Quora Question Pairs

1. Business Problem

1.1 Description

Quora is a place to gain and share knowledge—about anything. It’s a platform to ask questions and connect with people who contribute unique insights and quality answers. This empowers people to learn from each other and to better understand the world.

Over 100 million people visit Quora every month, so it's no surprise that many people ask similarly worded questions. Multiple questions with the same intent can cause seekers to spend more time finding the best answer to their question, and make writers feel they need to answer multiple versions of the same question. Quora values canonical questions because they provide a better experience to active seekers and writers, and offer more value to both of these groups in the long term.

> Credits: Kaggle

Problem Statement

- Identify which questions asked on Quora are duplicates of questions that have already been asked.
- This could be useful to instantly provide answers to questions that have already been answered.
- We are tasked with predicting whether a pair of questions are duplicates or not.

1.2 Sources/Useful Links

- Source : https://www.kaggle.com/c/quora-question-pairs

Useful Links

- Discussions : https://www.kaggle.com/anokas/data-analysis-xgboost-starter-0-35460-lb/comments
- Kaggle Winning Solution and other approaches: https://www.dropbox.com/sh/93968nfnrzh8bp5/AACZdtsApc1QSTQc7X0H3QZ5a?dl=0
- Blog 1 : https://engineering.quora.com/Semantic-Question-Matching-with-Deep-Learning
- Blog 2 : https://towardsdatascience.com/identifying-duplicate-questions-on-quora-top-12-on-kaggle-4c1cf93f1c30

1.3 Real world/Business Objectives and Constraints

1. The cost of a mis-classification can be very high.
2. You would want a probability of a pair of questions to be duplicates so that you can choose any threshold of choice.
3. No strict latency concerns.
4. Interpretability is partially important.

2. Machine Learning Probelm

2.1 Data

2.1.1 Data Overview

- Data will be in a file Train.csv
- Train.csv contains 5 columns : qid1, qid2, question1, question2, is_duplicate
- Size of Train.csv 60MB

- Size of Train.csv - 60MB
- Number of rows in Train.csv = 404,290

2.1.2 Example Data point

```
"id","qid1","qid2","question1","question2","is_duplicate"
"0","1","2","What is the step by step guide to invest in share market in india?","What is
the step by step guide to invest in share market?","0"
"1","3","4","What is the story of Kohinoor (Koh-i-Noor) Diamond?","What would happen if the
Indian government stole the Kohinoor (Koh-i-Noor) diamond back?","0"
"7","15","16","How can I be a good geologist?","What should I do to be a great
geologist?","1"
"11","23","24","How do I read and find my YouTube comments?","How can I see all my Youtube
comments?","1"
```

2.2 Mapping the real world problem to an ML problem

2.2.1 Type of Machine Leaning Problem

It is a binary classification problem, for a given pair of questions we need to predict if they are duplicate or not.

2.2.2 Performance Metric

Source: https://www.kaggle.com/c/quora-question-pairs#evaluation

Metric(s):

- log-loss : https://www.kaggle.com/wiki/LogarithmicLoss
- Binary Confusion Matrix

2.3 Train and Test Construction

We build train and test by randomly splitting in the ratio of 70:30 or 80:20 whatever we choose as we have sufficient points to work with.

3. Exploratory Data Analysis

In [46]:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from subprocess import check_output
%matplotlib inline
import plotly.offline as py
py.init_notebook_mode(connected=True)
import plotly.graph_objs as go
import plotly.tools as tls
import gc
import sys
import os
from tqdm import tqdm

import re
from nltk.corpus import stopwords
import distance
from nltk.stem import PorterStemmer
from bs4 import BeautifulSoup
from fuzzywuzzy import fuzz
from sklearn.manifold import TSNE
```

```
from wordcloud import WordCloud, STOPWORDS
from os import path
from PIL import Image
color = sns.color_palette()
```

3.1 Reading data and basic stats

In [2]:

```
df = pd.read_csv("train.csv")

print("Number of data points:",df.shape[0])
```

```
Number of data points: 404290
```

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]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 404290 entries, 0 to 404289
Data columns (total 6 columns):
id              404290 non-null int64
qid1            404290 non-null int64
qid2            404290 non-null int64
question1       404289 non-null object
question2       404288 non-null object
is_duplicate    404290 non-null int64
dtypes: int64(4), object(2)
memory usage: 18.5+ MB
```

We are given a minimal number of data fields here, consisting of:

- id: Looks like a simple rowID
- qid{1, 2}: The unique ID of each question in the pair
- question{1, 2}: The actual textual contents of the questions.
- is_duplicate: The label that we are trying to predict - whether the two questions are duplicates of each other.

3.2.1 Distribution of data points among output classes

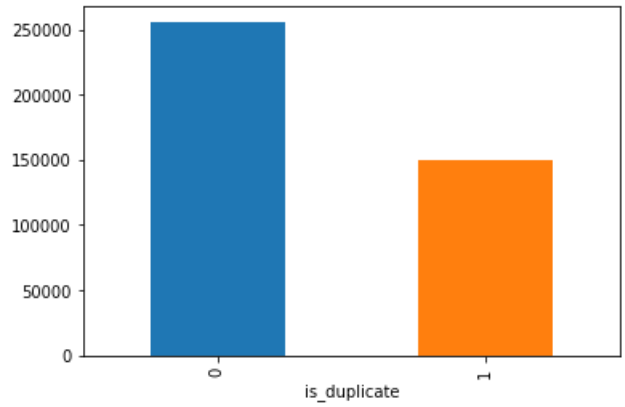
- Number of duplicate(smilar) and non-duplicate(non similar) questions

In [5]:

```
df.groupby("is_duplicate")['id'].count().plot.bar()
```

Out[5]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x152aa1b6588>
```



In [6]:

```
print('~> Total number of question pairs for training:\n   {}'.format(len(df)))
```

```
~> Total number of question pairs for training:
   404290
```

In [7]:

```
print('~> Question pairs are not Similar (is_duplicate = 0):\n   {}%'.format(100 -
round(df['is_duplicate'].mean()*100, 2)))
print('\n~> Question pairs are Similar (is_duplicate = 1):\n   {}%'.format(round(df['is_duplicate'
].mean()*100, 2)))
```

```
~> Question pairs are not Similar (is_duplicate = 0):
   63.08%

~> Question pairs are Similar (is_duplicate = 1):
   36.92%
```

3.2.2 Number of unique questions

In [8]:

```
qids = pd.Series(df['qid1'].tolist() + df['qid2'].tolist())
unique_qs = len(np.unique(qids))
qs_morethan_onetime = np.sum(qids.value_counts() > 1)
print ('Total number of  Unique Questions are: {}\n'.format(unique_qs))
#print len(np.unique(qids))

print ('Number of unique questions that appear more than one time: {}
({}%)\n'.format(qs_morethan_onetime,qs_morethan_onetime/unique_qs*100))

print ('Max number of times a single question is repeated: {}\n'.format(max(qids.value_counts())))


q_vals=qids.value_counts()

q_vals=q_vals.values
```

```
Total number of  Unique Questions are: 537933

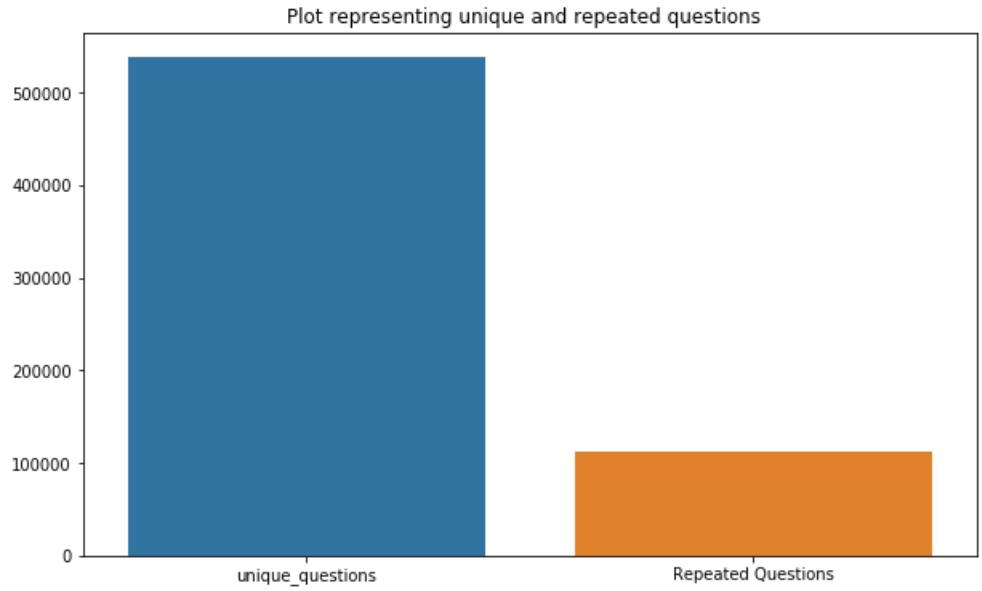
Number of unique questions that appear more than one time: 111780 (20.77953945937505%)

Max number of times a single question is repeated: 157
```

In [9]:

```
x = ["unique_questions" , "Repeated Questions"]
y =  [unique_qs , qs_morethan_onetime]

plt.figure(figsize=(10, 6))
plt.title ("Plot representing unique and repeated questions  ")
sns.barplot(x,y)
plt.show()
```



3.2.3 Checking for Duplicates

In [10]:

```
#checking whether there are any repeated pair of questions

pair_duplicates =
df[['qid1','qid2','is_duplicate']].groupby(['qid1','qid2']).count().reset_index()

print ("Number of duplicate questions",(pair_duplicates).shape[0] - df.shape[0])
```

```
Number of duplicate questions 0
```

3.2.4 Number of occurrences of each question

In [11]:

```
plt.figure(figsize=(20, 10))

plt.hist(qids.value_counts(), bins=160)

plt.yscale('log', nonposy='clip')

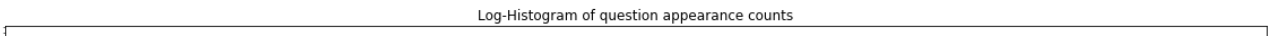
plt.title('Log-Histogram of question appearance counts')

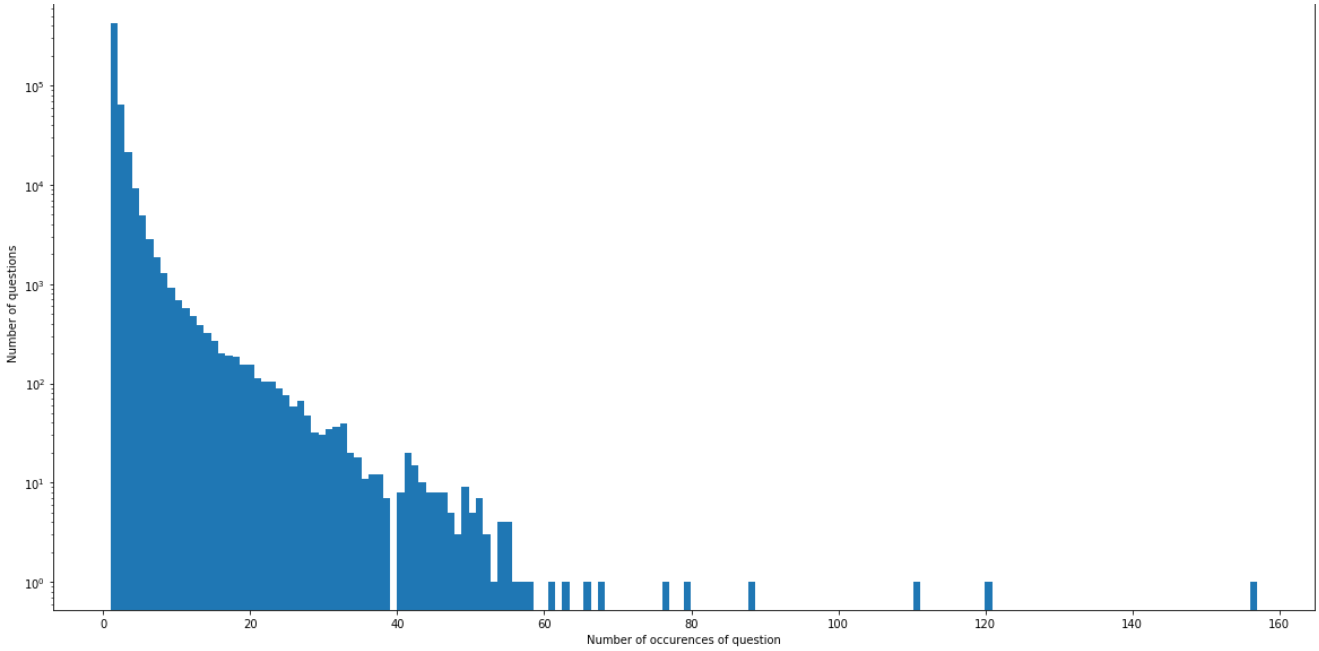
plt.xlabel('Number of occurences of question')

plt.ylabel('Number of questions')

print ('Maximum number of times a single question is repeated: {}\n'.format(max(qids.value_counts(
)))
```

```
Maximum number of times a single question is repeated: 157
```





3.2.5 Checking for NULL values

In [12]:

```
#Checking whether there are any rows with null values
nan_rows = df[df.isnull().any(1)]
print (nan_rows)
```

```
            id    qid1    qid2                         question1  \
105780  105780  174363  174364    How can I develop android app?
201841  201841  303951  174364  How can I create an Android app?
363362  363362  493340  493341                               NaN

                                             question2  is_duplicate
105780                                             NaN             0
201841                                             NaN             0
363362  My Chinese name is Haichao Yu. What English na...             0
```

- There are two rows with null values in question2

In [13]:

```
# Filling the null values with ' '
df = df.fillna('')
nan_rows = df[df.isnull().any(1)]
print (nan_rows)
```

```
Empty DataFrame
Columns: [id, qid1, qid2, question1, question2, is_duplicate]
Index: []
```

3.3 Basic Feature Extraction (before cleaning)

Let us now construct a few features like:

- **freq_qid1** = Frequency of qid1's
- **freq_qid2** = Frequency of qid2's
- **q1len** = Length of q1
- **q2len** = Length of q2
- **q1_n_words** = Number of words in Question 1
- **q2_n_words** = Number of words in Question 2
- **word_Common** = (Number of common unique words in Question 1 and Question 2)
- **word_Total** =(Total num of words in Question 1 + Total num of words in Question 2)

- **word_share** = (word_common)/(word_Total)
- **freq_q1+freq_q2** = sum total of frequency of qid1 and qid2
- **freq_q1-freq_q2** = absolute difference of frequency of qid1 and qid2

In [41]:

```
if os.path.isfile('df_fe_without_preprocessing_train.csv'):
    df = pd.read_csv("df_fe_without_preprocessing_train.csv",encoding='latin-1')
else:
    df['freq_qid1'] = df.groupby('qid1')['qid1'].transform('count')
    df['freq_qid2'] = df.groupby('qid2')['qid2'].transform('count')
    df['q1len'] = df['question1'].str.len()
    df['q2len'] = df['question2'].str.len()
    df['q1_n_words'] = df['question1'].apply(lambda row: len(row.split(" ")))
    df['q2_n_words'] = df['question2'].apply(lambda row: len(row.split(" ")))

    def normalized_word_Common(row):
        w1 = set(map(lambda word: word.lower().strip(), row['question1'].split(" ")))
        w2 = set(map(lambda word: word.lower().strip(), row['question2'].split(" ")))
        return 1.0 * len(w1 & w2)
    df['word_Common'] = df.apply(normalized_word_Common, axis=1)

    def normalized_word_Total(row):
        w1 = set(map(lambda word: word.lower().strip(), row['question1'].split(" ")))
        w2 = set(map(lambda word: word.lower().strip(), row['question2'].split(" ")))
        return 1.0 * (len(w1) + len(w2))
    df['word_Total'] = df.apply(normalized_word_Total, axis=1)

    def normalized_word_share(row):
        w1 = set(map(lambda word: word.lower().strip(), row['question1'].split(" ")))
        w2 = set(map(lambda word: word.lower().strip(), row['question2'].split(" ")))
        return 1.0 * len(w1 & w2)/(len(w1) + len(w2))
    df['word_share'] = df.apply(normalized_word_share, axis=1)

    df['freq_q1+q2'] = df['freq_qid1']+df['freq_qid2']
    df['freq_q1-q2'] = abs(df['freq_qid1']-df['freq_qid2'])

    df.to_csv("df_fe_without_preprocessing_train.csv", index=False)

df.head()
```

Out[41]:

	id	qid1	qid2	question1	question2	is_duplicate	freq_qid1	freq_qid2	q1len	q2len	q1_n_words	q2_n_words	word_
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	66	57	14	12	10.0
1	1	3	4	What is the story of Kohinoor (Koh-i-Noor) Dia...	What would happen if the Indian government sto...	0	4	1	51	88	8	13	4.0
2	2	5	6	How can I increase the speed of my internet co...	How can Internet speed be increased by hacking...	0	1	1	73	59	14	10	4.0
3	3	7	8	Why am I mentally very lonely?	Find the remainder when [math]23^{24}	0	1	1	50	65	11	9	0.0

	id	qid1	qid2	question1	question2	is_duplicate	freq_qid1	freq_qid2	q1len	q2len	q1_n_words	q2_n_words	word_
4	4	9	10	Which one dissolve in water quikly sugar, salt...	Which fish would survive in salt water?	0	3	1	76	39	13	7	2.0

number of words distribution in question

In [44]:

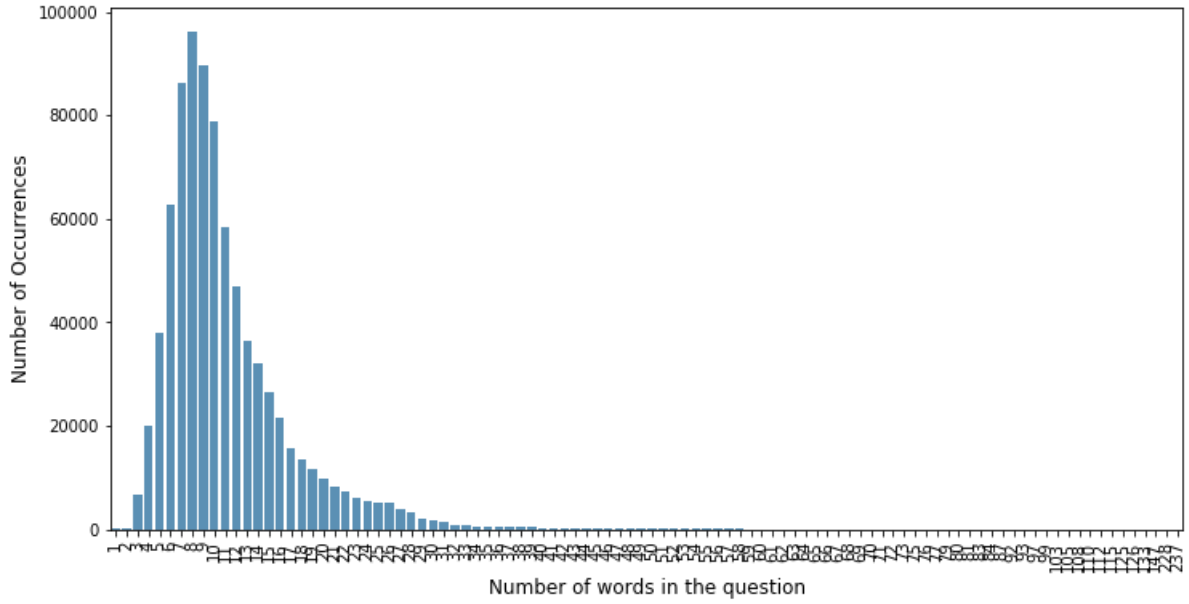
```
all_ques_df = pd.DataFrame(pd.concat([df['question1'], df['question2']]))
all_ques_df.columns = ["questions"]

all_ques_df["num_of_words"] = all_ques_df["questions"].apply(lambda x : len(str(x).split()))
```

In [47]:

```
cnt_srs = all_ques_df['num_of_words'].value_counts()

plt.figure(figsize=(12,6))
sns.barplot(cnt_srs.index, cnt_srs.values, alpha=0.8, color=color[0])
plt.ylabel('Number of Occurrences', fontsize=12)
plt.xlabel('Number of words in the question', fontsize=12)
plt.xticks(rotation='vertical')
plt.show()
```



observation:-The distribution here is right skewed with upto 237 words in question.There are also few questions with one or two words as well.

exploration of characters

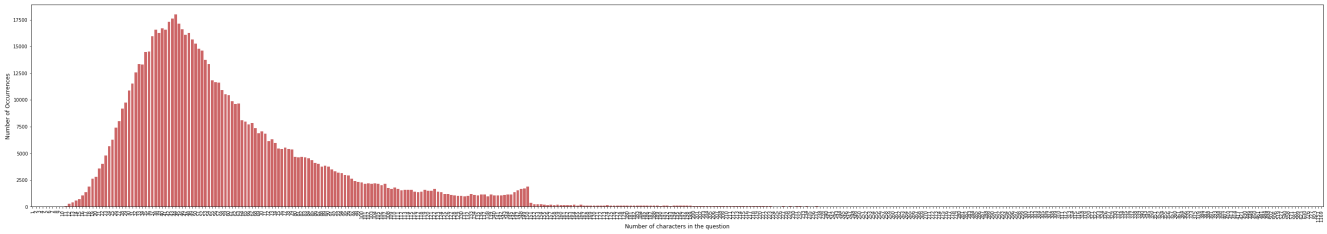
In [48]:

```
all_ques_df["num_of_chars"] = all_ques_df["questions"].apply(lambda x : len(str(x)))
cnt_srs = all_ques_df['num_of_chars'].value_counts()

plt.figure(figsize=(50,8))
sns.barplot(cnt_srs.index, cnt_srs.values, alpha=0.8, color=color[3])
plt.ylabel('Number of Occurrences', fontsize=12)
plt.xlabel('Number of characters in the question', fontsize=12)
```

```
plt.xticks(rotation='vertical')
plt.show()

del all_ques_df
```



observation:- 1.It is also right skewed distribution.

2.There is sudden dip at 160 character mark

Common unigrams between given question pairs

In [51]:

```
from nltk import word_tokenize, ngrams
eng_stopwords = set(stopwords.words('english'))
def get_unigrams(que):
    return [word for word in word_tokenize(que.lower()) if word not in eng_stopwords]

def get_common_unigrams(row):
    return len( set(row["unigrams_ques1"]).intersection(set(row["unigrams_ques2"])) )

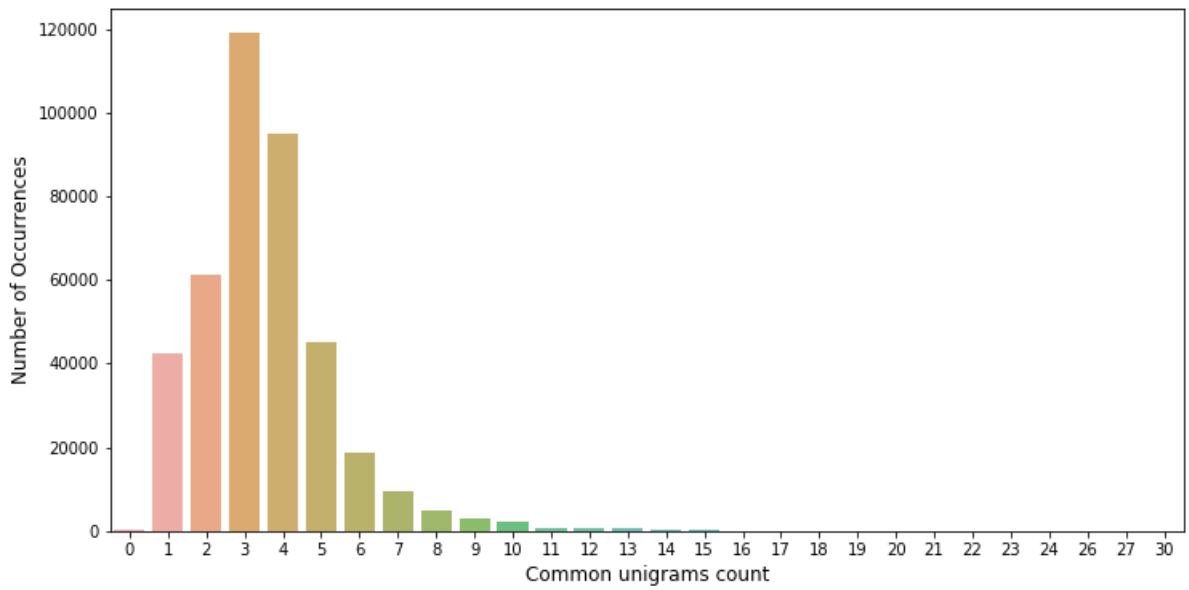
def get_common_unigram_ratio(row):
    return float(row["unigrams_common_count"]) / max(len( set(row["unigrams_ques1"]).union(set(row[
"unigrams_ques2"])) ),1)

df["unigrams_ques1"] = df['question1'].apply(lambda x: get_unigrams(str(x)))
df["unigrams_ques2"] = df['question2'].apply(lambda x: get_unigrams(str(x)))
df["unigrams_common_count"] = df.apply(lambda row: get_common_unigrams(row),axis=1)
df["unigrams_common_ratio"] = df.apply(lambda row: get_common_unigram_ratio(row), axis=1)
```

In [52]:

```
cnt_srs = df['unigrams_common_count'].value_counts()

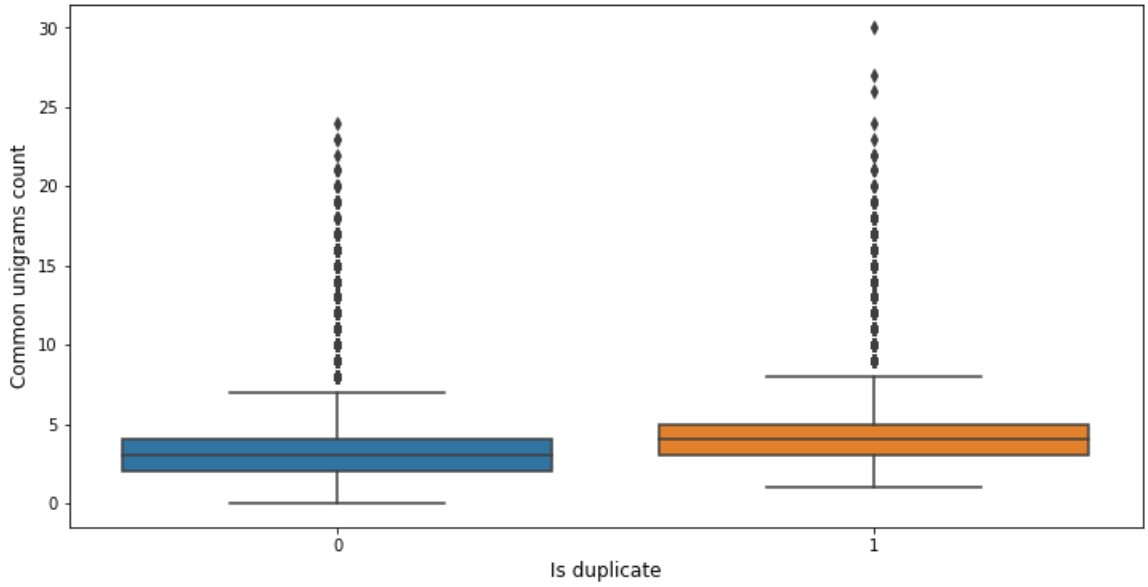
plt.figure(figsize=(12,6))
sns.barplot(cnt_srs.index, cnt_srs.values, alpha=0.8)
plt.ylabel('Number of Occurrences', fontsize=12)
plt.xlabel('Common unigrams count', fontsize=12)
plt.show()
```



from the above graph one can notice that there are few question pairs with no common words

In [54]:

```
plt.figure(figsize=(12,6))
sns.boxplot(x="is_duplicate", y="unigrams_common_count", data=df)
plt.xlabel('Is duplicate', fontsize=12)
plt.ylabel('Common unigrams count', fontsize=12)
plt.show()
```

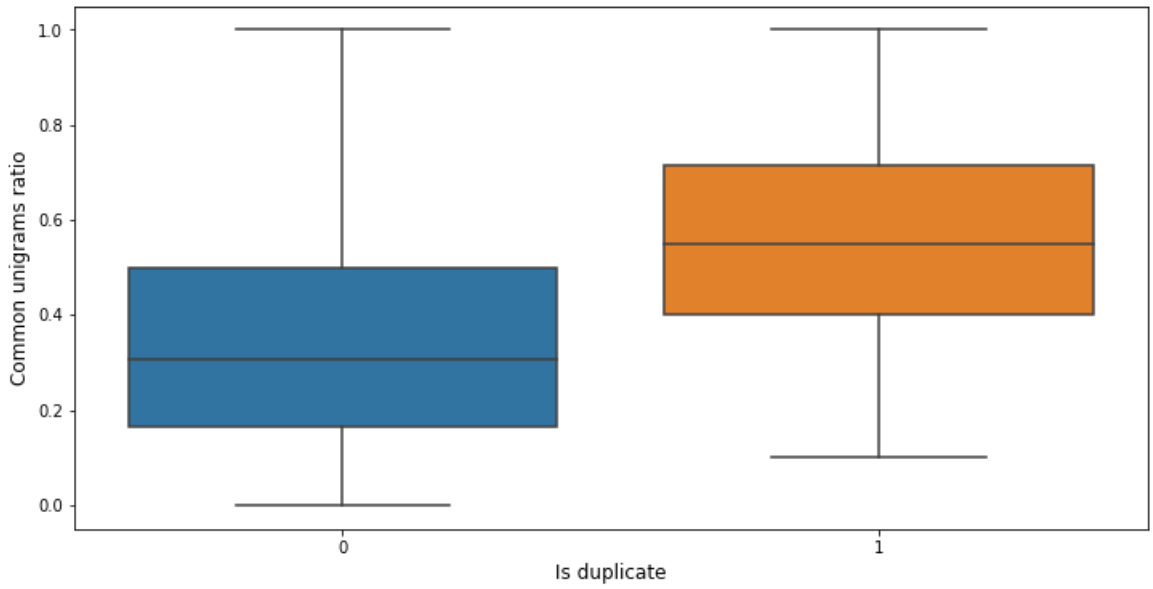


There is some good difference between 0 and 1 class using the common unigram count variable.

Let us look at the same graph using common unigrams ratio

In [55]:

```
plt.figure(figsize=(12,6))
sns.boxplot(x="is_duplicate", y="unigrams_common_ratio", data=df)
plt.xlabel('Is duplicate', fontsize=12)
plt.ylabel('Common unigrams ratio', fontsize=12)
plt.show()
```



q1 -q2 neighbour intersection count

In [57]:

```
ques = pd.concat([df[['question1', 'question2']]]).reset_index(drop='index')
```

In [58]:

```
from collections import defaultdict
q_dict = defaultdict(set)
for i in range(ques.shape[0]):
        q_dict[ques.question1[i]].add(ques.question2[i])
        q_dict[ques.question2[i]].add(ques.question1[i])
```

In [60]:

```
def q1_freq(row):
    return(len(q_dict[row['question1']]))

def q2_freq(row):
    return(len(q_dict[row['question2']]))

def q1_q2_intersect(row):
    return(len(set(q_dict[row['question1']]).intersection(set(q_dict[row['question2']])))))

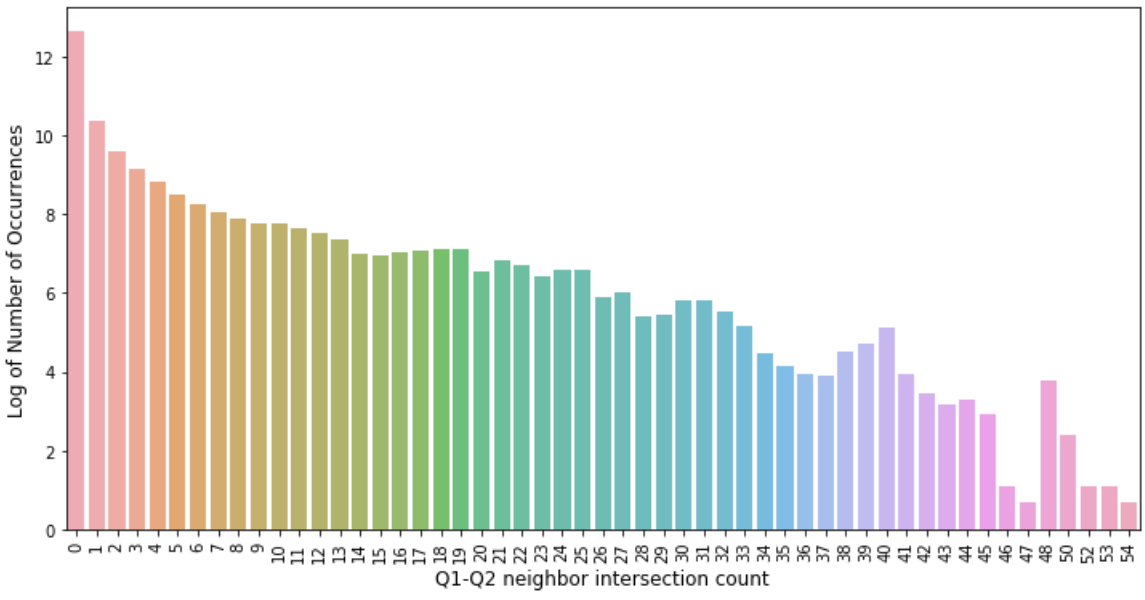
df['q1_q2_intersect'] = df.apply(q1_q2_intersect, axis=1, raw=True)
df['q1_freq'] = df.apply(q1_freq, axis=1, raw=True)
df['q2_freq'] = df.apply(q2_freq, axis=1, raw=True)
```

Let us first do simple count plots and see the distribution

In [61]:

```
cnt_srs = df['q1_q2_intersect'].value_counts()

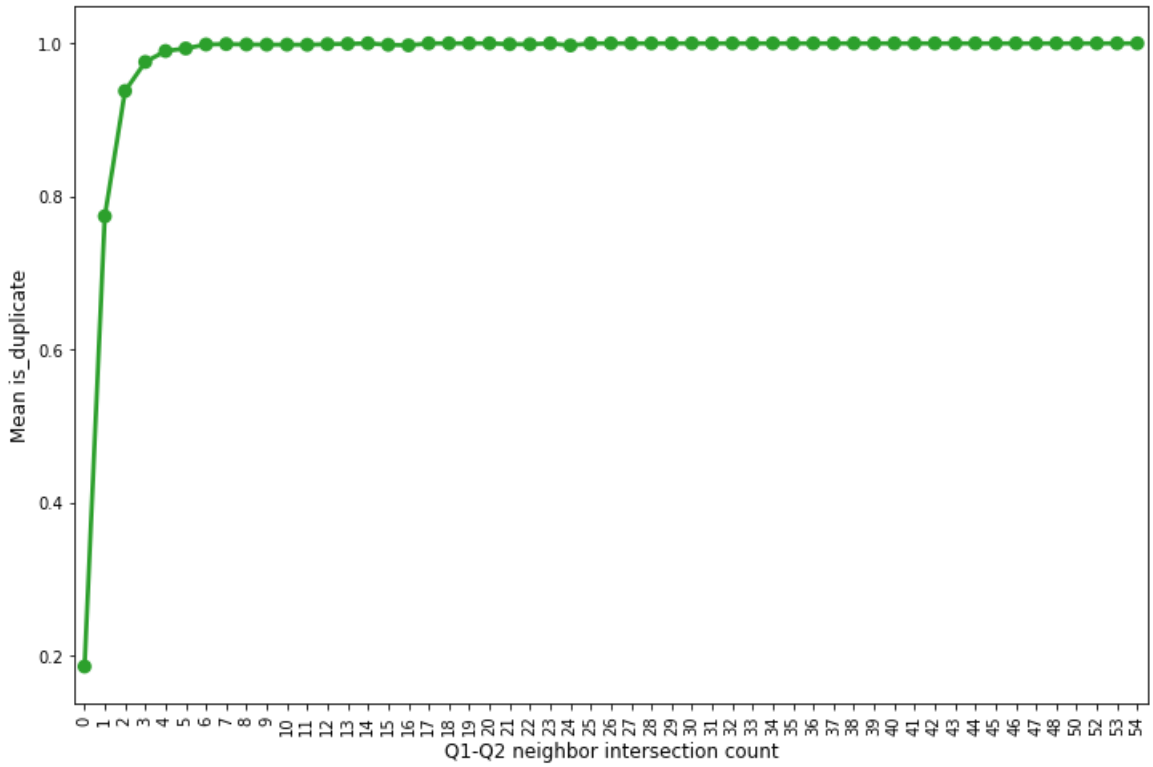
plt.figure(figsize=(12,6))
sns.barplot(cnt_srs.index, np.log1p(cnt_srs.values), alpha=0.8)
plt.xlabel('Q1-Q2 neighbor intersection count', fontsize=12)
plt.ylabel('Log of Number of Occurrences', fontsize=12)
plt.xticks(rotation='vertical')
plt.show()
```



In [62]:

```
grouped_df = df.groupby('q1_q2_intersect')['is_duplicate'].aggregate(np.mean).reset_index()
plt.figure(figsize=(12,8))
```

```
sns.pointplot(grouped_df["q1_q2_intersect"].values, grouped_df["is_duplicate"].values, alpha=0.8, c
olor=color[2])
plt.ylabel('Mean is_duplicate', fontsize=12)
plt.xlabel('Q1-Q2 neighbor intersection count', fontsize=12)
plt.xticks(rotation='vertical')
plt.show()
```



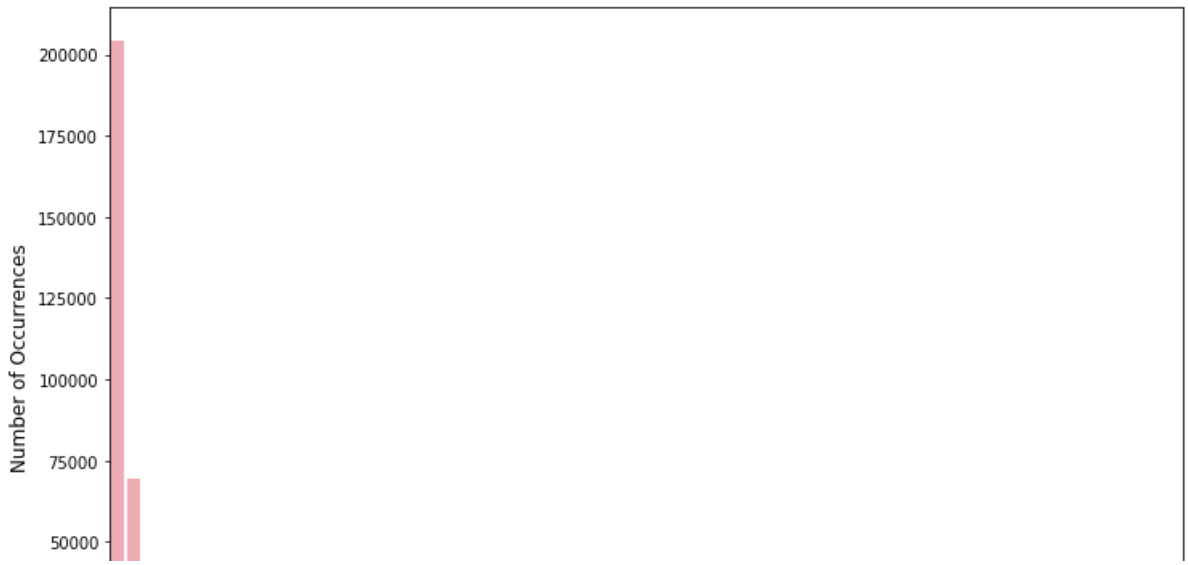
from the above graph we can see that this feature is super useful

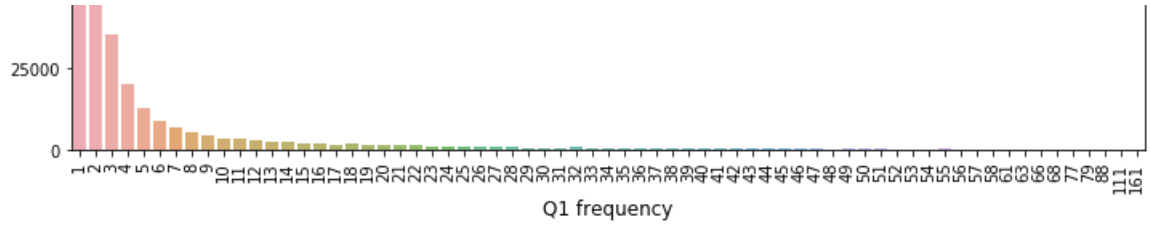
Question 1 Frequency

In [63]:

```
cnt_srs = df['q1_freq'].value_counts()

plt.figure(figsize=(12,8))
sns.barplot(cnt_srs.index, cnt_srs.values, alpha=0.8)
plt.xlabel('Q1 frequency', fontsize=12)
plt.ylabel('Number of Occurrences', fontsize=12)
plt.xticks(rotation='vertical')
plt.show()
```

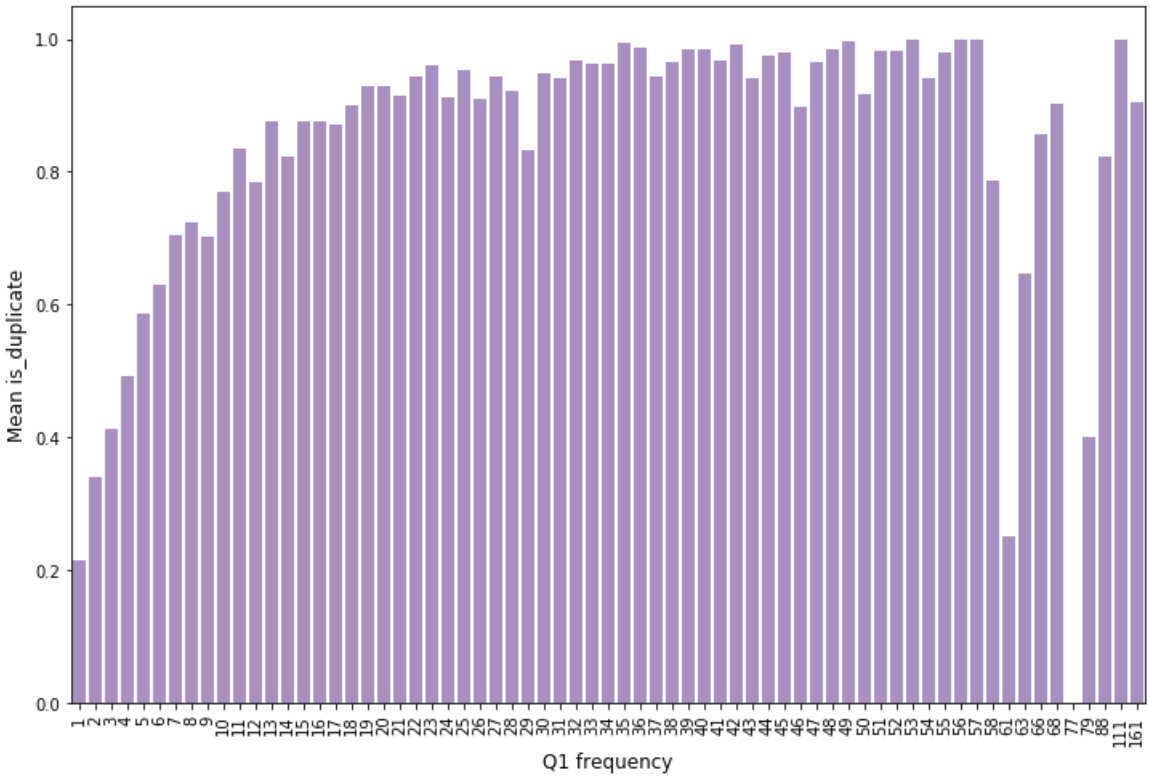




We could see a long tail here as well. Now let us check the target variable distribution.

In [64]:

```
plt.figure(figsize=(12,8))
grouped_df = df.groupby('q1_freq')['is_duplicate'].aggregate(np.mean).reset_index()
sns.barplot(grouped_df["q1_freq"].values, grouped_df["is_duplicate"].values, alpha=0.8, color=color
[4])
plt.ylabel('Mean is_duplicate', fontsize=12)
plt.xlabel('Q1 frequency', fontsize=12)
plt.xticks(rotation='vertical')
plt.show()
```



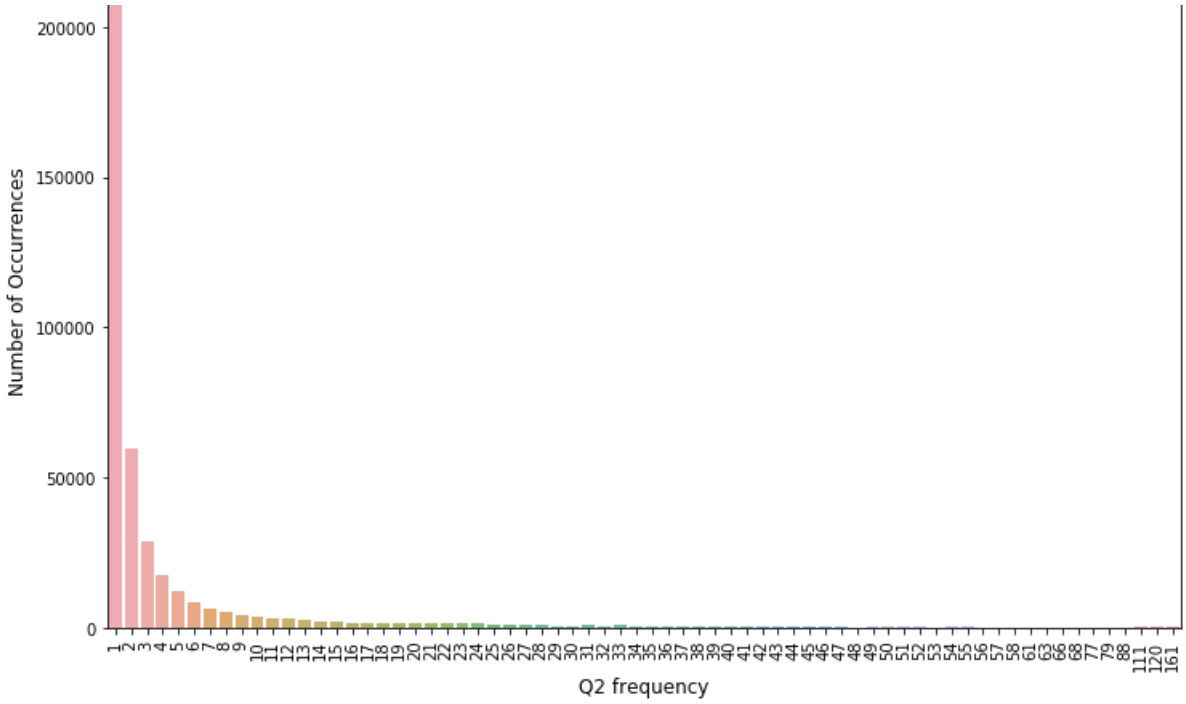
From the above plot there is increase in the mean target rate as the frequency increases.

Question2 Frequency

In [65]:

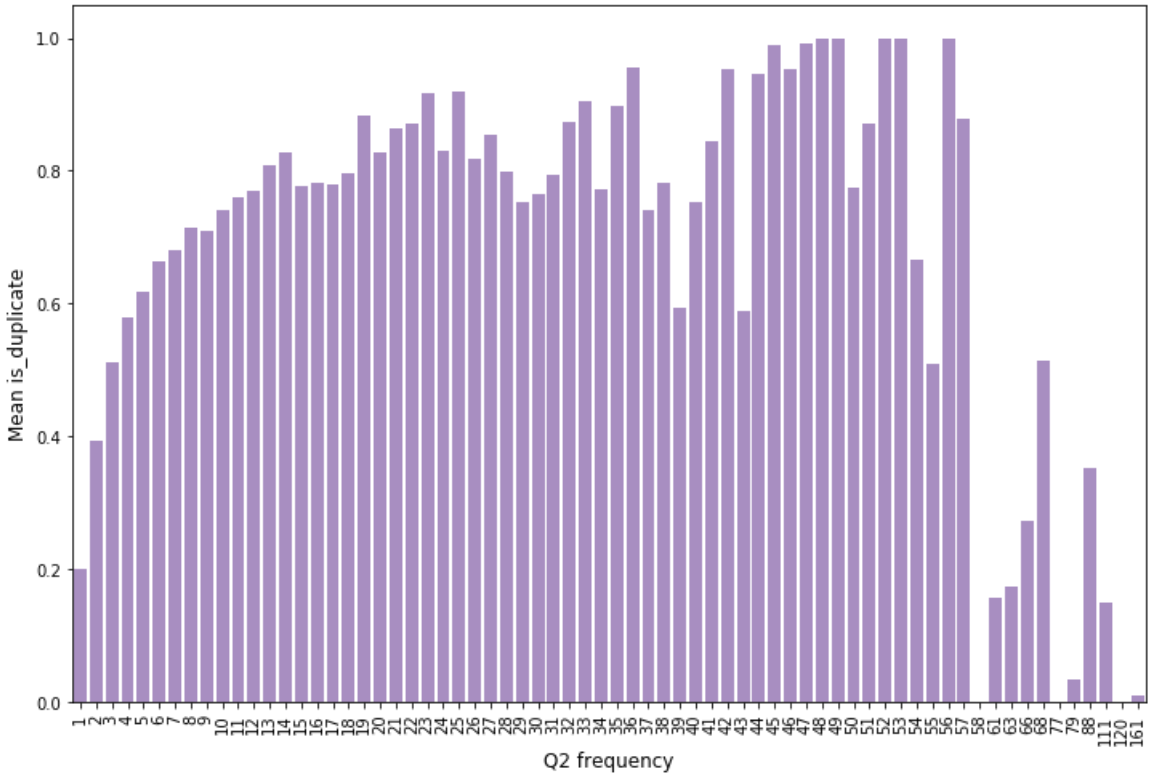
```
cnt_srs = df['q2_freq'].value_counts()

plt.figure(figsize=(12,8))
sns.barplot(cnt_srs.index, cnt_srs.values, alpha=0.8)
plt.xlabel('Q2 frequency', fontsize=12)
plt.ylabel('Number of Occurrences', fontsize=12)
plt.xticks(rotation='vertical')
plt.show()
```



In [66]:

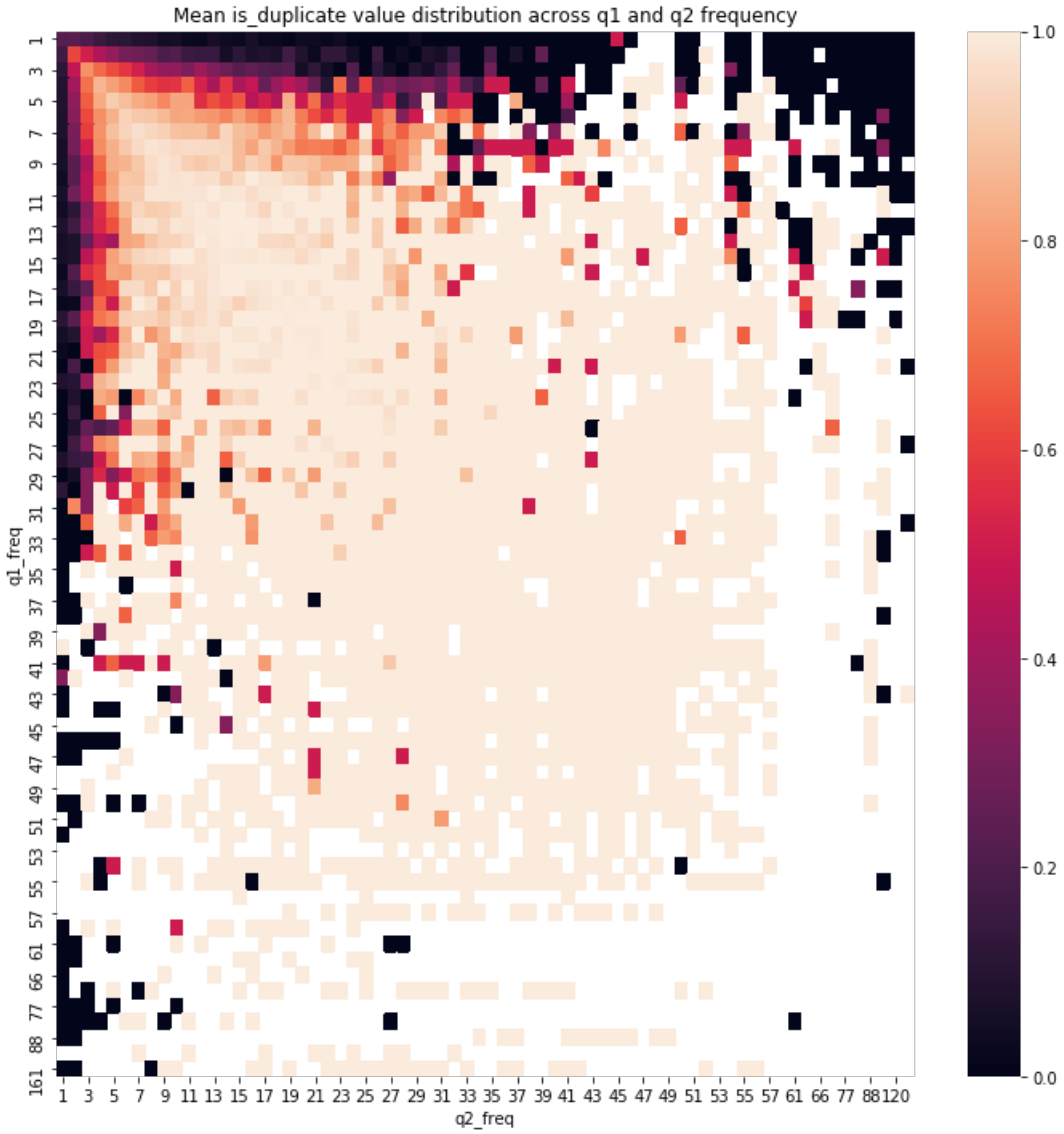
```
plt.figure(figsize=(12,8))
grouped_df = df.groupby('q2_freq')['is_duplicate'].aggregate(np.mean).reset_index()
sns.barplot(grouped_df["q2_freq"].values, grouped_df["is_duplicate"].values, alpha=0.8, color=color
[4])
plt.ylabel('Mean is_duplicate', fontsize=12)
plt.xlabel('Q2 frequency', fontsize=12)
plt.xticks(rotation='vertical')
plt.show()
```



Plotting heat map between q1 freq and q2 freq to check the target variable distribution

In [67]:

```
pvt_df = df.pivot_table(index="q1_freq", columns="q2_freq", values="is_duplicate")
plt.figure(figsize=(12,12))
sns.heatmap(pvt_df)
plt.title("Mean is_duplicate value distribution across q1 and q2 frequency")
plt.show()
```

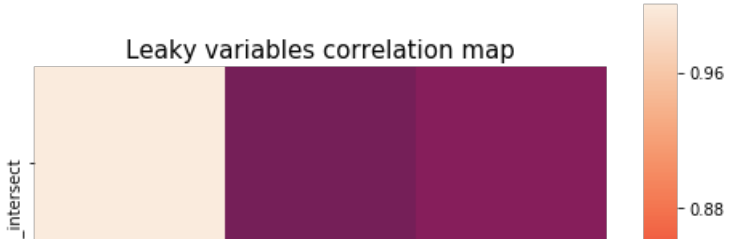


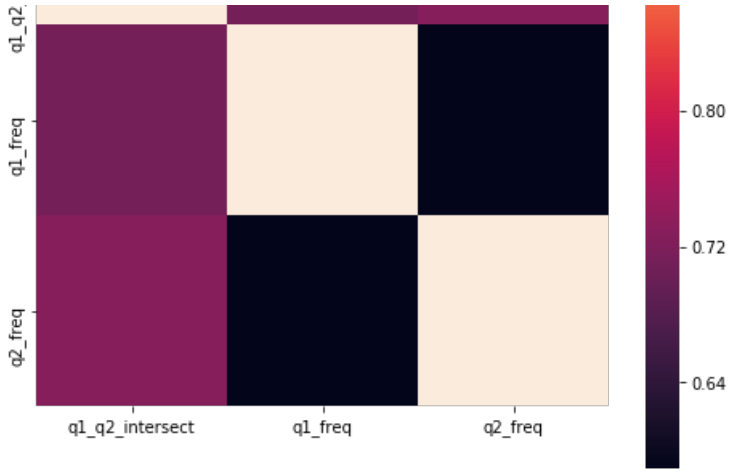
Let us also check the correlation between the three fields

In [68]:

```
cols_to_use = ['q1_q2_intersect', 'q1_freq', 'q2_freq']
temp_df = df[cols_to_use]
corrmat = temp_df.corr(method='spearman')
f, ax = plt.subplots(figsize=(8, 8))

# Draw the heatmap using seaborn
sns.heatmap(corrmat, vmax=1., square=True)
plt.title("Leaky variables correlation map", fontsize=15)
plt.show()
```





3.3.1 Analysis of some of the extracted features

- Here are some questions have only one single words.

In [15]:

```
print ("Minimum length of the questions in question1 : " , min(df['q1_n_words']))

print ("Minimum length of the questions in question2 : " , min(df['q2_n_words']))

print ("Number of Questions with minimum length [question1] :", df[df['q1_n_words']== 1].shape[0])
print ("Number of Questions with minimum length [question2] :", df[df['q2_n_words']== 1].shape[0])
```

```
Minimum length of the questions in question1 :  1
Minimum length of the questions in question2 :  1
Number of Questions with minimum length [question1] : 67
Number of Questions with minimum length [question2] : 24
```

3.3.1.1 Feature: word_share

In [16]:

```
plt.figure(figsize=(12, 8))

plt.subplot(1,2,1)
sns.violinplot(x = 'is_duplicate', y = 'word_share', data = df[0:])

plt.subplot(1,2,2)
sns.distplot(df[df['is_duplicate'] == 1.0]['word_share'][0:] , label = "1", color = 'red')
sns.distplot(df[df['is_duplicate'] == 0.0]['word_share'][0:] , label = "0" , color = 'blue' )
plt.show()
```

```
C:\Users\Shashank\Anaconda3\lib\site-packages\scipy\stats\stats.py:1713: FutureWarning:

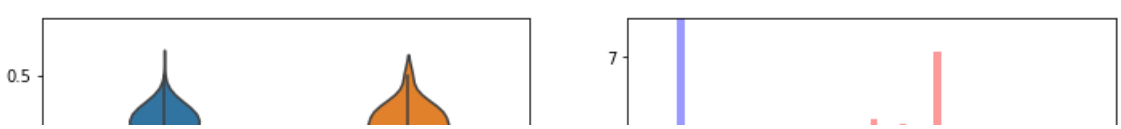
Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` inst
ead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`,
which will result either in an error or a different result.

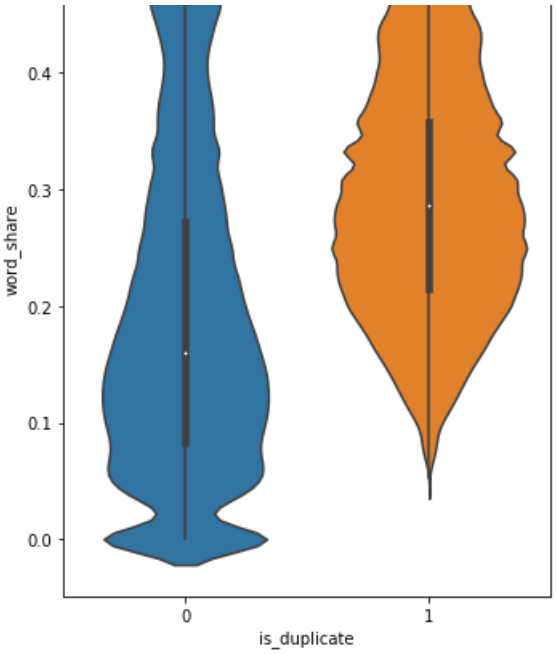
C:\Users\Shashank\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning:

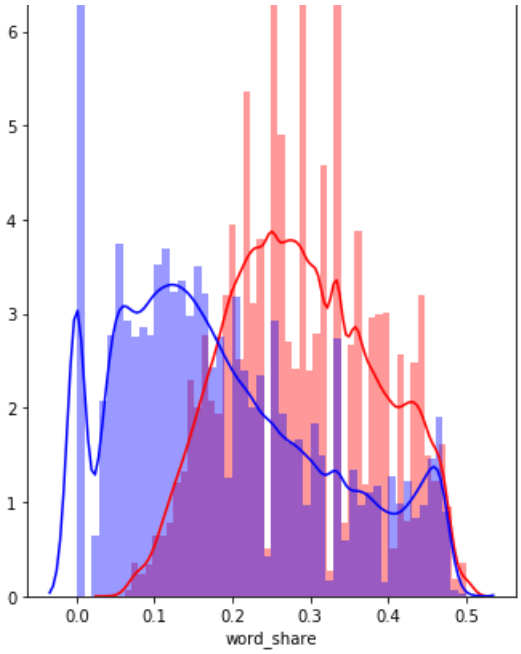
The 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.

C:\Users\Shashank\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning:

The 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.
```







- The distributions for normalized word_share have some overlap on the far right-hand side, i.e., there are quite a lot of questions with high word similarity
- The average word share and Common no. of words of qid1 and qid2 is more when they are duplicate(Similar)

3.3.1.2 Feature: word_Common

In [17]:

```
plt.figure(figsize=(12, 8))

plt.subplot(1,2,1)
sns.violinplot(x = 'is_duplicate', y = 'word_Common', data = df[0:])

plt.subplot(1,2,2)
sns.distplot(df[df['is_duplicate'] == 1.0]['word_Common'][0:] , label = "1", color = 'red')
sns.distplot(df[df['is_duplicate'] == 0.0]['word_Common'][0:] , label = "0" , color = 'blue' )
plt.show()
```

```
C:\Users\Shashank\Anaconda3\lib\site-packages\scipy\stats\stats.py:1713: FutureWarning:

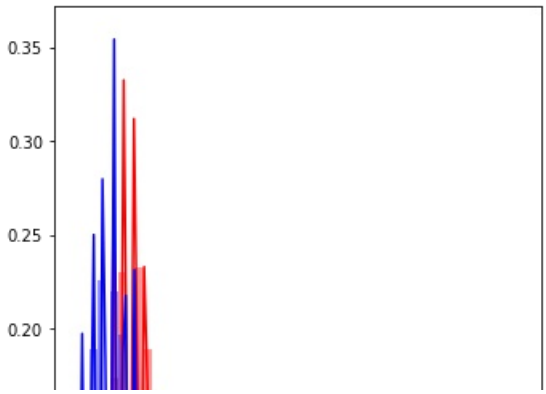
Using a non-tuple sequence for multidimensional indexing is deprecated; use `arr[tuple(seq)]` inst
ead of `arr[seq]`. In the future this will be interpreted as an array index, `arr[np.array(seq)]`,
which will result either in an error or a different result.

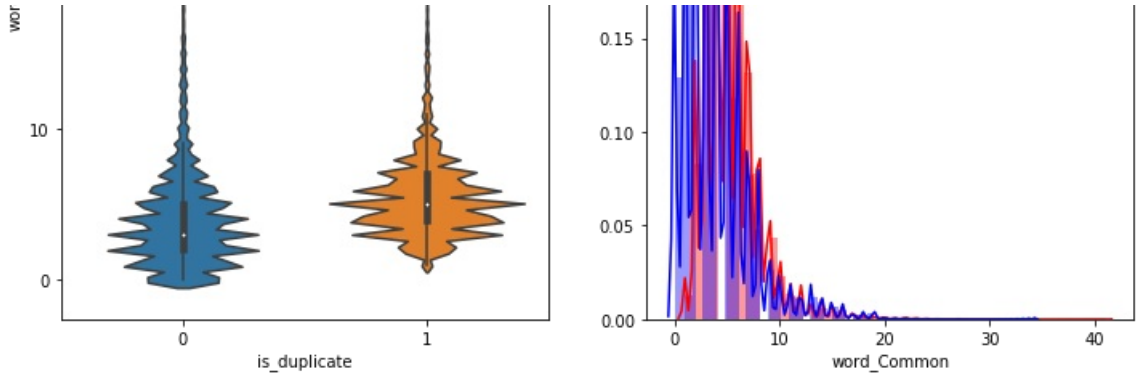
C:\Users\Shashank\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning:

The 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.

C:\Users\Shashank\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning:

The 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.
```





The distributions of the word_Common feature in similar and non-similar questions are highly overlapping

In [18]:

```
#https://stackoverflow.com/questions/12468179/unicodedecodeerror-utf8-codec-cant-decode-byte-0x9c
if os.path.isfile('df_fe_without_preprocessing_train.csv'):
    df = pd.read_csv("df_fe_without_preprocessing_train.csv",encoding='latin-1')
    df = df.fillna('')
    df.head()
else:
    print("get df_fe_without_preprocessing_train.csv from drive or run the previous notebook")
```

In [19]:

```
df.head(2)
```

Out[19]:

	id	qid1	qid2	question1	question2	is_duplicate	freq_qid1	freq_qid2	q1len	q2len	q1_n_words	q2_n_words	word_C
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	66	57	14	12	10.0
1	1	3	4	What is the story of Kohinoor (Koh-i-Noor) Dia...	What would happen if the Indian government sto...	0	4	1	51	88	8	13	4.0

3.4 Preprocessing of Text

- Preprocessing:

- Removing html tags
- Removing Punctuations
- Performing stemming
- Removing Stopwords
- Expanding contractions etc.

In [20]:

```
# To get the results in 4 decemal points
SAFE_DIV = 0.0001

STOP_WORDS = stopwords.words("english")


def preprocess(x):
    x = str(x).lower()
    x = x.replace(",000,000", "m").replace(",000", "k").replace("’", "'").replace("‘", "'")\
                           .replace("won't", "will not").replace("cannot", "can not").replace("can'
", "can not")\
                           .replace("n't", " not").replace("what's", "what is").replace("it's", "it
is")\
                           .replace("'ve", " have").replace("i'm", "i am").replace("'re", " are")\
                           .replace("he's", "he is").replace("she's", "she is").replace("'s", " own
)\
                           .replace("%", " percent ").replace("₹", " rupee ").replace("$", " dollar
")\
                           .replace("€", " euro ").replace("'ll", " will")
    x = re.sub(r"([0-9]+)000000", r"\1m", x)
    x = re.sub(r"([0-9]+)000", r"\1k", x)


    porter = PorterStemmer()
    pattern = re.compile('\W')

    if type(x) == type(''):
        x = re.sub(pattern, ' ', x)


    if type(x) == type(''):
        x = porter.stem(x)
        example1 = BeautifulSoup(x)
        x = example1.get_text()


    return x
```

Function to Compute and get the features : With 2 parameters of Question 1 and Question 2

3.5 Advanced Feature Extraction (NLP and Fuzzy Features)

Definition:

- **Token**: You get a token by splitting sentence a space
- **Stop_Word** : stop words as per NLTK.
- **Word** : A token that is not a stop_word

Features:

- **cwc_min** : Ratio of common_word_count to min lenghth of word count of Q1 and Q2
  cwc_min = common_word_count / (min(len(q1_words), len(q2_words))

- **cwc_max** : Ratio of common_word_count to max lenghth of word count of Q1 and Q2
  cwc_max = common_word_count / (max(len(q1_words), len(q2_words))

- **csc_min** : Ratio of common_stop_count to min lenghth of stop count of Q1 and Q2
  csc_min = common_stop_count / (min(len(q1_stops), len(q2_stops))

- **csc_max** : Ratio of common_stop_count to max lenghth of stop count of Q1 and Q2
  csc_max = common_stop_count / (max(len(q1_stops), len(q2_stops))

- **ctc_min** : Ratio of common_token_count to min lenghth of token count of Q1 and Q2
  ctc_min = common_token_count / (min(len(q1_tokens), len(q2_tokens))

- **ctc_max** : Ratio of common_token_count to max lenghth of token count of Q1 and Q2
  ctc_max = common_token_count / (max(len(q1_tokens), len(q2_tokens))

- **last_word_eq** : Check if First word of both questions is equal or not
  last_word_eq = int(q1_tokens[-1] == q2_tokens[-1])

- **first_word_eq** : Check if First word of both questions is equal or not
  first_word_eq = int(q1_tokens[0] == q2_tokens[0])

- **abs_len_diff** : Abs. length difference
  abs_len_diff = abs(len(q1_tokens) - len(q2_tokens))

- **mean_len** : Average Token Length of both Questions
  mean_len = (len(q1_tokens) + len(q2_tokens))/2

- **fuzz_ratio** : https://github.com/seatgeek/fuzzywuzzy#usage http://chairnerd.seatgeek.com/fuzzywuzzy-fuzzy-string-matching-in-python/

- **fuzz_partial_ratio** : https://github.com/seatgeek/fuzzywuzzy#usage http://chairnerd.seatgeek.com/fuzzywuzzy-fuzzy-string-matching-in-python/

- **token_sort_ratio** : https://github.com/seatgeek/fuzzywuzzy#usage http://chairnerd.seatgeek.com/fuzzywuzzy-fuzzy-string-matching-in-python/

- **token_set_ratio** : https://github.com/seatgeek/fuzzywuzzy#usage http://chairnerd.seatgeek.com/fuzzywuzzy-fuzzy-string-matching-in-python/

- **longest_substr_ratio** : Ratio of length longest common substring to min lenghth of token count of Q1 and Q2
  longest_substr_ratio = len(longest common substring) / (min(len(q1_tokens), len(q2_tokens))

In [21]:

```
def get_token_features(q1, q2):
    token_features = [0.0]*10

    # Converting the Sentence into Tokens:
    q1_tokens = q1.split()
    q2_tokens = q2.split()

    if len(q1_tokens) == 0 or len(q2_tokens) == 0:
        return token_features
    # Get the non-stopwords in Questions
    q1_words = set([word for word in q1_tokens if word not in STOP_WORDS])
    q2_words = set([word for word in q2_tokens if word not in STOP_WORDS])

    #Get the stopwords in Questions
    q1_stops = set([word for word in q1_tokens if word in STOP_WORDS])
    q2_stops = set([word for word in q2_tokens if word in STOP_WORDS])

    # Get the common non-stopwords from Question pair
    common_word_count = len(q1_words.intersection(q2_words))

    # Get the common stopwords from Question pair
    common_stop_count = len(q1_stops.intersection(q2_stops))

    # Get the common Tokens from Question pair
    common_token_count = len(set(q1_tokens).intersection(set(q2_tokens)))


    token_features[0] = common_word_count / (min(len(q1_words), len(q2_words)) + SAFE_DIV)
    token_features[1] = common_word_count / (max(len(q1_words), len(q2_words)) + SAFE_DIV)
    token_features[2] = common_stop_count / (min(len(q1_stops), len(q2_stops)) + SAFE_DIV)
    token_features[3] = common_stop_count / (max(len(q1_stops), len(q2_stops)) + SAFE_DIV)
    token_features[4] = common_token_count / (min(len(q1_tokens), len(q2_tokens)) + SAFE_DIV)
    token_features[5] = common_token_count / (max(len(q1_tokens), len(q2_tokens)) + SAFE_DIV)

    # Last word of both question is same or not
    token_features[6] = int(q1_tokens[-1] == q2_tokens[-1])

    # First word of both question is same or not
    token_features[7] = int(q1_tokens[0] == q2_tokens[0])
```

```
    token_features[8] = abs(len(q1_tokens) - len(q2_tokens))

    #Average Token Length of both Questions
    token_features[9] = (len(q1_tokens) + len(q2_tokens))/2
    return token_features

# get the Longest Common sub string

def get_longest_substr_ratio(a, b):
    strs = list(distance.lcsubstrings(a, b))
    if len(strs) == 0:
        return 0
    else:
        return len(strs[0]) / (min(len(a), len(b)) + 1)

def extract_features(df):
    # preprocessing each question
    df["question1"] = df["question1"].fillna("").apply(preprocess)
    df["question2"] = df["question2"].fillna("").apply(preprocess)

    print("token features...")

    # Merging Features with dataset

    token_features = df.apply(lambda x: get_token_features(x["question1"], x["question2"]), axis=1)

    df["cwc_min"]       = list(map(lambda x: x[0], token_features))
    df["cwc_max"]       = list(map(lambda x: x[1], token_features))
    df["csc_min"]       = list(map(lambda x: x[2], token_features))
    df["csc_max"]       = list(map(lambda x: x[3], token_features))
    df["ctc_min"]       = list(map(lambda x: x[4], token_features))
    df["ctc_max"]       = list(map(lambda x: x[5], token_features))
    df["last_word_eq"]  = list(map(lambda x: x[6], token_features))
    df["first_word_eq"] = list(map(lambda x: x[7], token_features))
    df["abs_len_diff"]  = list(map(lambda x: x[8], token_features))
    df["mean_len"]      = list(map(lambda x: x[9], token_features))

    #Computing Fuzzy Features and Merging with Dataset

    # do read this blog: http://chairnerd.seatgeek.com/fuzzywuzzy-fuzzy-string-matching-in-python/
    # https://stackoverflow.com/questions/31806695/when-to-use-which-fuzz-function-to-compare-2-st
rings
    # https://github.com/seatgeek/fuzzywuzzy
    print("fuzzy features..")

    df["token_set_ratio"]       = df.apply(lambda x: fuzz.token_set_ratio(x["question1"],
x["question2"]), axis=1)
    # The token sort approach involves tokenizing the string in question, sorting the tokens alpha
betically, and
    # then joining them back into a string We then compare the transformed strings with a simple r
atio().
    df["token_sort_ratio"]      = df.apply(lambda x: fuzz.token_sort_ratio(x["question1"],
x["question2"]), axis=1)
    df["fuzz_ratio"]            = df.apply(lambda x: fuzz.QRatio(x["question1"], x["question2"]), a
is=1)
    df["fuzz_partial_ratio"]    = df.apply(lambda x: fuzz.partial_ratio(x["question1"],
x["question2"]), axis=1)
    df["longest_substr_ratio"]  = df.apply(lambda x: get_longest_substr_ratio(x["question1"], x["qu
estion2"]), axis=1)
    return df
```

In [22]:

```
import warnings
warnings.filterwarnings("ignore")
if os.path.isfile('nlp_features_train.csv'):
    df = pd.read_csv("nlp_features_train.csv",encoding='latin-1')
    df.fillna('')
else:
    print("Extracting features for train:")
    df = pd.read_csv("train.csv")
    df = extract_features(df)
    df.to_csv("nlp_features_train.csv", index=False)
df.head(2)
```

Out[22]:

	id	qid1	qid2	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	...	ctc_max	last_word_eq	f
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	0.999980	0.833319	0.999983	0.999983	...	0.785709	0.0	1
1	1	3	4	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	...	0.466664	0.0	1

2 rows × 21 columns

3.5.1 Analysis of extracted features

3.5.1.1 Plotting Word clouds

- Creating Word Cloud of Duplicates and Non-Duplicates Question pairs
- We can observe the most frequent occuring words

In [23]:

```
df_duplicate = df[df['is_duplicate'] == 1]
dfp_nonduplicate = df[df['is_duplicate'] == 0]

# Converting 2d array of q1 and q2 and flatten the array: like {{1,2},{3,4}} to {1,2,3,4}
p = np.dstack([df_duplicate["question1"], df_duplicate["question2"]]).flatten()
n = np.dstack([dfp_nonduplicate["question1"], dfp_nonduplicate["question2"]]).flatten()

print ("Number of data points in class 1 (duplicate pairs) :",len(p))
print ("Number of data points in class 0 (non duplicate pairs) :",len(n))
```

```
Number of data points in class 1 (duplicate pairs) : 298526
Number of data points in class 0 (non duplicate pairs) : 510054
```

In [24]:

```
# reading the text files and removing the Stop Words:
d = path.dirname('.')

textp_w = open(path.join(d, 'train_p.txt')).read()
textn_w = open(path.join(d, 'train_n.txt')).read()
stopwords = set(STOPWORDS)
stopwords.add("said")
stopwords.add("br")
stopwords.add(" ")
stopwords.remove("not")

stopwords.remove("no")
#stopwords.remove("good")
#stopwords.remove("love")
stopwords.remove("like")
#stopwords.remove("best")
#stopwords.remove("!")
print ("Total number of words in duplicate pair questions :",len(textp_w))
print ("Total number of words in non duplicate pair questions :",len(textn_w))
```

```
Total number of words in duplicate pair questions : 891367
Total number of words in non duplicate pair questions : 33193130
```

Word Clouds generated from duplicate pair question's text

In [25]:

```
wc = WordCloud(background_color="white", max_words=len(textp_w), stopwords=stopwords)
wc.generate(textp_w)
print ("Word Cloud for Duplicate Question pairs")
plt.imshow(wc, interpolation='bilinear')
plt.axis("off")
plt.show()
```

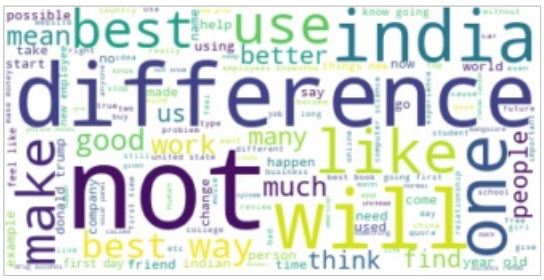
```
Word Cloud for Duplicate Question pairs
```

Word Clouds generated from non duplicate pair question's text

In [26]:

```
wc = WordCloud(background_color="white", max_words=len(textn_w),stopwords=stopwords)
# generate word cloud
wc.generate(textn_w)
print ("Word Cloud for non-Duplicate Question pairs:")
plt.imshow(wc, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
Word Cloud for non-Duplicate Question pairs:
```



3.5.1.2 Pair plot of features ['ctc_min', 'cwc_min', 'csc_min', 'token_sort_ratio']

In [27]:

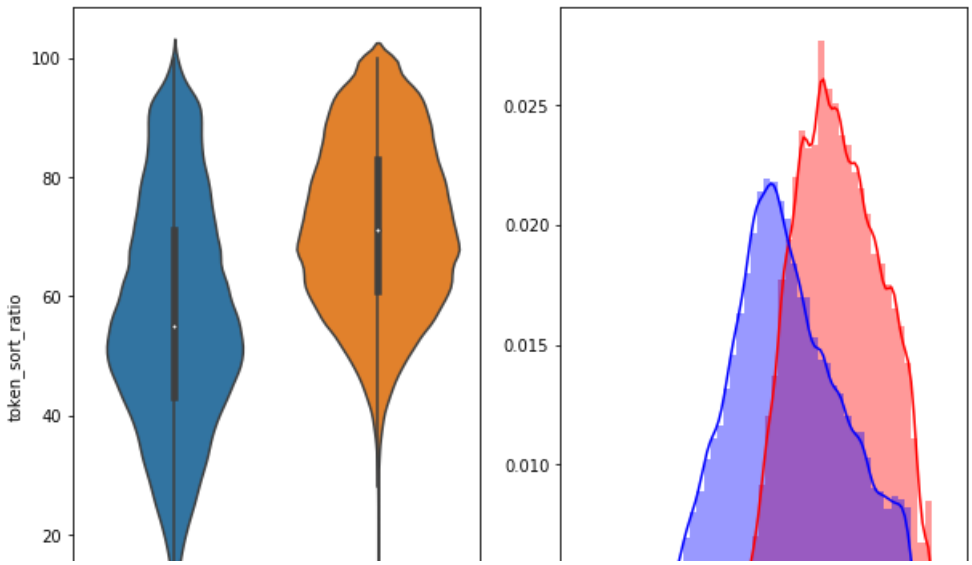
```
n = df.shape[0]
sns.pairplot(df[['ctc_min', 'cwc_min', 'csc_min', 'token_sort_ratio', 'is_duplicate']][0:n], hue='is_duplicate', vars=['ctc_min', 'cwc_min', 'csc_min', 'token_sort_ratio'])
plt.show()
```

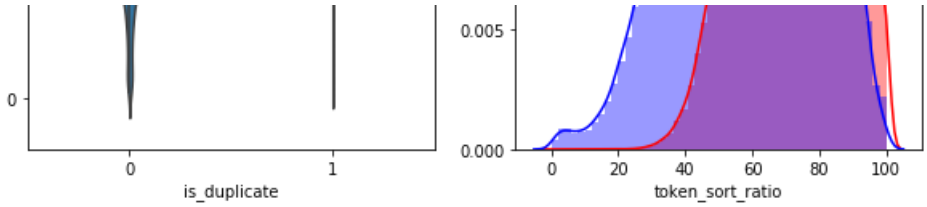
In [28]:

```
# Distribution of the token_sort_ratio
plt.figure(figsize=(10, 8))

plt.subplot(1,2,1)
sns.violinplot(x = 'is_duplicate', y = 'token_sort_ratio', data = df[0:] , )

plt.subplot(1,2,2)
sns.distplot(df[df['is_duplicate'] == 1.0]['token_sort_ratio'][0:] , label = "1", color = 'red')
sns.distplot(df[df['is_duplicate'] == 0.0]['token_sort_ratio'][0:] , label = "0" , color = 'blue' )
plt.show()
```



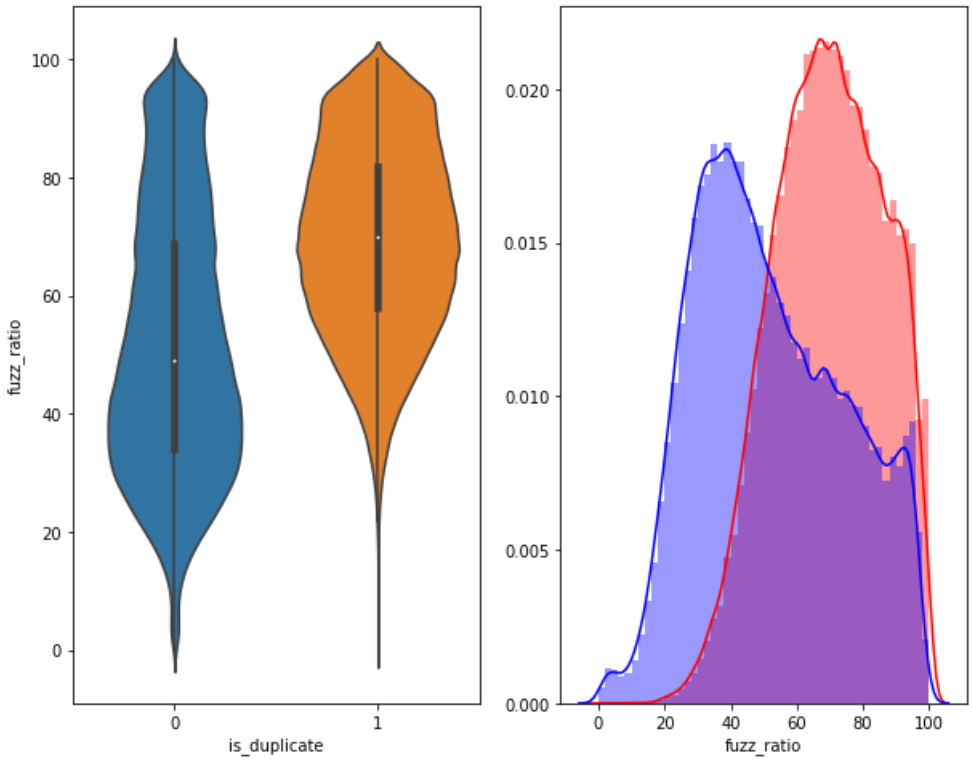


In [29]:

```
plt.figure(figsize=(10, 8))

plt.subplot(1,2,1)
sns.violinplot(x = 'is_duplicate', y = 'fuzz_ratio', data = df[0:] , )

plt.subplot(1,2,2)
sns.distplot(df[df['is_duplicate'] == 1.0]['fuzz_ratio'][0:] , label = "1", color = 'red')
sns.distplot(df[df['is_duplicate'] == 0.0]['fuzz_ratio'][0:] , label = "0" , color = 'blue' )
plt.show()
```



3.5.2 Visualization

In [30]:

```
# Using TSNE for Dimentionality reduction for 15 Features(Generated after cleaning the data) to 3
dimention

from sklearn.preprocessing import MinMaxScaler

dfp_subsampled = df[0:3000]
X = MinMaxScaler().fit_transform(dfp_subsampled[['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']])
y = dfp_subsampled['is_duplicate'].values
```

In [31]:

```
tsne2d = TSNE(
    n_components=2,
    init='random', # pca
```

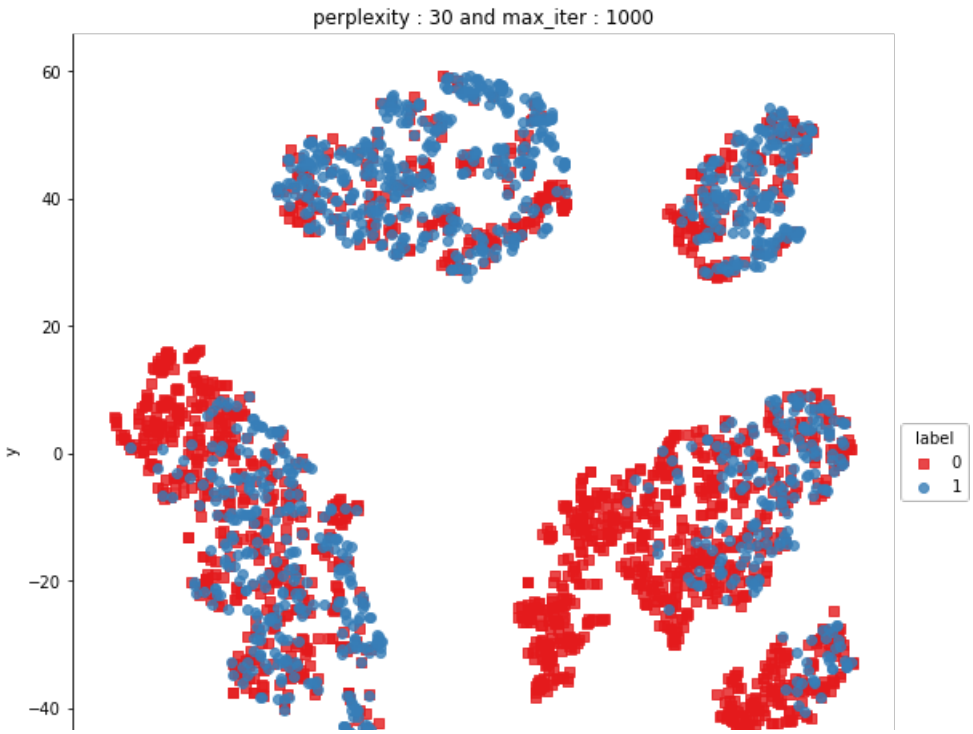
```
    random_state=101,
    method='barnes_hut',
    n_iter=1000,
    verbose=2,
    angle=0.5
).fit_transform(X)
```

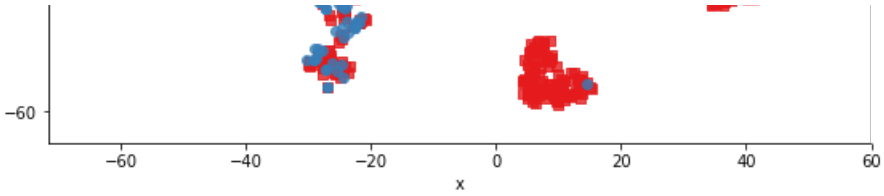
```
[t-SNE] Computing 91 nearest neighbors...
[t-SNE] Indexed 3000 samples in 0.023s...
[t-SNE] Computed neighbors for 3000 samples in 0.292s...
[t-SNE] Computed conditional probabilities for sample 1000 / 3000
[t-SNE] Computed conditional probabilities for sample 2000 / 3000
[t-SNE] Computed conditional probabilities for sample 3000 / 3000
[t-SNE] Mean sigma: 0.168100
[t-SNE] Computed conditional probabilities in 0.261s
[t-SNE] Iteration 50: error = 74.2438736, gradient norm = 0.0637462 (50 iterations in 2.442s)
[t-SNE] Iteration 100: error = 66.0404434, gradient norm = 0.0192010 (50 iterations in 1.760s)
[t-SNE] Iteration 150: error = 64.6748962, gradient norm = 0.0149074 (50 iterations in 1.649s)
[t-SNE] Iteration 200: error = 64.0936508, gradient norm = 0.0091195 (50 iterations in 1.545s)
[t-SNE] Iteration 250: error = 63.7366714, gradient norm = 0.0074293 (50 iterations in 1.541s)
[t-SNE] KL divergence after 250 iterations with early exaggeration: 63.736671
[t-SNE] Iteration 300: error = 1.3798265, gradient norm = 0.0011589 (50 iterations in 1.745s)
[t-SNE] Iteration 350: error = 1.0882488, gradient norm = 0.0004171 (50 iterations in 2.028s)
[t-SNE] Iteration 400: error = 0.9810162, gradient norm = 0.0002293 (50 iterations in 2.003s)
[t-SNE] Iteration 450: error = 0.9283460, gradient norm = 0.0001928 (50 iterations in 2.085s)
[t-SNE] Iteration 500: error = 0.9007203, gradient norm = 0.0001361 (50 iterations in 1.680s)
[t-SNE] Iteration 550: error = 0.8847462, gradient norm = 0.0001154 (50 iterations in 1.641s)
[t-SNE] Iteration 600: error = 0.8747767, gradient norm = 0.0001057 (50 iterations in 1.997s)
[t-SNE] Iteration 650: error = 0.8675045, gradient norm = 0.0000966 (50 iterations in 1.741s)
[t-SNE] Iteration 700: error = 0.8616202, gradient norm = 0.0000919 (50 iterations in 1.597s)
[t-SNE] Iteration 750: error = 0.8572435, gradient norm = 0.0000899 (50 iterations in 1.550s)
[t-SNE] Iteration 800: error = 0.8535899, gradient norm = 0.0000813 (50 iterations in 1.564s)
[t-SNE] Iteration 850: error = 0.8506539, gradient norm = 0.0000810 (50 iterations in 1.698s)
[t-SNE] Iteration 900: error = 0.8481503, gradient norm = 0.0000786 (50 iterations in 1.606s)
[t-SNE] Iteration 950: error = 0.8462221, gradient norm = 0.0000754 (50 iterations in 1.645s)
[t-SNE] Iteration 1000: error = 0.8442046, gradient norm = 0.0000767 (50 iterations in 1.577s)
[t-SNE] KL divergence after 1000 iterations: 0.844205
```

In [32]:

```
df = pd.DataFrame({'x':tsne2d[:,0], 'y':tsne2d[:,1] ,'label':y})

# draw the plot in appropriate place in the grid
sns.lmplot(data=df, x='x', y='y', hue='label', fit_reg=False, size=8,palette="Set1",markers=['s','o
'])
plt.title("perplexity : {} and max_iter : {}".format(30, 1000))
plt.show()
```





In [33]:

```
from sklearn.manifold import TSNE
tsne3d = TSNE(
    n_components=3,
    init='random', # pca
    random_state=101,
    method='barnes_hut',
    n_iter=1000,
    verbose=2,
    angle=0.5
).fit_transform(X)
```

```
[t-SNE] Computing 91 nearest neighbors...
[t-SNE] Indexed 3000 samples in 0.011s...
[t-SNE] Computed neighbors for 3000 samples in 0.318s...
[t-SNE] Computed conditional probabilities for sample 1000 / 3000
[t-SNE] Computed conditional probabilities for sample 2000 / 3000
[t-SNE] Computed conditional probabilities for sample 3000 / 3000
[t-SNE] Mean sigma: 0.168100
[t-SNE] Computed conditional probabilities in 0.299s
[t-SNE] Iteration 50: error = 73.4699097, gradient norm = 0.0385700 (50 iterations in 9.763s)
[t-SNE] Iteration 100: error = 65.1441422, gradient norm = 0.0062584 (50 iterations in 4.012s)
[t-SNE] Iteration 150: error = 64.2269669, gradient norm = 0.0040364 (50 iterations in 3.570s)
[t-SNE] Iteration 200: error = 63.7893677, gradient norm = 0.0036378 (50 iterations in 3.457s)
[t-SNE] Iteration 250: error = 63.5331802, gradient norm = 0.0024612 (50 iterations in 3.348s)
[t-SNE] KL divergence after 250 iterations with early exaggeration: 63.533180
[t-SNE] Iteration 300: error = 1.1797704, gradient norm = 0.0006941 (50 iterations in 4.685s)
[t-SNE] Iteration 350: error = 0.9385557, gradient norm = 0.0001770 (50 iterations in 5.615s)
[t-SNE] Iteration 400: error = 0.8433141, gradient norm = 0.0001146 (50 iterations in 5.987s)
[t-SNE] Iteration 450: error = 0.8030387, gradient norm = 0.0000924 (50 iterations in 5.653s)
[t-SNE] Iteration 500: error = 0.7852126, gradient norm = 0.0000608 (50 iterations in 5.170s)
[t-SNE] Iteration 550: error = 0.7742532, gradient norm = 0.0000479 (50 iterations in 5.870s)
[t-SNE] Iteration 600: error = 0.7652450, gradient norm = 0.0000435 (50 iterations in 5.155s)
[t-SNE] Iteration 650: error = 0.7574351, gradient norm = 0.0000433 (50 iterations in 5.701s)
[t-SNE] Iteration 700: error = 0.7521394, gradient norm = 0.0000360 (50 iterations in 5.456s)
[t-SNE] Iteration 750: error = 0.7471731, gradient norm = 0.0000336 (50 iterations in 5.507s)
[t-SNE] Iteration 800: error = 0.7434089, gradient norm = 0.0000336 (50 iterations in 5.580s)
[t-SNE] Iteration 850: error = 0.7409297, gradient norm = 0.0000338 (50 iterations in 5.314s)
[t-SNE] Iteration 900: error = 0.7386305, gradient norm = 0.0000289 (50 iterations in 5.259s)
[t-SNE] Iteration 950: error = 0.7365760, gradient norm = 0.0000274 (50 iterations in 5.401s)
[t-SNE] Iteration 1000: error = 0.7344688, gradient norm = 0.0000251 (50 iterations in 5.353s)
[t-SNE] KL divergence after 1000 iterations: 0.734469
```

In [34]:

```
trace1 = go.Scatter3d(
    x=tsne3d[:,0],
    y=tsne3d[:,1],
    z=tsne3d[:,2],
    mode='markers',
    marker=dict(
        sizemode='diameter',
        color = y,
        colorscale = 'Portland',
        colorbar = dict(title = 'duplicate'),
        line=dict(color='rgb(255, 255, 255)'),
        opacity=0.75
    )
)

data=[trace1]
layout=dict(height=800, width=800, title='3d embedding with engineered features')
fig=dict(data=data, layout=layout)
py.iplot(fig, filename='3DBubble')
```

In [35]:

```
all_ques_df = pd.DataFrame(pd.concat([df['question1'], df['question2']]))
all_ques_df.columns = ["questions"]

all_ques_df["num_of_words"] = all_ques_df["questions"].apply(lambda x : len(str(x).split()))
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
~\Anaconda3\lib\site-packages\pandas\core\indexes\base.py in get_loc(self, key, method, tolerance)
   3062             try:
-> 3063                 return self._engine.get_loc(key)
   3064             except KeyError:

pandas\_libs\index.pyx in pandas._libs.index.IndexEngine.get_loc()

pandas\_libs\index.pyx in pandas._libs.index.IndexEngine.get_loc()

pandas\_libs\hashtable_class_helper.pxi in pandas._libs.hashtable.PyObjectHashTable.get_item()

pandas\_libs\hashtable_class_helper.pxi in pandas._libs.hashtable.PyObjectHashTable.get_item()

KeyError: 'question1'

During handling of the above exception, another exception occurred:

KeyError                                  Traceback (most recent call last)
```

```
<ipython-input-35-754d55b51f98> in <module>()
----> 1 all_ques_df = pd.DataFrame(pd.concat([df['question1'], df['question2']]))
      2 all_ques_df.columns = ["questions"]
      3
      4 all_ques_df["num_of_words"] = all_ques_df["questions"].apply(lambda x : len(str(x).split()))
)

~\Anaconda3\lib\site-packages\pandas\core\frame.py in __getitem__(self, key)
   2683             return self._getitem_multilevel(key)
   2684         else:
-> 2685             return self._getitem_column(key)
   2686
   2687     def _getitem_column(self, key):

~\Anaconda3\lib\site-packages\pandas\core\frame.py in _getitem_column(self, key)
   2690         # get column
   2691         if self.columns.is_unique:
-> 2692             return self._get_item_cache(key)
   2693
   2694         # duplicate columns & possible reduce dimensionality

~\Anaconda3\lib\site-packages\pandas\core\generic.py in _get_item_cache(self, item)
   2484         res = cache.get(item)
   2485         if res is None:
-> 2486             values = self._data.get(item)
   2487             res = self._box_item_values(item, values)
   2488             cache[item] = res

~\Anaconda3\lib\site-packages\pandas\core\internals.py in get(self, item, fastpath)
   4113
   4114             if not isna(item):
-> 4115                 loc = self.items.get_loc(item)
   4116             else:
   4117                 indexer = np.arange(len(self.items))[isna(self.items)]

~\Anaconda3\lib\site-packages\pandas\core\indexes\base.py in get_loc(self, key, method, tolerance)
   3063                 return self._engine.get_loc(key)
   3064             except KeyError:
-> 3065                 return self._engine.get_loc(self._maybe_cast_indexer(key))
   3066
   3067         indexer = self.get_indexer([key], method=method, tolerance=tolerance)

pandas\_libs\index.pyx in pandas._libs.index.IndexEngine.get_loc()

pandas\_libs\index.pyx in pandas._libs.index.IndexEngine.get_loc()

pandas\_libs\hashtable_class_helper.pxi in pandas._libs.hashtable.PyObjectHashTable.get_item()

pandas\_libs\hashtable_class_helper.pxi in pandas._libs.hashtable.PyObjectHashTable.get_item()

KeyError: 'question1'
```

In [ ]:

```
all_ques_df = pd.DataFrame(pd.concat([train_df['question1'], train_df['question2']]))
all_ques_df.columns = ["questions"]

all_ques_df["num_of_words"] = all_ques_df["questions"].apply(lambda x : len(str(x).split()))
```

3.6 Featurizing text data with tfidf weighted word-vectors

In [27]:

```
# avoid decoding problems
df = pd.read_csv("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 [28]:

```
df.head()
```

Out[28]:

	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 [29]:

```
'''
# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039
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('glove.42B.300d.txt')

# ============================
Output:

Loading Glove Model
1917495it [06:32, 4879.69it/s]
Done. 1917495  words loaded!

# ============================

words = []
for i in preproced_texts:
    words.extend(i.split(' '))

for i in preproced_titles:
    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))


# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-pickle-to-sa
ve-and-load-variables-in-python/
```

```
ve and load variables in python)

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


'''
```

Out[29]:

```
'\n# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039\ndef
loadGloveModel(gloveFile):\n    print ("Loading Glove Model")\n    f = open(gloveFile,\'r\',
encoding="utf8")\n    model = {}\n    for line in tqdm(f):\n        splitLine = line.split()\n
word = splitLine[0]\n        embedding = np.array([float(val) for val in splitLine[1:]])\n        m
odel[word] = embedding\n    print ("Done.",len(model)," words loaded!")\n    return model\nmodel =
loadGloveModel(\'glove.42B.300d.txt\')\n\n# ============================\nOutput:\n    \nLoading G
love Model\n1917495it [06:32, 4879.69it/s]\nDone. 1917495  words loaded!\n\n#
============================\n\nwords = []\nfor i in preproced_texts:\n    words.extend(i.split(\'
\'))\n\nfor i in preproced_titles:\n    words.extend(i.split(\' \'))\nprint("all the words in the
coupus", len(words))\nwords = set(model)\nprint("the unique words in the coupus",
len(words))\n\ninter_words = set(model.keys()).intersection(words)\nprint("The number of words tha
t are present in both glove vectors and our coupus",       len(inter_words),"
(",np.round(len(inter_words)/len(words)*100,3),"%)")\n\nwords_courpus = {}\nwords_glove =
set(model.keys())\nfor i in words:\n    if i in words_glove:\n        words_courpus[i] = model[i]\r
print("word 2 vec length", len(words_courpus))\n\n\n# stronging variables into pickle files python
: http://www.jessicayung.com/how-to-use-pickle-to-save-and-load-variables-in-python/\n\nimport pic
kle\nwith open(\'glove_vectors\', \'wb\') as f:\n    pickle.dump(words_courpus, f)\n\n\n'
```

In [38]:

```
# 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
import pickle
with open('glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

In [39]:

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

tfidf = TfidfVectorizer(lowercase=False,)
tfidf.fit_transform(questions)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf.get_feature_names(), list(tfidf.idf_)))
tfidf_words = set(tfidf.get_feature_names())
```

In [40]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_qu1 = []; # the avg-w2v for each sentence/review is stored in this list
for qu1 in tqdm(list(df['question1'])): # 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 qu1.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]*(qu1.count(word)/len(qu1.split())) # getting the tfidf 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
    tfidf_w2v_vectors_qu1.append(vector)
print(len(tfidf_w2v_vectors_qu1))
```

```
print(len(tfidf_w2v_vectors_qu1[0]))
df['q1_feats_m'] = list(tfidf_w2v_vectors_qu1)
```

```
100%|
| 404290/404290
[00:51<00:00, 7912.94it/s]
```

```
404290
300
```

In [41]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_qu2 = []; # the avg-w2v for each sentence/review is stored in this list
for qu2 in tqdm(list(df['question2'])): # 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 qu2.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]*(qu2.count(word)/len(qu2.split())) # getting the tfidf 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
    tfidf_w2v_vectors_qu2.append(vector)
print(len(tfidf_w2v_vectors_qu2))
print(len(tfidf_w2v_vectors_qu2[0]))
df['q2_feats_m'] = list(tfidf_w2v_vectors_qu2)
```

```
100%|
| 404290/404290
[00:44<00:00, 9132.01it/s]
```

```
404290
300
```

In [44]:

```
df['question1'].values
```

Out[44]:

```
array(['What is the step by step guide to invest in share market in india?',
       'What is the story of Kohinoor (Koh-i-Noor) Diamond?',
       'How can I increase the speed of my internet connection while using a VPN?',
       ..., 'What is one coin?',
       'What is the approx annual cost of living while studying in UIC Chicago, for an Indian
student?',
       'What is like to have sex with cousin?'], dtype=object)
```

In [47]:

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

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

In [48]:

```
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)
df3_q1 = pd.DataFrame(df3.q1_feats_m.values.tolist(), index= df3.index)
df3_q2 = pd.DataFrame(df3.q2_feats_m.values.tolist(), index= df3.index)
```

In [49]:

```
# dataframe of nlp features
df1.head()
```

Out[49]:

	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 [50]:

```
# data before preprocessing
df2.head()
```

Out[50]:

	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 [51]:

```
# Questions 1 tfidf weighted word2vec
df3_q1.head()
```

Out[51]:

	0
0	(0, 65736)\t0.07960042526980049\n (0, 31890...
1	(0, 65736)\t0.07960042526980049\n (0, 31890...
2	(0, 65736)\t0.07960042526980049\n (0, 31890...
3	(0, 65736)\t0.07960042526980049\n (0, 31890...
4	(0, 65736)\t0.07960042526980049\n (0, 31890...

In [52]:

```
# Questions 2 tfidf weighted word2vec
df3_q2.head()
```

Out[52]:

Out[52]:

	0
0	(0, 60682)\t0.0829957010020072\n (0, 29680)...
1	(0, 60682)\t0.0829957010020072\n (0, 29680)...
2	(0, 60682)\t0.0829957010020072\n (0, 29680)...
3	(0, 60682)\t0.0829957010020072\n (0, 29680)...
4	(0, 60682)\t0.0829957010020072\n (0, 29680)...

In [53]:

```
print("Number of features in nlp dataframe :", df1.shape[1])
print("Number of features in preprocessed dataframe :", df2.shape[1])
print("Number of features in question1 w2v  dataframe :", df3_q1.shape[1])
print("Number of features in question2 w2v  dataframe :", df3_q2.shape[1])
print("Number of features in final dataframe  :", df1.shape[1]+df2.shape[1]+df3_q1.shape[1]+df3_q2.
shape[1])
```

```
Number of features in nlp dataframe : 17
Number of features in preprocessed dataframe : 12
Number of features in question1 w2v  dataframe : 1
Number of features in question2 w2v  dataframe : 1
Number of features in final dataframe  : 31
```

In [54]:

```
# storing the final features to csv file
if not os.path.isfile('final_features.csv'):
    df3_q1['id']=df1['id']
    df3_q2['id']=df1['id']
    df1  = df1.merge(df2, on='id',how='left')
    df2  = df3_q1.merge(df3_q2, on='id',how='left')
    result  = df1.merge(df2, on='id',how='left')
    result.to_csv('final_features.csv')
```

4. Machine Learning Models

4.1 Reading data from file and storing into sql table

In [55]:

```
#Creating db file from csv
if not os.path.isfile('train.db'):
    disk_engine = create_engine('sqlite:///train.db')
    start = dt.datetime.now()
    chunksize = 180000
    j = 0
    index_start = 1
    for df in pd.read_csv('final_features.csv', names=['Unnamed: 0','id','is_duplicate','cwc_min','
cwc_max','csc_min','csc_max','ctc_min','ctc_max','last_word_eq','first_word_eq','abs_len_diff','me
an_len','token_set_ratio','token_sort_ratio','fuzz_ratio','fuzz_partial_ratio','longest_substr_rati
o','freq_qid1','freq_qid2','q1len','q2len','q1_n_words','q2_n_words','word_Common','word_Total','w
ord_share','freq_q1+q2','freq_q1-
q2','0_x','1_x','2_x','3_x','4_x','5_x','6_x','7_x','8_x','9_x','10_x','11_x','12_x','13_x','14_x',
'15_x','16_x','17_x','18_x','19_x','20_x','21_x','22_x','23_x','24_x','25_x','26_x','27_x','28_x','
29_x','30_x','31_x','32_x','33_x','34_x','35_x','36_x','37_x','38_x','39_x','40_x','41_x','42_x','4
3_x','44_x','45_x','46_x','47_x','48_x','49_x','50_x','51_x','52_x','53_x','54_x','55_x','56_x','57
_x','58_x','59_x','60_x','61_x','62_x','63_x','64_x','65_x','66_x','67_x','68_x','69_x','70_x','71_
x','72_x','73_x','74_x','75_x','76_x','77_x','78_x','79_x','80_x','81_x','82_x','83_x','84_x','85_x
','86_x','87_x','88_x','89_x','90_x','91_x','92_x','93_x','94_x','95_x','96_x','97_x','98_x','99_x'
,'100_x','101_x','102_x','103_x','104_x','105_x','106_x','107_x','108_x','109_x','110_x','111_x','
112_x','113_x','114_x','115_x','116_x','117_x','118_x','119_x','120_x','121_x','122_x','123_x','12
```

```
4_x','125_x','126_x','127_x','128_x','129_x','130_x','131_x','132_x','133_x','134_x','135_x','136_
x','137_x','138_x','139_x','140_x','141_x','142_x','143_x','144_x','145_x','146_x','147_x','148_x'
,'149_x','150_x','151_x','152_x','153_x','154_x','155_x','156_x','157_x','158_x','159_x','160_x','
161_x','162_x','163_x','164_x','165_x','166_x','167_x','168_x','169_x','170_x','171_x','172_x','17
3_x','174_x','175_x','176_x','177_x','178_x','179_x','180_x','181_x','182_x','183_x','184_x','185_
x','186_x','187_x','188_x','189_x','190_x','191_x','192_x','193_x','194_x','195_x','196_x','197_x'
,'198_x','199_x','200_x','201_x','202_x','203_x','204_x','205_x','206_x','207_x','208_x','209_x','
210_x','211_x','212_x','213_x','214_x','215_x','216_x','217_x','218_x','219_x','220_x','221_x','22
2_x','223_x','224_x','225_x','226_x','227_x','228_x','229_x','230_x','231_x','232_x','233_x','234_
x','235_x','236_x','237_x','238_x','239_x','240_x','241_x','242_x','243_x','244_x','245_x','246_x'
,'247_x','248_x','249_x','250_x','251_x','252_x','253_x','254_x','255_x','256_x','257_x','258_x','
259_x','260_x','261_x','262_x','263_x','264_x','265_x','266_x','267_x','268_x','269_x','270_x','27
1_x','272_x','273_x','274_x','275_x','276_x','277_x','278_x','279_x','280_x','281_x','282_x','283_
x','284_x','285_x','286_x','287_x','288_x','289_x','290_x','291_x','292_x','293_x','294_x','295_x'
,'296_x','297_x','298_x','299_x','300_x','301_x','302_x','303_x','304_x','305_x','306_x','307_x','
308_x','309_x','310_x','311_x','312_x','313_x','314_x','315_x','316_x','317_x','318_x','319_x','32
0_x','321_x','322_x','323_x','324_x','325_x','326_x','327_x','328_x','329_x','330_x','331_x','332_
x','333_x','334_x','335_x','336_x','337_x','338_x','339_x','340_x','341_x','342_x','343_x','344_x'
,'345_x','346_x','347_x','348_x','349_x','350_x','351_x','352_x','353_x','354_x','355_x','356_x','
357_x','358_x','359_x','360_x','361_x','362_x','363_x','364_x','365_x','366_x','367_x','368_x','36
9_x','370_x','371_x','372_x','373_x','374_x','375_x','376_x','377_x','378_x','379_x','380_x','381_
x','382_x','383_x','0_y','1_y','2_y','3_y','4_y','5_y','6_y','7_y','8_y','9_y','10_y','11_y','12_y'
,'13_y','14_y','15_y','16_y','17_y','18_y','19_y','20_y','21_y','22_y','23_y','24_y','25_y','26_y',
'27_y','28_y','29_y','30_y','31_y','32_y','33_y','34_y','35_y','36_y','37_y','38_y','39_y','40_y','
41_y','42_y','43_y','44_y','45_y','46_y','47_y','48_y','49_y','50_y','51_y','52_y','53_y','54_y','5
5_y','56_y','57_y','58_y','59_y','60_y','61_y','62_y','63_y','64_y','65_y','66_y','67_y','68_y','69
_y','70_y','71_y','72_y','73_y','74_y','75_y','76_y','77_y','78_y','79_y','80_y','81_y','82_y','83_
y','84_y','85_y','86_y','87_y','88_y','89_y','90_y','91_y','92_y','93_y','94_y','95_y','96_y','97_y
','98_y','99_y','100_y','101_y','102_y','103_y','104_y','105_y','106_y','107_y','108_y','109_y','11
0_y','111_y','112_y','113_y','114_y','115_y','116_y','117_y','118_y','119_y','120_y','121_y','122_
y','123_y','124_y','125_y','126_y','127_y','128_y','129_y','130_y','131_y','132_y','133_y','134_y'
,'135_y','136_y','137_y','138_y','139_y','140_y','141_y','142_y','143_y','144_y','145_y','146_y','
147_y','148_y','149_y','150_y','151_y','152_y','153_y','154_y','155_y','156_y','157_y','158_y','15
9_y','160_y','161_y','162_y','163_y','164_y','165_y','166_y','167_y','168_y','169_y','170_y','171_
y','172_y','173_y','174_y','175_y','176_y','177_y','178_y','179_y','180_y','181_y','182_y','183_y'
,'184_y','185_y','186_y','187_y','188_y','189_y','190_y','191_y','192_y','193_y','194_y','195_y','
196_y','197_y','198_y','199_y','200_y','201_y','202_y','203_y','204_y','205_y','206_y','207_y','20
8_y','209_y','210_y','211_y','212_y','213_y','214_y','215_y','216_y','217_y','218_y','219_y','220_
y','221_y','222_y','223_y','224_y','225_y','226_y','227_y','228_y','229_y','230_y','231_y','232_y'
,'233_y','234_y','235_y','236_y','237_y','238_y','239_y','240_y','241_y','242_y','243_y','244_y','
245_y','246_y','247_y','248_y','249_y','250_y','251_y','252_y','253_y','254_y','255_y','256_y','25
7_y','258_y','259_y','260_y','261_y','262_y','263_y','264_y','265_y','266_y','267_y','268_y','269_
y','270_y','271_y','272_y','273_y','274_y','275_y','276_y','277_y','278_y','279_y','280_y','281_y'
,'282_y','283_y','284_y','285_y','286_y','287_y','288_y','289_y','290_y','291_y','292_y','293_y','
294_y','295_y','296_y','297_y','298_y','299_y','300_y','301_y','302_y','303_y','304_y','305_y','30
6_y','307_y','308_y','309_y','310_y','311_y','312_y','313_y','314_y','315_y','316_y','317_y','318_
y','319_y','320_y','321_y','322_y','323_y','324_y','325_y','326_y','327_y','328_y','329_y','330_y'
,'331_y','332_y','333_y','334_y','335_y','336_y','337_y','338_y','339_y','340_y','341_y','342_y','
343_y','344_y','345_y','346_y','347_y','348_y','349_y','350_y','351_y','352_y','353_y','354_y','35
5_y','356_y','357_y','358_y','359_y','360_y','361_y','362_y','363_y','364_y','365_y','366_y','367_
y','368_y','369_y','370_y','371_y','372_y','373_y','374_y','375_y','376_y','377_y','378_y','379_y'
,'380_y','381_y','382_y','383_y'], chunksize=chunksize, iterator=True, encoding='utf-8', ):
        df.index += index_start
        j+=1
        print('{} rows'.format(j*chunksize))
        df.to_sql('data', disk_engine, if_exists='append')
        index_start = df.index[-1] + 1
```

In [56]:

```
#http://www.sqlitetutorial.net/sqlite-python/create-tables/
import sqlite3
def create_connection(db_file):
    """ create a database connection to the SQLite database
        specified by db_file
    :param db_file: database file
    :return: Connection object or None
    """
    try:
        conn = sqlite3.connect(db_file)
        return conn
    except Error as e:
        print(e)

    return None
```

```
def checkTableExists(dbcon):
    cursr = dbcon.cursor()
    str = "select name from sqlite_master where type='table'"
    table_names = cursr.execute(str)
    print("Tables in the databse:")
    tables =table_names.fetchall()
    print(tables[0][0])
    return(len(tables))
```

In [57]:

```
read_db = 'train.db'
conn_r = create_connection(read_db)
checkTableExists(conn_r)
conn_r.close()
```

```
Tables in the databse:
data
```

In [58]:

```
# try to sample data according to the computing power you have
if os.path.isfile(read_db):
    conn_r = create_connection(read_db)
    if conn_r is not None:
        # for selecting first 1M rows
        # data = pd.read_sql_query("""SELECT * FROM data LIMIT 100001;""", conn_r)

        # for selecting random points
        data = pd.read_sql_query("SELECT * From data ORDER BY RANDOM() LIMIT 60000;", conn_r)
        conn_r.commit()

        conn_r.close()
```

In [59]:

```
# remove the first row
data.drop(data.index[0], inplace=True)
y_true = data['is_duplicate']
data.drop(['Unnamed: 0', 'id','index','is_duplicate'], axis=1, inplace=True)
```

In [60]:

```
data.head()
```

Out[60]:

	cwc_min	cwc_max	csc_min	csc_max	ctc_min	ctc_max
1	0.714275510349852	0.714275510349852	0.899991000089999	0.899991000089999	0.636360743814801	0.636360743814801
2	0.499987500312492	0.399992000159997	0.499987500312492	0.285710204139941	0.499993750078124	0.333330555578704
3	0.33332222259258	0.199996000079998	0.66664444518516	0.333327777870369	0.374995312558593	0.333329629670781
4	0.999950002499875	0.499987500312492	0.33332222259258	0.249993750156246	0.599988000239995	0.374995312558593
5	0.66664444518516	0.66664444518516	0.499987500312492	0.499987500312492	0.571420408279882	0.571420408279882

5 rows × 794 columns

4.2 Converting strings to numerics

4.2 Converting strings to numerics

In [61]:

```
# after we read from sql table each entry was read it as a string
# we convert all the features into numaric before we apply any model
cols = list(data.columns)
for i in cols:
    data[i] = data[i].apply(pd.to_numeric)
    print(i)
```

```
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
0_x
1_x
2_x
3_x
4_x
5_x
6_x
7_x
8_x
9_x
10_x
11_x
12_x
13_x
14_x
15_x
16_x
17_x
18_x
19_x
20_x
21_x
22_x
23_x
24_x
25_x
26_x
27_x
28_x
29_x
30_x
31_x
32_x
33_x
34_x
35_x
36_x
37_x
38_x
```

39_x
40_x
41_x
42_x
43_x
44_x
45_x
46_x
47_x
48_x
49_x
50_x
51_x
52_x
53_x
54_x
55_x
56_x
57_x
58_x
59_x
60_x
61_x
62_x
63_x
64_x
65_x
66_x
67_x
68_x
69_x
70_x
71_x
72_x
73_x
74_x
75_x
76_x
77_x
78_x
79_x
80_x
81_x
82_x
83_x
84_x
85_x
86_x
87_x
88_x
89_x
90_x
91_x
92_x
93_x
94_x
95_x
96_x
97_x
98_x
99_x
100_x
101_x
102_x
103_x
104_x
105_x
106_x
107_x
108_x
109_x
110_x
111_x
112_x
113_x
114_x
115_x

116_x
117_x
118_x
119_x
120_x
121_x
122_x
123_x
124_x
125_x
126_x
127_x
128_x
129_x
130_x
131_x
132_x
133_x
134_x
135_x
136_x
137_x
138_x
139_x
140_x
141_x
142_x
143_x
144_x
145_x
146_x
147_x
148_x
149_x
150_x
151_x
152_x
153_x
154_x
155_x
156_x
157_x
158_x
159_x
160_x
161_x
162_x
163_x
164_x
165_x
166_x
167_x
168_x
169_x
170_x
171_x
172_x
173_x
174_x
175_x
176_x
177_x
178_x
179_x
180_x
181_x
182_x
183_x
184_x
185_x
186_x
187_x
188_x
189_x
190_x
191_x
192_x

193_x
194_x
195_x
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In [62]:

```
# https://stackoverflow.com/questions/7368789/convert-all-strings-in-a-list-to-int
y_true = list(map(int, y_true.values))
```

4.3 Random train test split(70:30)

In [30]:

```
nlp_features_train=pd.read_csv('nlp_features_train.csv',encoding='latin-1')
```

In [31]:

```
nlp_features_train.head()
```

Out[31]:

	id	qid1	qid2	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	...	ctc_max	last_word_eq	f
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	0.999980	0.833319	0.999983	0.999983	...	0.785709	0.0	1
1	1	3	4	what is the story of kohinoor	what would happen if the indian government	0	0.799984	0.399996	0.749981	0.599988	...	0.466664	0.0	1

	id	qid1	qid2	question1	question2	is_duplicate	cwc_min	cwc_max	csc_min	csc_max	...	ctc_max	last_word_eq	f
2	2	5	6	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	...	0.285712	0.0	1
3	3	7	8	why am i mentally very lonely how can i solve...	find the remainder when math 23 24 math i...	0	0.000000	0.000000	0.000000	0.000000	...	0.000000	0.0	0
4	4	9	10	which one dissolve in water quikly sugar salt...	which fish would survive in salt water	0	0.399992	0.199998	0.999950	0.666644	...	0.307690	0.0	1

5 rows × 21 columns

In [32]:

```
df_fe_without_preprocessing_train=pd.read_csv('df_fe_without_preprocessing_train.csv',encoding='latin-1')
```

In [33]:

```
df_fe_without_preprocessing_train.head(3)
```

Out[33]:

	id	qid1	qid2	question1	question2	is_duplicate	freq_qid1	freq_qid2	q1len	q2len	q1_n_words	q2_n_words	word_C
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	66	57	14	12	10.0
1	1	3	4	What is the story of Kohinoor (Koh-i-Noor) Dia...	What would happen if the Indian government sto...	0	4	1	51	88	8	13	4.0
2	2	5	6	How can I increase the speed of my internet co...	How can Internet speed be increased by hacking...	0	1	1	73	59	14	10	4.0

In [34]:

```
d3=nlp_features_train.drop(['qid1','qid2'],axis=1)
d4=df_fe_without_preprocessing_train.drop(['qid1','qid2','question1','question2','is_duplicate'],axis=1)
data=d3.merge(d4,on='id',how='left')
```

In [35]:

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

In [37]:

```
#spliting the data into train and test dataset
from sklearn.model_selection import train_test_split
X_train,X_test, y_train, y_test = train_test_split(data, y_class, stratify=y_class, test_size=0.3)
```

In [43]:

```
print(X_train.shape)
print(X_test.shape)
```

```
(283003, 26)
(121287, 26)
```

In [40]:

```
#transforming question1 and question2 of train dataset
from sklearn.feature_extraction.text import TfidfVectorizer
tfidf1 = TfidfVectorizer()
train_q1 = tfidf1.fit_transform(X_train['question1'].values.astype('U'))
test_q1 =tfidf1.transform(X_test['question1'].values.astype('U'))
```

In [41]:

```
#transforming question1 and question2 of test dataset
tfidf2=TfidfVectorizer()
train_q2 = tfidf2.fit_transform(X_train['question2'].values.astype('U'))
test_q2 =tfidf2.transform(X_test['question2'].values.astype('U'))
```

In [42]:

```
#Dropping question-1 and question-2 and Replacing with tfidf values
X_train.drop(['question1','question2'], axis=1, inplace=True)
X_test.drop(['question1','question2'], axis=1, inplace=True)
```

In [45]:

```
#Combining Question-1 and Question-2
from scipy.sparse import coo_matrix, hstack
train_tfidf = hstack((train_q1,train_q2))
test_tfidf = hstack((test_q1,test_q2))
```

In [46]:

```
#combining all basic,advanced and tfidf features
X_train = hstack((X_train, train_tfidf)).tocsr()
X_test = hstack((X_test, test_tfidf)).tocsr()
```

In [47]:

```
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 : (283003, 112084)
Number of data points in test data : (121287, 112084)
```

In [68]:

```
# This function plots the confusion matrices given y_i, y_i_hat.
from sklearn.metrics import confusion_matrix
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()
```

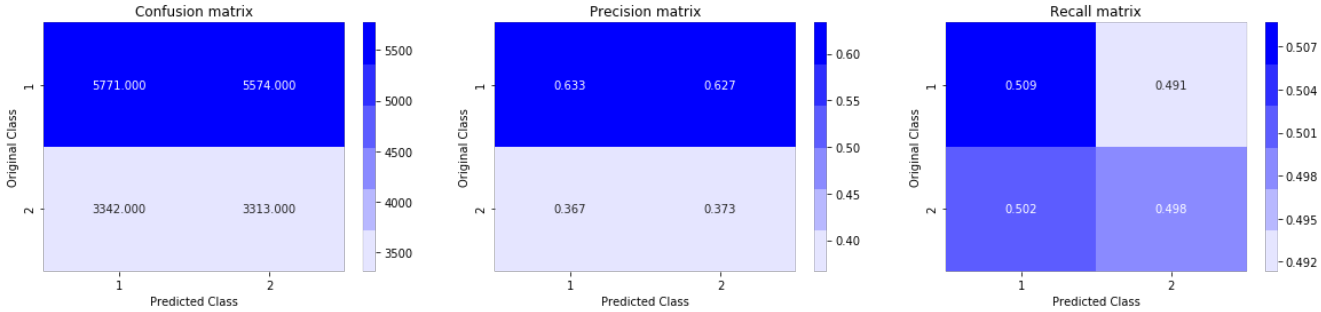
4.4 Building a random model (Finding worst-case log-loss)

In [69]:

```
# 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
from sklearn.metrics import log_loss
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 0.8837470522382065
```



4.4 Logistic Regression with hyperparameter tuning

In [72]:

```
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_i
ter=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:
#-------------------------------
from sklearn.linear_model import SGDClassifier
from sklearn.calibration import CalibratedClassifierCV
log_error_array=[]
for i in alpha:
    clf = SGDClassifier(alpha=i, penalty='l2', loss='log', random_state=42)
    clf.fit(X_train,y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
    sig_clf.fit(X_train, y_train)
    predict_y = sig_clf.predict_proba(X_test)
    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))

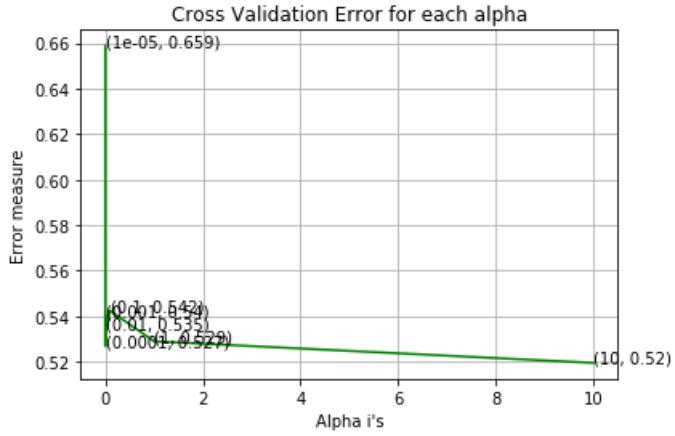
fig, ax = plt.subplots()
ax.plot(alpha, log_error_array,c='g')
for i, txt in enumerate(np.round(log_error_array,3)):
    ax.annotate((alpha[i],np.round(txt,3)), (alpha[i],log_error_array[i]))
plt.grid()
plt.title("Cross Validation Error for each alpha")
plt.xlabel("Alpha i's")
plt.ylabel("Error measure")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

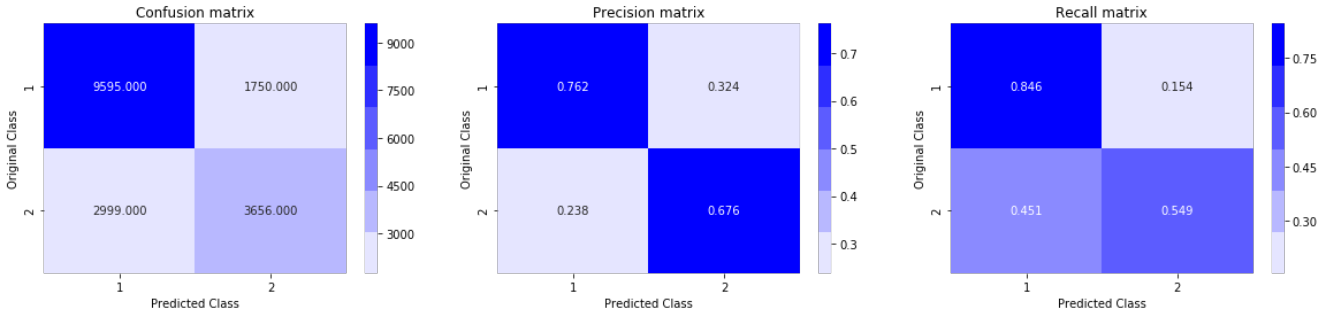
predict_y = sig_clf.predict_proba(X_train)
print('For values of best alpha = ', alpha[best_alpha], "The train log loss is:",log_loss(y_train,
predict_y, labels=clf.classes_, eps=1e-15))
```

```
predict_y = sig_clf.predict_proba(X_test)
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-05 The log loss is: 0.658807677966553
For values of alpha =  0.0001 The log loss is: 0.5268692295041751
For values of alpha =  0.001 The log loss is: 0.5402688688457457
For values of alpha =  0.01 The log loss is: 0.5347628254014818
For values of alpha =  0.1 The log loss is: 0.5424147491669886
For values of alpha =  1 The log loss is: 0.5289762417303445
For values of alpha =  10 The log loss is: 0.5195220613606596
```




```
For values of best alpha =  10 The train log loss is: 0.5148048328037605
For values of best alpha =  10 The test log loss is: 0.5195220613606596
Total number of data points : 18000
```



4.5 Linear SVM with hyperparameter tuning

In [74]:

```
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_i
ter=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:
```

```
# Video Link:
#------------------------------

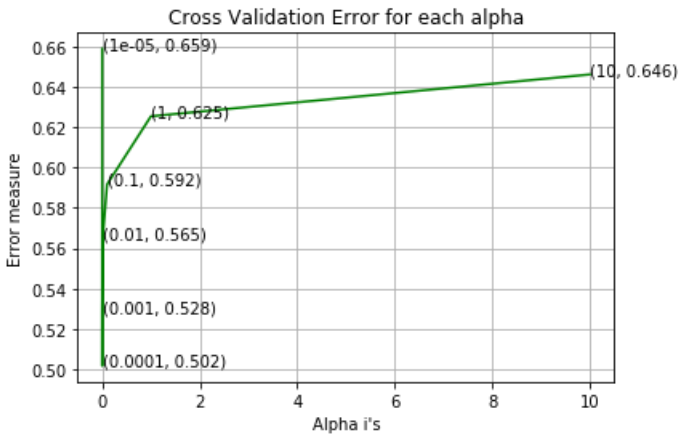

log_error_array=[]
for i in alpha:
    clf = SGDClassifier(alpha=i, penalty='l1', loss='hinge', random_state=42)
    clf.fit(X_train, y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
    sig_clf.fit(X_train, y_train)
    predict_y = sig_clf.predict_proba(X_test)
    log_error_array.append(log_loss(y_test, 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))

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()

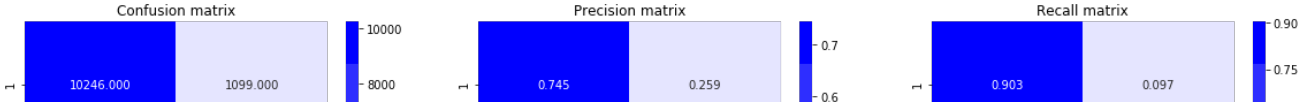

best_alpha = np.argmin(log_error_array)
clf = SGDClassifier(alpha=alpha[best_alpha], penalty='l1', loss='hinge', random_state=42)
clf.fit(X_train, y_train)
sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
sig_clf.fit(X_train, y_train)

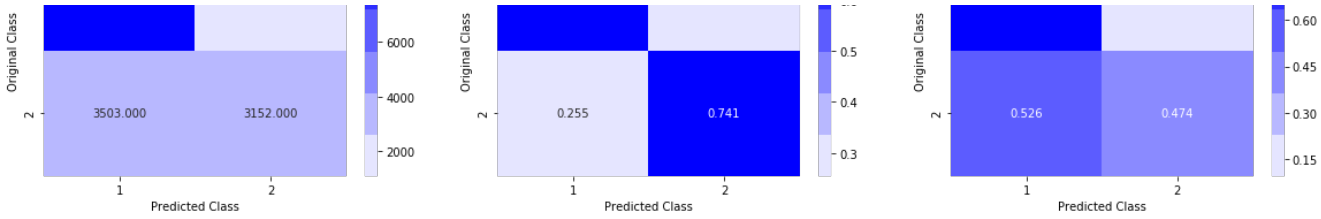
predict_y = sig_clf.predict_proba(X_train)
print('For values of best alpha = ', alpha[best_alpha], "The train log loss is:",log_loss(y_train,
predict_y, labels=clf.classes_, eps=1e-15))
predict_y = sig_clf.predict_proba(X_test)
print('For values of best alpha = ', alpha[best_alpha], "The test log loss 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-05 The log loss is: 0.658807677966553
For values of alpha =  0.0001 The log loss is: 0.501758546876382
For values of alpha =  0.001 The log loss is: 0.5282452062377582
For values of alpha =  0.01 The log loss is: 0.5646235090120997
For values of alpha =  0.1 The log loss is: 0.5916062464007461
For values of alpha =  1 The log loss is: 0.6253664924902231
For values of alpha =  10 The log loss is: 0.64605795435085
```




```
For values of best alpha =  0.0001 The train log loss is: 0.4961221923159768
For values of best alpha =  0.0001 The test log loss is: 0.501758546876382
Total number of data points : 18000
```





4.6 XGBoost

In [81]:

```
import xgboost as xgb
params = {}
params['objective'] = 'binary:logistic'
params['eval_metric'] = 'logloss'
params['eta'] = 0.02
params['max_depth'] = 4

d_train = xgb.DMatrix(new_x_train, label=new_y_train)
d_test = xgb.DMatrix(new_x_test, label=new_y_test)

watchlist = [(d_train, 'train'), (d_test, 'valid')]

bst = xgb.train(params, d_train, 400, watchlist, early_stopping_rounds=20, verbose_eval=10)

xgdmat = xgb.DMatrix(new_x_train,new_y_train)
predict_y = bst.predict(d_test)
print("The test log loss is:",log_loss(new_y_test, predict_y, labels=clf.classes_, eps=1e-15))
```

```
[00:18:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[0] train-logloss:0.6848 valid-logloss:0.685058
Multiple eval metrics have been passed: 'valid-logloss' will be used for early stopping.

Will train until valid-logloss hasn't improved in 20 rounds.
[00:18:50] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:18:50] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:51] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:18:51] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:51] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:18:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:53] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:53] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:53] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[10] train-logloss:0.61446 valid-logloss:0.617895
[00:18:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:55] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:55] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
```

```
[00:18:57] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:57] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[20] train-logloss:0.56219 valid-logloss:0.568852
[00:18:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:18:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:18:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:01] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:01] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:02] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:02] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[30] train-logloss:0.522788 valid-logloss:0.5323
[00:19:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:05] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:05] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[40] train-logloss:0.492439 valid-logloss:0.504408
[00:19:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:10] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:10] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[50] train-logloss:0.468933 valid-logloss:0.482611
[00:19:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:12] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:12] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
```

```
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:14] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:14] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[60] train-logloss:0.450064 valid-logloss:0.465942
[00:19:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[70] train-logloss:0.434713 valid-logloss:0.452835
[00:19:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:20] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:20] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:23] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[80] train-logloss:0.421935 valid-logloss:0.441803
[00:19:23] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[90] train-logloss:0.411574 valid-logloss:0.43327
```

```
[00:19:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:28] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:28] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:28] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:29] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:29] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:30] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:30] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:30] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[100] train-logloss:0.402689 valid-logloss:0.425953
[00:19:31] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:31] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:32] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:32] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:32] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:33] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:33] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:34] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:34] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:34] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[110] train-logloss:0.395111 valid-logloss:0.419973
[00:19:35] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:35] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:35] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:36] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:36] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:38] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:38] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[120] train-logloss:0.388919 valid-logloss:0.415257
[00:19:38] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:39] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:39] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:40] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:40] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:40] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:41] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
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[00:19:41] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:41] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:42] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[130] train-logloss:0.383085 valid-logloss:0.411005
[00:19:42] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:19:43] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:43] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:43] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:19:44] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:44] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:44] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:45] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:45] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:19:46] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[140] train-logloss:0.378201 valid-logloss:0.407783
[00:19:46] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:46] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:47] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:47] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:48] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:48] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:48] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:50] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[150] train-logloss:0.373427 valid-logloss:0.404624
[00:19:50] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:51] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:51] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:53] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:53] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[160] train-logloss:0.369037 valid-logloss:0.402013
[00:19:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:55] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:55] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:55] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
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ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:57] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:19:57] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[170] train-logloss:0.365122 valid-logloss:0.39993
[00:19:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:19:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:19:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:19:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:01] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:01] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:20:01] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[180] train-logloss:0.361553 valid-logloss:0.398133
[00:20:02] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:02] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:20:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:05] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:05] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:05] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[190] train-logloss:0.357987 valid-logloss:0.396266
[00:20:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:20:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:20:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[200] train-logloss:0.354598 valid-logloss:0.394658
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[illegible] train-logloss:[illegible] valid-logloss:[illegible]
[00:20:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:10] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:10] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:12] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:12] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:12] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[210] train-logloss:0.351333 valid-logloss:0.393348
[00:20:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:14] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:14] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[220] train-logloss:0.348261 valid-logloss:0.392073
[00:20:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:20] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:20] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[230] train-logloss:0.345177 valid-logloss:0.391089
[00:20:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:23] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
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ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:23] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[240] train-logloss:0.342257 valid-logloss:0.390056
[00:20:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:28] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:28] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[250] train-logloss:0.339199 valid-logloss:0.388778
[00:20:28] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:29] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:29] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:30] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:30] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:30] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:31] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:31] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:32] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:32] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[260] train-logloss:0.336292 valid-logloss:0.388116
[00:20:32] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:33] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:33] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:33] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:34] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[00:20:34] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:35] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:35] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:35] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:36] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[270] train-logloss:0.333249 valid-logloss:0.387383
[00:20:36] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
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[00:20:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:38] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:38] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:38] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:39] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:39] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:40] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[280] train-logloss:0.330425 valid-logloss:0.386772
[00:20:40] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:40] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:41] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:41] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:42] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:42] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:43] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:43] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:43] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:44] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[290] train-logloss:0.327226 valid-logloss:0.385969
[00:20:44] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:44] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:45] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:20:45] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:46] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:46] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:47] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:47] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:47] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:48] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[300] train-logloss:0.324399 valid-logloss:0.385407
[00:20:48] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:50] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:20:50] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:50] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:51] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:20:51] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[310] train-logloss:0.321398 valid-logloss:0.384751

[310] train-logloss:0.321396 valid-logloss:0.384751
[00:20:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:53] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:53] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:54] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:55] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:55] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:20:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[320] train-logloss:0.318934 valid-logloss:0.38415
[00:20:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:20:57] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:57] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:57] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:20:58] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:20:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:20:59] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[330] train-logloss:0.316043 valid-logloss:0.383912
[00:21:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 20 extra nodes, 0 pruned nodes, max_depth=4
[00:21:01] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:01] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:02] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:02] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:02] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[340] train-logloss:0.313561 valid-logloss:0.383465
[00:21:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:05] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:05] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:21:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:06] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4

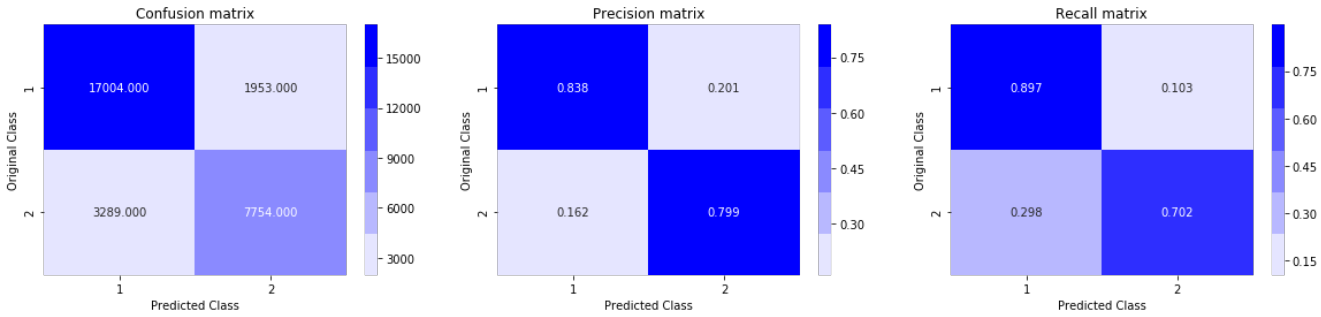
```
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:21:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[350] train-logloss:0.310877 valid-logloss:0.383089
[00:21:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:08] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:21:09] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:10] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:10] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:12] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[360] train-logloss:0.308227 valid-logloss:0.382917
[00:21:12] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:21:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:13] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:14] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:21:14] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:14] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:16] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 24 extra nodes, 0 pruned nodes, max_depth=4
[370] train-logloss:0.306009 valid-logloss:0.382586
[00:21:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:21:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:21:17] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:20] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:20] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:20] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[380] train-logloss:0.3038 valid-logloss:0.38214
[00:21:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
```

```
[00:21:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:23] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:21:23] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:23] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 28 extra nodes, 0 pruned nodes, max_depth=4
[00:21:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:21:24] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[390] train-logloss:0.301228 valid-logloss:0.381765
[00:21:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 18 extra nodes, 0 pruned nodes, max_depth=4
[00:21:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 22 extra nodes, 0 pruned nodes, max_depth=4
[00:21:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 26 extra nodes, 0 pruned nodes, max_depth=4
[00:21:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[00:21:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 30 extra nodes, 0 pruned nodes, max_depth=4
[399] train-logloss:0.298798 valid-logloss:0.381676
The test log loss is: 0.381676321641348
```

In [179]:

```
predicted_y =np.array(predict_y>0.5,dtype=int)
print("Total number of data points :", len(predicted_y))
plot_confusion_matrix(new_y_test, predicted_y)
```

```
Total number of data points : 30000
```



5. Assignments

1. Try out models (Logistic regression, Linear-SVM) with simple TF-IDF vectors instead of TD_IDF weighted word2Vec.
2. Hyperparameter tune XgBoost using RandomSearch to reduce the log-loss.

Logistic Regression with TFIDF and hyperparameter tuning

In [61]:

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

```
# 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_i
ter=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.

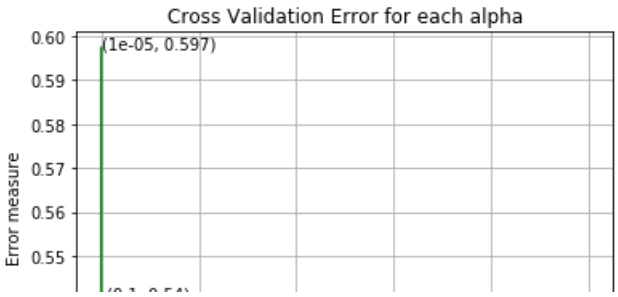
#-------------------------------
# video link:
#-------------------------------
from sklearn.linear_model import SGDClassifier
from sklearn.calibration import CalibratedClassifierCV
log_error_array=[]
for i in alpha:
    clf = SGDClassifier(alpha=i, penalty='l2', loss='log', random_state=42)
    clf.fit(X_train,y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
    sig_clf.fit(X_train, y_train)
    predict_y = sig_clf.predict_proba(X_test)
    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))

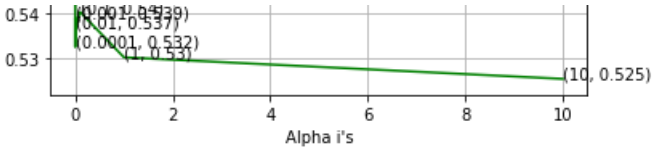
fig, ax = plt.subplots()
ax.plot(alpha, log_error_array,c='g')
for i, txt in enumerate(np.round(log_error_array,3)):
    ax.annotate((alpha[i],np.round(txt,3)), (alpha[i],log_error_array[i]))
plt.grid()
plt.title("Cross Validation Error for each alpha")
plt.xlabel("Alpha i's")
plt.ylabel("Error measure")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

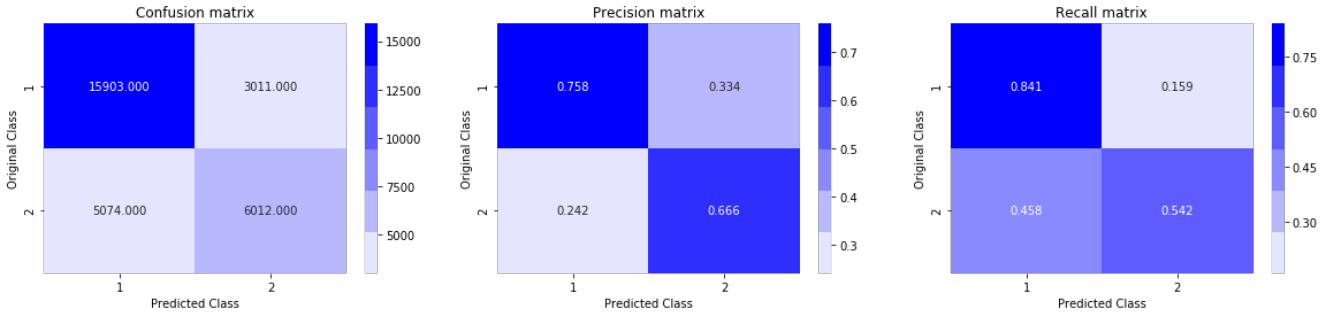
predict_y = sig_clf.predict_proba(X_train)
print('For values of best alpha = ', alpha[best_alpha], "The train log loss
is:",log_loss(new_y_train, predict_y, labels=clf.classes_, eps=1e-15))
predict_y = sig_clf.predict_proba(X_test)
print('For values of best alpha = ', alpha[best_alpha], "The test log 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-05 The log loss is: 0.5973379930195214
For values of alpha =  0.0001 The log loss is: 0.5324688775826292
For values of alpha =  0.001 The log loss is: 0.5391307902511334
For values of alpha =  0.01 The log loss is: 0.5370251185379298
For values of alpha =  0.1 The log loss is: 0.5404253950867678
For values of alpha =  1 The log loss is: 0.5301213032440313
For values of alpha =  10 The log loss is: 0.525223471496805
```






```
For values of best alpha =  10 The train log loss is: 0.5163528679900335
For values of best alpha =  10 The test log loss is: 0.525223471496805
Total number of data points : 30000
```



Linear SVM with TFIDF and hyperparameter tuning

In [82]:

```
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_i
ter=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(new_x_train, new_y_train)
    sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
    sig_clf.fit(new_x_train, new_y_train)
    predict_y = sig_clf.predict_proba(X_test)
    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))

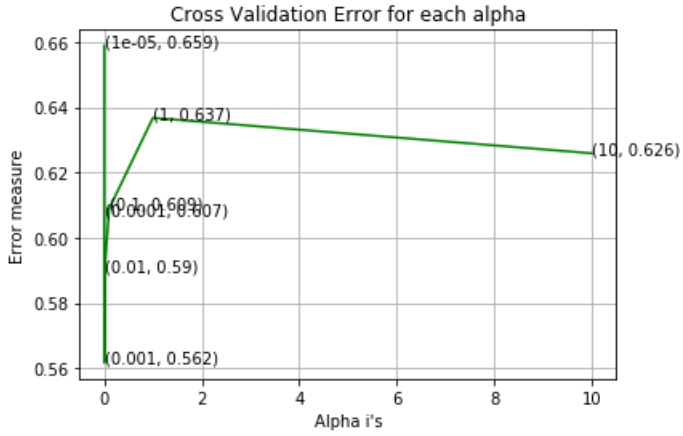
fig, ax = plt.subplots()
ax.plot(alpha, log_error_array,c='g')
for i, txt in enumerate(np.round(log_error_array,3)):
    ax.annotate((alpha[i],np.round(txt,3)), (alpha[i],log_error_array[i]))
plt.grid()
plt.title("Cross Validation Error for each alpha")
plt.xlabel("Alpha i's")
plt.ylabel("Error measure")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


best_alpha = np.argmin(log_error_array)
clf = SGDClassifier(alpha=alpha[best_alpha], penalty='l1', loss='hinge', random_state=42)
clf.fit(new_x_train, new_y_train)
```

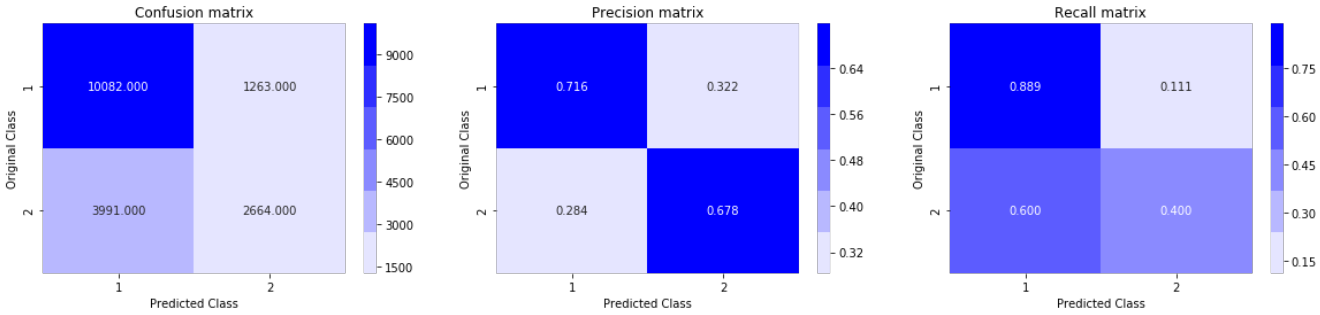
```
sig_clf = CalibratedClassifierCV(clf, method="sigmoid")
sig_clf.fit(new_x_train, new_y_train)

predict_y = sig_clf.predict_proba(new_x_train)
print('For values of best alpha = ', alpha[best_alpha], "The train log loss
is:",log_loss(new_y_train, predict_y, labels=clf.classes_, eps=1e-15))
predict_y = sig_clf.predict_proba(X_test)
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-05 The log loss is: 0.6588378264676555
For values of alpha =  0.0001 The log loss is: 0.6071160913315697
For values of alpha =  0.001 The log loss is: 0.5616058796517264
For values of alpha =  0.01 The log loss is: 0.5896569821761471
For values of alpha =  0.1 The log loss is: 0.6088181085142541
For values of alpha =  1 The log loss is: 0.6367239445519107
For values of alpha =  10 The log loss is: 0.6258621473423245
```




```
For values of best alpha =  0.001 The train log loss is: 0.538992339428178
For values of best alpha =  0.001 The test log loss is: 0.5616058796517264
Total number of data points : 18000
```



Hyperparameter tune for Xgboost

In [75]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.GridSearchCV.html
from sklearn.model_selection import GridSearchCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.datasets import make_classification
from xgboost import XGBClassifier

model = XGBClassifier()
param_grid = {
    'n_estimators': [100,200,300],

    'max_depth' : [5,10]
```

```
}

clf = GridSearchCV(model, param_grid, scoring ='roc_auc', cv = 10)

clf.fit(new_x_train, new_y_train)


train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']

best_parameters=clf.best_params_
```

In [76]:

```
for param_name in sorted(best_parameters.keys()):
     print("%s: %r" % (param_name, best_parameters[param_name]))
```

```
max_depth: 10
n_estimators: 300
```

In [78]:

```
 from sklearn.metrics import log_loss
import xgboost as xgb
params = {}
params['objective'] = 'binary:logistic'
params['eval_metric'] = 'logloss'
params['max_depth'] = 10
params['n_estimators'] = 300



d_train = xgb.DMatrix(final_x, label=final_y)
d_test = xgb.DMatrix(X_test, label=y_test)

watchlist = [(d_train, 'train'), (d_test, 'valid')]

bst = xgb.train(params, d_train, 400, watchlist, early_stopping_rounds=20, verbose_eval=10)

xgdmat = xgb.DMatrix(new_x_train,new_y_train)
predict_y = bst.predict(d_test)
print("The test log loss is:",log_loss(y_test, predict_y, labels=clf.classes_, eps=1e-15))
```

```
[13:57:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 570 extra nodes, 0 pruned nodes, max_depth=10
[0] train-logloss:0.537612 valid-logloss:0.570369
Multiple eval metrics have been passed: 'valid-logloss' will be used for early stopping.

Will train until valid-logloss hasn't improved in 20 rounds.
[13:57:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 594 extra nodes, 0 pruned nodes, max_depth=10
[13:57:26] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 568 extra nodes, 0 pruned nodes, max_depth=10
[13:57:29] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 604 extra nodes, 0 pruned nodes, max_depth=10
[13:57:33] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 522 extra nodes, 0 pruned nodes, max_depth=10
[13:57:37] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 564 extra nodes, 0 pruned nodes, max_depth=10
[13:57:41] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 640 extra nodes, 0 pruned nodes, max_depth=10
[13:57:45] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 350 extra nodes, 0 pruned nodes, max_depth=10
[13:57:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 306 extra nodes, 0 pruned nodes, max_depth=10
[13:57:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 294 extra nodes, 0 pruned nodes, max_depth=10
[13:57:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 362 extra nodes, 0 pruned nodes, max_depth=10
[10] train-logloss:0.183503 valid-logloss:0.375455
[13:58:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 360 extra nodes, 0 pruned nodes, max_depth=10
[13:58:03] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
```

```
ts, 440 extra nodes, 0 pruned nodes, max_depth=10
[13:58:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 464 extra nodes, 0 pruned nodes, max_depth=10
[13:58:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 272 extra nodes, 0 pruned nodes, max_depth=10
[13:58:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 434 extra nodes, 0 pruned nodes, max_depth=10
[13:58:19] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 274 extra nodes, 0 pruned nodes, max_depth=10
[13:58:22] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 402 extra nodes, 0 pruned nodes, max_depth=10
[13:58:27] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 220 extra nodes, 0 pruned nodes, max_depth=10
[13:58:31] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 488 extra nodes, 0 pruned nodes, max_depth=10
[13:58:35] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 470 extra nodes, 0 pruned nodes, max_depth=10
[20] train-logloss:0.096059 valid-logloss:0.375361
[13:58:38] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 338 extra nodes, 0 pruned nodes, max_depth=10
[13:58:42] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 408 extra nodes, 0 pruned nodes, max_depth=10
[13:58:46] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 496 extra nodes, 0 pruned nodes, max_depth=10
[13:58:49] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 250 extra nodes, 0 pruned nodes, max_depth=10
[13:58:52] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 324 extra nodes, 0 pruned nodes, max_depth=10
[13:58:56] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 600 extra nodes, 0 pruned nodes, max_depth=10
[13:59:00] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 616 extra nodes, 0 pruned nodes, max_depth=10
[13:59:04] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 354 extra nodes, 0 pruned nodes, max_depth=10
[13:59:07] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 256 extra nodes, 0 pruned nodes, max_depth=10
[13:59:11] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 486 extra nodes, 0 pruned nodes, max_depth=10
[30] train-logloss:0.049011 valid-logloss:0.382999
[13:59:15] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 530 extra nodes, 0 pruned nodes, max_depth=10
[13:59:18] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 284 extra nodes, 0 pruned nodes, max_depth=10
[13:59:21] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 436 extra nodes, 0 pruned nodes, max_depth=10
[13:59:25] d:\build\xgboost\xgboost-0.80.git\src\tree\updater_prune.cc:74: tree pruning end, 1 roo
ts, 264 extra nodes, 0 pruned nodes, max_depth=10
Stopping. Best iteration:
[14] train-logloss:0.142144 valid-logloss:0.372167

The test log loss is: 0.3848602981221957
```

In [81]:

```
# http://zetcode.com/python/prettytable/
#Xgboost observation
from prettytable import PrettyTable

#If you get a ModuleNotFoundError error , install prettytable using: pip3 install prettytable

x = PrettyTable()
x.field_names = ["Featurization","MODEL","test log loss"]
x.add_row(["TFIDF_W2V","Logistic Regression", 0.51])
x.add_row(["TFIDF_W2V","Linear SVM",0.50])
x.add_row(["TFIDF_W2V","XGBoost",0.40])
x.add_row(["TFIDF","Logistic Regression",0.52])
x.add_row(["TFIDF","Linear SVM",0.49])
x.add_row(["TFIDF","XGBoost(with hyperparameter tuning)",0.38])

print(x)
```

```
+---------------+-------------------------------------+---------------+
| Featurization |                MODEL                | test log loss |
+---------------+-------------------------------------+---------------+
|   TFIDF_W2V   |         Logistic Regression         |      0.51     |
```

TFIDF_W2V	Linear SVM	0.5
TFIDF_W2V	XGBoost	0.4
TFIDF	Logistic Regression	0.52
TFIDF	Linear SVM	0.49
TFIDF	XGBoost(with hyperparameter tuning)	0.38

Conclusion

1.As we know that linear model works well using high dimension data, so we use tfidf featurization for linear models like logistic regression and linear svm.

2.We have used both the featurization (tfidf and tfidf avg) for xgboost.

3.XGBOOST using tfidf avg seems overfit as high difference between train log loss and test log loss. So we will discard this.

4.We get low log-loss value using xgboost model with tfidf featurization and not getting high difference between train and test log loss as well.

5.So we can use XGBOOST model with tfidf featurization for this problem.