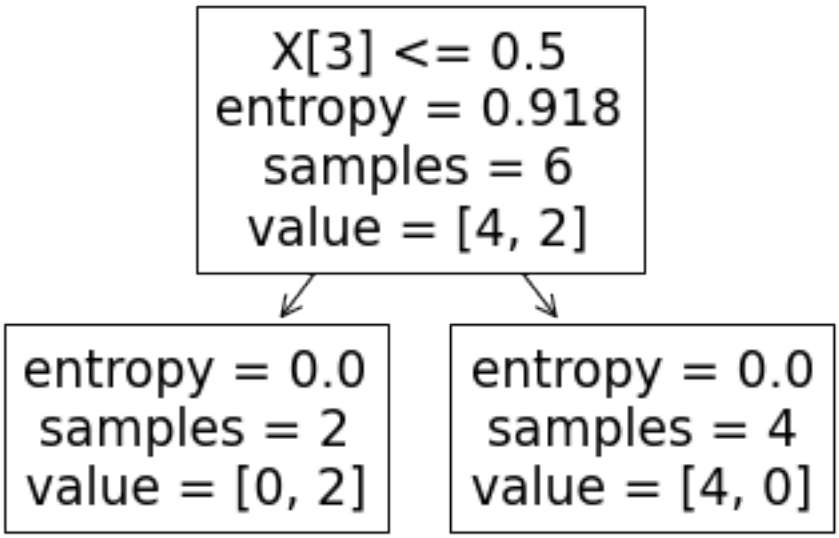
Install necessary package for visualization. The following sample code will help you to understand visualization.

Now open tree1.txt file which will be created in your working directory then Copy and paste the code to http://webgraphviz.com/

0.0.4 Another Way to visualize

[25]:
```
%matplotlib inline
tree.plot_tree(clf)
```

[25]:
```
[Text(167.4, 163.07999999999998, 'X[3] <= 0.5\nentropy = 0.918\nsamples =
6\nvalue = [4, 2]'),
 Text(83.7, 54.360000000000014, 'entropy = 0.0\nsamples = 2\nvalue = [0, 2]'),
 Text(251.10000000000002, 54.360000000000014, 'entropy = 0.0\nsamples = 4\nvalue
= [4, 0]')]
```



0.0.5 Step3. [Create a Test Set]

0.0.6 Create a testing csv file with 3 samples as below. (columns 2, 3, 4, 5 only)

[26]:
```
import csv
fields = ['Name','Toothed', 'Hair', 'Breathes', 'Legs', 'Species']


rows = [ ['Turtile','FALSE','FALSE','TRUE','FALSE','Reptile'],
         ['Blue Whales','FALSE','TRUE','TRUE','TRUE','Mammal'],
         ['Crocodile','TRUE','FALSE','TRUE','TRUE','Reptile'] ]

filename = "testing.csv"


with open(filename, 'w') as file:

    writer = csv.writer(file)


    writer.writerow(fields)
```

```
    writer.writerows(rows)
```

[27]:
```
teset = pd.read_csv('testing.csv')
teset
```

[27]:

	Name	Toothed	Hair	Breathes	Legs	Species
0	Turtile	False	False	True	False	Reptile
1	Blue Whales	False	True	True	True	Mammal
2	Crocodile	True	False	True	True	Reptile

[30]:
```
teset["Label"] = laben.fit_transform(teset["Species"])
teset
```

[30]:

	Name	Toothed	Hair	Breathes	Legs	Species	Label
0	Turtile	False	False	True	False	Reptile	1
1	Blue Whales	False	True	True	True	Mammal	0
2	Crocodile	True	False	True	True	Reptile	1

0.0.7 Step4. [Perform prediction]

Use your ID3 DT model that you created before and predict labels for this test set. Check your predictions. Correct?

[31]:
```
step4 = teset.drop(['Name','Species','Label'],axis=1)
y_predi = clf.predict(step4)
y_predi
```

[31]:
```
array([1, 0, 0])
```

[32]:
```
accuracy_score(teset.Label,y_predi)
```

[32]:
```
0.6666666666666666
```

0.0.8 Step5. [Build CART Decision Tree Model]

Now, you are going to build a new CART decision tree using criterion='gini'.

Train you model with full training data (No, train test split, this time)

Predict samples for the test file

Visualize your CART DT using graphviz

[33]:
```
clf1 = DecisionTreeClassifier(criterion='gini',max_depth=4, random_state=42)
clf1.fit(X,y)
```

[33]:
```
DecisionTreeClassifier(max_depth=4, random_state=42)
```

[34]:
```
clf1.predict(step4)
```

[34]:
```
array([1, 0, 1])
```

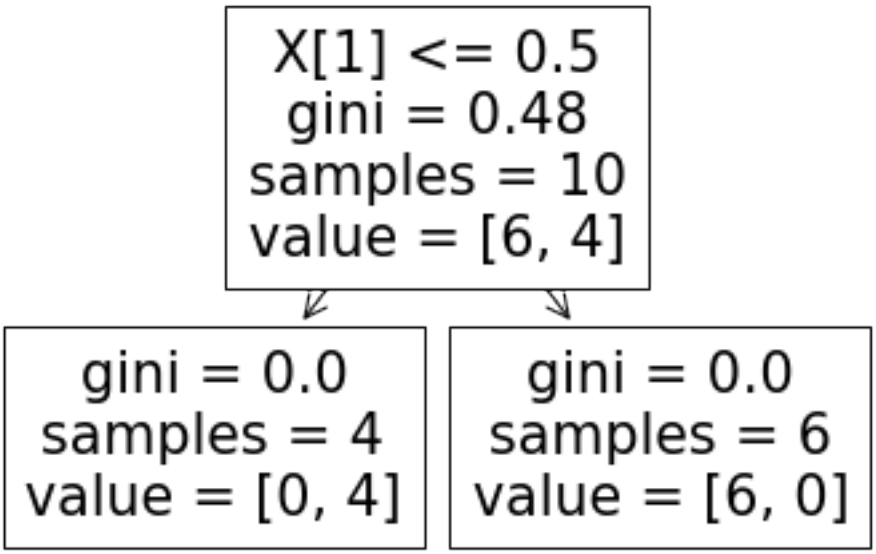
[35]:
```
with open("tree2.txt", 'w') as f:
    f = tree.export_graphviz(clf1,out_file=f,max_depth = 4,impurity =␣
↪False,feature_names = X.columns.values,class_names = categories,filled= True␣
↪)
```

Now open tree2.txt file which will be created in your working directory then Copy and paste the code to http://webgraphviz.com/

0.0.9 Another Way to visualize

[36]:
```
tree.plot_tree(clf1)
```

[36]:
```
[Text(167.4, 163.07999999999998, 'X[1] <= 0.5\ngini = 0.48\nsamples = 10\nvalue
= [6, 4]'),
 Text(83.7, 54.360000000000014, 'gini = 0.0\nsamples = 4\nvalue = [0, 4]'),
 Text(251.10000000000002, 54.360000000000014, 'gini = 0.0\nsamples = 6\nvalue =
[6, 0]')]
```



0.0.10 Step6. [Buid DT with Zoo dataset]

Import, build model using ID3 and CART, train and test accuracy. Print classification report. Visualize your trees.

[37]:
```
ani1 = pd.read_csv("zoo.csv")
```

[38]:
```
ani1.head()
```

[38]:

	name	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	\
0	aardvark	1	0	0	1	0	0	1	1	
1	antelope	1	0	0	1	0	0	0	1	
2	bass	0	0	1	0	0	1	1	1	
3	bear	1	0	0	1	0	0	1	1	
4	boar	1	0	0	1	0	0	1	1	

	backbone	breathes	venomous	fins	legs	tail	domestic	catsize	type
0	1	1	0	0	4	0	0	1	1
1	1	1	0	0	4	1	0	1	1
2	1	0	0	1	0	1	0	0	4
3	1	1	0	0	4	0	0	1	1
4	1	1	0	0	4	1	0	1	1

[39]:
```
ani1.shape
```

[39]:
```
(101, 18)
```

[40]:
```
ani1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 101 entries, 0 to 100
Data columns (total 18 columns):
 #   Column    Non-Null Count  Dtype
---  ------    --------------  -----
 0   name      101 non-null    object
 1   hair      101 non-null    int64
 2   feathers  101 non-null    int64
 3   eggs      101 non-null    int64
 4   milk      101 non-null    int64
 5   airborne  101 non-null    int64
 6   aquatic   101 non-null    int64
 7   predator  101 non-null    int64
 8   toothed   101 non-null    int64
 9   backbone  101 non-null    int64
 10  breathes  101 non-null    int64
 11  venomous  101 non-null    int64
 12  fins      101 non-null    int64
 13  legs      101 non-null    int64
 14  tail      101 non-null    int64
 15  domestic  101 non-null    int64
 16  catsize   101 non-null    int64
 17  type      101 non-null    int64
dtypes: int64(17), object(1)
memory usage: 14.3+ KB
```

[41]:
```
ani1.dtypes
```

[41]:
```
name        object
hair         int64
feathers     int64
eggs         int64
milk         int64
airborne     int64
aquatic      int64
predator     int64
toothed      int64
backbone     int64
breathes     int64
venomous     int64
fins         int64
legs         int64
tail         int64
domestic     int64
catsize      int64
type         int64
dtype: object
```

[42]:
```
ani1.dtypes.value_counts()
```

[42]:
```
int64     17
object     1
dtype: int64
```

[43]:
```
ani1.columns
```

[43]:
```
Index(['name', 'hair', 'feathers', 'eggs', 'milk', 'airborne', 'aquatic',
       'predator', 'toothed', 'backbone', 'breathes', 'venomous', 'fins',
       'legs', 'tail', 'domestic', 'catsize', 'type'],
      dtype='object')
```

[44]:
```
X_1 = ani1.drop(['name','type'],axis=1)
y_1 = ani1.type
```

[45]:
```
X_1
```

[45]:

	hair	feathers	eggs	milk	airborne	aquatic	predator	toothed	\
0	1	0	0	1	0	0	1	1	
1	1	0	0	1	0	0	0	1	
2	0	0	1	0	0	1	1	1	
3	1	0	0	1	0	0	1	1	
4	1	0	0	1	0	0	1	1	
..	…	…	…	…	…	…	…	…	
96	1	0	0	1	0	0	0	1	

```
97      1         0     1     0         1        0         0        0
98      1         0     0     1         0        0         1        1
99      0         0     1     0         0        0         0        0
100     0         1     1     0         1        0         0        0

     backbone  breathes  venomous  fins  legs  tail  domestic  catsize
0           1         1         0     0     4     0         0        1
1           1         1         0     0     4     1         0        1
2           1         0         0     1     0     1         0        0
3           1         1         0     0     4     0         0        1
4           1         1         0     0     4     1         0        1
..        ...       ...       ...   ...   ...   ...       ...      ...
96          1         1         0     0     2     1         0        1
97          0         1         1     0     6     0         0        0
98          1         1         0     0     4     1         0        1
99          0         1         0     0     0     0         0        0
100         1         1         0     0     2     1         0        0

[101 rows x 16 columns]
```

[46]:
```
y_1
```

[46]:
```
0      1
1      1
2      4
3      1
4      1
      ..
96     1
97     6
98     1
99     7
100    2
Name: type, Length: 101, dtype: int64
```

[47]:
```
X__train,X__test,y__train,y__test = train_test_split(X_1,y_1,test_size=0.
↪33,random_state=0)
```

[48]:
```
clf3 = DecisionTreeClassifier(criterion='entropy',max_depth=3, random_state=52)
clf3.fit(X__train,y__train)
```

[48]:
```
DecisionTreeClassifier(criterion='entropy', max_depth=3, random_state=52)
```

[49]:
```
clf3.predict(X__test)
```

[49]:
```
array([4, 4, 4, 1, 1, 1, 2, 4, 1, 1, 7, 1, 2, 7, 4, 6, 1, 7, 2, 4, 2, 4,
       1, 2, 1, 1, 1, 2, 4, 4, 4, 4, 4, 1], dtype=int64)
```

[50]:
```
clf4 = DecisionTreeClassifier(criterion='gini',max_depth=4, random_state=42)
clf4.fit(X__train,y__train)
```

[50]:
```
DecisionTreeClassifier(max_depth=4, random_state=42)
```

[53]:
```
from sklearn.preprocessing import StandardScaler
```

[55]:
```
scl = StandardScaler()
```

[56]:
```
st_sc = scale.fit_transform(X__train)
```

[57]:
```
st_sc1 = scale.transform(X__test)
```

[60]:
```
print("Train accuracy :",clf4.score(st_sc,y__train))
print("Test accuracy  :",clf4.score(st_sc1,y__test))
```

```
Train accuracy : 0.9253731343283582
Test accuracy  : 0.8235294117647058
```

[67]:
```
ani1.type.value_counts(dropna=False)
```

[67]:
```
1    41
2    20
4    13
7    10
6     8
3     5
5     4
Name: type, dtype: int64
```

[70]:
```
with open("tree3.txt", 'w') as f:
    f = tree.export_graphviz(clf4,out_file=f,max_depth = 16,impurity =␣
↪False,feature_names = X_1.columns.values,class_names =␣
↪['1','2','3','4','5','6','7'] ,filled= True )
```

Now open tree3.txt file which will be created in your working directory then Copy and paste the code to http://webgraphviz.com/

[77]:
```
tree.plot_tree(clf4)
```

[77]:
```
[Text(239.14285714285714, 195.696, 'X[3] <= 0.5\ngini = 0.736\nsamples =
67\nvalue = [29, 14, 1, 6, 3, 6, 8]'),
 Text(191.31428571428572, 152.208, 'X[1] <= 0.5\ngini = 0.763\nsamples =
38\nvalue = [0, 14, 1, 6, 3, 6, 8]'),
 Text(143.4857142857143, 108.72, 'X[11] <= 0.5\ngini = 0.747\nsamples =
24\nvalue = [0, 0, 1, 6, 3, 6, 8]'),
 Text(95.65714285714286, 65.232, 'X[4] <= 0.5\ngini = 0.66\nsamples = 18\nvalue
= [0, 0, 1, 0, 3, 6, 8]'),
 Text(47.82857142857143, 21.744, 'gini = 0.556\nsamples = 13\nvalue = [0, 0, 1,
```

```
0, 3, 1, 8]'),
 Text(143.4857142857143, 21.744, 'gini = 0.0\nsamples = 5\nvalue = [0, 0, 0, 0,
0, 5, 0]'),
 Text(191.31428571428572, 65.232, 'gini = 0.0\nsamples = 6\nvalue = [0, 0, 0, 6,
0, 0, 0]'),
 Text(239.14285714285714, 108.72, 'gini = 0.0\nsamples = 14\nvalue = [0, 14, 0,
0, 0, 0, 0]'),
 Text(286.9714285714286, 152.208, 'gini = 0.0\nsamples = 29\nvalue = [29, 0, 0,
0, 0, 0, 0]')]
```