3.6 Featurizing text data with tfidf weighted word-vectors

In [78]:

```
import pandas as pd
import matplotlib.pyplot as plt
import re
import time
import warnings
import numpy as np
from nltk.corpus import stopwords
from sklearn.preprocessing import normalize
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfVectorizer
warnings.filterwarnings("ignore")
import sys
import os
import pandas as pd
import numpy as np
from tqdm import tqdm
from scipy.sparse import hstack
# exctract word2vec vectors
# https://github.com/explosion/spaCy/issues/1721
# http://landinghub.visualstudio.com/visual-cpp-build-tools
import spacy
from sklearn.model_selection import train_test_split
```

In [79]:

```
# avoid decoding problems
df = pd.read_csv("train.csv")
df=df[:100000]
# encode questions to unicode
# https://stackoverflow.com/a/6812069
# ----------------- python 2 ---------------------
# df['question1'] = df['question1'].apply(lambda x: unicode(str(x),"utf-8"))
# df['question2'] = df['question2'].apply(lambda x: unicode(str(x),"utf-8"))
# ----------------- python 3 ---------------------
df['question1'] = df['question1'].apply(lambda x: str(x))
df['question2'] = df['question2'].apply(lambda x: str(x))
```

In [80]:

```
#prepro_features_train.csv (Simple Preprocessing Feartures)
#nlp_features_train.csv (NLP Features)
if os.path.isfile('nlp_features_train.csv'):
    dfnlp = pd.read_csv("nlp_features_train.csv",encoding='latin-1')
    dfnlp=dfnlp[:100000]
else:
    print("download nlp_features_train.csv from drive or run previous notebook")

if os.path.isfile('df_fe_without_preprocessing_train.csv'):
    dfppro = pd.read_csv("df_fe_without_preprocessing_train.csv",encoding='latin-1')
    dfppro=dfppro[:100000]
else:
    print("download df_fe_without_preprocessing_train.csv from drive or run previous notebook")
```

In [81]:

```
data=pd.concat([df,dfnlp,dfppro],axis=1)
print(data.shape)
#https://stackoverflow.com/questions/14984119/python-pandas-remove-duplicate-columns
data = data.loc[:,~data.columns.duplicated()]
print(data.shape)
```

```
(100000, 44)
(100000, 32)
```

In [82]:

```
y_true = data['is_duplicate']
data.drop(['is_duplicate'], axis=1, inplace=True)
```

In [83]:

```
X_tr,X_test, y_tr, y_test = train_test_split(data, y_true, stratify=y_true, test_size=0.3)
```

In [84]:

```
print("Number of data points in train data :",X_tr.shape)
print("Number of data points in test data :",X_test.shape)
```

```
Number of data points in train data : (70000, 31)
Number of data points in test data : (30000, 31)
```

In [85]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer
# merge texts
questions = list(X_tr['question1']) + list(X_tr['question2']) + list(X_test['question1']) + list(X_
test['question2'])

tfidf = TfidfVectorizer(lowercase=False, )
tfidf.fit_transform(questions)

# dict key:word and value:tf-idf score
word2tfidf = dict(zip(tfidf.get_feature_names(), tfidf.idf_))
```

In [86]:

```
# en_vectors_web_lg, which includes over 1 million unique vectors.
nlp = spacy.load('en_core_web_sm')
def vectoriser(source_df,dest_df,source_column,dest_column):
    vecs1 = []
        # https://github.com/noamraph/tqdm
        # tqdm is used to print the progrsource_columness bar
    for qu1 in tqdm(list(source_df[source_column])):
        doc1 = nlp(qu1)
        # 384 is the number of dimensions of vectors
        mean_vec1 = np.zeros([len(doc1), len(doc1[0].vector)])
        for word1 in doc1:
            # word2vec
            vec1 = word1.vector
            # fetch df score
            try:
                idf = word2tfidf[str(word1)]
            except:
                idf = 0
            # compute final vec
            mean_vec1 += vec1 * idf
        mean_vec1 = mean_vec1.mean(axis=0)
        vecs1.append(mean_vec1)
    dest_df[dest_column] = list(vecs1)
```

In [87]:

```
vectoriser(X_tr,X_tr,'question1','q1_feats_m')
vectoriser(X_tr,X_tr,'question2','q2_feats_m')
vectoriser(X_test,X_test,'question1','q1_feats_m')
vectoriser(X_test,X_test,'question2','q2_feats_m')
```

```
100%|██████████| 70000/70000 [30
:46<00:00, 37.90it/s]
100%|██████████| 70000/70000 [31
:56<00:00, 36.53it/s]
100%|██████████| 30000/30000 [09
:49<00:00, 50.86it/s]
100%|██████████| 30000/30000 [10
```

```
:02<00:00, 50.54it/s]
```

In [88]:

```
print("Number of data points in train data :",X_tr.shape)
print("Number of data points in test data :",X_test.shape)
```

```
Number of data points in train data : (70000, 33)
Number of data points in test data : (30000, 33)
```

In [89]:

```
#https://stackoverflow.com/questions/40924332/splitting-a-list-in-a-pandas-cell-into-multiple-colu
mns
X_tr1=pd.concat([X_tr,pd.DataFrame(X_tr['q1_feats_m'].values.tolist(),index=X_tr.index,columns=['0_
1','1_1','2_1','3_1','4_1','5_1','6_1','7_1','8_1','9_1','10_1','11_1','12_1','13_1','14_1','15_1',
'16_1','17_1','18_1','19_1','20_1','21_1','22_1','23_1','24_1','25_1','26_1','27_1','28_1','29_1','
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4_1','45_1','46_1','47_1','48_1','49_1','50_1','51_1','52_1','53_1','54_1','55_1','56_1','57_1','58
_1','59_1','60_1','61_1','62_1','63_1','64_1','65_1','66_1','67_1','68_1','69_1','70_1','71_1','72_
1','73_1','74_1','75_1','76_1','77_1','78_1','79_1','80_1','81_1','82_1','83_1','84_1','85_1','86_1
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0_1','371_1','372_1','373_1','374_1','375_1','376_1','377_1','378_1','379_1','380_1','381_1','382_
1','383_1'])], axis=1)
X_tr1=pd.concat([X_tr1,pd.DataFrame(X_tr['q2_feats_m'].values.tolist(),index=X_tr.index,columns=['0
_2','1_2','2_2','3_2','4_2','5_2','6_2','7_2','8_2','9_2','10_2','11_2','12_2','13_2','14_2','15_2'
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3_2','334_2','335_2','336_2','337_2','338_2','339_2','340_2','341_2','342_2','343_2','344_2','345_
```

```
2','346_2','347_2','348_2','349_2','350_2','351_2','352_2','353_2','354_2','355_2','356_2','357_2'
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370_2','371_2','372_2','373_2','374_2','375_2','376_2','377_2','378_2','379_2','380_2','381_2','38
2_2','383_2'])], axis=1)
X_test1=pd.concat([X_test,pd.DataFrame(X_test['q1_feats_m'].values.tolist(),index=X_test.index,colu
mns=['0_1','1_1','2_1','3_1','4_1','5_1','6_1','7_1','8_1','9_1','10_1','11_1','12_1','13_1','14_1'
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9_1','370_1','371_1','372_1','373_1','374_1','375_1','376_1','377_1','378_1','379_1','380_1','381_
1','382_1','383_1'])], axis=1)
X_test1=pd.concat([X_test1,pd.DataFrame(X_test['q1_feats_m'].values.tolist(),index=X_test.index,col
umns=['0_2','1_2','2_2','3_2','4_2','5_2','6_2','7_2','8_2','9_2','10_2','11_2','12_2','13_2','14_2
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_2','86_2','87_2','88_2','89_2','90_2','91_2','92_2','93_2','94_2','95_2','96_2','97_2','98_2','99_
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271_2','272_2','273_2','274_2','275_2','276_2','277_2','278_2','279_2','280_2','281_2','282_2','28
3_2','284_2','285_2','286_2','287_2','288_2','289_2','290_2','291_2','292_2','293_2','294_2','295_
2','296_2','297_2','298_2','299_2','300_2','301_2','302_2','303_2','304_2','305_2','306_2','307_2'
,'308_2','309_2','310_2','311_2','312_2','313_2','314_2','315_2','316_2','317_2','318_2','319_2','
320_2','321_2','322_2','323_2','324_2','325_2','326_2','327_2','328_2','329_2','330_2','331_2','33
2_2','333_2','334_2','335_2','336_2','337_2','338_2','339_2','340_2','341_2','342_2','343_2','344_
2','345_2','346_2','347_2','348_2','349_2','350_2','351_2','352_2','353_2','354_2','355_2','356_2'
,'357_2','358_2','359_2','360_2','361_2','362_2','363_2','364_2','365_2','366_2','367_2','368_2','
369_2','370_2','371_2','372_2','373_2','374_2','375_2','376_2','377_2','378_2','379_2','380_2','38
1_2','382_2','383_2'])], axis=1)
```

In [90]:

```
print("Number of data points in train data :",X_tr.shape)
print("Number of data points in test data :",X_test.shape)
print("Number of data points in train data :",X_tr1.shape)
print("Number of data points in test data :",X_test1.shape)
```

```
Number of data points in train data : (70000, 33)
Number of data points in test data : (30000, 33)
Number of data points in train data : (70000, 801)
Number of data points in test data : (30000, 801)
```

In [92]:

```
X_tr.drop(['q1_feats_m','q2_feats_m'], axis=1,inplace=True)
X_test.drop(['q1_feats_m','q2_feats_m'], axis=1,inplace=True)
X_tr1.drop(['qid1','qid2','question1','question2','q1_feats_m','q2_feats_m'], axis=1,inplace=True)
X_test1.drop(['qid1','qid2','question1','question2','q1_feats_m','q2_feats_m'],
axis=1,inplace=True)
```

In [93]:

```
print("Number of data points in train data :",X_tr.shape)
print("Number of data points in test data :",X_test.shape)
print("Number of data points in train data :",X_tr1.shape)
print("Number of data points in test data :",X_test1.shape)
```

```
Number of data points in train data : (70000, 31)
Number of data points in test data : (30000, 31)
Number of data points in train data : (70000, 795)
Number of data points in test data : (30000, 795)
```

In [94]:

```
from sqlalchemy import create_engine
engine = create_engine('sqlite:///w2v_data.db')

#X_tr_q1  = X_tr_q1.merge(X_tr_q2, on='id',how='left')
#w2v_tr  = df1_tr.merge(X_tr_q1, on='id',how='left')
print(X_tr1.shape)
X_tr1.to_sql('X_tr', engine, if_exists='replace')
y_tr.to_sql('y_tr', engine, if_exists='replace')

#X_test_q1  = X_test_q1.merge(X_test_q2, on='id',how='left')
#w2v_test  = df1_test.merge(X_test_q1, on='id',how='left')
print(X_test1.shape)
X_test1.to_sql('X_test', engine, if_exists='replace')
y_test.to_sql('y_test', engine, if_exists='replace')
```

```
(70000, 795)
(30000, 795)
```

In [96]:

```
print("Number of data points in train data :",X_tr.shape)
print("Number of data points in test data :",X_test.shape)
```

```
Number of data points in train data : (70000, 31)
Number of data points in test data : (30000, 31)
```

In [97]:

```
#https://stackoverflow.com/questions/45961747/append-tfidf-to-pandas-dataframe
from sklearn.feature_extraction.text import TfidfVectorizer

tfidf = TfidfVectorizer(min_df=10)
tfidf_ques1_tr= tfidf.fit_transform(X_tr['question1'])
tfidf_ques1_test= tfidf.transform(X_test['question1'])

X_q1_tr = pd.DataFrame(tfidf_ques1_tr.toarray(), columns=tfidf.get_feature_names(), index=
X_tr.index)
X_q1_test = pd.DataFrame(tfidf_ques1_test.toarray(), columns=tfidf.get_feature_names(), index=
X_test.index)
#X_tr['q1_feats_m'] = list(tfidf_ques1_tr.toarray())
#X_test['q1_feats_m'] = list(tfidf_ques1_test.toarray())
#X_tr['q2_feats_m'] = list(tfidf_ques2_tr.toarray())
#X_test['q2_feats_m'] = list(tfidf_ques2_test.toarray())
```

- After we find TF-IDF scores, we convert each question to a weighted average of word2vec vectors by these scores.
- here we use a pre-trained GLOVE model which comes free with "Spacy". https://spacy.io/usage/vectors-similarity
- It is trained on Wikipedia and therefore, it is stronger in terms of word semantics.

In [99]:

```
#X_q1_tr = pd.DataFrame(tfidf_ques1_tr.toarray(), index= X_tr.index)

tfidf = TfidfVectorizer(min_df=10)
tfidf_ques2_tr= tfidf.fit_transform(X_tr['question2'])
tfidf_ques2_test= tfidf.transform(X_test['question2'])

X_q2_tr = pd.DataFrame(tfidf_ques2_tr.toarray(), columns=tfidf.get_feature_names(), index=
X_tr.index)
X_q2_test = pd.DataFrame(tfidf_ques2_test.toarray(), columns=tfidf.get_feature_names(), index=
X_test.index)
```

In [101]:

```
print("Number of data points in train data :",X_tr.shape)
print("Number of data points in test data :",X_test.shape)
```

```
Number of data points in train data : (70000, 31)
Number of data points in test data : (30000, 31)
```

In [102]:

```
X_tr.drop(['qid1','qid2','question1','question2'],axis=1,inplace=True)
X_test.drop(['qid1','qid2','question1','question2'],axis=1,inplace=True)
```

In [106]:

```
X_tr=pd.concat([X_tr,X_q1_tr,X_q2_tr], axis=1)
X_test=pd.concat([X_test,X_q1_test,X_q2_test], axis=1)
```

In [108]:

```
print("Number of data points in train data :",X_tr.shape)
print("Number of data points in test data :",X_test.shape)
```

```
Number of data points in train data : (70000, 10431)
Number of data points in test data : (30000, 10431)
```

In [109]:

```
#X_q1_tr  = X_q1_tr.merge(X_q2_tr, on='id',how='left')
#tfidf_tr  = df2_tr.merge(X_q1_tr, on='id',how='left')
print(X_tr.shape)
X_tr.to_csv('X_tr.csv',index='id')
#X_q1_test  = X_q1_test.merge(X_q2_test, on='id',how='left')
#tfidf_test  = df2_test.merge(X_q1_test, on='id',how='left')
print(X_test.shape)
X_test.to_csv('X_test.csv',index='id')
```

```
(70000, 10431)
(30000, 10431)
```