Introduction

The Quora Question Pairs dataset, featured in a Kaggle competition, comprises question pairs labeled as duplicates (1) or non-duplicates (0). Released by Quora, this large dataset challenges machine learning models to accurately discern duplicate questions. With tens of thousands of question pairs in the training set, the competition aimed to minimize log loss. The dataset's practical application lies in enhancing user experience by automating the identification of duplicate questions, streamlining information retrieval on the Quora platform. This dataset has spurred advancements in natural language processing and machine learning, attracting global participation and fostering innovation in duplicate question detection.

1 import Necessary Library

In [140…

```
import numpy as np
import pandas as pd
import os
```

In [141…

```
import matplotlib.pyplot as plt
import seaborn as sns
```

2 import Dataset

In [142…

```
df=pd.read_csv('/kaggle/input/question-pairs-dataset/questions.csv')
```

3 Data Analysis

In [143…

```
df.head()
```

Out[143…

	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)	What would happen if the Indian government sto	0

				Dia...	Indian government sto...	
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 [144…
```
df.tail()
```

Out[144…

	id	qid1	qid2	question1	question2	is_duplicate
404346	404346	789792	789793	How many keywords are there in the Racket prog...	How many keywords are there in PERL Programmin...	0
404347	404347	789794	789795	Do you believe there is life after death?	Is it true that there is life after death?	1
404348	404348	789796	789797	What is one coin?	What's this coin?	0
404349	404349	789798	789799	What is the approx annual cost of living while...	I am having little hairfall problem but I want...	0
404350	404350	789800	789801	What is like to have sex with cousin?	What is it like to have sex with your cousin?	0

In [145…
```
df['is_duplicate'].value_counts()
```

Out[145…
```
is_duplicate
0    255045
1    149306
Name: count, dtype: int64
```

In [146…
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 404351 entries, 0 to 404350
Data columns (total 6 columns):
 #   Column        Non-Null Count   Dtype 
---  ------        --------------   ----- 
 0   id            404351 non-null  int64 
 1   qid1          404351 non-null  int64 
 2   qid2          404351 non-null  int64 
 3   question1     404350 non-null  object
 4   question2     404349 non-null  object
 5   is_duplicate  404351 non-null  int64 
dtypes: int64(4), object(2)
memory usage: 18.5+ MB
```

In [147…
```
df.describe
```

Out[147…
```
<bound method NDFrame.describe of            id    qid1    qid2  \
0            0       1       2
1            1       3       4
2            2       5       6
3            3       7       8
4            4       9      10
...        ...     ...     ...
404346  404346  789792  789793
404347  404347  789794  789795
404348  404348  789796  789797
404349  404349  789798  789799
404350  404350  789800  789801

                                                question1  \
0       What is the step by step guide to invest in sh...
1       What is the story of Kohinoor (Koh-i-Noor) Dia...
2       How can I increase the speed of my internet co...
3       Why am I mentally very lonely? How can I solve...
4       Which one dissolve in water quikly sugar, salt...
...                                                   ...
404346  How many keywords are there in the Racket prog...
404347         Do you believe there is life after death?
404348                                  What is one coin?
404349  What is the approx annual cost of living while...
404350              What is like to have sex with cousin?

                                                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
...                                                   ...           ...
404346  How many keywords are there in PERL Programmin...             0
404347        Is it true that there is life after death?             1
404348                                  What's this coin?             0
404349  I am having little hairfall problem but I want...             0
404350     What is it like to have sex with your cousin?             0

[404351 rows x 6 columns]>
```

In [148…
```
df.shape
```

Out[148…
```
(404351, 6)
```

4 Data cleaning and Preprocessing:

In [149…
```
new_df=df.sample(3000,random_state=2)
```

In [150…
```
new_df.head()
```

Out[150…

	id	qid1	qid2	question1	question2	is_duplicate
339499	339499	665522	665523	Why was Cyrus Mistry removed as the Chairman o...	Why did the Tata Sons sacked Cyrus Mistry?	1
289521	289521	568878	568879	By what age would you think a man should be	When my wrist is extended I feel a	0

				ma...	shock and b...	
4665	4665	9325	9326	How would an arbitrageur seek to capitalize gi...	How would an arbitrageur seek to capitalize gi...	0
54203	54203	107861	107862	Why did Quora mark my question as incomplete?	Why does Quora detect my question as an incomp...	1
132566	132566	262554	91499	What is it like working with Pivotal Labs as a...	What's it like to work at Pivotal Labs?	0

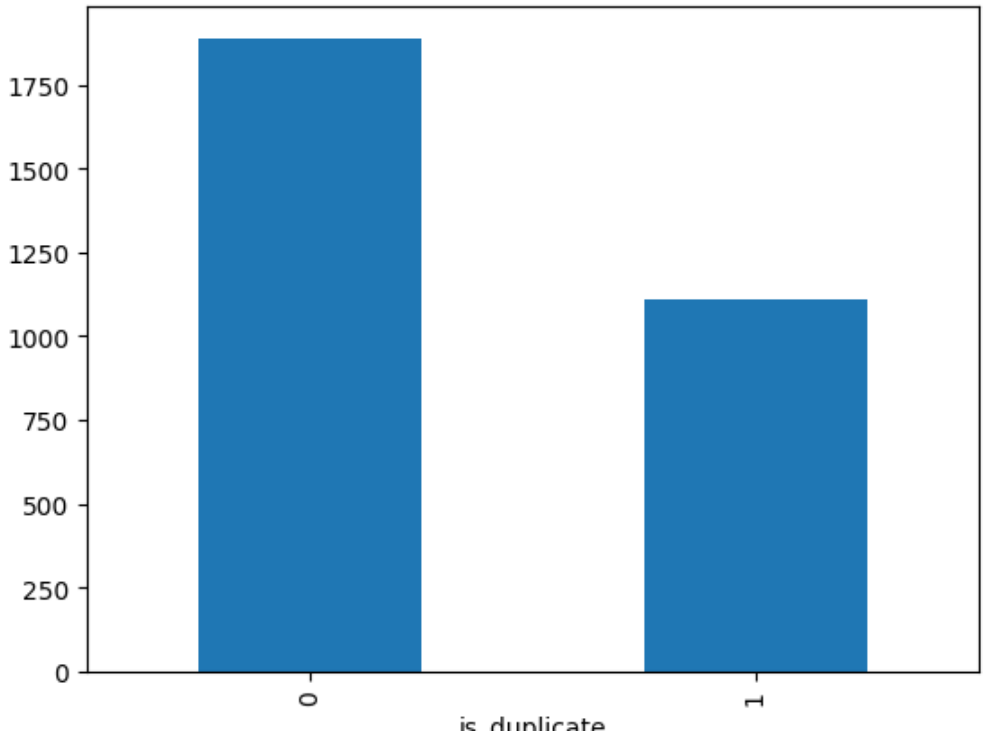
In [151…
```
new_df.isnull().sum()
```

Out[151…
```
id              0
qid1            0
qid2            0
question1       0
question2       0
is_duplicate    0
dtype: int64
```

In [152…
```
print(new_df['is_duplicate'].value_counts())
print((new_df['is_duplicate'].value_counts()/new_df['is_duplicate'].count())*
new_df['is_duplicate'].value_counts().plot(kind='bar')
```

```
is_duplicate
0    1889
1    1111
Name: count, dtype: int64
is_duplicate
0    62.966667
1    37.033333
Name: count, dtype: float64
```

Out[152… <Axes: xlabel='is_duplicate'>



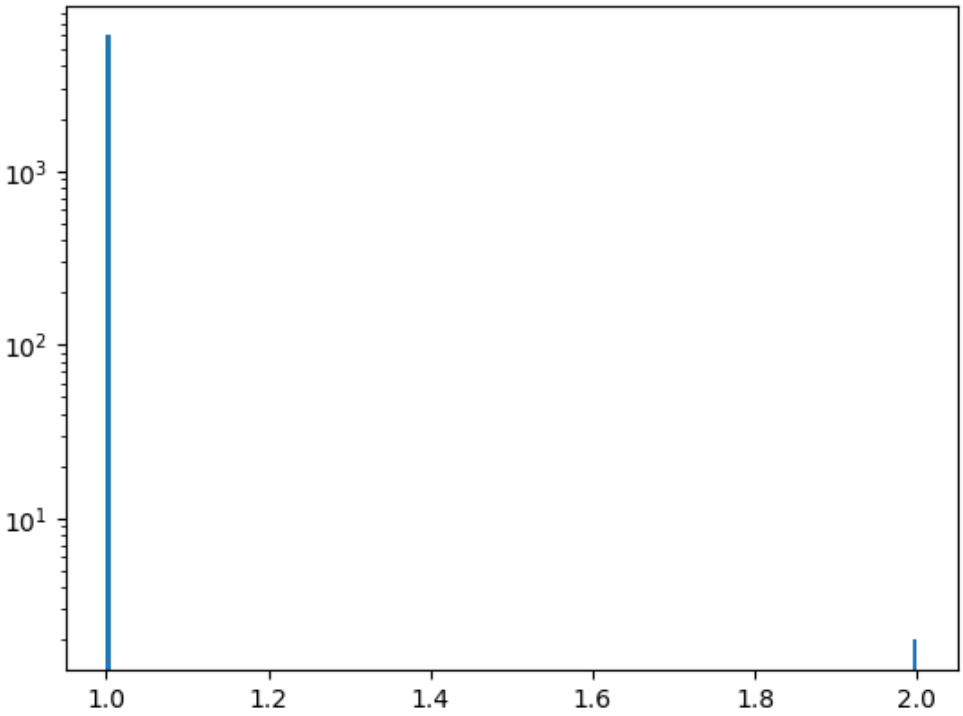
In [153…

```
qid = pd.Series(new_df['qid1'].tolist() + new_df['qid2'].tolist())
print('Number of unique questions',np.unique(qid).shape[0])
x = qid.value_counts()>1
print('Number of questions getting repeated',x[x].shape[0])
```

```
Number of unique questions 5998
Number of questions getting repeated 2
```

In [154…

```
plt.hist(qid.value_counts().values,bins=160)
plt.yscale('log')
plt.show()
```



5 Feature Extraction

In [155…

```
new_df['q1_len']=new_df['question1'].str.len()
new_df['q2_len']=new_df['question2'].str.len()

new_df.head()
```

Out[155…

	id	qid1	qid2	question1	question2	is_duplicate	q1_len	q2_le
339499	339499	665522	665523	Why was Cyrus Mistry removed as the Chairman o...	Why did the Tata Sons sacked Cyrus Mistry?	1	58	4
289521	289521	568878	568879	By what age would you think a man should be	When my wrist is extended I feel a shock and	0	52	10

				ma...	shock and b...			
4665	4665	9325	9326	How would an arbitrageur seek to capitalize gi...	How would an arbitrageur seek to capitalize gi...	0	125	12
54203	54203	107861	107862	Why did Quora mark my question as incomplete?	Why does Quora detect my question as an incomp...	1	45	6
132566	132566	262554	91499	What is it like working with Pivotal Labs as a...	What's it like to work at Pivotal Labs?	0	54	3

In [156...

```
new_df['q1_num_words']=new_df['question1'].apply(lambda row: len(row.split("
new_df['q2_num_words']=new_df['question2'].apply(lambda row: len(row.split("

new_df.head()
```

Out[156...

	id	qid1	qid2	question1	question2	is_duplicate	q1_len	q2_le
339499	339499	665522	665523	Why was Cyrus Mistry removed as the Chairman o...	Why did the Tata Sons sacked Cyrus Mistry?	1	58	4
289521	289521	568878	568879	By what age would you think a man should be ma...	When my wrist is extended I feel a shock and b...	0	52	10
4665	4665	9325	9326	How would an arbitrageur seek to capitalize gi...	How would an arbitrageur seek to capitalize gi...	0	125	12
54203	54203	107861	107862	Why did Quora mark my question as incomplete?	Why does Quora detect my question as an incomp...	1	45	6
132566	132566	262554	91499	What is it like working with Pivotal Labs as a...	What's it like to work at Pivotal Labs?	0	54	3

In [157…

```
def common_words(row):
    q1=set(map(lambda word: word.lower().strip(),row['question1'].split(" ")))
    q2=set(map(lambda word: word.lower().strip(),row['question2'].split(" ")))
    return len(q1 & q2)
```

In [158…

```
new_df['common_words']=new_df.apply(common_words,axis=1)

new_df.head()
```

Out[158…

	id	qid1	qid2	question1	question2	is_duplicate	q1_len	q2_le
339499	339499	665522	665523	Why was Cyrus Mistry removed as the Chairman o...	Why did the Tata Sons sacked Cyrus Mistry?	1	58	4
289521	289521	568878	568879	By what age would you think a man should be ma...	When my wrist is extended I feel a shock and b...	0	52	10
4665	4665	9325	9326	How would an arbitrageur seek to capitalize gi...	How would an arbitrageur seek to capitalize gi...	0	125	12
54203	54203	107861	107862	Why did Quora mark my question as incomplete?	Why does Quora detect my question as an incomp...	1	45	6
132566	132566	262554	91499	What is it like working with Pivotal Labs as a...	What's it like to work at Pivotal Labs?	0	54	3

In [159…

```
def total_words(row):
    w1 = set(map(lambda word: word.lower().strip(), row['question1'].split("
    w2 = set(map(lambda word: word.lower().strip(), row['question2'].split("
    return (len(w1) + len(w2))
```

In [160…

```
new_df['word_total'] = new_df.apply(total_words, axis=1)
new_df.head()
```

Out[160…

	id	qid1	qid2	question1	question2	is_duplicate	q1_len	q2_le

339499	339499	665522	665523	Why was Cyrus Mistry removed as the Chairman o...	Why did the Tata Sons sacked Cyrus Mistry?	1	58	4
289521	289521	568878	568879	By what age would you think a man should be ma...	When my wrist is extended I feel a shock and b...	0	52	10
4665	4665	9325	9326	How would an arbitrageur seek to capitalize gi...	How would an arbitrageur seek to capitalize gi...	0	125	12
54203	54203	107861	107862	Why did Quora mark my question as incomplete?	Why does Quora detect my question as an incomp...	1	45	6
132566	132566	262554	91499	What is it like working with Pivotal Labs as a...	What's it like to work at Pivotal Labs?	0	54	3

In [161…

```
new_df['word_share']=round(new_df['common_words']/new_df['word_total'],2)
new_df.head()
```

Out[161…

	id	qid1	qid2	question1	question2	is_duplicate	q1_len	q2_le
339499	339499	665522	665523	Why was Cyrus Mistry removed as the Chairman o...	Why did the Tata Sons sacked Cyrus Mistry?	1	58	4
289521	289521	568878	568879	By what age would you think a man should be ma...	When my wrist is extended I feel a shock and b...	0	52	10
4665	4665	9325	9326	How would an arbitrageur seek to capitalize gi...	How would an arbitrageur seek to capitalize gi...	0	125	12
				Why did	Why does			

54203	54203	107861	107862	Quora mark my question as incomplete?	Quora detect my question as an incomp...	1	45	6
132566	132566	262554	91499	What is it like working with Pivotal Labs as a...	What's it like to work at Pivotal Labs?	0	54	3

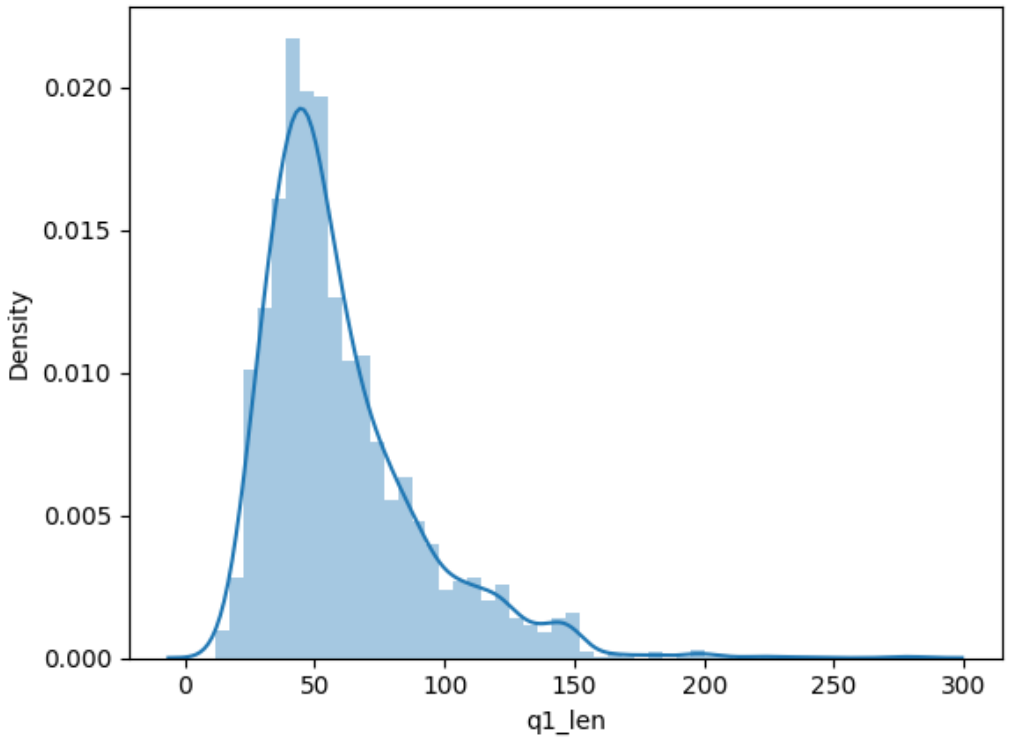
5| Data visualisation

EDA (Exploratory Data Analysis)

In [162…

```
sns.distplot(new_df['q1_len'])
print('minimum characters',new_df['q1_len'].min())
print('maximum characters',new_df['q1_len'].max())
print('average num of characters',int(new_df['q1_len'].mean()))
```

```
minimum characters 12
maximum characters 281
average num of characters 60
```



In [163…

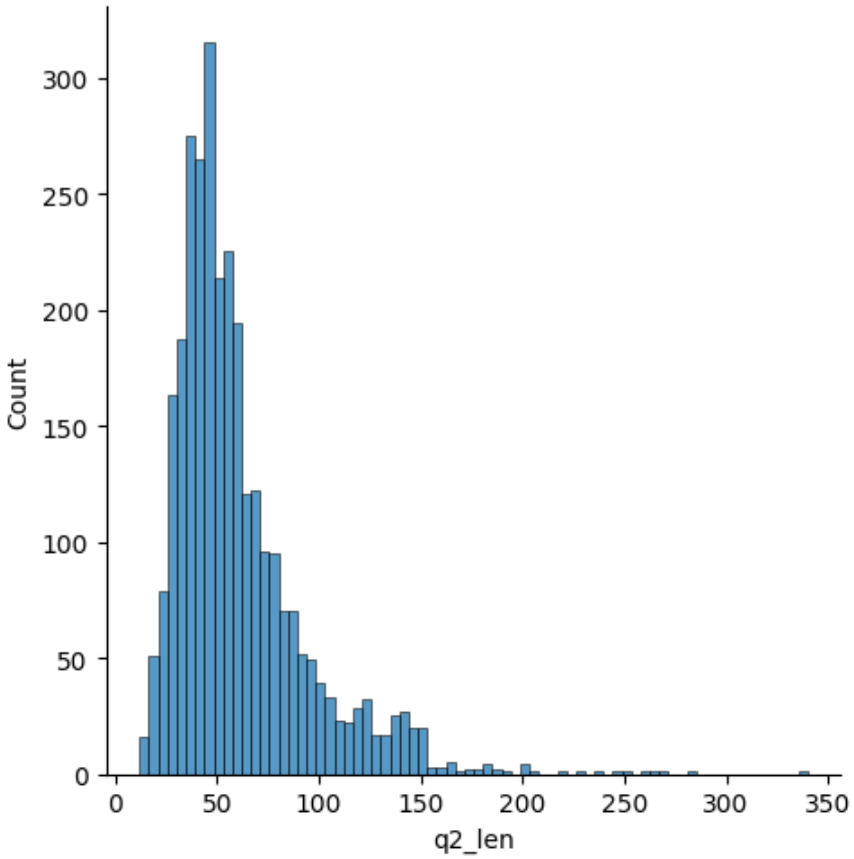
```
import warnings
warnings.filterwarnings('ignore')
```

In [164…

```
sns.displot(new_df['q2_len'])
print('minimum characters',new_df['q2_len'].min())
```

```
print('maximum characters',new_df['q2_len'].max())
print('average num of characters',int(new_df['q2_len'].mean()))
```

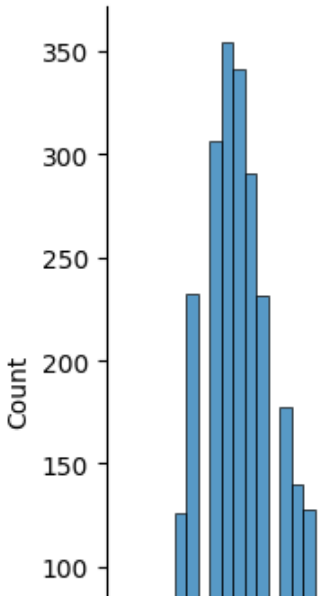
```
minimum characters 12
maximum characters 340
average num of characters 60
```

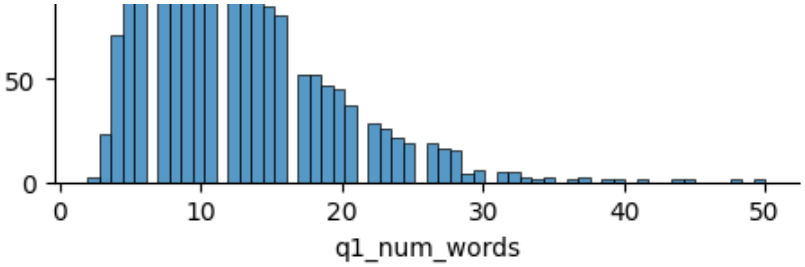


In [165…

```
sns.displot(new_df['q1_num_words'])
print('minimum words',new_df['q1_num_words'].min())
print('maximum words',new_df['q1_num_words'].max())
print('average num of words',int(new_df['q1_num_words'].mean()))
```

```
minimum words 2
maximum words 50
average num of words 11
```

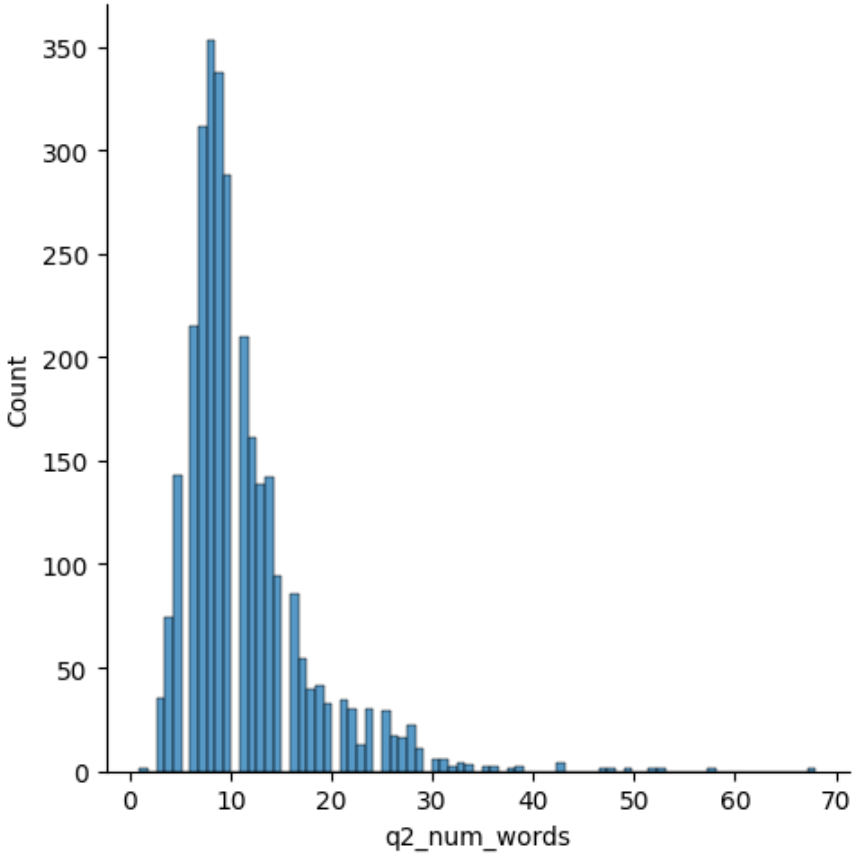




In [166…

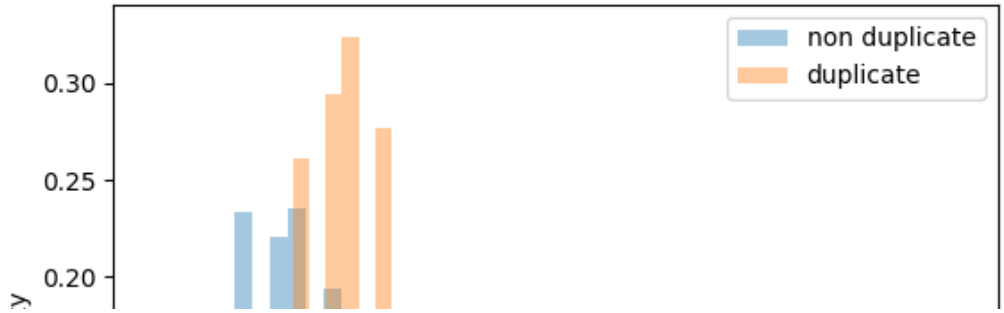
```
sns.displot(new_df['q2_num_words'])
print('minimum words',new_df['q2_num_words'].min())
print('maximum words',new_df['q2_num_words'].max())
print('average num of words',int(new_df['q2_num_words'].mean()))
```

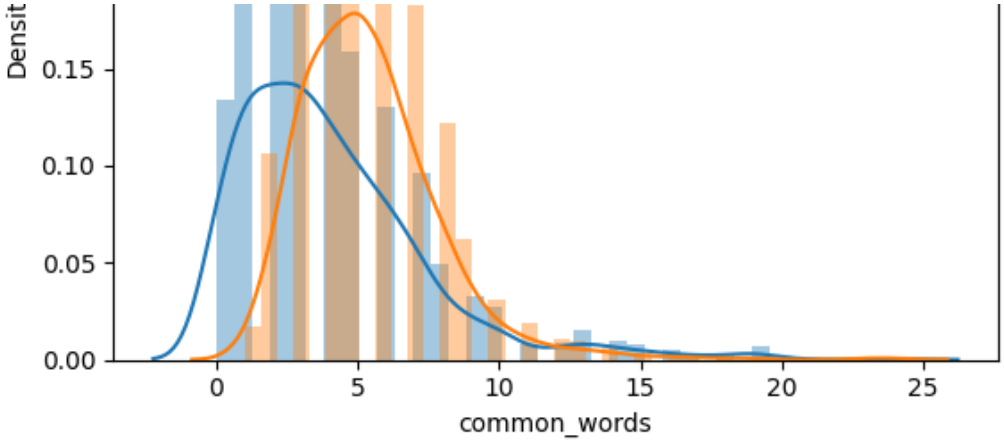
```
minimum words 1
maximum words 68
average num of words 11
```



In [167…

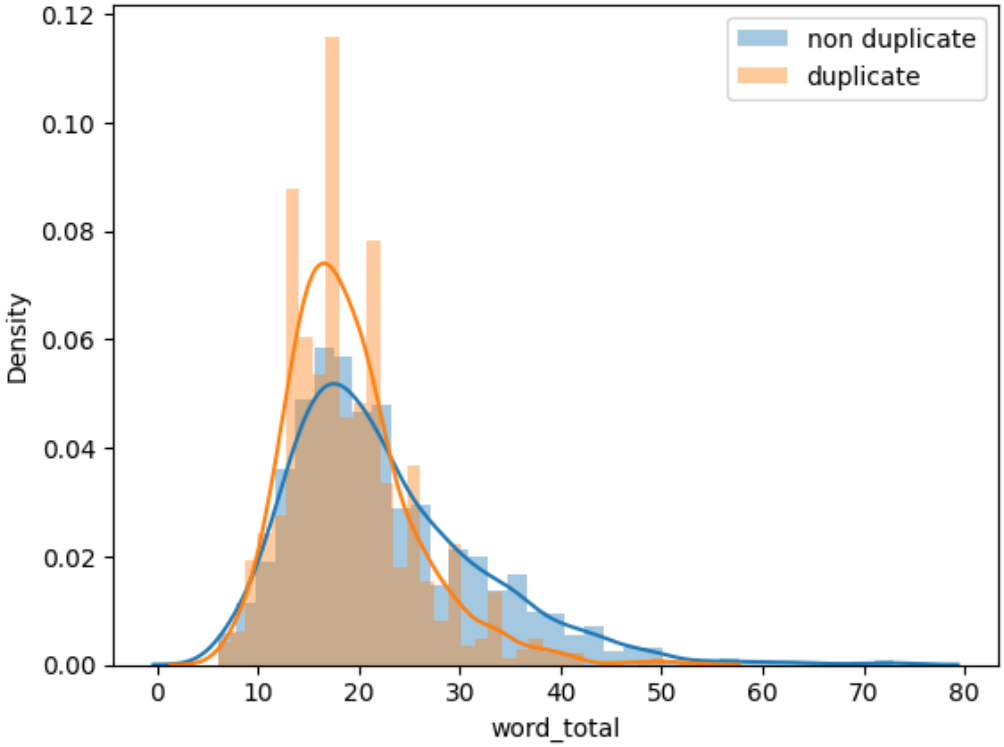
```
sns.distplot(new_df[new_df['is_duplicate'] == 0]['common_words'],label='non d
sns.distplot(new_df[new_df['is_duplicate'] == 1]['common_words'],label='dupli
plt.legend()
plt.show()
```





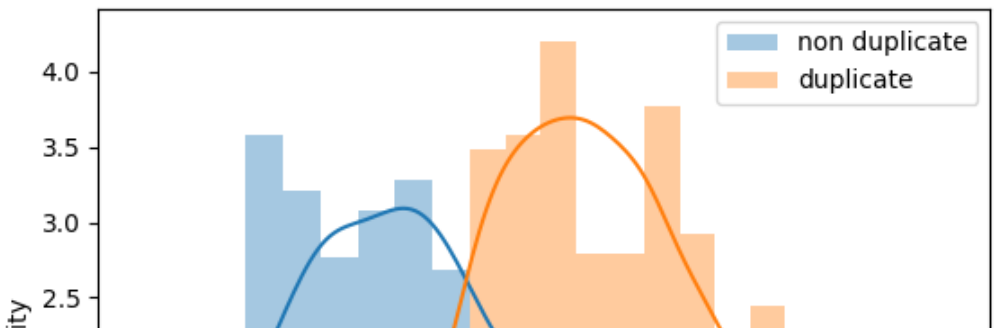
In [168…

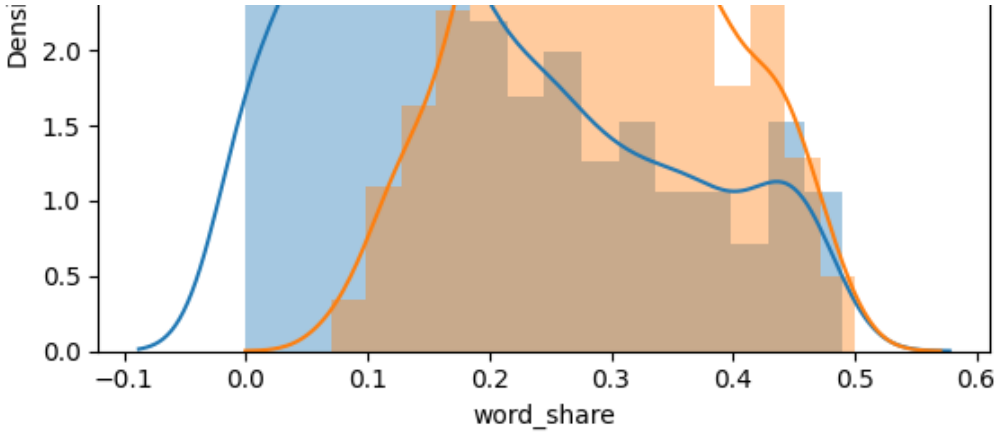
```
sns.distplot(new_df[new_df['is_duplicate'] == 0]['word_total'],label='non dup
sns.distplot(new_df[new_df['is_duplicate'] == 1]['word_total'],label='duplica
plt.legend()
plt.show()
```



In [169…

```
sns.distplot(new_df[new_df['is_duplicate'] == 0]['word_share'],label='non dup
sns.distplot(new_df[new_df['is_duplicate'] == 1]['word_share'],label='duplica
plt.legend()
plt.show()
```





In [170…

```
Que_df=new_df[['question1','question2']]
Que_df.head()
```

Out[170…

	question1	question2
339499	Why was Cyrus Mistry removed as the Chairman o...	Why did the Tata Sons sacked Cyrus Mistry?
289521	By what age would you think a man should be ma...	When my wrist is extended I feel a shock and b...
4665	How would an arbitrageur seek to capitalize gi...	How would an arbitrageur seek to capitalize gi...
54203	Why did Quora mark my question as incomplete?	Why does Quora detect my question as an incomp...
132566	What is it like working with Pivotal Labs as a...	What's it like to work at Pivotal Labs?

In [171…

```
final_df=new_df.drop(columns=['id','qid1','qid2','question1','question2'])
print(final_df.shape)
final_df.head()
```

```
(3000, 8)
```

Out[171…

	is_duplicate	q1_len	q2_len	q1_num_words	q2_num_words	common_words
339499	1	58	42	11	8	4
289521	0	52	105	11	22	2
4665	0	125	124	24	24	20
54203	1	45	60	8	10	5
132566	0	54	39	11	8	3

In [172…

```
from sklearn.feature_extraction.text import CountVectorizer

Questions = list(Que_df['question1']) + list(Que_df['question2'])

cv = CountVectorizer(max_features=3000)
q1_arr, q2_arr = np.vsplit(cv.fit_transform(Questions).toarray(),2)
```

In [173…

```
temp1=pd.DataFrame(q1_arr,index=Que_df.index)
```

```
temp2=pd.DataFrame(q2_arr,index=Que_df.index)

temp=pd.concat([temp1,temp2],axis=1)

temp.head()
```

Out[173…

	0	1	2	3	4	5	6	7	8	9	…	2990	2991	2992	2993	2994	2995	2
339499	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	
289521	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	
4665	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	
54203	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	
132566	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	

5 rows × 6000 columns

In [174…

```
final_df=pd.concat([final_df,temp],axis=1)
print(final_df.shape)
final_df.head()
```

```
(3000, 6008)
```

Out[174…

	is_duplicate	q1_len	q2_len	q1_num_words	q2_num_words	common_words
339499	1	58	42	11	8	4
289521	0	52	105	11	22	2
4665	0	125	124	24	24	20
54203	1	45	60	8	10	5
132566	0	54	39	11	8	3

5 rows × 6008 columns

6 | Split the Dataset

In [175…

```
from sklearn.model_selection import train_test_split
```

In [176…

```
X_train,X_test,y_train,y_test = train_test_split(final_df.iloc[:,1:].values
```

In [177…

```
X_train.shape, X_test.shape, y_train.shape, y_test.shape
```

Out[177…

```
((2250, 6007), (750, 6007), (2250,), (750,))
```

Machine Learning Algorithm

Algorithm 🔄

1. KNN 🔄

In [178…
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.model_selection import train_test_split
```

In [179…
```
knn_classifier = KNeighborsClassifier(n_neighbors=3)
```

In [180…
```
knn_classifier.fit(X_train, y_train)
```

Out[180…
```
KNeighborsClassifier(n_neighbors=3)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [181…
```
train_predictions = knn_classifier.predict(X_train)

train_accuracy1 = accuracy_score(y_train, train_predictions)
```

In [182…
```
test_predictions = knn_classifier.predict(X_test)

test_accuracy1 = accuracy_score(y_test, test_predictions)
```

In [183…
```
print(f"Training Accuracy: {train_accuracy1}")
print(f"Testing Accuracy: {test_accuracy1}")
```

```
Training Accuracy: 0.8275555555555556
Testing Accuracy: 0.6506666666666666
```

(2) Naive Bayes classifier 🔄

In [184…
```
from sklearn.naive_bayes import GaussianNB
from sklearn.naive_bayes import BernoulliNB
from sklearn.naive_bayes import MultinomialNB

from sklearn import metrics
```

In [185…
```
# GaussianNB
```

In [186…
```
G_classifier = GaussianNB()
```

In [187…
```
G_classifier.fit(X_train, y_train)
```

Out[187…
```
GaussianNB()
```
In a Jupyter environment, please rerun this cell to show the HTML

representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [188…
```
train_predictions = G_classifier.predict(X_train)

train_accuracy21 = accuracy_score(y_train, train_predictions)
```

In [189…
```
test_predictions = G_classifier.predict(X_test)

test_accuracy21 = accuracy_score(y_test, test_predictions)
```

In [190…
```
print(f"Training Accuracy: {train_accuracy21}")
print(f"Testing Accuracy: {test_accuracy21}")
```

```
Training Accuracy: 0.9106666666666666
Testing Accuracy: 0.624
```

In [191…
```
# BernoulliNB
```

In [192…
```
B_classifier = BernoulliNB()
```

In [193…
```
B_classifier.fit(X_train, y_train)
```

Out[193…
```
BernoulliNB()
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [194…
```
train_predictions = B_classifier.predict(X_train)

train_accuracy22 = accuracy_score(y_train, train_predictions)
```

In [195…
```
test_predictions = G_classifier.predict(X_test)

test_accuracy22 = accuracy_score(y_test, test_predictions)
```

In [196…
```
print(f"Training Accuracy: {train_accuracy22}")
print(f"Testing Accuracy: {test_accuracy22}")
```

```
Training Accuracy: 0.8973333333333333
Testing Accuracy: 0.624
```

In [197…
```
# MultinomialNB
```

In [198…
```
M_classifier = MultinomialNB()
```

In [199…
```
M_classifier.fit(X_train, y_train)
```

Out[199… MultinomialNB()

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [200…
```
train_predictions = M_classifier.predict(X_train)

train_accuracy23 = accuracy_score(y_train, train_predictions)
```

In [201…
```
test_predictions = M_classifier.predict(X_test)

test_accuracy23 = accuracy_score(y_test, test_predictions)
```

In [202…
```
print(f"Training Accuracy: {train_accuracy23}")
print(f"Testing Accuracy: {test_accuracy23}")
```

```
Training Accuracy: 0.904
Testing Accuracy: 0.7106666666666667
```

👉 GaussianNB

Training Accuracy: 0.9106666666666666

Testing Accuracy: 0.624

👉 BernoulliNB

Training Accuracy: 0.8973333333333333

Testing Accuracy: 0.624

👉 MultinomialNB

Training Accuracy: 0.904

Testing Accuracy: 0.7106666666666667

Being the best of them | 🔥 MultinomialNB |

(3) Decision Tree 🔄

In [203…
```
from sklearn.tree import DecisionTreeClassifier
```

In [204…
```
clf = DecisionTreeClassifier()
```

In [205…
```
clf.fit(X_train, y_train)
```

```
clf.fit(X_train, y_train)
```

Out[205… DecisionTreeClassifier()

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [206…
```
train_predictions = clf.predict(X_train)

train_accuracy3 = accuracy_score(y_train, train_predictions)
```

In [207…
```
test_predictions = clf.predict(X_test)

test_accuracy3 = accuracy_score(y_test, test_predictions)
```

In [208…
```
print(f"Training Accuracy: {train_accuracy3}")
print(f"Testing Accuracy: {test_accuracy3}")
```

```
Training Accuracy: 1.0
Testing Accuracy: 0.6746666666666666
```

4. RandomForest

In [209…
```
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
```

In [210…
```
rf_classifier = RandomForestClassifier(n_estimators=100, random_state=42)
```

In [211…
```
rf_classifier.fit(X_train, y_train)
```

Out[211… RandomForestClassifier(random_state=42)

In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [212…
```
train_predictions = rf_classifier.predict(X_train)

train_accuracy4 = accuracy_score(y_train, train_predictions)
```

In [213…
```
test_predictions = rf_classifier.predict(X_test)

test_accuracy4 = accuracy_score(y_test, test_predictions)
```

In [214…
```
print(f"Training Accuracy: {train_accuracy4}")
print(f"Testing Accuracy: {test_accuracy4}")
```

```
Training Accuracy: 1.0
Testing Accuracy: 0.7106666666666667
```

(5) Boosting Algorithm

In [215…
```
from sklearn.ensemble import AdaBoostClassifier
```

In [216…
```
base_classifier = DecisionTreeClassifier(max_depth=1)
```

In [217…
```
adaboost_classifier = AdaBoostClassifier(base_classifier, n_estimators=50,
```

In [218…
```
adaboost_classifier.fit(X_train, y_train)
```

Out[218…
```
AdaBoostClassifier(estimator=DecisionTreeClassifier(max_depth=1),
                   random_state=42)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [219…
```
train_predictions = adaboost_classifier.predict(X_train)

train_accuracy5 = accuracy_score(y_train, train_predictions)
```

In [220…
```
test_predictions = adaboost_classifier.predict(X_test)

test_accuracy5 = accuracy_score(y_test, test_predictions)
```

In [221…
```
print(f"Training Accuracy: {train_accuracy5}")
print(f"Testing Accuracy: {test_accuracy5}")
```

```
Training Accuracy: 0.7724444444444445
Testing Accuracy: 0.712
```

(6). Logistic Regression

In [222…
```
from sklearn import linear_model
```

In [223…
```
lrg = linear_model.LogisticRegression()
```

In [224…
```
lrg.fit(X_train, y_train)
```

Out[224…
```
LogisticRegression()
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [225…
```
train_predictions = lrg.predict(X_train)
```

```
train_accuracy7 = accuracy_score(y_train, train_predictions)
```

In [226…
```
test_predictions = lrg.predict(X_test)

test_accuracy7 = accuracy_score(y_test, test_predictions)
```

In [227…
```
print(f"Training Accuracy: {train_accuracy7}")
print(f"Testing Accuracy: {test_accuracy7}")
```

```
Training Accuracy: 0.8391111111111111
Testing Accuracy: 0.7066666666666667
```

(7).Linear Regression

In [228…
```
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error
```

In [229…
```
model = LinearRegression()
```

In [230…
```
model.fit(X_train, y_train)
```

Out[230…
```
LinearRegression()
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [231…
```
train_predictions = clf.predict(X_train)

train_accuracy8 = accuracy_score(y_train, train_predictions)
```

In [232…
```
test_predictions = clf.predict(X_test)

test_accuracy8 = accuracy_score(y_test, test_predictions)
```

In [233…
```
print(f"Training Accuracy: {train_accuracy8}")
print(f"Testing Accuracy: {test_accuracy8}")
```

```
Training Accuracy: 1.0
Testing Accuracy: 0.6746666666666666
```

(9).Gradient Boosting Machines (GBM)

In [234…
```
from sklearn.ensemble import GradientBoostingClassifier
```

In [235…
```
model = GradientBoostingClassifier(n_estimators=100, learning_rate=0.1, max_
```

In [236…
```
model.fit(X_train, y_train)
```

Out[236…
```
GradientBoostingClassifier(random_state=42)
```
In a Jupyter environment, please rerun this cell to show the HTML representation or trust the notebook.
On GitHub, the HTML representation is unable to render, please try loading this page with nbviewer.org.

In [237…
```
train_predictions = model.predict(X_train)

train_accuracy9 = accuracy_score(y_train, train_predictions)
```

In [238…
```
test_predictions = model.predict(X_test)

test_accuracy9 = accuracy_score(y_test, test_predictions)
```

In [239…
```
print(f"Training Accuracy: {train_accuracy9}")
print(f"Testing Accuracy: {test_accuracy9}")
```

```
Training Accuracy: 0.816
Testing Accuracy: 0.7
```

Random Forest Algorithm is the best accuracy

(Random Forest)

Training Accuracy: 1.0

Testing Accuracy: 0.7106666666666667