In [1]:
```
# importing some important libraries
import pandas as pd
import numpy as np
from sklearn.ensemble import BaggingClassifier
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.tree import DecisionTreeClassifier
from sklearn import tree
import matplotlib.pyplot as plt
%matplotlib inline
```

In [3]:
```
# reading winequality csv file
df = pd.read_csv("https://raw.githubusercontent.com/aniruddhachoudhury/Red-Wine-Q
```

In [21]:
```
df
```

Out[21]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcoh
0	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.99780	3.51	0.56	9
1	7.8	0.880	0.00	2.6	0.098	25.0	67.0	0.99680	3.20	0.68	9
2	7.8	0.760	0.04	2.3	0.092	15.0	54.0	0.99700	3.26	0.65	9
3	11.2	0.280	0.56	1.9	0.075	17.0	60.0	0.99800	3.16	0.58	9
4	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.99780	3.51	0.56	9
...	...	...	...	...	...	...	...	...	...	...	
1594	6.2	0.600	0.08	2.0	0.090	32.0	44.0	0.99490	3.45	0.58	10
1595	5.9	0.550	0.10	2.2	0.062	39.0	51.0	0.99512	3.52	0.76	11
1596	6.3	0.510	0.13	2.3	0.076	29.0	40.0	0.99574	3.42	0.75	11
1597	5.9	0.645	0.12	2.0	0.075	32.0	44.0	0.99547	3.57	0.71	10
1598	6.0	0.310	0.47	3.6	0.067	18.0	42.0	0.99549	3.39	0.66	11

1599 rows × 12 columns

In [4]:
```
x = df.drop(columns=['quality'])
```

In [5]:
```
y = df.quality
```

In [10]:
```
# train and test split
X_train,x_test,Y_train,y_test = train_test_split(x,y,test_size=0.2,random_state=2
```

BaggingClassifier with DecisionTreeClassifier

In [11]:
```
# Creating a bagging classifier object 100 decision trees as base estimators
bag_dt = BaggingClassifier(DecisionTreeClassifier(),n_estimators=100)
```

In [13]:
```
# Training the data
bag_dt.fit(X_train,Y_train)
```

Out[13]:
```
BaggingClassifier(base_estimator=DecisionTreeClassifier(), n_estimators=100)
```

In [17]:
```
bag_dt.base_estimator_  # showing base estimator
```

Out[17]:
```
DecisionTreeClassifier()
```

In [20]:
```
bag_dt.classes_  # showing classes or label values
```

Out[20]:
```
array([3, 4, 5, 6, 7, 8], dtype=int64)
```

In [41]:
```
# Numbers of features used
bag_dt.n_features_in_
```

Out[41]:
```
11
```

In [42]:
```
# we can check parameters which are used to train decision trees
bag_dt.get_params()
```

Out[42]:
```
{'base_estimator__ccp_alpha': 0.0,
 'base_estimator__class_weight': None,
 'base_estimator__criterion': 'gini',
 'base_estimator__max_depth': None,
 'base_estimator__max_features': None,
 'base_estimator__max_leaf_nodes': None,
 'base_estimator__min_impurity_decrease': 0.0,
 'base_estimator__min_impurity_split': None,
 'base_estimator__min_samples_leaf': 1,
 'base_estimator__min_samples_split': 2,
 'base_estimator__min_weight_fraction_leaf': 0.0,
 'base_estimator__presort': 'deprecated',
 'base_estimator__random_state': None,
 'base_estimator__splitter': 'best',
 'base_estimator': DecisionTreeClassifier(),
 'bootstrap': True,
 'bootstrap_features': False,
 'max_features': 1.0,
 'max_samples': 1.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
```

In [43]:
```
# accuracy score
bag_dt.score(x_test,y_test)
```

Out[43]:
```
0.69375
```

In [44]:
```
# making prediction
bag_dt.predict(x_test)
```

Out[44]:
```
array([5, 5, 5, 5, 6, 6, 5, 6, 5, 5, 6, 6, 4, 5, 5, 5, 6, 6, 5, 5, 5, 7,
       5, 5, 6, 5, 5, 5, 6, 5, 6, 5, 5, 6, 5, 7, 6, 5, 6, 6, 5, 5, 6, 5,
       7, 5, 6, 6, 6, 6, 6, 5, 5, 5, 6, 5, 5, 5, 5, 5, 5, 5, 6, 5, 5, 5,
       6, 5, 6, 6, 5, 6, 6, 6, 5, 7, 5, 6, 6, 6, 5, 7, 5, 6, 6, 6, 5, 5,
       5, 5, 5, 6, 5, 6, 6, 6, 6, 5, 7, 6, 5, 5, 7, 5, 6, 6, 5, 5, 5, 6,
       5, 5, 5, 5, 5, 6, 6, 5, 5, 6, 5, 6, 6, 5, 6, 6, 6, 6, 5, 7, 6, 5,
       5, 5, 5, 6, 6, 6, 5, 7, 5, 6, 6, 5, 6, 7, 4, 5, 5, 6, 5, 5, 5, 6,
       6, 6, 5, 5, 5, 7, 6, 6, 6, 5, 6, 6, 5, 5, 5, 6, 7, 7, 5, 6, 6, 7,
       5, 6, 5, 5, 7, 7, 6, 6, 5, 5, 6, 6, 5, 5, 6, 5, 6, 6, 6, 7, 5, 6,
       7, 6, 7, 6, 6, 5, 6, 5, 5, 5, 5, 6, 6, 6, 5, 6, 6, 5, 5, 6, 7, 6,
       5, 5, 7, 5, 6, 7, 5, 8, 6, 6, 5, 6, 6, 7, 5, 6, 7, 5, 6, 5, 5, 5,
       7, 5, 6, 6, 5, 6, 5, 6, 6, 6, 6, 5, 5, 6, 6, 5, 5, 7, 6, 5, 5, 6,
       6, 5, 5, 7, 6, 5, 6, 7, 7, 6, 5, 7, 6, 6, 6, 5, 5, 6, 6, 5, 5, 5,
       5, 6, 5, 7, 5, 6, 6, 7, 7, 7, 6, 5, 7, 5, 5, 5, 5, 5, 5, 5, 5, 5,
       6, 6, 7, 6, 6, 5, 5, 6, 5, 5, 5, 6], dtype=int64)
```

In [46]:
```
# prediction probabilites of each class for each data row in the x_test
bag_dt.predict_proba(x_test)
```

Out[46]:
```
array([[0.  , 0.01, 0.46, 0.32, 0.2 , 0.01],
       [0.  , 0.06, 0.91, 0.03, 0.  , 0.  ],
       [0.  , 0.04, 0.85, 0.11, 0.  , 0.  ],
       ...,
       [0.  , 0.04, 0.71, 0.25, 0.  , 0.  ],
       [0.2 , 0.05, 0.69, 0.04, 0.02, 0.  ],
       [0.  , 0.01, 0.22, 0.56, 0.2 , 0.01]])
```

BaggingClassifier using KNeighborsClassifier

In [49]:
```
# importing knn classifier
from sklearn.neighbors import KNeighborsClassifier
```

In [50]:
```
# creating bagging object with knn classifier as base estimator
bag_knn = BaggingClassifier(base_estimator=KNeighborsClassifier(6),n_estimators=1
```

In [52]:
```
# Training the model
bag_knn.fit(X_train,Y_train)
```

Out[52]:
```
BaggingClassifier(base_estimator=KNeighborsClassifier(n_neighbors=6),
                  n_estimators=100)
```

In [53]:
```
# showing base estimator name
bag_knn.base_estimator_
```

Out[53]:
```
KNeighborsClassifier(n_neighbors=6)
```

In [55]:
```
# classes or label in which classification has to be done
bag_knn.classes_
```

Out[55]:
```
array([3, 4, 5, 6, 7, 8], dtype=int64)
```

In [56]:
```
# Numbers of features on which model is trained
bag_knn.n_features_in_
```

Out[56]:
```
11
```

In [59]:
```
# shows all the parameters availabe which we can play to influence the quality of
bag_knn.get_params()
```

Out[59]:
```
{'base_estimator__algorithm': 'auto',
 'base_estimator__leaf_size': 30,
 'base_estimator__metric': 'minkowski',
 'base_estimator__metric_params': None,
 'base_estimator__n_jobs': None,
 'base_estimator__n_neighbors': 6,
 'base_estimator__p': 2,
 'base_estimator__weights': 'uniform',
 'base_estimator': KNeighborsClassifier(n_neighbors=6),
 'bootstrap': True,
 'bootstrap_features': False,
 'max_features': 1.0,
 'max_samples': 1.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
```

In [61]:
```
# shows accuracy of the model
bag_knn.score(x_test,y_test)
```

Out[61]:
```
0.5
```

In [63]:
```
# prediction on x_test dataset
bag_knn.predict(x_test)
```

Out[63]:
```
array([6, 5, 5, 5, 6, 5, 6, 5, 5, 6, 6, 5, 6, 5, 5, 5, 5, 6, 5, 6, 5, 7,
       5, 6, 7, 6, 6, 5, 5, 5, 5, 5, 5, 6, 5, 7, 6, 5, 6, 6, 5, 5, 6, 5,
       7, 6, 5, 5, 6, 6, 6, 5, 5, 6, 6, 6, 5, 6, 5, 6, 6, 5, 6, 5, 5, 5,
       5, 6, 7, 5, 5, 5, 6, 6, 5, 5, 6, 5, 6, 5, 6, 6, 6, 7, 5, 6, 5, 5,
       5, 5, 5, 6, 5, 6, 6, 6, 5, 5, 7, 6, 5, 5, 7, 4, 6, 6, 6, 5, 7, 6,
       5, 6, 7, 5, 5, 6, 5, 5, 5, 6, 5, 5, 5, 6, 5, 6, 5, 5, 5, 6, 5, 5,
       5, 5, 7, 5, 6, 5, 6, 6, 5, 5, 6, 6, 5, 6, 4, 6, 5, 6, 6, 5, 6, 6,
       6, 5, 5, 6, 5, 6, 6, 6, 6, 5, 5, 7, 5, 7, 5, 5, 6, 6, 5, 6, 6, 6,
       6, 7, 5, 5, 7, 7, 7, 5, 5, 6, 6, 5, 7, 5, 6, 5, 6, 6, 5, 7, 5, 5,
       6, 6, 6, 5, 7, 5, 6, 5, 6, 6, 5, 6, 6, 6, 5, 6, 7, 5, 5, 7, 6, 6,
       5, 5, 6, 6, 6, 7, 5, 6, 7, 6, 5, 5, 7, 6, 6, 5, 8, 5, 6, 5, 5, 7,
       6, 5, 5, 6, 5, 6, 5, 5, 5, 5, 6, 5, 5, 6, 7, 6, 5, 6, 6, 5, 5, 5,
       6, 5, 5, 7, 6, 4, 7, 6, 7, 6, 5, 7, 7, 5, 6, 5, 6, 6, 6, 5, 5, 5,
       5, 6, 6, 6, 5, 6, 5, 7, 6, 6, 5, 5, 6, 6, 5, 5, 5, 5, 5, 5, 5, 6,
       5, 7, 5, 5, 5, 6, 5, 5, 5, 5, 5, 6], dtype=int64)
```

In [65]:
```
# prediction probabilites of each class for each data row in the x_test
bag_knn.predict_proba(x_test)
```

Out[65]:
```
array([[0.        , 0.15833333, 0.055     , 0.50666667, 0.10166667,
        0.17833333],
       [0.        , 0.00166667, 0.97833333, 0.02      , 0.        ,
        0.        ],
       [0.        , 0.195     , 0.775     , 0.03      , 0.        ,
        0.        ],
       ...,
       [0.        , 0.        , 0.805     , 0.00166667, 0.12333333,
        0.07      ],
       [0.        , 0.24666667, 0.40166667, 0.19666667, 0.00333333,
        0.15166667],
       [0.        , 0.        , 0.07166667, 0.76333333, 0.165     ,
        0.        ]])
```

RandomForestClassifier

In [68]:
```
# importing random forest
from sklearn.ensemble import RandomForestClassifier
```

In [91]:
```
# creating random forest classifier object
rf = RandomForestClassifier(100)
```

In [120]:
```
# training model
rf.fit(X_train,Y_train)
```

Out[120]:
```
RandomForestClassifier()
```

In [93]:
```
# base estimator is shown as decision tree classifer
rf.base_estimator_
```

Out[93]:
```
DecisionTreeClassifier()
```

In [94]:
```
# classes
rf.classes_
```

Out[94]:
```
array([3, 4, 5, 6, 7, 8], dtype=int64)
```

In [95]:
```
# features
rf.n_features_
```

Out[95]:
```
11
```

In [96]:
```
# show all parameter used to create base estimator
rf.get_params()
```

Out[96]:
```
{'bootstrap': True,
 'ccp_alpha': 0.0,
 'class_weight': None,
 'criterion': 'gini',
 'max_depth': None,
 'max_features': 'auto',
 'max_leaf_nodes': None,
 'max_samples': None,
 'min_impurity_decrease': 0.0,
 'min_impurity_split': None,
 'min_samples_leaf': 1,
 'min_samples_split': 2,
 'min_weight_fraction_leaf': 0.0,
 'n_estimators': 100,
 'n_jobs': None,
 'oob_score': False,
 'random_state': None,
 'verbose': 0,
 'warm_start': False}
```

In [122]:
```
# accuracy
rf.score(x_test,y_test)
```

Out[122]:
```
0.6875
```

In [123]:
```
# prediction on x_test
rf.predict(x_test)
```

Out[123]:
```
array([6, 5, 5, 5, 6, 6, 5, 6, 5, 5, 6, 6, 5, 5, 5, 5, 5, 6, 5, 6, 5, 7,
       5, 5, 6, 5, 6, 5, 6, 5, 5, 5, 5, 6, 5, 7, 6, 5, 6, 6, 5, 5, 7, 5,
       7, 5, 6, 6, 6, 6, 6, 5, 5, 5, 6, 5, 5, 5, 5, 5, 5, 5, 6, 5, 5, 5,
       6, 5, 6, 6, 5, 6, 6, 6, 5, 7, 5, 6, 6, 6, 5, 7, 5, 6, 6, 6, 5, 5,
       5, 5, 5, 6, 5, 6, 6, 6, 6, 5, 7, 6, 5, 5, 7, 4, 6, 6, 5, 5, 5, 6,
       5, 5, 5, 5, 5, 6, 6, 5, 5, 6, 5, 5, 6, 5, 5, 6, 6, 6, 5, 7, 6, 5,
       5, 5, 5, 6, 6, 6, 5, 7, 5, 6, 6, 5, 6, 6, 6, 5, 5, 6, 5, 5, 5, 6,
       6, 6, 5, 5, 5, 7, 6, 6, 6, 5, 6, 6, 5, 5, 5, 6, 7, 6, 5, 6, 6, 7,
       6, 6, 5, 5, 7, 7, 6, 6, 5, 5, 6, 6, 6, 5, 6, 5, 6, 6, 6, 7, 5, 6,
       7, 6, 7, 6, 6, 5, 6, 5, 5, 5, 5, 6, 6, 6, 5, 6, 6, 5, 5, 6, 6, 6,
       6, 5, 7, 5, 6, 6, 5, 7, 6, 6, 5, 6, 6, 7, 5, 5, 7, 5, 6, 5, 5, 7,
       7, 5, 5, 6, 5, 5, 5, 5, 5, 6, 6, 5, 5, 6, 6, 5, 5, 7, 6, 5, 5, 5,
       6, 5, 5, 7, 6, 5, 6, 7, 7, 6, 5, 7, 6, 6, 6, 5, 5, 6, 6, 5, 5, 5,
       5, 6, 5, 7, 5, 6, 6, 7, 7, 7, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5,
       6, 6, 7, 6, 6, 5, 5, 6, 6, 5, 5, 6], dtype=int64)
```

In [124]:
```
## prediction probabilites of each class for each data row in the x_test
rf.predict_proba(x_test)
```

Out[124]:
```
array([[0.  , 0.01, 0.35, 0.42, 0.2 , 0.02],
       [0.  , 0.03, 0.91, 0.06, 0.  , 0.  ],
       [0.  , 0.03, 0.9 , 0.07, 0.  , 0.  ],
       ...,
       [0.  , 0.03, 0.72, 0.24, 0.01, 0.  ],
       [0.12, 0.13, 0.69, 0.06, 0.  , 0.  ],
       [0.01, 0.01, 0.24, 0.58, 0.15, 0.01]])
```

comparision between above created models

In [100]:
```
# accuracy of bagging with 100 decision trees
bag_dt.score(x_test,y_test)
```

Out[100]:
```
0.69375
```

In [101]:
```
# accuracy of bagging with 100 knn
bag_knn.score(x_test,y_test)
```

Out[101]:
```
0.5
```

In [102]:
```
# accuracy of random forest where 100 decision trees is used
rf.score(x_test,y_test)
```

Out[102]:
```
0.71875
```

Observation - Random forest model gives better accuracy

EXTRA EXPERIMENTS WITH RANDOM FOREST

In [105]:
```
# shows all decision trees classifiers
rf.estimators_
```

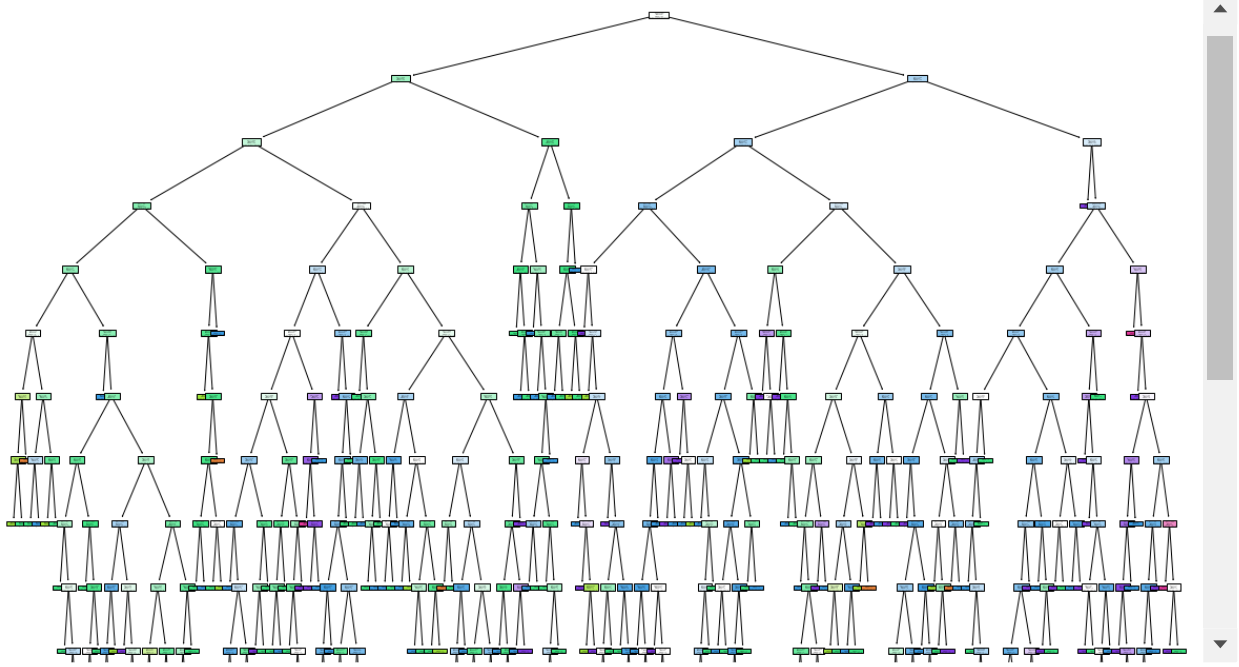
Out[105]:
```
[DecisionTreeClassifier(max_features='auto', random_state=312740373),
 DecisionTreeClassifier(max_features='auto', random_state=501395558),
 DecisionTreeClassifier(max_features='auto', random_state=557653086),
 DecisionTreeClassifier(max_features='auto', random_state=540797481),
 DecisionTreeClassifier(max_features='auto', random_state=1511964624),
 DecisionTreeClassifier(max_features='auto', random_state=1504556210),
 DecisionTreeClassifier(max_features='auto', random_state=265342615),
 DecisionTreeClassifier(max_features='auto', random_state=2107936750),
 DecisionTreeClassifier(max_features='auto', random_state=912578988),
 DecisionTreeClassifier(max_features='auto', random_state=1667734836),
 DecisionTreeClassifier(max_features='auto', random_state=529365236),
 DecisionTreeClassifier(max_features='auto', random_state=1627003457),
 DecisionTreeClassifier(max_features='auto', random_state=542956394),
 DecisionTreeClassifier(max_features='auto', random_state=301313637),
 DecisionTreeClassifier(max_features='auto', random_state=1422842175),
 DecisionTreeClassifier(max_features='auto', random_state=553057207),
 DecisionTreeClassifier(max_features='auto', random_state=2076940166),
 DecisionTreeClassifier(max_features='auto', random_state=2071920328),
 DecisionTreeClassifier(max_features='auto', random_state=727855028),
 DecisionTreeClassifier(max_features='auto', random_state=1787214414),
 DecisionTreeClassifier(max_features='auto', random_state=661811813),
 DecisionTreeClassifier(max_features='auto', random_state=2081664800),
 DecisionTreeClassifier(max_features='auto', random_state=443620103),
 DecisionTreeClassifier(max_features='auto', random_state=663835942),
 DecisionTreeClassifier(max_features='auto', random_state=1627590358),
 DecisionTreeClassifier(max_features='auto', random_state=905918762),
 DecisionTreeClassifier(max_features='auto', random_state=2029246914),
 DecisionTreeClassifier(max_features='auto', random_state=476728404),
 DecisionTreeClassifier(max_features='auto', random_state=666656415),
 DecisionTreeClassifier(max_features='auto', random_state=873514685),
 DecisionTreeClassifier(max_features='auto', random_state=1540258354),
 DecisionTreeClassifier(max_features='auto', random_state=1144086889),
 DecisionTreeClassifier(max_features='auto', random_state=411263395),
 DecisionTreeClassifier(max_features='auto', random_state=1147673243),
 DecisionTreeClassifier(max_features='auto', random_state=1735133656),
 DecisionTreeClassifier(max_features='auto', random_state=1042472732),
 DecisionTreeClassifier(max_features='auto', random_state=159797054),
 DecisionTreeClassifier(max_features='auto', random_state=2101646931),
 DecisionTreeClassifier(max_features='auto', random_state=1978037760),
 DecisionTreeClassifier(max_features='auto', random_state=527641289),
 DecisionTreeClassifier(max_features='auto', random_state=47556576),
 DecisionTreeClassifier(max_features='auto', random_state=1043034224),
 DecisionTreeClassifier(max_features='auto', random_state=740185955),
 DecisionTreeClassifier(max_features='auto', random_state=1689296212),
 DecisionTreeClassifier(max_features='auto', random_state=1916029355),
 DecisionTreeClassifier(max_features='auto', random_state=2056178505),
 DecisionTreeClassifier(max_features='auto', random_state=528428343),
 DecisionTreeClassifier(max_features='auto', random_state=768326405),
 DecisionTreeClassifier(max_features='auto', random_state=2072593606),
 DecisionTreeClassifier(max_features='auto', random_state=623639442),
 DecisionTreeClassifier(max_features='auto', random_state=869824446),
 DecisionTreeClassifier(max_features='auto', random_state=1478189093),
 DecisionTreeClassifier(max_features='auto', random_state=1040143818),
```

```
 DecisionTreeClassifier(max_features='auto', random_state=1491541750),
 DecisionTreeClassifier(max_features='auto', random_state=304217153),
 DecisionTreeClassifier(max_features='auto', random_state=79878926),
 DecisionTreeClassifier(max_features='auto', random_state=333806279),
 DecisionTreeClassifier(max_features='auto', random_state=78271061),
 DecisionTreeClassifier(max_features='auto', random_state=2001447860),
 DecisionTreeClassifier(max_features='auto', random_state=615288930),
 DecisionTreeClassifier(max_features='auto', random_state=811092897),
 DecisionTreeClassifier(max_features='auto', random_state=402753445),
 DecisionTreeClassifier(max_features='auto', random_state=803241188),
 DecisionTreeClassifier(max_features='auto', random_state=1991803271),
 DecisionTreeClassifier(max_features='auto', random_state=1589823085),
 DecisionTreeClassifier(max_features='auto', random_state=266782430),
 DecisionTreeClassifier(max_features='auto', random_state=1923976267),
 DecisionTreeClassifier(max_features='auto', random_state=1013439913),
 DecisionTreeClassifier(max_features='auto', random_state=1091767324),
 DecisionTreeClassifier(max_features='auto', random_state=1046333134),
 DecisionTreeClassifier(max_features='auto', random_state=991988346),
 DecisionTreeClassifier(max_features='auto', random_state=1216253569),
 DecisionTreeClassifier(max_features='auto', random_state=1073359155),
 DecisionTreeClassifier(max_features='auto', random_state=1238070029),
 DecisionTreeClassifier(max_features='auto', random_state=232697891),
 DecisionTreeClassifier(max_features='auto', random_state=416565981),
 DecisionTreeClassifier(max_features='auto', random_state=1340735253),
 DecisionTreeClassifier(max_features='auto', random_state=584043586),
 DecisionTreeClassifier(max_features='auto', random_state=1396916814),
 DecisionTreeClassifier(max_features='auto', random_state=1461070228),
 DecisionTreeClassifier(max_features='auto', random_state=1848863425),
 DecisionTreeClassifier(max_features='auto', random_state=510803409),
 DecisionTreeClassifier(max_features='auto', random_state=1541029432),
 DecisionTreeClassifier(max_features='auto', random_state=1035054934),
 DecisionTreeClassifier(max_features='auto', random_state=2119037477),
 DecisionTreeClassifier(max_features='auto', random_state=1186688076),
 DecisionTreeClassifier(max_features='auto', random_state=578380015),
 DecisionTreeClassifier(max_features='auto', random_state=102894615),
 DecisionTreeClassifier(max_features='auto', random_state=2025988657),
 DecisionTreeClassifier(max_features='auto', random_state=251211642),
 DecisionTreeClassifier(max_features='auto', random_state=877618950),
 DecisionTreeClassifier(max_features='auto', random_state=2043115325),
 DecisionTreeClassifier(max_features='auto', random_state=1519876068),
 DecisionTreeClassifier(max_features='auto', random_state=1561189135),
 DecisionTreeClassifier(max_features='auto', random_state=336195706),
 DecisionTreeClassifier(max_features='auto', random_state=1820559425),
 DecisionTreeClassifier(max_features='auto', random_state=1445046562),
 DecisionTreeClassifier(max_features='auto', random_state=948796864),
 DecisionTreeClassifier(max_features='auto', random_state=1271323882),
 DecisionTreeClassifier(max_features='auto', random_state=160613891)]
```

In [106]:
```
rf.estimators_[0]
```

Out[106]:
```
DecisionTreeClassifier(max_features='auto', random_state=312740373)
```

In [108]:
```
#Plotting tree structure of one and first decision tree
plt.figure(figsize=(20,20))
tp = tree.plot_tree(rf.estimators_[0],filled=True)
```



GRID SEARCH

In [109]:
```
# setting some parameter which we want to tune for randome forest
grid_param = {
    "n_estimators":[100,150,200],
    "criterion" : ["gini","random"],
    "max_depth" : range(5,10),
    "min_samples_leaf" : range(5)
}
```

In [110]:
```
rf = RandomForestClassifier()
```

In [111]:
```
# gridsearchcv for hyperparameter tuning
grid_search_rf = GridSearchCV(estimator=rf,param_grid=grid_param,cv=10,n_jobs=6,v
```

In [112]:
```
# training
grid_search_rf.fit(X_train,Y_train)
```

```
Fitting 10 folds for each of 150 candidates, totalling 1500 fits

C:\Users\aniyant\anaconda3\lib\site-packages\sklearn\model_selection\_split.py:
670: UserWarning: The least populated class in y has only 9 members, which is l
ess than n_splits=10.
  warnings.warn(("The least populated class in y has only %d"
[Parallel(n_jobs=6)]: Using backend LokyBackend with 6 concurrent workers.
[Parallel(n_jobs=6)]: Done  38 tasks      | elapsed:   15.7s
[Parallel(n_jobs=6)]: Done 188 tasks      | elapsed:   37.1s
[Parallel(n_jobs=6)]: Done 438 tasks      | elapsed:  1.3min
[Parallel(n_jobs=6)]: Done 788 tasks      | elapsed:  2.2min
[Parallel(n_jobs=6)]: Done 1238 tasks      | elapsed:  2.5min
[Parallel(n_jobs=6)]: Done 1500 out of 1500 | elapsed:  2.7min finished
```

Out[112]:
```
GridSearchCV(cv=10, estimator=RandomForestClassifier(), n_jobs=6,
             param_grid={'criterion': ['gini', 'random'],
                         'max_depth': range(5, 10),
                         'min_samples_leaf': range(0, 5),
                         'n_estimators': [100, 150, 200]},
             verbose=1)
```

In [113]:
```
# best parameter we got from grid search
grid_search_rf.best_params_
```

Out[113]:
```
{'criterion': 'gini',
 'max_depth': 9,
 'min_samples_leaf': 1,
 'n_estimators': 200}
```

In [114]:
```
# new random forest model
rf_new = RandomForestClassifier(n_estimators=200,criterion='gini',max_depth=9,mir
```

In [116]:
```
rf_new.fit(X_train,Y_train)
```

Out[116]:
```
RandomForestClassifier(max_depth=9, n_estimators=200)
```

In [118]:
```
# accuracy of this model
rf_new.score(x_test,y_test)
```

Out[118]:
```
0.696875
```

In [125]:
```
# accuracy of the previous model
rf.score(x_test,y_test)
```

Out[125]:
```
0.6875
```

GridSearchCV may or may not be able to increase the accuracy of the model, it's just a matter of experiment

In [ ]:
```

```