EDA

September 21, 2021

[1]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

[2]:
```
import os
import pathlib
from pathlib import Path
os.chdir("/content/drive/My Drive/Classroom/projects/BERT")
!ls -l
```

```
total 1247
drwx------ 2 root root   4096 Sep 12 15:56 Data
-rw------- 1 root root 737225 Sep 21 15:49 EDA.ipynb
-rw------- 1 root root 531326 Sep 20 05:02 EDA.pdf
drwx------ 2 root root   4096 Sep 12 15:53 papers
```

[3]:
```
pip install fuzzywuzzy
```

```
Collecting fuzzywuzzy
  Downloading fuzzywuzzy-0.18.0-py2.py3-none-any.whl (18 kB)
Installing collected packages: fuzzywuzzy
Successfully installed fuzzywuzzy-0.18.0
```

[4]:
```
# util lib import
import warnings
warnings.filterwarnings("ignore")
import pandas as pd
import xml.etree.ElementTree as et
import os
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import pathlib
from pathlib import Path
import csv
```

```
from tqdm.notebook import tqdm
from fuzzywuzzy import fuzz
from wordcloud import WordCloud, STOPWORDS
```

[5]:
```
data = 'Data//aesw2016(v1.2)_train.xml'
#data = 'Data//New Text Document.xml'
csvfile = 'Data//data.csv'
```

[6]:
```
etree = et.parse(data)
```

[7]:
```
myroot = etree.getroot()
```

[ ]:
```
print(myroot)
```

```
<Element 'aesw' at 0x7f040cf975f0>
```

[ ]:
```
type(myroot)
```

[ ]:
```
xml.etree.ElementTree.Element
```

[ ]:
```
p = set()
for x in myroot.iter():
  p.add(x.tag)
```

[ ]:
```
p
```

[ ]:
```
{'aesw',
 'affiliation',
 'attribution',
 'copyright',
 'del',
 'email',
 'header',
 'ins',
 'license',
 'licenseText',
 'par',
 'sentence',
 'training',
 'year'}
```

[ ]:
```
p = set()
for x in myroot[1].iter():
  p.add(x.tag)
```

[ ]:
```
p
```

[ ]:
```
{'del', 'ins', 'par', 'sentence', 'training'}
```

[ ]:
```
p = set()
for x in myroot[1][0].iter():
  p.add(x.tag)
```

[ ]:
```
p
```

[ ]:
```
{'del', 'ins', 'par', 'sentence'}
```

[ ]:
```
p = set()
for x in myroot[1][0][0].iter():
  p.add(x.tag)
p
```

[ ]:
```
{'del', 'ins', 'sentence'}
```

[ ]:
```
myroot[1][0][0].text
```

[ ]:
```
'To facilitate an easier notation throughout the paper we define Heaviside and
Dirac functions for complex'
```

[111]:
```
'''
functions to read strigs before editing(SBE) and strings after editing(SAE)
'''
##https://github.com/samuelstevens/sentence-editing-interpretability/blob/main/
 ↪paper/aesw_to_sentences.py
## code snippet taked\n from the above github repo, an implementation of Bert␣
 ↪editing paper


def SBE(sent_elem) -> str:
  ''' SBE : String Before Editing'''
  assert sent_elem.tag == "sentence"
  string_builder = [str(sent_elem.text) if sent_elem.text else ""]


  del_word= ''
  for del_ins in sent_elem:
      if del_ins.tag == "del" and del_ins.text:
          string_builder.append(str(del_ins.text))
          del_word = del_ins.text
      if del_ins.tail:
          string_builder.append(str(del_ins.tail))

  return "".join(string_builder),del_word




##https://github.com/samuelstevens/sentence-editing-interpretability/blob/main/
 ↪paper/aesw_to_sentences.py
## code snippet taked\n from the above github repo, an implementation of Bert␣
 ↪editing paper
def SAE(sent_elem) -> str:
  ''' SAE : String After Editing'''
```

```
  assert sent_elem.tag == "sentence"
  string_builder = [str(sent_elem.text) if sent_elem.text else ""]


  ins_word=''

  for del_ins in sent_elem:
      if del_ins.tag == "ins" and del_ins.text:
          string_builder.append(str(del_ins.text))
          ins_word = del_ins.text

      if del_ins.tail:
          string_builder.append(str(del_ins.tail))

  return "".join(string_builder),ins_word
```

[112]:
```
if os.path.isfile(csvfile):
  os.remove(csvfile)

with open(csvfile, "w") as file:
  writer = csv.writer(file)
  writer.writerow(['SID','Domain','SBE','SAE','del_word','ins_word','Label'])

  for para in tqdm(myroot.iter('par')):
    domain = para.attrib['domain']

    for sent in para.iter('sentence'):
      l = 1 if len(list(sent)) > 0 else 0
      sid = str(sent.attrib["sid"])
      sbe,del_word = SBE(sent)
      sae,ins_word = SAE(sent)

      writer.writerow([sid, domain, sbe, sae, del_word, ins_word, l])
```

```
0it [00:00, ?it/s]
```

[117]:
```
df = pd.read_csv(csvfile)
```

[118]:
```
df
```

[118]:

	SID	Domain	...	ins_word	Label
0	1.0	Physics	...	,	1
1	1.1	Physics	...	NaN	0
2	1.2	Physics	...	NaN	0
3	1.3	Physics	...	NaN	0
4	2.0	Mathematics	...	NaN	0
...	...	...	...	...	...
1189407	254143.4	Computer Science	...	hand-held	1

```
1189408  254143.5  Computer Science  ...          ,     1
1189409  254144.0       Mathematics  ...        NaN     0
1189410  254144.1       Mathematics  ...          ,     1
1189411  254144.2       Mathematics  ...        NaN     0

[1189412 rows x 7 columns]
```

[119]:
```
print("Number of data points:",df.shape[0])
```

```
Number of data points: 1189412
```

[120]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1189412 entries, 0 to 1189411
Data columns (total 7 columns):
 #   Column    Non-Null Count    Dtype
---  ------    --------------    -----
 0   SID       1189412 non-null  float64
 1   Domain    1189412 non-null  object
 2   SBE       1189321 non-null  object
 3   SAE       1189315 non-null  object
 4   del_word  331932 non-null   object
 5   ins_word  411244 non-null   object
 6   Label     1189412 non-null  int64
dtypes: float64(1), int64(1), object(5)
memory usage: 63.5+ MB
```

[121]:
```
df.isnull().sum()
```

[121]:
```
SID              0
Domain           0
SBE             91
SAE             97
del_word    857480
ins_word    778168
Label            0
dtype: int64
```

[122]:
```
df[df['SAE'].isnull()]
```

[122]:
```
              SID            Domain  ... ins_word Label
12356      2694.0       Engineering  ...      NaN     1
23774      5167.0       Mathematics  ...      NaN     1
30674      6667.0       Mathematics  ...      NaN     1
41501      8985.1       Mathematics  ...      NaN     1
45142      9754.0       Engineering  ...      NaN     1
...           ...               ...  ...      ...   ...
1113929  238119.0  Computer Science  ...      NaN     1
```

```
1136308  242920.2       Mathematics  ...       NaN     1
1153671  246576.0  Computer Science  ...       NaN     1
1176268  251399.0       Engineering  ...       NaN     1
1179687  252091.0           Physics  ...       NaN     1

[97 rows x 7 columns]
```

[123]:
```
df[df['SBE'].isnull()]
```

[123]:
```
              SID            Domain  ...                          ins_word Label
6045       1315.0       Engineering  ...  Methods to remove redundancy.      1
22220      4820.0       Mathematics  ...                              2.      1
41504      8985.4       Mathematics  ...               Let _MATHDISP_.      1
41505      8985.5       Mathematics  ...              Then _MATHDISP_.      1
47023     10158.0       Mathematics  ...                              2.      1
...           ...               ...  ...                             ...   ...
1085085  231936.0       Mathematics  ...                               .      1
1129431  241447.0       Mathematics  ...                               .      1
1162047  248363.0       Mathematics  ...                                .     1
1179447  252032.0       Mathematics  ...                             1.      1
1180893  252354.0  Computer Science  ...              Configuration 3.      1

[91 rows x 7 columns]
```

[124]:
```
df[df['Label']==1][df['ins_word'].isnull()]
```

[124]:
```
              SID            Domain  ... ins_word Label
8             3.0       Engineering  ...      NaN     1
10            3.2       Engineering  ...      NaN     1
16            5.1  Computer Science  ...      NaN     1
124          33.8         Chemistry  ...      NaN     1
130          35.1       Engineering  ...      NaN     1
...           ...               ...  ...      ...   ...
1189343  254129.0       Mathematics  ...      NaN     1
1189355  254131.1       Engineering  ...      NaN     1
1189366  254134.0           Physics  ...      NaN     1
1189374  254135.0       Mathematics  ...      NaN     1
1189393  254141.0       Engineering  ...      NaN     1

[55428 rows x 7 columns]
```

[125]:
```
df.fillna('',inplace= True)
```

[126]:
```
df[df['Label']==1][df['ins_word']=='']
```

[126]:
```
              SID            Domain  ... ins_word Label
8             3.0       Engineering  ...              1
10            3.2       Engineering  ...              1
16            5.1  Computer Science  ...              1
124          33.8         Chemistry  ...              1
```

```
130          35.1       Engineering  ...              1
...           ...               ...  ...      ...   ...
1189343  254129.0       Mathematics  ...              1
1189355  254131.1       Engineering  ...              1
1189366  254134.0           Physics  ...              1
1189374  254135.0       Mathematics  ...              1
1189393  254141.0       Engineering  ...              1

[55428 rows x 7 columns]
```

[127]:
```
df[df['Label']==1][df['del_word']=='']
```

[127]:
```
              SID            Domain  ... ins_word Label
13            4.2       Engineering  ...      and     1
17            6.0       Engineering  ...        ,     1
20            7.1  Computer Science  ...        ,     1
22            7.3  Computer Science  ...        ,     1
35           11.2  Computer Science  ...     the      1
...           ...               ...  ...      ...   ...
1189386  254139.3       Mathematics  ...        ,     1
1189392  254140.0       Mathematics  ...        ,     1
1189398  254142.2       Mathematics  ...        ,     1
1189402  254142.6       Mathematics  ...        ,     1
1189410  254144.1       Mathematics  ...        ,     1

[134740 rows x 7 columns]
```

[128]:
```
def list_to_dict(lst):
  freq = {}
  for val in lst:
    if val in freq.keys():
      freq[val]+=1
    else:
      freq[val]=1
  return freq
```

[148]:
```
vocab = []
rows = df[df['Label']==1]
for _,row in rows.iterrows():
  try:
    vocab.extend(row['del_word'].split(' '))
  except:
    print(row['ins_word'])
    break
  #print(row['del_word'])
#wrds = [wrd for wrd in vocab if wrd != '']
```

[149]:
```
freq = list_to_dict(vocab)
```

[150]:
```
len(freq.keys())
```

[150]:
```
26732
```

[151]:
```
frq2=sorted(freq.items(), key=lambda x: x[1], reverse=True)
frq2
```

[151]:
```
[('', 244273),
 (',', 46806),
 ('-', 17618),
 ('the', 14057),
 (':', 13348),
 ('.', 6388),
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 ('that', 4586),
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 ('be', 1442),
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 ("'", 1065),
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```

[152]:
```
wc = WordCloud(background_color="white", max_words=2000)
wc.generate_from_frequencies(freq)
print ("Word Cloud for Deleted Words")
plt.imshow(wc, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
Word Cloud for Deleted Words
```

[134]:
```
vocab = []
rows = df[df['Label']==1]
for _,row in rows.iterrows():
```

```
  try:
    vocab.extend(row['ins_word'].split(' '))
  except:
    print(row['ins_word'])
    break
  #print(row['del_word'])
#wrds = [wrd for wrd in vocab if wrd != '']
```

[135]:
```
freq = list_to_dict(vocab)
```

[136]:
```
len(freq.keys())
```

[136]:
```
19803
```

[137]:
```
frq2=sorted(freq.items(), key=lambda x: x[1], reverse=True)
frq2
```

[137]:
```
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```
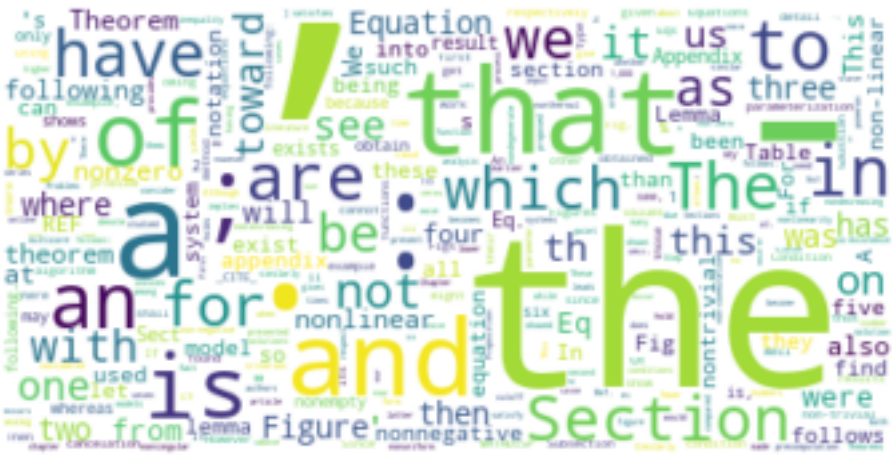

[138]:
```
wc = WordCloud(background_color="white", max_words=2000)
wc.generate_from_frequencies(freq)
print ("Word Cloud for Instered Words")
plt.imshow(wc, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
Word Cloud for Instered Words
```



[153]:
```
vocab = []
rows = df[df['Label']==1]
for _,row in rows.iterrows():
  try:
    delw = row['del_word']
    insw = row['ins_word']
    both = delw + '' + insw
    both.strip()
    vocab.append(both)
  except:
    print(row['ins_word'])
    break
  #print(row['del_word'])
#wrds = [wrd for wrd in vocab if wrd != '']
```

[154]:
```
freq = list_to_dict(vocab)
```

[155]:
```
len(freq.keys())
```

[155]: 70665

[156]:
```
frq2=sorted(freq.items(), key=lambda x: x[1], reverse=True)
frq2
```

[156]:
```
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```
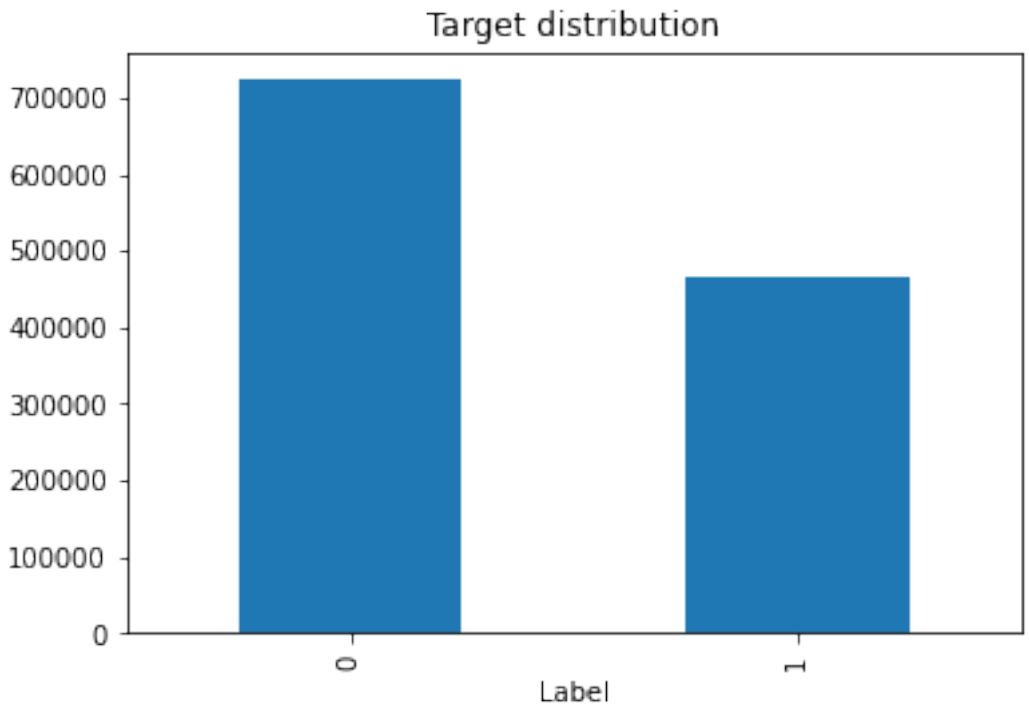

[157]:
```
wc = WordCloud(background_color="white", max_words=2000)
wc.generate_from_frequencies(freq)
print ("Word Cloud for del ins Words together")
plt.imshow(wc, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
Word Cloud for Instered Words
```

[ ]:
```
plt.title('Target distribution')
df.groupby("Label")['SID'].count().plot.bar()
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7b6fe8b790>
```

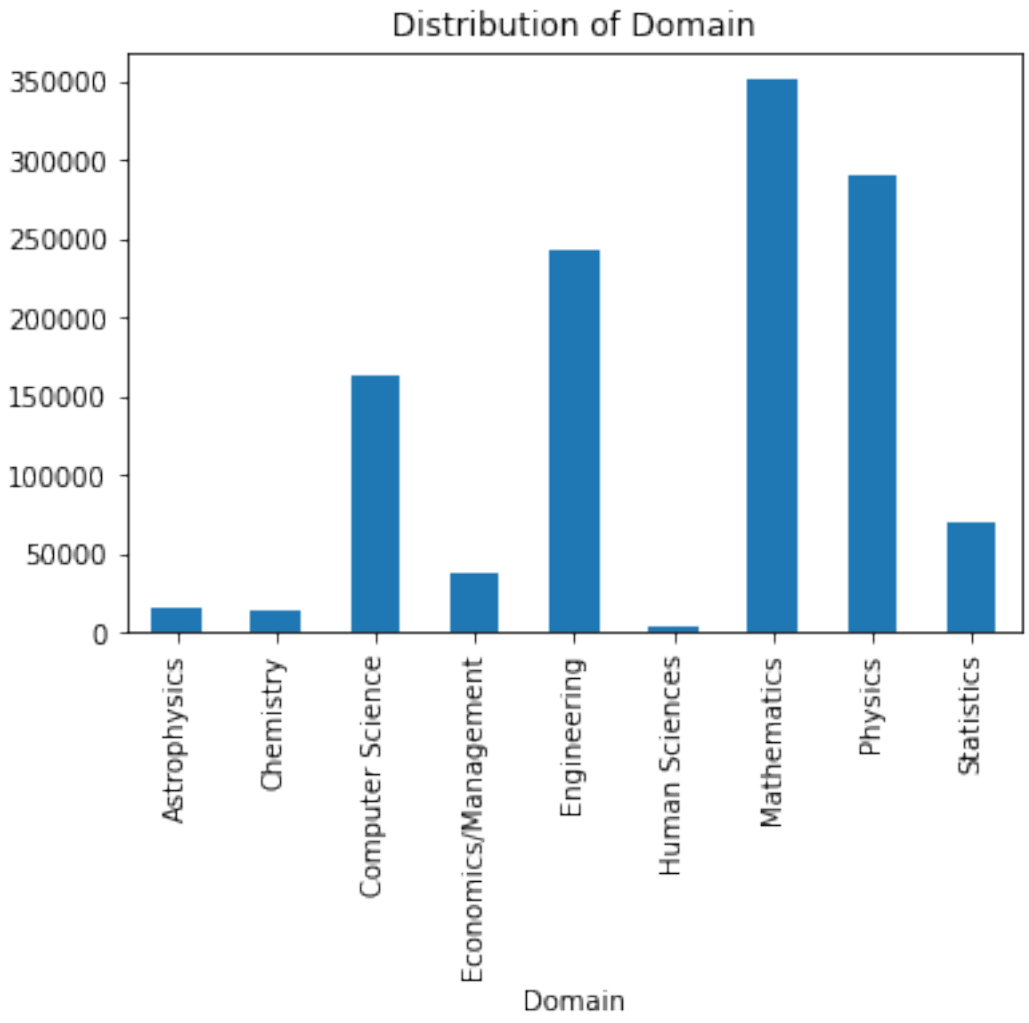


[ ]:
```
print('edited sentences percentage:   {}%'.format(round((df['Label'].
 ↪mean())*100, 2)))
print('not edited sentences percentage:   {}%'.format(100 - round((df['Label'].
 ↪mean())*100, 2)))
```

```
edited sentences percentage:   39.24%
not edited sentences percentage:   60.76%
```

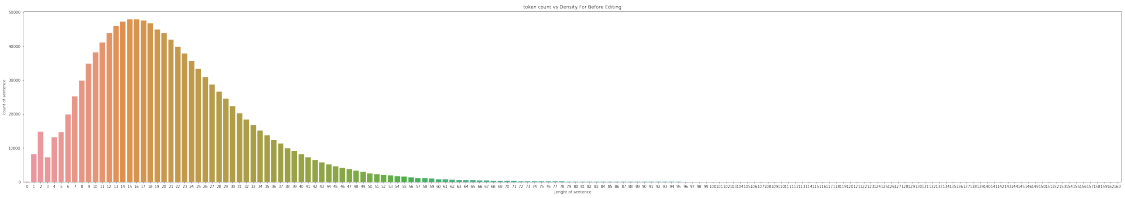
[ ]:
```
plt.title('Distribution of Domain')
df.groupby("Domain")['SID'].count().plot.bar()
```

[ ]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f7b6f8c5e50>
```



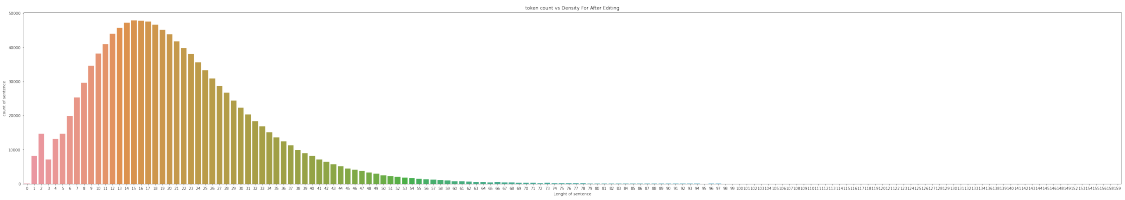
[ ]:
```
plt.figure(figsize=(50, 8))

SBE = df['SBE'].str.split().apply(len).value_counts().sort_index()

SBE = SBE[SBE.index<np.percentile(SBE.index,90)]

plt.title('token count vs Density For Before Editing')
sns.barplot(x=SBE.index ,y=SBE.values,order = SBE.index).set(xlabel='Lenght of␣
 ↪sentence', ylabel='count of sentence')
```

[ ]:
```
[Text(0, 0.5, 'count of sentence'), Text(0.5, 0, 'Lenght of sentence')]
```



[ ]:
```
plt.figure(figsize=(50, 8))

SBE = df['SAE'].str.split().apply(len).value_counts().sort_index()

SBE = SBE[SBE.index<np.percentile(SBE.index,90)]

plt.title('token count vs Density For After Editing')
sns.barplot(x=SBE.index ,y=SBE.values,order = SBE.index).set(xlabel='Lenght of␣
 ↪sentence', ylabel='count of sentence')
```

[ ]:
```
[Text(0, 0.5, 'count of sentence'), Text(0.5, 0, 'Lenght of sentence')]
```



[158]:
```
df['SBE_len'] = df['SBE'].str.len()
df['SAE_len'] = df['SAE'].str.len()
df['SAE_n_words'] = df['SAE'].astype('str').apply(lambda row: len(row.split("␣
 ↪")))
df['SBE_n_words'] = df['SBE'].astype('str').apply(lambda row: len(row.split("␣
 ↪")))
```

[159]:
```
df
```

[159]:

	SID	Domain	...	SAE_n_words	SBE_n_words
0	1.0	Physics	...	35	36
1	1.1	Physics	...	21	21
2	1.2	Physics	...	22	22
3	1.3	Physics	...	11	11
4	2.0	Mathematics	...	8	8
...	...	...	...	...	...
1189407	254143.4	Computer Science	...	24	24
1189408	254143.5	Computer Science	...	37	37
1189409	254144.0	Mathematics	...	23	23
1189410	254144.1	Mathematics	...	33	33

```
1189411  254144.2       Mathematics  ...          15          15

[1189412 rows x 11 columns]
```

[31]:
```
df.shape
```

[31]:
```
(1189412, 11)
```

[160]:
```
# More features form quora question pair similarity
def more_features_from_QQPS(row:str):

  '''
  featurs = WordCommon, WordShare,WordTotal
  '''
  w1 = set(map(lambda word: word.lower().strip(), row['SAE'].split(" ")))
  w2 = set(map(lambda word: word.lower().strip(), row['SBE'].split(" ")))
  common = 1.0 * len(w1 & w2)
  total = 1.0 * (len(w1) + len(w2))
  share = 1.0 * common/total

  return common,total,share
```

[161]:
```
df['word_Common'],df['word_Total'],df['word_share'] = zip(*df.
 ↪apply(more_features_from_QQPS,axis =1))
```

[34]:
```
df.head()
```

[34]:
```
   SID       Domain  ... word_Total word_share
0  1.0      Physics  ...       57.0   0.438596
1  1.1      Physics  ...       40.0   0.500000
2  1.2      Physics  ...       38.0   0.500000
3  1.3      Physics  ...       22.0   0.500000
4  2.0  Mathematics  ...       16.0   0.500000

[5 rows x 14 columns]
```

[36]:
```
df.shape
```

[36]:
```
(1189412, 14)
```

[35]:
```
df.columns
```

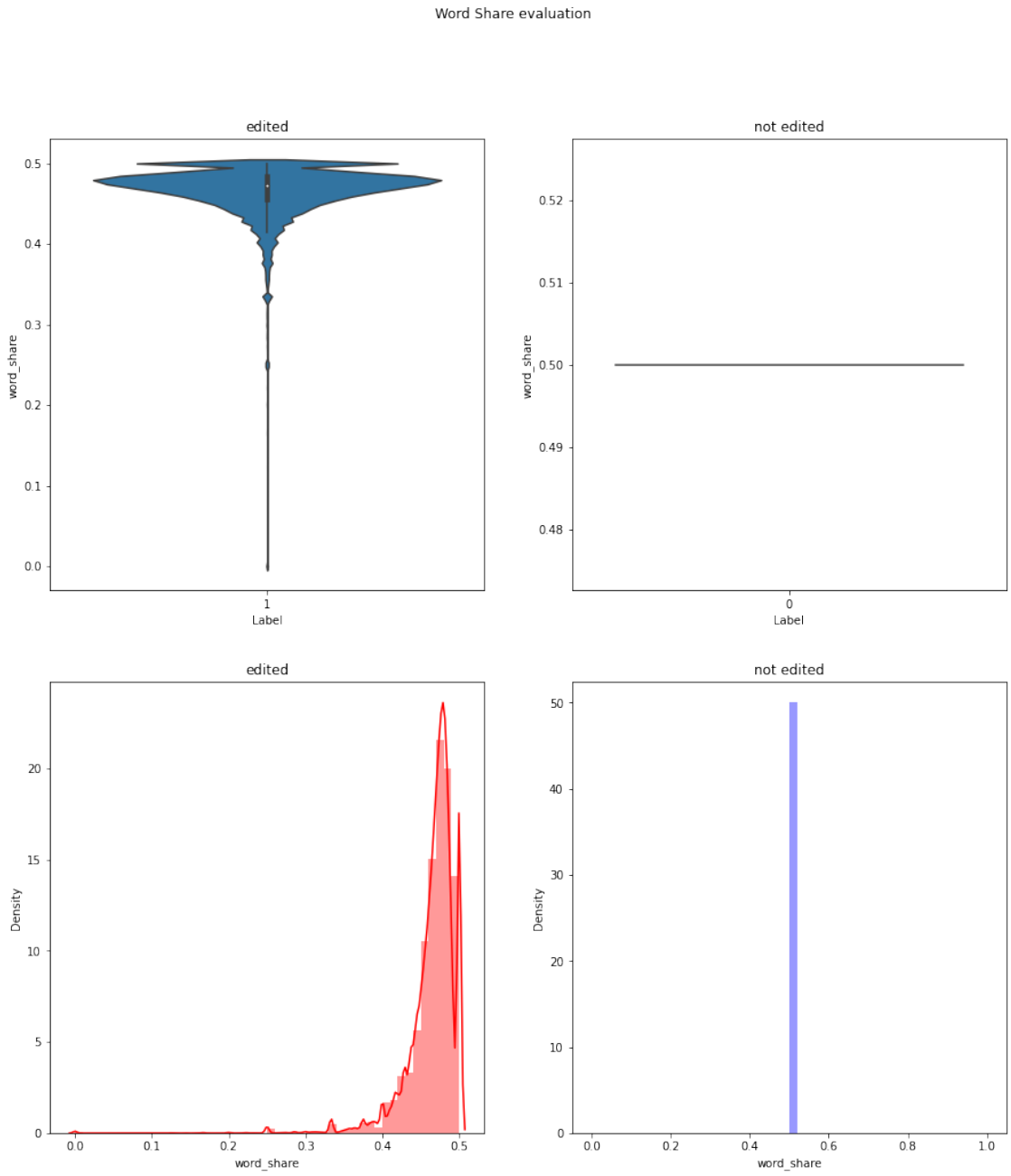
[35]:
```
Index(['SID', 'Domain', 'SBE', 'SAE', 'del_word', 'ins_word', 'Label',
       'SBE_len', 'SAE_len', 'SAE_n_words', 'SBE_n_words', 'word_Common',
       'word_Total', 'word_share'],
      dtype='object')
```

[37]:
```
print ("Minimum length of the SBE : " , min(df['SBE_n_words']))

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

```
print ("Number of Questions with minimum length SBE :", df[df['SBE_n_words']==␣
 ↪min(df['SBE_n_words'])].shape[0])
print ("Number of Questions with minimum length SAE :", df[df['SAE_n_words']==␣
 ↪min(df['SAE_n_words'])].shape[0])
```

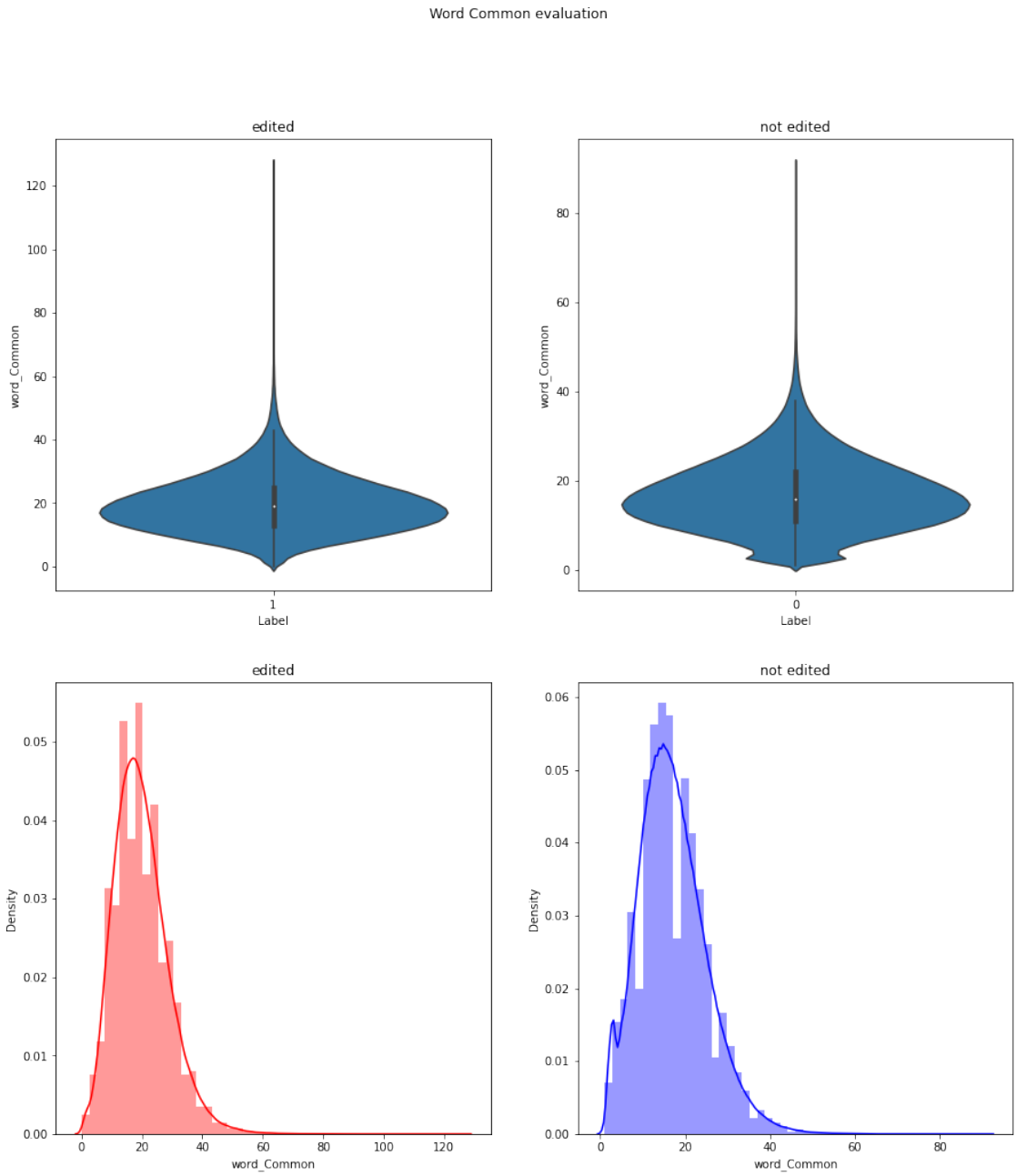
```
Minimum length of the SBE :  1
Minimum length of the questions in SAE :  1
Number of Questions with minimum length SBE : 1213
Number of Questions with minimum length SAE : 1183
```

[38]:
```
plt.figure(figsize=(15, 16))
plt.suptitle('Word Share evaluation')
plt.subplot(2,2,1)
plt.title('edited')
sns.violinplot(x = 'Label', y = 'word_share', data = df[df['Label'] == 1])

plt.subplot(2,2,2)
plt.title('not edited')
sns.violinplot(x = 'Label', y = 'word_share', data = df[df['Label'] == 0])

plt.subplot(2,2,3)
plt.title('edited')
sns.distplot(df[df['Label'] == 1.0]['word_share'][0:] , label = "1", color =␣
 ↪'red')

plt.subplot(2,2,4)
plt.title('not edited')
sns.distplot(df[df['Label'] == 0.0]['word_share'][0:] , label = "0" , color =␣
 ↪'blue' )
plt.show()
```



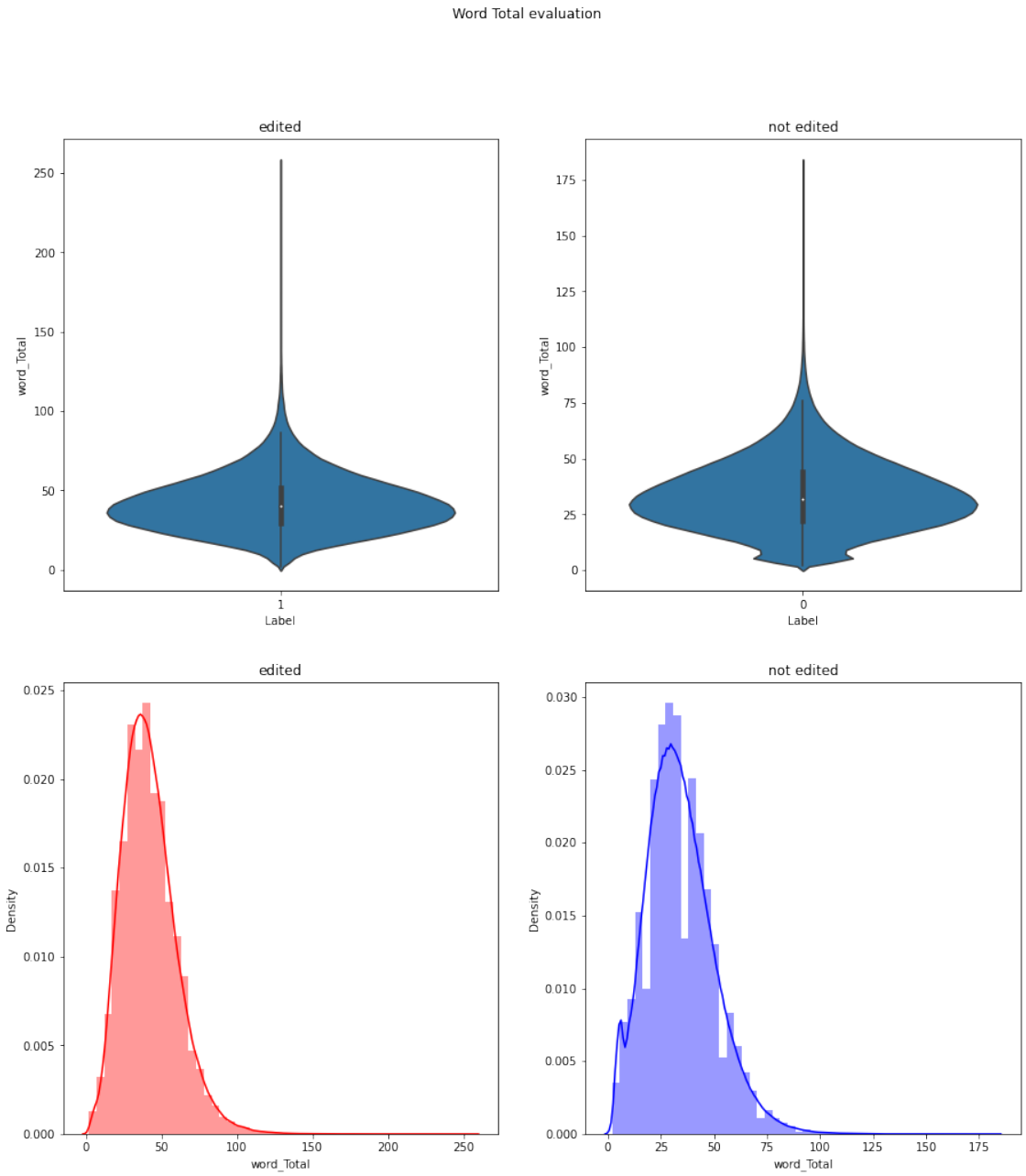
[ ]:
```
plt.figure(figsize=(15, 16))
plt.suptitle('Word Common evaluation')

plt.subplot(2,2,1)
plt.title('edited')
sns.violinplot(x = 'Label', y = 'word_Common', data = df[df['Label'] == 1])

plt.subplot(2,2,2)
```

```
plt.title('not edited')
sns.violinplot(x = 'Label', y = 'word_Common', data = df[df['Label'] == 0])

plt.subplot(2,2,3)
plt.title('edited')
sns.distplot(df[df['Label'] == 1.0]['word_Common'][0:] , label = "1", color =␣
 ↪'red')

plt.subplot(2,2,4)
plt.title('not edited')
sns.distplot(df[df['Label'] == 0.0]['word_Common'][0:] , label = "0" , color =␣
 ↪'blue' )
plt.show()
```



[ ]:
```
plt.figure(figsize=(15, 16))
plt.suptitle('Word Total evaluation')

plt.subplot(2,2,1)
plt.title('edited')
sns.violinplot(x = 'Label', y = 'word_Total', data = df[df['Label'] == 1])

plt.subplot(2,2,2)
plt.title('not edited')
```

```
sns.violinplot(x = 'Label', y = 'word_Total', data = df[df['Label'] == 0])

plt.subplot(2,2,3)
plt.title('edited')
sns.distplot(df[df['Label'] == 1.0]['word_Total'][0:] , label = "1", color =␣
 ↪'red')

plt.subplot(2,2,4)
plt.title('not edited')
sns.distplot(df[df['Label'] == 0.0]['word_Total'][0:] , label = "0" , color =␣
 ↪'blue' )
plt.show()
```



0.0.1 Using Fuzzywuzzy library for more EDA

[162]:
```
df['str_sim'] = df.apply(lambda row:  fuzz.ratio(row['SBE'],row['SAE']),axis=1)
```

[163]:
```
df['par_str_sim'] = df.apply(lambda row:  fuzz.
 ↪partial_ratio(row['SBE'],row['SAE']),axis=1)
```

[164]:
```
df['tok_set_ratio'] = df.apply(lambda row:  fuzz.
 ↪token_set_ratio(row['SBE'],row['SAE']),axis=1)
```

[165]:
```
df['tok_sort_ratio'] = df.apply(lambda row:  fuzz.
↪token_sort_ratio(row['SBE'],row['SAE']),axis=1)
```

[43]:
```
df.shape
```

[43]:
```
(1189412, 18)
```

[44]:
```
df.columns
```

[44]:
```
Index(['SID', 'Domain', 'SBE', 'SAE', 'del_word', 'ins_word', 'Label',
       'SBE_len', 'SAE_len', 'SAE_n_words', 'SBE_n_words', 'word_Common',
       'word_Total', 'word_share', 'str_sim', 'par_str_sim', 'tok_set_ratio',
       'tok_sort_ratio'],
      dtype='object')
```

[166]:
```
df.to_csv(csvfile,index=False)
```

[167]:
```
df = pd.read_csv(csvfile)
```

[168]:
```
df.head()
```

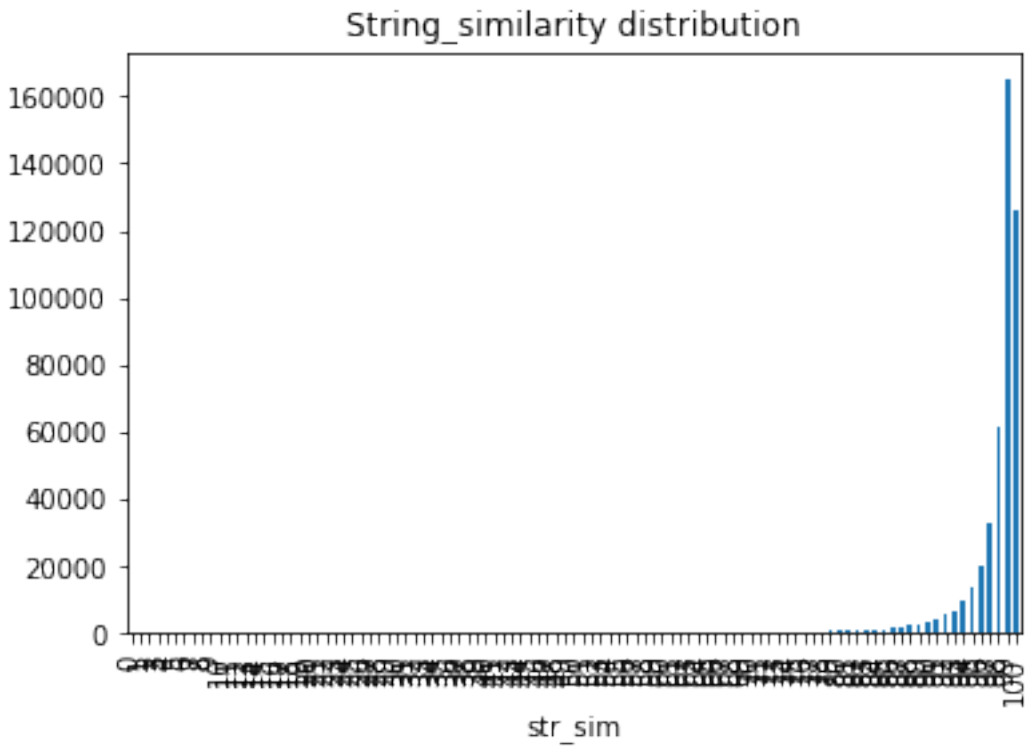
[168]:

	SID	Domain	...	tok_set_ratio	tok_sort_ratio
0	1.0	Physics	...	100	100
1	1.1	Physics	...	100	100
2	1.2	Physics	...	100	100
3	1.3	Physics	...	100	100
4	2.0	Mathematics	...	100	100

[5 rows x 18 columns]

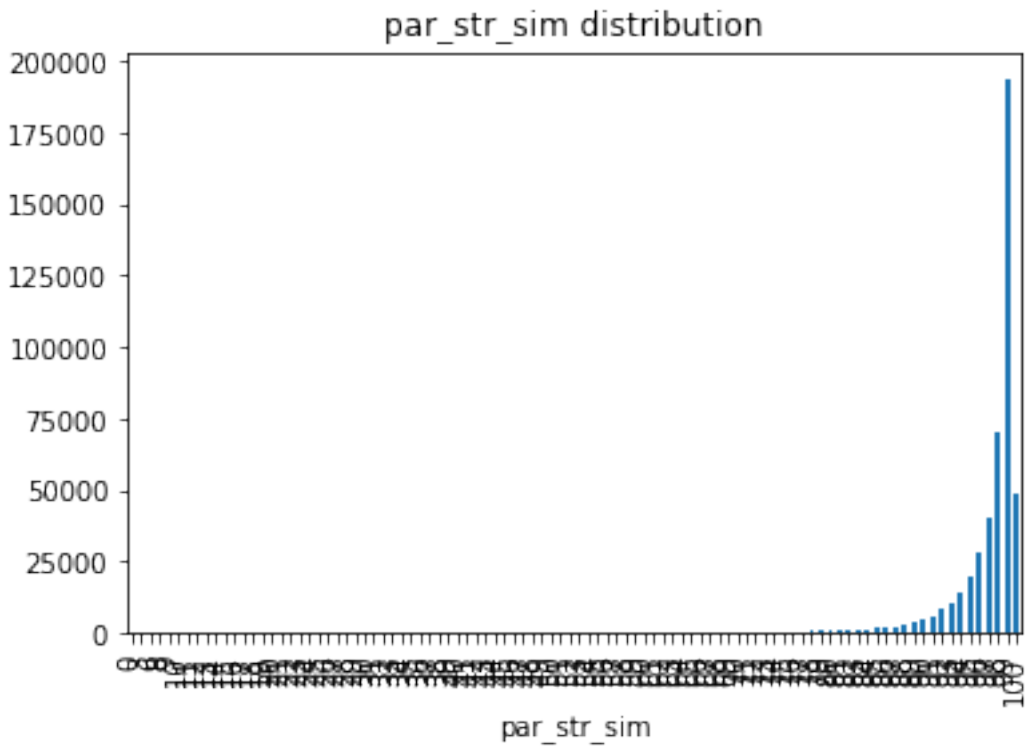
[169]:
```
plt.title('String_similarity distribution')
df[df['Label']==1].groupby('str_sim')['SID'].count().plot.bar()
```

[169]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fea16d1e910>
```



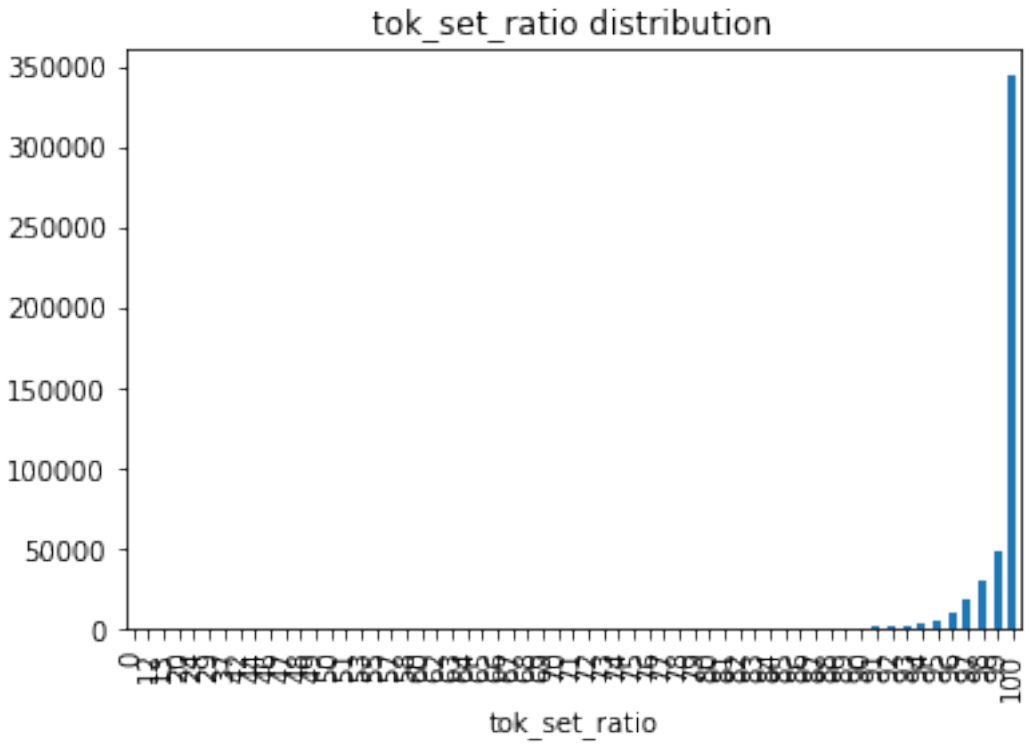
[170]:
```
plt.title('par_str_sim distribution')
df[df['Label']==1].groupby('par_str_sim')['SID'].count().plot.bar()
```

[170]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe9cdc48950>
```



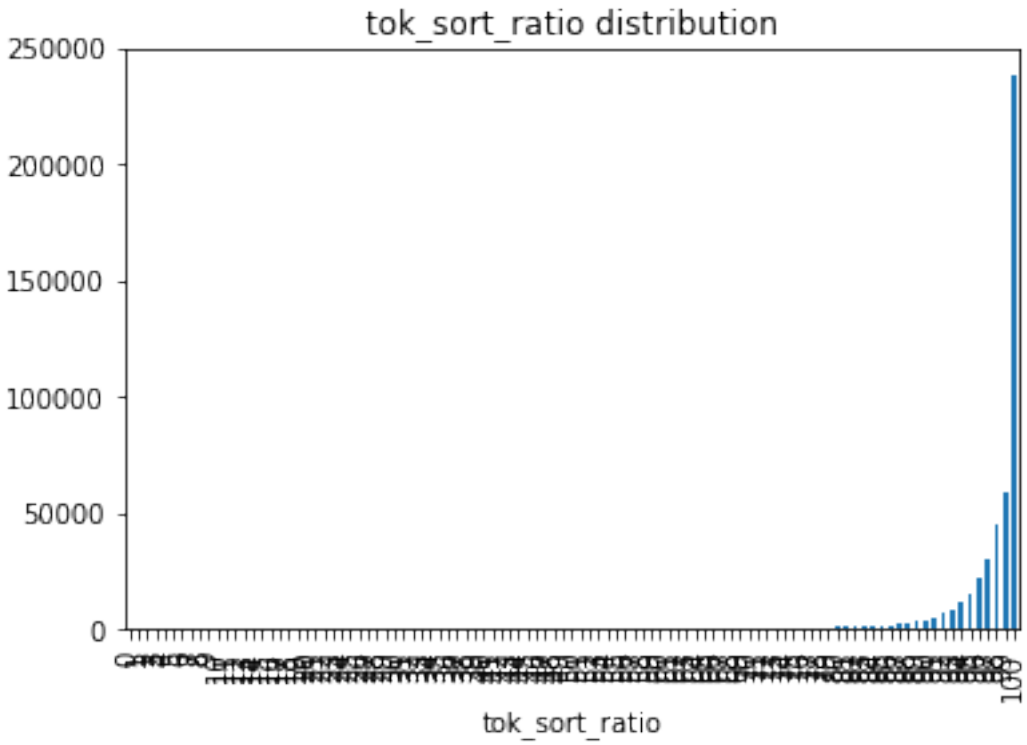
[171]:
```
plt.title('tok_set_ratio distribution')
df[df['Label']==1].groupby('tok_set_ratio')['SID'].count().plot.bar()
```

[171]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe9cda229d0>
```



[172]:
```
plt.title('tok_sort_ratio distribution')
df[df['Label']==1].groupby('tok_sort_ratio')['SID'].count().plot.bar()
```

[172]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fe9cda31990>
```


tok_sort_ratio distribution
250000
200000
150000
100000
50000
0
tok_sort_ratio