Compute performance metrics for the given Y and Y_score without sklearn

In [1]:
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
# other than these two you should not import any other packages
```

A. Compute performance metrics for the given data **5_a.csv**
Note 1: in this data you can see number of positive points >> number of negatives points
Note 2: use pandas or numpy to read the data from **5_a.csv**
Note 3: you need to derive the class labels from given score

$y^{pred} = [0 \text{ if y\_score} < 0.5 \text{ else } 1]$

1. Compute Confusion Matrix
2. Compute F1 Score
3. Compute AUC Score, you need to compute different thresholds and for each threshold compute tpr,fpr and then use numpy.trapz(tpr_array, fpr_array) https://stackoverflow.com/q/53603376/4084039, https://stackoverflow.com/a/39678975/4084039 Note: it should be numpy.trapz(tpr_array, fpr_array) not numpy.trapz(fpr_array, tpr_array)
4. Compute Accuracy Score

In [2]:
```python
df = pd.read_csv("5_a.csv")
df.head()
```

Out[2]:

	y	proba
0	1.0	0.637387
1	1.0	0.635165
2	1.0	0.766586
3	1.0	0.724564
4	1.0	0.889199

In [3]:
```python
y = df.y.value_counts().to_list()
```

In [4]:
```python
print("Positive Label:{0} and Negative label :{1}".format(y[0],y[1]))
```

```
Positive Label:10000 and Negative label :100
```

In [5]:
```python
def predict(probabilityScore,threshold):
    y_predict =  [1 if i > 0.5 else 0 for i in probabilityScore]
    return y_predict
```

In [6]:
```python
df['y_predict'] = predict(df.proba.to_numpy(),0.5)
df.head()
```

Out[6]:

	y	proba	y_predict
0	1.0	0.637387	1
1	1.0	0.635165	1
2	1.0	0.766586	1
3	1.0	0.724564	1
4	1.0	0.889199	1

In [7]:
```python
def confusionMatrix(actual_value,predicted_value):

    #Create a numpy 2d matrix assigned as zero
    confusion_matrix = np.zeros((2,2))
    for y,y_hat in zip(range(len(actual_value)),range(len(predicted_value))):

        if (actual_value[y] == 0 and predicted_value[y_hat] == 0):

            confusion_matrix[0,0] += 1
        elif(actual_value[y] == 0 and predicted_value[y_hat] == 1):
            confusion_matrix[1,0] += 1

        elif(actual_value[y] == 1 and predicted_value[y_hat] == 0):
            confusion_matrix[0,1] += 1
        else:
            confusion_matrix[1,1] += 1
    return confusion_matrix
```

In [8]:
```python
actual_value = df.y.to_numpy()
predicted_value = df.y_predict.to_numpy()

confusion_matrix = confusionMatrix(actual_value,predicted_value)

print("Confusion Matrix :{0}".format(confusion_matrix))
```

```
Confusion Matrix :[[    0.     0.]
 [  100. 10000.]]
```

In [9]:
```python
def precisionScore(actual_value,predicted_value):

    true_positive = 0
    false_positive = 0
    precision_score = 0.0
    for y,y_hat in zip(range(len(actual_value)),range(len(predicted_value))):

        if(actual_value[y] == 0 and predicted_value[y_hat] == 1):
            false_positive += 1

        elif (actual_value[y] == 1 and predicted_value[y_hat] == 1):
            true_positive += 1
    precision_score = true_positive / (true_positive + false_positive)
    return precision_score
```

In [10]:
```python
actual_value = df.y.to_numpy()
predicted_value = df.y_predict.to_numpy()
print("Precision Score of the Dataset :{0}".format(precisionScore(actual_value,predicted_value)))
precision_score = precisionScore(actual_value,predicted_value)
```

```
Precision Score of the Dataset :0.9900990099009901
```

In [11]:
```python
#recall Score is also called as true positive rate recall = true_positive / false_negative + true_positive
def recallScore(actual_value,predicted_value):
    true_positive = 0
    false_negative = 0
    recall_score = 0.0
    for y,y_hat in zip(range(len(actual_value)),range(len(predicted_value))):

        if (actual_value[y] == 1 and predicted_value[y_hat] == 0):
            false_negative += 1

        elif(actual_value[y] == 1 and predicted_value[y_hat] == 1):
            true_positive += 1
    recall_score = true_positive / (true_positive + false_negative)

    return recall_score
```

In [12]:
```python
actual_value = df.y.to_numpy()
predicted_value = df.y_predict.to_numpy()
print("Recall Score of the Dataset :{0}".format(recallScore(actual_value,predicted_value)))
recall_score = recallScore(actual_value,predicted_value)
```

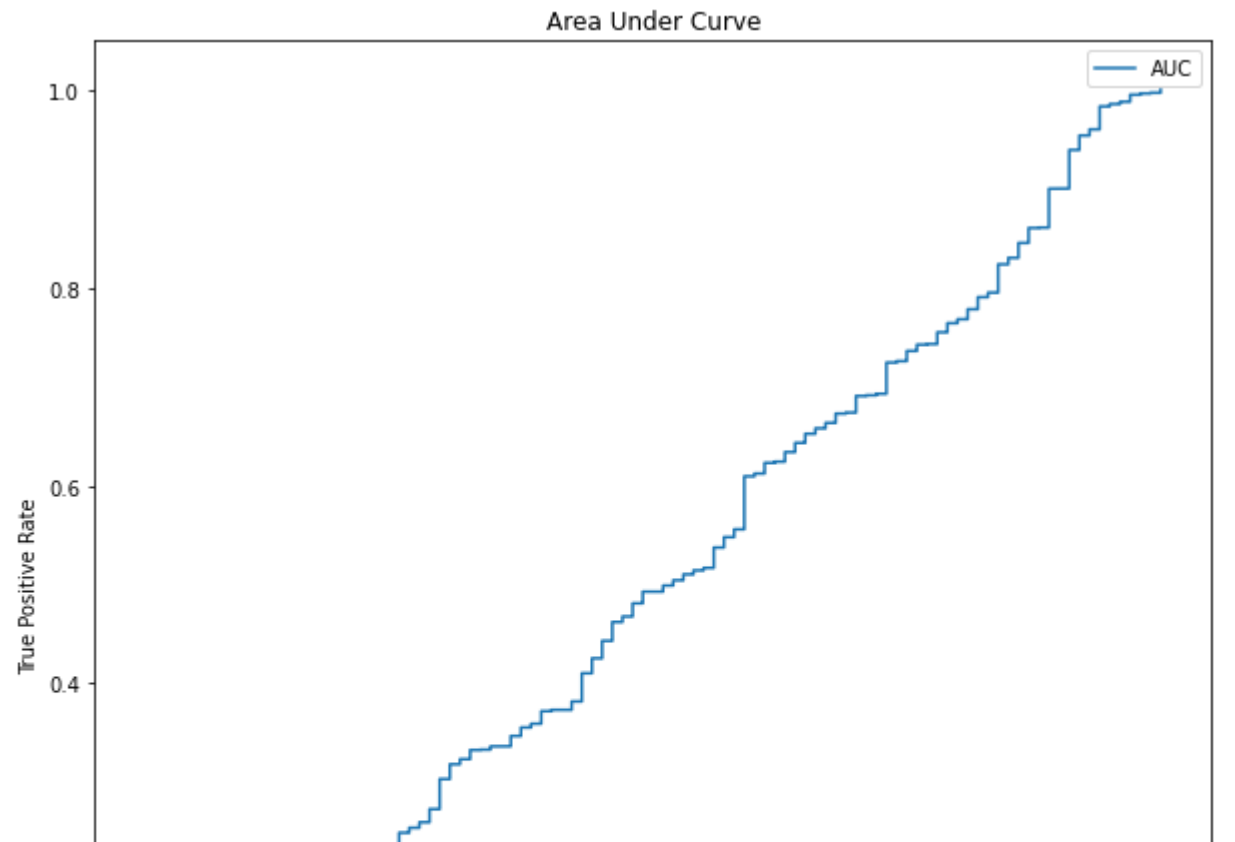
```
Recall Score of the Dataset :1.0
```

In [13]:
```python
#F1 Score = hormonic mean of precsion and recall
def f1Score(precisionScore,recallScore):
    return 2 * ((precisionScore * recallScore) / (precisionScore + recallScore))
print("F1Score :{0}".format(f1Score(precision_score,recall_score)))
```

```
F1Score :0.9950248756218906
```

In [14]:
```python
def auc(actualValue,probabilityScore,threshold):

    predictedValue = np.where(probabilityScore >= threshold,1,0)
    confusion_matrix = confusionMatrix(actualValue,predictedValue)
    totalSum = np.sum(confusion_matrix,axis = 0)

    #positive  class
    totalPositive = totalSum[1]
    totalNegative = totalSum[0]
    TPR = confusion_matrix[1,1] / totalPositive
    FPR = confusion_matrix[1,0] / totalNegative

    return [TPR,FPR]


TPRList =[]
FPRList = []

dataframeSorted = df.sort_values(by='proba',ascending = False)

actualValue = dataframeSorted.y.to_numpy()
probabilityValue = dataframeSorted.proba.unique()

for threshold in probabilityValue[:]:
    areaUnderCurve = auc(actualValue,probabilityValue,threshold)
    TPRList.append(areaUnderCurve[0])
    FPRList.append(areaUnderCurve[1])
aucScore = np.trapz(TPRList,FPRList)
print("AUCSCORE = {}".format(aucScore))
plt.figure(figsize = (10,10))
plt.plot(FPRList,TPRList)
plt.title("Area Under Curve")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.legend(['AUC'], loc = 'upper right')
plt.show()
```

```
AUCSCORE = 0.48829900000000004
```



In [15]:
```python
#np.ravel is flattern the array
#np.diagonal - is sum of diagonal
#np.trace() - isn sum of the diagonal
#https://www.geeksforgeeks.org/calculate-the-sum-of-the-diagonal-elements-of-a-numpy-array/
accuracyScore = np.sum(np.diagonal(confusion_matrix))/np.sum(np.ravel(confusion_matrix))
print(accuracyScore)
```

```
0.9900990099009901
```

B. Compute performance metrics for the given data **5_b.csv**
Note 1: in this data you can see number of positive points << number of negatives points
Note 2: use pandas or numpy to read the data from **5_b.csv**
Note 3: you need to derive the class labels from given score

$y^{pred} = [0 \text{ if y\_score} < 0.5 \text{ else } 1]$

1. Compute Confusion Matrix
2. Compute F1 Score
3. Compute AUC Score, you need to compute different thresholds and for each threshold compute tpr,fpr and then use numpy.trapz(tpr_array, fpr_array) https://stackoverflow.com/q/53603376/4084039, https://stackoverflow.com/a/39678975/4084039
4. Compute Accuracy Score

In [16]:
```python
df2 = pd.read_csv("5_b.csv")
df2.head()
```

Out[16]:

	y	proba
0	0.0	0.281035
1	0.0	0.465152
2	0.0	0.352793
3	0.0	0.157818
4	0.0	0.276648

In [17]:
```python
df2.shape
```

Out[17]: (10100, 2)

In [18]:
```python
y = df2.y.value_counts()
print("Positive Label:{0} and Negative label :{1}".format(y[1],y[0]))
```

```
Positive Label:100 and Negative label :10000
```

In [19]:
```python
df2['y_predict'] = predict(df2.proba.to_numpy(),0.5)
df2.head()
```

Out[19]:

	y	proba	y_predict
0	0.0	0.281035	0
1	0.0	0.465152	0
2	0.0	0.352793	0
3	0.0	0.157818	0
4	0.0	0.276648	0

In [20]:
```python
actualValue = df2['y'].to_numpy()
predictedValue = df2['y_predict'].to_numpy()
confusion_matrix = confusionMatrix(actualValue,predictedValue)
print("Confusion Matrix = {0}".format(confusion_matrix))
```

```
Confusion Matrix = [[9761.   45.]
 [ 239.   55.]]
```

In [21]:
```python
recall_score = recallScore(actualValue,predictedValue)
precision_Score = precisionScore(actualValue,predictedValue)
print("Recall Score of the Dataset :{0}".format(recall_score))
print("Precision Score of the Dataset :{0}".format(precisionScore(actualValue,predictedValue)))
print("F1Score :{0}".format(f1Score(precision_Score,recall_score)))
```

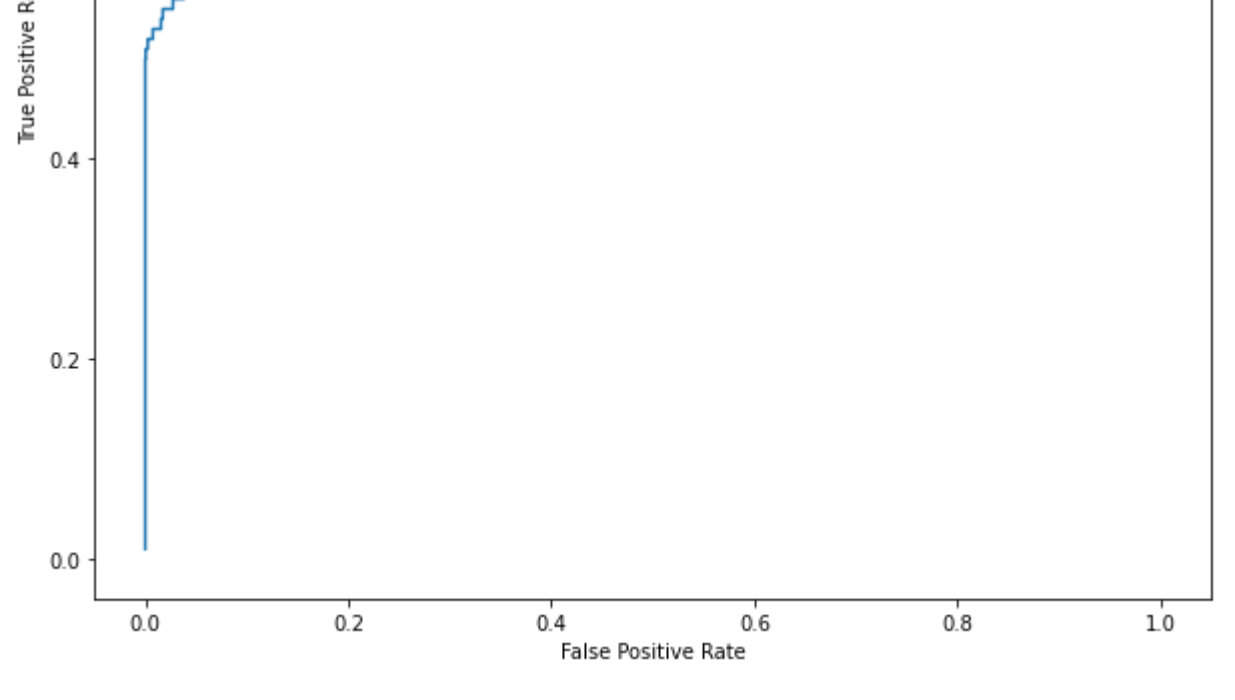
```
Recall Score of the Dataset :0.55
Precision Score of the Dataset :0.1870748299319728
F1Score :0.2791878172588833
```

In [22]:
```python
accuracyScore = np.sum(np.diagonal(confusion_matrix))/np.sum(np.ravel(confusion_matrix))
print("AccuracyScore = {0}".format(accuracyScore))
```

```
AccuracyScore = 0.9718811881188119
```

In [23]:
```python
#Area Under Curve

TPRList =[]
FPRList = []

dataframeSorted = df2.sort_values(by='proba',ascending = False)

actualValue = dataframeSorted.y.to_numpy()
probabilityValue = dataframeSorted.proba.unique()

for threshold in probabilityValue[:]:
    areaUnderCurve = auc(actualValue,probabilityValue,threshold)
    TPRList.append(areaUnderCurve[0])
    FPRList.append(areaUnderCurve[1])
aucScore = np.trapz(TPRList,FPRList)
print("AUCSCORE = {}".format(aucScore))
plt.figure(figsize = (10,10))
plt.plot(FPRList,TPRList)
plt.title("Area Under Curve")
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.legend(['AUC'], loc = 'upper right')
plt.show()
```

```
AUCSCORE = 0.9377570000000001
```



C. Compute the best threshold (similarly to ROC curve computation) of probability which gives lowest values of metric **A** for the given data **5_c.csv**

you will be predicting label of a data points like this: $y^{pred} = [0 \text{ if y\_score} < \text{threshold} \text{ else } 1]$

$A = 500 \times \text{number of false negative} + 100 \times \text{numebr of false positive}$

Note 1: in this data you can see number of negative points > number of positive points
Note 2: use pandas or numpy to read the data from **5_c.csv**

In [24]:
```python
df3 = pd.read_csv('5_c.csv')
df3.head()
```

Out[24]:

	y	prob
0	0	0.458521
1	0	0.505037
2	0	0.418652
3	0	0.412057
4	0	0.375579

In [25]:
```python
print("Shape of the Data : {0}".format(df3.shape))
```

```
Shape of the Data : (2852, 2)
```

In [26]:
```python
df3.y.value_counts()
```

Out[26]:
```
0    1805
1    1047
Name: y, dtype: int64
```

In [27]:
```python
df3['y_predict'] = predict(df3.prob.to_numpy(),0.5)
df3.head()
```

Out[27]:

	y	prob	y_predict
0	0	0.458521	0
1	0	0.505037	1
2	0	0.418652	0
3	0	0.412057	0
4	0	0.375579	0

In [28]:
```python
df3.prob.nunique()
```

Out[28]: 2791

In [29]:
```python
#Compute the unique Value
df3_sorted = df3.sort_values(by = 'prob' , ascending = True)
df3_sorted.head()
```

Out[29]:

	y	prob	y_predict
473	0	0.028038	0
412	0	0.028396	0
454	0	0.028964	0
435	0	0.030269	0
468	0	0.031114	0

In [30]:
```python
def ROC(actualValue,probabilityScore,threshold):

    predictedValue = np.where(probabilityScore >= threshold,1,0)
    confusion_matrix = confusionMatrix(actualValue,predictedValue)

    falsePositive = confusion_matrix[1,0]
    falseNegative = confusion_matrix[0,1]

    A = (500 * falseNegative) + (100 * falsePositive)

    return A
```

In [31]:
```python
actualValue = df3_sorted.y.to_numpy()
uniqueProbValue = df3_sorted.prob.unique()
probabilityScore = df3_sorted.prob.to_numpy()
thresholdDict = {}
for threshold in uniqueProbValue:
    probValue = ROC(actualValue,probabilityScore,threshold)
    thresholdDict[threshold] = probValue
minValue = min(thresholdDict.values())
minValueAndThreshold = [(threshold,value) for threshold, value in thresholdDict.items() if value == minValue]
print("The minimum value is {0} and the threshold is {1}".format(minValueAndThreshold[0][0] , minValueAndThreshold[0][1]))
```

```
The minimum value is 0.2300390278970873 and the threshold is 141000.0
```

D. Compute performance metrics(for regression) for the given data **5_d.csv**
Note 2: use pandas or numpy to read the data from **5_d.csv**
Note 1: **5_d.csv** will having two columns Y and predicted_Y both are real valued features

1. Compute Mean Square Error
2. Compute MAPE: https://www.youtube.com/watch?v=ly6ztgIkUxk
3. Compute R^2 error: https://en.wikipedia.org/wiki/Coefficient_of_determination#Definitions

In [32]:
```python
df4 = pd.read_csv('5_d.csv')
df4.head()
```

Out[32]:

	y	pred
0	101.0	100.0
1	120.0	100.0
2	131.0	113.0
3	164.0	125.0
4	154.0	152.0

In [33]:
```python
print("Shape of the data :{0}".format(df4.shape))
```

```
Shape of the data :(157200, 2)
```

In [34]:
```python
#Mean Square Error
y = df4.y.to_numpy()
y_hat = df4.pred.to_numpy()

MSE = np.sum((y-y_hat)**2) / len(y)
print("Mean Squared Error = {0}".format(MSE))
```

```
Mean Squared Error = 177.16569974554707
```

In [35]:
```python
#Mean Absolute Error
#check if any actual Value is zero
print(df4.loc[df4.y == 0].shape)
#so in this Problem 5717 actual Value as ZERO

actualValueSum = np.sum(y)

MAPE = np.sum(np.absolute(y-y_hat))/actualValueSum
print("Mean Absolute Percentage Error : {0}".format(MAPE))
```

```
(5717, 2)
Mean Absolute Percentage Error : 0.1291202994009687
```

In [36]:
```python
#r2-Square

SSresidual = np.sum((y-y_hat) ** 2)
SStotal = np.sum((y-np.mean(y)) ** 2)

r2Score = 1 - (SSresidual / SStotal)

print("R2 Score = {0}".format(r2Score))
```

```
R2 Score = 0.9563582786990937
```