Machine Learning Assignment No: 2 (Classification).

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ASSIGNMENT QUESTION:

Classify the following dataset to distinguish between skin color and nonskin color. You may try different models but report at least the two top scoring classifiers. Use the following settings for the experiments.

1. Stratified 5-Fold cross-validation (the dataset is imbalanced)
2. Report precision, recall, and F1-score (with micro as averaging scheme)

Data Set: https://archive.ics.uci.edu/ml/datasets/Skin+Segmentation (https://archive.ics.uci.edu/ml/datasets/Skin+Segmentation)

Submit a code document and a word document with setup, results and discussion.

Importing Libraries

In [14]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from sklearn.metrics import classification_report, confusion_matrix#for visualiz
from sklearn.tree import plot_tree
from sklearn.metrics import precision_recall_curve, f1_score
from sklearn.model_selection import StratifiedKFold
from statistics import mean, stdev
from sklearn import datasets
from sklearn.metrics import confusion_matrix, roc_auc_score ,roc_curve,auc
import seaborn as sns
from sklearn import metrics
from sklearn.tree import DecisionTreeClassifier#for checking testing results
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import GaussianNB
from sklearn.ensemble import AdaBoostClassifier
from sklearn.neighbors import KNeighborsClassifier
```

Importing the Data

In [15]:

```
def load_data():
    '''
    Loading the data for this file into a pandas DataFrame.
    '''
    frame = pd.read_csv(
        "Skin_NonSkin.txt",

        # Specify the file encoding
        encoding='utf-8',  # UTF-8 is  common

        # Specify the separator in the data
        sep='\t',          # tab separated values

        # Ignore spaces after the separator
        skipinitialspace=True,

        # Generate row labels from each row number
        index_col=None,

        # Generate column headers row from each column number
        header=0,
    )
    # Return the entire frame
    return frame
```

Exploratory Data Analysis (EDA)

In [13]:

```
#reading the data
def ExploratoryDataAnalysis(i):
    df= load_data()
    df.head()
    #getting information of dataset
    df.info()
    df.head()
    if i==1:
        # let's plot pair plot to visualise the attributes all at once
        sns.pairplot(data=load_data(), hue = 'L1')
ExploratoryDataAnalysis(0)
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 245057 entries, 0 to 245056
Data columns (total 4 columns):
 #   Column  Non-Null Count   Dtype
---  ------  --------------   -----
 0   c1      245057 non-null  int64
 1   c2      245057 non-null  int64
 2   c3      245057 non-null  int64
 3   L1      245057 non-null  int64
dtypes: int64(4)
memory usage: 7.5 MB
```

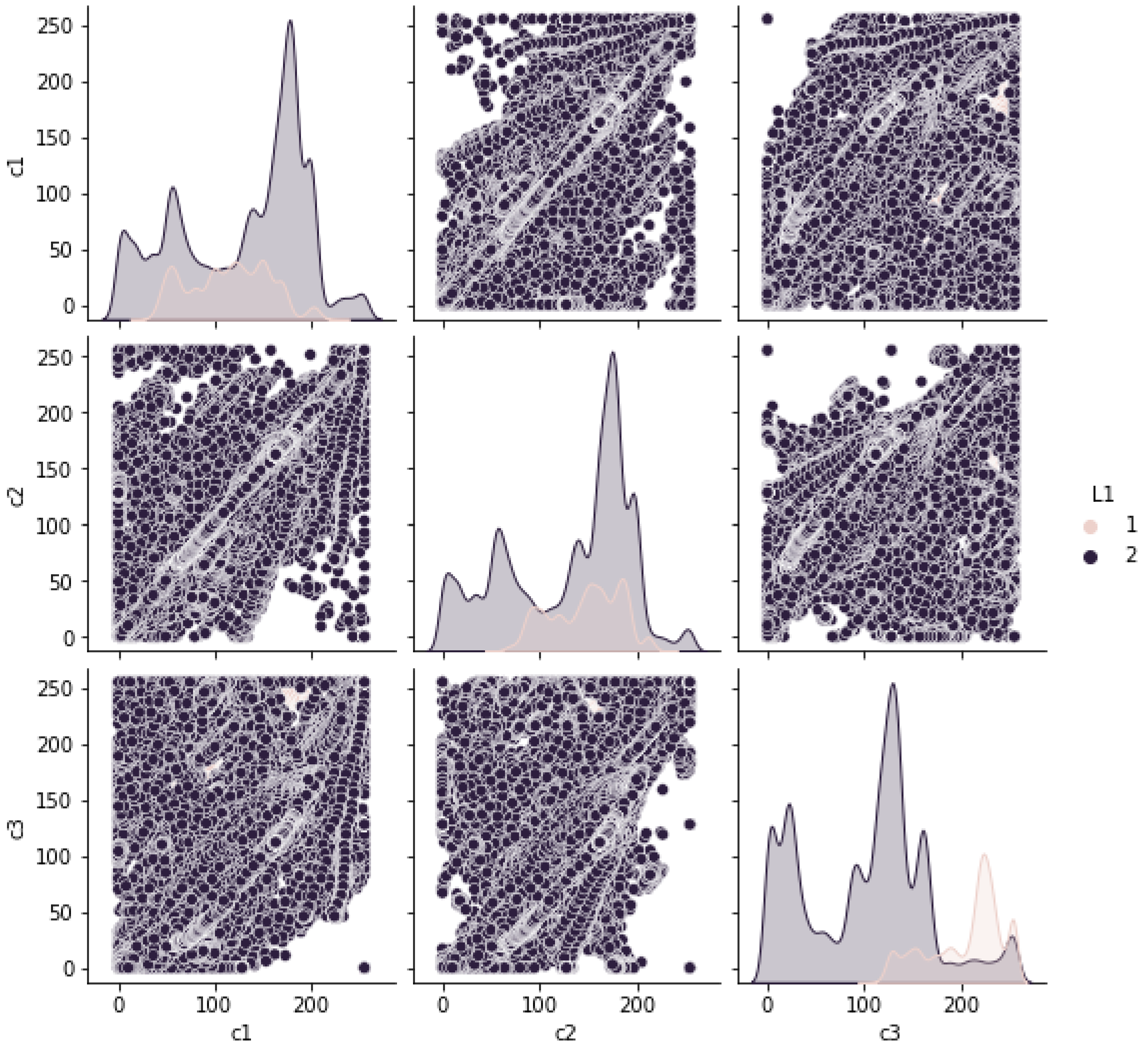
We understand that this dataset has 245057 records, 4 columns with the type int and there are no

NAN values as form following command

Now we perform some basic EDA on this dataset. Let’s check the correlation of all the features with each other

```
In [22]: # let's plot pair plot to visualise the attributes all at once
         sns.pairplot(data=load_data(), hue = 'L1')
```

```
Out[22]: <seaborn.axisgrid.PairGrid at 0x2656a530dc0>
```



We have a total of 2 targets that we want to predict: 1, and 2. We can see that 1 always forms a different cluster from the 2.

Data Preprocessing

Now, we will separate the target variable(y) and features(X) as follows

In [12]:

```
def DataPreprocessing():
    df = load_data()
    target = df['L1']
    df1 = df.copy()
    df1 = df1.drop('L1', axis =1)
    # Defining the attributes
    X = np.delete(df1.to_numpy(), (0), axis=0)
    y = np.delete(target.to_numpy(), (0), axis=0)
    # converting targt values to (0, 1)
    t=0;
    for i in y:
        if i==1:

            y[t]= 0
        else:
            y[t]= 1
        t=t+1
    return X, y
```

Training and Testing

Stratified 5-Fold cross-validation (the dataset is imbalanced)

In [11]:
```
def ApplyClassifier(model):

    model_name = type(model).__name__
    kfold = StratifiedKFold(n_splits=5, shuffle=True, random_state=1)
    model_accu_stratified = []
    cv_score =[]
    i=1

    print('---------------------------------------------------------------------
    print('Classifier Name: ', model_name)
    print('---------------------------------------------------------------------
    for train_ix, test_ix in kfold.split(X, y):
    # select rows
        train_X, test_X = X[train_ix], X[test_ix]
        train_y, test_y = y[train_ix], y[test_ix]

        # summarize train and test composition
        train_1, train_2 = len(train_y[train_y==0]), len(train_y[train_y==1])
        test_1, test_2 = len(test_y[test_y==0]), len(test_y[test_y==1])

        print('{} of KFold {}'.format(i,kfold.n_splits))
        print('           >Train: 1=%d, 2=%d, Test: 1=%d, 2=%d' % (train_1, train


        model.fit(train_X, train_y)
        score = roc_auc_score(test_y, model.predict(test_X))

        print('           ROC AUC score:',score)
        cv_score.append(score)

        model_accu_stratified.append(model.score(test_X, test_y))
        i+=1
    print('---------------------------------------------------------------------
#     call to evaluations
    Evaluation(model, model_accu_stratified,cv_score,test_X, test_y, model_name )
```

Evaluation

In [10]:

```
def Evaluation(model, model_accu_stratified,cv_score, test_X, test_y, classifireN

    print('List of possible accuracy are :',(round(model_accu_stratified[0], 5))
          , ', ', round(model_accu_stratified[1],5) ,  ' , ',round(model_accu_str
    print('\nMaximum Accuracy That can be obtained from this model is:',
          max(model_accu_stratified)*100, '%')
    print('\nMinimum Accuracy:',
          min(model_accu_stratified)*100, '%')
    print('\nOverall(Mean) Accuracy:',
          mean(model_accu_stratified)*100, '%')
    print('\nStandard Deviation is:', stdev(model_accu_stratified))
    print('---------------------------------------------------------------------
    print('Cv: ',cv_score,'\nMean cv Score :',np.mean(cv_score))
    print('---------------------------------------------------------------------
    print("\n            Confusion Matrix on tested 5th flod data\n")


    cm =confusion_matrix(test_y,model.predict(test_X))
    print('---------------------------------------------------------------------
    tp, fn, fp, tn =confusion_matrix(test_y,model.predict(test_X)).reshape(-1)

    # classification report for precision, recall f1-score and accuracy
    matrix = classification_report(test_y, model.predict(test_X))
    print('Classification report : \n',matrix)
    print('---------------------------------------------------------------------

    plt.figure(figsize=(9,9))
    sns.heatmap(cm, annot=True, fmt=".3f", linewidths=.5, square = True, cmap = '
    plt.ylabel('Actual label');
    plt.xlabel('Predicted label');
    all_sample_title = 'Accuracy Score is  {0} of {1}'.format(round(np.mean(cv_sc
    plt.title(all_sample_title, size = 15);
```

-------------------------------------Driver Class-------------- ------------------

In [16]:

```
load_data()
ExploratoryDataAnalysis(0)
X, y = DataPreprocessing()
load_data().head()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 245057 entries, 0 to 245056
Data columns (total 4 columns):
 #   Column  Non-Null Count   Dtype
---  ------  --------------   -----
 0   c1      245057 non-null  int64
 1   c2      245057 non-null  int64
 2   c3      245057 non-null  int64
 3   L1      245057 non-null  int64
dtypes: int64(4)
memory usage: 7.5 MB
```

Out[16]:

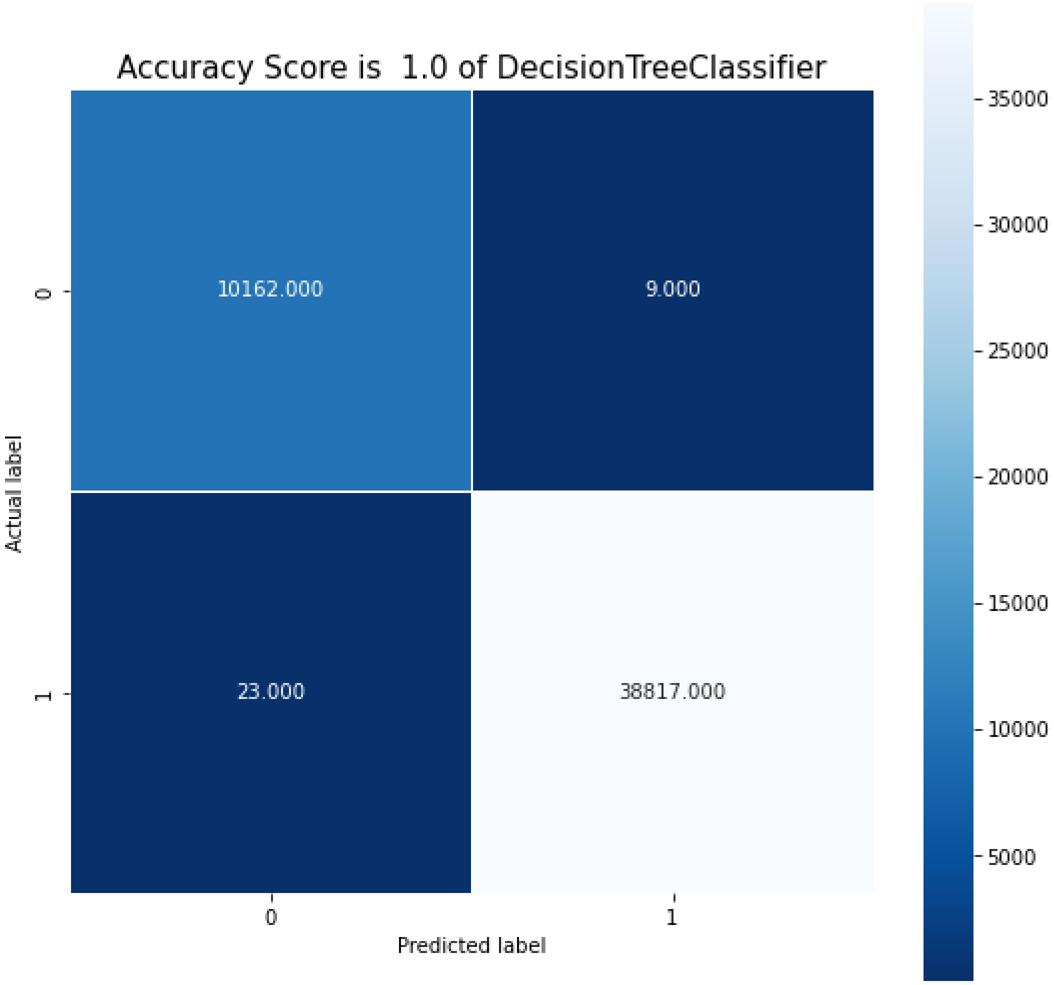
	c1	c2	c3	L1
0	74	85	123	1
1	73	84	122	1
2	72	83	121	1
3	70	81	119	1
4	70	81	119	1

1. Decision Tree Classifier

In [17]:
```python
# Create  classifier object.
dtree = DecisionTreeClassifier()
ApplyClassifier(dtree)
```

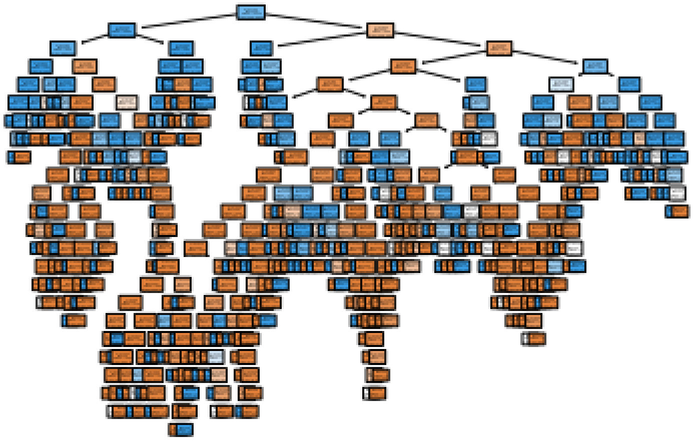
```
-----------------------------------------------------------------------------
------------
Classifier Name:  DecisionTreeClassifier
-----------------------------------------------------------------------------
------------
1 of KFold 5
           >Train: 1=40686, 2=155358, Test: 1=10172, 2=38840
           ROC AUC score: 0.9988706250432824
2 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.9989689278294233
3 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.9992638550807013
4 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.9989384422867423
5 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.9992614791190113
-----------------------------------------------------------------------------
------------
List of possible accuracy are : 0.99925 ,  0.99929  ,  0.99941

Maximum Accuracy That can be obtained from this model is: 99.94082960967945 %

Minimum Accuracy: 99.91226459366264 %

Overall(Mean) Accuracy: 99.92817969636089 %

Standard Deviation is: 0.00010834921257841509
-----------------------------------------------------------------------------
------------
Cv:  [0.9988706250432824, 0.9989689278294233, 0.9992638550807013, 0.998938442
2867423, 0.9992614791190113]
Mean cv Score : 0.9990606658718321
-----------------------------------------------------------------------------
------------

            Confusion Matrix on tested 5th flod data

-----------------------------------------------------------------------------
------------
Classification report :
               precision    recall  f1-score   support

           0       1.00      1.00      1.00     10171
           1       1.00      1.00      1.00     38840

    accuracy                           1.00     49011
   macro avg       1.00      1.00      1.00     49011
weighted avg       1.00      1.00      1.00     49011
```

```
-------------------------------------------------------------------------------
------------
```



Visualizing the decision tree

In [143]:
```
# Visualising the graph without the use of graphvizplt.figure(figsize = (20,20))
dec_tree = plot_tree(decision_tree=dtree, feature_names = df1.columns,
                     class_names =["1", "2"] , filled = True , precision = 3, rou
```



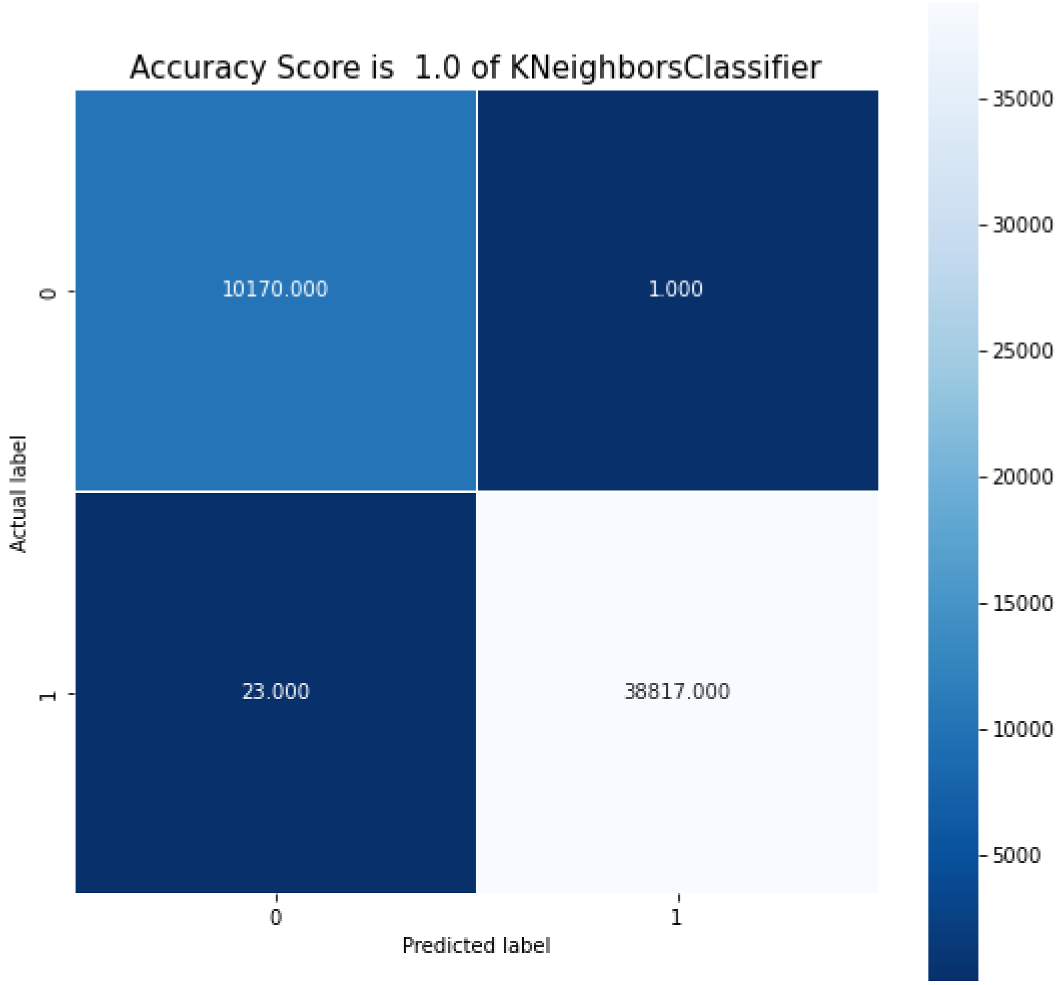
2. KNeighbors Classifier

In [18]:

```
# Create  classifier object.
k = KNeighborsClassifier()
ApplyClassifier(k)
```

```
----------------------------------------------------------------------------
------------
Classifier Name:  KNeighborsClassifier
----------------------------------------------------------------------------
------------
1 of KFold 5
           >Train: 1=40686, 2=155358, Test: 1=10172, 2=38840
           ROC AUC score: 0.9996079431714774
2 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.9996313440998963
3 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.9997167795257345
4 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.9995541014359904
5 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.9996547541165535
----------------------------------------------------------------------------
------------
List of possible accuracy are : 0.99955 ,  0.99953  ,  0.99955

Maximum Accuracy That can be obtained from this model is: 99.9551130335428 %

Minimum Accuracy: 99.94082960967945 %

Overall(Mean) Accuracy: 99.95103158428502 %

Standard Deviation is: 5.948772589477762e-05
----------------------------------------------------------------------------
------------
Cv:  [0.9996079431714774, 0.9996313440998963, 0.9997167795257345, 0.999554101
4359904, 0.9996547541165535]
Mean cv Score : 0.9996329844699303
----------------------------------------------------------------------------
------------


            Confusion Matrix on tested 5th flod data

----------------------------------------------------------------------------
------------
Classification report :
               precision    recall  f1-score   support

           0       1.00      1.00      1.00     10171
           1       1.00      1.00      1.00     38840

    accuracy                           1.00     49011
   macro avg       1.00      1.00      1.00     49011
weighted avg       1.00      1.00      1.00     49011
```

```
--------------------------------------------------------------------------------------------
```

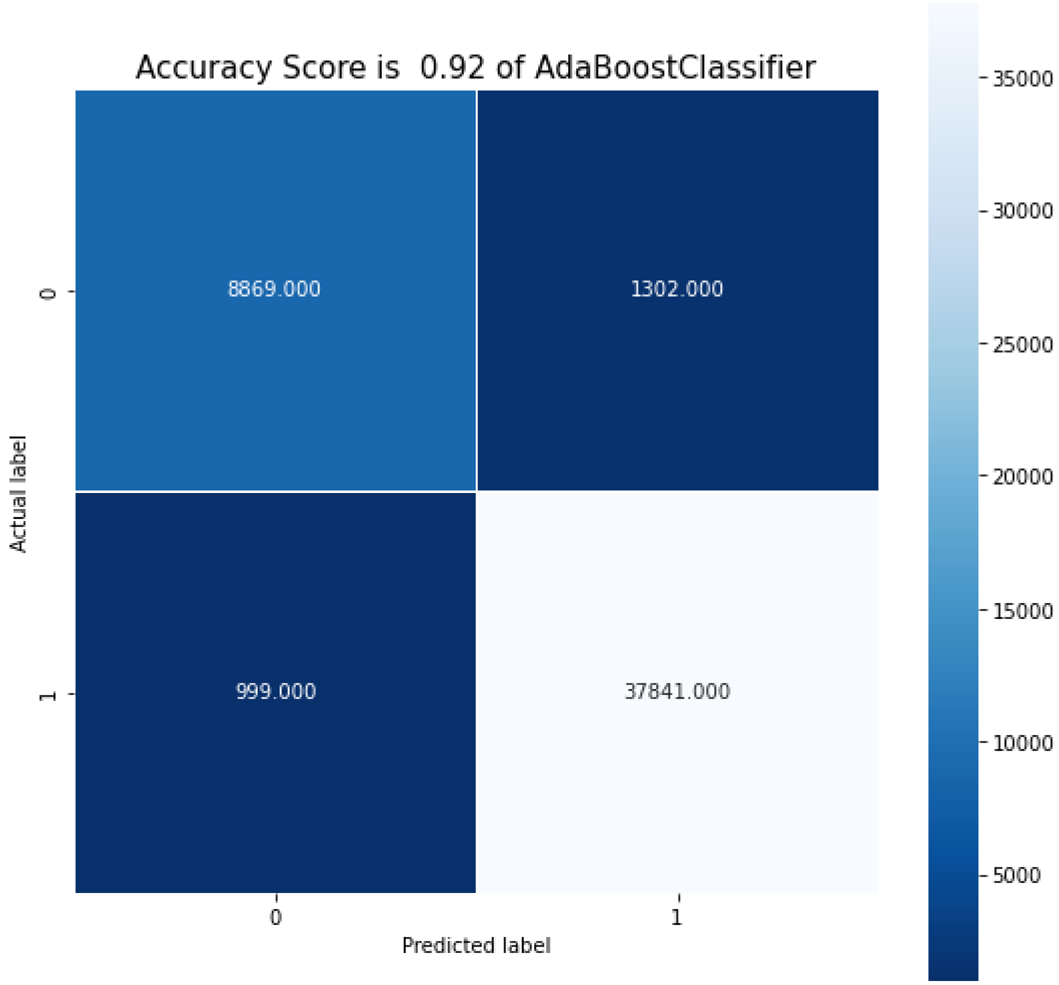


3. AdaBoostClassifier

In [19]:
```
# Create  classifier object.
Ada = AdaBoostClassifier(n_estimators=50, learning_rate=1.0, algorithm='SAMME.R')
ApplyClassifier(Ada)
```

```
-----------------------------------------------------------------------------
------------
Classifier Name:  AdaBoostClassifier
-----------------------------------------------------------------------------
------------
1 of KFold 5
           >Train: 1=40686, 2=155358, Test: 1=10172, 2=38840
           ROC AUC score: 0.9235979362989536
2 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.9227771870418569
3 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.9245092964566701
4 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.9282899038187469
5 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.9231340410089429
-----------------------------------------------------------------------------
------------
List of possible accuracy are : 0.95332 ,  0.95368  ,  0.9547

Maximum Accuracy That can be obtained from this model is: 95.53569606822958 %

Minimum Accuracy: 95.30513558180816 %

Overall(Mean) Accuracy: 95.40227568604807 %

Standard Deviation is: 0.0009746834098173316
-----------------------------------------------------------------------------
------------
Cv:  [0.9235979362989536, 0.9227771870418569, 0.9245092964566701, 0.928289903
8187469, 0.9231340410089429]
Mean cv Score : 0.9244616729250341
-----------------------------------------------------------------------------
------------

            Confusion Matrix on tested 5th flod data

-----------------------------------------------------------------------------
------------
Classification report :
               precision    recall  f1-score   support

           0       0.90      0.87      0.89     10171
           1       0.97      0.97      0.97     38840

    accuracy                           0.95     49011
   macro avg       0.93      0.92      0.93     49011
weighted avg       0.95      0.95      0.95     49011
```

```
--------------------------------------------------------------------------------
------------
```

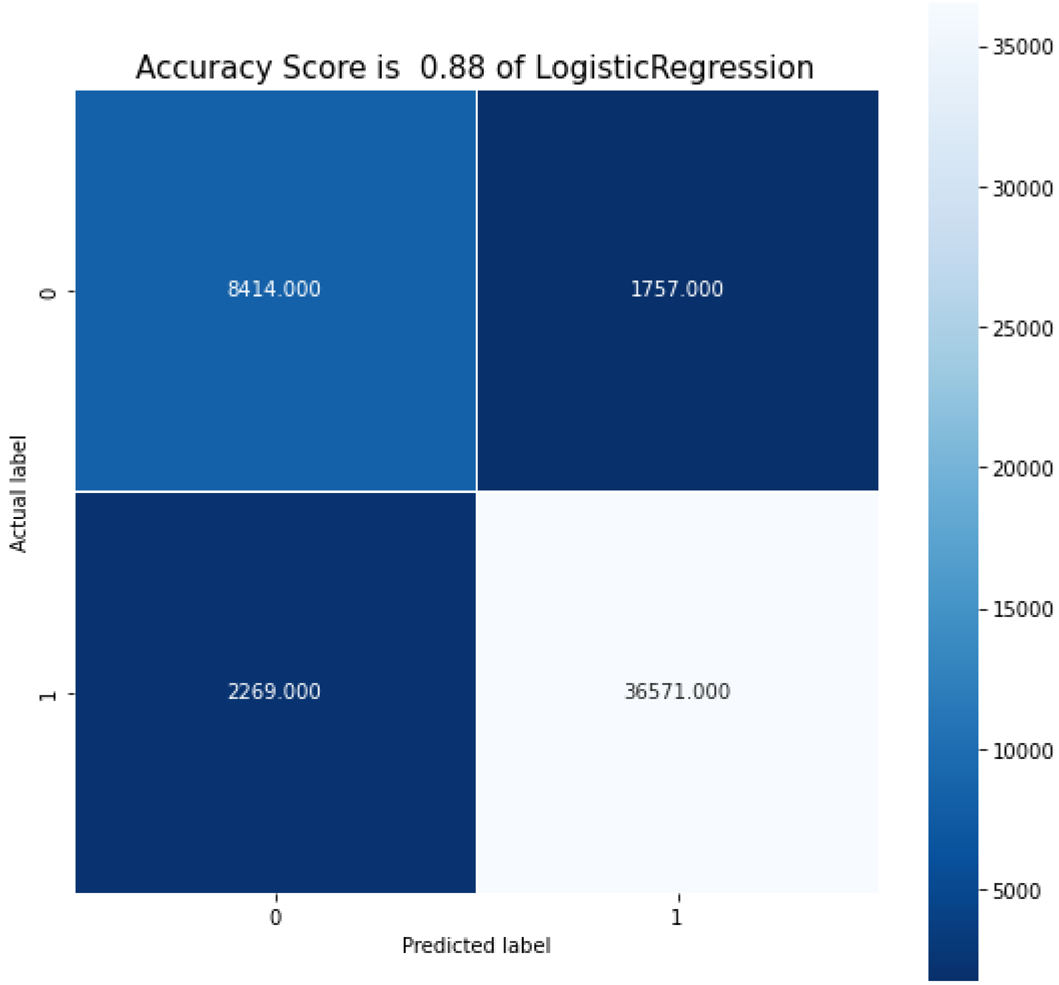


# 4. LogisticRegression

In [20]:
```
# Create  classifier object.
lr = LogisticRegression()
ApplyClassifier(lr)
```

```
-----------------------------------------------------------------------------
------------
Classifier Name:  LogisticRegression
-----------------------------------------------------------------------------
------------
1 of KFold 5
           >Train: 1=40686, 2=155358, Test: 1=10172, 2=38840
           ROC AUC score: 0.8799387355204185
2 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.8817356745017649
3 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.8841933952677609
4 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.8877354017667605
5 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.8844174009099395
-----------------------------------------------------------------------------
------------
List of possible accuracy are : 0.91753 ,  0.91773  ,  0.91939

Maximum Accuracy That can be obtained from this model is: 92.14462059537655 %

Minimum Accuracy: 91.75304007181914 %

Overall(Mean) Accuracy: 91.87899959992626 %

Standard Deviation is: 0.001657425755787211
-----------------------------------------------------------------------------
------------
Cv:  [0.8799387355204185, 0.8817356745017649, 0.8841933952677609, 0.887735401
7667605, 0.8844174009099395]
Mean cv Score : 0.8836041215933289
-----------------------------------------------------------------------------
------------


            Confusion Matrix on tested 5th flod data

-----------------------------------------------------------------------------
------------
Classification report :
               precision    recall  f1-score   support

           0       0.79      0.83      0.81     10171
           1       0.95      0.94      0.95     38840

    accuracy                           0.92     49011
   macro avg       0.87      0.88      0.88     49011
weighted avg       0.92      0.92      0.92     49011
```

```
----------------------------------------------------------------------------------------------
```



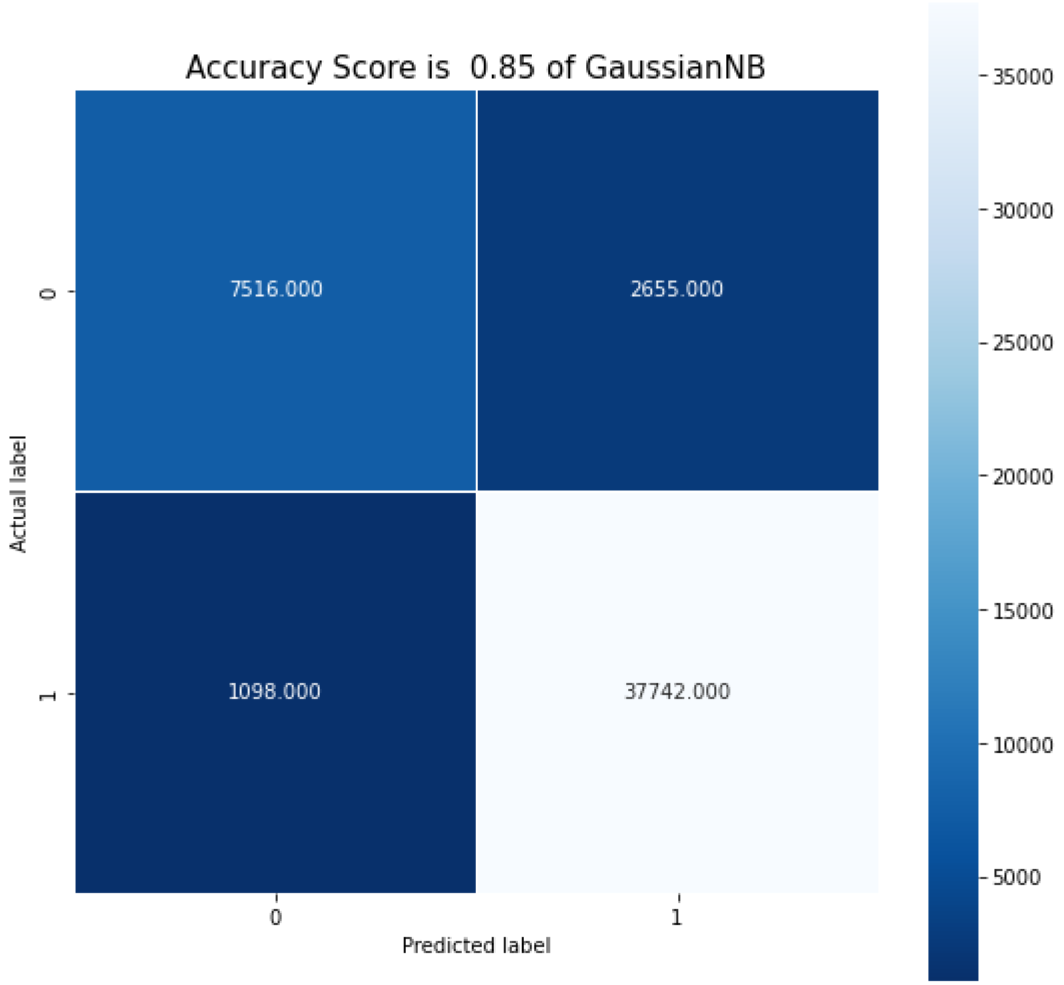
5. Naive Bayes Classification

In [21]:

```
# Create  classifier object.
nBayes = GaussianNB()
ApplyClassifier(nBayes)
```

```
-----------------------------------------------------------------------------
------------
Classifier Name:  GaussianNB
-----------------------------------------------------------------------------
------------
1 of KFold 5
           >Train: 1=40686, 2=155358, Test: 1=10172, 2=38840
           ROC AUC score: 0.8494471607405154
2 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.8542522613468588
3 of KFold 5
           >Train: 1=40686, 2=155359, Test: 1=10172, 2=38839
           ROC AUC score: 0.855135863563809
4 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.8577942302487404
5 of KFold 5
           >Train: 1=40687, 2=155358, Test: 1=10171, 2=38840
           ROC AUC score: 0.8553469477293583
-----------------------------------------------------------------------------
------------
List of possible accuracy are : 0.92188 ,  0.92357  ,  0.92485

Maximum Accuracy That can be obtained from this model is: 92.57513619391565 %

Minimum Accuracy: 92.18762751979106 %

Overall(Mean) Accuracy: 92.38949546988422 %

Standard Deviation is: 0.0014805093501863067
-----------------------------------------------------------------------------
------------
Cv:  [0.8494471607405154, 0.8542522613468588, 0.855135863563809, 0.8577942302
487404, 0.8553469477293583]
Mean cv Score : 0.8543952927258565
-----------------------------------------------------------------------------
------------

            Confusion Matrix on tested 5th flod data

-----------------------------------------------------------------------------
------------
Classification report :
               precision    recall  f1-score   support

           0       0.87      0.74      0.80     10171
           1       0.93      0.97      0.95     38840

    accuracy                           0.92     49011
   macro avg       0.90      0.86      0.88     49011
weighted avg       0.92      0.92      0.92     49011
```

```
--------------------------------------------------------------------------------
------------
```


Accuracy Score is 0.85 of GaussianNB
7516.000
2655.000
1098.000
37742.000
Actual label
0
1
Predicted label
0
1
35000
30000
25000
20000
15000
10000
5000

In [ ]: