Read LIB

In [0]:

```
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 [0]:

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6
qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3aietf%3awg%3aoauth%3a2.0%
b&response_type=code&scope=email%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2
www.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly
ttps%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly

Enter your authorization code:
··········
Mounted at /content/drive
```

In [0]:

```
# avoid decoding problems
df = pd.read_csv("/content/drive/My Drive/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 [0]:

```
df.head()
```

Out[0]:

	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

	id	qid1	qid2	question1	question2	is_duplicate
2	2	3	4	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 [0]:

```
df.shape
```

Out[0]:

```
(404290, 6)
```

Load nlp_features_train & df_fe_without_preprocessing_train

In [0]:

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

if os.path.isfile('/content/drive/My Drive/Quora/df_fe_without_preprocessing_train.csv'):
    dfppro = pd.read_csv("/content/drive/My
Drive/Quora/df_fe_without_preprocessing_train.csv",encoding='latin-1')
else:
    print("download df_fe_without_preprocessing_train.csv from drive or run previous notebook")
```

In [0]:

```
dfnlp.shape
```

Out[0]:

```
(404290, 21)
```

In [0]:

```
df1 = dfnlp.drop(['qid1','qid2'],axis=1)
df2 = dfppro.drop(['qid1','qid2','question1','question2','is_duplicate'],axis=1)
df3 = df.drop(['qid1','qid2','question1','question2','is_duplicate'],axis=1)
```

In [0]:

```
df1.head(3)
```

Out[0]:

	id	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_
0	0	what is the step by step guide to invest in sh...	what is the step by step guide to invest in sh...	0	0.999980	0.833319	0.999983	0.999983	0.916659	0.785709	0.0	1.0
1	1	what is the story of kohinoor koh i noor ...	what would happen if the indian government sto...	0	0.799984	0.399996	0.749981	0.599988	0.699993	0.466664	0.0	1.0

	id	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_
2	2	how can i increase the speed of my internet co...	how can internet speed be increased by hacking...	0	0.399992	0.333328	0.399992	0.249997	0.399996	0.285712	0.0	1.0

In [0]:

```
df2.head(2)
```

Out[0]:

	id	freq_qid1	freq_qid2	q1len	q2len	q1_n_words	q2_n_words	word_Common	word_Total	word_share	freq_q1+q2	f
0	0	1	1	66	57	14	12	10.0	23.0	0.434783	2	0
1	1	4	1	51	88	8	13	4.0	20.0	0.200000	5	3

In [0]:

```
df3.head(3)
```

Out[0]:

	id
0	0
1	1
2	2

In [0]:

```
print("Number of features in nlp dataframe :", df1.shape[1])
print("Number of features in preprocessed dataframe :", df2.shape[1])
```

```
Number of features in nlp dataframe : 19
Number of features in preprocessed dataframe : 12
```

Merging featured data

In [0]:

```
df1  = df1.merge(df2, on='id',how='left')

df1.shape
```

Out[0]:

```
(404290, 30)
```

In [0]:

```
df1.head(3)
```

Out[0]:

	id	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_

	id	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_w
0	0	what is the step by step guide to invest in sh...	what is the step by step guide to invest in sh...	0	0.999980	0.833319	0.999983	0.999983	0.916659	0.785709	0.0	1.0
1	1	what is the story of kohinoor koh i noor dia...	what would happen if the indian government sto...	0	0.799984	0.399996	0.749981	0.599988	0.699993	0.466664	0.0	1.0
2	2	how can i increase the speed of my internet co...	how can internet speed be increased by hacking...	0	0.399992	0.333328	0.399992	0.249997	0.399996	0.285712	0.0	1.0

Preprocessing of ques1 & ques2

In [0]:

```
df1["question1"] = df1["question1"].fillna("")
df1["question2"] = df1["question2"].fillna("")
```

In [0]:

```
df1.isnull().any().any()
```

Out[0]:

```
False
```

In [0]:

```
# https://stackoverflow.com/a/47091490/4084039
import re

def decontracted(phrase):
    # specific
    phrase = re.sub(r"won't", "will not", phrase)
    phrase = re.sub(r"can\'t", "can not", phrase)

    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    phrase = re.sub(r"\',000,000", " m", phrase)
    phrase = re.sub(r"\',000", " k", phrase)
    phrase = re.sub(r"\'₹", " rupee", phrase)
    phrase = re.sub(r"\'%", " percent", phrase)
    phrase = re.sub(r"\'$", " dollar", phrase)

    return phrase
```

In [0]:

```
 import nltk
nltk.download('stopwords')

stopwords = stopwords.words("english")
```

```
from bs4 import BeautifulSoup
from tqdm import tqdm
preprocessed_ques1 = []
# tqdm is for printing the status bar
for sentance in tqdm(df1["question1"].values):
    sentance = str(sentance).lower()
    sentance = re.sub(r"http\S+", "", sentance)
    sentance = BeautifulSoup(sentance, 'lxml').get_text()
    sentance = decontracted(sentance)
    sentance = re.sub("\S*\d\S*", "", sentance).strip()
    sentance = re.sub('[^A-Za-z]+', ' ', sentance)

    sentance = re.sub(r"([0-9]+)000000", r"\1m", sentance)
    sentance = re.sub(r"([0-9]+)000", r"\1k", sentance)
    # https://gist.github.com/sebleier/554280
    sentance = ' '.join(e.lower() for e in sentance.split() if e.lower() not in stopwords)
    preprocessed_ques1.append(sentance.strip())
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
```

```
100%|██████████| 404290/404290 [01:53<00:00, 3569.78it/s]
```

In [0]:

```
from bs4 import BeautifulSoup
from tqdm import tqdm
preprocessed_ques2 = []
# tqdm is for printing the status bar
for sentance in tqdm(df1["question2"].values):
    sentance = str(sentance).lower()
    sentance = re.sub(r"http\S+", "", sentance)
    sentance = BeautifulSoup(sentance, 'lxml').get_text()
    sentance = decontracted(sentance)
    sentance = re.sub("\S*\d\S*", "", sentance).strip()
    sentance = re.sub('[^A-Za-z]+', ' ', sentance)

    sentance = re.sub(r"([0-9]+)000000", r"\1m", sentance)
    sentance = re.sub(r"([0-9]+)000", r"\1k", sentance)
    # https://gist.github.com/sebleier/554280
    sentance = ' '.join(e.lower() for e in sentance.split() if e.lower() not in stopwords)
    preprocessed_ques2.append(sentance.strip())
```

```
100%|██████████| 404290/404290 [01:55<00:00, 3492.30it/s]
```

In [0]:

```
df1["preprocessed_q1"] = preprocessed_ques1
df1["preprocessed_q2"] = preprocessed_ques2

df1.head(3)
```

Out[0]:

	id	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_v
0	0	what is the step by step guide to invest in sh...	what is the step by step guide to invest in sh...	0	0.999980	0.833319	0.999983	0.999983	0.916659	0.785709	0.0	1.0
1	1	what is the story of kohinoor koh i noor dia...	what would happen if the indian government sto...	0	0.799984	0.399996	0.749981	0.599988	0.699993	0.466664	0.0	1.0

	id	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_w
2	2	how can i increase the speed of my internet co...	how can internet speed be increased by hacking...	0	0.399992	0.333328	0.399992	0.249997	0.399996	0.285712	0.0	1.0

Train Test Split

In [0]:

```
# Take randomly 100K points

df1 = df1.sample(n=100000)

df1.shape
```

Out[0]:

```
(100000, 32)
```

In [0]:

```
from sklearn.model_selection import train_test_split

df1.drop(df1.index[0],inplace = True)

y = df1["is_duplicate"]
df1.drop(['is_duplicate',"question1","question2"], axis=1, inplace=True)

x = df1

x.head(3)
```

Out[0]:

	id	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_word_eq	abs_len_diff	me
49299	49299	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0	0.0	3.0	11.
75615	75615	0.666656	0.571420	0.666656	0.571420	0.615380	0.499997	0.0	1.0	3.0	14.
115310	115310	0.499988	0.499988	0.999975	0.799984	0.749991	0.599994	0.0	1.0	2.0	9.0

In [0]:

```
x.shape
```

Out[0]:

```
(99999, 29)
```

In [0]:

```
X_train,X_test, y_train, y_test = train_test_split(x, y, stratify=y, test_size=0.3)
```

In [0]:

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

```
Number of data points in train data : (69999, 29) (69999,)
Number of data points in test data : (30000, 29) (30000,)
```

Tf-IDf on ques1 & ques 2

In [0]:

```
# On Clean Essay
#from sklearn.preprocessing import normalize
from sklearn.feature_extraction.text import TfidfVectorizer

vectorizer1 = TfidfVectorizer(ngram_range = (1,4))
preprocessed_ques1_tfidf_train = vectorizer1.fit_transform(X_train['preprocessed_q1'])
#preprocessed_ques1_tfidf_train = normalize(preprocessed_ques1_tfidf_train,axis = 0)

print("Shape of matrix after one hot encodig ",preprocessed_ques1_tfidf_train.shape)

preprocessed_ques1_tfidf_test = vectorizer1.transform(X_test['preprocessed_q1'])
#preprocessed_ques1_tfidf_test = normalize(preprocessed_ques1_tfidf_test,axis = 0)

print("Shape of matrix after one hot encodig ",preprocessed_ques1_tfidf_test.shape)
```

```
Shape of matrix after one hot encodig  (69999, 562925)
Shape of matrix after one hot encodig  (30000, 562925)
```

In [0]:

```
# On Clean_title

vectorizer2 = TfidfVectorizer(ngram_range = (1,4))
preprocessed_ques2_tfidf_train = vectorizer2.fit_transform(X_train['preprocessed_q2'])
#preprocessed_ques2_tfidf_train = normalize(preprocessed_ques2_tfidf_train,axis = 0)

print("Shape of matrix after one hot encodig ",preprocessed_ques2_tfidf_train.shape)

preprocessed_ques2_tfidf_test = vectorizer2.transform(X_test['preprocessed_q2'])
#preprocessed_ques2_tfidf_test = normalize(preprocessed_ques2_tfidf_test,axis = 0)

print("Shape of matrix after one hot encodig ",preprocessed_ques2_tfidf_test.shape)
```

```
Shape of matrix after one hot encodig  (69999, 571515)
Shape of matrix after one hot encodig  (30000, 571515)
```

Take all features together for train our model

In [0]:

```
# Remove undesried columns

X_train_idf = X_train.drop(['id','preprocessed_q1','preprocessed_q2'],axis=1,inplace = False)

print(X_train_idf.shape)

X_train_idf.head(2)
```

```
(69999, 26)
```

Out[0]:

	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_word_eq	abs_len_diff	mean_len
312461	0.666644	0.499988	0.999967	0.999967	0.833319	0.714276	1.0	1.0	1.0	6.5
296943	0.999967	0.999967	0.999967	0.599988	0.999983	0.749991	1.0	1.0	2.0	7.0

In [0]:

```
# Remove undesried columns

X_test_idf = X_test.drop(['id','preprocessed_q1','preprocessed_q2'],axis=1,inplace = False)

print(X_test_idf.shape)

X_test_idf.head(2)
```

```
(30000, 26)
```

Out[0]:

	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_word_eq	abs_len_diff	mean_len
90353	0.599988	0.499992	0.499988	0.399992	0.499995	0.416663	0.0	1.0	2.0	11.0
237131	0.857131	0.857131	0.799984	0.666656	0.714281	0.666662	1.0	0.0	1.0	14.5

In [0]:

```
X_train_idf.columns
```

Out[0]:

```
Index(['cwc_min', 'cwc_max', 'csc_min', 'csc_max', 'ctc_min', 'ctc_max',
       'last_word_eq', 'first_word_eq', 'abs_len_diff', 'mean_len',
       'token_set_ratio', 'token_sort_ratio', 'fuzz_ratio',
       'fuzz_partial_ratio', 'longest_substr_ratio', 'freq_qid1', 'freq_qid2',
       'q1len', 'q2len', 'q1_n_words', 'q2_n_words', 'word_Common',
       'word_Total', 'word_share', 'freq_q1+q2', 'freq_q1-q2'],
      dtype='object')
```

In [0]:

```
# NORMALIZING NUMERICAL FEATURES

from sklearn.preprocessing import MinMaxScaler # NORMALIZE

mnn=MinMaxScaler(feature_range = (0,1))
X_train_num_minmax = mnn.fit_transform(X_train_idf[[ 'cwc_min', 'cwc_max', 'csc_min', 'csc_max',
'ctc_min', 'ctc_max',
       'last_word_eq', 'first_word_eq', 'abs_len_diff', 'mean_len',
       'token_set_ratio', 'token_sort_ratio', 'fuzz_ratio',
       'fuzz_partial_ratio', 'longest_substr_ratio', 'freq_qid1', 'freq_qid2',
       'q1len', 'q2len', 'q1_n_words', 'q2_n_words', 'word_Common',
       'word_Total', 'word_share', 'freq_q1+q2', 'freq_q1-q2']])

X_test_num_minmax = mnn.transform(X_test_idf[[ 'cwc_min', 'cwc_max', 'csc_min', 'csc_max',
'ctc_min', 'ctc_max',
       'last_word_eq', 'first_word_eq', 'abs_len_diff', 'mean_len',
       'token_set_ratio', 'token_sort_ratio', 'fuzz_ratio',
       'fuzz_partial_ratio', 'longest_substr_ratio', 'freq_qid1', 'freq_qid2',
       'q1len', 'q2len', 'q1_n_words', 'q2_n_words', 'word_Common',
       'word_Total', 'word_share', 'freq_q1+q2', 'freq_q1-q2']])
print(X_train_num_minmax.shape)
print(X_test_num_minmax.shape)
```

```
(69999, 26)
(30000, 26)
```

In [0]:

```
# merge tfidf vectors of ques1 , ques2 & and all token features

from scipy.sparse import hstack

X_train_tfidf =
hstack((preprocessed_ques1_tfidf_train,preprocessed_ques2_tfidf_train,X_train_num_minmax))
```

```
X_test_tfidf =
hstack((preprocessed_ques1_tfidf_test,preprocessed_ques2_tfidf_test,X_test_num_minmax))

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

```
Number of data points in train data : (69999, 1134466)
Number of data points in test data : (30000, 1134466)
```

Train Model Logistic Regression & Linear SVM on TF-IDF VEC

1. Building a random model (Finding worst-case log-loss)

In [0]:

```
from collections import Counter

print("-"*10, "Distribution of output variable in train data", "-"*10)
train_distr = Counter(y_train)
train_len = len(y_train)
print("Class 0: ",int(train_distr[0])/train_len,"Class 1: ", int(train_distr[1])/train_len)
print("-"*10, "Distribution of output variable in test data", "-"*10)
test_distr = Counter(y_test)
test_len = len(y_test)
print("Class 0: ",int(test_distr[1])/test_len, "Class 1: ",int(test_distr[1])/test_len)
```

```
---------- Distribution of output variable in train data ----------
Class 0:  0.6306804382919756 Class 1:  0.3693195617080244
---------- Distribution of output variable in test data ----------
Class 0:  0.3693 Class 1:  0.3693
```

In [0]:

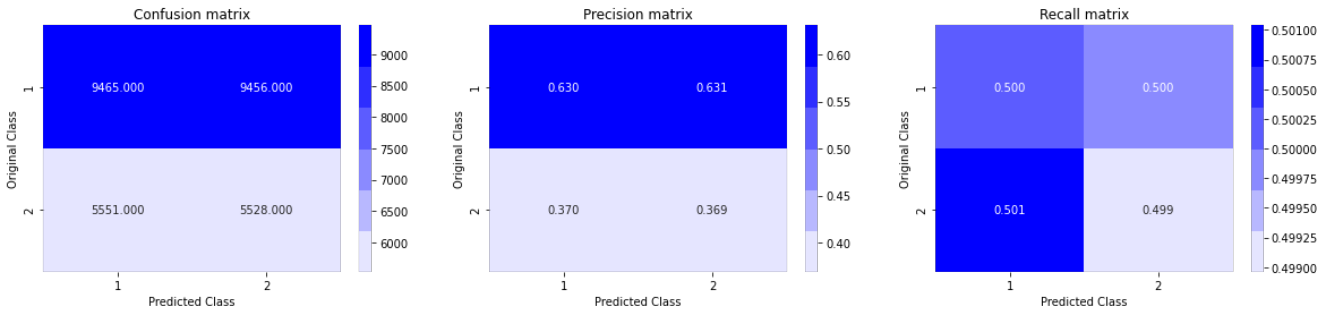
```
# This function plots the confusion matrices given y_i, y_i_hat.
def plot_confusion_matrix(test_y, predict_y):
    C = confusion_matrix(test_y, predict_y)
    # C = 9,9 matrix, each cell (i,j) represents number of points of class i are predicted class j

    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", xticklabels=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", xticklabels=labels, yticklabels=labels)
    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()
```

In [0]:

```
from sklearn.metrics import log_loss
from sklearn.metrics import confusion_matrix
import seaborn as sns

# we need to generate 9 numbers and the sum of numbers should be 1
# one solution is to genarate 9 numbers and divide each of the numbers by their sum
# ref: https://stackoverflow.com/a/18662466/4084039
# we create a output array that has exactly same size as the CV data
predicted_y = np.zeros((test_len,2))
for i in range(test_len):
    rand_probs = np.random.rand(1,2)
    predicted_y[i] = ((rand_probs/sum(sum(rand_probs)))[0])
print("Log loss on Test Data using Random Model",log_loss(y_test, predicted_y, eps=1e-15))

predicted_y =np.argmax(predicted_y, axis=1)
plot_confusion_matrix(y_test, predicted_y)
```

```
Log loss on Test Data using Random Model 0.8843933056800091
```



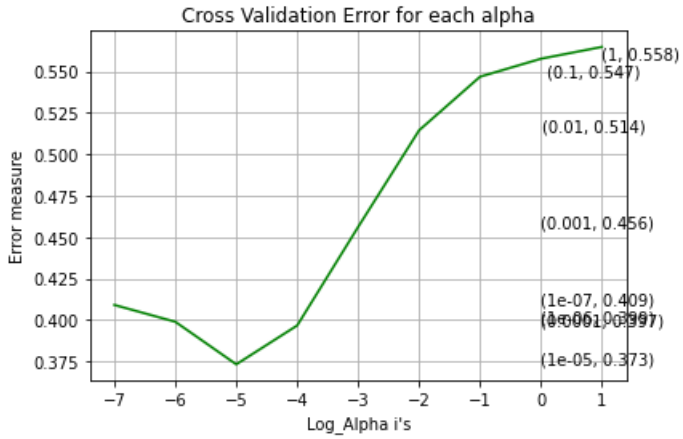
2. Logistic Regression with hyperparameter tuning

In [0]:

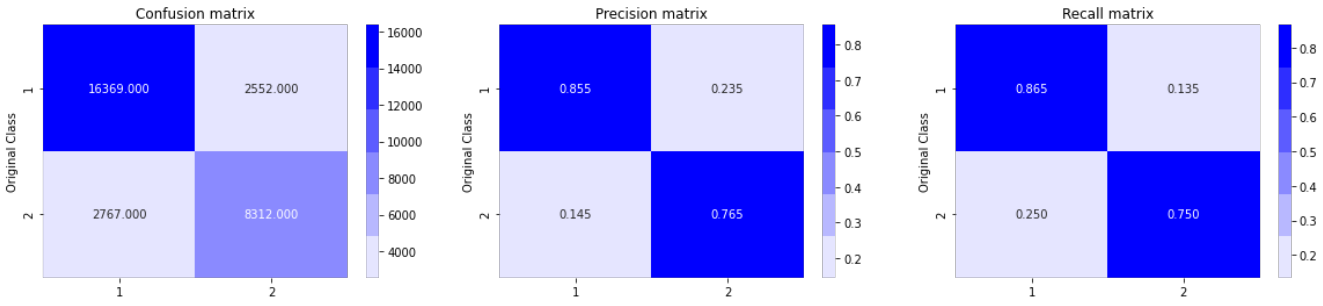
```
from sklearn.linear_model import SGDClassifier
from sklearn.calibration import CalibratedClassifierCV
import math

alpha = [10 ** x for x in range(-7, 2)] # hyperparam for SGD classifier.


log_error_array=[]
for i in alpha:
    clf = SGDClassifier(alpha=i, penalty='l2',class_weight = "balanced", loss='log', random_state=2
1,n_jobs=6)
    clf.fit(X_train_tfidf, y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid",cv=10)
    sig_clf.fit(X_train_tfidf, y_train)
    predict_y = sig_clf.predict_proba(X_test_tfidf)
    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.cl
asses_, eps=1e-15))



a = [math.log10(10 ** x) for x in range(-7, 2)]
fig, ax = plt.subplots()
ax.plot(a, 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("Log_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=21,n_jobs=6)
clf.fit(X_train_tfidf, y_train)
sig_clf = CalibratedClassifierCV(clf, method="sigmoid",cv=10)
sig_clf.fit(X_train_tfidf, y_train)

predict_y = sig_clf.predict_proba(X_train_tfidf)
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_tfidf)
print('For values of best alpha = ', alpha[best_alpha], "The test log loss is:",log_loss(y_test, p
redict_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-07 The log loss is: 0.4090589414979204
For values of alpha =  1e-06 The log loss is: 0.3988868712159295
For values of alpha =  1e-05 The log loss is: 0.3732089367531055
For values of alpha =  0.0001 The log loss is: 0.3966685627213073
For values of alpha =  0.001 The log loss is: 0.45614761824363353
For values of alpha =  0.01 The log loss is: 0.5144611465087484
For values of alpha =  0.1 The log loss is: 0.5468180090148933
For values of alpha =  1 The log loss is: 0.5576752494145414
For values of alpha =  10 The log loss is: 0.5648109551588324
```




```
For values of best alpha =  1e-05 The train log loss is: 0.20766144260191635
For values of best alpha =  1e-05 The test log loss is: 0.37265288130795304
Total number of data points : 30000
```



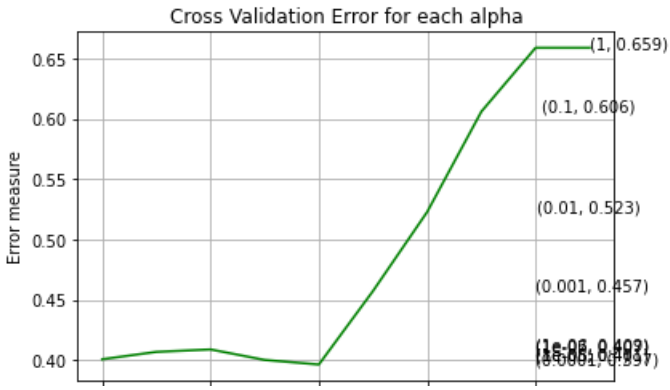
Predicted Class Predicted Class Predicted Class

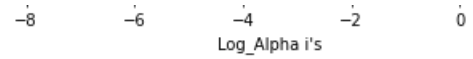
3. Linear SVM with hyperparameter tuning

In [0]:

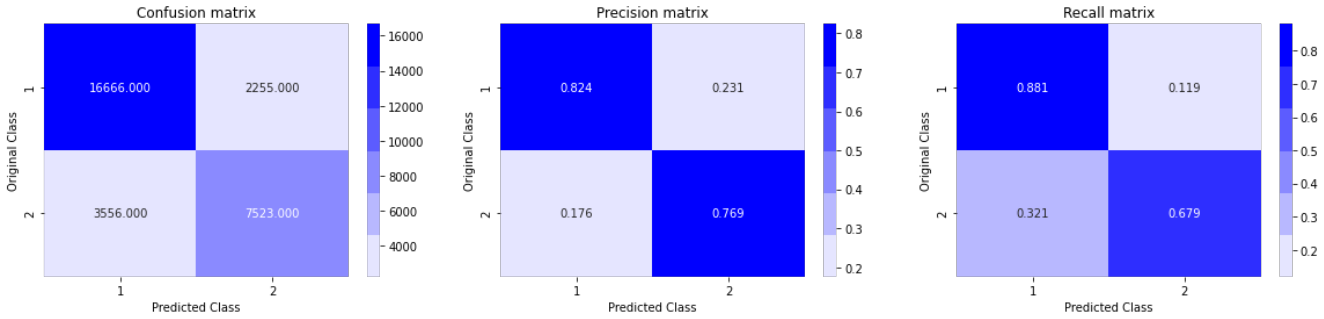
```
alpha = [10 ** x for x in range(-8, 2)]


log_error_array=[]
for i in alpha:
    clf = SGDClassifier(alpha=i,class_weight = "balanced", penalty='l1', loss='hinge', random_state
=21,n_jobs=6)
    clf.fit(X_train_tfidf, y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
    sig_clf.fit(X_train_tfidf, y_train)
    predict_y = sig_clf.predict_proba(X_test_tfidf)
    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.cl
asses_, eps=1e-15))

a = [math.log10(10 ** x) for x in range(-8, 2)]
fig, ax = plt.subplots()
ax.plot(a, 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("Log_Alpha i's")
plt.ylabel("Error measure")
plt.show()


best_alpha = np.argmin(log_error_array)
clf = SGDClassifier(alpha=alpha[best_alpha], penalty='l1', loss='hinge', random_state=21,n_jobs=6)
clf.fit(X_train_tfidf, y_train)
sig_clf = CalibratedClassifierCV(clf, method="sigmoid",cv=10)
sig_clf.fit(X_train_tfidf, y_train)

predict_y = sig_clf.predict_proba(X_train_tfidf)
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_tfidf)
print('For values of best alpha = ', alpha[best_alpha], "The test log loss is:",log_loss(y_test, p
redict_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-08 The log loss is: 0.4009639274867782
For values of alpha =  1e-07 The log loss is: 0.40706390804075987
For values of alpha =  1e-06 The log loss is: 0.4090866426118164
For values of alpha =  1e-05 The log loss is: 0.40039631792530084
For values of alpha =  0.0001 The log loss is: 0.3966156632120013
For values of alpha =  0.001 The log loss is: 0.45747612197543475
For values of alpha =  0.01 The log loss is: 0.5229013836460963
For values of alpha =  0.1 The log loss is: 0.6058619839160266
For values of alpha =  1 The log loss is: 0.6585820784107572
For values of alpha =  10 The log loss is: 0.6585820784107572
```






```
For values of best alpha =  0.0001 The train log loss is: 0.40335956197719486
For values of best alpha =  0.0001 The test log loss is: 0.39884298301400073
Total number of data points : 30000
```



TFIDF-W2V (make own WORD VEC)

In [0]:

```
!apt install rsync
```

```
Reading package lists... Done
Building dependency tree
Reading state information... Done
rsync is already the newest version (3.1.2-2.1ubuntu1.1).
0 upgraded, 0 newly installed, 0 to remove and 25 not upgraded.
```

In [0]:

```
!unzip -q "/content/drive/My Drive/Copy of glove.42B.300d.zip"
```

downloading 'glove.6B.200d.txt' from kaggle due to 'glove.42B.300d.zip' is taking more time to compute.

In [0]:

```
def loadGloveModel(gloveFile):
    print ("Loading Glove Model")
    f = open(gloveFile,'r', encoding="utf8")
    model = {}
    for line in tqdm(f):
        splitLine = line.split()
        word = splitLine[0]
        embedding = np.array([float(val) for val in splitLine[1:]])
        model[word] = embedding
    print ("Done.",len(model)," words loaded!")
    return model
model = loadGloveModel('/content/glove.42B.300d.txt')
```

```
864it [00:00, 8637.27it/s]
```

```
Loading Glove Model
```

```
1917495it [03:09, 10092.94it/s]
```

```
Done. 1917495  words loaded!
```

In [0]:

```
words = []
for i in X_train['preprocessed_q1'].values:
    words.extend(i.split(' '))

for i in X_train['preprocessed_q2']:
```

```
    words.extend(i.split(' '))
print("all the words in the coupus", len(words))
words = set(words)
print("the unique words in the coupus", len(words))

inter_words = set(model.keys()).intersection(words)
print("The number of words that are present in both glove vectors and our coupus", \
      len(inter_words),"(",np.round(len(inter_words)/len(words)*100,3),"%)")

words_courpus = {}
words_glove = set(model.keys())
for i in words:
    if i in words_glove:
        words_courpus[i] = model[i]
print("word 2 vec length", len(words_courpus))
```

```
all the words in the coupus 755815
the unique words in the coupus 36846
The number of words that are present in both glove vectors and our coupus 34665 ( 94.081 %)
word 2 vec length 34665
```

In [0]:

```
import pickle
with open('/content/glove_vectors', 'wb') as f:
    pickle.dump(words_courpus, f)
```

In [0]:

```
# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-pickle-to-sa
ve-and-load-variables-in-python/
# make sure you have the glove_vectors file
with open('/content/glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

In [0]:

```
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
tfidf_model = TfidfVectorizer(min_df = 5,ngram_range = (1,4),max_features=10000)
tfidf_model.fit(X_train['preprocessed_q1'])
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [0]:

```
# average Word2Vec
# compute average word2vec for each review.
X_train_tfidf_w2v_vectors_q1 = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(X_train['preprocessed_q1']): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf
value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf
idf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    X_train_tfidf_w2v_vectors_q1.append(vector)

print(len(X_train_tfidf_w2v_vectors_q1))
print(len(X_train_tfidf_w2v_vectors_q1[0]))

X_train_tfidf_w2v_vectors_q1 = normalize(X_train_tfidf_w2v_vectors_q1,axis=0)
```

```
100%|██████████| 69999/69999 [00:03<00:00, 18993.34it/s]
```

```
69999
300
```

In [0]:

```
# average Word2Vec
# compute average word2vec for each review.
X_test_tfidf_w2v_vectors_q1 = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(X_test['preprocessed_q1']): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf
value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf
idf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    X_test_tfidf_w2v_vectors_q1.append(vector)

print(len(X_test_tfidf_w2v_vectors_q1))
print(len(X_test_tfidf_w2v_vectors_q1[0]))

X_test_tfidf_w2v_vectors_q1 = normalize(X_test_tfidf_w2v_vectors_q1,axis=0)
```

```
100%|██████████| 30000/30000 [00:01<00:00, 19443.08it/s]
```

```
30000
300
```

In [0]:

```
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
tfidf_model2 = TfidfVectorizer(min_df = 5,ngram_range = (1,4),max_features=10000)
tfidf_model2.fit(X_train['preprocessed_q2'])
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model2.get_feature_names(), list(tfidf_model2.idf_)))
tfidf_words2 = set(tfidf_model2.get_feature_names())
```

In [0]:

```
# average Word2Vec
# compute average word2vec for each review.
X_train_tfidf_w2v_vectors_q2 = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(X_train['preprocessed_q2']): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words2):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf
value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf
idf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    X_train_tfidf_w2v_vectors_q2.append(vector)

print(len(X_train_tfidf_w2v_vectors_q2))
print(len(X_train_tfidf_w2v_vectors_q2[0]))

X_train_tfidf_w2v_vectors_q2 = normalize(X_train_tfidf_w2v_vectors_q2,axis=0)
```

```
100%|██████████| 69999/69999 [00:03<00:00, 18321.74it/s]
```

```
69999
300
```

In [0]:

```
# average Word2Vec
# compute average word2vec for each review.
X_test_tfidf_w2v_vectors_q2 = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(X_test['preprocessed_q2']): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words2):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf
value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf
idf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    X_test_tfidf_w2v_vectors_q2.append(vector)

print(len(X_test_tfidf_w2v_vectors_q2))
print(len(X_test_tfidf_w2v_vectors_q2[0]))

X_test_tfidf_w2v_vectors_q2 = normalize(X_test_tfidf_w2v_vectors_q2,axis=0)
```

```
100%|██████████| 30000/30000 [00:01<00:00, 17987.50it/s]
```

```
30000
300
```

In [0]:

```
# Merge TFIDF-W2v and all other tokenized features

X_train_tfidf_w2v =
np.hstack((X_train_tfidf_w2v_vectors_q1,X_train_tfidf_w2v_vectors_q2,X_train_num_minmax))

X_test_tfidf_w2v =
np.hstack((X_test_tfidf_w2v_vectors_q1,X_test_tfidf_w2v_vectors_q2,X_test_num_minmax))

print(X_train_tfidf_w2v.shape)
print(X_test_tfidf_w2v.shape)
```

```
(69999, 626)
(30000, 626)
```

Train model using TFIDF - W2V

In [0]:

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

params={
        "max_depth"               : [ 3, 4, 5, 6, 8, 10, 12, 15,20],
        "min_child_weight"        : [0.5, 1.0, 3.0, 5.0, 7.0, 10.0],

  }
estimator1 = xgb.XGBClassifier(objective= 'binary:logistic',
eval_metric= 'logloss',scale_pos_weight = 1)
Rsearch1= RandomizedSearchCV(estimator1,param_distributions=params,scoring='neg_log_loss',n_jobs=-1
,iid=False,  cv=5,verbose=21,random_state=21)
Rsearch1.fit(X_train_tfidf_w2v,y_train)
Rsearch1.best_params_, Rsearch1.best_score_
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 tasks      | elapsed:  8.9min
[Parallel(n_jobs=-1)]: Done   2 tasks      | elapsed:  9.0min
[Parallel(n_jobs=-1)]: Done   3 tasks      | elapsed: 17.7min
[Parallel(n_jobs=-1)]: Done   4 tasks      | elapsed: 17.8min
[Parallel(n_jobs=-1)]: Done   5 tasks      | elapsed: 26.4min
[Parallel(n_jobs=-1)]: Done   6 tasks      | elapsed: 47.7min
[Parallel(n_jobs=-1)]: Done   7 tasks      | elapsed: 56.2min
[Parallel(n_jobs=-1)]: Done   8 tasks      | elapsed: 77.6min
[Parallel(n_jobs=-1)]: Done   9 tasks      | elapsed: 86.1min
[Parallel(n_jobs=-1)]: Done  10 tasks      | elapsed: 107.2min
[Parallel(n_jobs=-1)]: Done  11 tasks      | elapsed: 116.8min
[Parallel(n_jobs=-1)]: Done  12 tasks      | elapsed: 137.7min
[Parallel(n_jobs=-1)]: Done  13 tasks      | elapsed: 147.5min
[Parallel(n_jobs=-1)]: Done  14 tasks      | elapsed: 168.5min
[Parallel(n_jobs=-1)]: Done  15 tasks      | elapsed: 177.6min
[Parallel(n_jobs=-1)]: Done  16 tasks      | elapsed: 186.5min
[Parallel(n_jobs=-1)]: Done  17 tasks      | elapsed: 195.5min
[Parallel(n_jobs=-1)]: Done  18 tasks      | elapsed: 204.3min
[Parallel(n_jobs=-1)]: Done  19 tasks      | elapsed: 213.5min
[Parallel(n_jobs=-1)]: Done  20 tasks      | elapsed: 222.0min
[Parallel(n_jobs=-1)]: Done  21 tasks      | elapsed: 224.5min
[Parallel(n_jobs=-1)]: Done  22 tasks      | elapsed: 233.0min
[Parallel(n_jobs=-1)]: Done  23 tasks      | elapsed: 235.5min
[Parallel(n_jobs=-1)]: Done  24 tasks      | elapsed: 244.0min
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed: 246.4min
[Parallel(n_jobs=-1)]: Done  26 tasks      | elapsed: 250.6min
[Parallel(n_jobs=-1)]: Done  27 tasks      | elapsed: 253.0min
[Parallel(n_jobs=-1)]: Done  28 tasks      | elapsed: 257.1min
[Parallel(n_jobs=-1)]: Done  29 tasks      | elapsed: 259.5min
[Parallel(n_jobs=-1)]: Done  30 tasks      | elapsed: 263.6min
[Parallel(n_jobs=-1)]: Done  31 tasks      | elapsed: 272.6min
[Parallel(n_jobs=-1)]: Done  32 tasks      | elapsed: 276.6min
[Parallel(n_jobs=-1)]: Done  33 tasks      | elapsed: 285.7min
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed: 289.8min
[Parallel(n_jobs=-1)]: Done  35 tasks      | elapsed: 298.0min
[Parallel(n_jobs=-1)]: Done  36 tasks      | elapsed: 310.6min
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed: 318.3min
[Parallel(n_jobs=-1)]: Done  38 tasks      | elapsed: 330.7min
[Parallel(n_jobs=-1)]: Done  39 tasks      | elapsed: 338.2min
[Parallel(n_jobs=-1)]: Done  40 tasks      | elapsed: 347.8min
[Parallel(n_jobs=-1)]: Done  41 tasks      | elapsed: 350.2min
[Parallel(n_jobs=-1)]: Done  42 tasks      | elapsed: 357.3min
[Parallel(n_jobs=-1)]: Done  43 tasks      | elapsed: 359.7min
[Parallel(n_jobs=-1)]: Done  44 tasks      | elapsed: 366.8min
[Parallel(n_jobs=-1)]: Done  45 tasks      | elapsed: 369.1min
[Parallel(n_jobs=-1)]: Done  46 tasks      | elapsed: 397.5min
[Parallel(n_jobs=-1)]: Done  47 tasks      | elapsed: 399.4min
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed: 445.7min remaining:    0.0s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed: 445.7min finished
```

Out[0]:

```
({'max_depth': 8, 'min_child_weight': 1.0}, -0.33185418056896093)
```

In [0]:

```
w=Rsearch1.best_params_["min_child_weight"]
d=Rsearch1.best_params_['max_depth']
print(w)
print(d)
```

```
1.0
8
```

In [0]:

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

params={
```

```
 "colsample_bytree"         : [0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0],
 'subsample'                :[0.5, 0.6, 0.7, 0.8, 0.9, 1.0],

  }
estimator2 =xgb.XGBClassifier(objective= 'binary:logistic',
eval_metric= 'logloss',scale_pos_weight = 1,random_state=21,min_child_weight = w,max_depth = d)
Rsearch2= RandomizedSearchCV(estimator2,param_distributions=params,scoring='neg_log_loss',n_jobs=-1
,iid=False, cv=5,verbose=21,random_state=21)
Rsearch2.fit(X_train_tfidf_w2v,y_train)
Rsearch2.best_params_, Rsearch2.best_score_
```

```
Fitting 5 folds for each of 10 candidates, totalling 50 fits
```

```
[Parallel(n_jobs=-1)]: Using backend LokyBackend with 2 concurrent workers.
[Parallel(n_jobs=-1)]: Done   1 tasks      | elapsed: 15.0min
[Parallel(n_jobs=-1)]: Done   2 tasks      | elapsed: 15.0min
[Parallel(n_jobs=-1)]: Done   3 tasks      | elapsed: 29.9min
[Parallel(n_jobs=-1)]: Done   4 tasks      | elapsed: 30.1min
[Parallel(n_jobs=-1)]: Done   5 tasks      | elapsed: 38.3min
[Parallel(n_jobs=-1)]: Done   6 tasks      | elapsed: 44.5min
[Parallel(n_jobs=-1)]: Done   7 tasks      | elapsed: 46.4min
[Parallel(n_jobs=-1)]: Done   8 tasks      | elapsed: 52.7min
[Parallel(n_jobs=-1)]: Done   9 tasks      | elapsed: 54.6min
[Parallel(n_jobs=-1)]: Done  10 tasks      | elapsed: 60.8min
[Parallel(n_jobs=-1)]: Done  11 tasks      | elapsed: 62.6min
[Parallel(n_jobs=-1)]: Done  12 tasks      | elapsed: 68.9min
[Parallel(n_jobs=-1)]: Done  13 tasks      | elapsed: 70.7min
[Parallel(n_jobs=-1)]: Done  14 tasks      | elapsed: 77.0min
[Parallel(n_jobs=-1)]: Done  15 tasks      | elapsed: 78.7min
[Parallel(n_jobs=-1)]: Done  16 tasks      | elapsed: 86.6min
[Parallel(n_jobs=-1)]: Done  17 tasks      | elapsed: 88.3min
[Parallel(n_jobs=-1)]: Done  18 tasks      | elapsed: 96.2min
[Parallel(n_jobs=-1)]: Done  19 tasks      | elapsed: 97.9min
[Parallel(n_jobs=-1)]: Done  20 tasks      | elapsed: 105.7min
[Parallel(n_jobs=-1)]: Done  21 tasks      | elapsed: 109.7min
[Parallel(n_jobs=-1)]: Done  22 tasks      | elapsed: 117.5min
[Parallel(n_jobs=-1)]: Done  23 tasks      | elapsed: 121.4min
[Parallel(n_jobs=-1)]: Done  24 tasks      | elapsed: 129.4min
[Parallel(n_jobs=-1)]: Done  25 tasks      | elapsed: 133.1min
[Parallel(n_jobs=-1)]: Done  26 tasks      | elapsed: 136.3min
[Parallel(n_jobs=-1)]: Done  27 tasks      | elapsed: 139.9min
[Parallel(n_jobs=-1)]: Done  28 tasks      | elapsed: 143.1min
[Parallel(n_jobs=-1)]: Done  29 tasks      | elapsed: 146.7min
[Parallel(n_jobs=-1)]: Done  30 tasks      | elapsed: 149.9min
[Parallel(n_jobs=-1)]: Done  31 tasks      | elapsed: 160.5min
[Parallel(n_jobs=-1)]: Done  32 tasks      | elapsed: 163.7min
[Parallel(n_jobs=-1)]: Done  33 tasks      | elapsed: 174.2min
[Parallel(n_jobs=-1)]: Done  34 tasks      | elapsed: 177.3min
[Parallel(n_jobs=-1)]: Done  35 tasks      | elapsed: 187.7min
[Parallel(n_jobs=-1)]: Done  36 tasks      | elapsed: 190.2min
[Parallel(n_jobs=-1)]: Done  37 tasks      | elapsed: 200.7min
[Parallel(n_jobs=-1)]: Done  38 tasks      | elapsed: 203.1min
[Parallel(n_jobs=-1)]: Done  39 tasks      | elapsed: 213.6min
[Parallel(n_jobs=-1)]: Done  40 tasks      | elapsed: 215.8min
[Parallel(n_jobs=-1)]: Done  41 tasks      | elapsed: 222.1min
[Parallel(n_jobs=-1)]: Done  42 tasks      | elapsed: 224.2min
[Parallel(n_jobs=-1)]: Done  43 tasks      | elapsed: 230.5min
[Parallel(n_jobs=-1)]: Done  44 tasks      | elapsed: 232.7min
[Parallel(n_jobs=-1)]: Done  45 tasks      | elapsed: 238.9min
[Parallel(n_jobs=-1)]: Done  46 tasks      | elapsed: 243.6min
[Parallel(n_jobs=-1)]: Done  47 tasks      | elapsed: 249.8min
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed: 263.6min remaining:    0.0s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed: 263.6min finished
```

Out[0]:

```
({'colsample_bytree': 0.5, 'subsample': 1.0}, -0.33100446991814236)
```

In [0]:

```
c=Rsearch2.best_params_["colsample_bytree"]
s=Rsearch2.best_params_['subsample']
```

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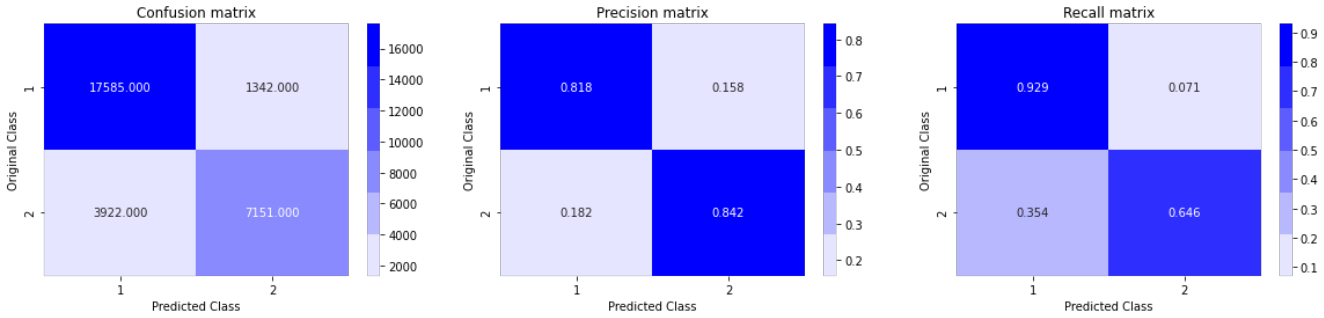
```
# train Final Xgboost model using all tunned hyperParameters

import xgboost as xgb
from sklearn.metrics import log_loss
from sklearn.metrics import confusion_matrix
import seaborn as sns

estimator =xgb.XGBClassifier(objective= 'binary:logistic',
eval_metric= 'logloss',scale_pos_weight = 1,random_state=21,min_child_weight = w,max_depth = d,cols
ample_bytree = c, subsample = s)
estimator.fit(X_train_tfidf_w2v,y_train)

predict_y = estimator.predict_proba(X_train_tfidf_w2v)
print("The train log loss is:",log_loss(y_train, predict_y, labels=estimator.classes_, eps=1e-15))

predict_y = estimator.predict_proba(X_test_tfidf_w2v)
print("The test log loss is:", log_loss(y_test, predict_y, labels=estimator.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)
```

```
The train log loss is: 0.20681258070377484
The test log loss is: 0.348692281844108
Total number of data points : 30000
```



In [1]:

```
from prettytable import PrettyTable

ptable = PrettyTable()

ptable.title = " Model Comparision "
ptable.field_names = ['Serial No.', 'Model Name', 'Tokenizer','Hyperparameter Tunning', 'Test Log L
oss']
ptable.add_row(["1","Random","TFIDF","-","0.88"])
ptable.add_row(["2","Logistic Regression","TFIDF Weighted W2V","Done","0.37"])
ptable.add_row(["3","Linear SVM","TFIDF Weighted W2V","Done","0.39"])

ptable.add_row(["\n","\n","\n","\n","\n"])


ptable.add_row(["1","XGBoost","TFIDF Weighted W2V","Done","0.35"])
print(ptable)
```

```
+------------+--------------------+--------------------+------------------------+---------------+
| Serial No. |     Model Name     |     Tokenizer      | Hyperparameter Tunning | Test Log Loss |
+------------+--------------------+--------------------+------------------------+---------------+
|     1      |       Random       |       TFIDF        |           -            |      0.88     |
|     2      | Logistic Regression | TFIDF Weighted W2V |          Done          |      0.37     |
|     3      |     Linear SVM     | TFIDF Weighted W2V |          Done          |      0.39     |
|            |                    |                    |                        |               |
|            |                    |                    |                        |               |
|     1      |      XGBoost       | TFIDF Weighted W2V |          Done          |      0.35     |
+------------+--------------------+--------------------+------------------------+---------------+
```