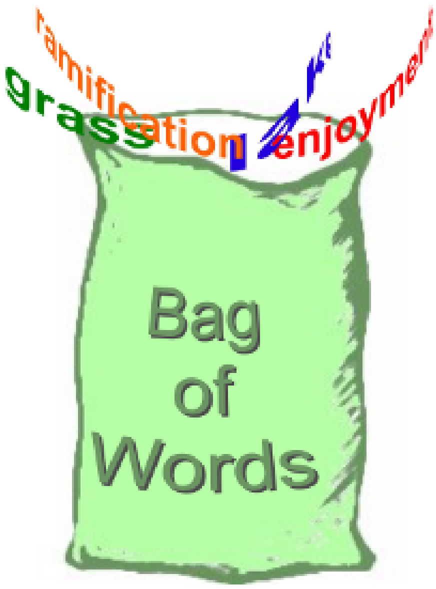
Textklassifikation in Python

Einführung



Im vorigen Kapitel hatten wir die Formel zur Berechnung der Wahrscheinlichkeit hergleitet, dass ein Document d in zu einer Klasse bzw. Kategorie c gehört, bezeichnet als P(c|d).

Wir haben die Standardformel für P(c|d), so wie sie in verschiedenen wissenschaftlichen Abhandlungen verwendet wird[1], in eine numerisch stabile Form gewandelt.

Für unsere Implementierung in Python benutzen wir einen auf "Naive Bayes" basierenden Klassifikator. Eine formale Einführung in das Konzept eines Naive-Bayes-Klassifikators befindet sich im vorigen Kapitel "Einführung in die Textklassifikation".

Python ist ideal für die Textklassifikation wegen seiner Stringklasse und deren mächtigen Methoden. Weiterhin werden mit dem Modul re leistungsstarke Tools zur Verfügung gestellt, die weit über den Rahmen anderer Programmiersprachen hinausgehen.

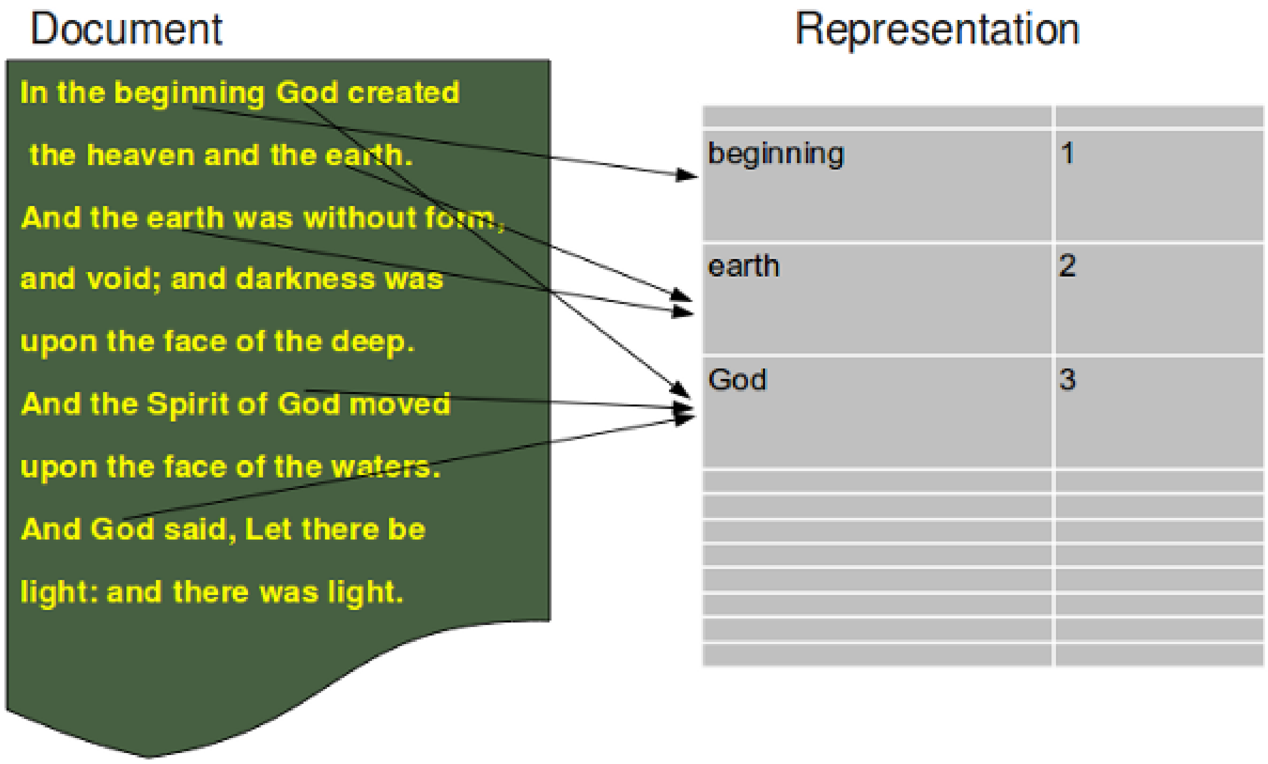
Die vorliegende Python-Implementierung eines Naive-Bayes-Klassifikators ist allerdings nicht auf Effizienz optimiert.

Python-Implementierung

Warnung: Die vorliegende Implementierung ist Python 3 geschrieben und nicht Python 2.x kompatibel!

Dokumenten-Repräsentation

Die Dokumente werden in unserer Implementierung nach dem sogenannten "bag of words"-Modell implementiert, was wir im folgenden Diagramm illustrieren:



In the beginning God created
the heaven and the earth.
And the earth was without form,
and void; and darkness was
upon the face of the deep.
And the Spirit of God moved
upon the face of the waters.
And God said, Let there be
light: and there was light.

beginning	1
earth	2
God	3

Benötigte Module

Unsere Implementierung benötigt das Modul re für reguläre Ausdrücke und die Betriebssystemschnittstelle im os-Modul:

```
import re, os
```

BagOfWords-Klasse

```
class BagOfWords(object):
    """ Implementing a bag of words, words corresponding with their frequency
of usages in a "document"
    for usage by the Document class, DocumentClass class and the Pool
class."""

    def __init__(self):
        self.__number_of_words = 0
        self.__bag_of_words = {}

    def __add__(self,other):
        """ Overloading of the "+" operator to join two BagOfWords """
        erg = BagOfWords()
        sum = erg.__bag_of_words
        for key in self.__bag_of_words:
            sum[key] = self.__bag_of_words[key]
            if key in other.__bag_of_words:
                sum[key] += other.__bag_of_words[key]
        for key in other.__bag_of_words:
            if key not in sum:
                sum[key] = other.__bag_of_words[key]
        return erg

    def add_word(self,word):
        """ A word is added in the dictionary __bag_of_words"""
        self.__number_of_words += 1
        if word in self.__bag_of_words:
            self.__bag_of_words[word] += 1
        else:
            self.__bag_of_words[word] = 1

    def len(self):
        """ Returning the number of different words of an object """
        return len(self.__bag_of_words)

    def Words(self):
        """ Returning a list of the words contained in the object """
        return self.__bag_of_words.keys()


    def BagOfWords(self):
        """ Returning the dictionary, containing the words (keys) with their
frequency (values)"""
        return self.__bag_of_words
    def WordFreq(self,word):
        """ Returning the frequency of a word """
        if word in self.__bag_of_words:
            return self.__bag_of_words[word]
        else:
            return 0
```

Dokumenten-Klasse

```
class Document(object):
    """ Used both for learning (training) documents and for testing documents.
The optional parameter lear
    has to be set to True, if a classificator should be trained. If it is a
test document learn has to be set to False. """
    _vocabulary = BagOfWords()

    def __init__(self, vocabulary):
        self.__name = ""
        self.__document_class = None
        self._words_and_freq = BagOfWords()
        Document._vocabulary = vocabulary

    def read_document(self,filename, learn=False):
        """ A document is read. It is assumed, that the document is either
encoded in utf-8 or in iso-8859... (latin-1).
        The words of the document are stored in a Bag of Words, i.e.
self._words_and_freq = BagOfWords() """
        try:
            text = open(filename,"r", encoding='utf-8').read()
        except UnicodeDecodeError:
            text = open(filename,"r", encoding='latin-1').read()
        text = text.lower()
        words = re.split("[^\wäöüÄÖÜß]*",text)

        self._number_of_words = 0
        for word in words:
            self._words_and_freq.add_word(word)
            if learn:
                Document._vocabulary.add_word(word)


    def __add__(self,other):
        """ Overloading the "+" operator. Adding two documents consists in
adding the BagOfWords of the Documents """
        res = Document(Document._vocabulary)
        res._words_and_freq = self._words_and_freq + other._words_and_freq
        return res

    def vocabulary_length(self):
        """ Returning the length of the vocabulary """
        return len(Document._vocabulary)

    def WordsAndFreq(self):
        """ Returning the dictionary, containing the words (keys) with their
frequency (values) as contained
```

```
        in the BagOfWords attribute of the document"""
        return self._words_and_freq.BagOfWords()

    def Words(self):
        """ Returning the words of the Document object """
        d =  self._words_and_freq.BagOfWords()
        return d.keys()

    def WordFreq(self,word):
        """ Returning the number of times the word "word" appeared in the
document """
        bow =  self._words_and_freq.BagOfWords()
        if word in bow:
            return bow[word]
        else:
            return 0

    def __and__(self, other):
        """ Intersection of two documents. A list of words occuring in both
documents is returned """
        intersection = []
        words1 = self.Words()
        for word in other.Words():
            if word in words1:
                intersection += [word]
        return intersection
```

Die Klasse DocumentClass

Die Klasse DocumentClass ist die Klasse für unser Dokumentenklassen. Sie erbt von der Klasse Document.

```
class DocumentClass(Document):
    def __init__(self, vocabulary):
        Document.__init__(self, vocabulary)
        self._number_of_docs = 0

    def Probability(self,word):
        """ returns the probabilty of the word "word" given the class "self"
"""
        voc_len = Document._vocabulary.len()
        SumN = 0
        for i in range(voc_len):
            SumN = DocumentClass._vocabulary.WordFreq(word)
        N = self._words_and_freq.WordFreq(word)
        erg = 1 + N
        erg /= voc_len + SumN
        return erg

    def __add__(self,other):
        """ Overloading the "+" operator. Adding two DocumentClass objects
consists in adding the
        BagOfWords of the DocumentClass objectss """
        res = DocumentClass(self._vocabulary)
        res._words_and_freq = self._words_and_freq + other._words_and_freq
        return res

    def SetNumberOfDocs(self, number):
        self._number_of_docs = number

    def NumberOfDocuments(self):
        return self._number_of_docs
```

Die Pool-Klasse

Die Klasse pool ist die Klasse, in der die Dokumentenklassen gelernt werden, und die die Klassifikationsmethoden zur Verfügung stellt:

```
class Pool(object):
    def __init__(self):
        self.__document_classes = {}
        self.__vocabulary = BagOfWords()

    def sum_words_in_class(self, dclass):
        """ The number of times all different words of a dclass appear in a
class """
        sum = 0
        for word in self.__vocabulary.Words():
            WaF = self.__document_classes[dclass].WordsAndFreq()
            if word in WaF:
                sum +=  WaF[word]
        return sum

    def learn(self, directory, dclass_name):
        """ directory is a path, where the files of the class with the name
dclass_name can be found """
        x = DocumentClass(self.__vocabulary)
        dir = os.listdir(directory)
        for file in dir:
            d = Document(self.__vocabulary)
            print(directory + "/" + file)
            d.read_document(directory + "/" +  file, learn = True)
            x = x + d
        self.__document_classes[dclass_name] = x
        x.SetNumberOfDocs(len(dir))


    def Probability(self, doc, dclass = ""):
        """Calculates the probability for a class dclass given a document
doc"""
        if dclass:
            sum_dclass = self.sum_words_in_class(dclass)
            prob = 0

            d = Document(self.__vocabulary)
            d.read_document(doc)

            for j in self.__document_classes:
                sum_j = self.sum_words_in_class(j)
                prod = 1
                for i in d.Words():
                    wf_dclass = 1 +
self.__document_classes[dclass].WordFreq(i)
                    wf = 1 + self.__document_classes[j].WordFreq(i)
                    r = wf * sum_dclass / (wf_dclass * sum_j)
                    prod *= r
                prob += prod * self.__document_classes[j].NumberOfDocuments()
/ self.__document_classes[dclass].NumberOfDocuments()
            if prob != 0:
                return 1 / prob
            else:
                return -1
        else:
            prob_list = []
            for dclass in self.__document_classes:
                prob = self.Probability(doc, dclass)
                prob_list.append([dclass,prob])
            prob_list.sort(key = lambda x: x[1], reverse = True)
            return prob_list

    def DocumentIntersectionWithClasses(self, doc_name):
        res = [doc_name]
        for dc in self.__document_classes:
            d = Document(self.__vocabulary)
            d.read_document(doc_name, learn=False)
            o = self.__document_classes[dc] &  d
            intersection_ratio = len(o) / len(d.Words())
            res += (dc, intersection_ratio)
        return res
```

Benutzung des Klassifikators

Damit Sie einen Klassifikator lernen und testen können, stellen wir einen ein"Lern und Testset zum Download" zur Verfügung. Dabei handelt es sich um sechs Klassen mit englischen Witzen der Rubriken "clinton", "lawyer", "math", "medical", "music", "sex".

```
from NaiveBayes import  Pool
import os

DClasses = ["clinton",  "lawyer",  "math",  "medical",  "music",  "sex"]

base = "../learn/"
p = Pool()
for i in DClasses:
    p.learn(base + i, i)



base = "../test/"
for i in DClasses:
    dir = os.listdir(base + i)
    for file in dir:
        res = p.Probability(base + i + "/" + file)
        print(i + ": " + file + ": " + str(res))
```