In [1]:

```
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

# exctract word2vec vectors
# https://github.com/explosion/spaCy/issues/1721
# http://landinghub.visualstudio.com/visual-cpp-build-tools
import spacy
```

In [2]:

```
# avoid decoding problems
df = pd.read_csv("G:\\machine_learning\\case_study\\Quora\\train.csv")

# 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 [3]:

```
df.head()
```

Out[3]:

	id	qid1	qid2	question1	question2	is_duplicate
0	0	1	2	What is the step by step guide to invest in sh...	What is the step by step guide to invest in sh...	0
1	1	3	4	What is the story of Kohinoor (Koh-i-Noor) Dia...	What would happen if the Indian government sto...	0
2	2	5	6	How can I increase the speed of my internet co...	How can Internet speed be increased by hacking...	0
3	3	7	8	Why am I mentally very lonely? How can I solve...	Find the remainder when [math]23^{24}[/math] i...	0
4	4	9	10	Which one dissolve in water quikly sugar, salt...	Which fish would survive in salt water?	0

In [4]:

```
#prepro_features_train.csv (Simple Preprocessing Feartures)
#nlp_features_train.csv (NLP Features)
if os.path.isfile('G:\\machine_learning\\case_study\\Quora\\n
lp_features_train.csv'):
    dfnlp = pd.read_csv("G:\\machine_learning\\case_study\\Qu
ora\\nlp_features_train.csv",encoding='latin-1')
else:
    print("download nlp_features_train.csv from drive or run
previous notebook")

if os.path.isfile('G:\\machine_learning\\case_study\\Quora\\d
f_fe_without_preprocessing_train.csv'):
    dfppro = pd.read_csv("G:\\machine_learning\\case_study\\Q
uora\\df_fe_without_preprocessing_train.csv",encoding='latin-
1')
else:
    print("download df_fe_without_preprocessing_train.csv fro
m drive or run previous notebook")
```

In [5]:

```
df1 = dfnlp.drop(['id','qid1','qid2','question1','question
2'],axis=1)
df2 = dfppro.drop(['id','qid1','qid2','question1','question
2','is_duplicate'],axis=1)
df3 = df.drop(['id','qid1','qid2','is_duplicate'],axis=1)
```

In [6]:

```
df4 = df1.join(df2)
```

In [7]:

```
df5 = df4.join(df3)
```

In [8]:

```
df5
```

Out[8]:

	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ct
0	0	0.999980	0.833319	0.999983	0.999983	0.916659	0.7
1	0	0.799984	0.399996	0.749981	0.599988	0.699993	0.4
2	0	0.399992	0.333328	0.399992	0.249997	0.399996	0.2
3	0	0.000000	0.000000	0.000000	0.000000	0.000000	0.0
4	0	0.399992	0.199998	0.999950	0.666644	0.571420	0.3
...	...	...	...	...	...	...	
404285	0	0.857131	0.857131	0.999980	0.833319	0.846147	0.7
404286	1	0.666644	0.666644	0.599988	0.599988	0.624992	0.5
404287	0	0.999900	0.499975	0.999950	0.666644	0.749981	0.7
404288	0	0.000000	0.000000	0.124998	0.099999	0.058823	0.0

Out[8]:

	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ct
404289	0	0.999967	0.999967	0.999980	0.714276	0.999988	0.7

404290 rows × 29 columns

In [9]:
```
df3
```

Out[9]:

	question1	question2
0	What is the step by step guide to invest in sh...	What is the step by step guide to invest in sh...
1	What is the story of Kohinoor (Koh-i-Noor) Dia...	What would happen if the Indian government sto...
2	How can I increase the speed of my internet co...	How can Internet speed be increased by hacking...
3	Why am I mentally very lonely? How can I solve...	Find the remainder when [math]23^{24}[/math] i...
4	Which one dissolve in water quikly sugar, salt...	Which fish would survive in salt water?
...	...	...
404285	How many keywords are there in the Racket prog...	How many keywords are there in PERL Programmin...
404286	Do you believe there is life after death?	Is it true that there is life after death?
404287	What is one coin?	What's this coin?
404288	What is the approx annual cost of living while...	I am having little hairfall problem but I want...
404289	What is like to have sex with cousin?	What is it like to have sex with your cousin?

404290 rows × 2 columns

In [10]:
```
df5.shape
```

Out[10]:
```
(404290, 29)
```

In [11]:
```
df_final = df5[0:100000]
```

In [12]:

```
from sklearn.model_selection import train_test_split
y_true = df_final['is_duplicate']
df_final1 = df_final.drop(['is_duplicate'],axis=1)
```

In [13]:

```
X_train,X_test, y_train, y_test = train_test_split(df_final1,
y_true, test_size=0.3)
```

In [14]:

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

```
Number of data points in train data : (70000, 28)
Number of data points in test data : (30000, 28)
```

In [15]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer
# merge texts
questions = (X_train['question1']) + (X_train['question2'])
questions1 = (X_test['question1']) + (X_test['question2'])

tfidf = TfidfVectorizer(lowercase=False, )
x_train_data = tfidf.fit_transform(questions)
x_test_data = tfidf.transform(questions1)
```

In [16]:

```
x_train_final = X_train.drop(['question1','question2'],axis=
1)
x_test_final = X_test.drop(['question1','question2'],axis=1)
```

In [17]:

```
from scipy.sparse import hstack

x_train_final_data = hstack((x_train_data,x_train_final)).toc
sr()
x_test_final_data = hstack((x_test_data,x_test_final)).tocsr
()
```

In [18]:

```
# This function plots the confusion matrices given y_i, y_i_h
at.
def plot_confusion_matrix(test_y, predict_y):
    C = confusion_matrix(test_y, predict_y)
    # C = 9,9 matrix, each cell (i,j) represents number of po
ints of class i are predicted class j

    A =(((C.T)/(C.sum(axis=1))).T)
    #divid each element of the confusion matrix with the sum
of elements in that column

    # C = [[1, 2],
    #     [3, 4]]
    # C.T = [[1, 3],
    #        [2, 4]]
    # C.sum(axis = 1)  axis=0 corresonds to columns and axis=
1 corresponds to rows in two diamensional array
    # C.sum(axix =1) = [[3, 7]]
    # ((C.T)/(C.sum(axis=1))) = [[1/3, 3/7]
    #                            [2/3, 4/7]]

    # ((C.T)/(C.sum(axis=1))).T = [[1/3, 2/3]
    #                            [3/7, 4/7]]
    # sum of row elements = 1

    B =(C/C.sum(axis=0))
    #divid each element of the confusion matrix with the sum
of elements in that row
    # C = [[1, 2],
    #     [3, 4]]
    # C.sum(axis = 0)  axis=0 corresonds to columns and axis=
1 corresponds to rows in two diamensional array
    # C.sum(axix =0) = [[4, 6]]
    # (C/C.sum(axis=0)) = [[1/4, 2/6],
    #                       [3/4, 4/6]]
    plt.figure(figsize=(20,4))

    labels = [1,2]
    # representing A in heatmap format
    cmap=sns.light_palette("blue")
    plt.subplot(1, 3, 1)
    sns.heatmap(C, annot=True, cmap=cmap, fmt=".3f", xticklab
els=labels, yticklabels=labels)
    plt.xlabel('Predicted Class')
    plt.ylabel('Original Class')
    plt.title("Confusion matrix")

    plt.subplot(1, 3, 2)
    sns.heatmap(B, annot=True, cmap=cmap, fmt=".3f", xticklab
els=labels, yticklabels=labels)
```

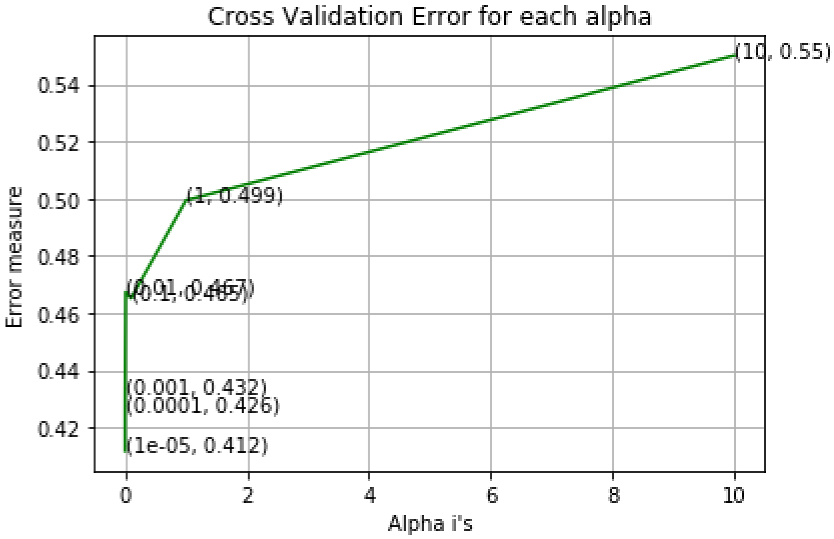
```python
    plt.xlabel('Predicted Class')
    plt.ylabel('Original Class')
    plt.title("Precision matrix")

    plt.subplot(1, 3, 3)
    # representing B in heatmap format
    sns.heatmap(A, annot=True, cmap=cmap, fmt=".3f", xticklabels=labels, yticklabels=labels)
    plt.xlabel('Predicted Class')
    plt.ylabel('Original Class')
    plt.title("Recall matrix")

    plt.show()
```

4.4 Logistic Regression with hyperparameter tuning

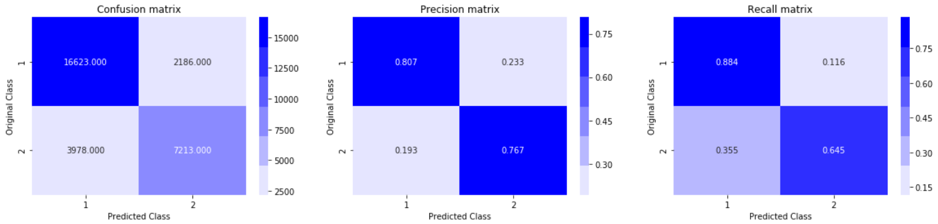
In [19]:

```
from sklearn.linear_model import SGDClassifier
from sklearn.calibration import CalibratedClassifierCV
from sklearn.metrics.classification import accuracy_score, log_loss
from sklearn.metrics import confusion_matrix
import seaborn as sns
alpha = [10 ** x for x in range(-5, 2)] # hyperparam for SGD classifier.

# read more about SGDClassifier() at http://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.html
# ------------------------------
# default parameters
# SGDClassifier(loss=’hinge’, penalty=’l2’, alpha=0.0001, l1_ratio=0.15, fit_intercept=True, max_iter=None, tol=None,
# shuffle=True, verbose=0, epsilon=0.1, n_jobs=1, random_state=None, learning_rate=’optimal’, eta0=0.0, power_t=0.5,
# class_weight=None, warm_start=False, average=False, n_iter=None)

# some of methods
# fit(X, y[, coef_init, intercept_init, …])     Fit linear model with Stochastic Gradient Descent.
# predict(X)    Predict class labels for samples in X.

#------------------------------
# video link:
#------------------------------



log_error_array=[]
for i in alpha:
    clf = SGDClassifier(alpha=i, penalty='l2', loss='log', random_state=42)
    clf.fit(x_train_final_data, y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
    sig_clf.fit(x_train_final_data, y_train)
    predict_y = sig_clf.predict_proba(x_test_final_data)
    log_error_array.append(log_loss(y_test, predict_y, labels=clf.classes_, eps=1e-15))
    print('For values of alpha = ', i, "The log loss is:",log_loss(y_test, predict_y, labels=clf.classes_, eps=1e-15))

fig, ax = plt.subplots()
ax.plot(alpha, log_error_array,c='g')
for i, txt in enumerate(np.round(log_error_array,3)):
    ax.annotate((alpha[i],np.round(txt,3)), (alpha[i],log_error_array[i]))
plt.grid()
plt.title("Cross Validation Error for each alpha")
plt.xlabel("Alpha i's")
plt.ylabel("Error measure")
plt.show()


best_alpha = np.argmin(log_error_array)
clf = SGDClassifier(alpha=alpha[best_alpha], penalty='l2', loss='log', random_state=42)
clf.fit(x_train_final_data, y_train)
sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
sig_clf.fit(x_train_final_data, y_train)

predict_y = sig_clf.predict_proba(x_train_final_data)
print('For values of best alpha = ', alpha[best_alpha], "The train log loss is:",log_loss(y_train, predict_y, labels=clf.classes_, eps=1e-15))
predict_y = sig_clf.predict_proba(x_test_final_data)
print('For values of best alpha = ', alpha[best_alpha], "The test log loss is:",log_loss(y_test, predict_y, labels=clf.classes_, eps=1e-15))
predicted_y =np.argmax(predict_y,axis=1)
print("Total number of data points :", len(predicted_y))
plot_confusion_matrix(y_test, predicted_y)
```

```
For values of alpha =  1e-05 The log loss is: 0.41174775245813044
For values of alpha =  0.0001 The log loss is: 0.42612839037450145
For values of alpha =  0.001 The log loss is: 0.43232417292253766
For values of alpha =  0.01 The log loss is: 0.46729035838984345
For values of alpha =  0.1 The log loss is: 0.46509339157119073
For values of alpha =  1 The log loss is: 0.4993668911341836
For values of alpha =  10 The log loss is: 0.549998771104127
```



```
For values of best alpha =  1e-05 The train log loss is: 0.4
0486775920825946
For values of best alpha =  1e-05 The test log loss is: 0.41
174775245813044
Total number of data points : 30000
```



4.5 Linear SVM with hyperparameter tuning

In [20]:

```
alpha = [10 ** x for x in range(-5, 2)] # hyperparam for SGD classifier.

# read more about SGDClassifier() at http://scikit-learn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.html
# ------------------------------
# default parameters
# SGDClassifier(loss='hinge', penalty='l2', alpha=0.0001, l1_ratio=0.15, fit_intercept=True, max_iter=None, tol=None,
# shuffle=True, verbose=0, epsilon=0.1, n_jobs=1, random_state=None, learning_rate='optimal', eta0=0.0, power_t=0.5,
# class_weight=None, warm_start=False, average=False, n_iter=None)

# some of methods
# fit(X, y[, coef_init, intercept_init, …])     Fit linear model with Stochastic Gradient Descent.
# predict(X)    Predict class labels for samples in X.

#-------------------------------
# video link:
#------------------------------



log_error_array=[]
for i in alpha:
    clf = SGDClassifier(alpha=i, penalty='l1', loss='hinge', random_state=42)
    clf.fit(x_train_final_data, y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
    sig_clf.fit(x_train_final_data, y_train)
    predict_y = sig_clf.predict_proba(x_test_final_data)
    log_error_array.append(log_loss(y_test, predict_y, labels=clf.classes_, eps=1e-15))
    print('For values of alpha = ', i, "The log loss is:",log_loss(y_test, predict_y, labels=clf.classes_, eps=1e-15))

fig, ax = plt.subplots()
ax.plot(alpha, log_error_array,c='g')
for i, txt in enumerate(np.round(log_error_array,3)):
    ax.annotate((alpha[i],np.round(txt,3)), (alpha[i],log_error_array[i]))
plt.grid()
plt.title("Cross Validation Error for each alpha")
plt.xlabel("Alpha i's")
plt.ylabel("Error measure")
plt.show()
```

```
best_alpha = np.argmin(log_error_array)
clf = SGDClassifier(alpha=alpha[best_alpha], penalty='l1', lo
ss='hinge', random_state=42)
clf.fit(x_train_final_data, y_train)
sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
sig_clf.fit(x_train_final_data, y_train)

predict_y = sig_clf.predict_proba(x_train_final_data)
print('For values of best alpha = ', alpha[best_alpha], "The
train log loss is:",log_loss(y_train, predict_y, labels=clf.c
lasses_, eps=1e-15))
predict_y = sig_clf.predict_proba(x_test_final_data)
print('For values of best alpha = ', alpha[best_alpha], "The
test log loss is:",log_loss(y_test, predict_y, labels=clf.cla
sses_, eps=1e-15))
predicted_y =np.argmax(predict_y,axis=1)
print("Total number of data points :", len(predicted_y))
plot_confusion_matrix(y_test, predicted_y)
```

```
For values of alpha =  1e-05 The log loss is: 0.426413287354
66766
For values of alpha =  0.0001 The log loss is: 0.45817853229
767475
```

```
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
```

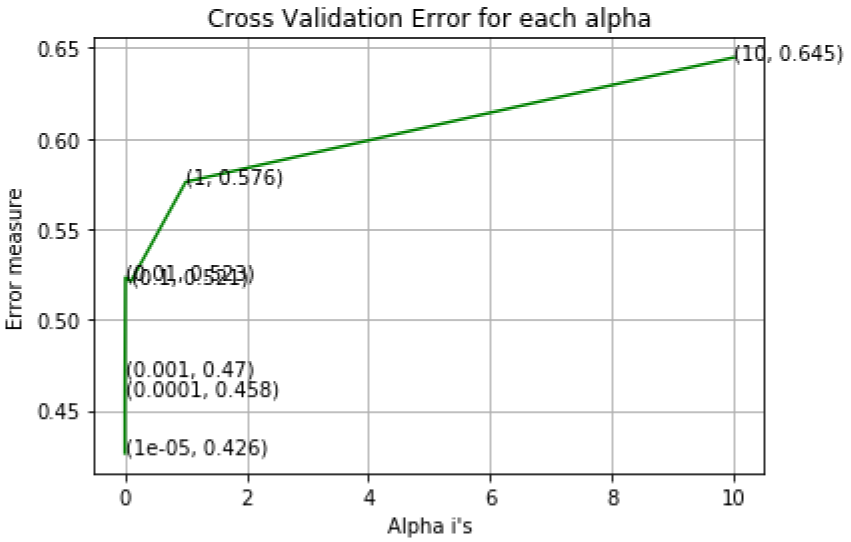
```
For values of alpha =  0.001 The log loss is: 0.469850558146
8644
```

```
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
```

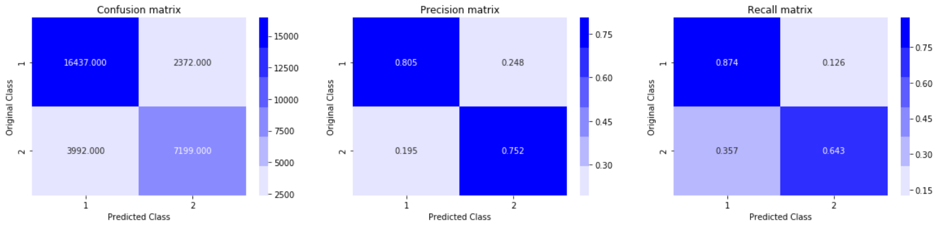
```
For values of alpha =  0.01 The log loss is: 0.5232135613932
204
For values of alpha =  0.1 The log loss is: 0.52106580829761
92
```

```
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\linear
_model\_stochastic_gradient.py:557: ConvergenceWarning: Maxi
mum number of iteration reached before convergence. Consider
increasing max_iter to improve the fit.
  ConvergenceWarning)
```

```
For values of alpha =  1 The log loss is: 0.5759456054589881
For values of alpha =  10 The log loss is: 0.644621310981079
6
```



```
For values of best alpha =  1e-05 The train log loss is: 0.4
191456275483644
For values of best alpha =  1e-05 The test log loss is: 0.42
641328735466766
Total number of data points : 30000
```



TF-IDF W2V for xgboost

In [21]:
```
# dict key:word and value:tf-idf score
word2tfidf = dict(zip(tfidf.get_feature_names(), tfidf.idf_))
```

In [22]:
```
# en_vectors_web_lg, which includes over 1 million unique vec
tors.
nlp = spacy.load('en_core_web_sm')

vecs1 = []
# https://github.com/noamraph/tqdm
# tqdm is used to print the progress bar
for qu1 in tqdm(list(questions)):
    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)
#df['q1_feats_m'] = list(vecs1)
```

```
100%|████████████████████████████████████| 70000/70000 [19:3
5<00:00, 59.56it/s]
```

In [23]:

```
# en_vectors_web_lg, which includes over 1 million unique vec
tors.
nlp = spacy.load('en_core_web_sm')

vecs2 = []
# https://github.com/noamraph/tqdm
# tqdm is used to print the progress bar
for qu1 in tqdm(list(questions1)):
    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)
    vecs2.append(mean_vec1)
#df['q1_feats_m'] = list(vecs1)
```

```
100%|████████████████████████████████████| 30000/30000 [08:2
6<00:00, 59.27it/s]
```

In [24]:

```
first = pd.DataFrame(vecs1)
```

In [25]:

```
second = pd.DataFrame(vecs2)
```

In [26]:

```
xg_train = hstack((first,x_train_final))
xg_test = hstack((second,x_test_final))
```

4.6 XGBoost

In [65]:

```
import xgboost as xgb
from sklearn.model_selection import RandomizedSearchCV


#base_learners = [5,10,15,20]
Depths = [1,2,3,4]
#learning_rate = [0.001, 0.01, 0.1, 0.2, 0.3]
#reg_lambda = [0.1, 1.0, 5.0, 10.0, 50.0, 100.0]


neigh = xgb.XGBRegressor()
#params we need to try on classifier
param_grid = {'max_depth':Depths}
#tscv = TimeSeriesSplit(n_splits=10) #For time based splittin
g
clf = RandomizedSearchCV(neigh,param_grid,cv=2,verbose=1)
clf.fit(xg_train,y_train)
```

```
C:\Users\hemant\AnacondaNew\lib\site-packages\sklearn\model_
selection\_search.py:281: UserWarning: The total space of pa
rameters 4 is smaller than n_iter=10. Running 4 iterations.
For exhaustive searches, use GridSearchCV.
  % (grid_size, self.n_iter, grid_size), UserWarning)
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1
concurrent workers.
```

```
Fitting 2 folds for each of 4 candidates, totalling 8 fits
```

```
[Parallel(n_jobs=1)]: Done   8 out of   8 | elapsed:  6.9min
finished
```

```
Out[65]: RandomizedSearchCV(cv=2, error_score=nan,
                             estimator=XGBRegressor(base_score=0.5, bo
          oster='gbtree',
                                                    colsample_bylevel=
          1,
                                                    colsample_bytree=
          1, gamma=0,
                                                    importance_type='g
          ain',
                                                    learning_rate=0.1,
          max_delta_step=0,
                                                    max_depth=3, min_c
          hild_weight=1,
                                                    missing=None, n_es
          timators=100,
                                                    n_jobs=1, nthread=
          None,
                                                    objective='reg:lin
          ear',
                                                    random_state=0, re
          g_alpha=0,
                                                    reg_lambda=1, scal
          e_pos_weight=1,
                                                    seed=None, silent=
          True, subsample=1),
                             iid='deprecated', n_iter=10, n_jobs=None,
                             param_distributions={'max_depth': [1, 2,
          3, 4]},
                             pre_dispatch='2*n_jobs', random_state=Non
          e, refit=True,
                             return_train_score=False, scoring=None, v
          erbose=1)
```

In [66]:

```
# Optimal value of number of base learners
#optimal_learners = clf.best_estimator_.n_estimators
#print("The optimal number of base learners is : ",optimal_le
arners)

# Optimal value of depth
optimal_depth = clf.best_estimator_.max_depth
print("\nThe optimal value of depth is : ",optimal_depth)

"""
optimal_learning_rate = clf.best_estimator_.learning_rate
print("\nThe optimal value of learning rate is : ",optimal_le
arning_rate)


optimal_reg_lambda = clf.best_estimator_.reg_lambda
print("\nThe optimal value of learning rate is : ",optimal_re
g_lambda)
"""
#optimal_learners_data = optimal_learners
optimal_depth_data = optimal_depth
#optimal_learning_rate_data = optimal_learning_rate
#optimal_reg_lambda_data = optimal_reg_lambda
```

```
The optimal value of depth is :  4
```

In [76]:

```
model = xgb.XGBRegressor(max_depth = int(optimal_depth))
model.fit(xg_train,y_train)
```

Out[76]:

```
XGBRegressor(base_score=0.5, booster='gbtree', colsample_byl
evel=1,
             colsample_bytree=1, gamma=0, importance_type='g
ain',
             learning_rate=0.1, max_delta_step=0, max_depth=
10,
             min_child_weight=1, missing=None, n_estimators=
100, n_jobs=1,
             nthread=None, objective='reg:linear', random_st
ate=0, reg_alpha=0,
             reg_lambda=1, scale_pos_weight=1, seed=None, si
lent=True,
             subsample=1)
```

In [74]:

```
from sklearn.metrics import log_loss
probs = model.predict(xg_test)
# calculate log loss
loss = log_loss(y_test, probs,eps=1e-7)
```

In [75]:

```
print(loss)
```

```
0.35614581661169603
```

```
In [ ]:
```