[2]:
```
import numpy as np
import pandas as pd
from IPython.core.interactiveshell import InteractiveShell

InteractiveShell.ast_node_interactivity = "all"


pd.set_option("display.max_columns", 100)
pd.set_option("display.max_rows", 100)

data = pd.read_csv('DataSetForPhishingVSBenignUrl.csv', header=0)

data.head(10)
```

[2]:
```
   Querylength  domain_token_count  path_token_count  avgdomaintokenlen  \
0            0                   4                 5                5.5   
1            0                   4                 5                5.5   
2            0                   4                 5                5.5   
3            0                   4                12                5.5   
4            0                   4                 6                5.5   
5            0                   4                 8                5.5   
6            0                   4                 5                5.5   
7            0                   4                 7                5.5   
8            0                   4                 6                5.5   
9            0                   4                 5                5.5   

   longdomaintokenlen  avgpathtokenlen  tld  charcompvowels  charcompace  \
0                  14         4.400000    4               8            3   
1                  14         6.000000    4              12            4   
2                  14         5.800000    4              12            5   
3                  14         5.500000    4              32           16   
4                  14         7.333334    4              18           11   
5                  14         6.500000    4              22           10   
6                  14         7.800000    4              17           10   
7                  14         6.285714    4              16            9   
8                  14         6.500000    4              16           10   
9                  14         3.600000    4               7            3   

   ldl_url  ldl_domain  ldl_path  ldl_filename  ldl_getArg  dld_url  \
0        0           0         0             0           0        0   
1        0           0         0             0           0        0   
2        0           0         0             0           0        0   
3        0           0         0             0           0        0   
4        0           0         0             0           0        0   
5        0           0         0             0           0        0   
6        0           0         0             0           0        0   
7        0           0         0             0           0        0   
8        0           0         0             0           0        0   
9        0           0         0             0           0        0   

   dld_domain  dld_path  dld_filename  dld_getArg  urlLen  domainlength  \
0           0         0             0           0       58            25
1           0         0             0           0       66            25
2           0         0             0           0       65            25
3           0         0             0           0      109            25
4           0         0             0           0       81            25
5           0         0             0           0       91            25
6           0         0             0           0       75            25
7           0         0             0           0       82            25
8           0         0             0           0       76            25
9           0         0             0           0       54            25

   pathLength  subDirLen  fileNameLen  this.fileExtLen  ArgLen  pathurlRatio  \
0          26         26           13                1       2      0.448276
1          34         34            2                2       2      0.515151
2          33         33            2                2       2      0.507692
3          77         77            2                2       2      0.706422
4          49         49            2                2       2      0.604938
5          59         59            2                2       2      0.648352
6          43         43            2                2       2      0.573333
7          50         50            2                2       2      0.609756
8          44         44            2                2       2      0.578947
9          22         22            9                1       2      0.407407

   ArgUrlRatio  argDomanRatio  domainUrlRatio  pathDomainRatio argPathRatio  \
0     0.034483           0.08        0.431034             1.04    0.0769231
1     0.030303           0.08        0.378788             1.36    0.0588235
2     0.030769           0.08        0.384615             1.32    0.0606061
3     0.018349           0.08        0.229358             3.08     0.025974
4     0.024691           0.08        0.308642             1.96    0.0408163
5     0.021978           0.08        0.274725             2.36    0.0338983
6     0.026667           0.08        0.333333             1.72    0.0465116
7     0.024390           0.08        0.304878             2.00         0.04
8     0.026316           0.08        0.328947             1.76    0.0454545
9     0.037037           0.08        0.462963             0.88    0.0909091

   executable  isPortEighty  NumberofDotsinURL  ISIpAddressInDomainName  \
0           0            -1                  5                       -1
1           0            -1                  4                       -1
2           0            -1                  4                       -1
3           0            -1                  4                       -1
4           0            -1                  4                       -1
5           0            -1                  4                       -1
6           0            -1                  4                       -1
7           0            -1                  4                       -1
8           0            -1                  4                       -1
9           0            -1                  5                       -1

   CharacterContinuityRate  LongestVariableValue  URL_DigitCount  \
0                      0.6                    -1               1
1                      0.6                    -1               0
2                      0.6                    -1               0
```

```
3                      0.6                    -1               0
4                      0.6                    -1               0
5                      0.6                    -1               0
6                      0.6                    -1               0
7                      0.6                    -1               8
8                      0.6                    -1               0
9                      0.6                    -1               1

   host_DigitCount  Directory_DigitCount  File_name_DigitCount  \
0                0                     0                     0
1                0                     0                     0
2                0                     0                     0
3                0                     0                     0
4                0                     0                     0
5                0                     0                     0
6                0                     0                     0
7                0                     0                     0
8                0                     0                     0
9                0                     0                     0

   Extension_DigitCount  Query_DigitCount  URL_Letter_Count  \
0                     1                -1                47
1                     0                -1                56
2                     0                -1                55
3                     0                -1                92
4                     0                -1                70
5                     0                -1                78
6                     0                -1                65
7                     8                -1                62
8                     0                -1                65
9                     1                -1                43

   host_letter_count  Directory_LetterCount  Filename_LetterCount  \
0                 22                      8                    13
1                 22                      8                    13
2                 22                      8                    13
3                 22                      8                    13
4                 22                      8                    13
5                 22                      8                    13
6                 22                      8                    13
7                 22                      8                    13
8                 22                      8                    13
9                 22                      8                     9

   Extension_LetterCount  Query_LetterCount  LongestPathTokenLength  \
0                      0                 -1                      13
1                      9                 -1                      13
2                      8                 -1                      13
3                     45                 -1                      52
4                     23                 -1                      24
5                     31                 -1                      34
```

```
6                     18                 -1                      18
7                     15                 -1                      25
8                     18                 -1                      19
9                      0                 -1                       9

   Domain_LongestWordLength  Path_LongestWordLength  \
0                        14                      13
1                        14                      13
2                        14                      13
3                        14                      13
4                        14                      13
5                        14                      15
6                        14                      18
7                        14                      13
8                        14                      13
9                        14                       9

   sub-Directory_LongestWordLength  Arguments_LongestWordLength  \
0                                5                           -1
1                                5                           -1
2                                5                           -1
3                               13                           -1
4                               13                           -1
5                               13                           -1
6                                5                           -1
7                               13                           -1
8                               13                           -1
9                                5                           -1

   URL_sensitiveWord  URLQueries_variable  spcharUrl  delimeter_Domain  \
0                  0                    0          3                 0
1                  0                    0          4                 0
2                  0                    0          4                 0
3                  0                    0          4                 0
4                  0                    0          4                 0
5                  0                    0          4                 0
6                  0                    0          4                 0
7                  0                    0          4                 0
8                  0                    0          4                 0
9                  0                    0          3                 0

   delimeter_path  delimeter_Count  NumberRate_URL  NumberRate_Domain  \
0               2               -1        0.017241                0.0
1               1               -1        0.000000                0.0
2               1               -1        0.000000                0.0
3               8               -1        0.000000                0.0
4               2               -1        0.000000                0.0
5               4               -1        0.000000                0.0
6               1               -1        0.000000                0.0
7               3               -1        0.097561                0.0
8               2               -1        0.000000                0.0
```

```
9               2                -1        0.018519               0.0

   NumberRate_DirectoryName  NumberRate_FileName  NumberRate_Extension  \
0                       0.0             0.066667                   1.0
1                       0.0             0.000000                   NaN
2                       0.0             0.000000                   NaN
3                       0.0             0.000000                   NaN
4                       0.0             0.000000                   NaN
5                       0.0             0.000000                   NaN
6                       0.0             0.000000                   NaN
7                       0.0             0.320000                   NaN
8                       0.0             0.000000                   NaN
9                       0.0             0.090909                   1.0

   NumberRate_AfterPath  SymbolCount_URL  SymbolCount_Domain  \
0                  -1.0                8                   3
1                  -1.0                8                   3
2                  -1.0                8                   3
3                  -1.0                8                   3
4                  -1.0                8                   3
5                  -1.0                8                   3
6                  -1.0                8                   3
7                  -1.0                8                   3
8                  -1.0                8                   3
9                  -1.0                8                   3

   SymbolCount_Directoryname  SymbolCount_FileName  SymbolCount_Extension  \
0                          2                     1                      0
1                          3                     0                      0
2                          3                     0                      0
3                          3                     0                      0
4                          3                     0                      0
5                          3                     0                      0
6                          3                     0                      0
7                          3                     0                      0
8                          3                     0                      0
9                          2                     1                      0

   SymbolCount_Afterpath  Entropy_URL  Entropy_Domain  Entropy_DirectoryName  \
0                     -1     0.726298        0.784493               0.894886
1                     -1     0.688635        0.784493               0.814725
2                     -1     0.695049        0.784493               0.814725
3                     -1     0.640130        0.784493               0.814725
4                     -1     0.681307        0.784493               0.814725
5                     -1     0.666676        0.784493               0.814725
6                     -1     0.682440        0.784493               0.814725
7                     -1     0.709396        0.784493               0.814725
8                     -1     0.678242        0.784493               0.814725
9                     -1     0.740950        0.784493               0.894886

   Entropy_Filename  Entropy_Extension  Entropy_Afterpath URL_Type_obf_Type
```

```
0          0.850608                NaN               -1.0         Defacement
1          0.859793                0.0               -1.0         Defacement
2          0.801880                0.0               -1.0         Defacement
3          0.663210                0.0               -1.0         Defacement
4          0.804526                0.0               -1.0         Defacement
5          0.755658                0.0               -1.0         Defacement
6          0.766719                0.0               -1.0         Defacement
7          0.797498                0.0               -1.0         Defacement
8          0.732258                0.0               -1.0         Defacement
9          0.894886                NaN               -1.0         Defacement
```

Handle columns with Nulls in the current data set

[61]:

```
data.isnull().sum()
```

[61]:

```
Querylength                       0
domain_token_count                0
path_token_count                  0
avgdomaintokenlen                 0
longdomaintokenlen                0
avgpathtokenlen                 280
tld                               0
charcompvowels                    0
charcompace                       0
ldl_url                           0
ldl_domain                        0
ldl_path                          0
ldl_filename                      0
ldl_getArg                        0
dld_url                           0
dld_domain                        0
dld_path                          0
dld_filename                      0
dld_getArg                        0
urlLen                            0
domainlength                      0
pathLength                        0
subDirLen                         0
fileNameLen                       0
this.fileExtLen                   0
ArgLen                            0
pathurlRatio                      0
ArgUrlRatio                       0
argDomanRatio                     0
domainUrlRatio                    0
pathDomainRatio                   0
argPathRatio                      0
executable                        0
isPortEighty                      0
NumberofDotsinURL                 0
ISIpAddressInDomainName           0
```

```
CharacterContinuityRate                0
LongestVariableValue                   0
URL_DigitCount                         0
host_DigitCount                        0
Directory_DigitCount                   0
File_name_DigitCount                   0
Extension_DigitCount                   0
Query_DigitCount                       0
URL_Letter_Count                       0
host_letter_count                      0
Directory_LetterCount                  0
Filename_LetterCount                   0
Extension_LetterCount                  0
Query_LetterCount                      0
LongestPathTokenLength                 0
Domain_LongestWordLength               0
Path_LongestWordLength                 0
sub-Directory_LongestWordLength        0
Arguments_LongestWordLength            0
URL_sensitiveWord                      0
URLQueries_variable                    0
spcharUrl                              0
delimeter_Domain                       0
delimeter_path                         0
delimeter_Count                        0
NumberRate_URL                         0
NumberRate_Domain                      0
NumberRate_DirectoryName              10
NumberRate_FileName                   10
NumberRate_Extension               10130
NumberRate_AfterPath                   3
SymbolCount_URL                        0
SymbolCount_Domain                     0
SymbolCount_Directoryname              0
SymbolCount_FileName                   0
SymbolCount_Extension                  0
SymbolCount_Afterpath                  0
Entropy_URL                            0
Entropy_Domain                         0
Entropy_DirectoryName               8468
Entropy_Filename                     236
Entropy_Extension                     40
Entropy_Afterpath                      6
URL_Type_obf_Type                      0
dtype: int64
```

[4]:

```
data_clean = data.dropna()          #(subset=['Entropy_DirectoryName'])
```

[5]:

```
data_clean['URL_Type_obf_Type'].unique()
```

```
[5]: array(['Defacement', 'benign', 'malware', 'phishing', 'spam'],
           dtype=object)
```

```
[6]: data_clean.dtypes
```

```
[6]: Querylength                          int64
     domain_token_count                   int64
     path_token_count                     int64
     avgdomaintokenlen                  float64
     longdomaintokenlen                   int64
     avgpathtokenlen                    float64
     tld                                  int64
     charcompvowels                       int64
     charcompace                          int64
     ldl_url                              int64
     ldl_domain                           int64
     ldl_path                             int64
     ldl_filename                         int64
     ldl_getArg                           int64
     dld_url                              int64
     dld_domain                           int64
     dld_path                             int64
     dld_filename                         int64
     dld_getArg                           int64
     urlLen                               int64
     domainlength                         int64
     pathLength                           int64
     subDirLen                            int64
     fileNameLen                          int64
     this.fileExtLen                      int64
     ArgLen                               int64
     pathurlRatio                       float64
     ArgUrlRatio                        float64
     argDomanRatio                      float64
     domainUrlRatio                     float64
     pathDomainRatio                    float64
     argPathRatio                        object
     executable                           int64
     isPortEighty                         int64
     NumberofDotsinURL                    int64
     ISIpAddressInDomainName              int64
     CharacterContinuityRate            float64
     LongestVariableValue                 int64
     URL_DigitCount                       int64
     host_DigitCount                      int64
     Directory_DigitCount                 int64
     File_name_DigitCount                 int64
     Extension_DigitCount                 int64
     Query_DigitCount                     int64
     URL_Letter_Count                     int64
     host_letter_count                    int64
```

```
Directory_LetterCount                int64
Filename_LetterCount                 int64
Extension_LetterCount                int64
Query_LetterCount                    int64
LongestPathTokenLength               int64
Domain_LongestWordLength             int64
Path_LongestWordLength               int64
sub-Directory_LongestWordLength      int64
Arguments_LongestWordLength          int64
URL_sensitiveWord                    int64
URLQueries_variable                  int64
spcharUrl                            int64
delimeter_Domain                     int64
delimeter_path                       int64
delimeter_Count                      int64
NumberRate_URL                     float64
NumberRate_Domain                  float64
NumberRate_DirectoryName           float64
NumberRate_FileName                float64
NumberRate_Extension               float64
NumberRate_AfterPath               float64
SymbolCount_URL                      int64
SymbolCount_Domain                   int64
SymbolCount_Directoryname            int64
SymbolCount_FileName                 int64
SymbolCount_Extension                int64
SymbolCount_Afterpath                int64
Entropy_URL                        float64
Entropy_Domain                     float64
Entropy_DirectoryName              float64
Entropy_Filename                   float64
Entropy_Extension                  float64
Entropy_Afterpath                  float64
URL_Type_obf_Type                   object
dtype: object
```

[62]:

```python
# split into input and output elements



data_numpy = data_clean.values
X, y = data_numpy[:, :-1], data_numpy[:, -1]



#X = data_clean.drop('URL_Type_obf_Type',axis = 'columns')
#y =  data_clean.URL_Type_obf_Type
```

SMOT Oversampling the data to removed skewed classes

[63]:

```python
from sklearn.preprocessing import LabelEncoder
from imblearn.over_sampling import SMOTE
from collections import Counter
```

```
y = LabelEncoder().fit_transform(y)

# transform the dataset
oversample = SMOTE()
X, y = oversample.fit_resample(X, y)
# summarize distribution
```

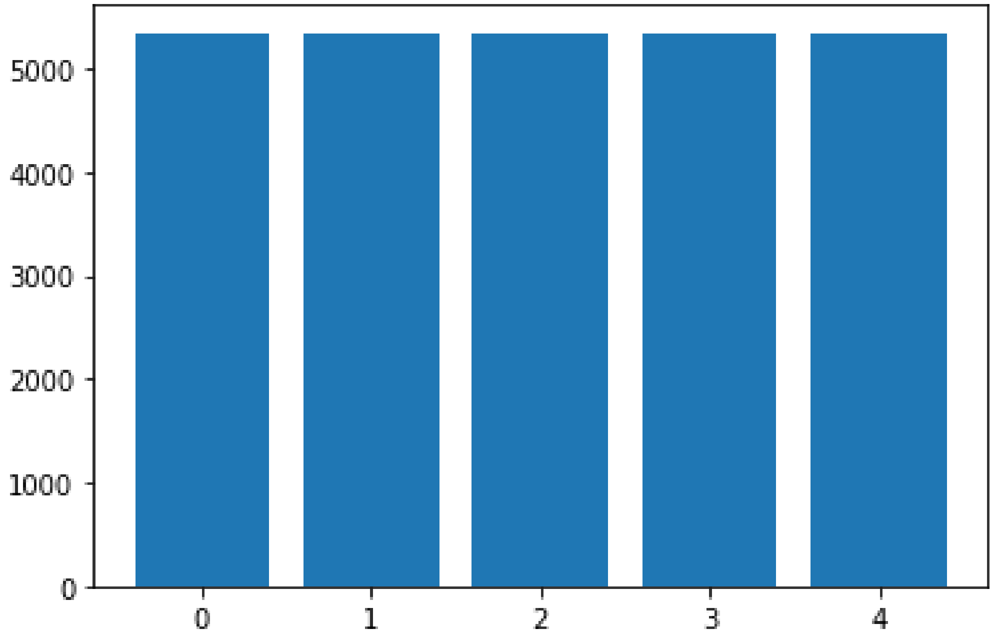
[64]:

```
from matplotlib import pyplot

counter = Counter(y)
for k,v in counter.items():
    per = v / len(y) * 100
    print('Class=%d, n=%d (%.3f%%)' % (k, v, per))
# plot the distribution
pyplot.bar(counter.keys(), counter.values())
pyplot.show()
```

```
Class=0, n=5342 (20.000%)
Class=1, n=5342 (20.000%)
Class=2, n=5342 (20.000%)
Class=3, n=5342 (20.000%)
Class=4, n=5342 (20.000%)
```

[64]:

```
<BarContainer object of 5 artists>
```



Test and Training Split and Scaling the data

[66]:

```
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler


X_train, X_test, y_train, y_test = train_test_split(
    X, y, test_size=0.2, random_state=1, stratify=y)


sc = StandardScaler()
sc.fit(X_train)

X_train_std = sc.transform(X_train)
X_test_std = sc.transform(X_test)

print('Labels count in y:', np.bincount(y))
print('Labels count in y_train:', np.bincount(y_train))

print('Labels count in y_test:', np.bincount(y_test))
```

[66]:

```
StandardScaler()
```

```
Labels count in y: [5342 5342 5342 5342 5342]
Labels count in y_train: [4273 4274 4274 4273 4274]
Labels count in y_test: [1069 1068 1068 1069 1068]
```

TRAIN MODEL & CREATE PREDICTIONS USING SKLEARN - GINI CRITERION

[49]:

```
from sklearn.tree import DecisionTreeClassifier


clf_gini_d1 = DecisionTreeClassifier(criterion = 'gini' , max_depth = 1 , splitter =␣
 ↪'best')
clf_gini_d2 = DecisionTreeClassifier(criterion = 'gini' , max_depth = 2 , splitter =␣
 ↪'best')
clf_gini_d3 = DecisionTreeClassifier(criterion = 'gini' , max_depth = 3 , splitter =␣
 ↪'best')
clf_gini_d4 = DecisionTreeClassifier(criterion = 'gini' , max_depth = 4 , splitter =␣
 ↪'best')
clf_gini_d5 = DecisionTreeClassifier(criterion = 'gini' , max_depth = 5 , splitter =␣
 ↪'best')
clf_gini_d6 = DecisionTreeClassifier(criterion = 'gini' , max_depth = 6 , splitter =␣
 ↪'best')


#developing a model with gini

clf_gini_d1 = clf_gini_d1.fit(X_train_std,y_train)
clf_gini_d2 = clf_gini_d2.fit(X_train_std,y_train)
clf_gini_d3 = clf_gini_d3.fit(X_train_std,y_train)
clf_gini_d4 = clf_gini_d4.fit(X_train_std,y_train)
```

```
clf_gini_d5 = clf_gini_d5.fit(X_train_std,y_train)
clf_gini_d6 = clf_gini_d6.fit(X_train_std,y_train)
```

[50]:
```
pred_gini_d1 = clf_gini_d1.predict(X_test_std)
pred_gini_d2 = clf_gini_d2.predict(X_test_std)
pred_gini_d3 = clf_gini_d3.predict(X_test_std)
pred_gini_d4 = clf_gini_d4.predict(X_test_std)
pred_gini_d5 = clf_gini_d5.predict(X_test_std)
pred_gini_d6 = clf_gini_d6.predict(X_test_std)
```

TRAIN MODEL & CREATE PREDICTIONS USING SKLEARN - ENTROPY CRITERION

[51]:
```
clf_en_d1 = DecisionTreeClassifier(criterion = 'entropy' , max_depth = 1 , splitter =␣
 ↪'best')
clf_en_d2 = DecisionTreeClassifier(criterion = 'entropy' , max_depth = 2 , splitter =␣
 ↪'best')
clf_en_d3 = DecisionTreeClassifier(criterion = 'entropy' , max_depth = 3 , splitter =␣
 ↪'best')
clf_en_d4 = DecisionTreeClassifier(criterion = 'entropy' , max_depth = 4 , splitter =␣
 ↪'best')
clf_en_d5 = DecisionTreeClassifier(criterion = 'entropy' , max_depth = 5 , splitter =␣
 ↪'best')
clf_en_d6 = DecisionTreeClassifier(criterion = 'entropy' , max_depth = 6 , splitter =␣
 ↪'best')

clf_en_d1 = clf_en_d1.fit(X_train_std,y_train)
clf_en_d2 = clf_en_d2.fit(X_train_std,y_train)
clf_en_d3 = clf_en_d3.fit(X_train_std,y_train)
clf_en_d4 = clf_en_d4.fit(X_train_std,y_train)
clf_en_d5 = clf_en_d5.fit(X_train_std,y_train)
clf_en_d6 = clf_en_d6.fit(X_train_std,y_train)
```

[ ]:
```
pred_en_d1 = clf_en_d1.predict(X_test_std)
pred_en_d2 = clf_en_d2.predict(X_test_std)
pred_en_d3 = clf_en_d3.predict(X_test_std)
pred_en_d4 = clf_en_d4.predict(X_test_std)
pred_en_d5 = clf_en_d5.predict(X_test_std)
pred_en_d6 = clf_en_d6.predict(X_test_std)
```

Create GINICLASSFICATION REPORT USING SKLEARN

[67]:
```
from sklearn.metrics import classification_report

print('-------------------------------------CLASSICATION REPORT [Differnt␣
 ↪heights]------------------------')
print('')
print('')
print('ml_gini=1',classification_report(y_test,pred_gini_d1,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))

print('##############################################################################################
print('')
print('')
print('ml_gini=2',classification_report(y_test,pred_gini_d2,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))

print('##########################################################################################
print('')
print('')
print('ml_gini=3',classification_report(y_test,pred_gini_d3,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))


print('##########################################################################################
print('')
print('')
print('ml_gini=4',classification_report(y_test,pred_gini_d4,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))


print('##########################################################################################
print('')
print('')
print('ml_gini=5',classification_report(y_test,pred_gini_d5,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))


print('##########################################################################################
print('')
print('')
print('ml_gini=6',classification_report(y_test,pred_gini_d6,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))
```

```
-------------------------------------CLASSICATION REPORT [Differnt
heights]------------------------


ml_gini=1               precision    recall  f1-score   support

  Defacement       0.00      0.00      0.00      1069
      benign       0.46      0.93      0.61      1068
     malware       0.00      0.00      0.00      1068
    phishing       0.00      0.00      0.00      1069
        spam       0.34      1.00      0.50      1068

    accuracy                           0.39      5342
   macro avg       0.16      0.39      0.22      5342
weighted avg       0.16      0.39      0.22      5342

##########################################################################################
##########
```

```
ml_gini=2               precision    recall  f1-score   support

  Defacement       0.34      0.57      0.43      1069
      benign       0.62      0.93      0.75      1068
     malware       0.00      0.00      0.00      1068
    phishing       0.56      0.30      0.39      1069
        spam       0.65      0.83      0.73      1068

    accuracy                           0.53      5342
   macro avg       0.43      0.53      0.46      5342
weighted avg       0.43      0.53      0.46      5342

##########################################################################################
##########


ml_gini=3               precision    recall  f1-score   support

  Defacement       0.68      0.69      0.68      1069
      benign       0.77      0.84      0.80      1068
     malware       0.83      0.21      0.33      1068
    phishing       0.47      0.75      0.58      1069
        spam       0.80      0.82      0.81      1068

    accuracy                           0.66      5342
   macro avg       0.71      0.66      0.64      5342
weighted avg       0.71      0.66      0.64      5342

##########################################################################################
##########


ml_gini=4               precision    recall  f1-score   support

  Defacement       0.84      0.67      0.74      1069
      benign       0.84      0.77      0.81      1068
     malware       0.67      0.62      0.64      1068
    phishing       0.53      0.75      0.62      1069
        spam       0.86      0.82      0.84      1068

    accuracy                           0.73      5342
   macro avg       0.75      0.73      0.73      5342
weighted avg       0.75      0.73      0.73      5342

##########################################################################################
##########


ml_gini=5               precision    recall  f1-score   support

  Defacement       0.69      0.88      0.77      1069
      benign       0.85      0.86      0.85      1068
     malware       0.75      0.65      0.70      1068
    phishing       0.70      0.70      0.70      1069
        spam       0.91      0.76      0.83      1068

    accuracy                           0.77      5342
   macro avg       0.78      0.77      0.77      5342
weighted avg       0.78      0.77      0.77      5342

########################################################################################
##########


ml_gini=6               precision    recall  f1-score   support

  Defacement       0.76      0.88      0.82      1069
      benign       0.86      0.90      0.88      1068
     malware       0.89      0.75      0.82      1068
    phishing       0.76      0.71      0.73      1069
        spam       0.91      0.92      0.91      1068

    accuracy                           0.83      5342
   macro avg       0.84      0.83      0.83      5342
weighted avg       0.84      0.83      0.83      5342

/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
```

```
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Create ENTROPY CLASSFICATION REPORT USING SKLEARN

[68]:
```
from sklearn.metrics import classification_report

print('-------------------------------------ENTROPY CLASSICATION REPORT [Differnt␣
 ↪heights]------------------------')
print('')
print('')
print('ml_en=1',classification_report(y_test,pred_en_d1,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))

print('##########################################################################################
print('')
print('')
print('ml_en=2',classification_report(y_test,pred_gini_d2,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))

print('##########################################################################################
print('')
print('')
print('ml_en=3',classification_report(y_test,pred_gini_d3,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))


print('##########################################################################################
print('')
print('')
print('ml_en=4',classification_report(y_test,pred_gini_d4,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))


print('##########################################################################################
print('')
print('')
print('ml_en=5',classification_report(y_test,pred_gini_d5,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))


print('##########################################################################################
print('')
print('')
print('ml_en=6',classification_report(y_test,pred_gini_d6,target_names=['Defacement','benign',␣
 ↪'malware', 'phishing', 'spam']))
```

```
-------------------------------------ENTROPY CLASSICATION REPORT [Differnt
heights]------------------------
```

```
ml_en=1               precision    recall  f1-score   support

  Defacement       0.00      0.00      0.00      1069
      benign       0.46      0.93      0.61      1068
     malware       0.00      0.00      0.00      1068
    phishing       0.00      0.00      0.00      1069
        spam       0.34      1.00      0.50      1068

    accuracy                           0.39      5342
   macro avg       0.16      0.39      0.22      5342
weighted avg       0.16      0.39      0.22      5342

##########################################################################################
##########


ml_en=2               precision    recall  f1-score   support

  Defacement       0.34      0.57      0.43      1069
      benign       0.62      0.93      0.75      1068
     malware       0.00      0.00      0.00      1068
    phishing       0.56      0.30      0.39      1069
        spam       0.65      0.83      0.73      1068

    accuracy                           0.53      5342
   macro avg       0.43      0.53      0.46      5342
weighted avg       0.43      0.53      0.46      5342

##########################################################################################
##########


ml_en=3               precision    recall  f1-score   support

  Defacement       0.68      0.69      0.68      1069
      benign       0.77      0.84      0.80      1068
     malware       0.83      0.21      0.33      1068
    phishing       0.47      0.75      0.58      1069
        spam       0.80      0.82      0.81      1068

    accuracy                           0.66      5342
   macro avg       0.71      0.66      0.64      5342
weighted avg       0.71      0.66      0.64      5342

##########################################################################################
##########


ml_en=4               precision    recall  f1-score   support

  Defacement       0.84      0.67      0.74      1069
      benign       0.84      0.77      0.81      1068
     malware       0.67      0.62      0.64      1068
    phishing       0.53      0.75      0.62      1069
        spam       0.86      0.82      0.84      1068

    accuracy                           0.73      5342
   macro avg       0.75      0.73      0.73      5342
weighted avg       0.75      0.73      0.73      5342

##########################################################################################
##########


ml_en=5               precision    recall  f1-score   support

  Defacement       0.69      0.88      0.77      1069
      benign       0.85      0.86      0.85      1068
     malware       0.75      0.65      0.70      1068
    phishing       0.70      0.70      0.70      1069
        spam       0.91      0.76      0.83      1068

    accuracy                           0.77      5342
   macro avg       0.78      0.77      0.77      5342
weighted avg       0.78      0.77      0.77      5342

##########################################################################################
##########


ml_en=6               precision    recall  f1-score   support

  Defacement       0.76      0.88      0.82      1069
      benign       0.86      0.90      0.88      1068
     malware       0.89      0.75      0.82      1068
    phishing       0.76      0.71      0.73      1069
        spam       0.91      0.92      0.91      1068

    accuracy                           0.83      5342
   macro avg       0.84      0.83      0.83      5342
weighted avg       0.84      0.83      0.83      5342

/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
```

```
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/Users/samipsinghal/opt/anaconda3/lib/python3.7/site-
packages/sklearn/metrics/_classification.py:1308: UndefinedMetricWarning: Precision and
F-score are ill-defined and being set to 0.0 in labels with no predicted samples. Use
`zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

ANSWER : As the depth of the tree increases , the accuracy of prediction increases

VISUALIZING A TREE [for numpy , depth =2)

[69]:

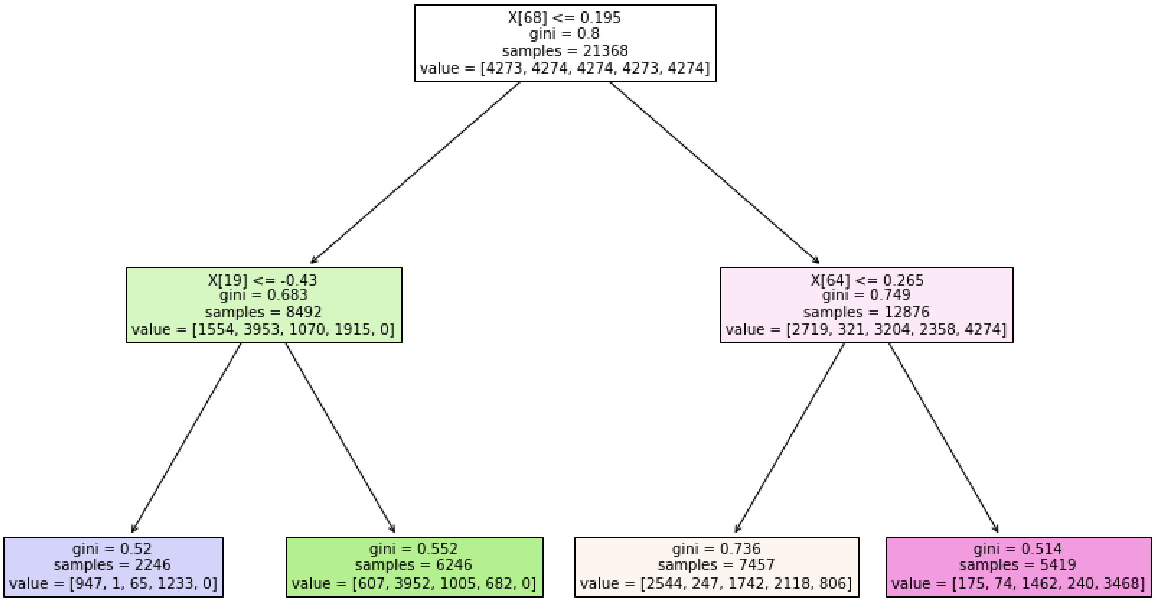
```
import matplotlib.pyplot as plt
from sklearn import tree
%matplotlib inline

plt.figure(figsize=(15,10))
tree.plot_tree(clf_gini_d2,filled='true')
```

[69]:

```
<Figure size 1080x720 with 0 Axes>
```

[69]:

```
[Text(418.5, 453.0, 'X[68] <= 0.195\ngini = 0.8\nsamples = 21368\nvalue = [4273, 4274,
4274, 4273, 4274]'),
 Text(209.25, 271.8, 'X[19] <= -0.43\ngini = 0.683\nsamples = 8492\nvalue = [1554, 3953,
1070, 1915, 0]'),
 Text(104.625, 90.59999999999997, 'gini = 0.52\nsamples = 2246\nvalue = [947, 1, 65,
1233, 0]'),
 Text(313.875, 90.59999999999997, 'gini = 0.552\nsamples = 6246\nvalue = [607, 3952,
1005, 682, 0]'),
 Text(627.75, 271.8, 'X[64] <= 0.265\ngini = 0.749\nsamples = 12876\nvalue = [2719, 321,
3204, 2358, 4274]'),
 Text(523.125, 90.59999999999997, 'gini = 0.736\nsamples = 7457\nvalue = [2544, 247,
1742, 2118, 806]'),
 Text(732.375, 90.59999999999997, 'gini = 0.514\nsamples = 5419\nvalue = [175, 74, 1462,
240, 3468]')]
```


X[68] <= 0.195
gini = 0.8
samples = 21368
value = [4273, 4274, 4274, 4273, 4274]
X[19] <= -0.43
gini = 0.683
samples = 8492
value = [1554, 3953, 1070, 1915, 0]
X[64] <= 0.265
gini = 0.749
samples = 12876
value = [2719, 321, 3204, 2358, 4274]
gini = 0.52
samples = 2246
value = [947, 1, 65, 1233, 0]
gini = 0.552
samples = 6246
value = [607, 3952, 1005, 682, 0]
gini = 0.736
samples = 7457
value = [2544, 247, 1742, 2118, 806]
gini = 0.514
samples = 5419
value = [175, 74, 1462, 240, 3468]

[ ]:

[ ]: