بسم الله الرحمن الرحیم

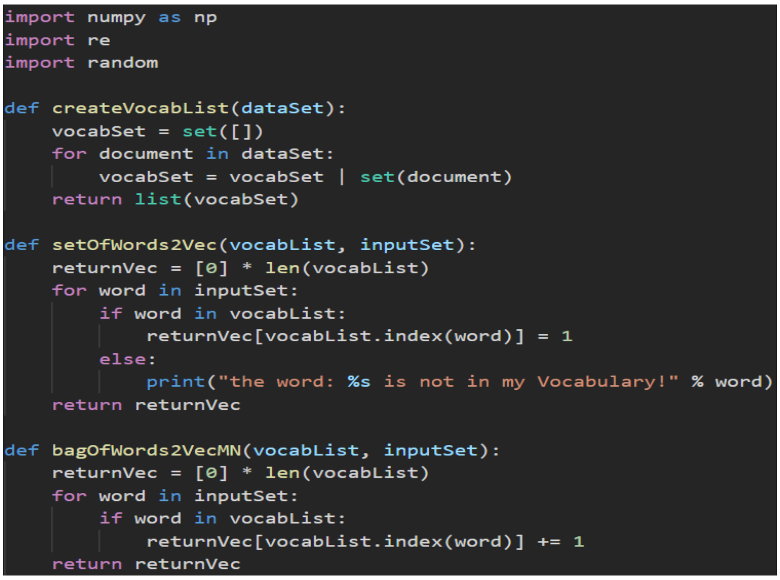
مهشید مولائی 99464114 ، دانشگاه زنجان ، استاد : سرکارخانم دکتر صفری ، تمرین : ۳مدل اول(NLP3):

Dataset:

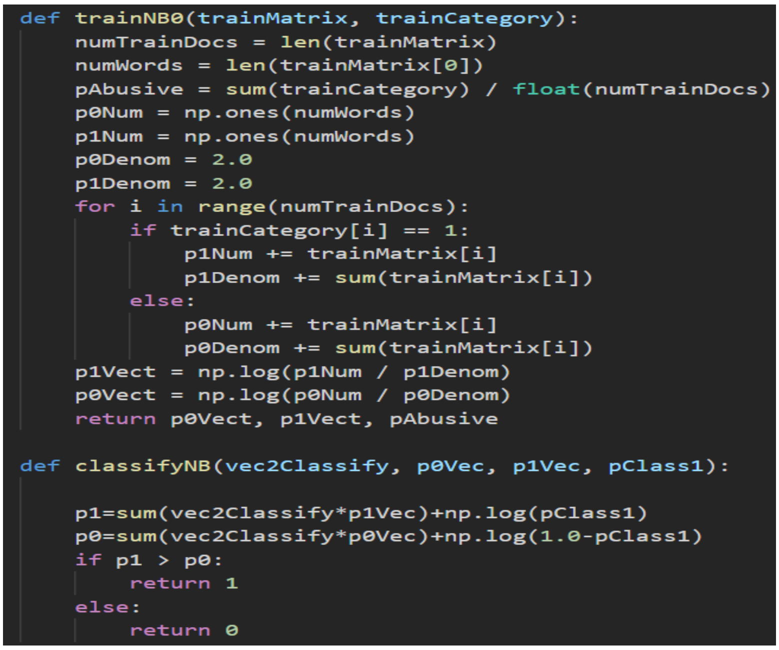
دیتاستی که استفاده کردیم دو لیبلی که داشتیم در پوشه های مجزا استخراج کردیم و اسم فایل ها را عددی تبدیل کردیم تابتواند بخوانیم.

Code:

با مدل NB مدل را آموزش دادیم و دقت تست را پیدا کردیم.

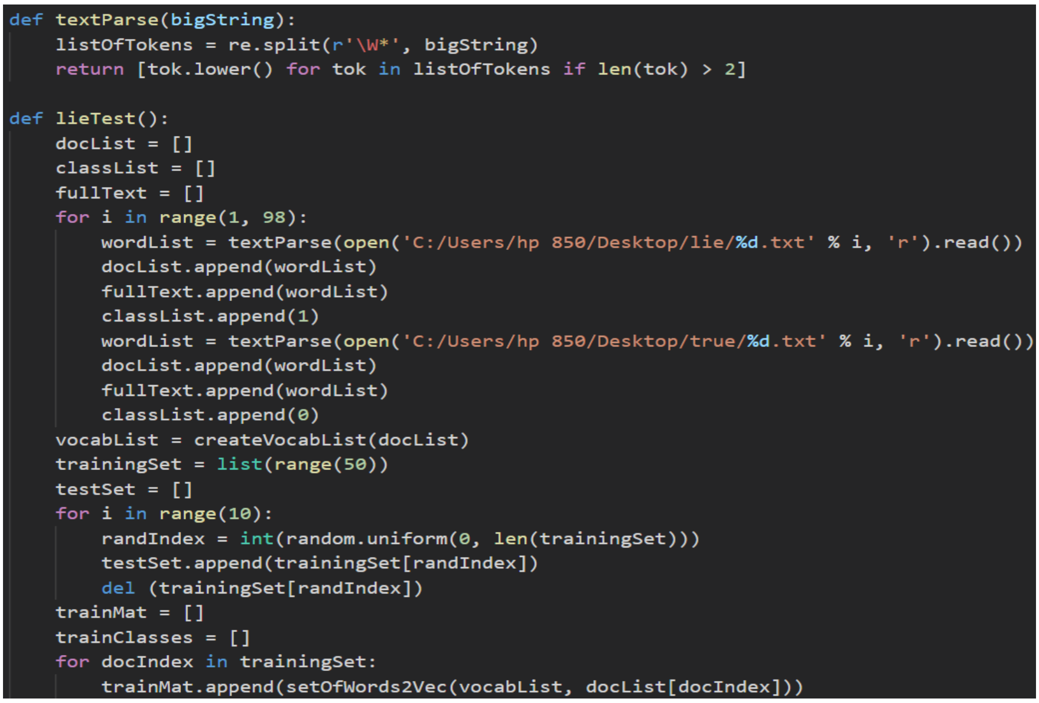


```python
import numpy as np
import re
import random

def createVocabList(dataSet):
    vocabSet = set([])
    for document in dataSet:
        vocabSet = vocabSet | set(document)
    return list(vocabSet)

def setOfWords2Vec(vocabList, inputSet):
    returnVec = [0] * len(vocabList)
    for word in inputSet:
        if word in vocabList:
            returnVec[vocabList.index(word)] = 1
        else:
            print("the word: %s is not in my Vocabulary!" % word)
    return returnVec

def bagOfWords2VecMN(vocabList, inputSet):
    returnVec = [0] * len(vocabList)
    for word in inputSet:
        if word in vocabList:
            returnVec[vocabList.index(word)] += 1
    return returnVec
```

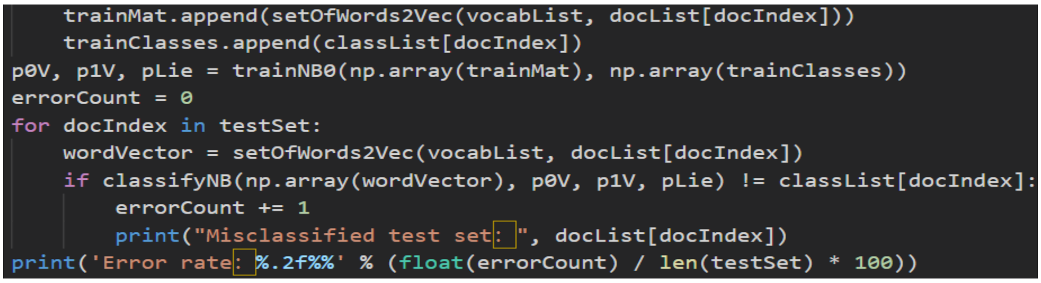


```python
def trainNB0(trainMatrix, trainCategory):
    numTrainDocs = len(trainMatrix)
    numWords = len(trainMatrix[0])
    pAbusive = sum(trainCategory) / float(numTrainDocs)
    p0Num = np.ones(numWords)
    p1Num = np.ones(numWords)
    p0Denom = 2.0
    p1Denom = 2.0
    for i in range(numTrainDocs):
        if trainCategory[i] == 1:
            p1Num += trainMatrix[i]
            p1Denom += sum(trainMatrix[i])
        else:
            p0Num += trainMatrix[i]
            p0Denom += sum(trainMatrix[i])
    p1Vect = np.log(p1Num / p1Denom)
    p0Vect = np.log(p0Num / p0Denom)
    return p0Vect, p1Vect, pAbusive

def classifyNB(vec2Classify, p0Vec, p1Vec, pClass1):

    p1=sum(vec2Classify*p1Vec)+np.log(pClass1)
    p0=sum(vec2Classify*p0Vec)+np.log(1.0-pClass1)
    if p1 > p0:
        return 1
    else:
        return 0
```

فایل هارا همان طور که در بخشdataset توضیح دادیم فراخوانی کرده ایم.

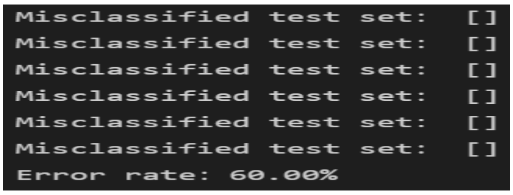


```
def textParse(bigString):
    listOfTokens = re.split(r'\W*', bigString)
    return [tok.lower() for tok in listOfTokens if len(tok) > 2]

def lieTest():
    docList = []
    classList = []
    fullText = []
    for i in range(1, 98):
        wordList = textParse(open('C:/Users/hp 850/Desktop/lie/%d.txt' % i, 'r').read())
        docList.append(wordList)
        fullText.append(wordList)
        classList.append(1)
        wordList = textParse(open('C:/Users/hp 850/Desktop/true/%d.txt' % i, 'r').read())
        docList.append(wordList)
        fullText.append(wordList)
        classList.append(0)
    vocabList = createVocabList(docList)
    trainingSet = list(range(50))
    testSet = []
    for i in range(10):
        randIndex = int(random.uniform(0, len(trainingSet)))
        testSet.append(trainingSet[randIndex])
        del (trainingSet[randIndex])
    trainMat = []
    trainClasses = []
    for docIndex in trainingSet:
        trainMat.append(setOfWords2Vec(vocabList, docList[docIndex]))
```



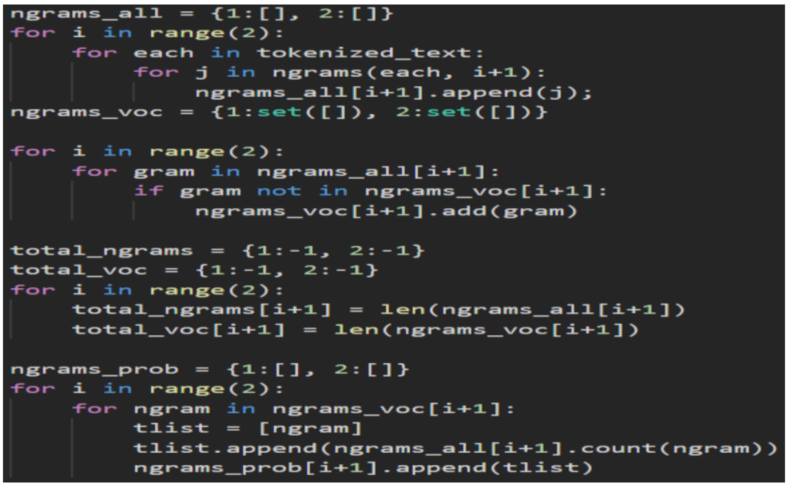
```
    trainMat.append(setOfWords2Vec(vocabList, docList[docIndex]))
    trainClasses.append(classList[docIndex])
p0V, p1V, pLie = trainNB0(np.array(trainMat), np.array(trainClasses))
errorCount = 0
for docIndex in testSet:
    wordVector = setOfWords2Vec(vocabList, docList[docIndex])
    if classifyNB(np.array(wordVector), p0V, p1V, pLie) != classList[docIndex]:
        errorCount += 1
        print("Misclassified test set: ", docList[docIndex])
print('Error rate: %.2f%%' % (float(errorCount) / len(testSet) * 100))
```

خروجی کد: این خروجی مربوط به زمانی است که نرمال سازی و توکن سازی و ... انجام نداده ایم.

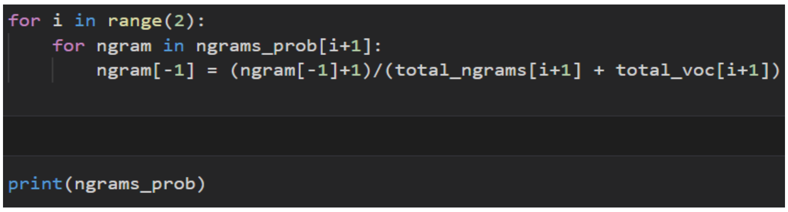


```
Misclassified test set:  []
Misclassified test set:  []
Misclassified test set:  []
Misclassified test set:  []
Misclassified test set:  []
Misclassified test set:  []
Error rate: 60.00%
```

مرحله add one است که ازشمارش صفرجلوگیری شود:

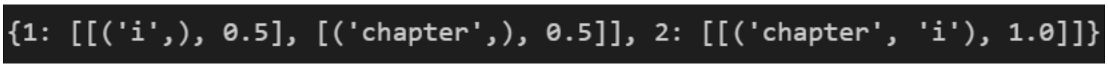


```
ngrams_all = {1:[], 2:[]}
for i in range(2):
    for each in tokenized_text:
        for j in ngrams(each, i+1):
            ngrams_all[i+1].append(j);
ngrams_voc = {1:set([]), 2:set([])}

for i in range(2):
    for gram in ngrams_all[i+1]:
        if gram not in ngrams_voc[i+1]:
            ngrams_voc[i+1].add(gram)

total_ngrams = {1:-1, 2:-1}
total_voc = {1:-1, 2:-1}
for i in range(2):
    total_ngrams[i+1] = len(ngrams_all[i+1])
    total_voc[i+1] = len(ngrams_voc[i+1])

ngrams_prob = {1:[], 2:[]}
for i in range(2):
    for ngram in ngrams_voc[i+1]:
        tlist = [ngram]
        tlist.append(ngrams_all[i+1].count(ngram))
        ngrams_prob[i+1].append(tlist)
```



```
for i in range(2):
    for ngram in ngrams_prob[i+1]:
        ngram[-1] = (ngram[-1]+1)/(total_ngrams[i+1] + total_voc[i+1])


print(ngrams_prob)
```

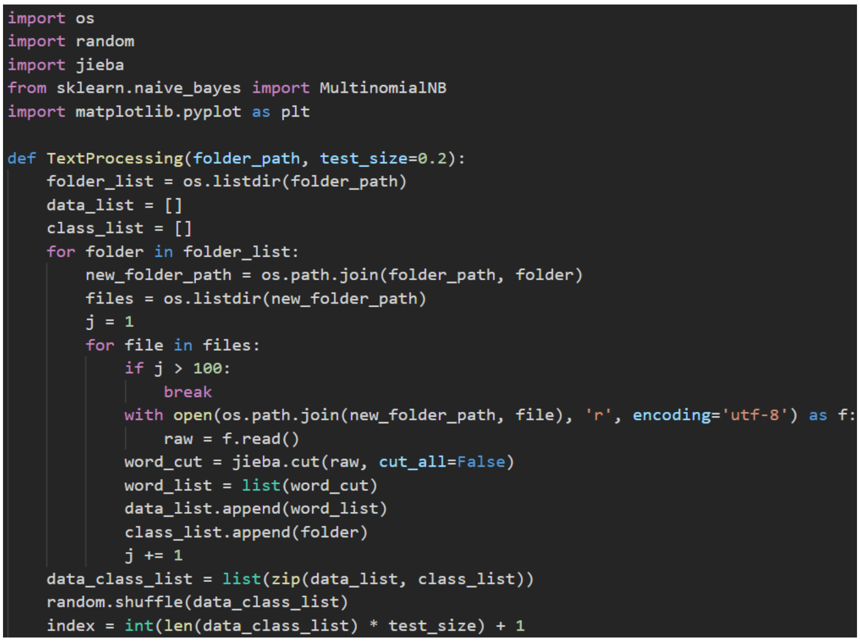
خروجی کد:



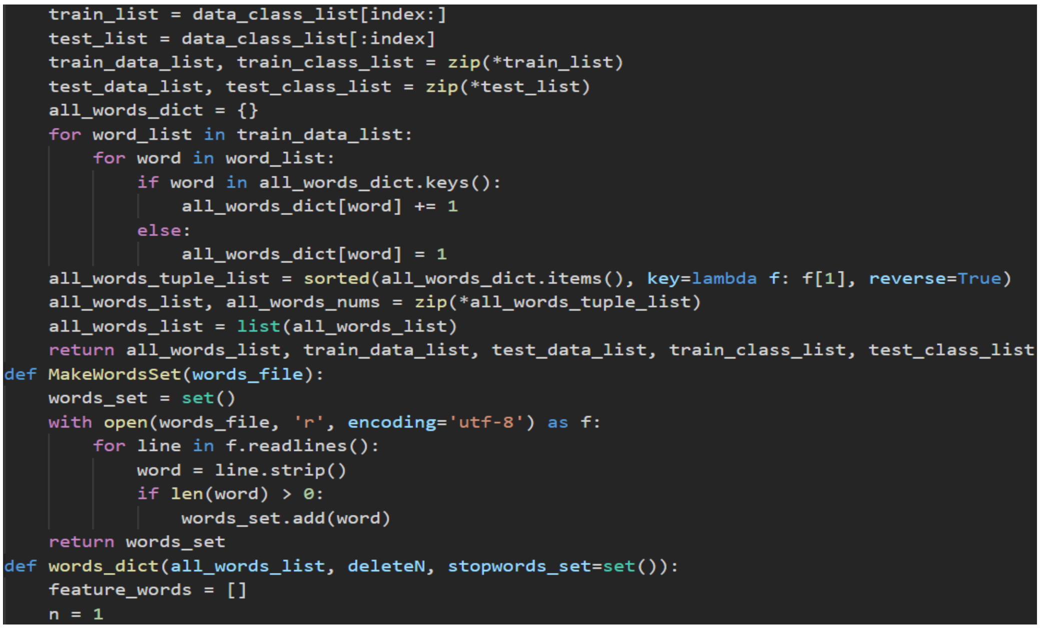
```
{1: [[('i',), 0.5], [('chapter',), 0.5]], 2: [[('chapter', 'i'), 1.0]]}
```

مدل NB دوم بازهم بدون نرمال سازی و توکن سازی و... است:

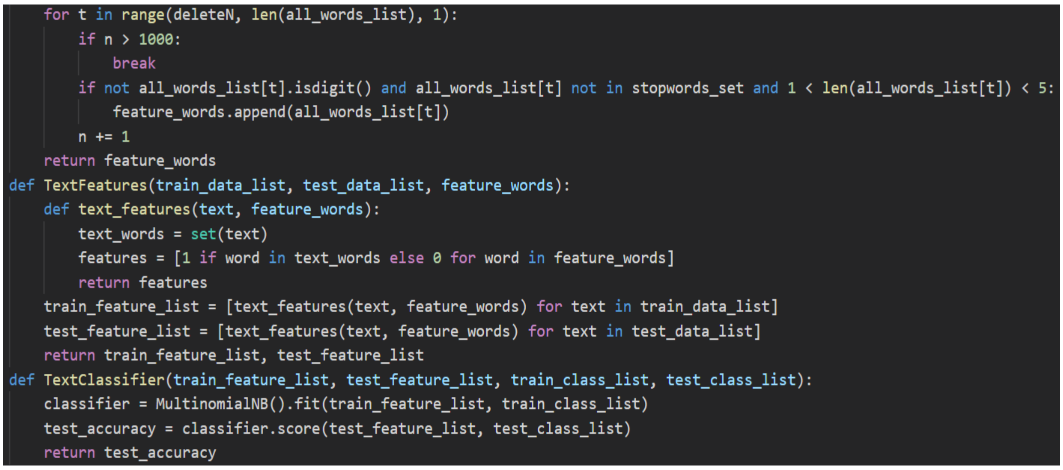
داده های این را با آدرس دهی فولدر دهی استفاده کردم. مدل را آموزش دادیم و تست آنرا محاسبه کردیم.



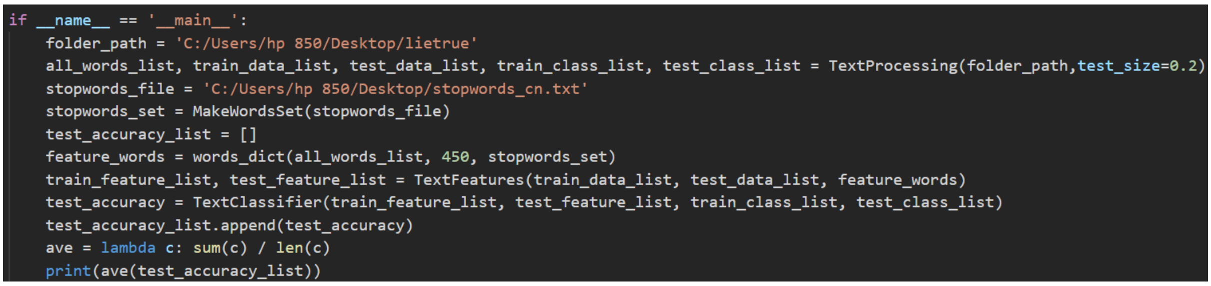
```
import os
import random
import jieba
from sklearn.naive_bayes import MultinomialNB
import matplotlib.pyplot as plt

def TextProcessing(folder_path, test_size=0.2):
    folder_list = os.listdir(folder_path)
    data_list = []
    class_list = []
    for folder in folder_list:
        new_folder_path = os.path.join(folder_path, folder)
        files = os.listdir(new_folder_path)
        j = 1
        for file in files:
            if j > 100:
                break
            with open(os.path.join(new_folder_path, file), 'r', encoding='utf-8') as f:
                raw = f.read()
            word_cut = jieba.cut(raw, cut_all=False)
            word_list = list(word_cut)
            data_list.append(word_list)
            class_list.append(folder)
            j += 1
    data_class_list = list(zip(data_list, class_list))
    random.shuffle(data_class_list)
    index = int(len(data_class_list) * test_size) + 1
```



```
    train_list = data_class_list[index:]
    test_list = data_class_list[:index]
    train_data_list, train_class_list = zip(*train_list)
    test_data_list, test_class_list = zip(*test_list)
    all_words_dict = {}
    for word_list in train_data_list:
        for word in word_list:
            if word in all_words_dict.keys():
                all_words_dict[word] += 1
            else:
                all_words_dict[word] = 1
    all_words_tuple_list = sorted(all_words_dict.items(), key=lambda f: f[1], reverse=True)
    all_words_list, all_words_nums = zip(*all_words_tuple_list)
    all_words_list = list(all_words_list)
    return all_words_list, train_data_list, test_data_list, train_class_list, test_class_list
def MakeWordsSet(words_file):
    words_set = set()
    with open(words_file, 'r', encoding='utf-8') as f:
        for line in f.readlines():
            word = line.strip()
            if len(word) > 0:
                words_set.add(word)
    return words_set
def words_dict(all_words_list, deleteN, stopwords_set=set()):
    feature_words = []
    n = 1
```

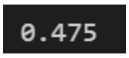


```python
    for t in range(deleteN, len(all_words_list), 1):
        if n > 1000:
            break
        if not all_words_list[t].isdigit() and all_words_list[t] not in stopwords_set and 1 < len(all_words_list[t]) < 5:
            feature_words.append(all_words_list[t])
        n += 1
    return feature_words
def TextFeatures(train_data_list, test_data_list, feature_words):
    def text_features(text, feature_words):
        text_words = set(text)
        features = [1 if word in text_words else 0 for word in feature_words]
        return features
    train_feature_list = [text_features(text, feature_words) for text in train_data_list]
    test_feature_list = [text_features(text, feature_words) for text in test_data_list]
    return train_feature_list, test_feature_list
def TextClassifier(train_feature_list, test_feature_list, train_class_list, test_class_list):
    classifier = MultinomialNB().fit(train_feature_list, train_class_list)
    test_accuracy = classifier.score(test_feature_list, test_class_list)
    return test_accuracy
```



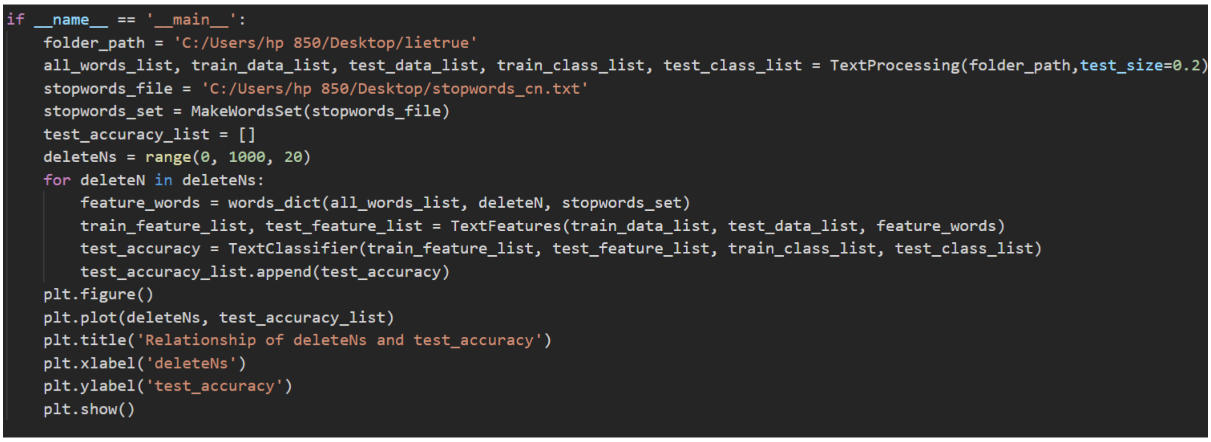
```python
if __name__ == '__main__':
    folder_path = 'C:/Users/hp 850/Desktop/lietrue'
    all_words_list, train_data_list, test_data_list, train_class_list, test_class_list = TextProcessing(folder_path,test_size=0.2)
    stopwords_file = 'C:/Users/hp 850/Desktop/stopwords_cn.txt'
    stopwords_set = MakeWordsSet(stopwords_file)
    test_accuracy_list = []
    feature_words = words_dict(all_words_list, 450, stopwords_set)
    train_feature_list, test_feature_list = TextFeatures(train_data_list, test_data_list, feature_words)
    test_accuracy = TextClassifier(train_feature_list, test_feature_list, train_class_list, test_class_list)
    test_accuracy_list.append(test_accuracy)
    ave = lambda c: sum(c) / len(c)
    print(ave(test_accuracy_list))
```

خروجی کد:

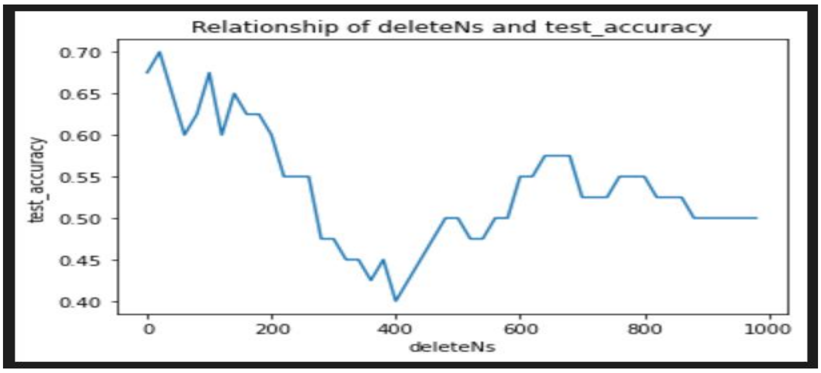


```
0.475
```

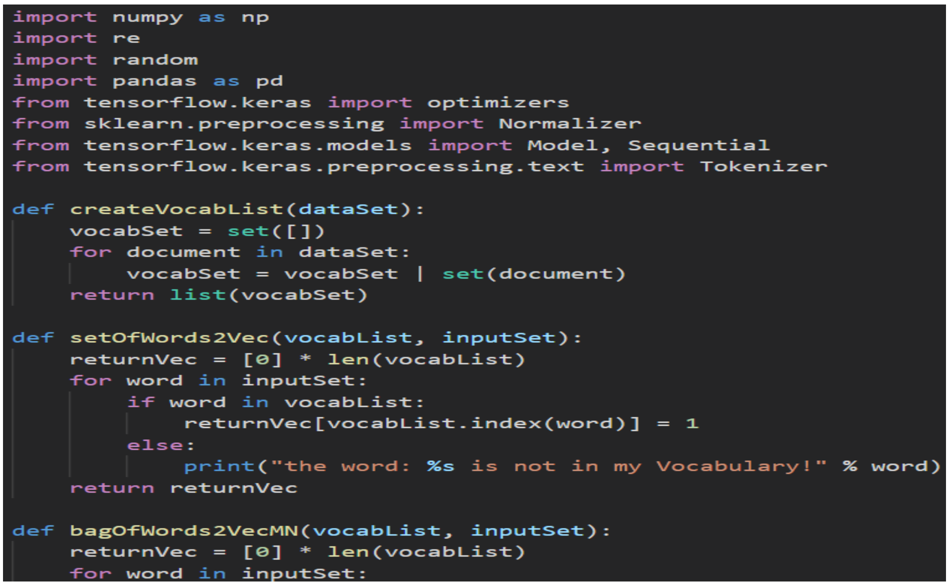
کد نمایش خروجی با نمودار:



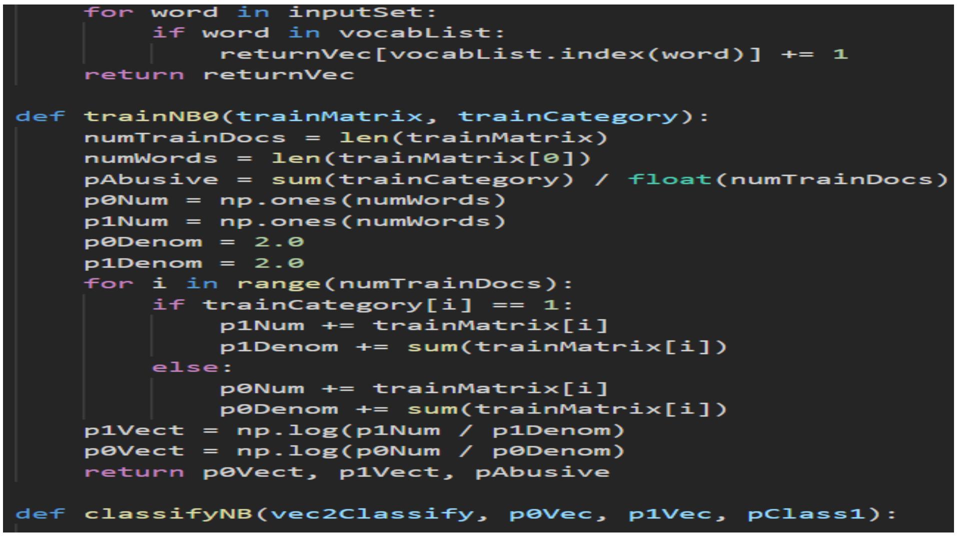
```python
if __name__ == '__main__':
    folder_path = 'C:/Users/hp 850/Desktop/lietrue'
    all_words_list, train_data_list, test_data_list, train_class_list, test_class_list = TextProcessing(folder_path,test_size=0.2)
    stopwords_file = 'C:/Users/hp 850/Desktop/stopwords_cn.txt'
    stopwords_set = MakeWordsSet(stopwords_file)
    test_accuracy_list = []
    deleteNs = range(0, 1000, 20)
    for deleteN in deleteNs:
        feature_words = words_dict(all_words_list, deleteN, stopwords_set)
        train_feature_list, test_feature_list = TextFeatures(train_data_list, test_data_list, feature_words)
        test_accuracy = TextClassifier(train_feature_list, test_feature_list, train_class_list, test_class_list)
        test_accuracy_list.append(test_accuracy)
    plt.figure()
    plt.plot(deleteNs, test_accuracy_list)
    plt.title('Relationship of deleteNs and test_accuracy')
    plt.xlabel('deleteNs')
    plt.ylabel('test_accuracy')
    plt.show()
```



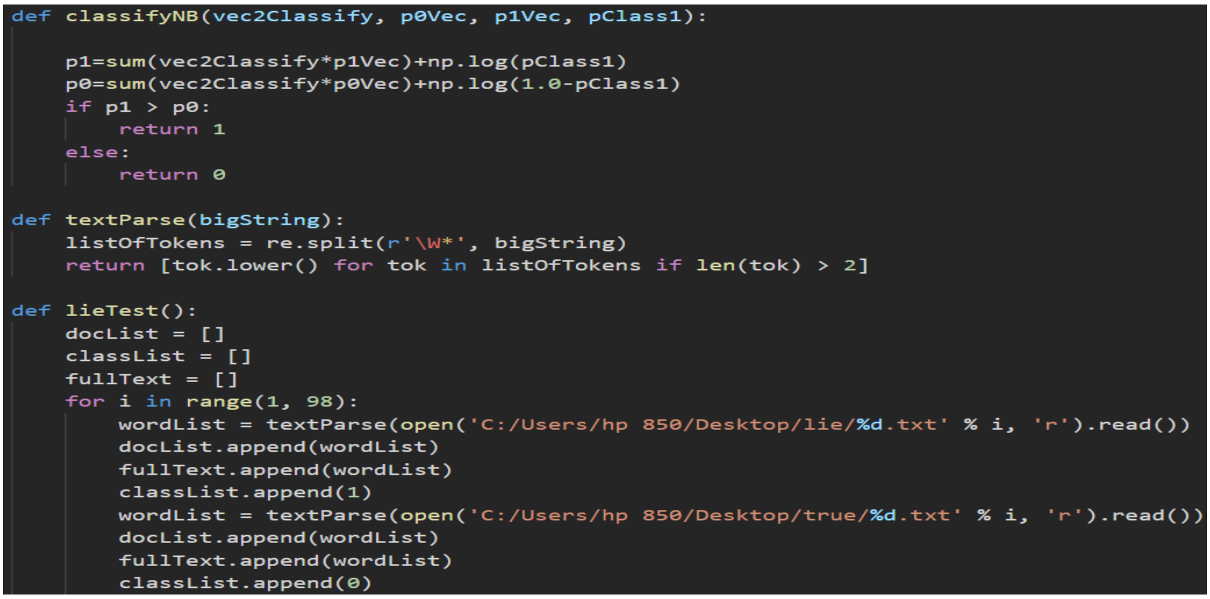
مدلNB سوم که نرمالایزوتوکنایزکردن و... استفاده کرده ایم و نحوه فراخوانی دیتاست راهم قبلا بیان شده اند:



```
import numpy as np
import re
import random
import pandas as pd
from tensorflow.keras import optimizers
from sklearn.preprocessing import Normalizer
from tensorflow.keras.models import Model, Sequential
from tensorflow.keras.preprocessing.text import Tokenizer

def createVocabList(dataSet):
    vocabSet = set([])
    for document in dataSet:
        vocabSet = vocabSet | set(document)
    return list(vocabSet)

def setOfWords2Vec(vocabList, inputSet):
    returnVec = [0] * len(vocabList)
    for word in inputSet:
        if word in vocabList:
            returnVec[vocabList.index(word)] = 1
        else:
            print("the word: %s is not in my Vocabulary!" % word)
    return returnVec

def bagOfWords2VecMN(vocabList, inputSet):
    returnVec = [0] * len(vocabList)
    for word in inputSet:
```

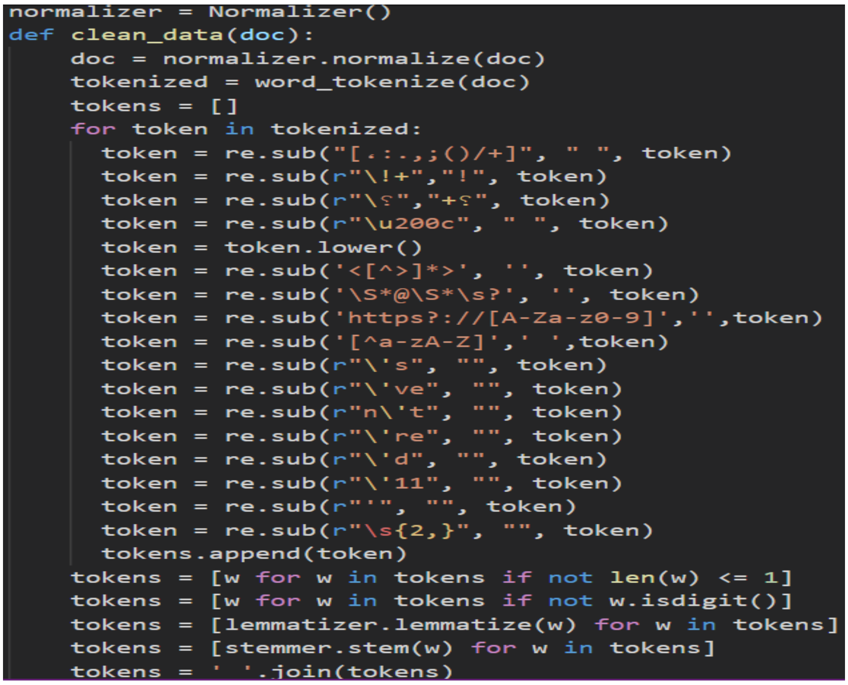


```
    for word in inputSet:
        if word in vocabList:
            returnVec[vocabList.index(word)] += 1
    return returnVec

def trainNB0(trainMatrix, trainCategory):
    numTrainDocs = len(trainMatrix)
    numWords = len(trainMatrix[0])
    pAbusive = sum(trainCategory) / float(numTrainDocs)
    p0Num = np.ones(numWords)
    p1Num = np.ones(numWords)
    p0Denom = 2.0
    p1Denom = 2.0
    for i in range(numTrainDocs):
        if trainCategory[i] == 1:
            p1Num += trainMatrix[i]
            p1Denom += sum(trainMatrix[i])
        else:
            p0Num += trainMatrix[i]
            p0Denom += sum(trainMatrix[i])
    p1Vect = np.log(p1Num / p1Denom)
    p0Vect = np.log(p0Num / p0Denom)
    return p0Vect, p1Vect, pAbusive

def classifyNB(vec2Classify, p0Vec, p1Vec, pClass1):
```

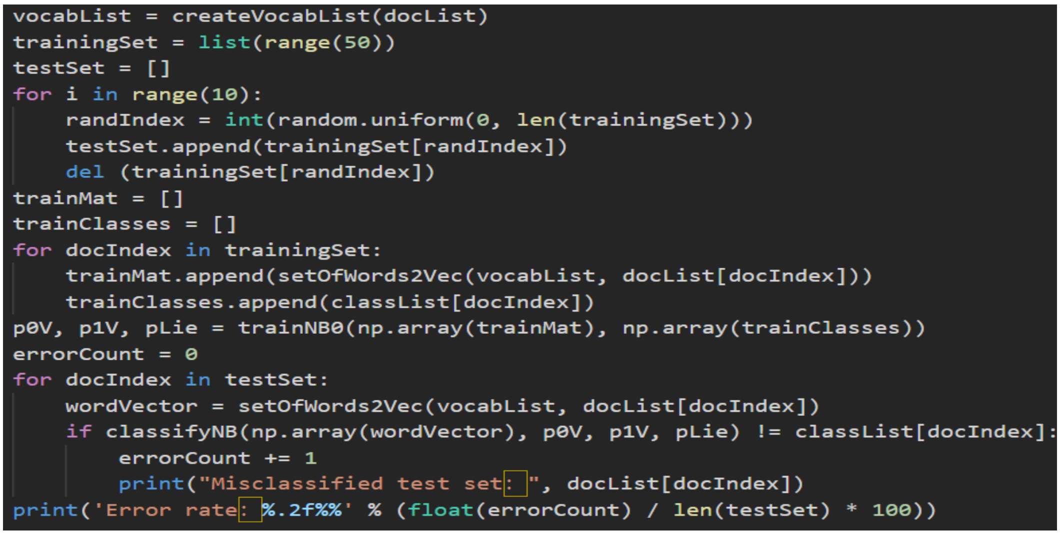


```
def classifyNB(vec2Classify, p0Vec, p1Vec, pClass1):

    p1=sum(vec2Classify*p1Vec)+np.log(pClass1)
    p0=sum(vec2Classify*p0Vec)+np.log(1.0-pClass1)
    if p1 > p0:
        return 1
    else:
        return 0

def textParse(bigString):
    listOfTokens = re.split(r'\W*', bigString)
    return [tok.lower() for tok in listOfTokens if len(tok) > 2]

def lieTest():
    docList = []
    classList = []
    fullText = []
    for i in range(1, 98):
        wordList = textParse(open('C:/Users/hp 850/Desktop/lie/%d.txt' % i, 'r').read())
        docList.append(wordList)
        fullText.append(wordList)
        classList.append(1)
        wordList = textParse(open('C:/Users/hp 850/Desktop/true/%d.txt' % i, 'r').read())
        docList.append(wordList)
        fullText.append(wordList)
        classList.append(0)
```

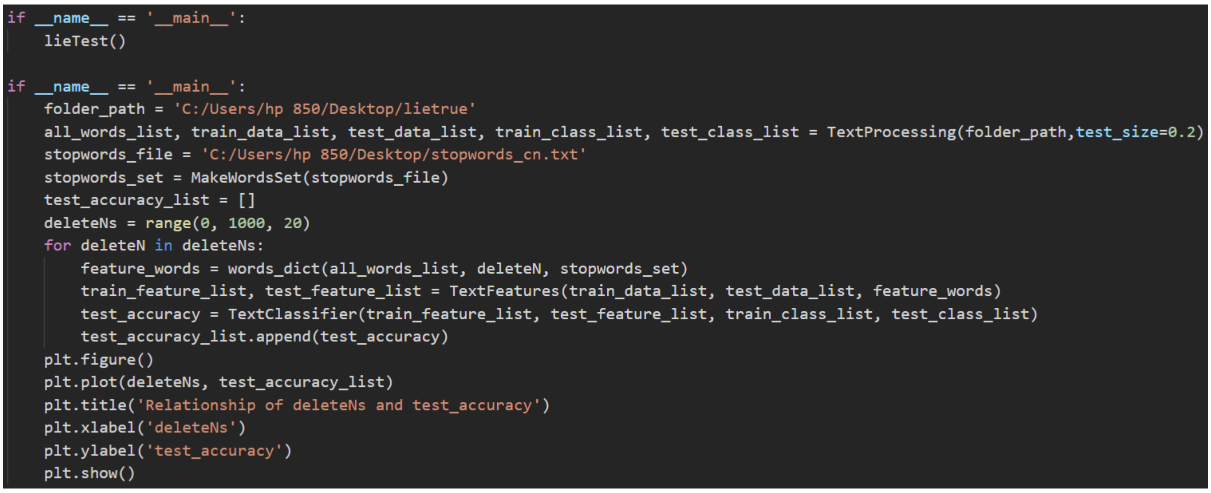
بخش نرمال سازی و توکنایزکردن:



```
normalizer = Normalizer()
def clean_data(doc):
    doc = normalizer.normalize(doc)
    tokenized = word_tokenize(doc)
    tokens = []
    for token in tokenized:
        token = re.sub("[،:.,;()/+]", " ", token)
        token = re.sub(r"\!+","!", token)
        token = re.sub(r"\؟","+؟", token)
        token = re.sub(r"\u200c", " ", token)
        token = token.lower()
        token = re.sub('<[^>]*>', '', token)
        token = re.sub('\S*@\S*\s?', '', token)
        token = re.sub('https?://[A-Za-z0-9]','',token)
        token = re.sub('[^a-zA-Z]',' ',token)
        token = re.sub(r"\'s", "", token)
        token = re.sub(r"\'ve", "", token)
        token = re.sub(r"n\'t", "", token)
        token = re.sub(r"\'re", "", token)
        token = re.sub(r"\'d", "", token)
        token = re.sub(r"\'11", "", token)
        token = re.sub(r"'", "", token)
        token = re.sub(r"\s{2,}", "", token)
        tokens.append(token)
    tokens = [w for w in tokens if not len(w) <= 1]
    tokens = [w for w in tokens if not w.isdigit()]
    tokens = [lemmatizer.lemmatize(w) for w in tokens]
    tokens = [stemmer.stem(w) for w in tokens]
    tokens = ' '.join(tokens)
```

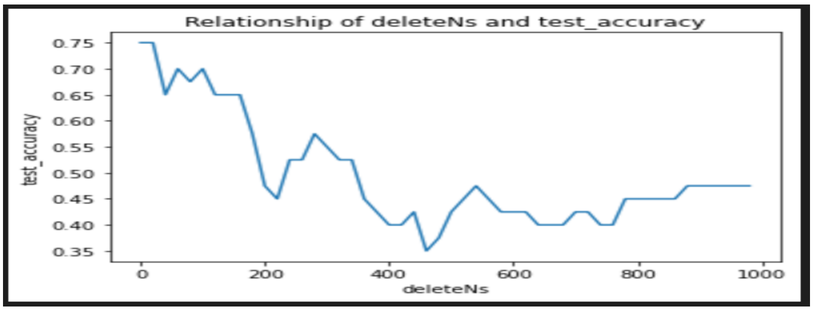


```
vocabList = createVocabList(docList)
trainingSet = list(range(50))
testSet = []
for i in range(10):
    randIndex = int(random.uniform(0, len(trainingSet)))
    testSet.append(trainingSet[randIndex])
    del (trainingSet[randIndex])
trainMat = []
trainClasses = []
for docIndex in trainingSet:
    trainMat.append(setOfWords2Vec(vocabList, docList[docIndex]))
    trainClasses.append(classList[docIndex])
p0V, p1V, pLie = trainNB0(np.array(trainMat), np.array(trainClasses))
errorCount = 0
for docIndex in testSet:
    wordVector = setOfWords2Vec(vocabList, docList[docIndex])
    if classifyNB(np.array(wordVector), p0V, p1V, pLie) != classList[docIndex]:
        errorCount += 1
        print("Misclassified test set: ", docList[docIndex])
print('Error rate: %.2f%%' % (float(errorCount) / len(testSet) * 100))
```

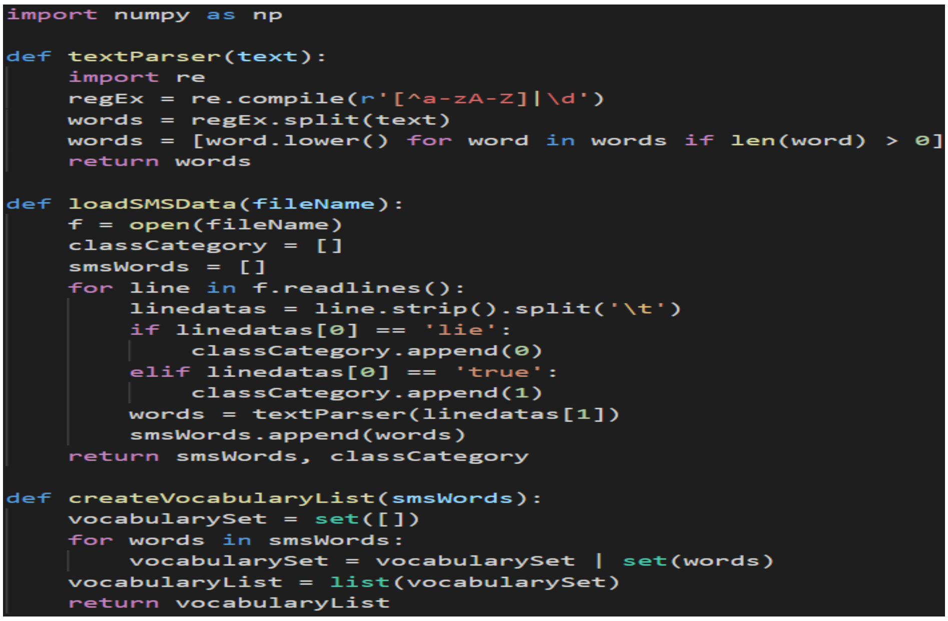


```
if __name__ == '__main__':
    lieTest()

if __name__ == '__main__':
    folder_path = 'C:/Users/hp 850/Desktop/lietrue'
    all_words_list, train_data_list, test_data_list, train_class_list, test_class_list = TextProcessing(folder_path,test_size=0.2)
    stopwords_file = 'C:/Users/hp 850/Desktop/stopwords_cn.txt'
    stopwords_set = MakeWordsSet(stopwords_file)
    test_accuracy_list = []
    deleteNs = range(0, 1000, 20)
    for deleteN in deleteNs:
        feature_words = words_dict(all_words_list, deleteN, stopwords_set)
        train_feature_list, test_feature_list = TextFeatures(train_data_list, test_data_list, feature_words)
        test_accuracy = TextClassifier(train_feature_list, test_feature_list, train_class_list, test_class_list)
        test_accuracy_list.append(test_accuracy)
    plt.figure()
    plt.plot(deleteNs, test_accuracy_list)
    plt.title('Relationship of deleteNs and test_accuracy')
    plt.xlabel('deleteNs')
    plt.ylabel('test_accuracy')
    plt.show()
```

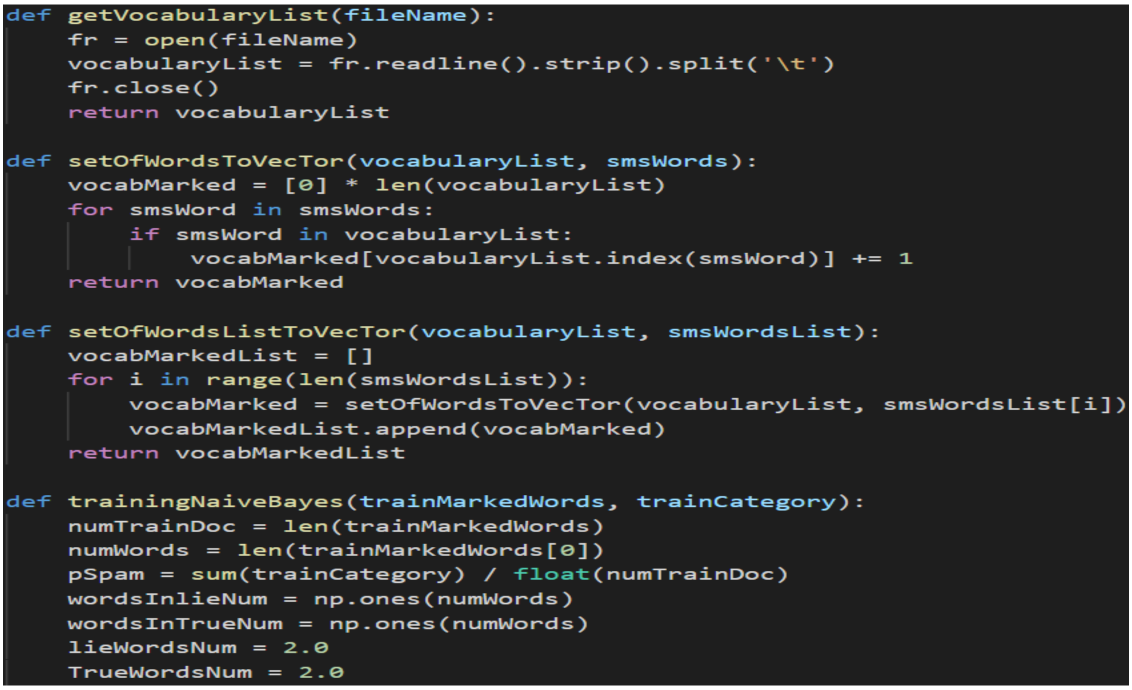
خروجی کد:



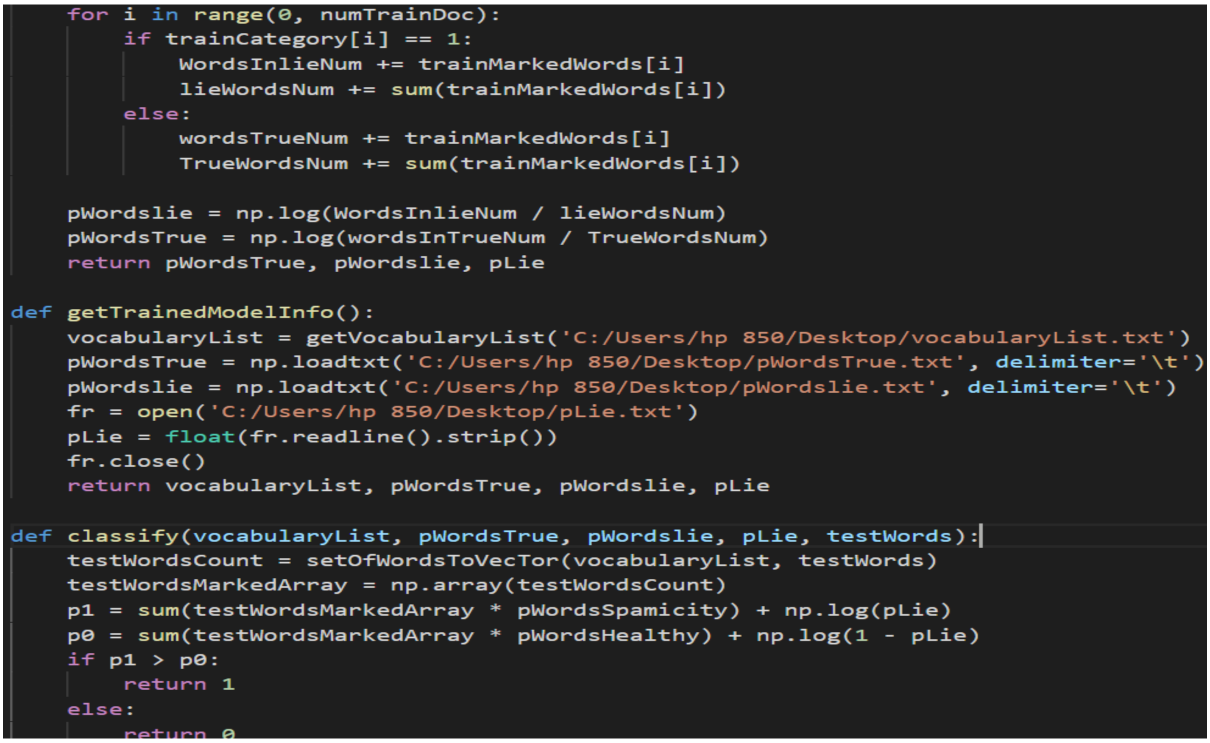
مدل NBبعدی درفایل NavieBayes.py :



```
import numpy as np

def textParser(text):
    import re
    regEx = re.compile(r'[^a-zA-Z]|\d')
    words = regEx.split(text)
    words = [word.lower() for word in words if len(word) > 0]
    return words

def loadSMSData(fileName):
    f = open(fileName)
    classCategory = []
    smsWords = []
    for line in f.readlines():
        linedatas = line.strip().split('\t')
        if linedatas[0] == 'lie':
            classCategory.append(0)
        elif linedatas[0] == 'true':
            classCategory.append(1)
        words = textParser(linedatas[1])
        smsWords.append(words)
    return smsWords, classCategory

def createVocabularyList(smsWords):
    vocabularySet = set([])
    for words in smsWords:
        vocabularySet = vocabularySet | set(words)
    vocabularyList = list(vocabularySet)
    return vocabularyList
```



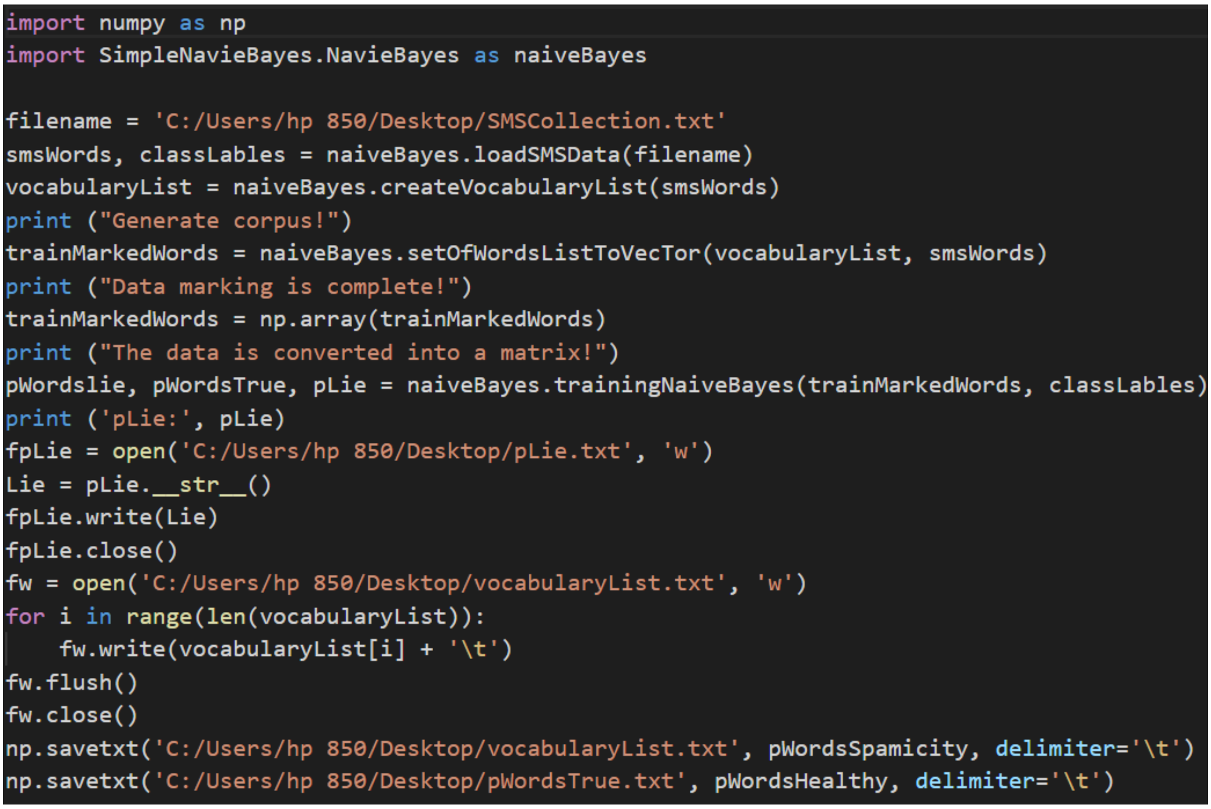
```
def getVocabularyList(fileName):
    fr = open(fileName)
    vocabularyList = fr.readline().strip().split('\t')
    fr.close()
    return vocabularyList

def setOfWordsToVecTor(vocabularyList, smsWords):
    vocabMarked = [0] * len(vocabularyList)
    for smsWord in smsWords:
        if smsWord in vocabularyList:
            vocabMarked[vocabularyList.index(smsWord)] += 1
    return vocabMarked

def setOfWordsListToVecTor(vocabularyList, smsWordsList):
    vocabMarkedList = []
    for i in range(len(smsWordsList)):
        vocabMarked = setOfWordsToVecTor(vocabularyList, smsWordsList[i])
        vocabMarkedList.append(vocabMarked)
    return vocabMarkedList

def trainingNaiveBayes(trainMarkedWords, trainCategory):
    numTrainDoc = len(trainMarkedWords)
    numWords = len(trainMarkedWords[0])
    pSpam = sum(trainCategory) / float(numTrainDoc)
    wordsInlieNum = np.ones(numWords)
    wordsInTrueNum = np.ones(numWords)
    lieWordsNum = 2.0
    TrueWordsNum = 2.0
```



```
    for i in range(0, numTrainDoc):
        if trainCategory[i] == 1:
            WordsInlieNum += trainMarkedWords[i]
            lieWordsNum += sum(trainMarkedWords[i])
        else:
            wordsTrueNum += trainMarkedWords[i]
            TrueWordsNum += sum(trainMarkedWords[i])

    pWordslie = np.log(WordsInlieNum / lieWordsNum)
    pWordsTrue = np.log(wordsInTrueNum / TrueWordsNum)
    return pWordsTrue, pWordslie, pLie

def getTrainedModelInfo():
    vocabularyList = getVocabularyList('C:/Users/hp 850/Desktop/vocabularyList.txt')
    pWordsTrue = np.loadtxt('C:/Users/hp 850/Desktop/pWordsTrue.txt', delimiter='\t')
    pWordslie = np.loadtxt('C:/Users/hp 850/Desktop/pWordslie.txt', delimiter='\t')
    fr = open('C:/Users/hp 850/Desktop/pLie.txt')
    pLie = float(fr.readline().strip())
    fr.close()
    return vocabularyList, pWordsTrue, pWordslie, pLie

def classify(vocabularyList, pWordsTrue, pWordslie, pLie, testWords):
    testWordsCount = setOfWordsToVecTor(vocabularyList, testWords)
    testWordsMarkedArray = np.array(testWordsCount)
    p1 = sum(testWordsMarkedArray * pWordsSpamicity) + np.log(pLie)
    p0 = sum(testWordsMarkedArray * pWordsHealthy) + np.log(1 - pLie)
    if p1 > p0:
        return 1
    else:
        return 0
```

دیتاست این بخش را هر۲لیبل جداگانه فراخوانی کردم و یک vocabulary تولید کردم.

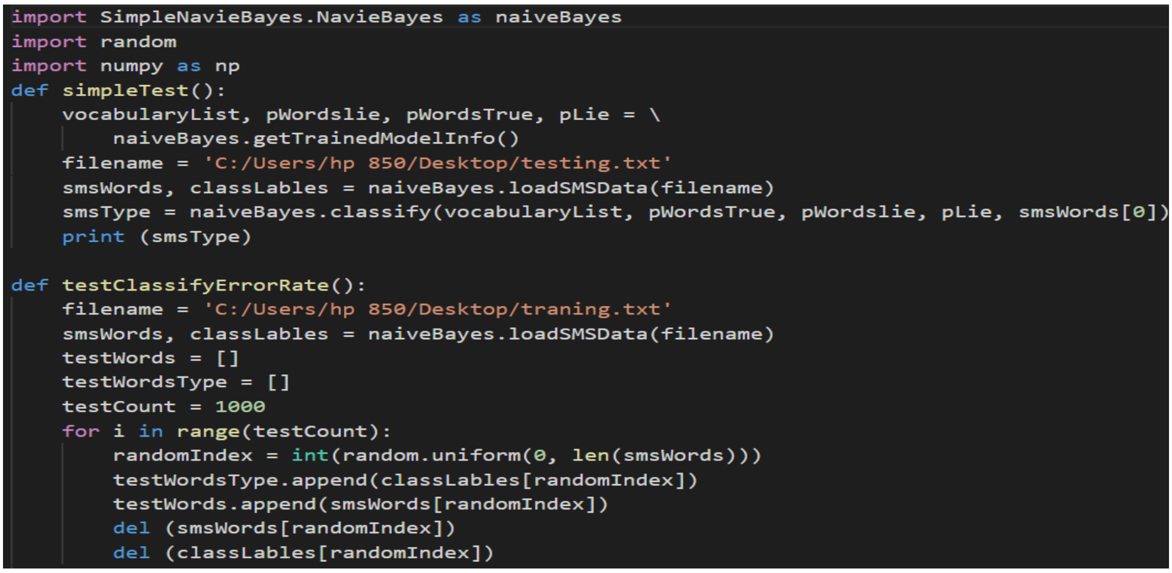
بخش آموزش آن که در فایل traning.py وجود دارند:



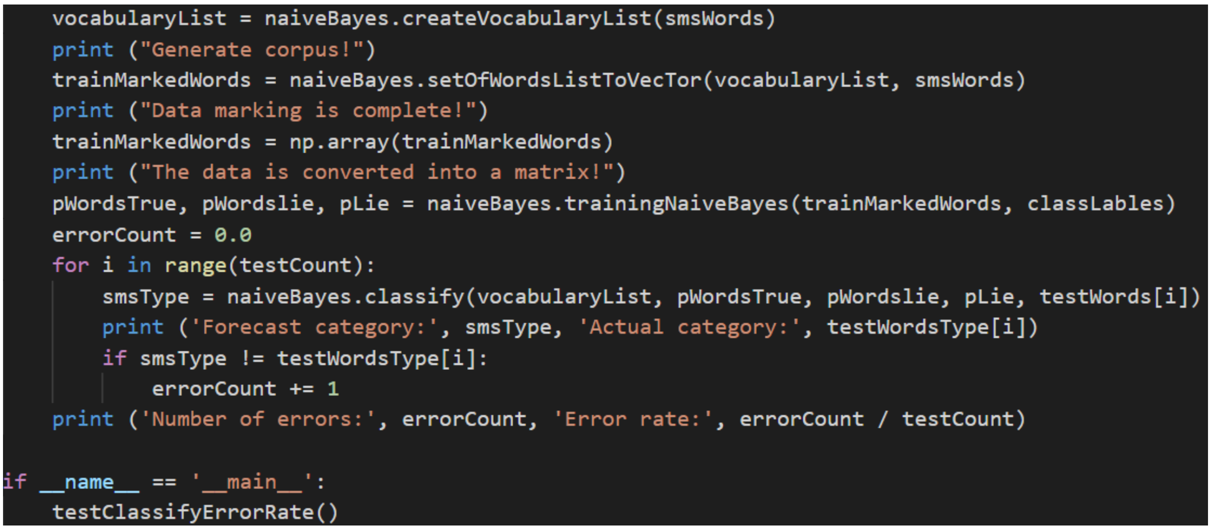
```
import numpy as np
import SimpleNavieBayes.NavieBayes as naiveBayes

filename = 'C:/Users/hp 850/Desktop/SMSCollection.txt'
smsWords, classLables = naiveBayes.loadSMSData(filename)
vocabularyList = naiveBayes.createVocabularyList(smsWords)
print ("Generate corpus!")
trainMarkedWords = naiveBayes.setOfWordsListToVecTor(vocabularyList, smsWords)
print ("Data marking is complete!")
trainMarkedWords = np.array(trainMarkedWords)
print ("The data is converted into a matrix!")
pWordslie, pWordsTrue, pLie = naiveBayes.trainingNaiveBayes(trainMarkedWords, classLables)
print ('pLie:', pLie)
fpLie = open('C:/Users/hp 850/Desktop/pLie.txt', 'w')
Lie = pLie.__str__()
fpLie.write(Lie)
fpLie.close()
fw = open('C:/Users/hp 850/Desktop/vocabularyList.txt', 'w')
for i in range(len(vocabularyList)):
    fw.write(vocabularyList[i] + '\t')
fw.flush()
fw.close()
np.savetxt('C:/Users/hp 850/Desktop/vocabularyList.txt', pWordsSpamicity, delimiter='\t')
np.savetxt('C:/Users/hp 850/Desktop/pWordsTrue.txt', pWordsHealthy, delimiter='\t')
```

فایل Plie برای لیبل گذاری داده ها است

بخش آزمایش آن که فایل testing.py وجود دارند:



```
import SimpleNavieBayes.NavieBayes as naiveBayes
import random
import numpy as np
def simpleTest():
    vocabularyList, pWordslie, pWordsTrue, pLie = \
        naiveBayes.getTrainedModelInfo()
    filename = 'C:/Users/hp 850/Desktop/testing.txt'
    smsWords, classLables = naiveBayes.loadSMSData(filename)
    smsType = naiveBayes.classify(vocabularyList, pWordsTrue, pWordslie, pLie, smsWords[0])
    print (smsType)

def testClassifyErrorRate():
    filename = 'C:/Users/hp 850/Desktop/traning.txt'
    smsWords, classLables = naiveBayes.loadSMSData(filename)
    testWords = []
    testWordsType = []
    testCount = 1000
    for i in range(testCount):
        randomIndex = int(random.uniform(0, len(smsWords)))
        testWordsType.append(classLables[randomIndex])
        testWords.append(smsWords[randomIndex])
        del (smsWords[randomIndex])
        del (classLables[randomIndex])
```



```
    vocabularyList = naiveBayes.createVocabularyList(smsWords)
    print ("Generate corpus!")
    trainMarkedWords = naiveBayes.setOfWordsListToVecTor(vocabularyList, smsWords)
    print ("Data marking is complete!")
    trainMarkedWords = np.array(trainMarkedWords)
    print ("The data is converted into a matrix!")
    pWordsTrue, pWordslie, pLie = naiveBayes.trainingNaiveBayes(trainMarkedWords, classLables)
    errorCount = 0.0
    for i in range(testCount):
        smsType = naiveBayes.classify(vocabularyList, pWordsTrue, pWordslie, pLie, testWords[i])
        print ('Forecast category:', smsType, 'Actual category:', testWordsType[i])
        if smsType != testWordsType[i]:
            errorCount += 1
    print ('Number of errors:', errorCount, 'Error rate:', errorCount / testCount)

if __name__ == '__main__':
    testClassifyErrorRate()
```