In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

In [2]:
```
from sklearn import tree
from sklearn.datasets import load_wine
from sklearn.model_selection import train_test_split, GridSearchCV, RandomizedSearchCV
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score, classification_report, confusion_matrix
from sklearn.tree import plot_tree
```

In [3]:
```
data = load_wine()
df = pd.DataFrame(data.data, columns=data.feature_names)
df['label'] = data.target
df.head()
```

Out[3]:

	alcohol	malic_acid	ash	alcalinity_of_ash	magnesium	total_phenols	flavanoids	nonflavanoid_phenols	proanthocyanins	color_intensi
0	14.23	1.71	2.43	15.6	127.0	2.80	3.06	0.28	2.29	5.6
1	13.20	1.78	2.14	11.2	100.0	2.65	2.76	0.26	1.28	4.3
2	13.16	2.36	2.67	18.6	101.0	2.80	3.24	0.30	2.81	5.6
3	14.37	1.95	2.50	16.8	113.0	3.85	3.49	0.24	2.18	7.8
4	13.24	2.59	2.87	21.0	118.0	2.80	2.69	0.39	1.82	4.3

In [4]:
```
X = df.iloc[:, :-1]
y = df.iloc[:, -1]
```

In [5]:
```
clf = DecisionTreeClassifier()
```

RandomizedSearchCV

In [6]:
```
param_distributions = {
    "max_depth": [3, None],
    "max_features": range(1, 11),
    "min_samples_split": range(2, 11),
    "criterion": ['gini', 'entropy'],
}
```

In [7]:
```
random_search = RandomizedSearchCV(clf, param_distributions=param_distributions, n_iter=10, cv=5)
random_search.fit(X, y)
```

Out[7]:
```
RandomizedSearchCV(cv=5, estimator=DecisionTreeClassifier(),
                   param_distributions={'criterion': ['gini', 'entropy'],
                                        'max_depth': [3, None],
                                        'max_features': range(1, 11),
                                        'min_samples_split': range(2, 11)})
```

In [8]:
```
random_search.best_estimator_
```

Out[8]:
```
DecisionTreeClassifier(max_features=7, min_samples_split=10)
```

In [9]:
```
random_search.best_params_
```

Out[9]:
```
{'min_samples_split': 10,
 'max_features': 7,
 'max_depth': None,
 'criterion': 'gini'}
```

In [10]:
```
random_search.best_score_
```

Out[10]:
```
0.9106349206349206
```

In [11]:
```
random_search.cv_results_
```

Out[11]:
```
{'mean_fit_time': array([0.00313077, 0.00312467, 0.        , 0.00312381, 0.00312433,
       0.        , 0.        , 0.        , 0.00312424, 0.        ]),
 'std_fit_time': array([0.00626154, 0.00624933, 0.        , 0.00624762, 0.00624866,
       0.        , 0.        , 0.        , 0.00624847, 0.        ]),
 'mean_score_time': array([0.        , 0.        , 0.        , 0.        , 0.        ,
       0.00312419, 0.        , 0.00312428, 0.        , 0.        ]),
 'std_score_time': array([0.        , 0.        , 0.        , 0.        , 0.        ,
       0.00624838, 0.        , 0.00624857, 0.        , 0.        ]),
 'param_min_samples_split': masked_array(data=[3, 7, 2, 10, 3, 9, 8, 6, 5, 3],
              mask=[False, False, False, False, False, False, False, False,
                    False, False],
       fill_value='?',
            dtype=object),
 'param_max_features': masked_array(data=[8, 8, 5, 7, 3, 10, 3, 1, 3, 2],
              mask=[False, False, False, False, False, False, False, False,
                    False, False],
       fill_value='?',
            dtype=object),
 'param_max_depth': masked_array(data=[3, 3, 3, None, 3, 3, 3, None, 3, 3],
              mask=[False, False, False, False, False, False, False, False,
                    False, False],
       fill_value='?',
            dtype=object),
 'param_criterion': masked_array(data=['entropy', 'entropy', 'gini', 'gini', 'gini',
                    'entropy', 'entropy', 'gini', 'gini', 'gini'],
              mask=[False, False, False, False, False, False, False, False,
                    False, False],
       fill_value='?',
            dtype=object),
 'params': [{'min_samples_split': 3,
   'max_features': 8,
   'max_depth': 3,
   'criterion': 'entropy'},
  {'min_samples_split': 7,
   'max_features': 8,
   'max_depth': 3,
   'criterion': 'entropy'},
  {'min_samples_split': 2,
   'max_features': 5,
   'max_depth': 3,
```

```
  'criterion': 'gini'},
 {'min_samples_split': 10,
  'max_features': 7,
  'max_depth': None,
  'criterion': 'gini'},
 {'min_samples_split': 3,
  'max_features': 3,
  'max_depth': 3,
  'criterion': 'gini'},
 {'min_samples_split': 9,
  'max_features': 10,
  'max_depth': 3,
  'criterion': 'entropy'},
 {'min_samples_split': 8,
  'max_features': 3,
  'max_depth': 3,
  'criterion': 'entropy'},
 {'min_samples_split': 6,
  'max_features': 1,
  'max_depth': None,
  'criterion': 'gini'},
 {'min_samples_split': 5,
  'max_features': 3,
  'max_depth': 3,
  'criterion': 'gini'},
 {'min_samples_split': 3,
  'max_features': 2,
  'max_depth': 3,
  'criterion': 'gini'}],
'split0_test_score': array([0.83333333, 0.77777778, 0.86111111, 0.83333333, 0.69444444,
       0.86111111, 0.86111111, 0.80555556, 0.86111111, 0.72222222]),
'split1_test_score': array([0.86111111, 0.83333333, 0.83333333, 0.88888889, 0.97222222,
       0.80555556, 0.83333333, 0.86111111, 0.77777778, 0.86111111]),
'split2_test_score': array([0.97222222, 0.83333333, 0.94444444, 0.91666667, 0.94444444,
       0.97222222, 0.66666667, 0.91666667, 0.86111111, 0.86111111]),
'split3_test_score': array([0.94285714, 0.97142857, 0.85714286, 0.94285714, 0.94285714,
       0.97142857, 0.88571429, 0.94285714, 0.94285714, 1.        ]),
'split4_test_score': array([0.88571429, 0.97142857, 0.85714286, 0.97142857, 0.88571429,
       0.88571429, 1.        , 0.94285714, 0.94285714, 1.        ]),
'mean_test_score': array([0.89904762, 0.87746032, 0.87063492, 0.91063492, 0.88793651,
       0.89920635, 0.84936508, 0.89380952, 0.87714286, 0.88888889]),
```

```
 'std_test_score': array([0.05139868, 0.07936127, 0.03819432, 0.04736865, 0.10075477,
        0.06473194, 0.10750427, 0.05327614, 0.06168336, 0.10393493]),
 'rank_test_score': array([ 3,  7,  9,  1,  6,  2, 10,  4,  8,  5])}
```

GridSearchCV

In [12]:
```
param_grid = {
    "max_depth": [3, None],
    "max_features": [1, 3, 10],
    "min_samples_split": [2, 3, 10],
    "criterion": ["gini", "entropy"],
}
```

In [13]:
```
grid_search = GridSearchCV(clf, param_grid=param_grid, cv=5)
grid_search.fit(X, y)
```

Out[13]:
```
GridSearchCV(cv=5, estimator=DecisionTreeClassifier(),
             param_grid={'criterion': ['gini', 'entropy'],
                         'max_depth': [3, None], 'max_features': [1, 3, 10],
                         'min_samples_split': [2, 3, 10]})
```

In [14]:
```
grid_search.best_estimator_
```

Out[14]:
```
DecisionTreeClassifier(criterion='entropy', max_features=3,
                       min_samples_split=10)
```

In [15]:
```
best_params = grid_search.best_params_
best_params
```

Out[15]:
```
{'criterion': 'entropy',
 'max_depth': None,
 'max_features': 3,
 'min_samples_split': 10}
```

In [16]:
```
grid_search.best_score_
```

Out[16]:
```
0.9438095238095237
```

Decision Tree

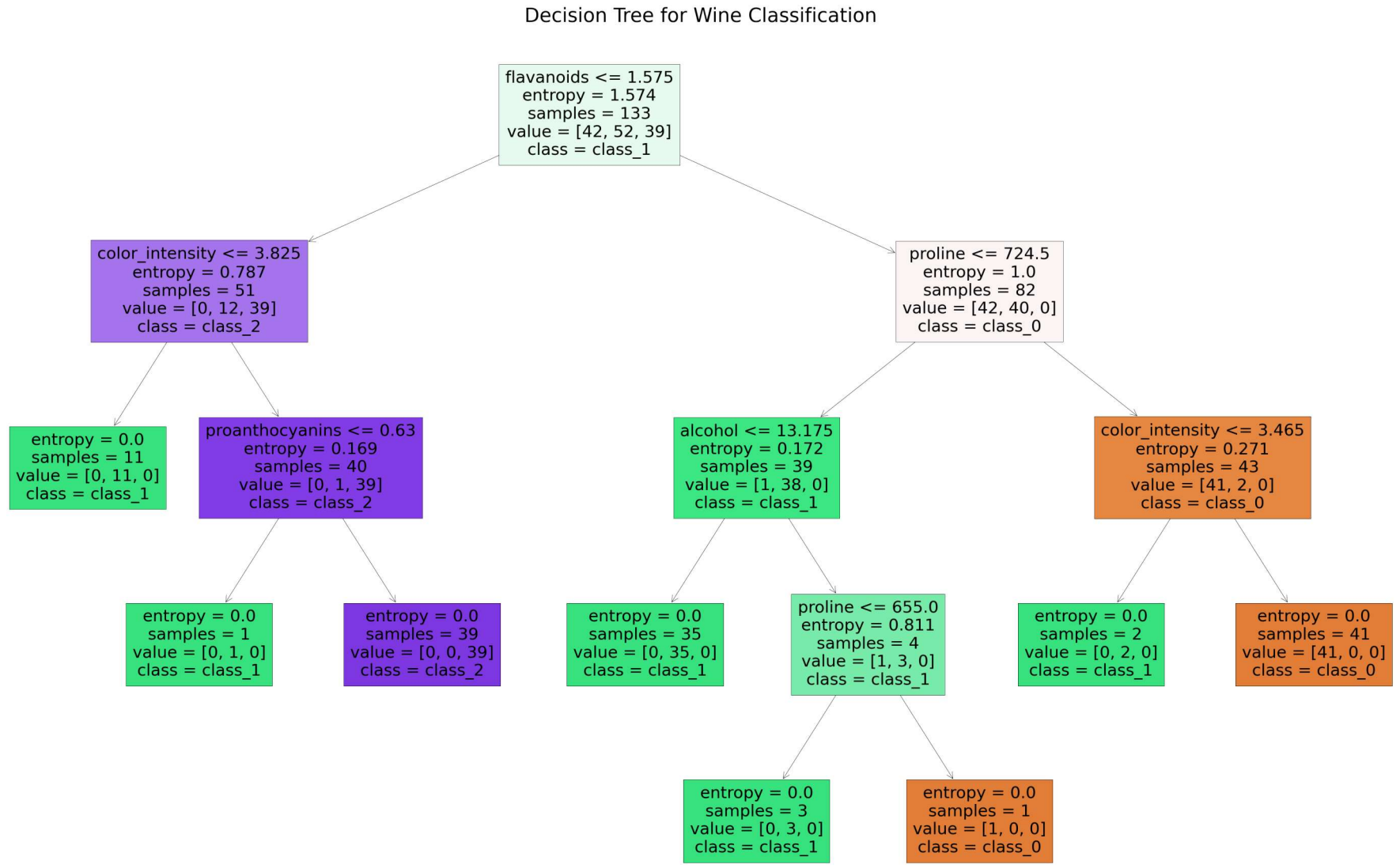
In [17]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y)
```

In [18]:
```
Better_model = DecisionTreeClassifier(criterion = "entropy",
                                      max_depth = None,
                                      max_features = 10,
                                      min_samples_split = 3)
Better_model.fit(X_train, y_train)
```

Out[18]:
```
DecisionTreeClassifier(criterion='entropy', max_features=10,
                       min_samples_split=3)
```

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

In [20]:
```
plt.figure(figsize=(80, 50))
plot_tree(Better_model, filled=True, feature_names=data.feature_names, class_names=data.target_names)
plt.title("Decision Tree for Wine Classification", fontsize=60)
plt.show()
```



In [21]:
```
accuracy_score(y_test, y_pred)
```

Out[21]: 0.9777777777777777

In [22]:
```
confusion_matrix(y_test, y_pred)
```

Out[22]:
```
array([[17,  0,  0],
       [ 0, 19,  0],
       [ 0,  1,  8]], dtype=int64)
```

In [ ]: