# Compute performance metrics for the given Y and Y_score without sklearn

In [2]:

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

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

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

# 1. Compute Confusion Matrix

In [44]:

```
data = pd.read_csv('5_a.csv')
print(data.y.value_counts())
data.head()
```

```
1.0    10000
0.0      100
Name: y, dtype: int64
```

Out[44]:

| | 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 [45]:

```
def predictor(x):
    if x < 0.5:
        return 0
    else:
        return 1
```

```
#Convering the 'proba' column into into a class label with only '0' and '1' as values
data.proba = data.proba.map(predictor)

#Giving a new name 'y_pred' to 'proba'
data.columns = ['y', 'y_pred']

print(data.y_pred.value_counts())
data.head()
```

```
1    10100
Name: y_pred, dtype: int64
```

Out[45]:

| | y | y_pred |
|---|---|---|
| **0** | 1.0 | 1 |
| **1** | 1.0 | 1 |
| **2** | 1.0 | 1 |
| **3** | 1.0 | 1 |
| **4** | 1.0 | 1 |

In [46]:

```
def Confusion_Matrix(data_frame, label1, label2):
    counter = 0
    for i in range(0, len(data_frame)):
        if data_frame.y[i] == label1 and data_frame.y_pred[i] == label2:
            counter += 1
    return counter
```

In [47]:

```
#Computing Confusion Matrix Parameter (TP,TN,FN,FP)
TP = Confusion_Matrix(data, 1, 1)
TN = Confusion_Matrix(data, 0, 0)
FN = Confusion_Matrix(data, 1, 0)
FP = Confusion_Matrix(data, 0, 1)

print("True Positive ",TP)
print("True Negative ",TN)
print("False Positive ",FP)
print("False Negative ",FN)
```

```
True Positive  10000
True Negative  0
False Positive  100
False Negative  0
```

In [48]:

```
#Creating Confusion-Matrix
Confusion_Matrix = [[TN,FN], [FP,TP]]
Confusion_Matrix
```

Out[48]:

```
[[0, 0], [100, 10000]]
```

# 2. Compute F1 Score

In [49]:

```
#Calculating Precision
Precision = TP/(TP+FP)
```

```
#Calculating Recall
Recall = TP/(TP+FN)

print("Precision ",Precision)
print("Recall ", Recall)

#Calculating F1-Score
F1_Score = 2*(Precision*Recall)/(Precision+Recall)

print("F1-Score ",F1_Score)
```

```
Precision  0.9900990099009901
Recall  1.0
F1-Score  0.9950248756218906
```

# 3. Compute AUC Score

In [14]:

```
data = pd.read_csv('5_a.csv')
data.head()
```

Out[14]:

| | 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 [15]:

```
#computing different thresholds and merging the labels based on that threshhold to the data
Threshold = set()
Threshold = sorted(data.proba,reverse=True)

for i in Threshold:
    lst = []
    for val in data.proba:
        if val < i:
            lst.append(0)
        else:
            lst.append(1)
    data['Threshold '+str(i)] = lst

#Printing first 5 values of the data
data.head()
```

Out[15]:

| | y | proba | Threshold 0.8999653487823838 | Threshold 0.899828305041011 | Threshold 0.89982484614942 | Threshold 0.8998118120764471 | Threshold 0.8997678816682531 | Thresl 0.899751042026 |
|---|---|---|---|---|---|---|---|---|
| **0** | 1.0 | 0.637387 | 0 | 0 | 0 | 0 | 0 | |
| **1** | 1.0 | 0.635165 | 0 | 0 | 0 | 0 | 0 | |
| **2** | 1.0 | 0.766586 | 0 | 0 | 0 | 0 | 0 | |
| **3** | 1.0 | 0.724564 | 0 | 0 | 0 | 0 | 0 | |
| **4** | 1.0 | 0.889199 | 0 | 0 | 0 | 0 | 0 | |

5 rows × 10102 columns

In [16]:

```
#Printing a column(on a given threshold) value counts
data['Threshold '+str(0.89982484614942)].value_counts()
```

Out[16]:

```
0    10097
1        3
Name: Threshold 0.89982484614942, dtype: int64
```

In [22]:

```
def Confusion_Matrix(data_frame, label1,label2):
    lst = []
    for thresh in Threshold:
        counter = 0
        for i in range(0,len(data_frame)):
            if data_frame.y[i] == label1 and data_frame['Threshold '+str(thresh)][i] == label2:
                counter +=1
        lst.append(counter)
    return lst
```

In [23]:

```
#Computing Confusion Matrix Parameter (TP,TN,FN,FP) for each threshold column
TP = Confusion_Matrix(data, 1, 1)
TN = Confusion_Matrix(data, 0, 0)
FN = Confusion_Matrix(data, 1, 0)
FP = Confusion_Matrix(data, 0, 1)


print("True Positive's ",TP[:10])
print("True Negative's ",TN[:10])
print("False Positive's ",FP[:10])
print("False Negative's ",FN[:10])
```

```
True Positive's  [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
True Negative's  [100, 100, 100, 100, 100, 100, 100, 100, 100, 100]
False Positive's  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
False Negative's  [9999, 9998, 9997, 9996, 9995, 9994, 9993, 9992, 9991, 9990]
```

In [31]:

```
def TPR_FPR_Calculator(arg1,arg2):
    lst = []
    for i in range(0, len(arg1)):
        lst.append(arg1[i]/(arg1[i]+arg2[i]))
    return lst
```

In [35]:

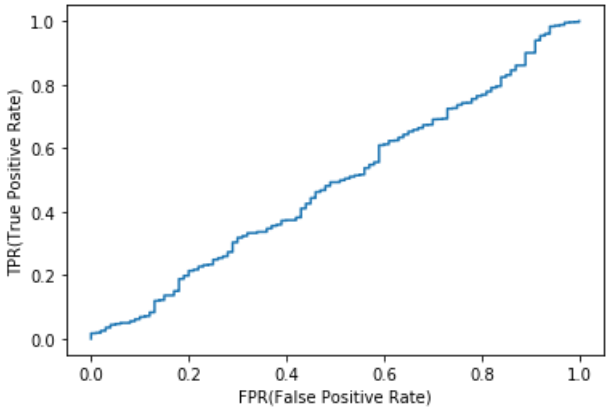
```
#Computing TPR & FPR values for each threshold column
TPR = TPR_FPR_Calculator(TP,FN)
FPR = TPR_FPR_Calculator(FP,TN)

print("True Positive Rate's :- ",TPR[:10])
print("False Positive Rate's :- ",FPR[:10])
```

```
True Positive Rate's :-  [0.0001, 0.0002, 0.0003, 0.0004, 0.0005, 0.0006, 0.0007, 0.0008, 0.0009,
0.001]
False Positive Rate's :-  [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
```

In [38]:

```
#plotting the TPR and FPR
import matplotlib.pyplot as plt
plt.plot(FPR,TPR)
plt.xlabel("FPR(False Positive Rate)")
plt.ylabel("TPR(True Positive Rate)")
plt.show()
```




In [43]:

```
#Computing AUC Score
print("The AUC score is :-",np.trapz(TPR, FPR))
```

```
The AUC score is :- 0.48829900000000004
```

# 4.Compute Accuracy Score

In [50]:

```
#Calculating Accuracy
Accuracy = (TP+TN)/(TP+TN+FP+FN)
print("Accuracy Score :- ",Accuracy)
```

```
Accuracy Score :-  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</pre> $y^{pred}= \text{[0 if y_score < 0.5 else 1]}$

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

# 1.Compute Confusion Matrix

In [51]:

```
data = pd.read_csv('5_b.csv')
print(data.y.value_counts())
data.head()
```

```
0.0    10000
1.0      100
Name: y, dtype: int64
```

Out[51]:

| | 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 [52]:

```
def predictor(x):
    if x < 0.5:
        return 0
    else:
        return 1

#Convering the 'proba' column into into a class label with only '0' and '1' as values
data.proba = data.proba.map(predictor)

#Giving a new name 'y_pred' to 'proba'
data.columns = ['y', 'y_pred']

print(data.y_pred.value_counts())
data.head()
```

```
0    9806
1     294
Name: y_pred, dtype: int64
```

Out[52]:

| | y | y_pred |
|---|---|---|
| **0** | 0.0 | 0 |
| **1** | 0.0 | 0 |
| **2** | 0.0 | 0 |
| **3** | 0.0 | 0 |
| **4** | 0.0 | 0 |

In [53]:

```
def Confusion_Matrix(data_frame, label1, label2):
    counter = 0
    for i in range(0, len(data_frame)):
        if data_frame.y[i] == label1 and data_frame.y_pred[i] == label2:
            counter += 1
    return counter
```

In [57]:

```
#Computing Confusion Matrix Parameter (TP,TN,FN,FP) for each threshold column
TP = Confusion_Matrix(data, 1, 1)
TN = Confusion_Matrix(data, 0, 0)
FN = Confusion_Matrix(data, 1, 0)
FP = Confusion_Matrix(data, 0, 1)


print("True Positive ",TP)
print("True Negative ",TN)
print("False Positive ",FP)
print("False Negative ",FN)
```

```
True Positive  55
True Negative  9761
False Positive  239
```

False Positive  239
False Negative  45

In [58]:

```
#Creating Confusion-Matrix
Confusion_Matrix = [[TN,FN], [FP,TP]]
Confusion_Matrix
```

Out[58]:

```
[[9761, 45], [239, 55]]
```

# 2.Compute F1 Score

In [59]:

```
#Calculating Precision
Precision = TP/(TP+FP)

#Calculating Recall
Recall = TP/(TP+FN)

print("Precision ",Precision)
print("Recall ", Recall)

#Calculating F1-Score
F1_Score = 2*(Precision*Recall)/(Precision+Recall)

print("F1-Score ",F1_Score)
```

```
Precision  0.1870748299319728
Recall  0.55
F1-Score  0.2791878172588833
```

# 3.Computing AUC Score

In [61]:

```
data = pd.read_csv('5_b.csv')
data.head()
```

Out[61]:

| | 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 [62]:

```
#computing different thresholds and merging the labels based on that threshhold to the data
Threshold = set()
Threshold = sorted(data.proba,reverse=True)

for i in Threshold:
    lst = []
    for val in data.proba:
        if val < i:
            lst.append(0)
        else:
            lst.append(1)
    data['Threshold '+str(i)] = lst
```

```
#Printing first 5 values of the data
data.head()
```

Out[62]:

| | y | proba | Threshold 0.5952941839776669 | Threshold 0.5948084022757003 | Threshold 0.5921978708413235 | Threshold 0.5901714464524004 | Threshold 0.5887181867417832 | Th 0.585174669 |
|---|---|---|---|---|---|---|---|---|
| **0** | 0.0 | 0.281035 | 0 | 0 | 0 | 0 | 0 | |
| **1** | 0.0 | 0.465152 | 0 | 0 | 0 | 0 | 0 | |
| **2** | 0.0 | 0.352793 | 0 | 0 | 0 | 0 | 0 | |
| **3** | 0.0 | 0.157818 | 0 | 0 | 0 | 0 | 0 | |
| **4** | 0.0 | 0.276648 | 0 | 0 | 0 | 0 | 0 | |

5 rows × 10102 columns

In [65]:

```
#Printing a column(on a given threshold) value counts
data['Threshold '+str(0.5887181867417832)].value_counts()
```

Out[65]:

```
0    10095
1        5
Name: Threshold 0.5887181867417832, dtype: int64
```

In [66]:

```
def Confusion_Matrix(data_frame, label1,label2):
    lst = []
    for thresh in Threshold:
        counter = 0
        for i in range(0,len(data_frame)):
            if data_frame.y[i] == label1 and data_frame['Threshold '+str(thresh)][i] == label2:
                counter +=1
        lst.append(counter)
    return lst
```

In [67]:

```
#Computing Confusion Matrix Parameter (TP,TN,FN,FP) for each threshold column
TP = Confusion_Matrix(data, 1, 1)
TN = Confusion_Matrix(data, 0, 0)
FN = Confusion_Matrix(data, 1, 0)
FP = Confusion_Matrix(data, 0, 1)


print("True Positive's ",TP[:10])
print("True Negative's ",TN[:10])
print("False Positive's ",FP[:10])
print("False Negative's ",FN[:10])
```

```
True Positive's  [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
True Negative's  [10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000, 10000]
False Positive's  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
False Negative's  [99, 98, 97, 96, 95, 94, 93, 92, 91, 90]
```

In [68]:

```
def TPR_FPR_Calculator(arg1,arg2):
    lst = []
    for i in range(0, len(arg1)):
        lst.append(arg1[i]/(arg1[i]+arg2[i]))
    return lst
```

In [69]:

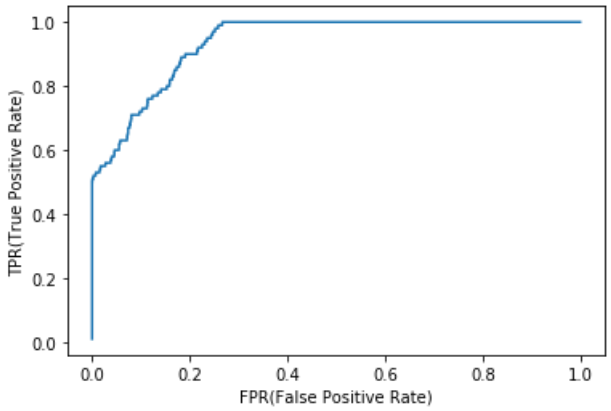
```
#Computing TPR & FPR values for each threshold column
TPR = TPR_FPR_Calculator(TP,FN)
FPR = TPR_FPR_Calculator(FP,TN)

print("True Positive Rate's :- ",TPR[:10])
print("False Positive Rate's :- ",FPR[:10])
```

```
True Positive Rate's :-  [0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.1]
False Positive Rate's :-  [0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0]
```

In [70]:

```
#plotting the TPR and FPR
import matplotlib.pyplot as plt
plt.plot(FPR,TPR)
plt.xlabel("FPR(False Positive Rate)")
plt.ylabel("TPR(True Positive Rate)")
plt.show()
```




In [71]:

```
#Computing AUC Score
print("The AUC score is :-",np.trapz(TPR, FPR))
```

```
The AUC score is :- 0.9377570000000001
```

# 4.Computing Accuracy

In [60]:

```
#Calculating Accuracy
Accuracy = (TP+TN)/(TP+TN+FP+FN)
print("Accuracy Score :- ",Accuracy)
```

```
Accuracy Score :-  0.9718811881188119
```

**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: $y^{pred}= \text{[0 if y_score < threshold else 1]}$

$ 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 [3]:

```
data = pd.read_csv('5_c.csv')
```

```
print(data.y.value_counts())
data.head()
```

```
0    1805
1    1047
Name: y, dtype: int64
```

Out[3]:

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

In [5]:

```
#computing different thresholds and merging the labels based on that threshhold to the data
Threshold = set()
Threshold = sorted(data.prob,reverse=True)

for i in Threshold:
    lst = []
    for val in data.prob:
        if val < i:
            lst.append(0)
        else:
            lst.append(1)
    data['Threshold '+str(i)] = lst

#Printing first 5 values of the data
data.head()
```

Out[5]:

| | y | prob | Threshold 0.9577467989277196 | Threshold 0.9514369163158778 | Threshold 0.9486377939984604 | Threshold 0.9440936134070964 | Threshold 0.9411131844327256 | Thre 0.92161076697 |
|---|---|---|---|---|---|---|---|---|
| **0** | 0 | 0.458521 | 0 | 0 | 0 | 0 | 0 | |
| **1** | 0 | 0.505037 | 0 | 0 | 0 | 0 | 0 | |
| **2** | 0 | 0.418652 | 0 | 0 | 0 | 0 | 0 | |
| **3** | 0 | 0.412057 | 0 | 0 | 0 | 0 | 0 | |
| **4** | 0 | 0.375579 | 0 | 0 | 0 | 0 | 0 | |

5 rows × 2793 columns

In [6]:

```
#Printing a column(on a given threshold) value counts
data['Threshold '+str(0.9486377939984604)].value_counts()
```

Out[6]:

```
0    2849
1       3
Name: Threshold 0.9486377939984604, dtype: int64
```

In [8]:

```
def Confusion_Matrix(data_frame, label1,label2):
    lst = []
    for thresh in Threshold:
        counter = 0
        for i in range(0,len(data_frame)):
            if data_frame.y[i] == label1 and data_frame['Threshold '+str(thresh)][i] == label2:
                counter +=1
```

```
        lst.append(counter)
    return lst
```

In [9]:

```
#Computing Confusion Matrix Parameter (TP,TN,FN,FP) for each threshold column
FN = Confusion_Matrix(data, 1, 0)
FP = Confusion_Matrix(data, 0, 1)

print("False Positive's ",FP[:10])
print("False Negative's ",FN[:10])
```

```
False Positive's  [0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
False Negative's  [1046, 1045, 1044, 1043, 1042, 1041, 1040, 1039, 1038, 1037]
```

In [11]:

```
A={}
for i in range(0, len(FP)):
    a = 500*FN[i] + 100*FP[i]
    A[Threshold[i]] = a
```

In [41]:

```
key_min = min(A.keys(), key=(lambda k: A[k]))

print("Threshold at which A is minimum ",key_min)
print('Minimum Value of A : ',A[key_min])
```

```
Threshold at which A is minimum  0.2300390278970873
Minimum Value of A :  141000
```

**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 [3]:

```
data = pd.read_csv('5_d.csv')
data.head()
```

Out[3]:

| | 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 |

# 1. Compute Mean Square Error

In [9]:

```
Mean_Square_Error = sum((data.y-data.pred)**2)/len(data)
print("Mean_Square_Error :- ",Mean_Square_Error)
```

```
Mean_Square_Error :-  177.16569974554707
```

# 2. Compute MAPE

In [28]:

```
MAPE = sum(abs(data.pred-data.y))/sum(data.y)
#OR WE CAN WRITE MAPE AS BELOW TWO LINES OF CODE BUT I HAVE COMMENTED IT
#APE = abs(data.pred-data.y)/(np.mean(data.y))
#MAPE = np.mean(APE)
print("Mean Absolute Percentage Error :- ",MAPE)
```

```
Mean Absolute Percentage Error :-  0.1291202994009687
```

# 3. Compute R^2 error

In [13]:

```
SS_total = sum((data.y-(np.mean(data.y)))**2)/len(data)
#R-Squared
R_Squared = 1-(Mean_Square_Error/SS_total)
print("R-Squred is : ",R_Squared)
```

```
R-Squred is :  0.9563582786990964
```