Quora_EDA_and_Data_Preparation

June 29, 2019

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/AACZd
- 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
- Number of rows in Train.csv = 404,290

2.1.2 Example Data point

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 [1]: # general purpose packages
        import pandas as pd
        import numpy as np
        import os
        import sys
        from datetime import datetime

        # viaualization realted packages
        import matplotlib.pyplot as plt
        import seaborn as sns
        sns.set()

        import plotly.offline as py
        py.init_notebook_mode(connected=True)
        import plotly.graph_objs as go
        import plotly.tools as tls
        import gc

        from wordcloud import WordCloud
        from sklearn.manifold import TSNE

        # text pre processing related packages
        import re
        from nltk.corpus import stopwords
        # set stop words for word cloud
```

```
from wordcloud import STOPWORDS
from nltk.stem import PorterStemmer
import distance
from fuzzywuzzy import fuzz


# scaling
from sklearn.preprocessing import MinMaxScaler

# featue extraction packge for text data
from sklearn.feature_extraction.text import TfidfVectorizer

# partition the dataset to train, test
from sklearn.model_selection import train_test_split
```

```
In [2]: print(datetime.now() ,' Started DF Geneartion')
```

```
2019-06-22 04:06:59.246211  Started DF Geneartion
```

1 Configs

```
In [3]: csv_path = '/media/amd_3/20DAD539DAD50BC2/DSET_REPO/DataSets/CS07_QUORA_QUESTION_PAIR/tr
        sample_size = 120000 # set -1 if you want to use full dataset size
```

3.1 Reading data and basic stats

```
In [4]: df = pd.read_csv(csv_path, index_col=False)
        print("Number of data points:",df.shape[0])
        df.head()
```

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

```
Out[4]:    id  qid1  qid2                                                question1  \
        0   0     1     2  What is the step by step guide to invest in sh...
        1   1     3     4  What is the story of Kohinoor (Koh-i-Noor) Dia...
        2   2     5     6  How can I increase the speed of my internet co...
        3   3     7     8  Why am I mentally very lonely? How can I solve...
        4   4     9    10  Which one dissolve in water quikly sugar, salt...

                                                question2  is_duplicate
        0  What is the step by step guide to invest in sh...             0
        1  What would happen if the Indian government sto...             0
        2  How can Internet speed be increased by hacking...             0
        3  Find the remainder when [math]23^{24}[/math] i...             0
        4              Which fish would survive in salt water?             0
```

```
In [5]: print('Data frame info: \n', 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
Data frame info:
 None
```

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.

1.1 Deduping based on duplicate question pairs

3.2.3 Checking for Duplicates

```
In [6]: print('Before deduping the data frame size :', df.shape[0])
        df = df.drop_duplicates(subset=['qid1', 'qid2'])
        #df = df.drop(['id'], axis=1)
        print('After deduping the data frame size :', df.shape[0])
```

```
Before deduping the data frame size : 404290
After deduping the data frame size : 404290
```

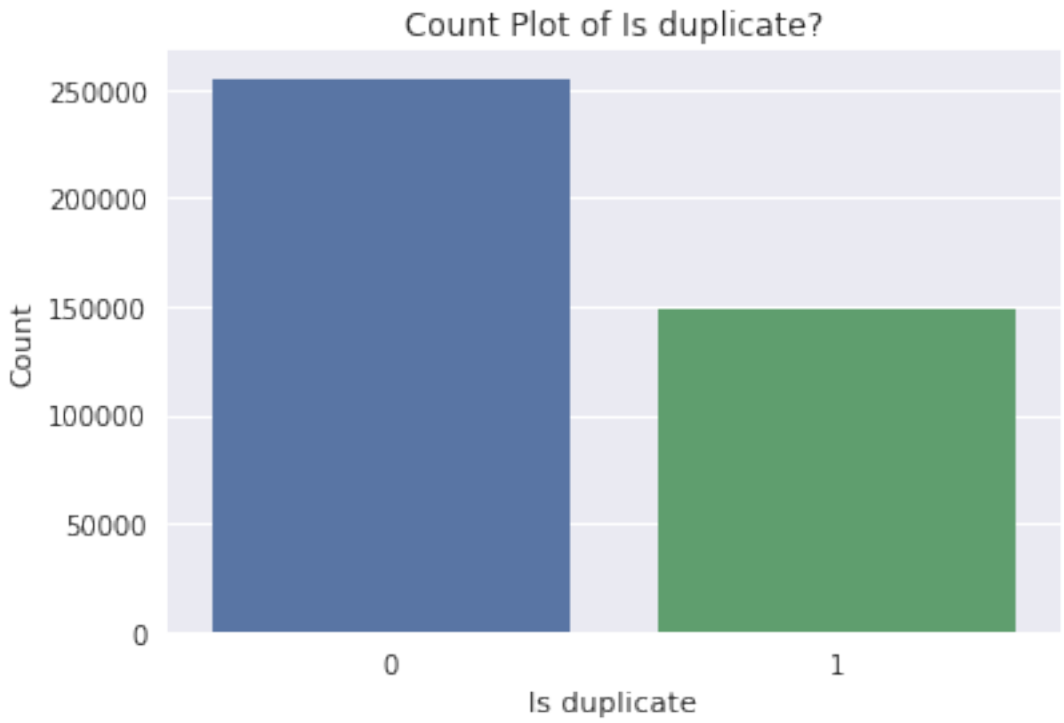
3.2.1 Distribution of data points among output classes

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

```
In [7]: print('Total number of question pairs for training', df.shape[0])
```

```
Total number of question pairs for training 404290
```

```
In [8]: sns.countplot(data=df, x='is_duplicate')
        plt.xlabel('Is duplicate')
        plt.ylabel('Count')
        plt.title('Count Plot of Is duplicate?')
        plt.show()
```




```
In [9]: count_info = df.groupby(['is_duplicate']).size()
        per_array = (count_info * 100.0) / df.shape[0]

In [10]: print('Question pairs are not Similar (is_duplicate = 0): ', per_array.loc[0])
         print('Question pairs are Similar (is_duplicate = 1)', per_array.loc[1])

Question pairs are not Similar (is_duplicate = 0):  63.0802146973707
Question pairs are Similar (is_duplicate = 1) 36.9197853026293
```

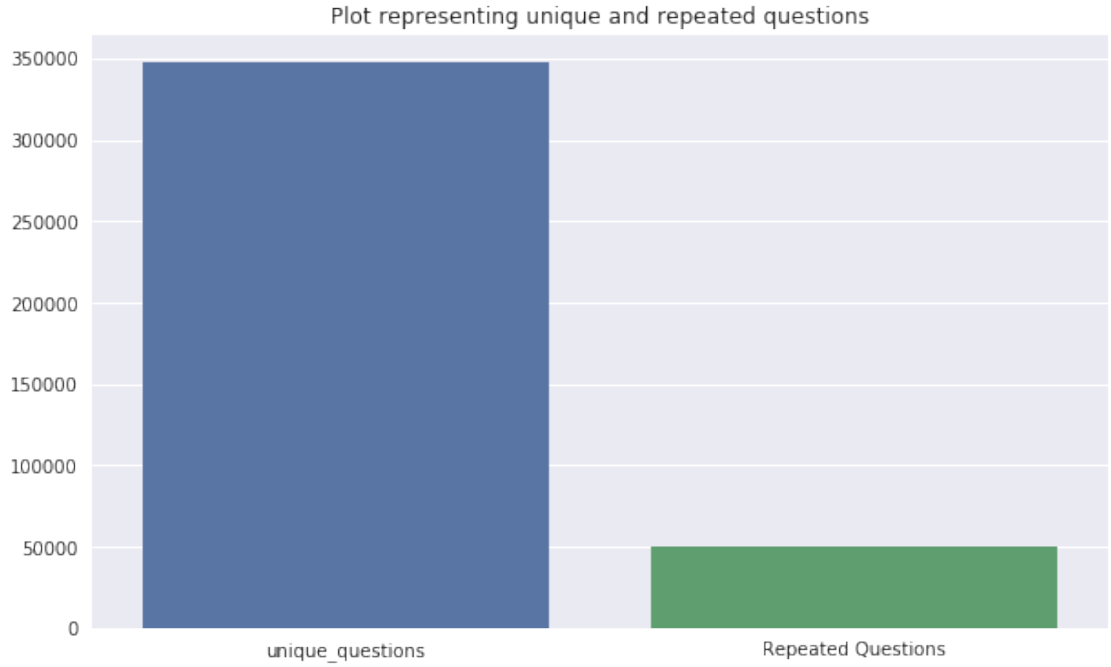
3.2.2 Number of unique questions

```
In [11]: full_qids = df['qid1'] + df['qid2']

         # all questionids unique
         qids =  set(full_qids)

         print('Number of unique questions:', len(qids))

         # count of repetation of each question
         qid_value_counts = full_qids.value_counts()
         qs_more_than_once = qid_value_counts[qid_value_counts > 1]

         print ('Number of questions that appeared more than once', len(qs_more_than_once),
```

```
        (len(qs_more_than_once)/len(qids))*100.0)

print ('Max number of times a single question is repeated ', max(qid_value_counts))
```

```
Number of unique questions: 347345
Number of questions that appeared more than once 50205 14.453929090673537
Max number of times a single question is repeated  6
```

```
In [12]: x = ['unique_questions' , 'Repeated Questions']
         y =  [len(qids) , len(qs_more_than_once)]

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

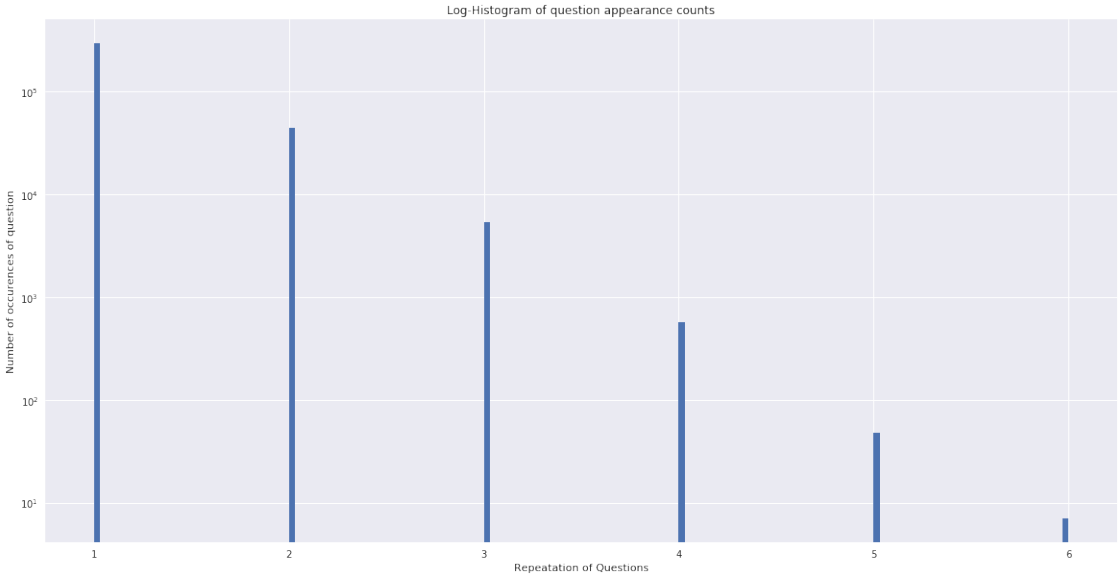


3.2.4 Number of occurrences of each question

```
In [13]: plt.figure(figsize=(20, 10))

         plt.hist(qid_value_counts, bins=160)

         plt.yscale('log', nonposy='clip')
         plt.title('Log-Histogram of question appearance counts')
         plt.xlabel('Repeatation of Questions')
         plt.ylabel('Number of occurences of question')
```

```
        print ('Maximum number of times a single question is repeated :', max(qid_value_counts)
```

```
Maximum number of times a single question is repeated : 6
```



3.2.5 Checking for NULL values

```
In [14]: #Checking whether there are any rows with null values
         null_df = df[df.isnull().any(axis=1)]
         print('number of rows where nan value is present:', null_df.shape[0])
         null_df.head()
```

```
number of rows where nan value is present: 3
```

```
Out[14]:            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 [15]: # Filling the null values with ' '
         df = df.fillna('  ')
         nan_rows = df[df.isnull().any(axis=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: - ____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)

In [16]:
```
def extract_feature_before_cleaning(df):

    print(datetime.now() ,' Extracting features before cleaning - started')

    # add the length of questions (number of characters)
    df['q1len'] = df['question1'].str.len()
    df['q2len'] = df['question2'].str.len()

    # add the number of words in the questions
    df['q1_n_words'] = df['question1'].apply(lambda x: len(x.split(' ')))
    df['q2_n_words'] = df['question2'].apply(lambda x: len(x.split(' ')))

    # words in common
    q_pair_list = list(zip(df['question1'], df['question2']))

    # common words
    df['word_Common'] = list(map(lambda x : len(set(x[0].lower().split()) & set(x[1].lo
                                 q_pair_list))

    df['word_Total'] = list(map(lambda x : len(set(x[0].lower().split())) +
                                           len(set(x[1].lower().split())),
                                q_pair_list))

    # get the ratio of words shared
    df['word_share'] = df['word_Common'] / df['word_Total']

    # save the file as data frame
    df.to_csv('./data/df_fe_without_preprocessing_train.csv', index=False)

    print(datetime.now() ,' Extracting features before cleaning - completed')

    return df
```

In [17]:
```
df =  extract_feature_before_cleaning(df)
df.head()
```

```
2019-06-22 04:07:03.631548  Extracting features before cleaning - started
2019-06-22 04:07:13.086527  Extracting features before cleaning - completed
```

Out[17]:

	id	qid1	qid2	question1	question2	is_duplicate	q1len	q2len	q1_n_words	q2_n_words	word_Common	word_Total	word_share
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	66	57	14	12	10	23	0.434783
1	1	3	4	What is the story of Kohinoor (Koh-i-Noor) Dia...	What would happen if the Indian government sto...	0	51	88	8	13	4	20	0.200000
2	2	5	6	How can I increase the speed of my internet co...	How can Internet speed be increased by hacking...	0	73	59	14	10	4	24	0.166667
3	3	7	8	Why am I mentally very lonely? How can I solve...	Find the remainder when [math]23^{24}[/math] i...	0	50	65	11	9	0	19	0.000000
4	4	9	10	Which one dissolve in water quikly sugar, salt...	Which fish would survive in salt water?	0	76	39	13	7	2	20	0.100000

3.3.1 Analysis of some of the extracted features

- Here are some questions have only one single words.

In [18]:
```
min_length_q1 = df['q1_n_words'].min()
min_length_q2 = df['q2_n_words'].min()

print ("Minimum length of the questions in question1 : " , min_length_q1)
print ("Minimum length of the questions in question2 : " , min_length_q2)

print ("Number of Questions with minimum length [question1] :",
       df[df['q1_n_words']== min_length_q1].shape[0])
print ("Number of Questions with minimum length [question2] :",
       df[df['q2_n_words']== min_length_q2].shape[0])
```

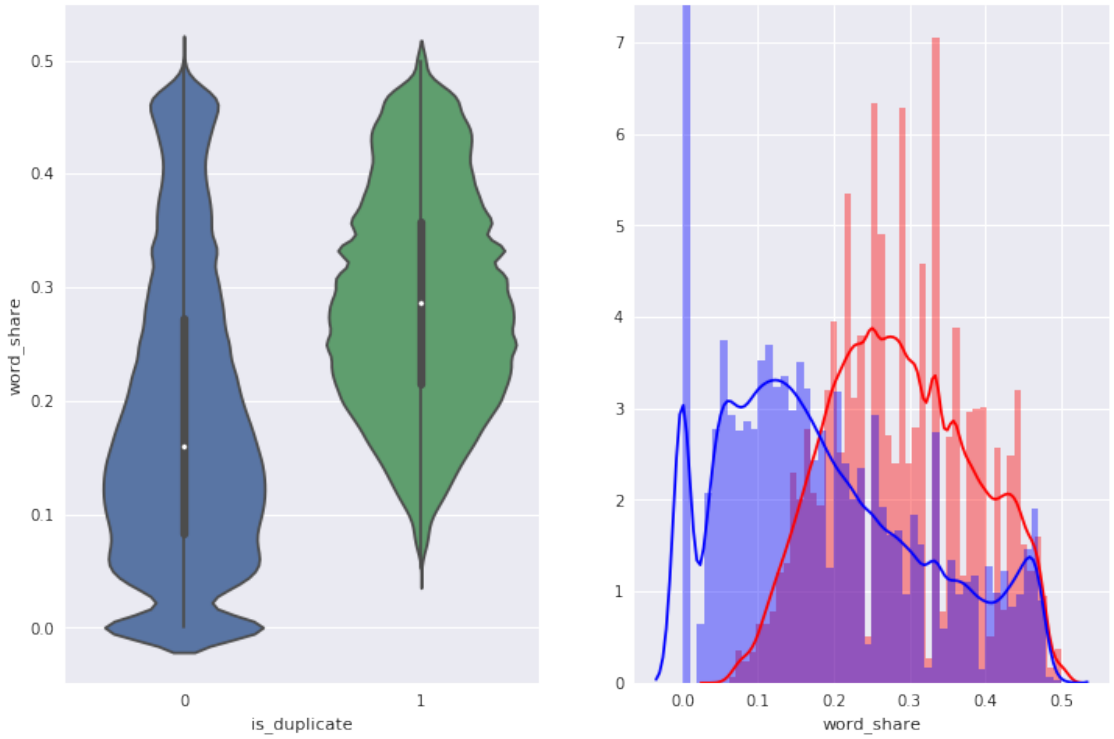
```
Minimum length of the questions in question1 :  1
Minimum length of the questions in question2 :  1
Number of Questions with minimum length [question1] : 66
Number of Questions with minimum length [question2] : 22
```

3.3.1.1 Feature: word_share

In [19]:
```
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]['word_share'][0:] , label = "1", color = 'red'
sns.distplot(df[df['is_duplicate'] == 0]['word_share'][0:] , label = "0" , color = 'blu
plt.show()
```

```
/home/amd_3/anaconda3/lib/python3.6/site-packages/matplotlib/axes/_axes.py:6462: UserWarning:

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

/home/amd_3/anaconda3/lib/python3.6/site-packages/matplotlib/axes/_axes.py:6462: UserWarning:

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

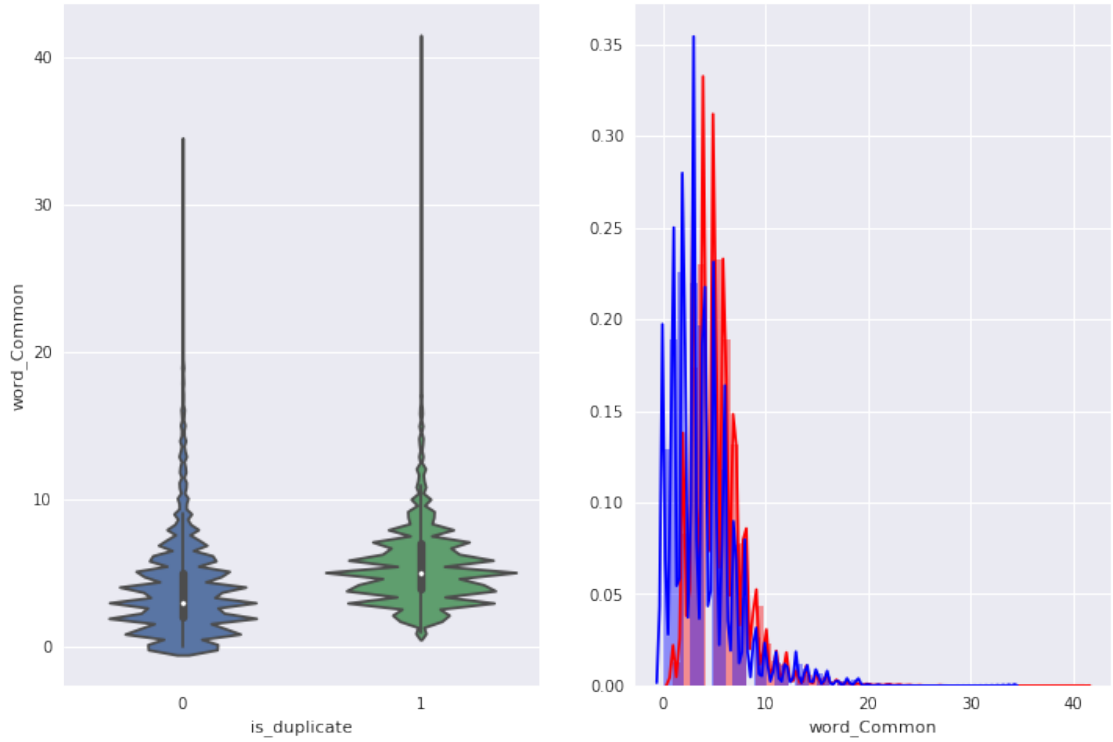


- The distributions for normalized word_share have some overlap on the far right-hand side, i.e., there are quite a lot of questions with high word similarity
- The average word share and Common no. of words of qid1 and qid2 is more when they are duplicate(Similar)

3.3.1.2 Feature: word_Common

```
In [20]: 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]['word_Common'][0:] , label = "1", color = 'red
         sns.distplot(df[df['is_duplicate'] == 0]['word_Common'][0:] , label = "0" , color = 'bl
         plt.show()
```

```
/home/amd_3/anaconda3/lib/python3.6/site-packages/matplotlib/axes/_axes.py:6462: UserWarning:

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

/home/amd_3/anaconda3/lib/python3.6/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

2 Preprocessig

```
In [21]: df = pd.read_csv('./data/df_fe_without_preprocessing_train.csv', index_col=False)

         # take sample if opted
         if sample_size > 0:
             df = df.sample(n=sample_size)

         df = df.reset_index(drop=True)
         df.head()
```

Out[21]:

	id	qid1	qid2	question1	question2	is_duplicate	q1len	q2len	q1_n_words	q2_n_words	word_Common	word_Total	word_share
0	126223	922	203482	Which book should I start with for the GATE pr...	Which is the best book to study the Constituti...	0	56	58	10	11	3	20	0.150000
1	125957	203109	109471	Does using apple cider vinegar for weight loss...	How do I use apple cider vinegar to lose weight?	0	70	48	12	10	3	22	0.136364
2	148615	234279	234280	Why is that sign of + used in country code in ...	Say all races and cultures are accepted in the...	0	59	96	13	16	1	28	0.035714
3	113198	185056	185057	What happens with a past curfew ticket in court?	Why do people think that the officer will not ...	0	48	85	9	17	1	26	0.038462
4	212253	317302	317303	If Microsoft didn't bundle Internet Explorer i...	Is Microsoft changing the name of Internet Exp...	0	133	52	20	8	3	26	0.115385

3.4 Preprocessing of Text

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

```
In [22]: STOP_WORDS = stopwords.words('english')
         html_tags = re.compile(r'<.*?>')
         porter = PorterStemmer()

         def clean_text(x):

             # Step 1: Remove HTML tags
```

```
    x = re.sub(html_tags, ' ', x)

    # Step 2: Convert to lower case
    x = x.lower()

    # Step 3: De-contraction of words
    x = x.replace(",000,000", "m").replace(",000", "k").replace("", "'").replace("", "'
                            .replace("won't", "will not").replace("cannot", "can not").r
                            .replace("n't", " not").replace("what's", "what is").replace
                            .replace("'ve", " have").replace("i'm", "i am").replace("'re
                            .replace("he's", "he is").replace("she's", "she is").replace
                            .replace("%", " percent ").replace("", " rupee ").replace("$
                            .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)

    # Step 4: Removal of special characters
    special_chars_pattern = re.compile('\W')
    x = re.sub(special_chars_pattern, ' ', x)

    # Step 5: Removal of stop words
    #x = list(filter(lambda x: x not in STOP_WORDS, x.split(' ')))

    # Step 6: Stemming of words
    x = [porter.stem(item) for item in x.split()]
    x = ' '.join(x)

    return x
```

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 Q2csc_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 Q2ctc_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 Q2ctc_max = common_token_count / (max(len(q1_tokens), len(q2_tokens))
- **last_word_eq** : Check if First word of both questions is equal or notlast_word_eq = int(q1_tokens[-1] == q2_tokens[-1])
- **first_word_eq** : Check if First word of both questions is equal or notfirst_word_eq = int(q1_tokens[0] == q2_tokens[0])

- **abs_len_diff** : Abs. length differenceabs_len_diff = abs(len(q1_tokens) - len(q2_tokens))
- **mean_len** : Average Token Length of both Questionsmean_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 Q2longest_substr_ratio = len(longest common substring) / (min(len(q1_tokens), len(q2_tokens))

In [23]:
```
def get_token_features(df):

    SAFE_DIV = 1e-5

    # convert the text to list
    question_1_txt_list = df['question1'].tolist()
    question_2_txt_list = df['question2'].tolist()

    # declare a list for holding all kind of token features
    token_feature_list = list()

    # get the features row wise
    for index in range(0, df.shape[0]):

        # get the tokens of both the questions individually
        q1_tokens_list = question_1_txt_list[index].split(' ')
        q2_tokens_list = question_1_txt_list[index].split(' ')

        # if both the list are non-empty
        if (len(q1_tokens_list) > 0  and len(q2_tokens_list) > 0):

            # get the stop words of both the questions individually
            q1_stopwords_set = set(filter(lambda x : x in STOP_WORDS, q1_tokens_list))
            q2_stopwords_set = set(filter(lambda x : x in STOP_WORDS, q2_tokens_list))

            # get the words of both the questions individually
            q1_words_set = set(q1_tokens_list) - q1_stopwords_set
            q2_words_set = set(q2_tokens_list) - q2_stopwords_set
```

```
# get count of word, token, stopwords individually for each question
q1_token_count, q2_token_count = len(q1_tokens_list), len(q2_tokens_list)
q1_word_count, q2_word_count = len(q1_words_set), len(q2_words_set)
q1_stopword_count, q2_stopword_count = len(q1_stopwords_set), len(q2_stopwo


# Get the common Tokens from Question pair
common_token_count = len(set(q1_tokens_list) & set(q2_tokens_list))

# Get the common non-stopwords from Question pair
common_word_count = len(q1_words_set & q2_words_set)

# Get the common stopwords from Question pair
common_stop_count = len(q1_stopwords_set & q2_stopwords_set)

# get individual features

# Feature 1 -
ctc_min = common_token_count / (min(q1_token_count, q2_token_count) + SAFE_
ctc_max = common_token_count / (max(q1_token_count, q2_token_count) + SAFE_

# Feature 2 -
cwc_min = common_word_count / (min(q1_word_count, q2_word_count) + SAFE_DIV
cwc_max = common_word_count / (max(q1_word_count, q2_word_count) + SAFE_DIV

# Feature 3 -
csc_min = common_stop_count / (min(q1_stopword_count, q2_stopword_count) +
csc_max = common_stop_count / (max(q1_stopword_count, q2_stopword_count) +

# First word of both question is same or not
first_word_same = int(q1_tokens_list[0] == q2_tokens_list[0])

# Last word of both question is same or not
last_word_same = int(q1_tokens_list[-1] == q2_tokens_list[-1])

# absolute difference between the word count of question 1 & question 2
abs_token_count_diff = abs(q1_token_count -q2_token_count)

# Average Token Length of both Questions
avg_token_length = (q1_token_count + q2_token_count)/2


# form the feature vector for this data point
feat_vector = [ctc_min, ctc_max, cwc_min, cwc_max, csc_min, csc_max,
               first_word_same, last_word_same, abs_token_count_diff,
               avg_token_length]
```

```
            # update the data list
            token_feature_list.append(feat_vector)



        # if atleast one of them is empty
        else:
            token_feature_list.append([0] * 10)



    # form token features df
    token_feat_df = pd.DataFrame(token_feature_list, columns=['ctc_min', 'ctc_max',
                                 'cwc_min', 'cwc_max','csc_min', 'csc_max',
                                 'first_word_same', 'last_word_same',
                                 'abs_token_count_diff', 'avg_token_length'])


    return token_feat_df
```

In [24]:
```
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)
```

In [25]:
```
def get_fuzzy_features(df):

    # declare a fuzzy feature dict
    fuzzy_feat_dict = dict()

    fuzzy_feat_dict['token_set_ratio'] = df.apply(
        lambda x: fuzz.token_set_ratio(x['question1'],x['question2']), axis=1)
    fuzzy_feat_dict['token_sort_ratio'] = df.apply(
        lambda x: fuzz.token_sort_ratio(x['question1'],x['question2']), axis=1)
    fuzzy_feat_dict['fuzz_ratio'] = df.apply(
        lambda x: fuzz.QRatio(x['question1'],x['question2']), axis=1)
    fuzzy_feat_dict['fuzz_partial_ratio'] = df.apply(
        lambda x: fuzz.partial_ratio(x['question1'],x['question2']), axis=1)
    fuzzy_feat_dict['longest_substr_ratio'] = df.apply(
        lambda x: get_longest_substr_ratio(x['question1'],x['question2']), axis=1)

    fuzzy_feat_df = pd.DataFrame(fuzzy_feat_dict, index=range(df.shape[0]))

    return fuzzy_feat_df
```

In [26]:
```
def get_feature_df(df):
```

```
    # get basic features
    basic_feat_df = df.drop(['qid1', 'qid2'], axis=1)

    # clean the text
    df['question1'] = df['question1'].apply(clean_text)
    df['question2'] = df['question2'].apply(clean_text)
    #df.head()

    # get token features
    token_feat_df = get_token_features(df)

    # get fuzzy features
    fuzzy_feat_df = get_fuzzy_features(df)

    # form the entire set of features , this data frame will have id column and labels
    # along with all the features

    full_feat_df = pd.concat([basic_feat_df, token_feat_df, fuzzy_feat_df], axis=1)

    return full_feat_df
```

In [27]:
```
full_feature_df = get_feature_df(df)
print('Full feature df shape : ', full_feature_df.shape)
full_feature_df.to_csv('./data/full_features.csv', index=False)
full_feature_df.head()
```

```
Full feature df shape :  (120000, 26)
```

Out[27]:

	id	question1	question2	is_duplicate	q1len	q2len	q1_n_words	q2_n_words	word_Common	word_Total
0	126223	Which book should I start with for the GATE pr...	Which is the best book to study the Constituti...	0	56	58	10	11	3	20
1	125957	Does using apple cider vinegar for weight loss...	How do I use apple cider vinegar to lose weight?	0	70	48	12	10	3	22
2	148615	Why is that sign of + used in country code in ...	Say all races and cultures are accepted in the...	0	59	96	13	16	1	28
3	113198	What happens with a past curfew ticket in court?	Why do people think that the officer will not ...	0	48	85	9	17	1	26
4	212253	If Microsoft didn't bundle Internet Explorer i...	Is Microsoft changing the name of Internet Exp...	0	133					

```
4     52          20           8            3          26

           ...            csc_max  first_word_same  last_word_same  \
0          ...           0.999998                1               1
1          ...           0.999990                1               1
2          ...           0.999998                1               1
3          ...           0.999998                1               1
4          ...           0.999999                1               1

   abs_token_count_diff  avg_token_length  token_set_ratio  token_sort_ratio  \
0                     0              10.0               56                52
1                     0              12.0               77                72
2                     0              12.0               44                43
3                     0               9.0               55                52
4                     0              21.0               77                47

   fuzz_ratio  fuzz_partial_ratio  longest_substr_ratio
0          46                  46              0.117647
1          64                  74              0.510638
2          39                  44              0.071429
3          45                  48              0.148936
4          41                  70              0.340426

[5 rows x 26 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

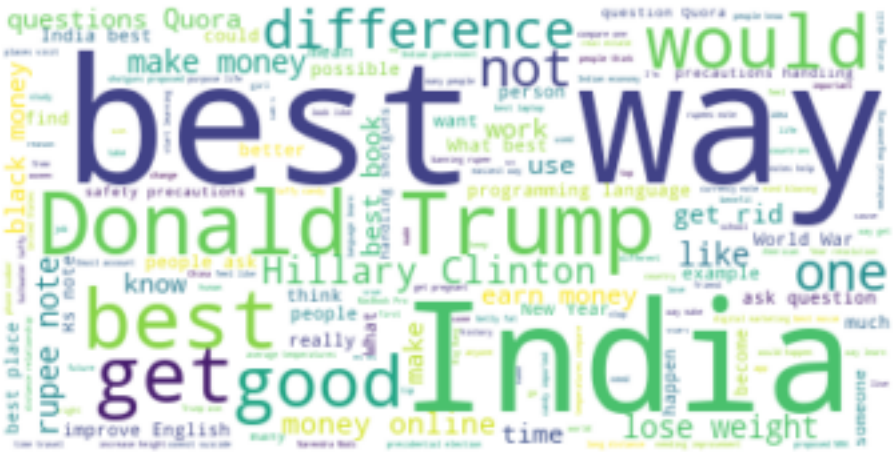
```
In [28]: def plot_wordcloud(df):

             df_yes = df[df['is_duplicate'] == 1]
             df_no = df[df['is_duplicate'] == 0]

             print ('Number of data points in class 1 (duplicate pairs) :', df_yes.shape[0])
             print ('Number of data points in class 0 (non duplicate pairs) :', df_no.shape[0])


             print('\n\n\n')

             df_yes_sentences = df_yes['question1'] + ' ' + df_yes['question2']
             df_no_sentences = df_no['question1'] + ' ' + df_no['question2']

             df_yes_text = str()
             df_no_text = str()
```

```
    for ques_txt in df_yes_sentences:
        df_yes_text += ques_txt

    for ques_txt in df_no_sentences:
        df_no_text += ques_txt

    stopwords = set(STOP_WORDS)
    stopwords.remove('not')
    stopwords.remove('no')

    stopwords.add('said')
    stopwords.add('br')
    stopwords.add(' ')

    wc = WordCloud(background_color='white', max_words=500, stopwords=stopwords)
    wc.generate(df_yes_text)
    print ('Word Cloud for Duplicate Question pairs (YES class)')
    plt.imshow(wc, interpolation='bilinear')
    plt.axis('off')
    plt.show()

    wc = WordCloud(background_color='white', max_words=500, stopwords=stopwords)
    wc.generate(df_no_text)
    print ('Word Cloud for Duplicate Question pairs (YES class)')
    plt.imshow(wc, interpolation='bilinear')
    plt.axis('off')
    plt.show()
```

In [29]:
```
plot_wordcloud(full_feature_df)
```

```
Number of data points in class 1 (duplicate pairs) : 44304
Number of data points in class 0 (non duplicate pairs) : 75696
```

Word Cloud for Duplicate Question pairs (YES class)



Word Cloud for Duplicate Question pairs (YES class)

The word India is present both in duplicate & non-duplicate data
The words Donald Trump, best way are the two frequently occuring word in YES class data
The word best, get , not are the most frequently occuring words in NO class

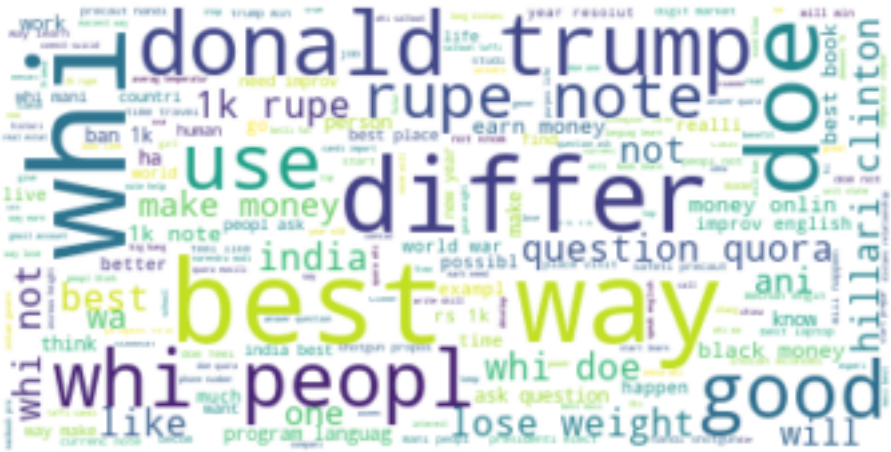
```
In [30]: stopwords = set(STOPWORDS)
         stopwords.remove('not')
         stopwords.remove('no')

         stopwords.add('said')
```

```
stopwords.add('br')
stopwords.remove('like')
stopwords.add(' ')
```

__ Word Clouds generated from duplicate pair question's text __

```
In [31]: pos_df = df[df['is_duplicate'] == 1]
         textp_w = pos_df['question1'] + ' ' + pos_df['question2']
         textp_w = ' '.join(list(textp_w))

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

```
Word Cloud for Duplicate Question pairs (YES class)
```



__ Word Clouds generated from non duplicate pair question's text __

```
In [32]: neg_df = df[df['is_duplicate'] == 0]
         textn_w = neg_df['question1'] + ' ' + neg_df['question2']
         textn_w = ' '.join(list(textn_w))

         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 (NO class)')
         plt.imshow(wc, interpolation='bilinear')
```

```
        plt.axis('off')
        plt.show()
```

```
Word Cloud for non-Duplicate Question pairs (NO class)
```

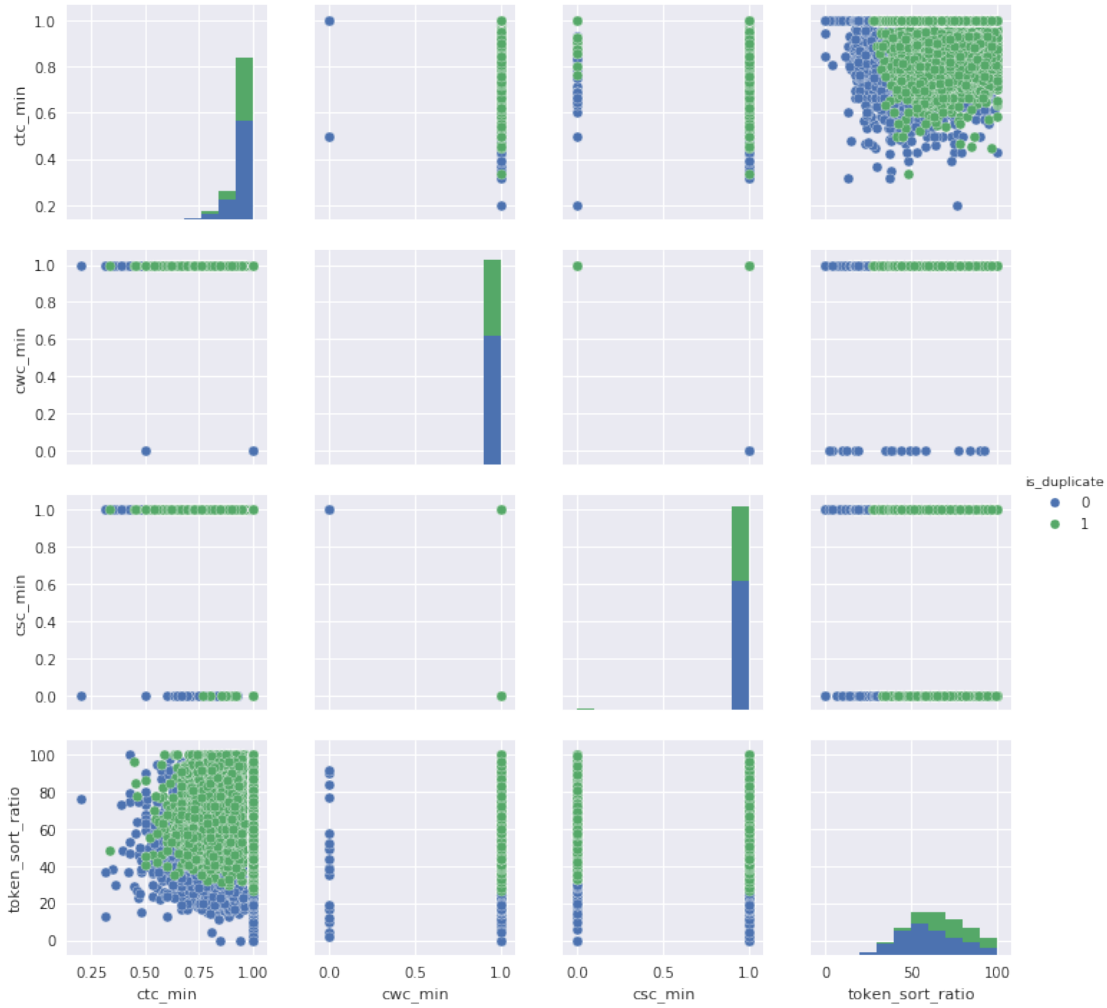

```
In [33]: full_feature_df[['ctc_min', 'cwc_min', 'csc_min', 'token_sort_ratio', 'is_duplicate']].
```

Out[33]:

	ctc_min	cwc_min	csc_min	token_sort_ratio	is_duplicate
0	0.999999	0.999998	0.999998	52	0
1	0.999999	0.999999	0.999990	72	0
2	0.916666	0.999999	0.999998	43	0
3	0.999999	0.999998	0.999998	52	0
4	0.904761	0.999999	0.999999	47	0

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

```
In [34]: sns.pairplot(full_feature_df[['ctc_min', 'cwc_min', 'csc_min', 'token_sort_ratio', 'is_
                      hue='is_duplicate',
                      vars=['ctc_min', 'cwc_min', 'csc_min', 'token_sort_ratio'])
         plt.show()
```

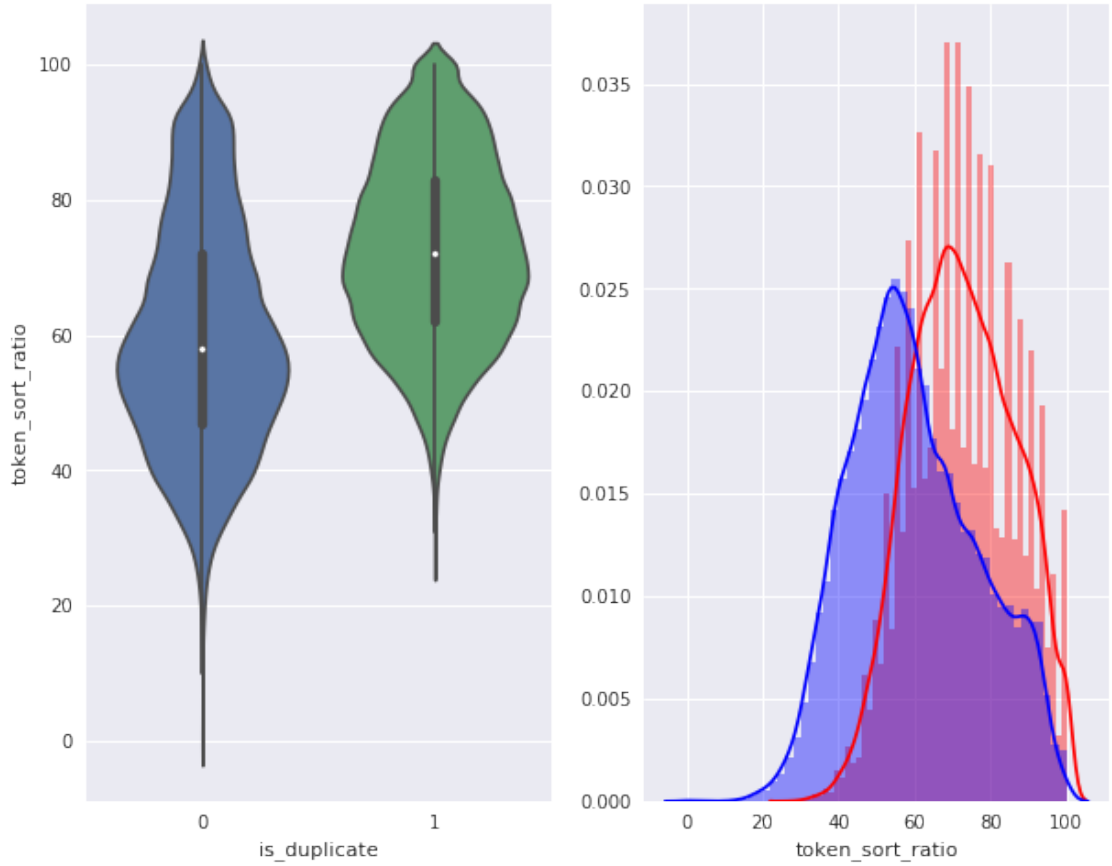


No correlation is identified for any pair of features

```
In [35]: # 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 = full_feature_df , )

         plt.subplot(1,2,2)
         sns.distplot(full_feature_df[full_feature_df['is_duplicate'] == 1]['token_sort_ratio'],
                      label='1', color='red')
         sns.distplot(full_feature_df[full_feature_df['is_duplicate'] == 0]['token_sort_ratio'],
                      label='0' , color='blue' )
         plt.show()
```

```
/home/amd_3/anaconda3/lib/python3.6/site-packages/matplotlib/axes/_axes.py:6462: UserWarning:
```

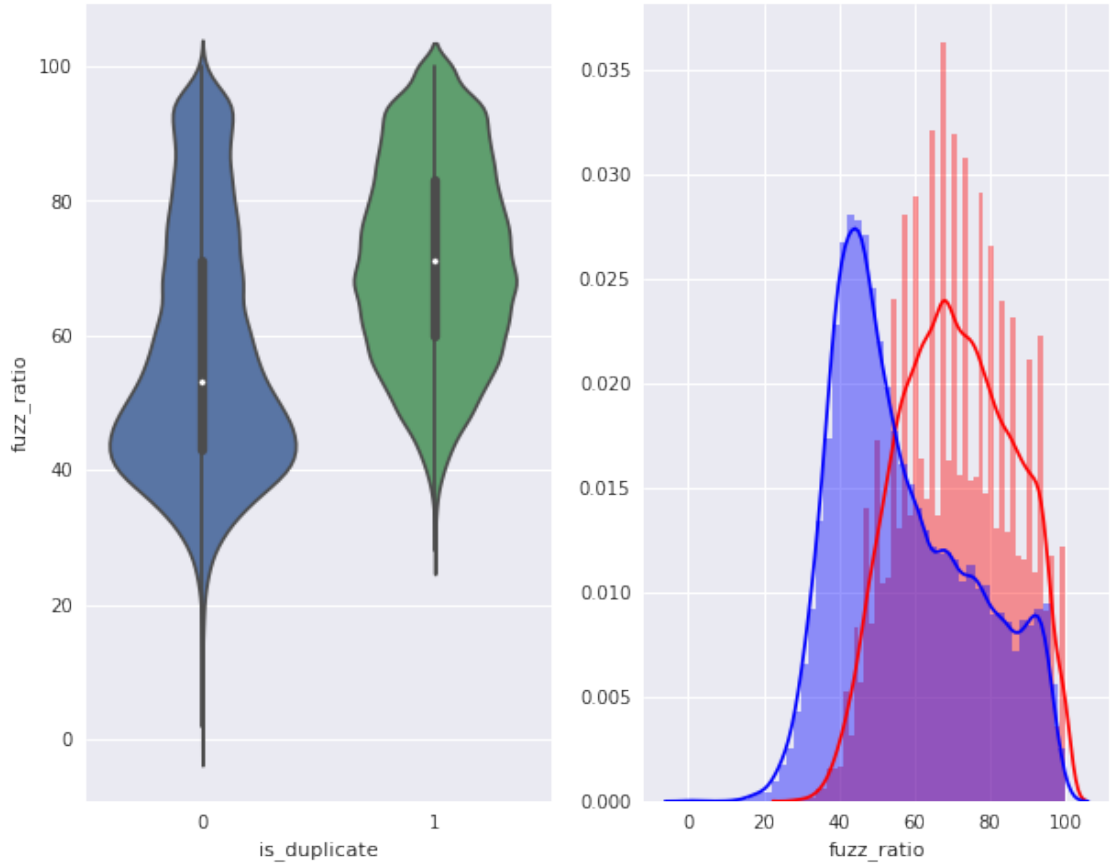
```
The 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.

/home/amd_3/anaconda3/lib/python3.6/site-packages/matplotlib/axes/_axes.py:6462: UserWarning:

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



The Q2 value of token sort ratio differs a lot between YES & NO class
The PDF plot shows a slight shift in mean towards right for the YES class

In [36]:
```
plt.figure(figsize=(10, 8))

plt.subplot(1,2,1)
sns.violinplot(x ='is_duplicate', y ='fuzz_ratio', data=full_feature_df)

plt.subplot(1,2,2)
sns.distplot(full_feature_df[full_feature_df['is_duplicate'] == 1]['fuzz_ratio'],
             label='1', color='red')
sns.distplot(full_feature_df[full_feature_df['is_duplicate'] == 0]['fuzz_ratio'],
             label='0', color='blue')
plt.show()
```

```
/home/amd_3/anaconda3/lib/python3.6/site-packages/matplotlib/axes/_axes.py:6462: UserWarning:
The 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.
/home/amd_3/anaconda3/lib/python3.6/site-packages/matplotlib/axes/_axes.py:6462: UserWarning:
The 'normed' kwarg is deprecated, and has been replaced by the 'density' kwarg.
```



The Q2 value of fuzz_ratio differs a lot between YES & NO class
The PDF plot shows a slight shift in mean towards right for the YES class
3.5.2 Visualization

```
In [37]: # Using TSNE for Dimentionality reduction for 15 Features(Generated after cleaning the
         df_sample = full_feature_df.sample(frac=1.0)

         X = MinMaxScaler().fit_transform(df_sample[['ctc_min', 'ctc_max', 'cwc_min', 'cwc_max',
                                                     'first_word_same', 'last_word_same', 'abs_t
                                                     'avg_token_length', 'token_set_ratio', 'tok
                                                     'fuzz_ratio','fuzz_partial_ratio', 'longest

         y = df_sample['is_duplicate'].values
```

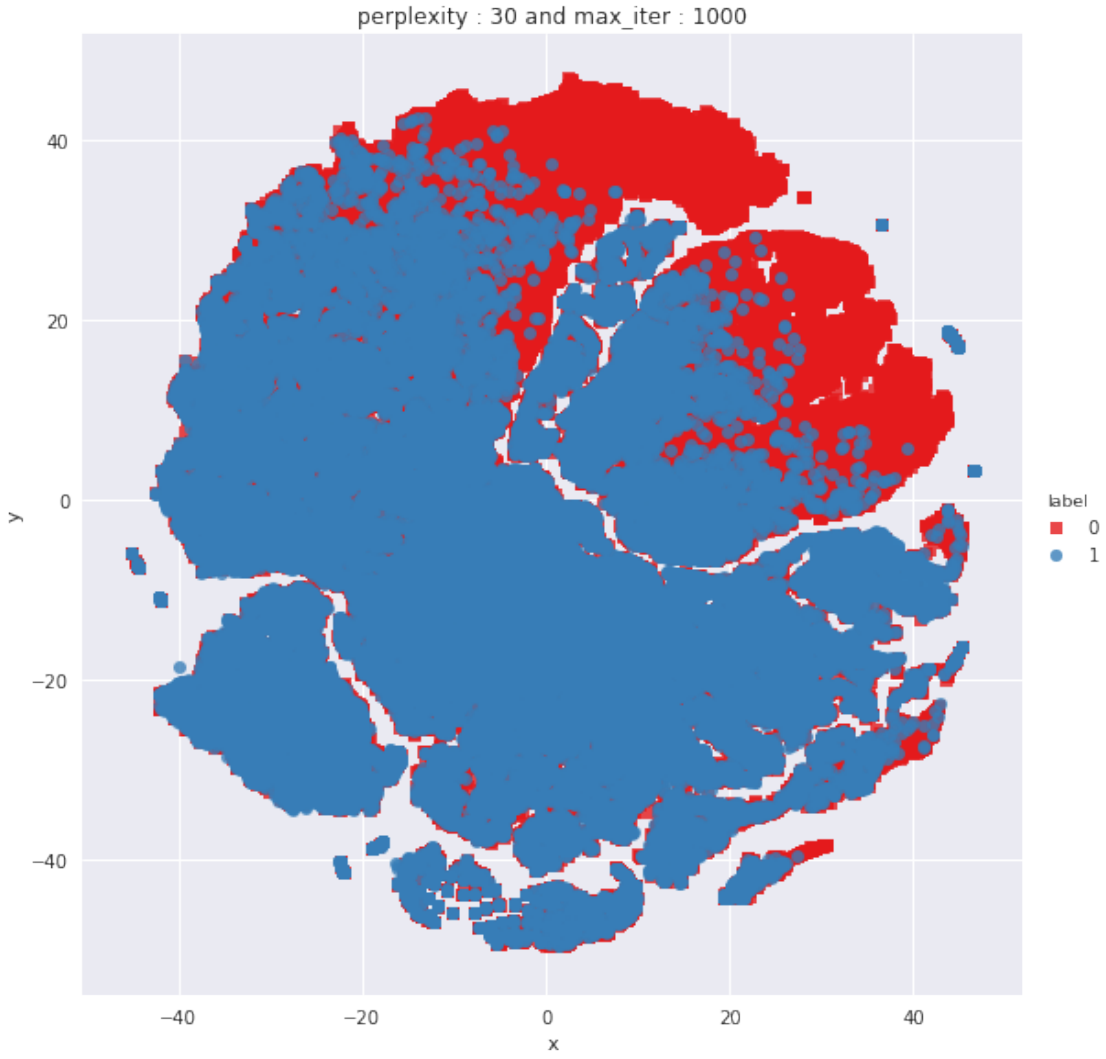
```
In [38]: tsne2d = TSNE(
             n_components=2,
             init='random', # pca
             random_state=101,
             method='barnes_hut',
             n_iter=1000,
             verbose=2,
             angle=0.5
         ).fit_transform(X)

[t-SNE] Computing 91 nearest neighbors...
[t-SNE] Indexed 120000 samples in 0.925s...
[t-SNE] Computed neighbors for 120000 samples in 85.816s...
[t-SNE] Computed conditional probabilities for sample 1000 / 120000
[t-SNE] Computed conditional probabilities for sample 2000 / 120000
[t-SNE] Computed conditional probabilities for sample 3000 / 120000
[t-SNE] Computed conditional probabilities for sample 4000 / 120000
[t-SNE] Computed conditional probabilities for sample 5000 / 120000
[t-SNE] Computed conditional probabilities for sample 6000 / 120000
[t-SNE] Computed conditional probabilities for sample 7000 / 120000
[t-SNE] Computed conditional probabilities for sample 8000 / 120000
[t-SNE] Computed conditional probabilities for sample 9000 / 120000
[t-SNE] Computed conditional probabilities for sample 10000 / 120000
[t-SNE] Computed conditional probabilities for sample 11000 / 120000
[t-SNE] Computed conditional probabilities for sample 12000 / 120000
[t-SNE] Computed conditional probabilities for sample 13000 / 120000
[t-SNE] Computed conditional probabilities for sample 14000 / 120000
[t-SNE] Computed conditional probabilities for sample 15000 / 120000
[t-SNE] Computed conditional probabilities for sample 16000 / 120000
[t-SNE] Computed conditional probabilities for sample 17000 / 120000
[t-SNE] Computed conditional probabilities for sample 18000 / 120000
[t-SNE] Computed conditional probabilities for sample 19000 / 120000
[t-SNE] Computed conditional probabilities for sample 20000 / 120000
[t-SNE] Computed conditional probabilities for sample 21000 / 120000
[t-SNE] Computed conditional probabilities for sample 22000 / 120000
[t-SNE] Computed conditional probabilities for sample 23000 / 120000
[t-SNE] Computed conditional probabilities for sample 24000 / 120000
[t-SNE] Computed conditional probabilities for sample 25000 / 120000
[t-SNE] Computed conditional probabilities for sample 26000 / 120000
[t-SNE] Computed conditional probabilities for sample 27000 / 120000
[t-SNE] Computed conditional probabilities for sample 28000 / 120000
[t-SNE] Computed conditional probabilities for sample 29000 / 120000
[t-SNE] Computed conditional probabilities for sample 30000 / 120000
[t-SNE] Computed conditional probabilities for sample 31000 / 120000
[t-SNE] Computed conditional probabilities for sample 32000 / 120000
[t-SNE] Computed conditional probabilities for sample 33000 / 120000
[t-SNE] Computed conditional probabilities for sample 34000 / 120000
[t-SNE] Computed conditional probabilities for sample 35000 / 120000
```

```
[t-SNE] Computed conditional probabilities for sample 36000 / 120000
[t-SNE] Computed conditional probabilities for sample 37000 / 120000
[t-SNE] Computed conditional probabilities for sample 38000 / 120000
[t-SNE] Computed conditional probabilities for sample 39000 / 120000
[t-SNE] Computed conditional probabilities for sample 40000 / 120000
[t-SNE] Computed conditional probabilities for sample 41000 / 120000
[t-SNE] Computed conditional probabilities for sample 42000 / 120000
[t-SNE] Computed conditional probabilities for sample 43000 / 120000
[t-SNE] Computed conditional probabilities for sample 44000 / 120000
[t-SNE] Computed conditional probabilities for sample 45000 / 120000
[t-SNE] Computed conditional probabilities for sample 46000 / 120000
[t-SNE] Computed conditional probabilities for sample 47000 / 120000
[t-SNE] Computed conditional probabilities for sample 48000 / 120000
[t-SNE] Computed conditional probabilities for sample 49000 / 120000
[t-SNE] Computed conditional probabilities for sample 50000 / 120000
[t-SNE] Computed conditional probabilities for sample 51000 / 120000
[t-SNE] Computed conditional probabilities for sample 52000 / 120000
[t-SNE] Computed conditional probabilities for sample 53000 / 120000
[t-SNE] Computed conditional probabilities for sample 54000 / 120000
[t-SNE] Computed conditional probabilities for sample 55000 / 120000
[t-SNE] Computed conditional probabilities for sample 56000 / 120000
[t-SNE] Computed conditional probabilities for sample 57000 / 120000
[t-SNE] Computed conditional probabilities for sample 58000 / 120000
[t-SNE] Computed conditional probabilities for sample 59000 / 120000
[t-SNE] Computed conditional probabilities for sample 60000 / 120000
[t-SNE] Computed conditional probabilities for sample 61000 / 120000
[t-SNE] Computed conditional probabilities for sample 62000 / 120000
[t-SNE] Computed conditional probabilities for sample 63000 / 120000
[t-SNE] Computed conditional probabilities for sample 64000 / 120000
[t-SNE] Computed conditional probabilities for sample 65000 / 120000
[t-SNE] Computed conditional probabilities for sample 66000 / 120000
[t-SNE] Computed conditional probabilities for sample 67000 / 120000
[t-SNE] Computed conditional probabilities for sample 68000 / 120000
[t-SNE] Computed conditional probabilities for sample 69000 / 120000
[t-SNE] Computed conditional probabilities for sample 70000 / 120000
[t-SNE] Computed conditional probabilities for sample 71000 / 120000
[t-SNE] Computed conditional probabilities for sample 72000 / 120000
[t-SNE] Computed conditional probabilities for sample 73000 / 120000
[t-SNE] Computed conditional probabilities for sample 74000 / 120000
[t-SNE] Computed conditional probabilities for sample 75000 / 120000
[t-SNE] Computed conditional probabilities for sample 76000 / 120000
[t-SNE] Computed conditional probabilities for sample 77000 / 120000
[t-SNE] Computed conditional probabilities for sample 78000 / 120000
[t-SNE] Computed conditional probabilities for sample 79000 / 120000
[t-SNE] Computed conditional probabilities for sample 80000 / 120000
[t-SNE] Computed conditional probabilities for sample 81000 / 120000
[t-SNE] Computed conditional probabilities for sample 82000 / 120000
[t-SNE] Computed conditional probabilities for sample 83000 / 120000
```

```
[t-SNE] Computed conditional probabilities for sample 84000 / 120000
[t-SNE] Computed conditional probabilities for sample 85000 / 120000
[t-SNE] Computed conditional probabilities for sample 86000 / 120000
[t-SNE] Computed conditional probabilities for sample 87000 / 120000
[t-SNE] Computed conditional probabilities for sample 88000 / 120000
[t-SNE] Computed conditional probabilities for sample 89000 / 120000
[t-SNE] Computed conditional probabilities for sample 90000 / 120000
[t-SNE] Computed conditional probabilities for sample 91000 / 120000
[t-SNE] Computed conditional probabilities for sample 92000 / 120000
[t-SNE] Computed conditional probabilities for sample 93000 / 120000
[t-SNE] Computed conditional probabilities for sample 94000 / 120000
[t-SNE] Computed conditional probabilities for sample 95000 / 120000
[t-SNE] Computed conditional probabilities for sample 96000 / 120000
[t-SNE] Computed conditional probabilities for sample 97000 / 120000
[t-SNE] Computed conditional probabilities for sample 98000 / 120000
[t-SNE] Computed conditional probabilities for sample 99000 / 120000
[t-SNE] Computed conditional probabilities for sample 100000 / 120000
[t-SNE] Computed conditional probabilities for sample 101000 / 120000
[t-SNE] Computed conditional probabilities for sample 102000 / 120000
[t-SNE] Computed conditional probabilities for sample 103000 / 120000
[t-SNE] Computed conditional probabilities for sample 104000 / 120000
[t-SNE] Computed conditional probabilities for sample 105000 / 120000
[t-SNE] Computed conditional probabilities for sample 106000 / 120000
[t-SNE] Computed conditional probabilities for sample 107000 / 120000
[t-SNE] Computed conditional probabilities for sample 108000 / 120000
[t-SNE] Computed conditional probabilities for sample 109000 / 120000
[t-SNE] Computed conditional probabilities for sample 110000 / 120000
[t-SNE] Computed conditional probabilities for sample 111000 / 120000
[t-SNE] Computed conditional probabilities for sample 112000 / 120000
[t-SNE] Computed conditional probabilities for sample 113000 / 120000
[t-SNE] Computed conditional probabilities for sample 114000 / 120000
[t-SNE] Computed conditional probabilities for sample 115000 / 120000
[t-SNE] Computed conditional probabilities for sample 116000 / 120000
[t-SNE] Computed conditional probabilities for sample 117000 / 120000
[t-SNE] Computed conditional probabilities for sample 118000 / 120000
[t-SNE] Computed conditional probabilities for sample 119000 / 120000
[t-SNE] Computed conditional probabilities for sample 120000 / 120000
[t-SNE] Mean sigma: 0.016209
[t-SNE] Computed conditional probabilities in 9.027s
[t-SNE] Iteration 50: error = 123.0098953, gradient norm = 0.0000002 (50 iterations in 167.277s)
[t-SNE] Iteration 100: error = 123.0021591, gradient norm = 0.0001848 (50 iterations in 202.601s
[t-SNE] Iteration 150: error = 108.5665817, gradient norm = 0.0011150 (50 iterations in 177.247s
[t-SNE] Iteration 200: error = 102.5423660, gradient norm = 0.0005122 (50 iterations in 158.595s
[t-SNE] Iteration 250: error = 100.6027222, gradient norm = 0.0003555 (50 iterations in 157.019s
[t-SNE] KL divergence after 250 iterations with early exaggeration: 100.602722
[t-SNE] Iteration 300: error = 5.7090769, gradient norm = 0.0009787 (50 iterations in 153.991s)
[t-SNE] Iteration 350: error = 5.2666669, gradient norm = 0.0006443 (50 iterations in 154.999s)
[t-SNE] Iteration 400: error = 4.9130254, gradient norm = 0.0004633 (50 iterations in 154.015s)
```

```
[t-SNE] Iteration 450: error = 4.6411591, gradient norm = 0.0003535 (50 iterations in 157.636s)
[t-SNE] Iteration 500: error = 4.4294548, gradient norm = 0.0002829 (50 iterations in 152.787s)
[t-SNE] Iteration 550: error = 4.2586803, gradient norm = 0.0002355 (50 iterations in 153.312s)
[t-SNE] Iteration 600: error = 4.1159015, gradient norm = 0.0002051 (50 iterations in 153.218s)
[t-SNE] Iteration 650: error = 3.9929361, gradient norm = 0.0001769 (50 iterations in 152.929s)
[t-SNE] Iteration 700: error = 3.8833425, gradient norm = 0.0001574 (50 iterations in 152.409s)
[t-SNE] Iteration 750: error = 3.7877367, gradient norm = 0.0001414 (50 iterations in 152.502s)
[t-SNE] Iteration 800: error = 3.7032161, gradient norm = 0.0001277 (50 iterations in 154.143s)
[t-SNE] Iteration 850: error = 3.6276779, gradient norm = 0.0001158 (50 iterations in 155.201s)
[t-SNE] Iteration 900: error = 3.5597112, gradient norm = 0.0001053 (50 iterations in 152.350s)
[t-SNE] Iteration 950: error = 3.4978771, gradient norm = 0.0000960 (50 iterations in 152.088s)
[t-SNE] Iteration 1000: error = 3.4415278, gradient norm = 0.0000883 (50 iterations in 151.958s)
[t-SNE] Error after 1000 iterations: 3.441528
```

In [39]:
```
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()
```



From the above t-SNE plot many +ve , -ve datapoints are highly overlapping
There moderately large red points which can be separated well from the rest of the points
Need to try complicated models to separate out the points

3 Vectorizer

```
In [42]: def get_vectorized_data(df):

             df_train, df_test = train_test_split(df, stratify=df['is_duplicate'],
                                                  test_size=0.30, shuffle=True)
             df_train = df_train.reset_index(drop=True)
             df_test = df_test.reset_index(drop=True)

             # merge texts
             questions = list(df_train['question1']) + list(df_train['question2'])
```

```
# Declare a text vectorizer
tfidf_q1 = TfidfVectorizer(lowercase=False, min_df=0.01, max_df=0.95,
                           max_features=4000, stop_words=set(STOP_WORDS))
tfidf_q2 = TfidfVectorizer(lowercase=False, min_df=0.01, max_df=0.95,
                           max_features=4000, stop_words=set(STOP_WORDS))

# fit to questions 1, 2 separately
tfidf_q1.fit(df_train['question1'])
tfidf_q2.fit(df_train['question2'])

# get the feature names as a list
q1_feature_columns = ['q1_' + item for item in list(tfidf_q1.get_feature_names())]
q2_feature_columns = ['q2_' + item for item in list(tfidf_q2.get_feature_names())]


# vectorize the train data
train_ques1_feature = tfidf_q1.transform(df_train['question1'])
train_ques2_feature = tfidf_q2.transform(df_train['question2'])

test_ques1_feature = tfidf_q1.transform(df_test['question1'])
test_ques2_feature = tfidf_q2.transform(df_test['question2'])

# get the vectorized outputs
train_ques1_feature_df = pd.DataFrame(train_ques1_feature.toarray(),
                                      columns=q1_feature_columns)
train_ques2_feature_df = pd.DataFrame(train_ques2_feature.toarray(),
                                      columns=q2_feature_columns)
test_ques1_feature_df = pd.DataFrame(test_ques1_feature.toarray(),
                                      columns=q1_feature_columns)
test_ques2_feature_df = pd.DataFrame(test_ques2_feature.toarray(),
                                      columns=q2_feature_columns)


# get the other features
df_train = df_train.drop(['question1', 'question2'], axis=1)
df_test = df_test.drop(['question1', 'question2'], axis=1)

# concate the data frames
df_train = pd.concat([df_train, train_ques1_feature_df, train_ques2_feature_df],
                     axis=1)
df_test = pd.concat([df_test, test_ques1_feature_df, test_ques2_feature_df],
                    axis=1)

# save files to disk
df_train.to_csv('./data/Final_train_df.csv', index=False)
df_test.to_csv('./data/Final_test_df.csv', index=False)
```

```
In [43]: get_vectorized_data(full_feature_df)

In [44]: df_train = pd.read_csv('./data/Final_train_df.csv', index_col=False)
         df_train.head()
```

Out[44]:

	id	is_duplicate	q1len	q2len	q1_n_words	q2_n_words	word_Common	\
0	223477	0	73	61	12	13	2	
1	111372	0	32	40	6	6	3	
2	291123	0	67	46	13	10	2	
3	317134	1	33	37	7	6	4	
4	246990	0	94	58	16	10	1	

	word_Total	word_share	ctc_min	...	q2_start	q2_think	q2_time	\
0	23	0.086957	0.999999	...	0.0	0.0	0.0	
1	12	0.250000	0.999998	...	0.0	0.0	0.0	
2	22	0.090909	0.923076	...	0.0	0.0	0.0	
3	13	0.307692	0.999999	...	0.0	0.0	0.0	
4	25	0.040000	0.937499	...	0.0	0.0	0.0	

	q2_use	q2_want	q2_way	q2_without	q2_work	q2_would	q2_year
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[5 rows x 123 columns]

```
In [45]: df_train.shape

Out[45]: (84000, 123)

In [46]: print(datetime.now() ,' Completed DF Geneartion')

2019-06-22 08:51:22.041387  Completed DF Geneartion
```

4 Procedure Summary

Deduping of the dataset is done
- Basic EDA such as count, distribution of clasess on the dataset is done
- NLP preprocessing is done on text data
- Fuzzy-Wuzzy features , Token set featues are genered for every data point.
- Most frequently occuring words for each class is identified and shown in word cloud
- TF-IDF vectorizer is used to vectorize the text
- Train, Test data set is prepared for the models

5 Conclusion

Basic EDA is done on the dataset
Vectorization of text data is done
Train, test dataset is prepared