In [1]:

```
import os
print(os.getcwd())
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import GridSearchCV
%matplotlib inline
```

```
C:\Users\riyav
```

In [2]:

```
df = pd.read_csv('car_evaluation.csv', header = None)
```

In [3]:

```
df.head()
```

Out[3]:

	0	1	2	3	4	5	6
0	vhigh	vhigh	2	2	small	low	unacc
1	vhigh	vhigh	2	2	small	med	unacc
2	vhigh	vhigh	2	2	small	high	unacc
3	vhigh	vhigh	2	2	med	low	unacc
4	vhigh	vhigh	2	2	med	med	unacc

In [4]:

```
col_names = ['buying', 'maint', 'doors', 'persons', 'lug_boot', 'safety', 'class']
df.columns = col_names
col_names
```

Out[4]:

```
['buying', 'maint', 'doors', 'persons', 'lug_boot', 'safety', 'class']
```

In [5]:

```
df.head()
```

Out[5]:

	buying	maint	doors	persons	lug_boot	safety	class
0	vhigh	vhigh	2	2	small	low	unacc
1	vhigh	vhigh	2	2	small	med	unacc
2	vhigh	vhigh	2	2	small	high	unacc
3	vhigh	vhigh	2	2	med	low	unacc
4	vhigh	vhigh	2	2	med	med	unacc

In [6]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1728 entries, 0 to 1727
Data columns (total 7 columns):
 #   Column    Non-Null Count  Dtype 
---  ------    --------------  ----- 
 0   buying    1728 non-null   object
 1   maint     1728 non-null   object
 2   doors     1728 non-null   object
 3   persons   1728 non-null   object
 4   lug_boot  1728 non-null   object
 5   safety    1728 non-null   object
 6   class     1728 non-null   object
```

```
dtypes: object(7)
memory usage: 94.6+ KB
```

In [7]:

```
for i in col_names:
    print(df[i].value_counts())
```

```
vhigh    432
high     432
med      432
low      432
Name: buying, dtype: int64
vhigh    432
high     432
med      432
low      432
Name: maint, dtype: int64
2        432
3        432
4        432
5more    432
Name: doors, dtype: int64
2       576
4       576
more    576
Name: persons, dtype: int64
small    576
med      576
big      576
Name: lug_boot, dtype: int64
low     576
med     576
high    576
Name: safety, dtype: int64
unacc    1210
acc       384
good       69
vgood      65
Name: class, dtype: int64
```

In [8]:

```
df.shape
```

Out[8]:

```
(1728, 7)
```

In [9]:

```
X = df.drop(['class'],axis = 1)
y = df['class']
```

In [10]:

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X,y,test_size=0.3,random_state=42)
```

In [11]:

```
from sklearn.preprocessing import OrdinalEncoder
enc = OrdinalEncoder()
X_train = enc.fit_transform(X_train)
X_test = enc.transform((X_test))
```

Gini index as criterion

In [12]:

```
from sklearn.tree import DecisionTreeClassifier
```

In [13]:

```
clf_gini = DecisionTreeClassifier(criterion='gini', max_depth=3, random_state=42)
clf_gini.fit(X_train, y_train)
```

Out[13]:
```
DecisionTreeClassifier(max_depth=3, random_state=42)
```

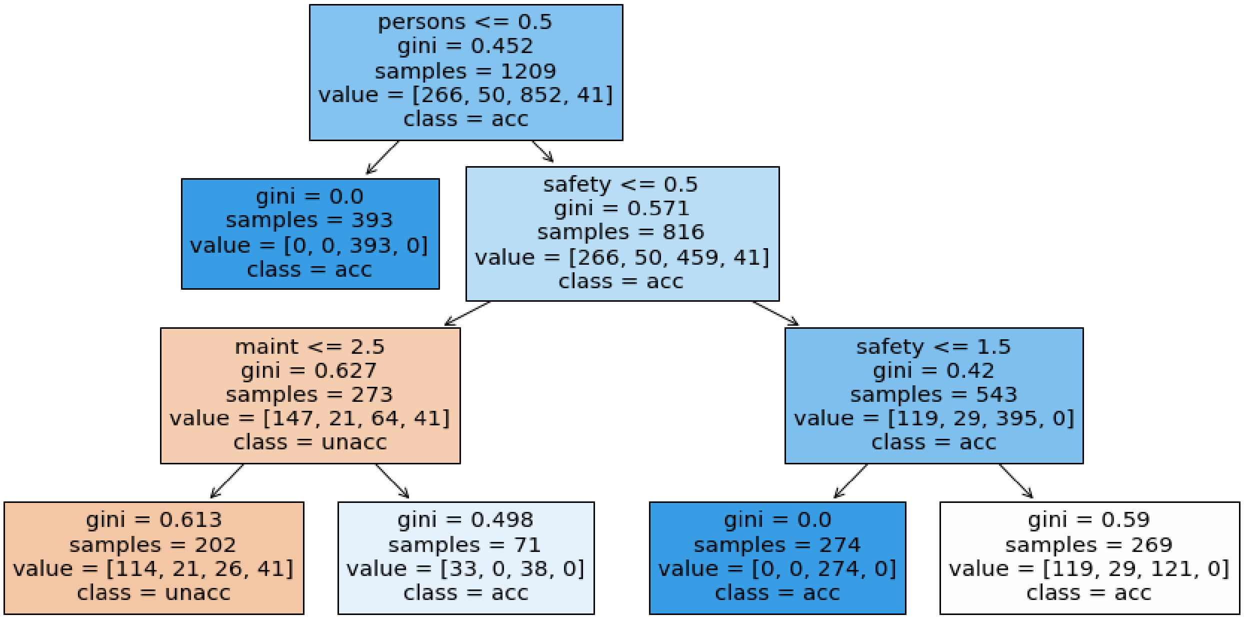
In [14]:
```python
y_pred = clf_gini.predict(X_test)
```

In [15]:
```python
from sklearn.metrics import accuracy_score

print(f'Model with gini index gives an accuracy of: {accuracy_score(y_true=y_test, y_pr
```

```
Model with gini index gives an accuracy of: 0.7572254335260116
```

In [16]:
```python
from sklearn import tree
plt.figure(figsize=(15,8))
tree.plot_tree(clf_gini,
               feature_names=['buying', 'maint', 'doors', 'persons', 'lug_boot', 'safet
               class_names= list(set(y_train)),
               filled = True)
plt.show()
```



In [17]:
```python
# Check for underfitting

print(f'Training set score: {clf_gini.score(X_train,y_train)}')
print(f'Test set score: {clf_gini.score(X_test,y_test)}')
```

```
Training set score: 0.7775020678246485
Test set score: 0.7572254335260116
```

Entropy as criterion

In [18]:
```python
clf_entropy = DecisionTreeClassifier(criterion='entropy', max_depth=3, random_state=42)
clf_entropy.fit(X_train, y_train)
```

Out[18]:
```
DecisionTreeClassifier(criterion='entropy', max_depth=3, random_state=42)
```

In [19]:
```python
y_pred = clf_entropy.predict(X_test)
```

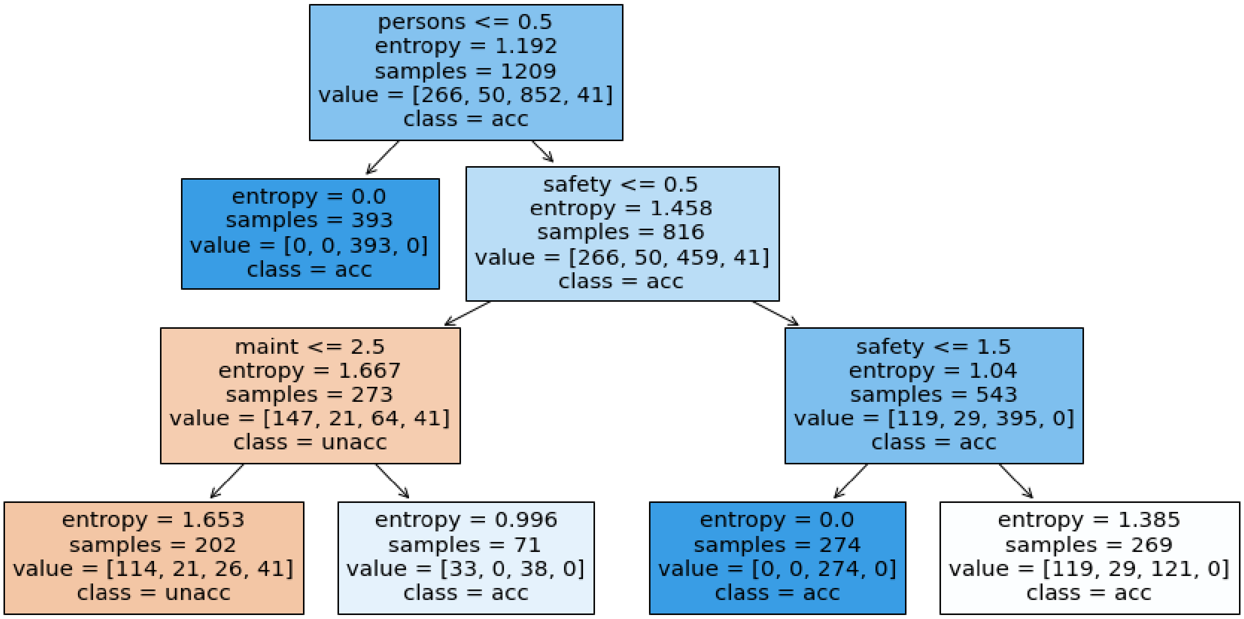
In [20]:
```python
from sklearn.metrics import accuracy_score
```

```
print(f'Model with gini index gives an accuracy of: {accuracy_score(y_test, y_pred)}')
```

```
Model with gini index gives an accuracy of: 0.7572254335260116
```

In [21]:

```
plt.figure(figsize=(15,8))
tree.plot_tree(clf_entropy,
               feature_names=['buying', 'maint', 'doors', 'persons', 'lug_boot', 'safet
               class_names= list(set(y_train)),
               filled = True)
plt.show()
```



In [22]:

```
# Check for underfitting

print(f'Training set score: {clf_entropy.score(X_train,y_train)}')
print(f'Test set score: {clf_entropy.score(X_test,y_test)}')
```

```
Training set score: 0.7775020678246485
Test set score: 0.7572254335260116
```

In [23]:

```
from sklearn.metrics import confusion_matrix, classification_report
cm = confusion_matrix(y_test, y_pred)
```

In [24]:

```
print(cm)
```

```
[[ 44   0  74   0]
 [  9   0  10   0]
 [  9   0 349   0]
 [ 24   0   0   0]]
```

In [25]:

```
print(classification_report(y_test, y_pred))
```

```
              precision    recall  f1-score   support

         acc       0.51      0.37      0.43       118
        good       0.00      0.00      0.00        19
       unacc       0.81      0.97      0.88       358
       vgood       0.00      0.00      0.00        24

    accuracy                           0.76       519
   macro avg       0.33      0.34      0.33       519
```

```
weighted avg       0.67      0.76      0.71       519

C:\Users\PRATYUSH\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: U
ndefinedMetricWarning: Precision and F-score are ill-defined and being set to 0.0 in lab
els with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\PRATYUSH\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: U
ndefinedMetricWarning: Precision and F-score are ill-defined and being set to 0.0 in lab
els with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\PRATYUSH\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1248: U
ndefinedMetricWarning: Precision and F-score are ill-defined and being set to 0.0 in lab
els with no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Cross Validation

In [26]:

```
params_grid = {
    'criterion':['gini','entropy'],
    'max_depth':[3,4,5,6,7,8,9,10]
}
```

In [27]:

```
decision_tree = DecisionTreeClassifier()
decision_tree.fit(X_train,y_train)
```

Out[27]:

```
DecisionTreeClassifier()
```

In [28]:

```
dt_validated = GridSearchCV(estimator=decision_tree, param_grid=params_grid,scoring='ac
```

In [29]:

```
%%time
dt_validated.fit(X_train,y_train)
```

```
Wall time: 840 ms
```

Out[29]:

```
GridSearchCV(cv=20, estimator=DecisionTreeClassifier(),
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [3, 4, 5, 6, 7, 8, 9, 10]},
             scoring='accuracy')
```

In [30]:

```
print(f'Best parameters for decison tree classifier after CV -> {dt_validated.best_para
print(f'Best score on decision tree classifier after CV -> {dt_validated.best_score_}')
```

```
Best parameters for decison tree classifier after CV -> {'criterion': 'entropy', 'max_de
pth': 10}
Best score on decision tree classifier after CV -> 0.979330601092896
```

In [31]:

```
print(f'Score on train set of DT classifier before CV -> {decision_tree.score(X_train,
print(f'Score on test set of DT classifier before CV -> {decision_tree.score(X_test, y_
print(f'Score on train set of DT classfifier after CV -> {dt_validated.score(X_train, y
print(f'Score on test set of DT classifier after CV -> {dt_validated.score(X_test, y_te
```

```
Score on train set of DT classifier before CV -> 1.0
Score on test set of DT classifier before CV -> 0.9653179190751445
Score on train set of DT classfifier after CV -> 0.9925558312655087
Score on test set of DT classifier after CV -> 0.9595375722543352
```

In [32]:

```
print('Classification report on train set')
print(classification_report(y_true=y_train, y_pred=dt_validated.predict(X_train)))
```

```
Classification report on train set
              precision    recall  f1-score   support
```

```
         acc       0.98      0.99      0.99       266
        good       0.98      0.98      0.98        50
       unacc       1.00      0.99      1.00       852
       vgood       0.98      1.00      0.99        41

    accuracy                           0.99      1209
   macro avg       0.98      0.99      0.99      1209
weighted avg       0.99      0.99      0.99      1209
```

In [33]:

```
print('Classification report on test set')
print(classification_report(y_true=y_test, y_pred=dt_validated.predict(X_test)))
```

```
Classification report on test set
              precision    recall  f1-score   support

         acc       0.92      0.92      0.92       118
        good       0.71      0.89      0.79        19
       unacc       0.99      0.98      0.99       358
       vgood       0.88      0.88      0.88        24

    accuracy                           0.96       519
   macro avg       0.88      0.92      0.89       519
weighted avg       0.96      0.96      0.96       519
```

In [34]:

```
print('Confusion matrix on train set')
print(confusion_matrix(y_true=y_train, y_pred=dt_validated.predict(X_train)))
```

```
Confusion matrix on train set
[[263   1   2   0]
 [  0  49   0   1]
 [  5   0 847   0]
 [  0   0   0  41]]
```

In [35]:

```
print('Confusion matrix on test set')
print(confusion_matrix(y_true=y_test, y_pred=dt_validated.predict(X_test)))
```

```
Confusion matrix on test set
[[108   7   2   1]
 [  0  17   0   2]
 [  6   0 352   0]
 [  3   0   0  21]]
```

In [39]:

```
best_dt = DecisionTreeClassifier(criterion='entropy',max_depth=9)
```

In [40]:

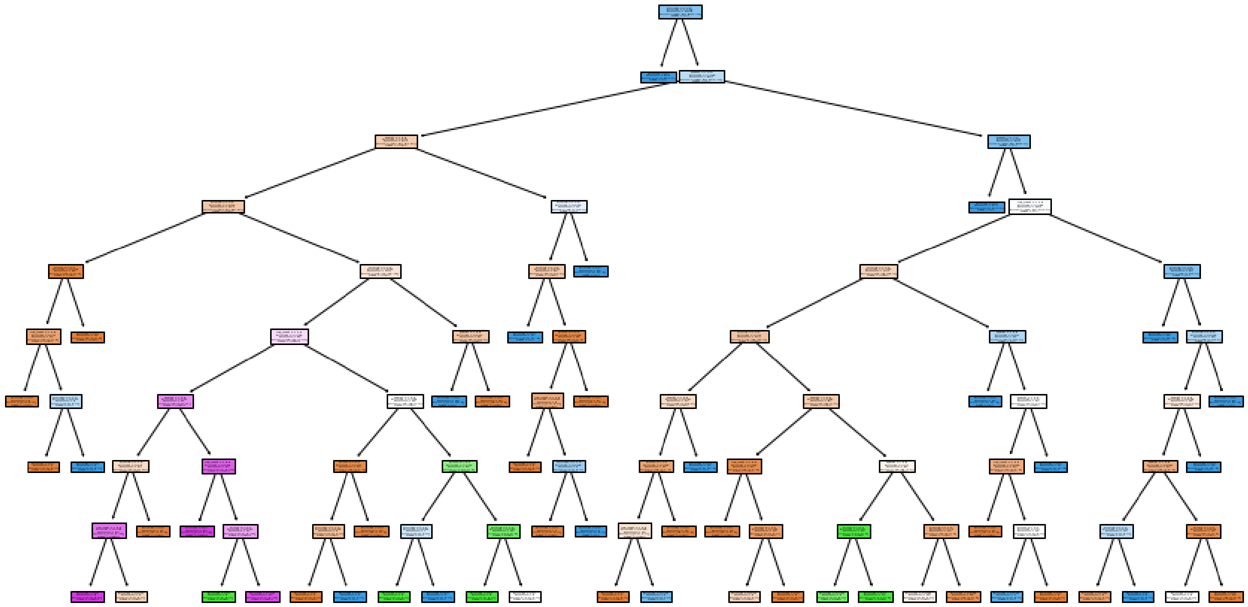
```
best_dt.fit(X_train,y_train)
```

Out[40]:

```
DecisionTreeClassifier(criterion='entropy', max_depth=9)
```

In [41]:

```
plt.figure(figsize=(15,8))
tree.plot_tree(best_dt,
               feature_names=['buying', 'maint', 'doors', 'persons', 'lug_boot', 'safet
               class_names= list(set(y_train)),
               filled = True)
plt.show()
```



In [ ]: