3.6 Featurizing text data with tfidf weighted word-vectors

In [16]:

```
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 sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from scipy.sparse import coo_matrix, vstack
import pandas as pd
import matplotlib.pyplot as plt
import re
import time
import warnings
import sqlite3
from sqlalchemy import create_engine # database connection
import csv
import os
warnings.filterwarnings("ignore")
import datetime as dt
import numpy as np
from nltk.corpus import stopwords
from sklearn.decomposition import TruncatedSVD
from sklearn.preprocessing import normalize
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.manifold import TSNE
import seaborn as sns
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import confusion_matrix
from sklearn.metrics.classification import accuracy_score, log_loss
from sklearn.feature_extraction.text import TfidfVectorizer
from collections import Counter
from scipy.sparse import hstack
from sklearn.multiclass import OneVsRestClassifier
from sklearn.svm import SVC
from sklearn.model_selection import StratifiedKFold
from collections import Counter, defaultdict
from sklearn.calibration import CalibratedClassifierCV
from sklearn.naive_bayes import MultinomialNB
from sklearn.naive_bayes import GaussianNB
from sklearn.model_selection import train_test_split
from sklearn.model_selection import GridSearchCV
import math
from sklearn.metrics import normalized_mutual_info_score
from sklearn.ensemble import RandomForestClassifier



from sklearn.model_selection import cross_val_score
from sklearn.linear_model import SGDClassifier
from mlxtend.classifier import StackingClassifier

from sklearn import model_selection
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import precision_recall_curve, auc, roc_curve
```

In [17]:

```
# avoid decoding problems
df = pd.read_csv(r"D:\AppliedAI\Homework-n-Assignments\# 20 Quora\train.csv")
df.sort_values(by=['id'])
df = df.head(70000)
# 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 [18]:

```
print (df.shape)
df.head()
```

```
(70000, 6)
```

Out[18]:

	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 [19]:

```
df_without_qid = df.drop(columns=['qid1', 'qid2','is_duplicate'])
df_without_qid.head()
```

Out[19]:

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

In [20]:

```
if os.path.isfile(r'D:\AppliedAI\Homework-n-Assignments\# 20 Quora\nlp_features_train.csv'):
    dfnlp = pd.read_csv("nlp_features_train.csv",encoding='latin-1')
    dfnlp = dfnlp.head(70000)
else:
    print("download nlp_features_train.csv from drive or run previous notebook")

if os.path.isfile(r'D:\AppliedAI\Homework-n-Assignments\# 20
Quora\df_fe_without_preprocessing_train.csv'):
    dfppro = pd.read_csv("df_fe_without_preprocessing_train.csv",encoding='latin-1')
    dfppro = dfppro.head(70000)

else:
```

```
    print("download df_fe_without_preprocessing_train.csv from drive or run previous notebook")


df1 = dfnlp.drop(['qid1','qid2','question1','question2'],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 [21]:

```
print (df1.shape)
df1.head()
```

```
(70000, 17)
```

Out[21]:

	id	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_word_eq	abs_len_diff	
0	0	0	0.999980	0.833319	0.999983	0.999983	0.916659	0.785709	0.0	1.0	2.0	
1	1	0	0.799984	0.399996	0.749981	0.599988	0.699993	0.466664	0.0	1.0	5.0	
2	2	0	0.399992	0.333328	0.399992	0.249997	0.399996	0.285712	0.0	1.0	4.0	
3	3	0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0	0.0	2.0	
4	4	0	0.399992	0.199998	0.999950	0.666644	0.571420	0.307690	0.0	1.0	6.0	

In [22]:

```
print (df2.shape)
df2.head()
```

```
(70000, 12)
```

Out[22]:

	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
2	2	1	1	73	59	14	10	4.0	24.0	0.166667	2	0
3	3	1	1	50	65	11	9	0.0	19.0	0.000000	2	0
4	4	3	1	76	39	13	7	2.0	20.0	0.100000	4	2

In [23]:

```
df4 =pd.merge(df1, df2, on='id')
df4.head()
```

Out[23]:

	id	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max	last_word_eq	first_word_eq	...	freq_qid2
0	0	0	0.999980	0.833319	0.999983	0.999983	0.916659	0.785709	0.0	1.0	...	1
1	1	0	0.799984	0.399996	0.749981	0.599988	0.699993	0.466664	0.0	1.0	...	1
2	2	0	0.399992	0.333328	0.399992	0.249997	0.399996	0.285712	0.0	1.0	...	1
3	3	0	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0	0.0	...	1
4	4	0	0.399992	0.199998	0.999950	0.666644	0.571420	0.307690	0.0	1.0	...	1

5 rows × 28 columns

In [24]:

```
df_final =pd.merge(df_without_qid, df4, on='id')
#print (df_final.shape)
```

In [25]:

```
df_final_train, df_final_test = train_test_split(df_final, test_size=0.33, shuffle=False)

#print (df_final_train.shape)
```

In [26]:

```
q1_train = df_final_train['question1'].values
q1_test = df_final_test['question1'].values

q2_train = df_final_train['question2'].values
q2_test = df_final_test['question2'].values

y_train = df_final_train['is_duplicate'].values
y_test = df_final_test['is_duplicate'].values
```

In [27]:

```
q_train = np.concatenate([q1_train,q2_train])
q_test = np.concatenate([q1_test,q2_test])

print (q_train.shape)
print (q_test.shape)
```

```
(93800,)
(46200,)
```

In [28]:

```
from gensim.models import Word2Vec
from gensim.models import KeyedVectors

lst_train_q1=[]
lst_test_q1=[]
lst_of_lst_train_q1 = []
lst_of_lst_test_q1 = []

for sentance in tqdm(q1_train):
    lst_train_q1.append(sentance.strip())
for sentance in tqdm(lst_train_q1):
    lst_of_lst_train_q1.append(sentance.split())

for sent in tqdm(q1_test):
    lst_test_q1.append(sent.strip())
for sent in tqdm(lst_test_q1):
    lst_of_lst_test_q1.append(sent.split())


w2v_model_self_taught_train_q1=Word2Vec(lst_of_lst_train_q1,min_count=1,size=50, workers=4)
w2v_words_train_q1 = list(w2v_model_self_taught_train_q1.wv.vocab)

##############################################################
lst_train_q2=[]
lst_test_q2=[]
lst_of_lst_train_q2 = []
lst_of_lst_test_q2 = []

for sentance in tqdm(q2_train):
    lst_train_q2.append(sentance.strip())
for sentance in tqdm(lst_train_q2):
    lst_of_lst_train_q2.append(sentance.split())

for sent in tqdm(q2_test):
    lst_test_q2.append(sent.strip())
for sent in tqdm(lst_test_q2):
```

```
    lst_of_lst_test_q2.append(sent.split())


w2v_model_self_taught_train_q2=Word2Vec(lst_of_lst_train_q1,min_count=1,size=50, workers=4)
w2v_words_train_q2 = list(w2v_model_self_taught_train_q2.wv.vocab)
```

```
100%|██████████| 46900/46900 [00:00<00:00, 1959525.62it/s]
100%|██████████| 46900/46900 [00:00<00:00, 783407.57it/s]
100%|██████████| 23100/23100 [00:00<00:00, 2105674.97it/s]
100%|██████████| 23100/23100 [00:00<00:00, 661765.48it/s]
100%|██████████| 46900/46900 [00:00<00:00, 1751891.22it/s]
100%|██████████| 46900/46900 [00:00<00:00, 644195.60it/s]
100%|██████████| 23100/23100 [00:00<00:00, 1930125.15it/s]
100%|██████████| 23100/23100 [00:00<00:00, 643396.41it/s]
```

In [29]:

```
tf_idf_vect_q1 = TfidfVectorizer(min_df=4,ngram_range=(1,3),max_features=2500)
tfidf_q1_train = tf_idf_vect_q1.fit_transform(q1_train)
dictionary_q1 = dict(zip(tf_idf_vect_q1.get_feature_names(), list(tf_idf_vect_q1.idf_)))
tfidfw2v_q1 = tf_idf_vect_q1.get_feature_names()
tfidf_q1_test = tf_idf_vect_q1.transform(q1_test)

####################

tf_idf_vect_q2 = TfidfVectorizer(min_df=4,ngram_range=(1,3),max_features=2500)
tfidf_q2_train = tf_idf_vect_q2.fit(q2_train)
dictionary_q2 = dict(zip(tf_idf_vect_q2.get_feature_names(), list(tf_idf_vect_q2.idf_)))
tfidfw2v_q2 = tf_idf_vect_q2.get_feature_names()
tfidf_q2_test = tf_idf_vect_q2.transform(q2_test)
```

In [30]:

```
#tf_idf_vect = TfidfVectorizer(min_df=4,ngram_range=(1,3),max_features=2500)
#tfidf_q1_train = tf_idf_vect.fit_transform(q1_train)
#tfidf_q1_test = tf_idf_vect.transform(q1_test)

#tfidf_q2_train = tf_idf_vect.fit_transform(q2_train)
#tfidf_q2_test = tf_idf_vect.transform(q2_test)
```

In [31]:

```
tfidf_w2v_q1_train = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent4 in tqdm(lst_of_lst_train_q1): # for each review/sentence
    sent_vec4 = np.zeros(50) # as word vectors are of zero length
    weight_sum4 =0; # num of words with a valid vector in the sentence/review
    for word4 in sent4: # for each word in a review/sentence
        if word4 in w2v_words_train_q1 and word4 in tfidfw2v_q1:
            vec4 = w2v_model_self_taught_train_q1.wv[word4]
            tf_idf_train_q1 = dictionary_q1[word4]*(sent4.count(word4)/len(sent4))
            sent_vec4 += (vec4 * tf_idf_train_q1)
            weight_sum4 += tf_idf_train_q1
    if weight_sum4 != 0:
        sent_vec4 /= weight_sum4
    tfidf_w2v_q1_train.append(sent_vec4)
    row += 1
```

```
100%|██████████| 46900/46900 [01:07<00:00, 699.64it/s]
```

In [32]:

```
tfidf_w2v_q1_test = []; # the tfidf-w2v for each sentence/review is stored in this list
```

```
row=0;
for sent5 in tqdm(lst_of_lst_test_q1): # for each review/sentence
    sent_vec5 = np.zeros(50) # as word vectors are of zero length
    weight_sum5 =0; # num of words with a valid vector in the sentence/review
    for word5 in sent5: # for each word in a review/sentence
        if word5 in w2v_words_train_q1 and word5 in tfidfw2v_q1:
            vec5 = w2v_model_self_taught_train_q1.wv[word5]
            tf_idf_test_q1 = dictionary_q1[word5]*(sent5.count(word5)/len(sent5))
            sent_vec5 += (vec5 * tf_idf_test_q1)
            weight_sum5 += tf_idf_test_q1
    if weight_sum5 != 0:
        sent_vec5 /= weight_sum5
    tfidf_w2v_q1_test.append(sent_vec5)
    row += 1
```

```
100%|██████████████████████████████████████████████████████████████████████████| 23100/23100 [00:
45<00:00, 509.46it/s]
```

In [33]:

```
tfidf_w2v_q2_train = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent2 in tqdm(lst_of_lst_train_q2): # for each review/sentence
    sent_vec2 = np.zeros(50) # as word vectors are of zero length
    weight_sum2 =0; # num of words with a valid vector in the sentence/review
    for word2 in sent2: # for each word in a review/sentence
        if word2 in w2v_words_train_q2 and word4 in tfidfw2v_q2:
            vec2 = w2v_model_self_taught_train_q2.wv[word2]
            tf_idf_train_q2 = dictionary_q2[word2]*(sent2.count(word2)/len(sent2))
            sent_vec2 += (vec2 * tf_idf_train_q2)
            weight_sum2 += tf_idf_train_q2
    if weight_sum2 != 0:
        sent_vec2 /= weight_sum2
    tfidf_w2v_q2_train.append(sent_vec2)
    row += 1
```

```
100%|██████████████████████████████████████████████████████████████████████████| 46900/46900 [01:
24<00:00, 551.88it/s]
```

In [34]:

```
tfidf_w2v_q2_test = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent3 in tqdm(lst_of_lst_test_q2): # for each review/sentence
    sent_vec3 = np.zeros(50) # as word vectors are of zero length
    weight_sum3 =0; # num of words with a valid vector in the sentence/review
    for word3 in sent3: # for each word in a review/sentence
        if word3 in w2v_words_train_q2 and word5 in tfidfw2v_q2:
            vec3 = w2v_model_self_taught_train_q2.wv[word3]
            tf_idf_test_q2 = dictionary_q2[word3]*(sent3.count(word3)/len(sent3))
            sent_vec3 += (vec3 * tf_idf_test_q2)
            weight_sum3 += tf_idf_test_q2
    if weight_sum3 != 0:
        sent_vec3 /= weight_sum3
    tfidf_w2v_q2_test.append(sent_vec3)
    row += 1
```

```
100%|██████████████████████████████████████████████████████████████████████████| 23100/23100 [00:
44<00:00, 524.40it/s]
```

In [35]:

```
q1_train_std =StandardScaler(with_mean=False,with_std=False).fit_transform(tfidf_w2v_q1_train)
q1_test_std =StandardScaler(with_mean=False,with_std=False).fit_transform(tfidf_w2v_q1_test)

q2_train_std =StandardScaler(with_mean=False,with_std=False).fit_transform(tfidf_w2v_q2_train)
q2_test_std =StandardScaler(with_mean=False,with_std=False).fit_transform(tfidf_w2v_q2_test)
```

In [38]:

```
#https://stackoverflow.com/questions/45961747/append-tfidf-to-pandas-dataframe
```

```
#https://www.researchgate.net/post/How_to_append_Tf-Idf_vector_into_pandas_dataframe

#q1_train_std_df = pd.DataFrame(q1_train_std.toarray())
#q1_test_std_df = pd.DataFrame(q1_test_std.toarray())

#q2_train_std_df = pd.DataFrame(q2_train_std.toarray())
#q2_test_std_df = pd.DataFrame(q2_test_std.toarray())

q1_train_std_df = pd.DataFrame(q1_train_std)
q1_test_std_df = pd.DataFrame(q1_test_std)

q2_train_std_df = pd.DataFrame(q2_train_std)
q2_test_std_df = pd.DataFrame(q2_test_std)
```

In [39]:

```
from scipy.sparse import coo_matrix, hstack
import scipy.sparse as ss

train_after_dropping = df_final_train.drop(['id','question1','question2','is_duplicate'],axis=1)
print (train_after_dropping.shape)
X_train = pd.concat([train_after_dropping, q2_train_std_df,q1_train_std_df], axis=1)

test_after_dropping = df_final_test.drop(['id','question1','question2','is_duplicate'],axis=1)
X_test1 = pd.concat([q2_test_std_df,q1_test_std_df],axis=1)
X_test = ss.hstack([test_after_dropping,X_test1])

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

```
(46900, 26)
Number of data points in train data : (46900, 126)
Number of data points in test data : (23100, 126)
```

In [40]:

```
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 train 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:  0.626226012793177 Class 1:  0.37377398720682303
---------- Distribution of output variable in train data ----------
Class 0:  0.36978354978354977 Class 1:  0.36978354978354977
```

In [41]:

```
# 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()
```

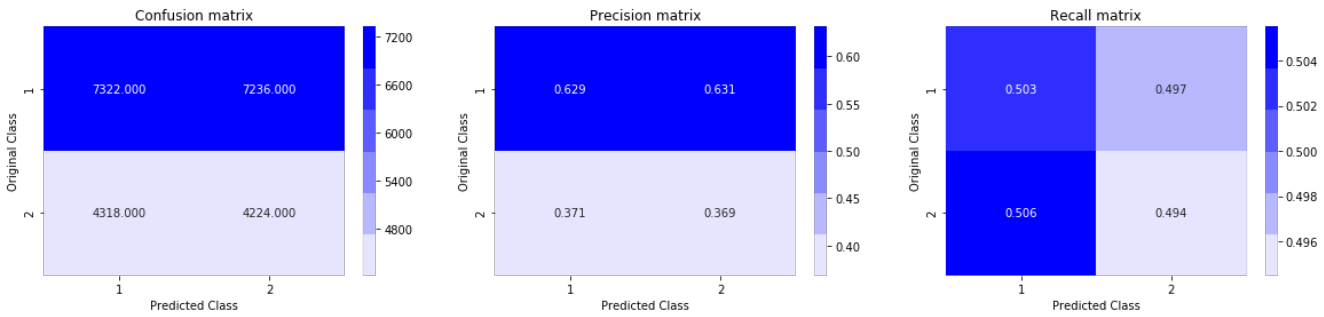
4.4 Building a random model (Finding worst-case log-loss)

In [42]:

```
# 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 0.8888108603784698
```



4.5 XGBoost

In [44]:

```
print (type(X_train))
print (type(X_test))
X_test = pd.DataFrame(X_test.toarray())
print (type(X_test))
X_train = X_train.as_matrix()
X_test = X_test.as_matrix()
```

```
<class 'pandas.core.frame.DataFrame'>
<class 'scipy.sparse.coo.coo_matrix'>
<class 'pandas.core.frame.DataFrame'>
```

In [45]:

```
print (type(X_train))
print (type(X_test))
```

```
<class 'numpy.ndarray'>
<class 'numpy.ndarray'>
```

In [46]:

```
from xgboost import XGBClassifier

from scipy.stats import uniform, randint
from sklearn.model_selection import cross_val_score, GridSearchCV, KFold, RandomizedSearchCV,
train_test_split
import warnings
warnings.filterwarnings("ignore")


XGB = XGBClassifier(booster='gbtree',objective = 'binary:logistic',eval_metric= 'logloss')

param_grid = {'max_depth':[3,9,11],'n_estimators':[50,100,300,500]}
xgboost_GBDT = RandomizedSearchCV(XGB,param_grid,cv=3, verbose=2)
xgboost_GBDT.fit(X_train,y_train)
xgboost_GBDT.best_params_
```

```
Fitting 3 folds for each of 10 candidates, totalling 30 fits

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.

[CV] n_estimators=100, max_depth=3 ....................................
[CV] ..... n_estimators=100, max_depth=3, total=  20.3s

[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:   20.2s remaining:    0.0s

[CV] n_estimators=100, max_depth=3 ....................................
[CV] ..... n_estimators=100, max_depth=3, total=  19.7s
[CV] n_estimators=100, max_depth=3 ....................................
[CV] ..... n_estimators=100, max_depth=3, total=  19.6s
[CV] n_estimators=50, max_depth=3 .....................................
[CV] ..... n_estimators=50, max_depth=3, total=  10.2s
[CV] n_estimators=50, max_depth=3 .....................................
[CV] ..... n_estimators=50, max_depth=3, total=  10.2s
[CV] n_estimators=50, max_depth=3 .....................................
[CV] ..... n_estimators=50, max_depth=3, total=  10.1s
[CV] n_estimators=50, max_depth=11 ....................................
[CV] ..... n_estimators=50, max_depth=11, total=  34.2s
[CV] n_estimators=50, max_depth=11 ....................................
[CV] ..... n_estimators=50, max_depth=11, total=  34.2s
[CV] n_estimators=50, max_depth=11 ....................................
[CV] ..... n_estimators=50, max_depth=11, total=  34.9s
[CV] n_estimators=300, max_depth=9 ....................................
[CV] ..... n_estimators=300, max_depth=9, total= 2.8min
[CV] n_estimators=300, max_depth=9 ....................................
[CV] ..... n_estimators=300, max_depth=9, total= 2.7min
[CV] n_estimators=300, max_depth=9 ....................................
[CV] ..... n_estimators=300, max_depth=9, total= 2.7min
[CV] n_estimators=100, max_depth=9 ....................................
[CV] ..... n_estimators=100, max_depth=9, total=  54.2s
[CV] n_estimators=100, max_depth=9 ....................................
```

```
[CV] ..... n_estimators=100, max_depth=9, total=  54.2s
[CV] n_estimators=100, max_depth=9 ....................................
[CV] ..... n_estimators=100, max_depth=9, total=  53.7s
[CV] n_estimators=300, max_depth=11 ...................................
[CV] ..... n_estimators=300, max_depth=11, total= 3.3min
[CV] n_estimators=300, max_depth=11 ...................................
[CV] ..... n_estimators=300, max_depth=11, total= 3.5min
[CV] n_estimators=300, max_depth=11 ...................................
[CV] ..... n_estimators=300, max_depth=11, total= 3.4min
[CV] n_estimators=100, max_depth=11 ...................................
[CV] ..... n_estimators=100, max_depth=11, total= 1.1min
[CV] n_estimators=100, max_depth=11 ...................................
[CV] ..... n_estimators=100, max_depth=11, total= 1.1min
[CV] n_estimators=100, max_depth=11 ...................................
[CV] ..... n_estimators=100, max_depth=11, total= 1.1min
[CV] n_estimators=500, max_depth=3 ....................................
[CV] ..... n_estimators=500, max_depth=3, total= 1.6min
[CV] n_estimators=500, max_depth=3 ....................................
[CV] ..... n_estimators=500, max_depth=3, total= 1.6min
[CV] n_estimators=500, max_depth=3 ....................................
[CV] ..... n_estimators=500, max_depth=3, total= 1.6min
[CV] n_estimators=300, max_depth=3 ....................................
[CV] ..... n_estimators=300, max_depth=3, total= 1.0min
[CV] n_estimators=300, max_depth=3 ....................................
[CV] ..... n_estimators=300, max_depth=3, total= 1.0min
[CV] n_estimators=300, max_depth=3 ....................................
[CV] ..... n_estimators=300, max_depth=3, total=  59.8s
[CV] n_estimators=500, max_depth=9 ....................................
[CV] ..... n_estimators=500, max_depth=9, total= 4.5min
[CV] n_estimators=500, max_depth=9 ....................................
[CV] ..... n_estimators=500, max_depth=9, total= 4.6min
[CV] n_estimators=500, max_depth=9 ....................................
[CV] ..... n_estimators=500, max_depth=9, total= 4.5min

[Parallel(n_jobs=1)]: Done  30 out of  30 | elapsed: 49.3min finished
```

Out[46]:

```
{'n_estimators': 300, 'max_depth': 9}
```

In [47]:

```
from xgboost import XGBClassifier

from scipy.stats import uniform, randint
from sklearn.model_selection import cross_val_score, GridSearchCV, KFold, RandomizedSearchCV,
train_test_split
import warnings

besthyperpara_xgboost = XGBClassifier(booster='gbtree',objective = 'binary:logistic',eval_metric= '
logloss',max_depth=9,n_estimators=300)
besthyperpara_xgboost.fit(X_train,y_train)
sig_clf = CalibratedClassifierCV(besthyperpara_xgboost, method="sigmoid")
sig_clf.fit(X_train, y_train)
predict_y_xgboo = sig_clf.predict_proba(X_test)
```

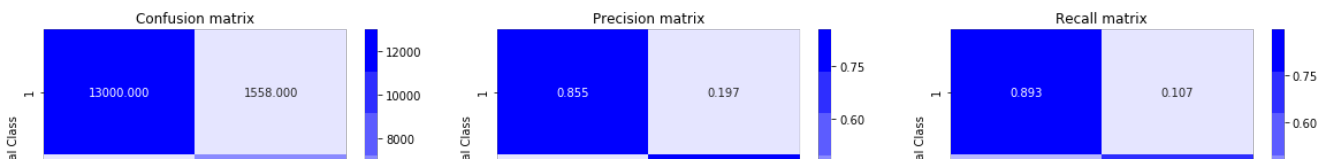
In [48]:

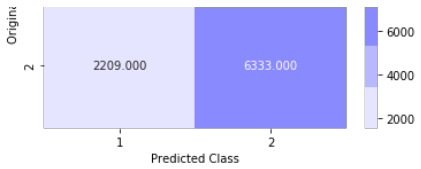
```
print (log_loss(y_test, predict_y_xgboo, labels=besthyperpara_xgboost.classes_, eps=1e-15))
```

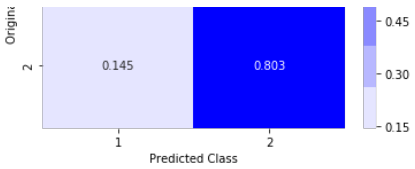
```
0.35881632092238686
```

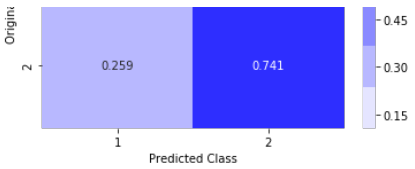
In [49]:

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




Origina
2
2209.000
6333.000
1
2
Predicted Class
6000
4000
2000


Origina
2
0.145
0.803
1
2
Predicted Class
0.45
0.30
0.15


Origina
2
0.259
0.741
1
2
Predicted Class
0.45
0.30
0.15