Programming Assignment 4: Naïve Bayes

Instructions:

- The aim of this assignment is to give you an initial hands-on regarding real-life machine learning application.
- Use separate training and testing data as discussed in class.
- You can only use Python programming language and Jupyter Notebook.
- Please use procedural programming style and comment your code thoroughly

  (otherwise marks will be deducted).
- There are two parts to this assignment. In part 1, you can only use **NumPy**, **scipy**, **pandas, matplotlib** and are not allowed to use **NLTK, scikit-learn or any other machine learning toolkit**. However, you have to use **scikit-learn** in part 2.
- **Carefully read the submission instructions, plagiarism, and late days policy.**
- The deadline to submit this assignment is **Sunday 21st November 2021.**

Submission Instructions:

Submit your code both as a notebook file (.ipynb) and python script (.py) on LMS. The name of both files should be your roll number. If you don't know how to save .ipynb as .py see this. **Failing to submit any one of them will result in the reduction of marks**.

Plagiarism Policy:

The code MUST be done independently. Any plagiarism or cheating of work from others or the internet will be immediately referred to the DC. If you are confused about what constitutes plagiarism, it is YOUR responsibility to consult with the instructor or the TA in a timely manner. No "after the fact" negotiations will be possible. The only way to guarantee that you do not lose marks is "DO NOT LOOK AT ANYONE ELSE'S CODE NOR DISCUSS IT WITH THEM".

Late Days Policy:

The deadline for the assignment is final. However, in order to accommodate all the 11th-hour issues, there is a late submission policy i.e. you can submit your assignment within 3 days after the deadline with a 25% deduction each day.

Problem:

The purpose of this assignment is to get you familiar with sentiment classification. By the end of this assignment, you will have your very own "Sentiment Analyzer". You are given a Large Movie Review Dataset that contains a separate labeled train and test set. Your task is to train a Naïve Bayes classifier on the train set and report accuracy on the test set.

Dataset:

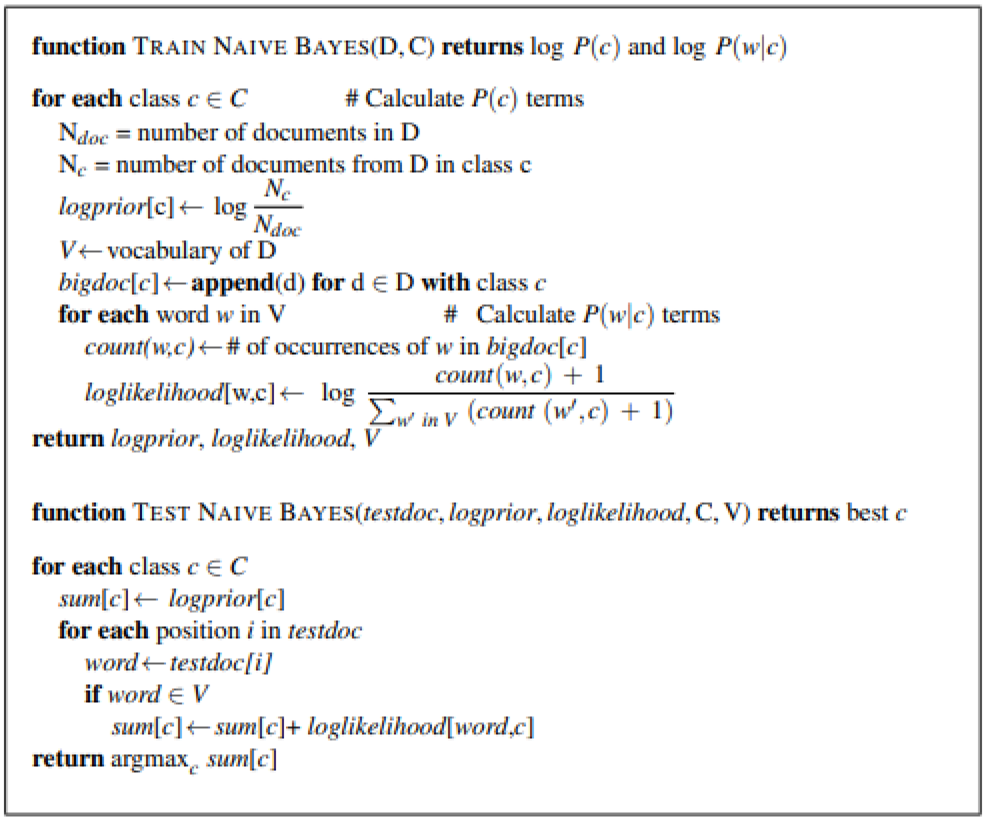
The core dataset contains 50,000 reviews split evenly into 25k train and 25k test sets. The overall distribution of labels is balanced (25k pos and 25k neg). There are two top-level directories [train/, test/] corresponding to the training and test sets. Each contains [pos/, neg/] directories for the reviews with binary labels positive and negative. Within these directories, reviews are stored in text files named following the convention [[id]_[rating].txt] where [id] is a unique id and [rating] is the star rating for that review on a 1-10 scale. For example, the file [test/pos/200_8.txt] is the text for a positive-labeled test set example with unique id 200 and star rating 8/10 from IMDb. The dataset can be downloaded from here.

Preprocessing:

In the preprocessing step you're required to remove the stop words and punctuation marks and other unwanted characters from the reviews and convert them to lower case. You may find the string and regex module useful for this purpose. A stop word list is provided with the dataset.

Part 1:

Implement Naïve Bayes for sentiment analysis from scratch keeping in view all the discussions from the class lectures. Feel free to read Chapter 4 (Section 4.1, 4.2, 4.3) of the Speech and Language Processing book to get an in-depth insight into the Naïve Bayes classifier. Use Bag-of-words representation and apply Laplace (Add-1) smoothing as discussed in the class lectures. Specifically, you will need to implement the following algorithm:



```
function TRAIN NAIVE BAYES(D, C) returns log $P(c)$ and log $P(w|c)$

for each class $c \in C$          # Calculate $P(c)$ terms
  $N_{doc}$ = number of documents in D
  $N_c$ = number of documents from D in class c
  $logprior[c] \leftarrow \log \frac{N_c}{N_{doc}}$
  $V \leftarrow$ vocabulary of D
  $bigdoc[c] \leftarrow$ append(d) for d $\in$ D with class $c$
  for each word $w$ in V                # Calculate $P(w|c)$ terms
    $count(w,c) \leftarrow$ # of occurrences of $w$ in $bigdoc[c]$
    $loglikelihood[w,c] \leftarrow \log \frac{count(w,c) + 1}{\sum_{w' \text{ in } V} (count(w',c) + 1)}$
return $logprior$, $loglikelihood$, $V$

function TEST NAIVE BAYES($testdoc$, $logprior$, $loglikelihood$, C, V) returns best $c$

for each class $c \in C$
  $sum[c] \leftarrow logprior[c]$
  for each position $i$ in $testdoc$
    $word \leftarrow testdoc[i]$
    if $word \in V$
      $sum[c] \leftarrow sum[c] + loglikelihood[word,c]$
return $\text{argmax}_c\ sum[c]$
```

Report accuracy and confusion matrix. The expected accuracy on the test set is around 80%.

Part 2:

Use scikit-learn's CountVectorizer to transform your train and test set to bag-of-words representation and Naïve Bayes implementation to train and test the Naïve Bayes on the provided dataset. Use scikit-learn's accuracy score function to calculate the accuracy and confusion_matrix function to calculate the confusion matrix on the test set.