In [1]:
```
# Import thư viện
```

In [2]:
```
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns

from sklearn.model_selection import train_test_split
from sklearn import tree
from sklearn.naive_bayes import GaussianNB
from sklearn import metrics
```

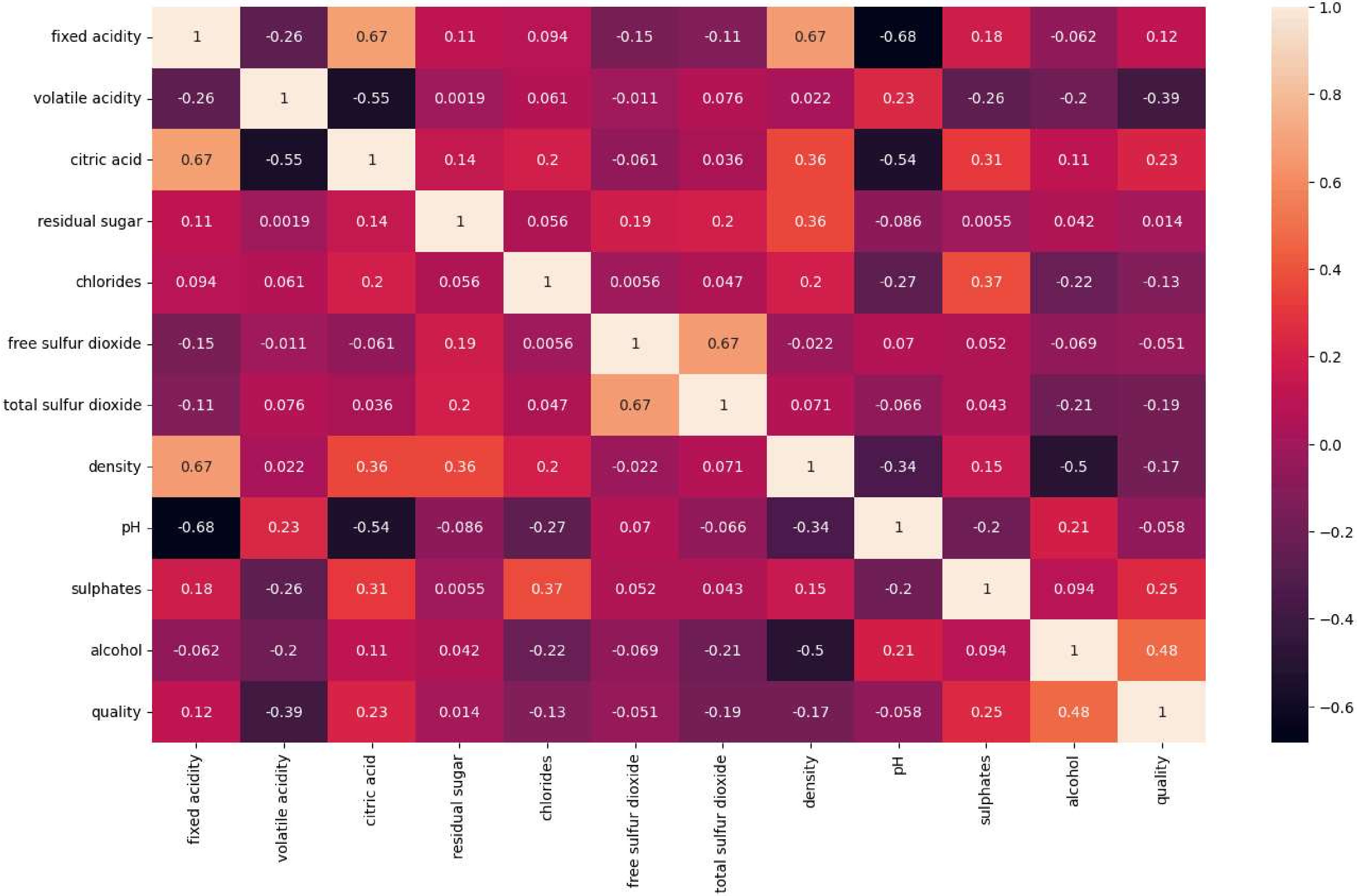
In [3]:
```
df = pd.read_csv('winequality-red.csv')
```

In [4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1599 entries, 0 to 1598
Data columns (total 12 columns):
 #   Column                Non-Null Count  Dtype  
---  ------                --------------  -----  
 0   fixed acidity         1599 non-null   float64
 1   volatile acidity      1599 non-null   float64
 2   citric acid           1599 non-null   float64
 3   residual sugar        1599 non-null   float64
 4   chlorides             1599 non-null   float64
 5   free sulfur dioxide   1599 non-null   float64
 6   total sulfur dioxide  1599 non-null   float64
 7   density               1599 non-null   float64
 8   pH                    1599 non-null   float64
 9   sulphates             1599 non-null   float64
 10  alcohol               1599 non-null   float64
 11  quality               1599 non-null   int64  
dtypes: float64(11), int64(1)
memory usage: 150.0 KB
```

```
In [5]: plt.figure(figsize=(16,9))
        sns.heatmap(df.corr(method='pearson'),annot=True)
```

```
Out[5]: <Axes: >
```



In [6]:

```
feature = df.drop('quality',axis=1)
label = df['quality']
```

In [7]:
```
feature.select_dtypes(exclude=['int64']).columns
```

Out[7]:
```
Index(['fixed acidity', 'volatile acidity', 'citric acid', 'residual sugar',
       'chlorides', 'free sulfur dioxide', 'total sulfur dioxide', 'density',
       'pH', 'sulphates', 'alcohol'],
      dtype='object')
```

In [8]:
```
feature_onehot = pd.get_dummies(feature,columns=feature.select_dtypes(exclude=['int64']).columns)
feature_onehot
```

Out[8]:

	fixed acidity_4.6	fixed acidity_4.7	fixed acidity_4.9	fixed acidity_5.0	fixed acidity_5.1	fixed acidity_5.2	fixed acidity_5.3	fixed acidity_5.4	fixed acidity_5.5	fixed acidity_5.6	...	alcohol_1
0	False	False	False	False	False	False	False	False	False	False	...	Fa
1	False	False	False	False	False	False	False	False	False	False	...	Fa
2	False	False	False	False	False	False	False	False	False	False	...	Fa
3	False	False	False	False	False	False	False	False	False	False	...	Fa
4	False	False	False	False	False	False	False	False	False	False	...	Fa
...	...	...	...	...	...	...	...	...	...	...	...	
1594	False	False	False	False	False	False	False	False	False	False	...	Fa
1595	False	False	False	False	False	False	False	False	False	False	...	Fa
1596	False	False	False	False	False	False	False	False	False	False	...	Fa
1597	False	False	False	False	False	False	False	False	False	False	...	Fa
1598	False	False	False	False	False	False	False	False	False	False	...	Fa

1599 rows × 1453 columns

In [9]:
```
x_train,x_test,y_train,y_test = train_test_split(feature,label,test_size=0.3,random_state=42)
```

In [10]:

```
clf = tree.DecisionTreeClassifier(criterion="entropy",random_state=0)
clf.fit(x_train,y_train)
```

Out[10]:

```
▾                    DecisionTreeClassifier
DecisionTreeClassifier(criterion='entropy', random_state=0)
```

In [11]:

```
tree_pred = clf.predict(x_test)

tree_score = metrics.accuracy_score(y_test,tree_pred)
print("Accuracy:",tree_score)
print("Report:",metrics.classification_report(y_test,tree_pred))
```

```
Accuracy: 0.5833333333333334
Report:               precision    recall  f1-score   support

           3       0.00      0.00      0.00         1
           4       0.08      0.12      0.10        17
           5       0.70      0.66      0.68       195
           6       0.60      0.60      0.60       200
           7       0.43      0.46      0.44        61
           8       0.25      0.17      0.20         6

    accuracy                           0.58       480
   macro avg       0.34      0.33      0.34       480
weighted avg       0.59      0.58      0.59       480
```

In [12]:

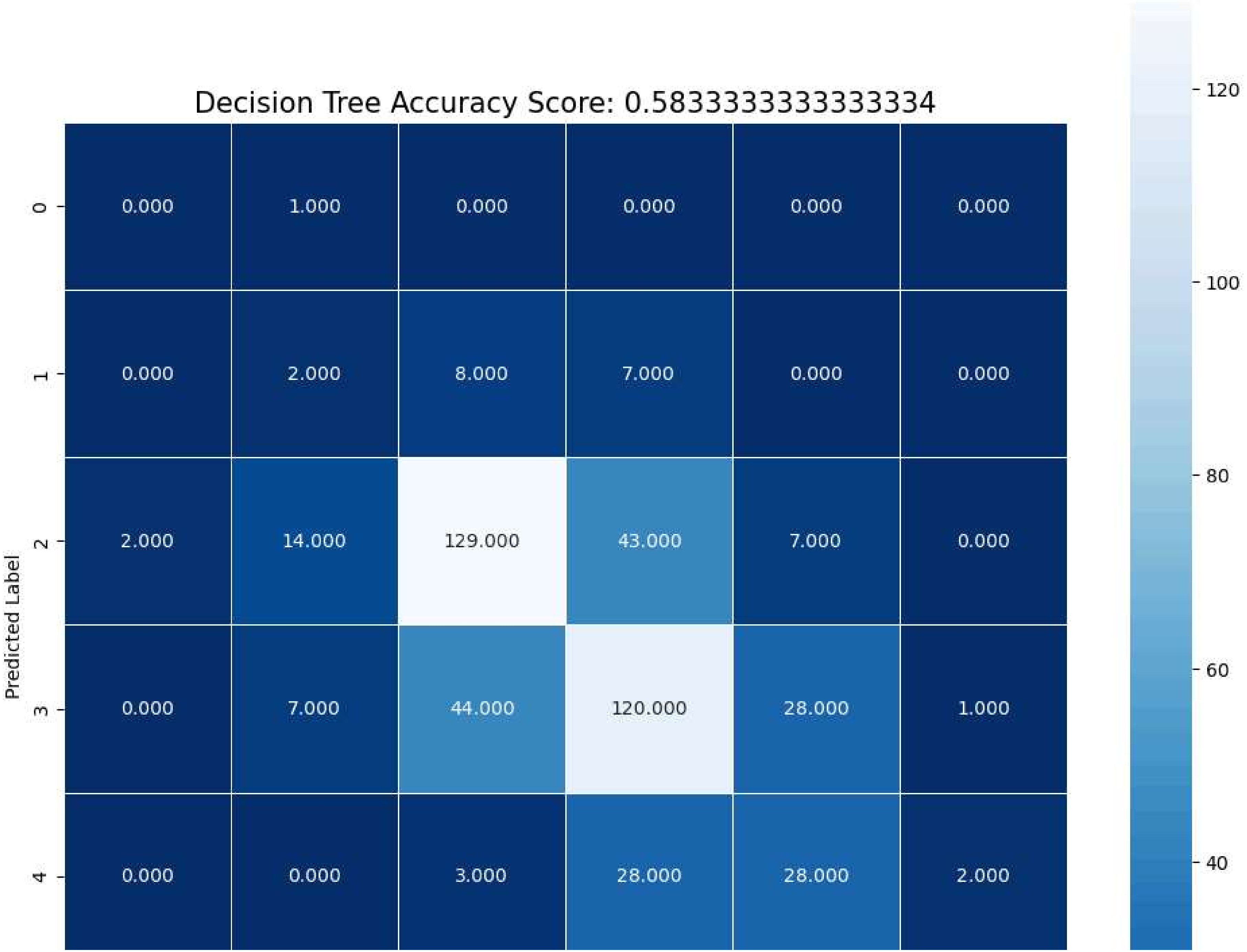
```
tree_cm = metrics.confusion_matrix(y_test,tree_pred)
```

In [13]:

```
plt.figure(figsize=(12,12))
sns.heatmap(tree_cm,annot=True, fmt=".3f",linewidth=.5,square=True,cmap='Blues_r')
plt.xlabel('Actual Label')
plt.ylabel('Predicted Label')
title ='Decision Tree Accuracy Score: {0}'.format(tree_score)
plt.title(title,size=15)
```

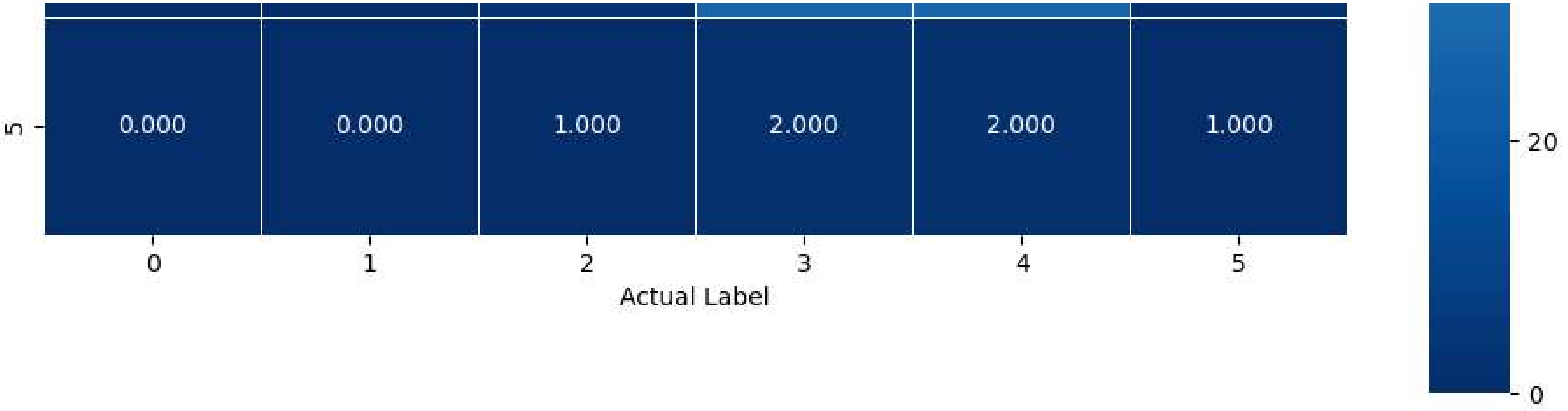
Out[13]:

```
Text(0.5, 1.0, 'Decision Tree Accuracy Score: 0.5833333333333334')
```

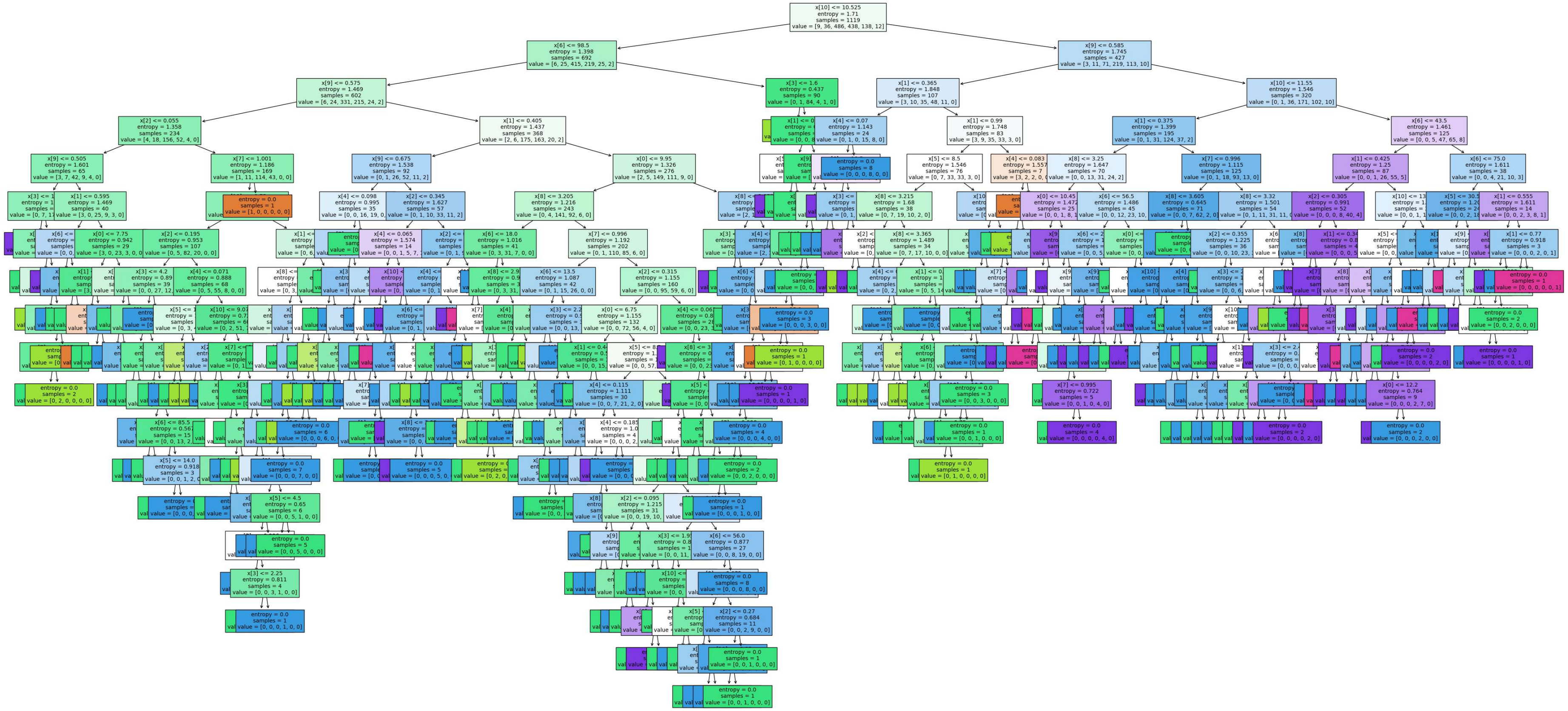


Decision Tree Accuracy Score: 0.5833333333333334

0	0.000	1.000	0.000	0.000	0.000	0.000
1	0.000	2.000	8.000	7.000	0.000	0.000
2	2.000	14.000	129.000	43.000	7.000	0.000
3	0.000	7.000	44.000	120.000	28.000	1.000
4	0.000	0.000	3.000	28.000	28.000	2.000



In [14]:
```
fig, ax = plt.subplots(figsize=(50,24))
tree.plot_tree(clf,filled=True,fontsize=10)
plt.savefig('decision_tree_cau4',dpi=100)
plt.show()
```



In [15]:
```
clf = tree.DecisionTreeClassifier(criterion="gini",random_state=0)
clf.fit(x_train,y_train)
```

Out[15]:
```
▾        DecisionTreeClassifier

DecisionTreeClassifier(random_state=0)
```

In [16]:
```
tree_pred = clf.predict(x_test)
tree_score = metrics.accuracy_score(y_test,tree_pred)
print("Accruracy:",tree_score)
print("Report:",metrics.classification_report(y_test,tree_pred))
```

```
Accruracy: 0.5625
Report:               precision    recall  f1-score   support

           3       0.00      0.00      0.00         1
           4       0.07      0.06      0.06        17
           5       0.64      0.62      0.63       195
           6       0.57      0.58      0.57       200
           7       0.45      0.49      0.47        61
           8       0.33      0.33      0.33         6

    accuracy                           0.56       480
   macro avg       0.34      0.35      0.35       480
weighted avg       0.56      0.56      0.56       480
```

In [17]:

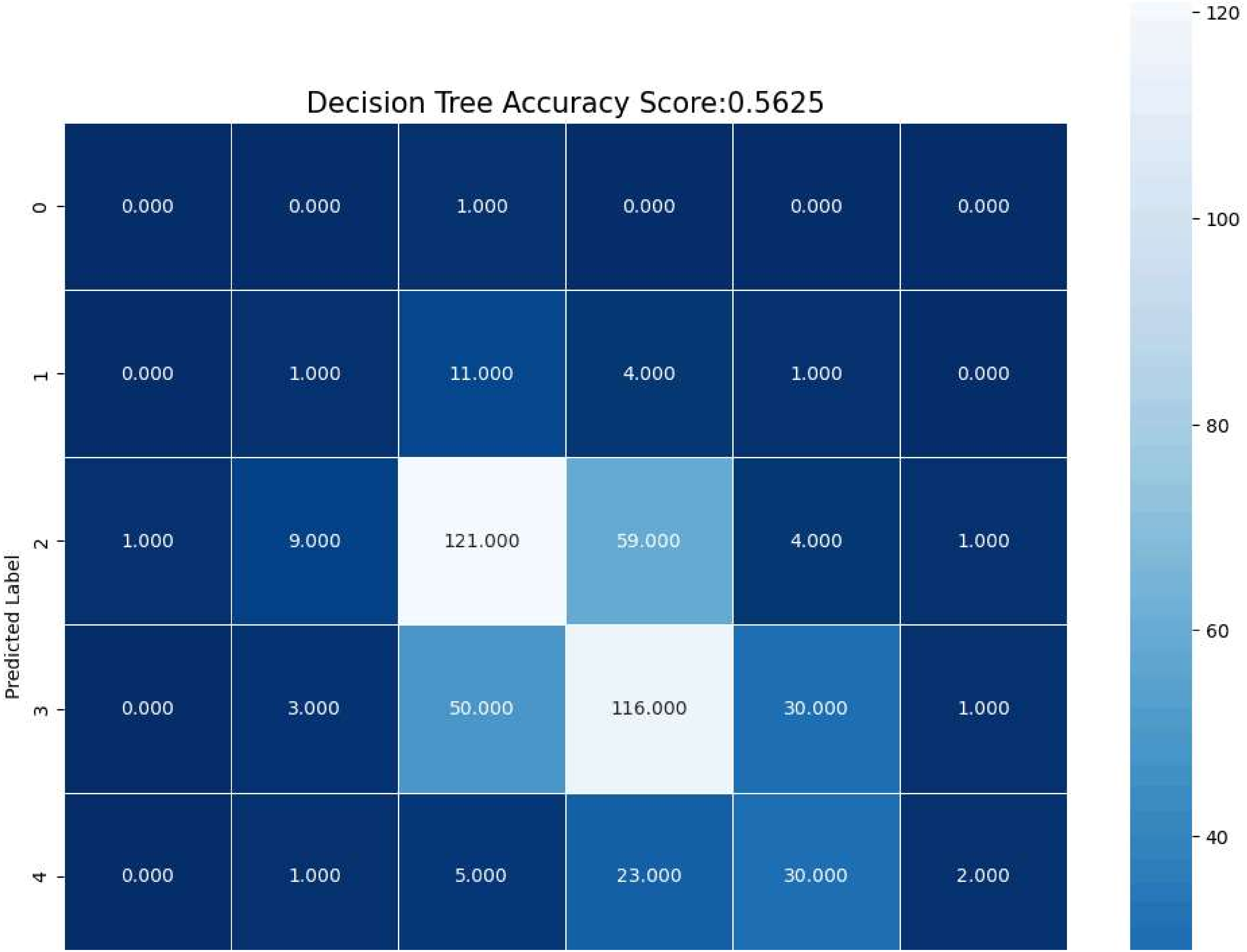
```
tree_cm = metrics.confusion_matrix(y_test,tree_pred)
```

In [18]:

```
plt.figure(figsize=(12,12))
sns.heatmap(tree_cm,annot=True, fmt=".3f",linewidth=.5,square=True,cmap='Blues_r')
plt.xlabel('Actual Label')
plt.ylabel('Predicted Label')
title ='Decision Tree Accuracy Score:{0}'.format(tree_score)
plt.title(title,size=15)
```

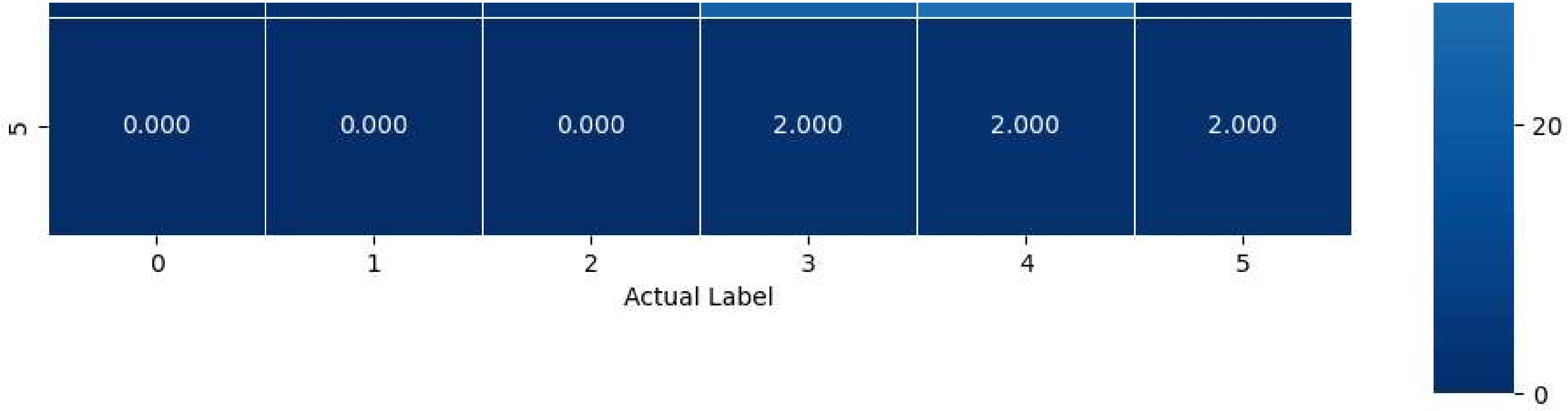
Out[18]:

```
Text(0.5, 1.0, 'Decision Tree Accuracy Score:0.5625')
```



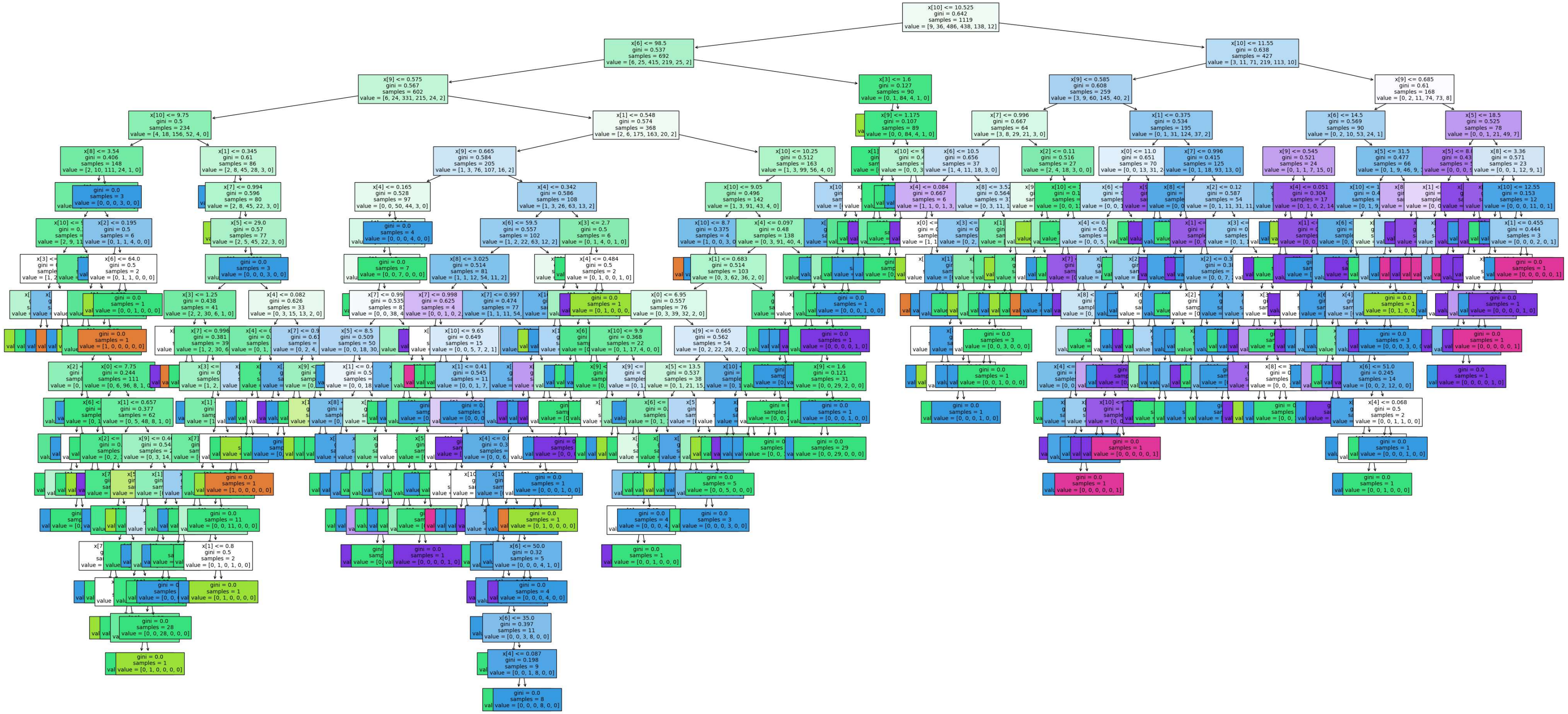
Decision Tree Accuracy Score:0.5625

Predicted Label						
0	0.000	0.000	1.000	0.000	0.000	0.000
1	0.000	1.000	11.000	4.000	1.000	0.000
2	1.000	9.000	121.000	59.000	4.000	1.000
3	0.000	3.000	50.000	116.000	30.000	1.000
4	0.000	1.000	5.000	23.000	30.000	2.000



In [19]:

```
fig, ax = plt.subplots(figsize=(50,24))
tree.plot_tree(clf,filled=True,fontsize=10)
plt.savefig('decision_tree_cau4_gini',dpi=100)
plt.show()
```



In [20]:

```
gnb = GaussianNB()
```

In [21]:

```
bayes_pred = gnb.fit(x_train, y_train).predict(x_test)
bayes_score = metrics.accuracy_score(y_test, bayes_pred)
print("Accuracy: ", bayes_score)
print("Report: ", metrics.classification_report(y_test, bayes_pred))
```

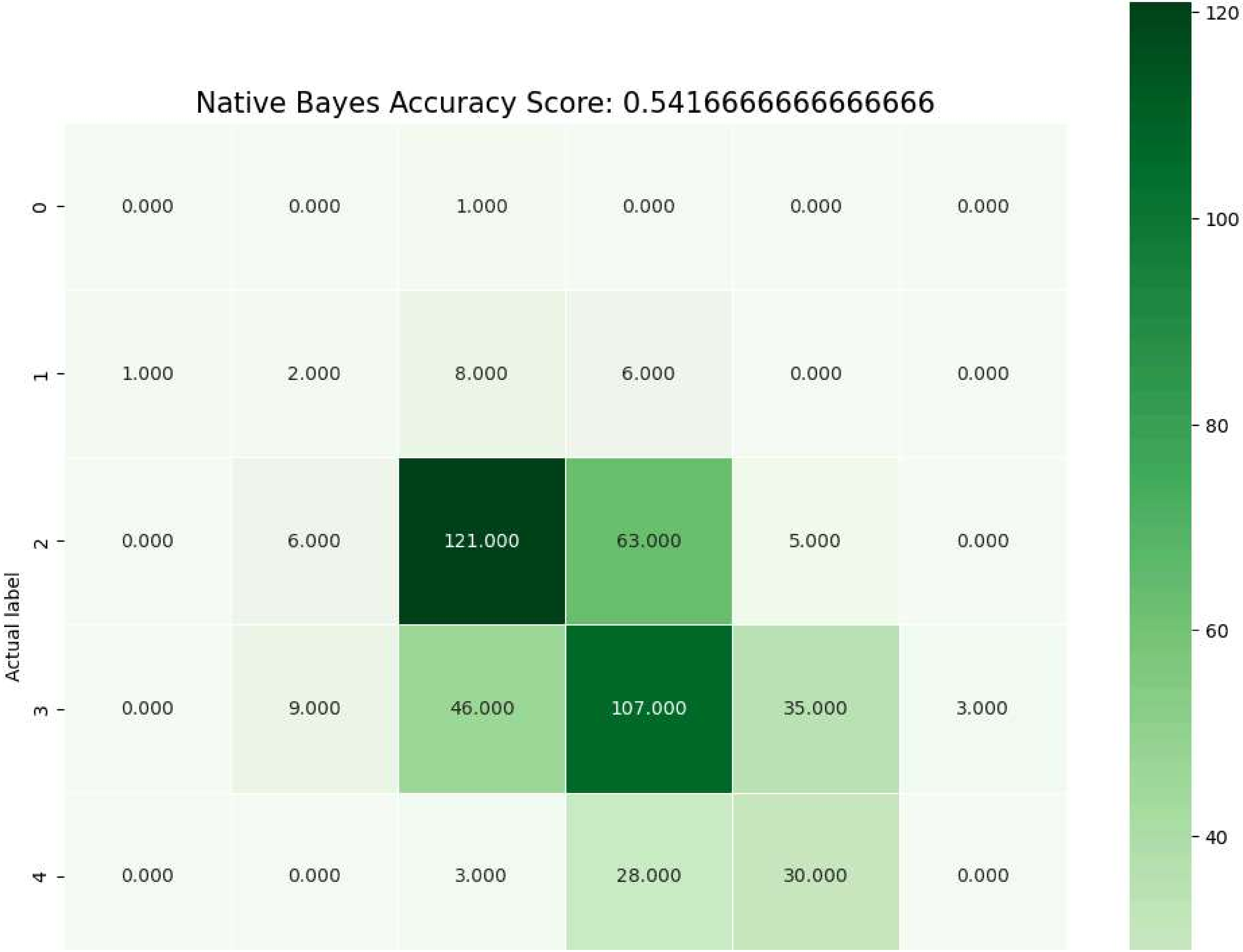
```
Accuracy:  0.5416666666666666
Report:               precision    recall  f1-score   support

           3       0.00      0.00      0.00         1
           4       0.12      0.12      0.12        17
           5       0.68      0.62      0.65       195
           6       0.52      0.54      0.53       200
           7       0.40      0.49      0.44        61
           8       0.00      0.00      0.00         6

    accuracy                           0.54       480
   macro avg       0.29      0.29      0.29       480
weighted avg       0.55      0.54      0.54       480
```

In [22]:

```python
bayes_cm = metrics.confusion_matrix(y_test, bayes_pred)
plt.figure(figsize=(12,12))
sns.heatmap(bayes_cm,annot=True, fmt=".3f",linewidth=.5,square=True,cmap='Greens')
plt.ylabel('Actual label')
plt.xlabel('Predicted label')
title = 'Native Bayes Accuracy Score: {0}'.format(bayes_score)
plt.title(title, size=15)
```

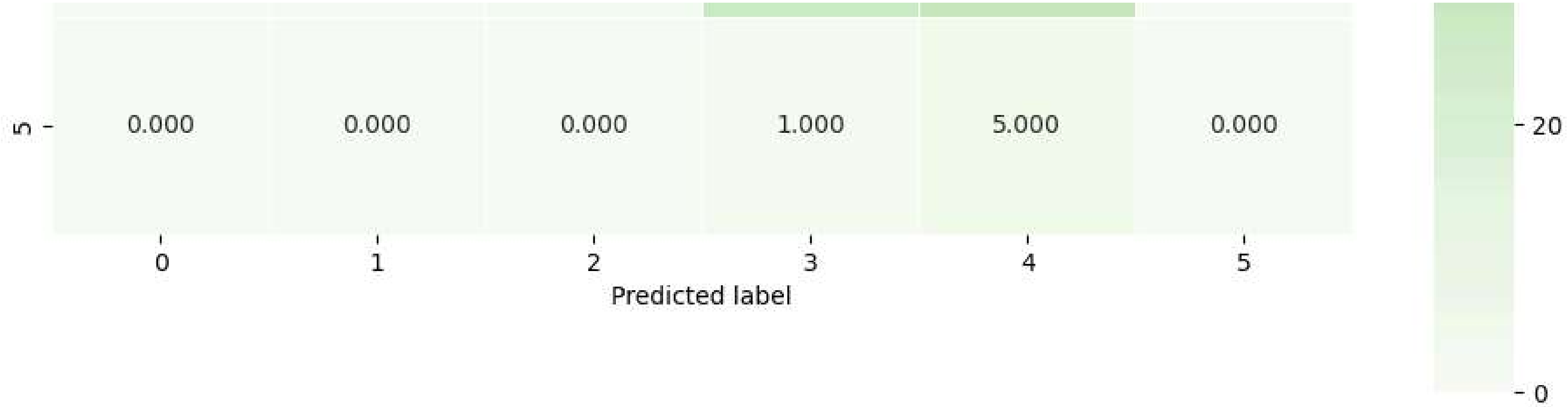
Out[22]:

```
Text(0.5, 1.0, 'Native Bayes Accuracy Score: 0.5416666666666666')
```



Native Bayes Accuracy Score: 0.5416666666666666

Actual label						
0	0.000	0.000	1.000	0.000	0.000	0.000
1	1.000	2.000	8.000	6.000	0.000	0.000
2	0.000	6.000	121.000	63.000	5.000	0.000
3	0.000	9.000	46.000	107.000	35.000	3.000
4	0.000	0.000	3.000	28.000	30.000	0.000



In [23]:

```
# SO SÁNH KẾT QUẢ
#Dựa vào mô hình ta có độ chính xác của các thuật toán lần lượt là:
#Thuật toán cây ID3 với 58.34%
#Thuật toán Naive Bayes với 56.25%
#Thuật toán cây CART với 54.167%
#Vậy đối với mô hình này sử dụng thuật toán cây quyết định ID3 cho ra độ chính xác cao nhất
```

In [ ]: