

Applied Machine Learning Homework 5

Due 2 May, 2022 (Monday) 11:59PM EST

Natural Language Processing

We will train a supervised training model to predict if a tweet has a positive or negative sentiment.

Dataset loading & dev/test splits

1.1) Load the twitter dataset from NLTK library

```
In [1]: import nltk
nltk.download('twitter_samples')
from nltk.corpus import twitter_samples
```

```
[nltk_data] Downloading package twitter_samples to
[nltk_data] /Users/eshankumar/nltk_data...
[nltk_data] Package twitter_samples is already up-to-date!
```

1.2) Load the positive & negative tweets

```
In [2]: all_positive_tweets = twitter_samples.strings('positive_tweets.json')
all_negative_tweets = twitter_samples.strings('negative_tweets.json')
```

```
In [6]: print("Example of positive tweet:\t" + all_positive_tweets[4])
print("\nExample of negative tweet:\t" + all_negative_tweets[4])
```

```
Example of positive tweet:      yeaaaah yippppy!!! my acct verified rqst has succeed got a blue tick mar
k on my fb profile :) in 15 days
```

```
Example of negative tweet:      Dang starting next week I have "work" :(
```

1.3) Create a development & test split (80/20 ratio):

```
In [39]: from sklearn.model_selection import train_test_split
import pandas as pd
```

```
posDF = pd.DataFrame(all_positive_tweets)
posDF['sentiment'] = 1
negDF = pd.DataFrame(all_negative_tweets)
negDF['sentiment'] = 0
```

```
tweetDF = posDF.append(negDF, ignore_index=True)
```

```
X_data = tweetDF.drop(columns=['sentiment'])
y_data = tweetDF['sentiment']
```

```
X_dev_raw, X_test_raw, y_dev, y_test = train_test_split(X_data, y_data, stratify=y_data,
                                                         test_size = 0.2, random_state=42)
```

```
/var/folders/mg/dz4xl9196tg095k9bq0ckpw40000gn/T/ipykernel_5950/3089239367.py:9: FutureWarning: The frame.
append method is deprecated and will be removed from pandas in a future version. Use pandas.concat instea
d.
```

```
tweetDF = posDF.append(negDF, ignore_index=True)
```

Data preprocessing

We will do some data preprocessing before we tokenize the data. We will remove # symbol, hyperlinks, stop words & punctuations from the data. You can use the `re` package in python to find and replace these strings.

1.4) Replace the # symbol with " in every tweet

```
In [50]: X_dev_list = X_dev_raw[0].tolist()
X_test_list = X_test_raw[0].tolist()

X_dev_poundless = [tweet.replace("#", "") for tweet in X_dev_list]
X_test_poundless = [tweet.replace("#", "") for tweet in X_test_list]
```

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1.5) Replace hyperlinks with " in every tweet

```
In [53]: import re

X_dev_no_link = [re.sub(r'http\S+', '', tweet) for tweet in X_dev_poundless]
X_test_no_link = [re.sub(r'http\S+', '', tweet) for tweet in X_test_poundless]

print(f"Before removing hyperlink:\t{X_dev_poundless[3]}")
print(f"\nAfter removing hyperlink:\t{X_dev_no_link[3]}")
```

Before removing hyperlink: Thankyou x :) <https://t.co/Y21tv7APVO> (<https://t.co/Y21tv7APVO>)

After removing hyperlink: Thankyou x :)

1.6) Remove all stop words

```
In [64]: from sklearn.feature_extraction.text import ENGLISH_STOP_WORDS
print(f"Number of stop words: {len(ENGLISH_STOP_WORDS)}")
print(f"Some stop words: {list(ENGLISH_STOP_WORDS)[:20]}")

def remove_stop_words(inputList):
    outputList = []
    for tweet in inputList:
        newtweet = tweet
        for word in ENGLISH_STOP_WORDS:
            newtweet = newtweet.replace(" "+word+" ", " ")
        outputList.append(newtweet)
    return outputList

X_dev_no_stop = remove_stop_words(X_dev_no_link)
X_test_no_stop = remove_stop_words(X_test_no_link)
```

```
print(f"\nBefore removing stop words:\n{X_dev_no_link[16]}")
print(f"\nAfter removing stop words:\n{X_dev_no_stop[16]}")
```

Number of stop words: 318

Some stop words: ['next', 'show', 'some', 'each', 'de', 'nothing', 'almost', 'nine', 'my', 'than', 'they', 'what', 'un', 'eg', 'besides', 'these', 'twenty', 'where', 'once', 'else']

Sentence with stop words included:

@JabongIndia ready and eagerly waiting for the next question. bring it on :) JabongatPumaUrbanStampede JabongatPumaUrbanStampede

Sentence with stop words removed:

@JabongIndia ready eagerly waiting question. bring :) JabongatPumaUrbanStampede JabongatPumaUrbanStampede

1.7) Remove all punctuations

```
In [65]: X_dev_no_punc = [re.sub(r'[\W\s]', '', tweet) for tweet in X_dev_no_stop]
X_test_no_punc = [re.sub(r'[\W\s]', '', tweet) for tweet in X_test_no_stop]

print(f"\nBefore removing punctuation:\n{X_dev_no_stop[16]}")
print(f"\nAfter removing punctuation:\n{X_dev_no_punc[16]}")
```

Before removing punctuation:

@JabongIndia ready eagerly waiting question. bring :) JabongatPumaUrbanStampede JabongatPumaUrbanStampede

After removing punctuation:

JabongIndia ready eagerly waiting question bring JabongatPumaUrbanStampede JabongatPumaUrbanStampede

1.8) Apply stemming on the development & test datasets using Porter algorithm

```
In [77]: from nltk.tokenize import word_tokenize, sent_tokenize
from nltk.stem import *
import nltk
nltk.download('punkt')

def stemSentence(sentence):
    token_words = word_tokenize(sentence)
    stem_sentence=[porter.stem(word) for word in token_words]
    return " ".join(stem_sentence)

[nltk_data] Downloading package punkt to
[nltk_data]      /Users/eshankumar/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
```

```
In [79]: porter = PorterStemmer()

X_dev = [stemSentence(tweet) for tweet in X_dev_no_punc]
X_test = [stemSentence(tweet) for tweet in X_test_no_punc]

print(f"\nBefore stemming:\n{X_dev_no_punc[16]}")
print(f"\nAfter stemming:\n{X_dev[16]}")
```

Before stemming:
JabongIndia ready eagerly waiting question bring JabongatPumaUrbanStampede JabongatPumaUrbanStampede

After stemming:
jabongindia readi eagerli wait question bring jabongatpumaurbanstamped jabongatpumaurbanstamped

Model training

1.9) Create bag of words features for each tweet in the development dataset

```
In [90]: from sklearn.feature_extraction.text import CountVectorizer
vector = CountVectorizer()

vector.fit(X_dev)
print(f"Some feature names in the fitted vector (dictionary):\n\
      {vector.get_feature_names()[4000:4020]}")
X_dev_BOW_vector = vector.transform(X_dev)
X_test_BOW_vector = vector.transform(X_test)

print(f"\nShape of X_dev:\t\t{X_dev_BOW_vector.shape}")
print(f"Shape of X_test\t\t{X_test_BOW_vector.shape}")

Some feature names in the fitted vector (dictionary):
['ebook', 'ebookwoman', 'ecclesteach', 'eckoxsoldi', 'eclair605209', 'ecotr', 'eczema', 'eczemanomor', 'e
d', 'ed_dur', 'eddie_avi', 'edelabayog', 'edenador', 'edgar_trilla', 'edin_gam', 'edinunineuro', 'edit',
'editi', 'editionsdulivr', 'edm']

Shape of X_dev:      (8000, 14735)
Shape of X_test     (2000, 14735)

/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/utils/deprecation.py:87: FutureWarning: F
unction get_feature_names is deprecated; get_feature_names_out is deprecated in 1.0 and will be removed in 1.
2. Please use get_feature_names_out instead.
  warnings.warn(msg, category=FutureWarning)
```

1.10) Train a supervised learning model of choice on the development dataset

```
In [85]: from sklearn.linear_model import LogisticRegressionCV
```

```
lr_BOW = LogisticRegressionCV().fit(X_dev_BOW_vector, y_dev)
```

```
/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed to converge (status=1):  
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

Increase the number of iterations (max_iter) or scale the data as shown in:

<https://scikit-learn.org/stable/modules/preprocessing.html> (<https://scikit-learn.org/stable/modules/preprocessing.html>)

Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)

```
n_iter_i = _check_optimize_result(
```

```
/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed to converge (status=1):  
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https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)
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n_iter_i = _check_optimize_result(
/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

1.11) Create TF-IDF features for each tweet in the development dataset

```
In [91]: from sklearn.feature_extraction.text import TfidfVectorizer
vector = TfidfVectorizer()

vector.fit(X_dev)
print(f"Some feature names in the fitted vector (dictionary):\n\
      {vector.get_feature_names()[4000:4020]}")
X_dev_TFIDF_vector = vector.transform(X_dev)
X_test_TFIDF_vector = vector.transform(X_test)

print(f"\nShape of X_dev:\t\t{X_dev_TFIDF_vector.shape}")
print(f"Shape of X_test\t\t{X_test_TFIDF_vector.shape}")
```

Some feature names in the fitted vector (dictionary):
['ebook', 'ebookwoman', 'ecclesteach', 'eckoxsoldi', 'eclair605209', 'ecotr', 'eczema', 'eczemanomor', 'e
d', 'ed_dur', 'eddie_avi', 'edelabayog', 'edenador', 'edgar_trilla', 'edin_gam', 'edinunineuro', 'edit',
'editi', 'editionsdulivr', 'edm']

Shape of X_dev: (8000, 14735)
Shape of X_test (2000, 14735)

1.12) Train the same supervised learning algorithm on the development dataset with TF-IDF features


```
In [92]: lr_TFIDF = LogisticRegressionCV().fit(X_dev_TFIDF_vector, y_dev)
```

```
/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed to converge (status=1):  
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

Increase the number of iterations (max_iter) or scale the data as shown in:

<https://scikit-learn.org/stable/modules/preprocessing.html> (<https://scikit-learn.org/stable/modules/preprocessing.html>)

Please also refer to the documentation for alternative solver options:

https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)

```
n_iter_i = _check_optimize_result(  
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```

Increase the number of iterations (max_iter) or scale the data as shown in:

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Please also refer to the documentation for alternative solver options:

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```
n_iter_i = _check_optimize_result(  
/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed to converge (status=1):  
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

Increase the number of iterations (max_iter) or scale the data as shown in:

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```
n_iter_i = _check_optimize_result(  
/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py:814: ConvergenceWarning: lbfgs failed to converge (status=1):  
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
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```
g/stable/modules/linear_model.html#logistic-regression)
n_iter_i = _check_optimize_result(
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eWarning: lbfgs failed to converge (status=1):
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```

Increase the number of iterations (max_iter) or scale the data as shown in:

```
https://scikit-learn.org/stable/modules/preprocessing.html (https://scikit-learn.org/stable/modules/preprocessing.html)
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```

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```

```
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/Users/eshankumar/mambaforge/lib/python3.9/site-packages/sklearn/linear_model/_logistic.py:814: Convergenc
eWarning: lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

Increase the number of iterations (max_iter) or scale the data as shown in:

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Please also refer to the documentation for alternative solver options:

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n_iter_i = _check_optimize_result(

```

1.13) Compare the performance of the two models on the test dataset

```

In [93]: print(f"\nScore of logistic regression model trained on BOW representation:\t\
        {lr_BOW.score(X_test_BOW_vector, y_test)}")
print(f"Score of logistic regression model trained on TF-IDF representation\t\
        {lr_TFIDF.score(X_test_TFIDF_vector, y_test)}")

```

Score of logistic regression model trained on BOW representation:	0.755
Score of logistic regression model trained on TF-IDF representation	0.754