Compute performance metrics for the given Y and Y_score without sklearn

```
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 poi
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 eacl
4. Compute Accuracy Score

```
# write your code here
from google.colab import files
files=files.upload()
```

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Saving 5_a.csv to 5_a.csv

```
#Note 2: use pandas or numpy to read the data from 5_a.csv
sample_data= pd.read_csv('5_a.csv')
sample_data.head(10)
```

	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
5	1.0	0.601600
6	1.0	0.666323
7	1.0	0.567012
8	1.0	0.650230
9	1.0	0.829346

```
sample_data.describe()
```

	y	proba
count	10100.000000	10100.000000
mean	0.990099	0.697493
std	0.099015	0.114336
min	0.000000	0.500019
25%	1.000000	0.600532
50%	1.000000	0.697013
75%	1.000000	0.793915
max	1.000000	0.899965

```
#Note 1: in this data you can see number of positive points >> number of negatives points
sum_of_positive_points=sum(sample_data['proba']>0.5)
sum_of_positive_points
```

```
10100
```

```
#Note 3: you need to derive the class labels from given score
#ypred=[0 if y_score < 0.5 else 1], thresh_hold=0.5

def predict(data,y,thresh_hold):
  y_hat=[]
  for label in data[y]:
    if label<thresh_hold:
      y_hat.append(0)
    else:
      y_hat.append(1)
  return y_hat
```

```
# 1. Compute confusion matrix:

def parameters(data,y,y_hat):
  tp=0
  tn=0
  fn=0
  fp=0
  for para1,para2 in enumerate(data['y']):
    if(data.y_hat[para1]==1) and data.y[para1]==1:
      tp=tp+1
    if(data.y_hat[para1]==0) and data.y[para1]==0:
      tn=tn+1
    if(data.y_hat[para1]==0) and data.y[para1]==1:
      fn=fn+1
    if(data.y_hat[para1]==1) and data.y[para1]==0:
      fp=fp+1
  return {'tn':tn,'tp':tp,'fn':fn,'fp':fp}



thresh_hold=0.5
sample_data['y_hat']=predict(sample_data,'proba',thresh_hold)
confusion_matrix=parameters(sample_data,'y','y_hat')
confusion_matrix
```

```
{'fn': 0, 'fp': 100, 'tn': 0, 'tp': 10000}
```

```
 #2.Compute F1 Score:


x=sample_data.y
P=x[1]
z=sample_data.proba

precision= confusion_matrix['tp']/(confusion_matrix['tp']+confusion_matrix['fp'])
recall= confusion_matrix['tp']/(confusion_matrix['fn']+confusion_matrix['tp'])
f1_score=(2*precision*recall)/(precision+recall)
f1_score
```

```
0.9950248756218906
```

```
# Accuracy
Acc=(confusion_matrix['tp']+confusion_matrix['tn'])/sample_data.shape[0]
print('the accuracy is: ',Acc)
sample_data
```

```
the accuracy is:  0.9900990099009901
```

	y	proba	y_hat
1664	1.0	0.899965	1
2099	1.0	0.899828	1
1028	1.0	0.899825	1
9592	1.0	0.899812	1
8324	1.0	0.899768	1
...	...	...	...
8294	1.0	0.500081	1

```
from tqdm import tqdm  # purpose of import tqdm is to just see progress
def auc(df):
  s = df['y'].value_counts()
  P = s[1]
  N = s[0]
  tpr = []
  fpr = []

  for i in tqdm(df['proba']):
    df['y_hat']=predict(df,'proba',i)
    confusion_matrix=parameters(df,'y','y_hat')
    tpr.append(confusion_matrix['tp']/P)
    fpr.append(confusion_matrix['fp']/N)
    df.drop(columns=['y_hat'])
  return np.trapz(tpr,fpr)


sample_data=sample_data.sort_values(by='proba',ascending=False)
sample_data.drop(columns=['y_hat'])
```

y **proba**

```
from tqdm import tqdm
AUC_score=auc(sample_data)
print ('the AUC Score is :',AUC_score)
```

```
100%|██████████| 10100/10100 [1:54:17<00:00,  1.47it/s]the AUC Score is : 0.48829900(
```

```
#comparing with sklearn: ref: https://scikit-learn.org/stable/modules/generated/sklearn.me

from sklearn.metrics import roc_auc_score
sklearn_roc_auc_score = roc_auc_score(x, y)
sklearn_roc_auc_score
```

```
0.48829900000000004
```

10100 rows × 2 columns

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 poi
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 eacl
4. Compute Accuracy Score

```
#Compute Confusion Matrix:
```

```
import numpy as np
```

```
import pandas as pd


# write your code here
from google.colab import files
files=files.upload()
```

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Saving 5_b.csv to 5_b.csv

```
df2= pd.read_csv("5_b.csv")
df2
```

	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
...	...	...
10095	0.0	0.474401
10096	0.0	0.128403
10097	0.0	0.499331
10098	0.0	0.157616
10099	0.0	0.296618

10100 rows × 2 columns

```
print(df2.shape)
df2.head(10)
```

```
(10100, 2)
```

	y	proba
0	0.0	0.281035

```
df2['y_pred'] = np.where(df2['proba'] >= 0.5, float(1), float(0))
df2.head()
```

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

```
# print(df2.to_numpy())
actual_y_train_arr = df2.iloc[:, 0].values
print('actual_y_train_arr ', actual_y_train_arr)

predicted_y_arr = df2.iloc[:, 2].values
print('predicted_y_arr ', predicted_y_arr)

y_proba = df2.iloc[:, 1].values
```

```
actual_y_train_arr  [0. 0. 0. ... 0. 0. 0.]
predicted_y_arr  [0. 0. 0. ... 0. 0. 0.]
```

```
#Compute Confusion Matrix:

def confusion_matrix(true_y_classes_array, predicted_y_classes_array):

  unique_classes = np.unique(true_y_classes_array)
  # For a binary class the above will give [0 1] numpy array

  # But the challenge here asks that the top left will be 'True Positive' so, reverse the

  unique_classes = unique_classes[::-1]

  # initialize a matrix with zero values that will be the final confusion matrix
  # For the binary class-label dataset, this confusion matrix will be a 2*2 square matrix
  confusion_matrix = np.zeros((len(unique_classes), len(unique_classes)))

  for i in range(len(unique_classes)):
    for j in range(len(unique_classes)):
      confusion_matrix[i, j] = np.sum((true_y_classes_array == unique_classes[j]) & (predi

  return confusion_matrix

confusion_matrix_5_b = confusion_matrix(actual_y_train_arr, predicted_y_arr)
print(confusion_matrix_5_b)
```

```
true_negative, false_positive, false_negative, true_positive = int(confusion_matrix_5_b[1]
```

```
[[  55.  239.]
 [  45. 9761.]]
```

```
print("tp:",true_positive,'|' 'tn:',true_negative, "|" 'fp:',false_positive, "|" "fn:",fal
```

```
tp: 55 |tn: 9761 |fp: 239 |fn: 45
```

```
# Testing my custom confusion_matrix result with scikit-learn
from sklearn.metrics import confusion_matrix
sklearn_confustion_matrix = confusion_matrix(actual_y_train_arr, predicted_y_arr)
print(sklearn_confustion_matrix)
```

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

```
# the below function will work only for binary confusion matrix

tn=true_negative
fp=false_positive
fn=false_negative
tp=true_positive

precision = tp / (tp + fp)
recall = tp/ (tp + fn)

f1_score = (2 * (precision * recall)) / (precision + recall )


accuracy_score = (tp + tn)/df2.shape[0]

   # return f1_score, accuracy_score

print("F1_score:", f1_score)
print("Accuracy Score:", accuracy_score )
```

```
F1_score: 0.2791878172588833
Accuracy Score: 0.9718811881188119
```

```
#Verify F1 score & Accuracy:

from sklearn.metrics import f1_score
from sklearn.metrics import accuracy_score

sklearn_f1_score = f1_score(actual_y_train_arr, predicted_y_arr)
print('sklearn_f1_score ', sklearn_f1_score)

sklearn_accuracy_score = accuracy_score(actual_y_train_arr, predicted_y_arr)
print('sklearn_accuracy_score ', sklearn_accuracy_score)
```

```
sklearn_f1_score  0.2791878172588833
sklearn_accuracy_score  0.9718811881188119
```

```
def get_single_tpr_fpr(df):

    '''
    Note, this implementation is only for binaly class labels (0 and 1)
    :param df: the dataframe should have 'y' and 'y_predicted' as its labels
    :return: a list containing tpr and fpr
    '''

    tp = ((df['y'] == 1.0 ) & (df['y_predicted'] == 1)).sum()
    fp = ((df['y'] == 0.0 ) & (df['y_predicted'] == 1)).sum()
    tn = ((df['y'] == 0.0 ) & (df['y_predicted'] == 0)).sum()
    fn = ((df['y'] == 1.0 ) & (df['y_predicted'] == 0)).sum()

    tpr = tp / (tp + fn )
    fpr = fp / (fp + tn)

    return [tpr, fpr]


def calculate_all_thresholds_tpr_fpr_arr(df_original):

    '''

    :param df_original: the original dataframe, which should have a 'proba' label
    :return: two arrays, tpr_arr_for_all_thresholds, fpr_arr_for_all_thresholds
    '''

    tpr_arr_for_all_thresholds = []
    fpr_arr_for_all_thresholds = []

    sorted_df = df_original.sort_values(by=['proba'], ascending=False)

    unique_probability_thresholds = sorted_df['proba'].unique()

    for threshold in tqdm(unique_probability_thresholds):
        sorted_df['y_predicted'] = np.where(sorted_df['proba'] >= threshold, 1, 0)
        tpr_fpr_arr = get_single_tpr_fpr(sorted_df)
        tpr_arr_for_all_thresholds.append(tpr_fpr_arr[0])
        fpr_arr_for_all_thresholds.append(tpr_fpr_arr[1])

    return tpr_arr_for_all_thresholds, fpr_arr_for_all_thresholds


from tqdm import tqdm
all_tpr_together_5_b, all_fpr_together_5_b = calculate_all_thresholds_tpr_fpr_arr(df2)
auc_score_5_b = np.trapz(all_tpr_together_5_b, all_fpr_together_5_b)
print('ROC-AUC Score for df2: ', auc_score_5_b)
```

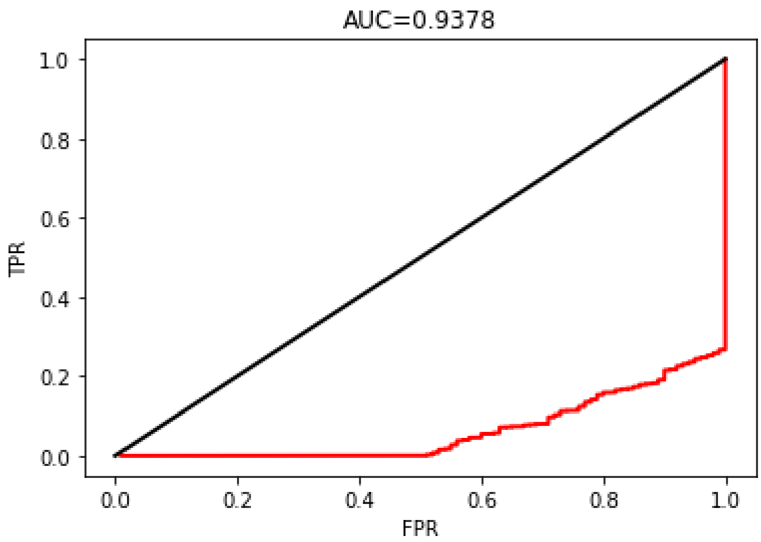
```
100%|██████████| 10100/10100 [00:43<00:00, 230.35it/s]ROC-AUC Score for df2:  0.9377
```

```
from sklearn.metrics import roc_auc_score
sklearn_roc_auc_score = roc_auc_score(actual_y_train_arr, y_proba)
print('sk-learn roc_auc_score for df2: ', sklearn_roc_auc_score)
```

```
sk-learn roc_auc_score for 5_a.csv:  0.9377570000000001
```

```
#Plot AUC ROC Curve:
import matplotlib.pyplot as plt
plt.plot(all_tpr_together_5_b, all_fpr_together_5_b, 'r', lw=2)
plt.plot([0, 1], [0, 1], 'k-', lw=2)
plt.xlabel('FPR')
plt.ylabel('TPR')
plt.title('AUC={}'.format(round(auc_score_5_b, 4)))
```

```
Text(0.5, 1.0, 'AUC=0.9378')
```



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

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

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

```
 # write your code:
import numpy as np
import pandas as pd


from google.colab import files
files=files.upload()
```

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```
df3=pd.read_csv("5_c.csv")
df3.head(10)
```

	y	prob
0	0	0.458521
1	0	0.505037
2	0	0.418652
3	0	0.412057
4	0	0.375579
5	0	0.595387
6	0	0.370288
7	0	0.299273
8	0	0.297000
9	0	0.266479

```
df3.describe()
```

	y	prob
count	2852.000000	2852.000000
mean	0.367111	0.370069
std	0.482102	0.207414
min	0.000000	0.028038
25%	0.000000	0.201460
50%	0.000000	0.336935
75%	1.000000	0.509001
max	1.000000	0.957747

```
sum_of_negative_points=sum(df3['y']==0)
print("No._of_negative_points:", sum_of_negative_points)

sum_of_positive_points=sum(df3['y']==1)
print("No._of_positive_points:", sum_of_positive_points)
```

```
No._of_negative_points: 1805
No._of_positive_points: 1047
```

```
actual_y_train_df3 = df3.iloc[:, 0].values
print('actual_y_train_app_5_c ', actual_y_train_5_c)
```

```
print('actual_y_train_arr_5_c ', actual_y_train_5_c)

y_proba_df3 = df3.iloc[:, 1].values
print('y_proba_5_c ', y_proba_5_c)

unique_probability_thresholds_df3= np.unique(df3['prob'])
```

```
actual_y_train_arr_5_c  [0 0 0 ... 1 1 1]
y_proba_5_c  [0.45852068 0.50503693 0.41865174 ... 0.65916054 0.45626546 0.65916054]
```

```
# compute the value of A

def get_A_metric(y_actual, y_prob, threshold):
    tp = 0
    fp = 0
    tn = 0
    fn = 0

    min_a = float('inf')

    for i in range(len(y_prob)):
        if y_prob[i] >= threshold:
            if y_actual[i] == 1:
                tp = tp+1
            else:
                fp =fp+1

        if y_prob[i] < threshold:
            if y_actual[i] == 0:
                tn = tn+1
            else:
                fn = fn+1

    A = (500 * fn) + (100 * fp)

    return A


#compute minimum value of A and also the corresponding threshold

def minimized(y_actual, y_prob, total_thresholds ):
  min_a = float('inf')
  min_t = 0

  for threshold in total_thresholds:
    a = get_A_metric(y_actual, y_prob, threshold)
    if a <= min_a:
        min_a = min(a, min_a)
        min_t = threshold

  return min_a, min_t


print(minimized(actual_y_train_df3, y_proba_df3, unique_probability_thresholds_df3))
```

```
(141000, 0.2300390278970873)
```

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 featu

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_determi

```
# write your code:
import numpy as np
import pandas as pd


from google.colab import files
files=files.upload()
```

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```
Saving 5_d.csv to 5_d.csv
```

```
df4=pd.read_csv("5_d.csv")
df4.head(10)
```

	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
5	133.0	153.0
6	148.0	139.0
7	172.0	145.0
8	153.0	162.0
9	162.0	154.0

```
# (df4.to_numpy()) convert to array so that I can apply numpy function

actual_y_df4= df4.iloc[:, 0].values
print('actual_y_arr_df4', actual_y_df4)

predicted_y_df4 = df4.iloc[:, 1].values
print('predicted_y_arr_df4 ', predicted_y_df4)
```

```
actual_y_arr_df4 [101. 120. 131. ... 106. 105.  81.]
predicted_y_arr_df4  [100. 100. 113. ...  93. 101. 104.]
```

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

def r2_score(y_t, y_predicted):
    y_avg = y_t.mean()     # y_avg = np.mean(y_t)

    sum_squared_res = ((y_t - y_predicted)**2).sum()
    sum_squared_total = ((y_t - y_avg)**2).sum()
    return 1 - (sum_squared_res/sum_squared_total)

h=print(r2_score(actual_y_df4, predicted_y_df4))
h
```

```
0.9563582786990937
```

```
def mse(y_actual, y_predicted):
    mse = np.mean((y_actual - y_predicted)**2)
    return mse

print(mse(actual_y_df4, predicted_y_df4))
```

```
177.16569974554707
```

```
def mean_absolute_percentage_error(y_actual, y_predicted):
    mape = np.mean((np.abs(y_actual - y_predicted)) / np.mean(y_actual)) * 100
    return mape

print(mean_absolute_percentage_error(actual_y_df4, predicted_y_df4))
```

```
12.912029940096867
```