KAUNO TECHNOLOGIJOS UNIVERSITETAS
INFORMATIKOS FAKULTETAS

Intelektikos Pagrindai (P176B101)

Pirmojo laboratorinio darbo ataskaita

Atliko:

IFF – 6/8 gr. studentas

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Priėmė:

Lekt. Germanas Budnikas

KAUNAS 2019

1. Darbo užduotis

Sukurti programą SPAMui klasifikuoti panaudojant Bajeso teoremą. Ištirti priklausomybę tarp programoje naudojamų nustatymų ir klasifikatoriaus darbo efektyvumo (*žr.reikalavimus ataskaitai*). Programavimo kalba pasirenkama laisvai.

Ataskaitos reikalavimai:

Ataskaitoje turi būti pateikta:

[ ] atlikti kryžminės patikros eksperimentai (segmentų N skaičius - 10);
apskaičiuotas vidutinis visų 10 eksperimentų tikslumas

[ ] klasifikatorius vaizduoja testuojamo failo(-ų) spamiškumo simbolinę ir skaitinę įvertį (pvz. 97%, Spamas)

[ ] ataskaitoje pateikta grafikų pagalba priklausomybės tarp programoje naudojamų nustatymų ir klasifikatoriaus darbo efektyvumo

{ } leksemos, sutinkamos pirmą kartą, spamiškumo tikimybės įverčio pokyčio (pvz. 0.45 ; 0.40 ; 0.35) įtaka į klasifikatoriaus darbo tikslumą*

{ } iš analizuojamo failo pasirenkamų leksemų skaičiaus N reikšmių (pvz. 8, 16, 20) pokyčio įtaka į klasifikatoriaus darbo tikslumą*

{ } spamiškumo slenksčio reikšmių pokyčio įtaka į klasifikatoriaus darbo tikslumą*.

(*) klasifikatoriaus darbo tikslumas turi būti vertinamas procentais skaičiuojant true positive ir false positive reikšmių vidutinę reikšmę, čia

1) true positive - vidutinė reikšmė, įvertinanti santykius: nespamas klasifikuotas kaip nespamas ir spamas klasifikuotas kaip spamas;
2) false positive - vidutinė reikšmė, įvertinanti santykius: nespamas klasifikuotas kaip spamas ir spamas klasifikuotas kaip nespamas.

Pateikiant priklausomybes grafikų pagalba vaizduoti true positive ir false positive reikšmių sandarą (kiekvienai dedamąjai, kuri buvo aprašyta aukščiau, turi atitikti atskira kreivė) taip pat grafike kartu pateikti kreivę, kuri atitinka bendrą klasifikatoriaus darbo tikslumą.

Darbo vykdymo rekomendacijos

Skaičiuojant kiekvienos leksemos (simbolių seka iš a..Z, 0..9, $, ', "; Visi kiti simboliai - yra skyrikliai tarp leksemų) pasirodymų skaičių kiekviename duomenų rinkinyje patartina naudoti *hash* lenteles.

2. Darbo eiga ir tyrimai

Darbas buvo atliktas Python programavimo kalba.

Programos kodas:

```
import os
import re

class Lexeme:
    def __init__(self, word, spamCount, hamCount, pWS, pWH, pSW):
        self.word = word
        self.spamCount = spamCount
        self.hamCount = hamCount
        self.pWS = pWS
        self.pWH = pWH
        self.pSW = pSW

    #Note to self: no need for getters and setters

#function responsible for reading a number of files, defined by the fileLimit
#and getting lexemes from those files and then putting them into a lexicon/dictionary
#funcion returns a dictionary and two integer values - spam and ham word counts
#for later calculations
def readFilesIntoDictionary(spamDirectory, hamDirectory, fileLimit):
    #initial values
    lexicon = {}
    spamCount = 0
    hamCount = 0
    fileCount = 0
    #for loop responsible for spam lexeme placement into a dictionary
    for file in os.listdir(spamDirectory):
        if file.endswith(".txt") and fileCount <= fileLimit:
            fileName = spamDirectory + "\\" + file
            with open(fileName, encoding="Latin-1") as f:
                for line in f:
                    for word in re.split('\W+', line):
                        if len(word) > 1:
                            if word in lexicon.keys():
                                lexicon[word].spamCount += 1
                            else:
                                lexema = Lexeme(word, 1, 0, 0, 0, 0)
                                lexicon[word] = lexema
                            spamCount += 1
            fileCount += 1
    fileCount = 0
    #for loop responsible for ham lexeme placement into the same dictionary as spam
    for file in os.listdir(hamDirectory): #all files in directory
        if file.endswith(".txt") and fileCount <= fileLimit:
            fileName = hamDirectory + "\\" + file
            with open(fileName, encoding="Latin-1") as f:
                for line in f:
                    for word in re.split('\W+', line):
```

```
                        if len(word) > 1:
                            if word in lexicon.keys():
                                lexicon[word].hamCount += 1
                            else:
                                lexema = Lexeme(word, 0, 1, 0, 0, 0)
                                lexicon[word] = lexema
                            hamCount += 1
            fileCount += 1
    return [lexicon, spamCount, hamCount]

#function responsible for counting the probabilities of lexemes
def probabilities(answerList):
    #dictionary with all lexemes
    lexicon = answerList[0]
    #total word counts from all read files
    totalSpamCount = answerList[1]
    totalHamCount = answerList[2]
    for key in lexicon.keys():
        #probability that lexeme is IN Spam directory
        lexicon[key].pWS = lexicon[key].spamCount / totalSpamCount
        #probability that lexeme is IN Ham directory
        lexicon[key].pWH = lexicon[key].hamCount / totalHamCount
        #probability that lexeme is Spam
        if lexicon[key].pWS <= 0: #if lexeme isnt found in any of the spam files
            lexicon[key].pSW = 0.01
        elif lexicon[key].pWH <= 0: #if lexeme isnt found in any of the ham files
            lexicon[key].pSW = 0.99
        else: #if lexeme is found in both spam and ham files
            lexicon[key].pSW = lexicon[key].pWS / (lexicon[key].pWS +
lexicon[key].pWH)
        #print(lexicon[key].word, " Spam Count: ", lexicon[key].spamCount, " Ham
count: ", lexicon[key].hamCount, " pWS ", lexicon[key].pWS, " pWH ",
lexicon[key].pWH, " pSW ", lexicon[key].pSW)
    #returns full lexicon with all probabilites
    return lexicon

#function responsible for the analysis of whole folder of testing data files
def analyse(analyseDirectory, lexicon, isSpam):
    results = []
    #this part is almost the same as read function except this one doesn't make any
Lexeme objects and instead
    #just places the spam probabilities of lexemes into a list and then passes it to
another function for further analysis
    for file in os.listdir(analyseDirectory): #all files in directory
        if file.endswith(".txt"):
            fileName = analyseDirectory + "\\" + file
            with open(fileName, encoding="Latin-1") as f:
                list1 = []
                for line in f:
                    for word in re.split('\W+', line):
                        if len(word) > 1:
                            if word in lexicon.keys():
                                list1.append(lexicon[word].pSW)
```

```
                            else:
                                list1.append(isSpam)
                print(fileName)
                tempResult = probabilityThatFileIsSpam(list1, 20) #after gathering
all lexemes from file
                results.append(tempResult)

#function that takes a number of lexemes that are farthest from neutral point
#(0.5 - neutral point, while 0 is min and 1 is max) from a file that needs to be
analyzed
#and then based on the probability of spam on each of these lexemes,
#calculates the overall probability that file is spam
#numberOfMaxValues - a maximum number of lexemes to be taken into account when
calculating overall probability
def probabilityThatFileIsSpam(list1, numberOfMaxValues):
    maxValues = []
    currentMaxDifference = 0
    currentMax = 0
    maxIndex = 0
    for i in range(0, numberOfMaxValues):
        #appends 0 to extend the lenght of list which allows accessing by index (NOT
REALLY NECESSARY)
        maxValues.append(0)
        for x in range(0, len(list1)):
            #difference calculation to find values that are farthest from neutral
point - 0.5
            difference = 0
            if list1[x] >= 0.5:
                difference = list1[x] - 0.5
            elif list1[x] < 0.5:
                difference = 0.5 - list1[x]
            if currentMaxDifference < difference:
                currentMaxDifference = difference
                currentMax = list1[x]
                maxIndex = x
        maxValues[i] = currentMax
        list1[maxIndex] = 0.5
        maxIndex = 0
        currentMax = 0
        currentMaxDifference = 0
    #calculates the overall probability p by using the following formula:
    # p = (p1 * p2 * p3 ...  * pn)/((p1 * p2 * p3 ...  * pn) + ((1-p1) * (1-p2) * (1-
p3) ...  * (1-pn))
    topSide = 1
    bottomSide = 1
    for i in range(0, len(maxValues)):
        topSide = topSide * maxValues[i]
        bottomSide = bottomSide * (1 - maxValues[i])
    spamProbability = (topSide / (topSide + bottomSide)) * 100

    #print(maxValues)
    print(spamProbability, "%")
    if spamProbability > 50:
```

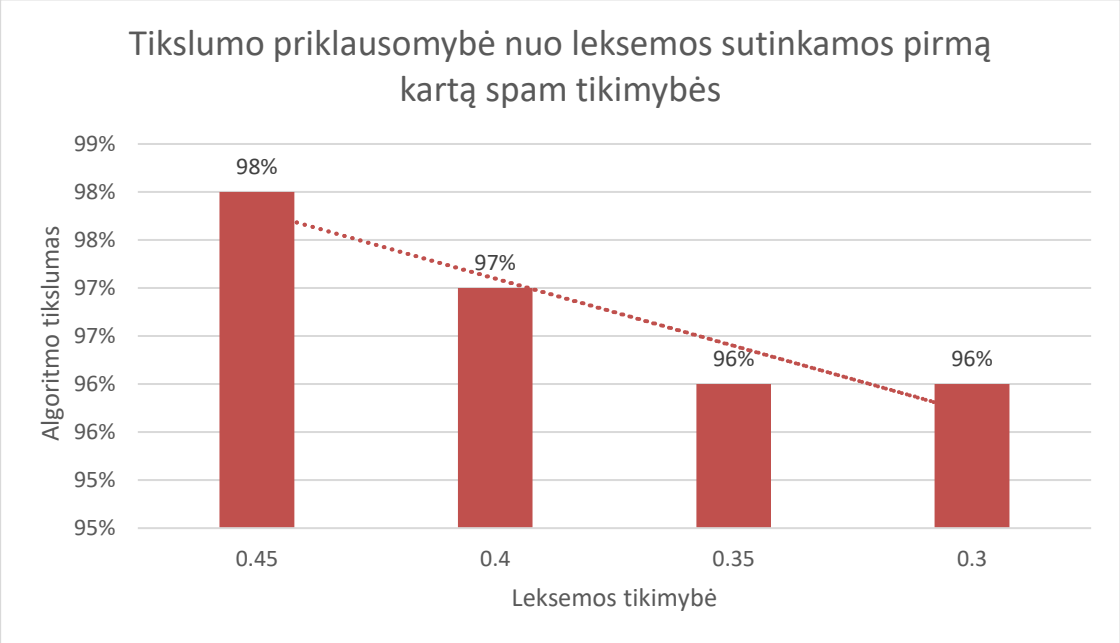
```
        print("SPAM")
    elif spamProbability < 50:
        print("NOT SPAM")
    return spamProbability

#directories for learning purposes *PATHS ARE NOT RELATIVE as ???apparently
os.listdir doesn't accept relative paths???*
spamDirectory = "D:\Tadas\KALBUTEORIJA\Python\spam"
hamDirectory = "D:\Tadas\KALBUTEORIJA\Python\ham"
#directory for files that need to be analyzed
analyseDirectory = "D:\Tadas\KALBUTEORIJA\Python\\analysis"

# answerList values: 0 - dictionary/lexicon, 1 - spam word count, 2 - ham word count
answerList = readFilesIntoDictionary(spamDirectory, hamDirectory, 150)
lexicon = probabilities(answerList)
analyse(analyseDirectory, lexicon, 0.4)
```

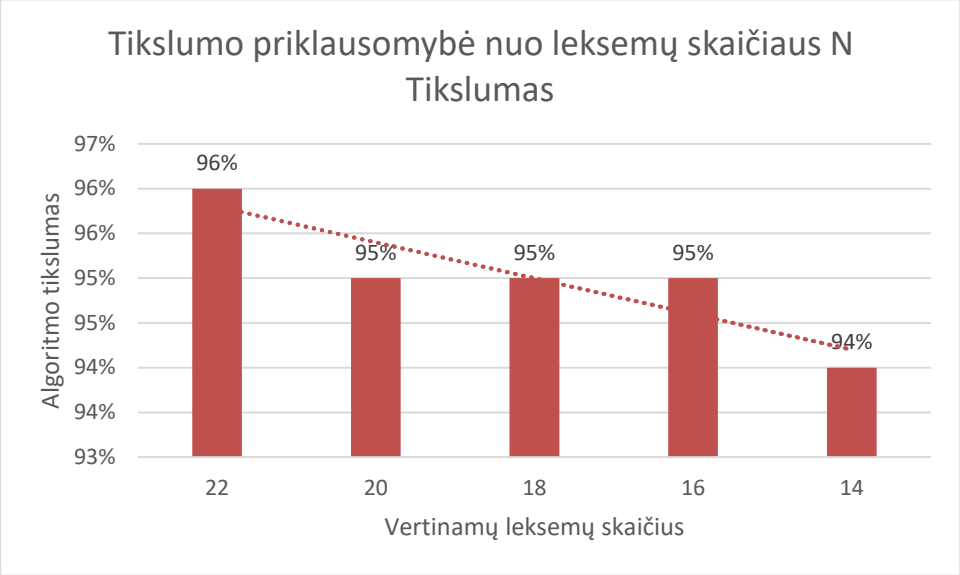
Tyrimai ir rezultatai:

Tikslumo priklausomybė nuo leksemos sutinkamos pirmą kartą spam tikimybės	
Leksemos tikymybė	Tikslumas
0.45	98%
0.4	97%
0.35	96%
0.3	96%

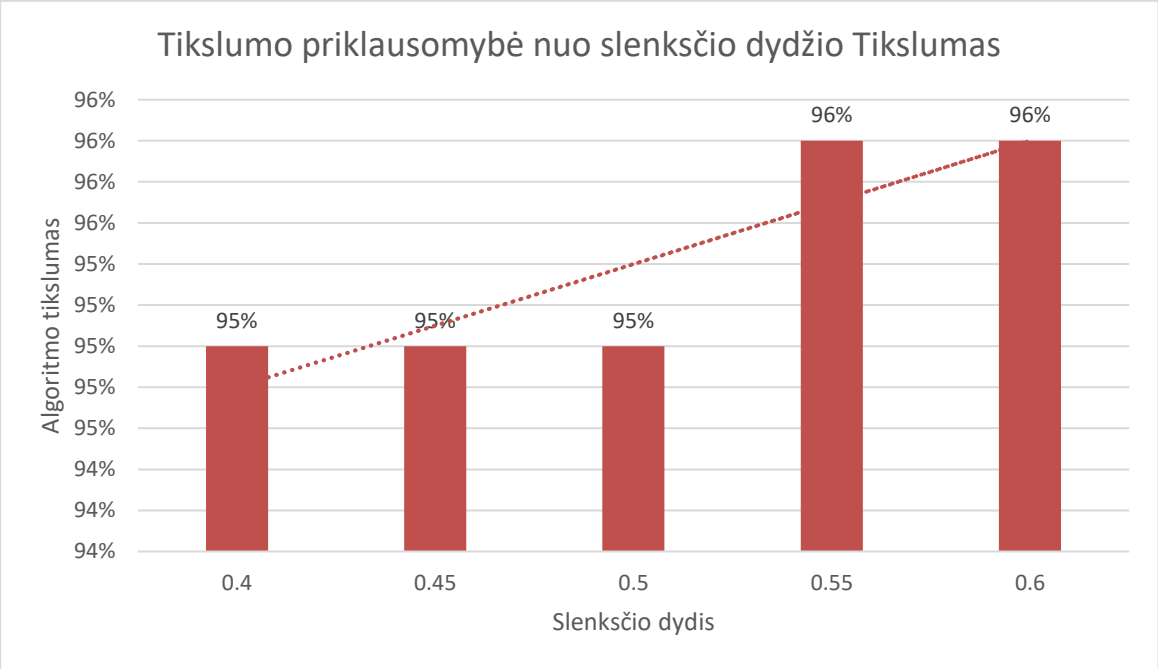


Tikslumo priklausomybė nuo leksemų skaičiaus N	
Leksemų skaičius (N)	Tikslumas
22	96%
20	95%
18	95%

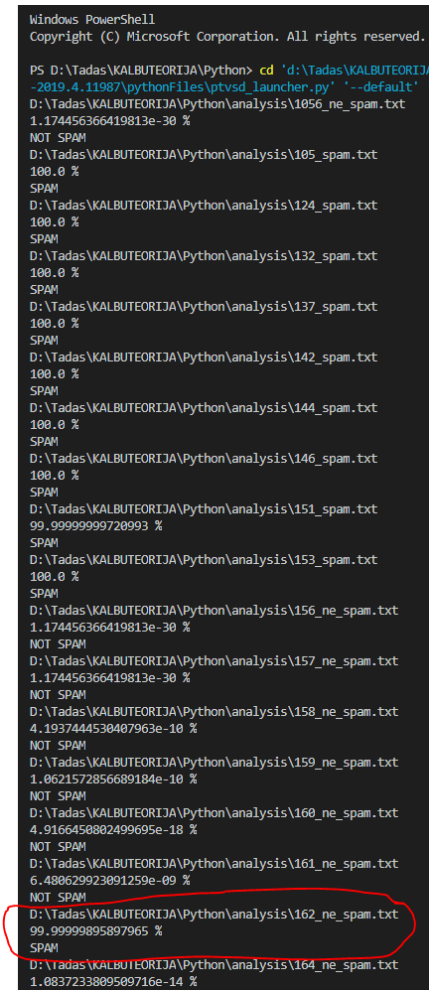
16	95%
14	94%

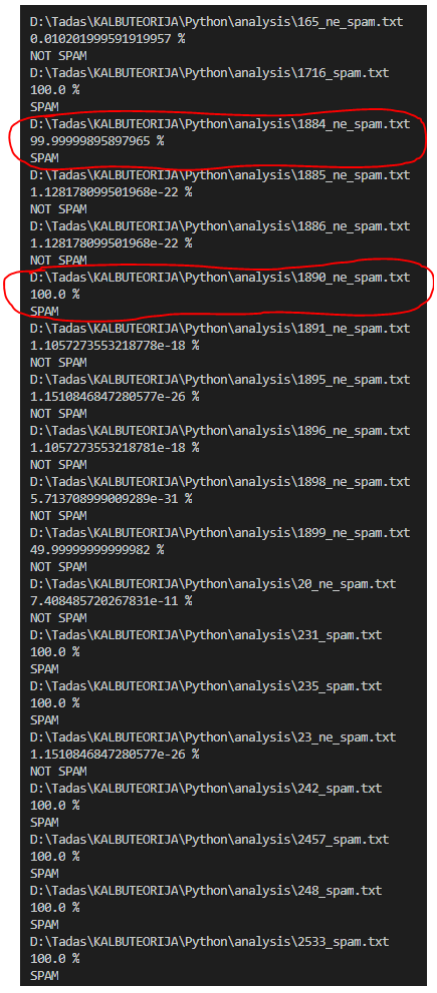


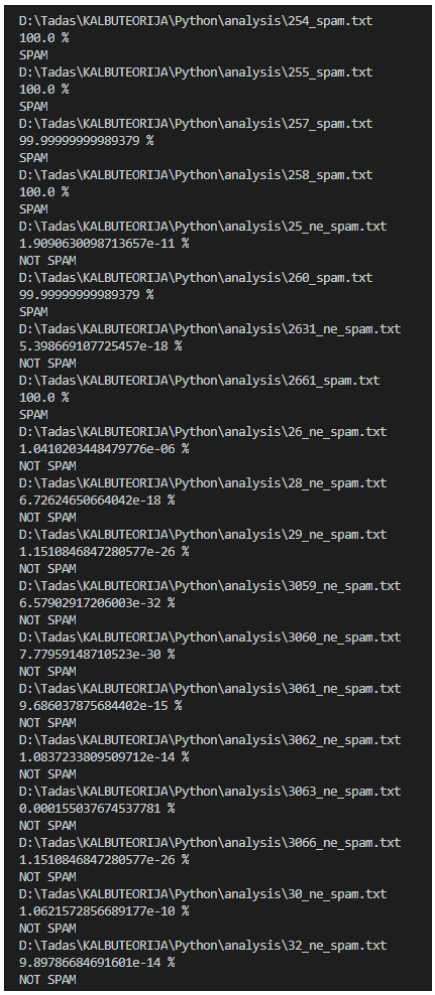
Tikslumo priklausomybė nuo slenksčio dydžio	
Slenkstis	Tikslumas
0.4	95%
0.45	95%
0.5	95%
0.55	96%
0.6	96%

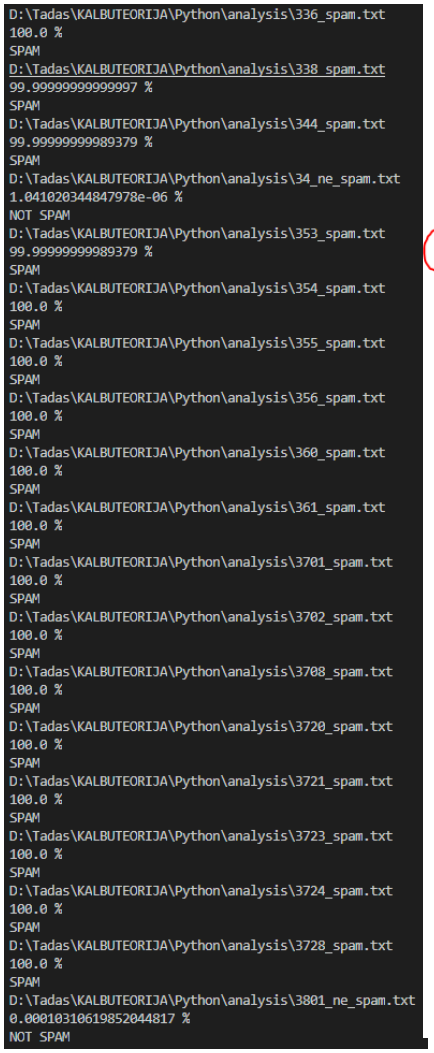


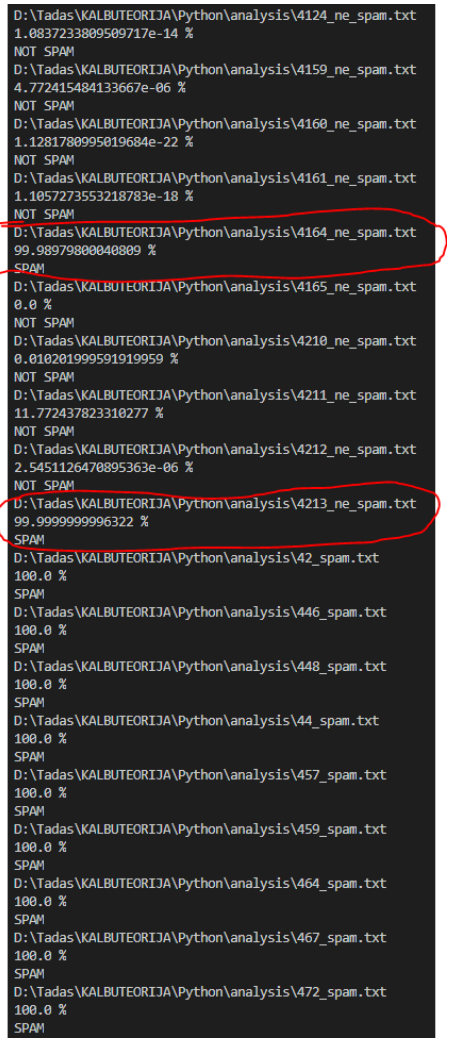
Rezultatų pavydys, naudojant N = 16, 0.4 dydžio slenkstį, 150 apsimokymo duomenų, 100 testavimo duomenų. Šiuo atveju tikslumas 96%. Raudonai apvesti false positive atvejai (true false atvejų nepasitaikė)

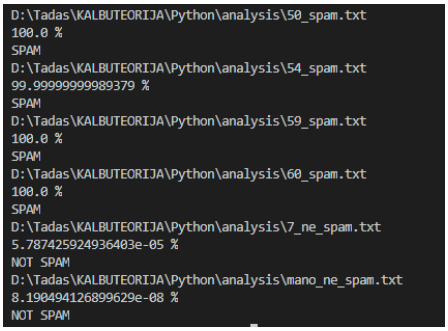

Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.
PS D:\Tadas\KALBUTEORIJA\Python> cd 'd:\Tadas\KALBUTEORIJA
-2019.4.11987\pythonFiles\ptvsd_launcher.py' '--default'
D:\Tadas\KALBUTEORIJA\Python\analysis\1056_ne_spam.txt
1.174456366419813e-30 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\105_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\124_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\132_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\137_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\142_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\144_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\146_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\151_spam.txt
99.99999999720993 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\153_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\156_ne_spam.txt
1.174456366419813e-30 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\157_ne_spam.txt
1.174456366419813e-30 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\158_ne_spam.txt
4.1937444530407963e-10 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\159_ne_spam.txt
1.0621572856689184e-10 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\160_ne_spam.txt
4.9166450802499695e-18 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\161_ne_spam.txt
6.480629923091259e-09 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\162_ne_spam.txt
99.99999895897965 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\164_ne_spam.txt
1.0837233809509716e-14 %


D:\Tadas\KALBUTEORIJA\Python\analysis\165_ne_spam.txt
0.010201999591919957 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1716_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1884_ne_spam.txt
99.99999895897965 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1885_ne_spam.txt
1.128178099501968e-22 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1886_ne_spam.txt
1.128178099501968e-22 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1890_ne_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1891_ne_spam.txt
1.1057273553218778e-18 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1895_ne_spam.txt
1.1510846847280577e-26 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1896_ne_spam.txt
1.1057273553218781e-18 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1898_ne_spam.txt
5.713708999009289e-31 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\1899_ne_spam.txt
49.99999999999982 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\20_ne_spam.txt
7.408485720267831e-11 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\231_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\235_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\23_ne_spam.txt
1.1510846847280577e-26 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\242_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\2457_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\248_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\2533_spam.txt
100.0 %
SPAM


D:\Tadas\KALBUTEORIJA\Python\analysis\254_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\255_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\257_spam.txt
99.99999999989379 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\258_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\25_ne_spam.txt
1.9090630098713657e-11 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\260_spam.txt
99.99999999989379 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\2631_ne_spam.txt
5.398669107725457e-18 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\2661_spam.txt
100.0 %
SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\26_ne_spam.txt
1.0410203448479776e-06 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\28_ne_spam.txt
6.726246506640 42e-18 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\29_ne_spam.txt
1.1510846847280577e-26 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\3059_ne_spam.txt
6.57902917206003e-32 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\3060_ne_spam.txt
7.779591487105 23e-30 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\3061_ne_spam.txt
9.686037875684402e-15 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\3062_ne_spam.txt
1.0837233809509712e-14 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\3063_ne_spam.txt
0.0001550376745377 81 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\3066_ne_spam.txt
1.1510846847280577e-26 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\30_ne_spam.txt
1.0621572856689177e-10 %
NOT SPAM
D:\Tadas\KALBUTEORIJA\Python\analysis\32_ne_spam.txt
9.89786684691601e-14 %
NOT SPAM







3. Išvada

Naudojant Bajeso teoremą galima nesunkiai atrūšiuoti spamą nuo ne spamo, bei keičiant įvairius kintamuosius išgauti gana tikslų rezultatą. Iš tyrimo matyti, kad tikslingiausia naudoti apie 22 leksemas nustatinėjant bendrą tikimybę, apmokyti algoritmą su bent 150 skirtingų duomenų failų, taip pat naudoti 0.45-0.6 dydžio slenkstį bei 0.45 naujai sutiktos leksemos tikimybę.