```
## Bagging
    # 1. Random Forest Classifier
    # 2. Extra Tree Classifier
    # 3. Voting Classifier
    # 4. Hyperparameter Tuning
```

```
import numpy as np
import pandas as pd
```

```
df=pd.read_csv("/content/winequality-red.csv",sep=",")
```

```
df
```

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

1599 rows × 12 columns

```
df['quality'].unique()
```

```
array([5, 6, 7, 4, 8, 3])
```

lenght of class

```
len(df['quality'].unique())
```

```
6
```

```
df['quality'].nunique()
```

```
6
```

```
df['quality'].value_counts()
```

```
5    681
6    638
7    199
4     53
8     18
3     10
Name: quality, dtype: int64
```

```
df.describe().T
```

	count	mean	std	min	25%	50%	75%	max
fixed acidity	1599.0	8.319637	1.741096	4.60000	7.1000	7.90000	9.200000	15.90000
volatile acidity	1599.0	0.527821	0.179060	0.12000	0.3900	0.52000	0.640000	1.58000
citric acid	1599.0	0.270976	0.194801	0.00000	0.0900	0.26000	0.420000	1.00000
residual sugar	1599.0	2.538806	1.409928	0.90000	1.9000	2.20000	2.600000	15.50000
chlorides	1599.0	0.087467	0.047065	0.01200	0.0700	0.07900	0.090000	0.61100
free sulfur dioxide	1599.0	15.874922	10.460157	1.00000	7.0000	14.00000	21.000000	72.00000
total sulfur dioxide	1599.0	46.467792	32.895324	6.00000	22.0000	38.00000	62.000000	289.00000
density	1599.0	0.996747	0.001887	0.99007	0.9956	0.99675	0.997835	1.00369

```
df.duplicated().sum()

    240
```

| alcohol | 1599.0 | 10.422983 | 1.065668 | 8.40000 | 9.5000 | 10.20000 | 11.100000 | 14.90000 |

```
X = df.drop("quality",axis=1)


y=df['quality']


from sklearn.model_selection import train_test_split, GridSearchCV


X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.30,random_state=10)


'''from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import StandardScaler
sclr = StandardScaler()
scr.fit()
scr.transform()'''

    'from sklearn.preprocessing import StandardScaler\nfrom sklearn.preprocessing import StandardScaler\ns
    clr = StandardScaler()\nscr.fit()\nscr.transform()'


from sklearn.tree import DecisionTreeClassifier
model = DecisionTreeClassifier()


model.fit(X_train,y_train)

    DecisionTreeClassifier()


model.score(X_train,y_train)

    1.0


from sklearn import tree
import matplotlib.pyplot as plt
fig = plt.figure(figsize=(25,15))
tree.plot_tree(model,filled=True)
```

```
[Text(0.3864619406882146, 0.9761904761904762, 'X[10] <= 9.85\ngini = 0.64\nsamples = 1119\nvalue = [8, 37, 471, 455, 141, 7]'),
 Text(0.21476473175021987, 0.9285714285714286, 'X[6] <= 98.5\ngini = 0.476\nsamples = 451\nvalue = [4, 15, 300, 128, 4, 0]'),
 Text(0.13698328935795953, 0.8809523809523809, 'X[9] <= 0.575\ngini = 0.508\nsamples = 391\nvalue = [4, 14, 243, 126, 4, 0]'),
 Text(0.06436895338610378, 0.8333333333333334, 'X[6] <= 88.5\ngini = 0.419\nsamples = 172\nvalue = [3, 10, 127, 31, 1, 0]'),
 Text(0.037708883025505714, 0.7857142857142857, 'X[10] <= 9.075\ngini = 0.388\nsamples = 162\nvalue = [3, 10, 124, 24, 1, 0]'),
 Text(0.014072119613016711, 0.7380952380952381, 'X[0] <= 7.8\ngini = 0.7\nsamples = 10\nvalue = [1, 3, 2, 4, 0, 0]'),
 Text(0.007036059806508356, 0.6904761904761905, 'X[1] <= 0.605\ngini = 0.375\nsamples = 4\nvalue = [0, 3, 1, 0, 0, 0]'),
 Text(0.003518029903254178, 0.6428571428571429, 'gini = 0.0\nsamples = 3\nvalue = [0, 3, 0, 0, 0, 0]'),
 Text(0.010554089709762533, 0.6428571428571429, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
 Text(0.021108179419525065, 0.6904761904761905, 'X[2] <= 0.55\ngini = 0.5\nsamples = 6\nvalue = [1, 0, 1, 4, 0, 0]'),
 Text(0.01759014951627089, 0.6428571428571429, 'gini = 0.0\nsamples = 4\nvalue = [0, 0, 0, 4, 0, 0]'),
 Text(0.024626209322779244, 0.6428571428571429, 'X[0] <= 12.45\ngini = 0.5\nsamples = 2\nvalue = [1, 0, 1, 0, 0, 0]'),
 Text(0.021108179419525065, 0.5952380952380952, 'gini = 0.0\nsamples = 1\nvalue = [1, 0, 0, 0, 0, 0]'),
 Text(0.028144239226033423, 0.5952380952380952, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
 Text(0.06134564643799472, 0.7380952380952381, 'X[4] <= 0.08\ngini = 0.336\nsamples = 152\nvalue = [2, 7, 122, 20, 1, 0]'),
 Text(0.04573438874230431, 0.6904761904761905, 'X[1] <= 0.42\ngini = 0.469\nsamples = 74\nvalue = [1, 4, 51, 17, 1, 0]'),
 Text(0.03869832893579595, 0.6428571428571429, 'X[4] <= 0.073\ngini = 0.494\nsamples = 9\nvalue = [0, 1, 2, 6, 0, 0]'),
 Text(0.03518029903254178, 0.5952380952380952, 'X[9] <= 0.535\ngini = 0.625\nsamples = 4\nvalue = [0, 1, 2, 1, 0, 0]'),
 Text(0.0316622691292876, 0.5476190476190477, 'X[4] <= 0.059\ngini = 0.5\nsamples = 2\nvalue = [0, 1, 0, 1, 0, 0]'),
 Text(0.028144239226033423, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 1, 0, 0, 0, 0]'),
 Text(0.03518029903254178, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
 Text(0.03869832893579595, 0.5476190476190477, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),
 Text(0.04221635883905013, 0.5952380952380952, 'gini = 0.0\nsamples = 5\nvalue = [0, 0, 0, 5, 0, 0]'),
 Text(0.052770448548812667, 0.6428571428571429, 'X[0] <= 10.2\ngini = 0.4\nsamples = 65\nvalue = [1, 3, 49, 11, 1, 0]'),
 Text(0.04925241864555849, 0.5952380952380952, 'X[9] <= 0.36\ngini = 0.364\nsamples = 63\nvalue = [1, 1, 49, 11, 1, 0]'),
 Text(0.04573438874230431, 0.5476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [1, 0, 0, 0, 0, 0]'),
 Text(0.052770448548812667, 0.5476190476190477, 'X[1] <= 0.945\ngini = 0.343\nsamples = 62\nvalue = [1, 0, 49, 11, 1, 0]'),
 Text(0.04925241864555849, 0.5, 'X[5] <= 38.0\ngini = 0.322\nsamples = 61\nvalue = [0, 0, 49, 11, 1, 0]'),
 Text(0.04573438874230431, 0.4523809523809524, 'X[7] <= 0.997\ngini = 0.305\nsamples = 60\nvalue = [0, 0, 49, 10, 1, 0]'),
 Text(0.04221635883905013, 0.40476190476190477, 'X[2] <= 0.29\ngini = 0.392\nsamples = 43\nvalue = [0, 0, 32, 10, 1, 0]'),
 Text(0.03869832893579595, 0.35714285714285715, 'X[5] <= 8.5\ngini = 0.352\nsamples = 41\nvalue = [0, 0, 32, 8, 1, 0]'),
 Text(0.03518029903254178, 0.30952380952380953, 'gini = 0.0\nsamples = 14\nvalue = [0, 0, 14, 0, 0, 0]'),
 Text(0.04221635883905013, 0.30952380952380953, 'X[5] <= 19.0\ngini = 0.466\nsamples = 27\nvalue = [0, 0, 18, 8, 1, 0]'),
 Text(0.03869832893579595, 0.2619047619047619, 'X[6] <= 73.0\ngini = 0.543\nsamples = 19\nvalue = [0, 0, 10, 8, 1, 0]'),
 Text(0.03518029903254178, 0.21428571428571427, 'X[10] <= 9.6\ngini = 0.508\nsamples = 16\nvalue = [0, 0, 10, 5, 1, 0]'),
 Text(0.0316622691292876, 0.16666666666666666, 'X[6] <= 38.0\ngini = 0.439\nsamples = 14\nvalue = [0, 0, 10, 3, 1, 0]'),
 Text(0.028144239226033423, 0.11904761904761904, 'X[8] <= 3.345\ngini = 0.612\nsamples = 7\nvalue = [0, 0, 3, 3, 1, 0]'),
 Text(0.024626209322779244, 0.07142857142857142, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 3, 0, 0]'),
 Text(0.0316622691292876, 0.07142857142857142, 'X[2] <= 0.01\ngini = 0.375\nsamples = 4\nvalue = [0, 0, 3, 0, 1, 0]'),
 Text(0.028144239226033423, 0.023809523809523808, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 3, 0, 0, 0]'),
 Text(0.03518029903254178, 0.023809523809523808, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
 Text(0.03518029903254178, 0.11904761904761904, 'gini = 0.0\nsamples = 7\nvalue = [0, 0, 7, 0, 0, 0]'),
 Text(0.03869832893579595, 0.16666666666666666, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),
 Text(0.04221635883905013, 0.21428571428571427, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 3, 0, 0]'),
 Text(0.04573438874230431, 0.2619047619047619, 'gini = 0.0\nsamples = 8\nvalue = [0, 0, 8, 0, 0, 0]'),
 Text(0.04573438874230431, 0.35714285714285715, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),
 Text(0.04925241864555849, 0.40476190476190477, 'gini = 0.0\nsamples = 17\nvalue = [0, 0, 17, 0, 0, 0]'),
 Text(0.052770448548812667, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
 Text(0.056288478452066845, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [1, 0, 0, 0, 0, 0]'),
 Text(0.056288478452066845, 0.5952380952380952, 'gini = 0.0\nsamples = 2\nvalue = [0, 2, 0, 0, 0, 0]'),
 Text(0.07695690413368514, 0.6904761904761905, 'X[7] <= 0.995\ngini = 0.168\nsamples = 78\nvalue = [1, 3, 71, 3, 0, 0]'),
 Text(0.06684256816182937, 0.6428571428571429, 'X[9] <= 0.495\ngini = 0.5\nsamples = 2\nvalue = [1, 1, 0, 0, 0, 0]'),
 Text(0.0633245382585752, 0.5952380952380952, 'gini = 0.0\nsamples = 1\nvalue = [0, 1, 0, 0, 0, 0]'),
 Text(0.07036059806508356, 0.5952380952380952, 'gini = 0.0\nsamples = 1\nvalue = [1, 0, 0, 0, 0, 0]'),
 Text(0.08707124010554.09, 0.6428571428571429, 'X[8] <= 3.305\ngini = 0.125\nsamples = 76\nvalue = [0, 2, 71, 3, 0, 0]'),
 Text(0.0773966578715919, 0.5952380952380952, 'X[10] <= 9.35\ngini = 0.041\nsamples = 48\nvalue = [0, 1, 47, 0, 0, 0]'),
 Text(0.07387862796833773, 0.5476190476190477, 'X[2] <= 0.28\ngini = 0.198\nsamples = 9\nvalue = [0, 1, 8, 0, 0, 0]'),
 Text(0.07036059806508356, 0.5, 'gini = 0.0\nsamples = 7\nvalue = [0, 0, 7, 0, 0, 0]'),
 Text(0.0773966578715919, 0.5, 'X[10] <= 9.25\ngini = 0.5\nsamples = 2\nvalue = [0, 1, 1, 0, 0, 0]'),
 Text(0.07387862796833773, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
 Text(0.08091468777484609, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 1, 0, 0, 0, 0]'),
 Text(0.08091468777484609, 0.5476190476190477, 'gini = 0.0\nsamples = 39\nvalue = [0, 0, 39, 0, 0, 0]'),
 Text(0.09674582233948989, 0.5952380952380952, 'X[9] <= 0.465\ngini = 0.253\nsamples = 28\nvalue = [0, 1, 24, 3, 0, 0]'),
 Text(0.08795074758135445, 0.5476190476190477, 'X[5] <= 12.5\ngini = 0.5\nsamples = 2\nvalue = [0, 1, 1, 0, 0, 0]'),
 Text(0.08443271767810026, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 1, 0, 0, 0, 0]'),
 Text(0.09146877748460862, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
 Text(0.10554089709762533, 0.5476190476190477, 'X[0] <= 9.1\ngini = 0.204\nsamples = 26\nvalue = [0, 0, 23, 3, 0, 0]'),
 Text(0.09850483729111698, 0.5, 'X[3] <= 2.05\ngini = 0.153\nsamples = 24\nvalue = [0, 0, 22, 2, 0, 0]'),
 Text(0.09498680738786279, 0.4523809523809524, 'X[4] <= 0.089\ngini = 0.346\nsamples = 9\nvalue = [0, 0, 7, 2, 0, 0]'),
 Text(0.09146877748460862, 0.40476190476190477, 'X[2] <= 0.14\ngini = 0.219\nsamples = 8\nvalue = [0, 0, 7, 1, 0, 0]'),
 Text(0.08795074758135445, 0.35714285714285715, 'X[1] <= 0.648\ngini = 0.5\nsamples = 2\nvalue = [0, 0, 1, 1, 0, 0]'),
 Text(0.08443271767810026, 0.30952380952380953, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
 Text(0.09146877748460862, 0.30952380952380953, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
 Text(0.09498680738786279, 0.35714285714285715, 'gini = 0.0\nsamples = 6\nvalue = [0, 0, 6, 0, 0, 0]'),
 Text(0.09850483729111698, 0.40476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
 Text(0.10202286719437115, 0.4523809523809524, 'gini = 0.0\nsamples = 15\nvalue = [0, 0, 15, 0, 0, 0]'),
 Text(0.11257695690413369, 0.5, 'X[6] <= 60.0\ngini = 0.5\nsamples = 2\nvalue = [0, 0, 1, 1, 0, 0]'),
 Text(0.1090589270008795, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
 Text(0.11609498680738786, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
 Text(0.09102902374670185, 0.7857142857142857, 'X[10] <= 9.533\ngini = 0.42\nsamples = 10\nvalue = [0, 0, 3, 7, 0, 0]'),
 Text(0.08751099384344767, 0.7380952380952381, 'X[2] <= 0.125\ngini = 0.375\nsamples = 4\nvalue = [0, 0, 3, 1, 0, 0]'),
 Text(0.08399296394019935, 0.6904761904761905, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
 Text(0.09102902374670185, 0.6904761904761905, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 3, 0, 0, 0]'),
 Text(0.09454705364995603, 0.7380952380952381, 'gini = 0.0\nsamples = 6\nvalue = [0, 0, 0, 6, 0, 0]'),
 Text(0.2095976253298153, 0.8333333333333334, 'X[6] <= 28.5\ngini = 0.531\nsamples = 219\nvalue = [1, 4, 116, 95, 3, 0]'),
 Text(0.1442392260334213, 0.7857142857142857, 'X[5] <= 4.5\ngini = 0.5\nsamples = 76\nvalue = [1, 1, 26, 47, 1, 0]'),
 Text(0.13016710642040458, 0.7380952380952381, 'X[1] <= 0.28\ngini = 0.219\nsamples = 8\nvalue = [0, 0, 7, 1, 0, 0]'),
 Text(0.1266490765171504, 0.6904761904761905, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
 Text(0.13368513632365875, 0.6904761904761905, 'gini = 0.0\nsamples = 7\nvalue = [0, 0, 7, 0, 0, 0]'),
 Text(0.158311345646438, 0.7380952380952381, 'X[4] <= 0.086\ngini = 0.464\nsamples = 68\nvalue = [1, 1, 19, 46, 1, 0]'),
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        Text(0.14072119613016712. 0.6904761904761905. 'X[9] <= 0.665\ngini = 0.317\nsamples = 43\nvalue = [0. 1. 6. 35. 1. 0]').
    fig.savefig("decision_tree_classifier.png")

        Text(0.12313104661389622. 0.5476190476190477. 'X[4] <= 0.079\ngini = 0.444\nsamples = 3\nvalue = [0. 0. 2. 1. 0. 0]').
    y_predict = model.predict(X_test)

        Text(0.13720316622691292. 0.5476190476190477. 'X[1] <= 0.555\ngini = 0.298\nsamples = 11\nvalue = [0. 0. 2. 9. 0. 0]')
    from sklearn.metrics import accuracy_score

        Text(0.13720316622691292. 0.45238095238090524. 'gini = 0.0\nsamples = 2\nvalue = [0. 0. 2. 0. 0. 0]')
    accuracy_score(y_test,y_predict)

        0.625

        Text(0.15127528583992964. 0.5952380952380952. 'X[1] <= 0.225\ngini = 0.074\nsamples = 26\nvalue = [0. 0. 0. 25. 1. 0]')
    ## hyperparameter tuning

        Text(0.17509140516270800. 0.6904761904761905. 'X[4] <= 0.164\ngini = 0.524\nsamples = 25\nvalue = [1. 0. 12. 11. 0. 0]')
    grid_param = {
        'criterion' :['gini','entropy'],
        'max_depth' : range(2,10,1),
        'min_samples_leaf' : range(1,8,1),
        'min_samples_split' : range(2,8,1),
        'splitter' : ['best','random']
    }
        Text(0.2749560246262093, 0.7857142857142857, 'X[4] <= 0.098\ngini = 0.491\nsamples = 143\nvalue = [0, 3, 90, 48, 2, 0]'),
    from sklearn.model_selection import GridSearchCV
    grid_searh = GridSearchCV(estimator=model, param_grid=grid_param,cv=3,verbose=1)
        Text(0.19349164467897978, 0.5952380952380952, 'X[6] <= 89.5\ngini = 0.087\nsamples = 22\nvalue = [0, 0, 21, 1, 0, 0]'),
    grid_searh.fit(X_train,y_train)

        Fitting 3 folds for each of 1344 candidates, totalling 4032 fits
        GridSearchCV(cv=3, estimator=DecisionTreeClassifier(),
                    param_grid={'criterion': ['gini', 'entropy'],
                                'max_depth': range(2, 10),
                                'min_samples_leaf': range(1, 8),
                                'min_samples_split': range(2, 8),
                                'splitter': ['best', 'random']},
                    verbose=1)
        Text(0.25417760605101143, 0.6428571428571429, 'X[0] <= 9.05\ngini = 0.498\nsamples = 50\nvalue = [0, 0, 17, 31, 2, 0]'),

    grid_searh.best_params_

        {'criterion': 'entropy',
         'max_depth': 9,
         'min_samples_leaf': 4,
         'min_samples_split': 6,
         'splitter': 'random'}
        Text(0.23218997361477572, 0.35714285714285715, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
    model_with_best_params = DecisionTreeClassifier(criterion= 'gini',
     max_depth= 5,
     min_samples_leaf= 2,
     min_samples_split =5,
     splitter= 'random')
        Text(0.29929019905349000, 0.4523809923809524, 'gini = 0.0\nsamples = 7\nvalue = [0, 0, 7, 0, 0, 0]'),

    model_with_best_params.fit(X_train,y_train)

        DecisionTreeClassifier(max_depth=5, min_samples_leaf=2, min_samples_split=5,
                               splitter='random')
        Text(0.27480552495982584, 0.35714285714285477, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),

    from sklearn import tree
    import matplotlib.pyplot as plt
    fig=plt.figure(figsize=(25,15))
    tree.plot_tree(model_with_best_params,filled=True,fontsize=10)
```

```
[Text(0.53125, 0.9166666666666666, 'X[7] <= 0.995\ngini = 0.64\nsamples =
1119\nvalue = [8, 37, 471, 455, 141, 7]'),
 Text(0.2784090909090909, 0.75, 'X[1] <= 0.514\ngini = 0.67\nsamples = 174\nvalue =
[2, 9, 34, 83, 43, 3]'),
 Text(0.17045454545454544, 0.5833333333333334, 'X[0] <= 8.007\ngini =
0.606\nsamples = 93\nvalue = [0, 1, 9, 45, 36, 2]'),
 Text(0.09090909090909091, 0.4166666666666667, 'X[0] <= 6.181\ngini =
0.569\nsamples = 63\nvalue = [0, 1, 7, 37, 17, 1]'),
 Text(0.045454545454545456, 0.25, 'X[9] <= 0.631\ngini = 0.68\nsamples = 16\nvalue
= [0, 0, 6, 6, 3, 1]'),
 Text(0.022727272727272728, 0.08333333333333333, 'gini = 0.375\nsamples = 8\nvalue
= [0, 0, 6, 2, 0, 0]'),
 Text(0.06818181818181818, 0.08333333333333333, 'gini = 0.594\nsamples = 8\nvalue =
[0, 0, 0, 4, 3, 1]'),
 Text(0.13636363636363635, 0.25, 'X[3] <= 2.776\ngini = 0.475\nsamples = 47\nvalue
= [0, 1, 1, 31, 14, 0]'),
 Text(0.11363636363636363, 0.08333333333333333, 'gini = 0.439\nsamples = 41\nvalue
= [0, 1, 1, 29, 10, 0]'),
 Text(0.1590909090909091, 0.08333333333333333, 'gini = 0.444\nsamples = 6\nvalue =
[0, 0, 0, 2, 4, 0]'),
 Text(0.25, 0.4166666666666667, 'X[4] <= 0.095\ngini = 0.522\nsamples = 30\nvalue =
[0, 0, 2, 8, 19, 1]'),
 Text(0.22727272727272727, 0.25, 'X[5] <= 22.192\ngini = 0.487\nsamples = 28\nvalue
= [0, 0, 2, 6, 19, 1]'),
 Text(0.20454545454545456, 0.08333333333333333, 'gini = 0.4\nsamples = 25\nvalue =
[0, 0, 2, 3, 19, 1]'),
 Text(0.25, 0.08333333333333333, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 3, 0,
0]'),
 Text(0.2727272727272727, 0.25, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0,
0]'),
 Text(0.38636363636363635, 0.5833333333333334, 'X[4] <= 0.158\ngini =
0.667\nsamples = 81\nvalue = [2, 8, 25, 38, 7, 1]'),
 Text(0.36363636363636365, 0.4166666666666667, 'X[9] <= 0.749\ngini =
0.652\nsamples = 79\nvalue = [1, 7, 25, 38, 7, 1]'),
 Text(0.3181818181818182, 0.25, 'X[8] <= 3.193\ngini = 0.652\nsamples = 64\nvalue =
[1, 7, 24, 28, 4, 0]'),
 Text(0.29545454545454547, 0.08333333333333333, 'gini = 0.0\nsamples = 6\nvalue =
[0, 0, 6, 0, 0, 0]'),
 Text(0.3409090909090909, 0.08333333333333333, 'gini = 0.651\nsamples = 58\nvalue =
[1, 7, 18, 28, 4, 0]'),
 Text(0.4090909090909091, 0.25, 'X[8] <= 3.518\ngini = 0.507\nsamples = 15\nvalue =
[0, 0, 1, 10, 3, 1]'),
 Text(0.38636363636363635, 0.08333333333333333, 'gini = 0.18\nsamples = 10\nvalue =
[0, 0, 0, 9, 1, 0]'),
 Text(0.4318181818181818, 0.08333333333333333, 'gini = 0.72\nsamples = 5\nvalue =
[0, 0, 1, 1, 2, 1]'),
 Text(0.4090909090909091, 0.4166666666666667, 'gini = 0.5\nsamples = 2\nvalue = [1,
1, 0, 0, 0, 0]'),
 Text(0.7840909090909091, 0.75, 'X[0] <= 9.305\ngini = 0.62\nsamples = 945\nvalue =
[6, 28, 437, 372, 98, 4]'),
 Text(0.6363636363636364, 0.5833333333333334, 'X[6] <= 64.398\ngini =
0.584\nsamples = 682\nvalue = [4, 23, 352, 259, 43, 1]'),
 Text(0.5454545454545454, 0.4166666666666667, 'X[9] <= 0.442\ngini = 0.616\nsamples
= 484\nvalue = [4, 19, 211, 208, 41, 1]'),
 Text(0.5, 0.25, 'X[10] <= 9.56\ngini = 0.473\nsamples = 13\nvalue = [0, 2, 9, 2,
0, 0]'),
 Text(0.4772727272727273, 0.08333333333333333, 'gini = 0.444\nsamples = 3\nvalue =
[0, 2, 1, 0, 0, 0]'),
 Text(0.5227272727272727, 0.08333333333333333, 'gini = 0.32\nsamples = 10\nvalue =
[0, 0, 8, 2, 0, 0]'),
 Text(0.5909090909090909, 0.25, 'X[10] <= 10.434\ngini = 0.616\nsamples =
471\nvalue = [4, 17, 202, 206, 41, 1]'),
 Text(0.5681818181818182, 0.08333333333333333, 'gini = 0.553\nsamples = 319\nvalue
= [3, 8, 171, 127, 9, 1]'),
 Text(0.6136363636363636, 0.08333333333333333, 'gini = 0.64\nsamples = 152\nvalue =
[1, 9, 31, 79, 32, 0]'),
 Text(0.7272727272727273, 0.4166666666666667, 'X[10] <= 11.36\ngini =
```

```
y_prediction2 = model_with_best_params.predict(X_test)
```

```
accuracy_score(y_test,y_prediction2)
```

```
0.56875
```

```
#logistic regression, svm, going forw(rf,xb,gb,ab)
```

```
from sklearn.ensemble import RandomForestClassifier
Rf_model = RandomForestClassifier()
```

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

```
RandomForestClassifier()
```

```
y_pred_rf = Rf_model.predict(X_test)
```

```
accuracy_score(y_test,y_pred_rf)
```

```
0.6708333333333333
```

```
#we are tuning three hyperparameters right now , we are passing the different values for both parameters
```

```
grid_param ={
    'n_estimators' :[90,100,115,130],
    'criterion' : ['gini','entropy'],
    'max_depth' : range(2,20,1),
    'min_samples_leaf' : range(1,10,1),
    'min_samples_split' : range(2,10,1),
    'max_features' : ['auto','log2']
}
```

```
from sklearn.model_selection import GridSearchCV
grid_search1 = GridSearchCV(estimator=Rf_model,param_grid = grid_param,cv=3, verbose=2,n_jobs=-1)
```

```
# grid_search1.fit(X_train,y_train)
```

```
# grid_search1.best_params_
```

```
Rf_model_with_best_params = RandomForestClassifier()
```

```
Rf_model_with_best_params=RandomForestClassifier(criterion='gini',max_depth= 14,max_features= 'log2',min_samples_leaf= 1,min_samples_spl
```

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

```
RandomForestClassifier(max_depth=14, max_features='log2', n_estimators=115)
```

```
y_predict_rf_bp=Rf_model_with_best_params.predict(X_test)
```

```
accuracy_score(y_test,y_predict_rf_bp)
```

```
0.65
```

```
# Bagging SVC
```

```
from sklearn.svm import SVC
from sklearn.ensemble import BaggingClassifier
from sklearn.datasets import make_classification
```

```
model_bagging_svc = BaggingClassifier(base_estimator=SVC(),n_estimators=50,random_state=0).fit(X_train,y_train)
```

```
y_predict_bagging=model_bagging_svc.predict(X_test)
```

```
accuracy_score(y_test,y_predict_bagging)
```

```
0.4666666666666667
```

```
# Extra Trees Classifier
```

```
from sklearn.ensemble import ExtraTreesClassifier
from sklearn.datasets import make_classification
```

```
etc = ExtraTreesClassifier()
```

```
etc_model = etc.fit(X_train,y_train)
```

```python
etc_y_pred = etc_model.predict(X_test)
```
      Text(0.6279683377308707, 0.6904761904761905, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),

```python
accuracy_score(etc_y_pred,y_test)
```

      0.6541666666666667
      Text(0.635004397537379, 0.64285714285714229, 'X[6] <= 46.0\ngini = 0.524\nsamples = 27\nvalue = [0, 0, 0, 11, 15, 1]'),

      Text(0.6314863676341249, 0.5476190476190477, 'X[7] <= 0.996\ngini = 0.304\nsamples = 17\nvalue = [0, 0, 0, 2, 14, 1]'),

```python
# Voting Classifier
```
      Text(0.6314863676341249, 0.4523809523809524, 'X[2] <= 0.49\ngini = 0.124\nsamples = 15\nvalue = [0, 0, 0, 0, 14, 1]'),

```python
import numpy as np
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB
from sklearn.ensemble import RandomForestClassifier, VotingClassifier
```
      Text(0.6420404573438874, 0.5952380952380952, 'X[10] <= 11.25\ngini = 0.219\nsamples = 8\nvalue = [0, 0, 0, 7, 1, 0]'),

```python
clf1 = LogisticRegression(multi_class='multinomial', random_state=1)
clf2 = RandomForestClassifier(n_estimators=50, random_state=1)
clf3 = GaussianNB()
```
      Text(0.6525454547533455, 0.5476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),

```python
eclf1 = VotingClassifier(estimators=[('lr',clf1),('rf',clf2),('gnb',clf3)],voting='hard')
```
      Text(0.6490783171363938, 0.4523809523809524, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),

```python
eclf1 = eclf1.fit(X_train,y_train)
```

      /usr/local/lib/python3.8/dist-packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed to converge (status=
      STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

      Increase the number of iterations (max_iter) or scale the data as shown in:
          https://scikit-learn.org/stable/modules/preprocessing.html
      Please also refer to the documentation for alternative solver options:
          https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
        n_iter_i = _check_optimize_result(

```python
voting_model = eclf1.predict(X_test)
```
      Text(0.6593528599799942, 0.4523809523809524, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),

```python
accuracy_score(voting_model,y_test)
```

      0.5833333333333334
      Text(0.7088836235637188, 0.4047619047619047, 'gini = 0.0\nsamples = 10\nvalue = [0, 0, 0, 10, 0, 0]'),

      Text(0.7229551451187335, 0.4047619047619047, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
      Text(0.7194371152154794, 0.5, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 0, 2, 0]'),
      Text(0.7458223394898856, 0.6904761904761905, 'X[6] <= 13.5\ngini = 0.255\nsamples = 57\nvalue = [1, 3, 1, 49, 3, 0]'),
      Text(0.7335092348284961, 0.64285714285714229, 'X[9] <= 0.625\ngini = 0.735\nsamples = 7\nvalue = [1, 3, 1, 1, 1, 0]'),
      Text(0.7264731750219877, 0.5952380952380952, 'X[2] <= 0.31\ngini = 0.375\nsamples = 4\nvalue = [0, 3, 0, 1, 0, 0]'),
      Text(0.7229551451187335, 0.5476190476190477, 'gini = 0.0\nsamples = 3\nvalue = [0, 3, 0, 0, 0, 0]'),
      Text(0.7299912049252418, 0.5476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
      Text(0.7405452946350044, 0.5952380952380952, 'X[2] <= 0.01\ngini = 0.667\nsamples = 3\nvalue = [1, 0, 1, 0, 1, 0]'),
      Text(0.7370272647317502, 0.5476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
      Text(0.7440633245382586, 0.5476190476190477, 'X[2] <= 0.23\ngini = 0.5\nsamples = 2\nvalue = [1, 0, 1, 0, 0, 0]'),
      Text(0.7405452946350044, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [1, 0, 0, 0, 0, 0]'),
      Text(0.7475813544415127, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
      Text(0.7581354441512753, 0.64285714285714229, 'X[3] <= 5.65\ngini = 0.077\nsamples = 50\nvalue = [0, 0, 0, 48, 2, 0]'),
      Text(0.7546174142480211, 0.5952380952380952, 'X[7] <= 0.996\ngini = 0.04\nsamples = 49\nvalue = [0, 0, 0, 48, 1, 0]'),
      Text(0.751099384344767, 0.5476190476190477, 'gini = 0.0\nsamples = 47\nvalue = [0, 0, 0, 47, 0, 0]'),
      Text(0.7581354441512753, 0.5476190476190477, 'X[2] <= 0.335\ngini = 0.5\nsamples = 2\nvalue = [0, 0, 0, 1, 1, 0]'),
      Text(0.7546174142480211, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
      Text(0.7616534740545294, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
      Text(0.7616534740545294, 0.5952380952380952, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
      Text(0.8843722515391381, 0.7380952380952381, 'X[10] <= 10.55\ngini = 0.631\nsamples = 195\nvalue = [0, 2, 51, 99, 40, 3]'),
      Text(0.8360268249780123, 0.6904761904761905, 'X[8] <= 3.42\ngini = 0.624\nsamples = 95\nvalue = [0, 2, 37, 43, 13, 0]'),
      Text(0.8145338610378188, 0.64285714285714229, 'X[4] <= 0.093\ngini = 0.622\nsamples = 72\nvalue = [0, 2, 21, 37, 12, 0]'),
      Text(0.794415127528584, 0.5952380952380952, 'X[5] <= 17.5\ngini = 0.559\nsamples = 56\nvalue = [0, 1, 16, 33, 6, 0]'),
      Text(0.7788038698328936, 0.5476190476190477, 'X[3] <= 4.8\ngini = 0.617\nsamples = 35\nvalue = [0, 1, 14, 16, 4, 0]'),
      Text(0.7686895338610378, 0.5, 'X[9] <= 0.685\ngini = 0.556\nsamples = 31\nvalue = [0, 1, 13, 16, 1, 0]'),
      Text(0.7590149516270889, 0.4523809523809524, 'X[3] <= 1.95\ngini = 0.576\nsamples = 21\nvalue = [0, 1, 11, 8, 1, 0]'),
      Text(0.7502198768689534, 0.40476190476190477, 'X[0] <= 11.95\ngini = 0.54\nsamples = 10\nvalue = [0, 1, 3, 6, 0, 0]'),
      Text(0.7431838170624451, 0.35714285714285715, 'X[1] <= 0.693\ngini = 0.245\nsamples = 7\nvalue = [0, 0, 1, 6, 0, 0]'),
      Text(0.7396657871591908, 0.30952380952380953, 'gini = 0.0\nsamples = 6\nvalue = [0, 0, 0, 6, 0, 0]'),
      Text(0.7467018469656992, 0.30952380952380953, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
      Text(0.7572559366754618, 0.35714285714285715, 'X[1] <= 0.54\ngini = 0.444\nsamples = 3\nvalue = [0, 1, 2, 0, 0, 0]'),
      Text(0.7537379067722075, 0.30952380952380953, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),
      Text(0.7607739665787159, 0.30952380952380953, 'gini = 0.0\nsamples = 1\nvalue = [0, 1, 0, 0, 0, 0]'),
      Text(0.7678100263852242, 0.40476190476190477, 'X[6] <= 34.5\ngini = 0.43\nsamples = 11\nvalue = [0, 0, 8, 2, 1, 0]'),
      Text(0.7642919964819701, 0.35714285714285715, 'gini = 0.0\nsamples = 6\nvalue = [0, 0, 6, 0, 0, 0]'),
      Text(0.7713280562884784, 0.35714285714285715, 'X[1] <= 0.425\ngini = 0.64\nsamples = 5\nvalue = [0, 0, 2, 2, 1, 0]'),
      Text(0.7678100263852242, 0.30952380952380953, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),
      Text(0.7748460861917327, 0.30952380952380953, 'X[4] <= 0.09\ngini = 0.444\nsamples = 3\nvalue = [0, 0, 0, 2, 1, 0]'),
      Text(0.7713280562884784, 0.2619047619047619, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),

```
Text(0.7783641160949868, 0.2619047619047619, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
Text(0.7783641160949868, 0.4523809523809524, 'X[1] <= 0.375\ngini = 0.32\nsamples = 10\nvalue = [0, 0, 2, 8, 0, 0]'),
Text(0.7748460861917327, 0.40476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.781882145998241, 0.40476190476190477, 'X[8] <= 3.025\ngini = 0.198\nsamples = 9\nvalue = [0, 0, 1, 8, 0, 0]'),
Text(0.7783641160949868, 0.35714285714285715, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.7854001759014951, 0.35714285714285715, 'gini = 0.0\nsamples = 8\nvalue = [0, 0, 0, 8, 0, 0]'),
Text(0.7889182058047494, 0.5, 'X[9] <= 0.705\ngini = 0.375\nsamples = 4\nvalue = [0, 0, 1, 0, 3, 0]'),
Text(0.7854001759014951, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.7924362357080035, 0.4523809523809524, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 0, 3, 0]'),
Text(0.8100263852242744, 0.5476190476190477, 'X[4] <= 0.065\ngini = 0.327\nsamples = 21\nvalue = [0, 0, 2, 17, 2, 0]'),
Text(0.802990325417766, 0.5, 'X[10] <= 10.2\ngini = 0.444\nsamples = 3\nvalue = [0, 0, 0, 1, 2, 0]'),
Text(0.7994722955145118, 0.4523809523809524, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 0, 2, 0]'),
Text(0.8065083553210203, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.8170624450307827, 0.5, 'X[2] <= 0.575\ngini = 0.198\nsamples = 18\nvalue = [0, 0, 2, 16, 0, 0]'),
Text(0.8135444151275286, 0.4523809523809524, 'X[7] <= 0.997\ngini = 0.111\nsamples = 17\nvalue = [0, 0, 1, 16, 0, 0]'),
Text(0.8100263852242744, 0.40476190476190477, 'X[7] <= 0.997\ngini = 0.444\nsamples = 3\nvalue = [0, 0, 1, 2, 0, 0]'),
Text(0.8065083553210203, 0.35714285714285715, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),
Text(0.8135444151275286, 0.35714285714285715, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.8170624450307827, 0.40476190476190477, 'gini = 0.0\nsamples = 14\nvalue = [0, 0, 0, 14, 0, 0]'),
Text(0.820580474934037, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.8346525945470537, 0.5952380952380952, 'X[4] <= 0.097\ngini = 0.695\nsamples = 16\nvalue = [0, 1, 5, 4, 6, 0]'),
Text(0.8311345646437994, 0.5476190476190477, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 0, 3, 0]'),
Text(0.8381706244503079, 0.5476190476190477, 'X[6] <= 38.0\ngini = 0.698\nsamples = 13\nvalue = [0, 1, 5, 4, 3, 0]'),
Text(0.8311345646437994, 0.5, 'X[9] <= 0.875\ngini = 0.612\nsamples = 7\nvalue = [0, 0, 1, 3, 3, 0]'),
Text(0.8276165347405453, 0.4523809523809524, 'X[9] <= 0.64\ngini = 0.56\nsamples = 5\nvalue = [0, 0, 1, 1, 3, 0]'),
Text(0.8240985048372911, 0.40476190476190477, 'X[6] <= 18.0\ngini = 0.5\nsamples = 2\nvalue = [0, 0, 1, 1, 0, 0]'),
Text(0.820580474934037, 0.35714285714285715, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.8276165347405453, 0.35714285714285715, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.8311345646437994, 0.40476190476190477, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 0, 3, 0]'),
Text(0.8346525945470537, 0.4523809523809524, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),
Text(0.8452066842568162, 0.5, 'X[7] <= 1.001\ngini = 0.5\nsamples = 6\nvalue = [0, 1, 4, 1, 0, 0]'),
Text(0.841688654353562, 0.4523809523809524, 'X[3] <= 1.65\ngini = 0.32\nsamples = 5\nvalue = [0, 1, 4, 0, 0, 0]'),
Text(0.8381706244503079, 0.40476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 1, 0, 0, 0, 0]'),
Text(0.8452066842568162, 0.40476190476190477, 'gini = 0.0\nsamples = 4\nvalue = [0, 0, 4, 0, 0, 0]'),
Text(0.8487247141600703, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.8575197889182058, 0.6428571428571429, 'X[10] <= 9.95\ngini = 0.446\nsamples = 23\nvalue = [0, 0, 16, 6, 1, 0]'),
Text(0.8487247141600703, 0.5952380952380952, 'X[4] <= 0.07\ngini = 0.444\nsamples = 6\nvalue = [0, 0, 2, 4, 0, 0]'),
Text(0.8452066842568162, 0.5476190476190477, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),
Text(0.8522427440633246, 0.5476190476190477, 'gini = 0.0\nsamples = 4\nvalue = [0, 0, 0, 4, 0, 0]'),
Text(0.8663148636763413, 0.5952380952380952, 'X[2] <= 0.36\ngini = 0.304\nsamples = 17\nvalue = [0, 0, 14, 2, 1, 0]'),
Text(0.8592788038698329, 0.5476190476190477, 'X[4] <= 0.082\ngini = 0.133\nsamples = 14\nvalue = [0, 0, 13, 0, 1, 0]'),
Text(0.8557607739665787, 0.5, 'gini = 0.0\nsamples = 10\nvalue = [0, 0, 10, 0, 0, 0]'),
Text(0.862796833773087, 0.5, 'X[9] <= 0.645\ngini = 0.375\nsamples = 4\nvalue = [0, 0, 3, 0, 1, 0]'),
Text(0.8592788038698329, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
Text(0.8663148636763413, 0.4523809523809524, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 3, 0, 0, 0]'),
Text(0.8733509234828496, 0.5476190476190477, 'X[2] <= 0.54\ngini = 0.444\nsamples = 3\nvalue = [0, 0, 1, 2, 0, 0]'),
Text(0.8698328935795955, 0.5, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),
Text(0.8768689533861038, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.9327176781002638, 0.6904761904761905, 'X[4] <= 0.089\ngini = 0.593\nsamples = 100\nvalue = [0, 0, 14, 56, 27, 3]'),
Text(0.911169744942832, 0.6428571428571429, 'X[1] <= 0.415\ngini = 0.48\nsamples = 64\nvalue = [0, 0, 4, 44, 13, 3]'),
Text(0.8944591029023746, 0.5952380952380952, 'X[3] <= 3.75\ngini = 0.676\nsamples = 21\nvalue = [0, 0, 3, 9, 7, 2]'),
Text(0.8909410729991205, 0.5476190476190477, 'X[8] <= 3.28\ngini = 0.644\nsamples = 17\nvalue = [0, 0, 3, 9, 3, 2]'),
Text(0.8839050131926122, 0.5, 'X[7] <= 0.997\ngini = 0.741\nsamples = 9\nvalue = [0, 0, 2, 2, 3, 2]'),
Text(0.8803869832893579, 0.4523809523809524, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 0, 3, 0]'),
Text(0.8874230430958663, 0.4523809523809524, 'X[0] <= 11.65\ngini = 0.667\nsamples = 6\nvalue = [0, 0, 2, 2, 0, 2]'),
Text(0.8839050131926122, 0.40476190476190477, 'X[8] <= 3.205\ngini = 0.5\nsamples = 4\nvalue = [0, 0, 2, 0, 0, 2]'),
Text(0.8803869832893579, 0.35714285714285715, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 0, 0, 2]'),
Text(0.8874230430958663, 0.35714285714285715, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),
Text(0.8909410729991205, 0.40476190476190477, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]'),
Text(0.8979771328056289, 0.5, 'X[2] <= 0.305\ngini = 0.219\nsamples = 8\nvalue = [0, 0, 1, 7, 0, 0]'),
Text(0.8944591029023746, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.9014951627088831, 0.4523809523809524, 'gini = 0.0\nsamples = 7\nvalue = [0, 0, 0, 7, 0, 0]'),
Text(0.8979771328056289, 0.5476190476190477, 'gini = 0.0\nsamples = 4\nvalue = [0, 0, 0, 0, 4, 0]'),
Text(0.9278803869832893, 0.5952380952380952, 'X[5] <= 27.5\ngini = 0.317\nsamples = 43\nvalue = [0, 0, 1, 35, 6, 1]'),
Text(0.9190853122251539, 0.5476190476190477, 'X[8] <= 3.57\ngini = 0.256\nsamples = 41\nvalue = [0, 0, 0, 35, 5, 1]'),
Text(0.9120492524186455, 0.5, 'X[10] <= 13.35\ngini = 0.193\nsamples = 38\nvalue = [0, 0, 0, 34, 3, 1]'),
Text(0.9085312225153914, 0.4523809523809524, 'X[10] <= 11.15\ngini = 0.149\nsamples = 37\nvalue = [0, 0, 0, 34, 3, 0]'),
Text(0.9050131926121372, 0.40476190476190477, 'gini = 0.0\nsamples = 20\nvalue = [0, 0, 0, 20, 0, 0]'),
Text(0.9120492524186455, 0.40476190476190477, 'X[7] <= 0.996\ngini = 0.291\nsamples = 17\nvalue = [0, 0, 0, 14, 3, 0]'),
Text(0.9085312225153914, 0.35714285714285715, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
Text(0.9155672823218998, 0.35714285714285715, 'X[6] <= 25.0\ngini = 0.219\nsamples = 16\nvalue = [0, 0, 0, 14, 2, 0]'),
Text(0.9120492524186455, 0.30952380952380953, 'gini = 0.0\nsamples = 8\nvalue = [0, 0, 0, 8, 0, 0]'),
Text(0.9190853122251539, 0.30952380952380953, 'X[2] <= 0.56\ngini = 0.375\nsamples = 8\nvalue = [0, 0, 0, 6, 2, 0]'),
Text(0.9155672823218998, 0.2619047619047619, 'X[10] <= 11.55\ngini = 0.245\nsamples = 7\nvalue = [0, 0, 0, 6, 1, 0]'),
Text(0.9120492524186455, 0.21428571428571427, 'X[8] <= 3.265\ngini = 0.5\nsamples = 2\nvalue = [0, 0, 0, 1, 1, 0]'),
Text(0.9085312225153914, 0.16666666666666666, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.9155672823218998, 0.16666666666666666, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
Text(0.9190853122251539, 0.21428571428571427, 'gini = 0.0\nsamples = 5\nvalue = [0, 0, 0, 5, 0, 0]'),
Text(0.9226033421284081, 0.2619047619047619, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
Text(0.9155672823218998, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 0, 1]'),
Text(0.9261213720316622, 0.5, 'X[4] <= 0.079\ngini = 0.444\nsamples = 3\nvalue = [0, 0, 0, 1, 2, 0]'),
Text(0.9226033421284081, 0.4523809523809524, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.9296394019349165, 0.4523809523809524, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 0, 2, 0]'),
Text(0.9366554617414248, 0.5476190476190477, 'X[5] <= 33.0\ngini = 0.5\nsamples = 2\nvalue = [0, 0, 1, 0, 1, 0]'),
Text(0.9331574318381706, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.9401193491644679, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 0, 1, 0]'),
Text(0.9542656112576957, 0.6428571428571429, 'X[1] <= 0.505\ngini = 0.66\nsamples = 36\nvalue = [0, 0, 10, 12, 14, 0]'),
Text(0.9472295514511874, 0.5952380952380952, 'X[2] <= 0.445\ngini = 0.631\nsamples = 23\nvalue = [0, 0, 7, 11, 5, 0]'),
Text(0.9437115215479331, 0.5476190476190477, 'gini = 0.0\nsamples = 5\nvalue = [0, 0, 5, 0, 0, 0]'),
Text(0.9507475813544415, 0.5476190476190477, 'X[9] <= 0.655\ngini = 0.537\nsamples = 18\nvalue = [0, 0, 2, 11, 5, 0]'),
Text(0.9472295514511874, 0.5, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 0, 0, 3, 0]'),
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Text(0.9542656112576957, 0.5, 'X[3] <= 4.3\ngini = 0.427\nsamples = 15\nvalue = [0, 0, 2, 11, 2, 0]'),
Text(0.9507475813544415, 0.4523809523809524, 'X[5] <= 10.5\ngini = 0.26\nsamples = 13\nvalue = [0, 0, 0, 11, 2, 0]'),
Text(0.9472295514511874, 0.40476190476190477, 'gini = 0.0\nsamples = 10\nvalue = [0, 0, 0, 10, 0, 0]'),
Text(0.9542656112576957, 0.40476190476190477, 'X[10] <= 11.5\ngini = 0.444\nsamples = 3\nvalue = [0, 0, 0, 1, 2, 0]'),
Text(0.9507475813544415, 0.35714285714285715, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.9577836411609498, 0.35714285714285715, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 0, 2, 0]'),
Text(0.9577836411609498, 0.4523809523809524, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 2, 0, 0, 0]'),
Text(0.961301671064204, 0.5952380952380952, 'X[3] <= 3.95\ngini = 0.462\nsamples = 13\nvalue = [0, 0, 3, 1, 9, 0]'),
Text(0.9577836411609498, 0.5476190476190477, 'gini = 0.0\nsamples = 9\nvalue = [0, 0, 0, 0, 9, 0]'),
Text(0.9648197009674582, 0.5476190476190477, 'X[7] <= 1.001\ngini = 0.375\nsamples = 4\nvalue = [0, 0, 3, 1, 0, 0]'),
Text(0.961301671064204, 0.5, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.9683377308707124, 0.5, 'gini = 0.0\nsamples = 3\nvalue = [0, 0, 3, 0, 0, 0]'),
Text(0.9753737906772207, 0.7857142857142857, 'X[4] <= 0.048\ngini = 0.559\nsamples = 34\nvalue = [0, 0, 21, 7, 4, 2]'),
Text(0.9683377308707124, 0.7380952380952381, 'X[0] <= 5.45\ngini = 0.444\nsamples = 6\nvalue = [0, 0, 0, 0, 4, 2]'),
Text(0.9648197009674582, 0.6904761904761905, 'gini = 0.0\nsamples = 4\nvalue = [0, 0, 0, 0, 4, 0]'),
Text(0.9718557607739666, 0.6904761904761905, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 0, 0, 2]'),
Text(0.9824098504837291, 0.7380952380952381, 'X[8] <= 3.21\ngini = 0.375\nsamples = 28\nvalue = [0, 0, 21, 7, 0, 0]'),
Text(0.978891820580475, 0.6904761904761905, 'gini = 0.0\nsamples = 4\nvalue = [0, 0, 0, 4, 0, 0]'),
Text(0.9859278803869833, 0.6904761904761905, 'X[10] <= 12.15\ngini = 0.219\nsamples = 24\nvalue = [0, 0, 21, 3, 0, 0]'),
Text(0.978891820580475, 0.6428571428571429, 'X[2] <= 0.13\ngini = 0.091\nsamples = 21\nvalue = [0, 0, 20, 1, 0, 0]'),
Text(0.9753737906772207, 0.5952380952380952, 'X[6] <= 91.0\ngini = 0.5\nsamples = 2\nvalue = [0, 0, 1, 1, 0, 0]'),
Text(0.9718557607739666, 0.5476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 1, 0, 0, 0, 0]'),
Text(0.978891820580475, 0.5476190476190477, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 0, 1, 0, 0]'),
Text(0.9824098504837291, 0.5952380952380952, 'gini = 0.0\nsamples = 19\nvalue = [0, 0, 19, 0, 0, 0]'),
Text(0.9929639401934917, 0.6428571428571429, 'X[2] <= 0.13\ngini = 0.444\nsamples = 3\nvalue = [0, 0, 1, 2, 0, 0]'),
Text(0.9894459102902374, 0.5952380952380952, 'gini = 0.0\nsamples = 1\nvalue = [0, 0, 1, 0, 0, 0]'),
Text(0.9964819700967458, 0.5952380952380952, 'gini = 0.0\nsamples = 2\nvalue = [0, 0, 0, 2, 0, 0]')]
```