modelEval

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1 CSCI6380 Data Mining: Assignment #3

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1.1.1 October 13, 2020

1.1.2 Importing Libraries

[2]:
```
from pathlib import Path
import glob
import os
import string
import pandas as pd
import numpy as np
from sklearn.metrics import confusion_matrix
from sklearn.metrics import classification_report
import sklearn.metrics as metrics
import math
import matplotlib
import matplotlib.pyplot as plt
import scipy.stats
from scipy.stats import norm,t, binom
from scipy import stats
```

1.2 Problem 1 - Calculate Classification Metrics

1.2.1 Input Data Manipulation

[3]:
```
dataA  = pd.read_csv("/Users/kivanc/DataMining-ML/Data/ModelEval/Data-A.csv",␣
 ↪header=0)

dataA = dataA[["Actual","M2"]]
#dataA.head()

conditions = [(dataA['M2'] >= 0.5) , (dataA['M2'] < 0.5)]
values = [1.0, 0.0]
```

```
dataA['Predicted'] = np.select(conditions, values)
dataA.head()
```

[3]:

	Actual	M2	Predicted
0	1.0	0.888361	1.0
1	1.0	0.842602	1.0
2	1.0	0.584694	1.0
3	1.0	0.973291	1.0
4	1.0	0.274050	0.0

1.2.2 Define the Functions

[10]:

```
def confusionMatrix (df):
    """
    Function to produce confusion matrix.
    Takes a dataframe as parameter. This
    dataframe has actual scores in one column
    and predicted scores in the second column.
    """
    conf_matrix = pd.DataFrame(np.zeros((2,2)), columns = ['Positive',␣
↪'Negative'],
                    index = ['Positive', 'Negative'])

    for row in df.itertuples(index=True, name='Pandas'):
        if (row.Actual == 1.0 and row.Predicted == 1.0):
            conf_matrix.at['Positive', 'Positive'] += 1
        if (row.Actual == 0.0 and row.Predicted == 0.0):
            conf_matrix.at['Negative', 'Negative'] += 1
        if (row.Actual == 0.0 and row.Predicted == 1.0):
            conf_matrix.at['Negative', 'Positive'] += 1
        if (row.Actual == 1.0 and row.Predicted == 0.0):
            conf_matrix.at['Positive', 'Negative'] += 1

    return conf_matrix
```

[13]:

```
def calcMetrics (conf_matrix):
    """
    Function to calculate classification
    metrics from a confusion matrix.
    """
    TP = conf_matrix.iat[0,0]
    FN = conf_matrix.iat[0,1]
    FP = conf_matrix.iat[1,0]
    TN = conf_matrix.iat[1,1]
    TP_Rate = TP/(TP+FN)
    FP_Rate = FP/(TN+FP)
    TN_Rate = TN/(TN+FP)
```

```
    FN_Rate = FN/(FN+TP)
    print("True Positive Rate:\t",TP_Rate)
    print("False Positive Rate:\t",FP_Rate)
    print("True Negative Rate:\t",TN_Rate)
    print("False Negative Rate:\t",FN_Rate)
    print('_'*30)

    # Calculate success rate
    Succ_Rate = (TP+TN)/(TP+TN+FP+FN)
    #metrics_df['Success(Accuracy)'] = Succ_Rate

    # Calculate precision
    Precision = TP/(TP+FP)
    # Calculate recall
    Recall = TP_Rate
    # Calculate F1-Score
    F1_Score = 2*(Precision * Recall)/(Precision+Recall)

    # Calculate the Matthews correlation coefficient
    MCC = ((TP*TN)-(FP*FN))/math.sqrt((TP+FP)*(TP+FN)*(TN+FP)*(TN+FN))

    # Calculate Kappa score
    Accuracy = Succ_Rate
    ## Source: https://en.wikipedia.org/wiki/Cohen's_kappa
    Exp_Accuracy = ((TP + FN) * (TP + FP) + (FP + TN) * (FN + TN)) / ((TP + TN␣
↪+ FP + FN)**2)
    Kappa_Score = (Accuracy - Exp_Accuracy)/(1 - Exp_Accuracy)

    metrics_data= [[Succ_Rate, Precision, Recall, FP_Rate, F1_Score, MCC,␣
↪Kappa_Score]]
    metrics_df = pd.DataFrame(metrics_data, index=['Model Scores'], columns =␣
↪['Success(Accuracy)', 'Precision', 'Recall(TP-Rate)', 'FP-Rate', 'F1-Score',␣
↪'MCC', 'Kappa'])

    return metrics_df
```

1.2.3 Compute the Confusion Matrix

[14]:
```
## Compute the confusion matrix
cmA = confusionMatrix(dataA)
print('', 'Confusion Matrix',sep="\t")
print('_'*30)
print(cmA)
print('_'*30)
```

```
        Confusion Matrix
```

```
------------------------------
          Positive  Negative
Positive     221.0      29.0
Negative      71.0     179.0
------------------------------
```

1.2.4 Compute the Classification Metrics

[15]:
```python
## Calculate classification metrics
calcMetrics(cmA)
```

```
True Positive Rate:      0.884
False Positive Rate:     0.284
True Negative Rate:      0.716
False Negative Rate:     0.116
------------------------------
```

[15]:
```
              Success(Accuracy)  Precision  Recall(TP-Rate)  FP-Rate  \
Model Scores                0.8   0.756849            0.884    0.284

              F1-Score       MCC  Kappa
Model Scores  0.815498  0.608651    0.6
```

1.3 Problem 2 - Generating an ROC curve

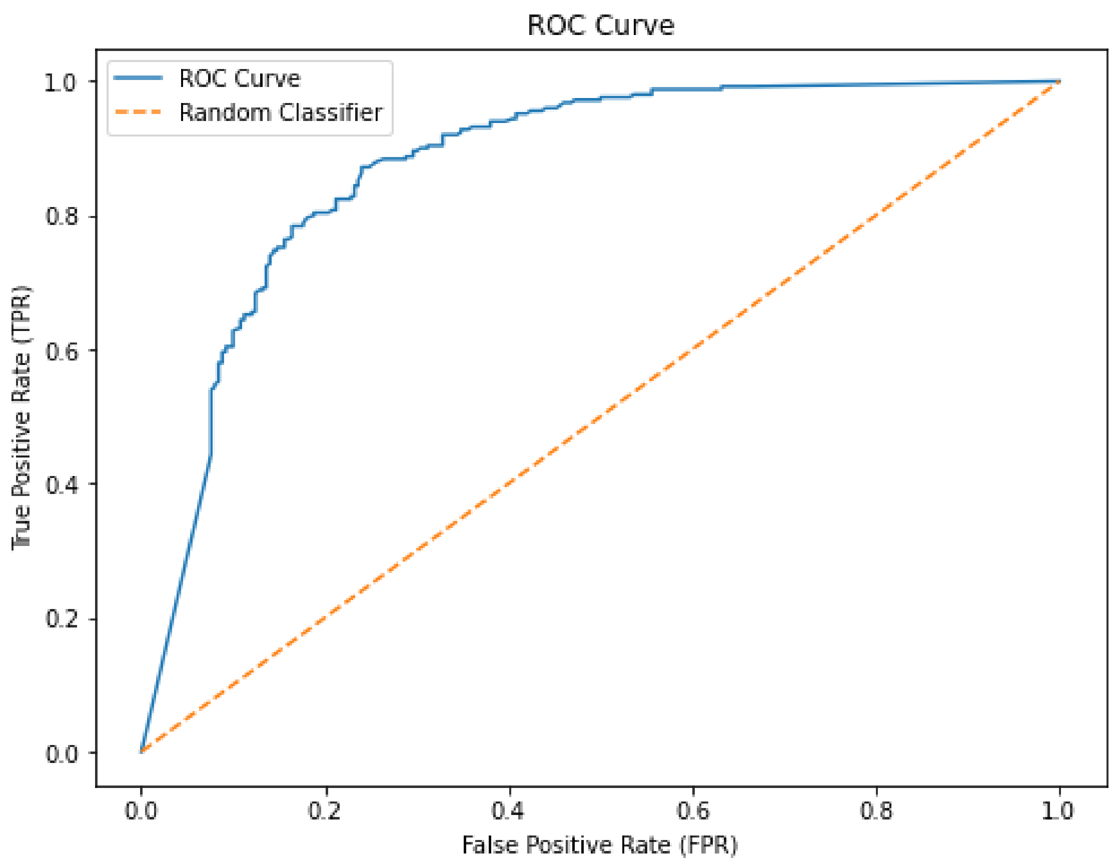
1.3.1 Define the Functions

[18]:
```python
def make_ROC(data_actual, data_predict):
    """
    Function to compute ROC. Takes two
    parameters: first is actual scores,
    and second is predicted scores.
    """
    N=len(data_actual)

    TPF=[]
    FPF=[]
    threshold=0
    j=0
    increment=1/N

    while(threshold<=1.1):
        #threshold=i
        TP, FP, TN, FN = 0, 0, 0, 0
        # Accumulate the true/false negative/positives
        for j in range(N):
```

```
            if data_actual[j]==1:
                if data_predict[j]>=threshold:
                    TP+=1
                else:
                    FN+=1
            if data_actual[j]==0:
                if data_predict[j]>=threshold:
                    FP+=1
                else:
                    TN+=1

        # Calcualate true positive rate for current threshold.
        TP_Rate=TP/(TP + FN)

        # Calcualate false positive rate for current threshold.
        FP_Rate=FP/(FP + TN)

        TPF.append(TP_Rate)
        FPF.append(FP_Rate)

        threshold+=increment

    return TPF, FPF

def plot_ROC(data_actual, data_predict):
    """
    Function to make ROC curve plot. Takes false
    positive rate and true positive rates list as
    parameters.
    """
    # Get True Positive Rate and False Positive Rate lists
    TPF, FPF = make_ROC(data_actual, data_predict)
    # Plot the ROC curve
    fig = plt.figure(figsize=(8,6))
    plt.title('ROC Curve')
    plt.plot(FPF, TPF, label='ROC Curve')
    plt.plot([0, 1], ls="--", label='Random Classifier')
    plt.xlabel('False Positive Rate (FPR)')
    plt.ylabel('True Positive Rate (TPR)')
    plt.legend()
    plt.show()
```

1.3.2 Compute and Plot the ROC

[19]:
```
## Input data manipulation
dataA_actual = np.asarray(dataA['Actual'])
dataA_M2 = np.asarray(dataA['M2'])

## Plot the ROC curve
plot_ROC(dataA_actual, dataA_M2)
```



1.4 Problem 3 - Performing t-test

1.4.1 Define the Functions

[22]:
```
def std_dev(data):
    """
    Function to calculate standard devaiation
    from a given data.
    """
    n = len(data)
```

```
    mean_data = sum(data)/n
    sum_of_square = 0
    for i in data:
        sum_of_square += (i-mean_data)**2
    sigsq = sum_of_square/(n-1)
    stdv = math.sqrt(sigsq)
    return stdv

def paired_ttest(data1, data2):
    """
    Function to perform independent two-sample
    t-test on two datasets. This function also
    calculates the p-value for hypothesis testing.
    """

    # Get means of eacg dataset
    mean_data1 = sum(data1)/len(data1)
    mean_data2 = sum(data2)/len(data2)

    # Get standard deviations of each dataset
    sd_data1 = std_dev(data1)
    sd_data2 = std_dev(data2)

    # standard error of the difference between two means
    ## Source: https://en.wikipedia.org/wiki/
↪Student%27s_t-test#Independent_two-sample_t-test
    SE_mean_d1_d2 = math.sqrt(sd_data1**2.0/len(data1) + sd_data2**2.0/
↪len(data2))
    # Calculate t-statistic
    t_stat = (mean_data1 - mean_data2)/SE_mean_d1_d2

    # Calculate degree of freedom
    df = len(data1) + len(data1) - 2

    # Calcualte p-value using "survival function"
    ## Source: https://docs.scipy.org/doc/scipy/reference/tutorial/stats.
↪html#t-test-and-ks-test
    p_val = stats.t.sf(np.abs(t_stat), df)*2

    return t_stat, p_val


def kfold_cv_paired_ttest(data1, data2, k=10):
    """
    Function to perform K-fold cross-validated
    paired t test. This function also calculates
    the p-value for hypothesis testing.
```

```
    """
    diff = [x - y for x, y in zip(data1, data2)]
    #The mean of differences
    mean_diff = sum(diff)/len(diff)
    #The variance of differences
    sigmaS = std_dev(diff)**2
    #The number of data points used for testing
    test_size = len(data1)/k
    #The number of data points used for training
    train_size = len(data1)-test_size
    #The total number of data points
    n=len(diff)
    #Compute the corrected variance
    sigmaS_corrected = sigmaS * (1/n + test_size/train_size)
    #Compute the t_static
    t_stat =  mean_diff / math.sqrt(sigmaS_corrected)
    #Compute the p-value
    #p_val = (1.0 - t.cdf(abs(t_stat), n-1)) * 2.0
    p_val = stats.t.sf(abs(t_stat), n-1)*2.0

    return t_stat, p_val
```

1.4.2 Perform t-test

[21]:
```
## Input data manipulation
dataB = pd.read_csv("/Users/kivanc/DataMining-ML/Data/ModelEval/Data-B.csv",␣
 ↪header=0)

M1 = dataB['M1'].tolist()
M2 = dataB['M2'].tolist()

## Perform 10-fold cross-validated paired t test
t_val , p_val = kfold_cv_paired_ttest(M1,M2)

print('', ' K-fold ross-validated paired t test',sep="\t")
print('')
print("t-statistic=\t",t_val)
print("p-value=\t",p_val)
```

```
         K-fold ross-validated paired t test

t-statistic=     -0.6330134168481609
p-value=         0.5281844102370656
```