Bajardi_Luca_s275782_Exam_Winter_2020

January 25, 2020

[1]:
```
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import seaborn as sns
from collections import Counter
import pattern.it
from stop_words import get_stop_words

import nltk
nltk.download('wordnet')
```

```
[nltk_data] Downloading package wordnet to
[nltk_data]     C:\Users\lucab\AppData\Roaming\nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
```

[1]:
```
True
```

1 Data exploration

[2]:
```
df = pd.read_csv('./development.csv')
df.head(10)
```

[2]:

	text	class
0	Non è l'hotel più lussuoso in cui abbia mai so...	pos
1	Siamo stati qui per 1 notte prima della nostra...	pos
2	Hotel è ben posizionato per visitare Torino. A...	pos
3	All'arrivo la cordialità e disponibilità dello...	pos
4	Abbiamo soggiornato per due notti alla fine de...	pos
5	Ho soggiornato nell'hotel Acca Palace per una ...	pos
6	Struttura a due passi dalla stazione di mestre...	pos
7	Ho transitato in questa struttura per qualche ...	pos
8	un ottimo hotel in zona centrale,molto partico...	pos
9	Sono stato all hotel la Pergola l, estate scor...	pos

[3]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 28754 entries, 0 to 28753
Data columns (total 2 columns):
text     28754 non-null object
class    28754 non-null object
dtypes: object(2)
memory usage: 449.4+ KB
```

[4]:
```
df_eval = pd.read_csv('./evaluation.csv')
df_eval.head(10)
```

[4]:

	text
0	Mi sono fermato una sola notte essendo di pass...
1	Ho prenotato questo hotel per essere vicino al...
2	Si tratta di un hotel di lusso costruito nel X...
3	Arrivo alle 23:30 faccio check in e chiedo la ...
4	Sono pochi gli Hotel che riescono a coniugare ...
5	Abbiamo soggiornato per una notte in questo Ho...
6	Sì, questa è la mia seconda volta, durante un ...
7	Sono andato a dare una conferenza per 3 giorni...
8	Sono stato in questa struttura per lavoro, in ...
9	Recentemente abbiamo visitato Ad place per un ...

[5]:
```
df_eval.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 12323 entries, 0 to 12322
Data columns (total 1 columns):
text    12323 non-null object
dtypes: object(1)
memory usage: 96.4+ KB
```

[6]:
```
df['class'].unique()
```

[6]:
```
array(['pos', 'neg'], dtype=object)
```

[7]:
```
Counter(df['class'])
```

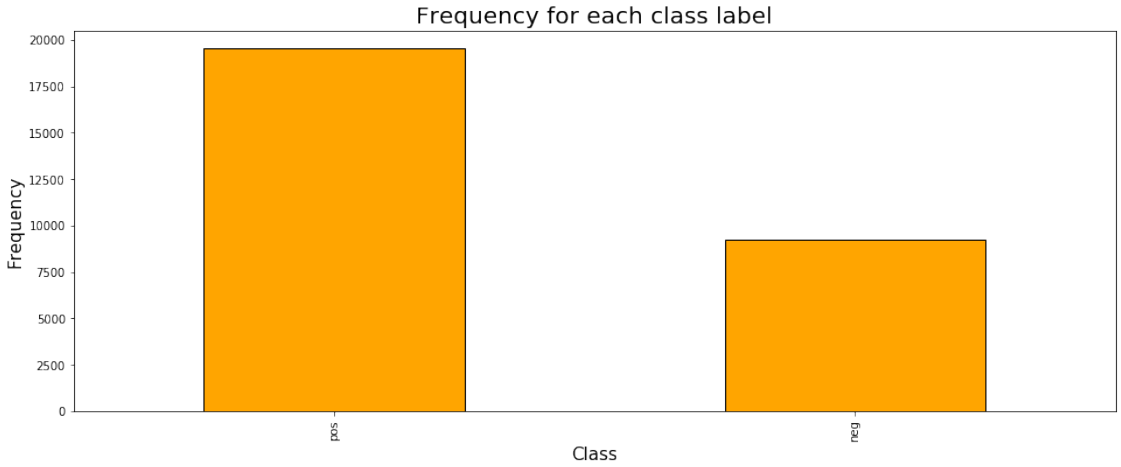
[7]:
```
Counter({'pos': 19532, 'neg': 9222})
```

[8]:
```
num_pos = len(df.loc[df['class']=='pos'])
num_neg = len(df.loc[df['class']=='neg'])
print("Percentage of positives: %2.2f%%" %(num_pos/(num_pos+num_neg)*100))
print("Percentage of negatives: %2.2f%%" %(num_neg/(num_pos+num_neg)*100))
```

```
Percentage of positives: 67.93%
Percentage of negatives: 32.07%
```

[9]:
```
plt.figure(figsize=(16, 6))
df['class'].value_counts().plot('bar',facecolor='orange',edgecolor='black')
```

```
plt.title('Frequency for each class label', fontsize=20)
plt.xlabel('Class', fontsize=15)
plt.ylabel('Frequency', fontsize=15)
plt.show()
```



[10]:
```
for ind in df.index:
    df.loc[ind,'len_text'] = len(df.loc[ind,'text'])
df.head(10)
```

[10]:

	text	class	len_text
0	Non è l'hotel più lussuoso in cui abbia mai so...	pos	4284.0
1	Siamo stati qui per 1 notte prima della nostra...	pos	308.0
2	Hotel è ben posizionato per visitare Torino. A...	pos	384.0
3	All'arrivo la cordialità e disponibilità dello...	pos	240.0
4	Abbiamo soggiornato per due notti alla fine de...	pos	411.0
5	Ho soggiornato nell'hotel Acca Palace per una ...	pos	545.0
6	Struttura a due passi dalla stazione di mestre...	pos	233.0
7	Ho transitato in questa struttura per qualche ...	pos	635.0
8	un ottimo hotel in zona centrale,molto partico...	pos	306.0
9	Sono stato all hotel la Pergola 1, estate scor...	pos	657.0

[11]:
```
df.describe()
```

[11]:

	len_text
count	28754.000000
mean	701.431662
std	606.395492
min	58.000000
25%	325.000000
50%	515.000000
75%	850.750000
max	9153.000000

[12]:
```
for ind in df_eval.index:
    df_eval.loc[ind,'len_text'] = len(df_eval.loc[ind,'text'])
df_eval.head(10)
```

[12]:

	text	len_text
0	Mi sono fermato una sola notte essendo di pass...	230.0
1	Ho prenotato questo hotel per essere vicino al...	1133.0
2	Si tratta di un hotel di lusso costruito nel X...	482.0
3	Arrivo alle 23:30 faccio check in e chiedo la ...	760.0
4	Sono pochi gli Hotel che riescono a coniugare ...	558.0
5	Abbiamo soggiornato per una notte in questo Ho...	613.0
6	Sì, questa è la mia seconda volta, durante un ...	492.0
7	Sono andato a dare una conferenza per 3 giorni...	663.0
8	Sono stato in questa struttura per lavoro, in ...	385.0
9	Recentemente abbiamo visitato Ad place per un ...	1459.0

[13]:
```
df_eval.describe()
```

[13]:

	len_text
count	12323.000000
mean	699.206119
std	605.312323
min	65.000000
25%	323.000000
50%	515.000000
75%	854.000000
max	9221.000000

[14]:
```
df.groupby('class')['len_text'].mean()
```

[14]:
```
class
neg    864.228475
pos    624.567428
Name: len_text, dtype: float64
```

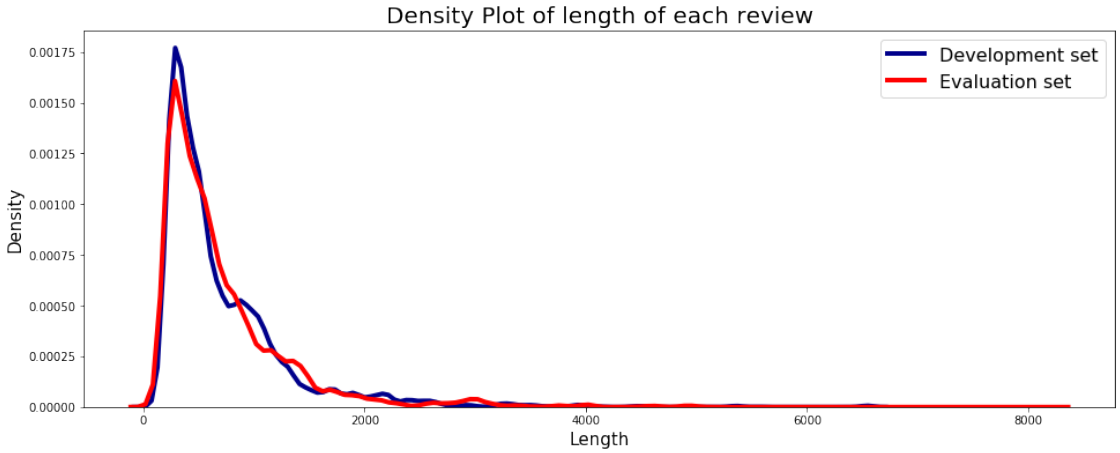
[15]:
```
df.groupby('class').describe().transpose()
```

[15]:

class		neg	pos
len_text	count	9222.000000	19532.000000
	mean	864.228475	624.567428
	std	740.823934	513.623093
	min	67.000000	58.000000
	25%	393.000000	307.000000
	50%	644.000000	465.000000
	75%	1071.000000	752.000000
	max	9153.000000	7800.000000

[16]:
```
plt.figure(figsize=(16, 6))
# Density Plot and Histogram of length of each review
sns.distplot(df.loc[df['len_text'],'len_text'], kde=True, hist=False,
             color = 'darkblue',
```

```
            hist_kws={'edgecolor':'black'},
            kde_kws={'linewidth': 4},
            label='Development set')
sns.distplot(df_eval.loc[df_eval['len_text'],'len_text'], kde=True, hist=False,
            color = 'red',
            hist_kws={'edgecolor':'black'},
            kde_kws={'linewidth': 4},
            label='Evaluation set')
# Plot formatting
plt.legend(prop={'size': 16})
plt.title('Density Plot of length of each review', fontsize=20)
plt.xlabel('Length', fontsize=15)
plt.ylabel('Density', fontsize=15)
plt.show()
```



[17]:
```
perc90 = np.percentile(df['len_text'], 90)
perc90
```

[17]:
```
1345.0
```

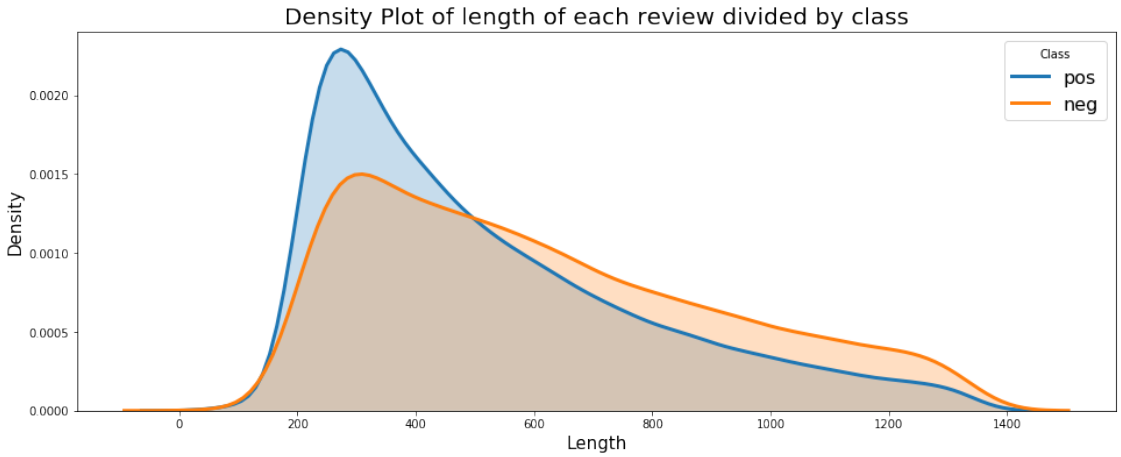
[18]:
```
# List of classes to plot
classes = ['pos', 'neg']

plt.figure(figsize=(16, 6))
# Iterate through the classes
for id_class in classes:
    # Subset to the class
    subset = df[df['class'] == id_class]

    # Draw the density plot
    sns.distplot(subset.loc[subset['len_text']<perc90,'len_text'], hist =␣
 ↪False, kde = True,
                 kde_kws = {'shade': True, 'linewidth': 3},
```

```
                label = id_class)

# Plot formatting
plt.legend(prop={'size': 16}, title = 'Class')
plt.title('Density Plot of length of each review divided by class', fontsize=20)
plt.xlabel('Length', fontsize=15)
plt.ylabel('Density', fontsize=15)
plt.show()
```



2 Preprocessing

[91]:
```
X = df['text']
X_eval = df_eval['text']
```

[20]:
```
def lemmatize_word(input_word):
    in_word = input_word
    word_it = pattern.it.parse(
        in_word,
        tokenize=False,
        tag=False,
        chunk=False,
        lemmata=True
    )
    the_lemmatized_word = word_it.split()[0][0][4]
    return the_lemmatized_word
```

[21]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
from nltk.tokenize import word_tokenize
from nltk.stem.wordnet import WordNetLemmatizer
from nltk.corpus import stopwords as sw
from nltk.stem import SnowballStemmer
```

```
import re
import string
import emoji
from alphabet_detector import AlphabetDetector

class LemmaTokenizer(object):
    def __init__(self):
        self.stemmer = SnowballStemmer("italian")
        self.ad = AlphabetDetector()

    def __call__(self, document):
        lemmas = []
        re_digit = re.compile("[0-9:]") # regular expression to filter digit␣
↪tokens

        for t in word_tokenize(document):
            t = t.strip() # elimination of spaces at the beginning and end
            t = t.strip(".-/_+*':,řč|^ť`=\\~") # elimination of symbols at the␣
↪beginning and end

            # separation caused by punctuation characters excluding -
            t = re.split(";|\.|\:||,|\*|/|_|\+|\n|'|ř||č|\||\^|ť|`|=|~|",t)

            for s in t:
                if len(s)>=2:
                    # I control words that are not just numbers and letters
                    if not s.isalnum():
                        s_aux = ""
                        for c in s: # scan characters in search of emojis,␣
↪dashes, particular symbols and non-Latin characters
                            if c not in emoji.UNICODE_EMOJI and c != '-' and c!
↪='' and c!='\\' \
                            and c!=u"\u200b" and c!=u"\ufe0f" and c!=u"\uff0c"␣
↪and c!=u"\u00d7"\
                            and c!=u"\u2022" and c!=u"\u3002"and self.ad.
↪is_latin(c):
                                s_aux = s_aux + c
                        s = s_aux # word without emoji, dashes, special symbols␣
↪and non-Latin characters

                    # words that contain both numbers and letters, then I␣
↪delete numbers
                    if (not (s.isalpha() or s.isdecimal())) and s.isalnum():
                        s_alpha = ""
                        for c in s: # scan characters in search of letters
                            if c.isalpha():
```

```
                                    s_alpha = s_alpha + c
                            s = s_alpha # words without numbers

                        lemma = lemmatize_word(s)
                        lemma = self.stemmer.stem(lemma)

                        # remove tokens with only punctuation chars and digits
                        if lemma not in string.punctuation and \
                           len(lemma) >= 2 and \
                           len(lemma) < 16 and \
                           not re_digit.match(lemma) and\
                           self.ad.is_latin(lemma):
                            lemmas.append(lemma)

        return lemmas
```

[22]:
```
import unicodedata

def strip_accents(text):
    """
    Strip accents from input String.

    :param text: The input string.
    :type text: String.

    :returns: The processed String.
    :rtype: String.
    """
    text = unicodedata.normalize('NFD', text)
    text = text.encode('ascii', 'ignore')
    text = text.decode("utf-8")
    return str(text)
```

[23]:
```
stopwords = list(set(get_stop_words('italian') + nltk.corpus.stopwords.
 ↪words('italian')))

# I get an error if they have already been removed previously
try:
    stopwords.remove('non')
except:
    pass
try:
    stopwords.remove('no')
except:
    pass
try:
    stopwords.remove('senza')
except:
```

```
    pass

print(stopwords)
```

```
['stanno', 'tua', 'sarebbe', 'pochi', 'stavamo', 'saremo', 'quanta', 'faresti',
'sull', 'poco', 'farò', 'faccio', 'ad', 'fece', 'vi', 'allo', 'avevi', 'dei',
'tuo', 'nella', 'abbiate', 'gli', 'delle', 'una', 'con', 'altre', 'a', 'fui',
'nostri', 'stando', 'col', 'chi', 'tuoi', 'vostro', 'stavate', 'come', 'tu',
'questi', 'aveste', 'starebbe', 'stiamo', 'avevo', 'stare', 'avesti', 'la',
'stesse', 'feci', 'foste', 'lo', 'avendo', 'i', 'facevano', 'facciamo', 'avrei',
'negl', 'è', 'tue', 'stesso', 'stette', 'vostra', 'degl', 'perché', 'stavo',
'dallo', 'stiate', 'starete', 'fino', 'stessero', 'sei', 'vostre', 'in', 'o',
'vostri', 'di', 'avesse', 'all', 'avrebbero', 'farà', 'fossi', 'fosti', 'fanno',
'mia', 'eravate', 'sue', 'ecco', 'eravamo', 'della', 'nelle', 'aveva',
'stareste', 'uno', 'avuti', 'ci', 'abbiamo', 'essendo', 'avrete', 'avessimo',
'ne', 'anche', 'da', 'staremmo', 'su', 'contro', 'avemmo', 'alle', 'avrò', 'ho',
'le', 'ed', 'faremmo', 'saranno', 'staremo', 'sotto', 'stava', 'sua', 'dalla',
'altro', 'quale', 'dal', 'l', 'quella', 'hai', 'dove', 'però', 'faceva',
'faremo', 'facessimo', 'avremo', 'lui', 'farei', 'mie', 'avuto', 'stesti', 'ti',
'avrà', 'negli', 'nell', 'fareste', 'starà', 'starebbero', 'ebbero', 'siamo',
'ero', 'stiano', 'stavano', 'suoi', 'faccia', 'fosse', 'dagli', 'degli',
'facesse', 'quindi', 'sia', 'al', 'farete', 'nello', 'avevano', 'sugl', 'stavi',
'stai', 'un', 'erano', 'tutto', 'faranno', 'fare', 'dov', 'tutti', 'quelli',
'facciano', 'sarei', 'steste', 'sulle', 'farebbe', 'starò', 'facesti', 'quanto',
'qui', 'abbiano', 'nostra', 'furono', 'li', 'quasi', 'starai', 'sarai', 'stia',
'avete', 'dalle', 'facevamo', 'sono', 'ebbe', 'facessi', 'me', 'facemmo', 'ha',
'sullo', 'mio', 'qua', 'faceste', 'starei', 'se', 'il', 'facciate', 'sarete',
'abbia', 'facevo', 'ai', 'fummo', 'siete', 'dai', 'avresti', 'fai', 'ebbi',
'loro', 'altri', 'dall', 'avevate', 'mi', 'siano', 'facendo', 'saremmo',
'sulla', 'sarà', 'siate', 'stessi', 'avessi', 'queste', 'nei', 'fecero', 'fu',
'quanti', 'sta', 'staresti', 'stessimo', 'nel', 'sarò', 'adesso', 'sareste',
'saresti', 'dentro', 'si', 'fossimo', 'nostro', 'vai', 'alla', 'noi', 'stemmo',
'coi', 'più', 'quante', 'e', 'del', 'stetti', 'eri', 'avevamo', 'dagl',
'sarebbero', 'hanno', 'quello', 'te', 'questo', 'avrai', 'avrebbe', 'dell',
'agl', 'avreste', 'avremmo', 'dello', 'nostre', 'sul', 'ma', 'allora', 'facevi',
'tra', 'avranno', 'ancora', 'per', 'c', 'farebbero', 'giù', 'questa',
'facessero', 'lei', 'sui', 'stettero', 'io', 'staranno', 'facevate', 'quelle',
'avere', 'avute', 'era', 'sopra', 'avessero', 'agli', 'suo', 'farai', 'cui',
'fra', 'sto', 'avuta', 'voi', 'miei', 'che', 'fossero', 'sugli']
```

[28]:
```
tokenizer = LemmaTokenizer()
stop_words_tok = []
for sw in stopwords:
    sw_no_acc = strip_accents(sw)
    sw_tok = tokenizer(sw_no_acc)
    if len(sw_tok)>0:
        stop_words_tok.append(sw_tok[0])
```

```
stop_words_tok = list(set(stop_words_tok))
print(stop_words_tok)
```

```
['all', 'farsen', 'nei', 'tua', 'dentr', 'quant', 'mia', 'sia', 'sar', 'al',
'ecco', 'foss', 'sugl', 'avro', 'nel', 'sull', 'un', 'esser', 'com', 'piu',
'uno', 'si', 'ad', 'dov', 'nostr', 'ci', 'vi', 'alla', 'allo', 'noi', 'dei',
'facc', 'coi', 'ne', 'anche', 'da', 'quell', 'tuo', 'perc', 'qui', 'su', 'del',
'altra', 'li', 'fac', 'fec', 'aglo', 'alle', 'dagl', 'una', 'con', 'sti', 'col',
'te', 'poc', 'ebbo', 'chi', 'le', 'ed', 'sopr', 'dell', 'quest', 'agl', 'me',
'lor', 'mio', 'tu', 'qua', 'sul', 'aver', 'ma', 'sua', 'ancor', 'altro', 'la',
'se', 'tra', 'allor', 'per', 'sott', 'dal', 'vostr', 'il', 'fin', 'lo', 'far',
'lei', 'giu', 'sui', 'lui', 'star', 'negl', 'mie', 'quind', 'io', 'avra', 'ti',
'ai', 'contr', 'degl', 'nell', 'vao', 'dai', 'avut', 'qual', 'suo', 'dall',
'mi', 'quas', 'cui', 'fra', 'adess', 'in', 'voi', 'stess', 'che', 'tutt', 'di']
```

[74]:
```
vectorizer = TfidfVectorizer(input='content', tokenizer=LemmaTokenizer(),\
                             stop_words=stop_words_tok,\
                             strip_accents='ascii', lowercase=True,␣
 ↪ngram_range=(1,3))

vectorizer.fit(pd.concat((X,X_eval)))
```

[74]:
```
TfidfVectorizer(analyzer='word', binary=False, decode_error='strict',
                dtype=<class 'numpy.float64'>, encoding='utf-8',
                input='content', lowercase=True, max_df=1.0, max_features=None,
                min_df=1, ngram_range=(1, 3), norm='l2', preprocessor=None,
                smooth_idf=True,
                stop_words=['all', 'farsen', 'nei', 'tua', 'dentr', 'quant',
                            'mia', 'sia', 'sar', 'al', 'ecco', 'foss', 'sugl',
                            'avro', 'nel', 'sull', 'un', 'esser', 'com', 'piu',
                            'uno', 'si', 'ad', 'dov', 'nostr', 'ci', 'vi',
                            'alla', 'allo', 'noi', ...],
                strip_accents='ascii', sublinear_tf=False,
                token_pattern='(?u)\\b\\w\\w+\\b',
                tokenizer=<__main__.LemmaTokenizer object at
0x000001D03BF73470>,
                use_idf=True, vocabulary=None)
```

[75]:
```
X_tfidf = vectorizer.transform(X)
X_tfidf
```

[75]:
```
<28754x2856518 sparse matrix of type '<class 'numpy.float64'>'
        with 4927112 stored elements in Compressed Sparse Row format>
```

[76]:
```
X_tfidf_eval = vectorizer.transform(X_eval)
X_tfidf_eval
```

[76]:
```
<12323x2856518 sparse matrix of type '<class 'numpy.float64'>'
        with 2107251 stored elements in Compressed Sparse Row format>
```

[77]:
```
# print first 100 feature names
print(vectorizer.get_feature_names()[:100])
```

```
['aa', 'aa frig', 'aa frig camer', 'aa venez', 'aa venez citt', 'aaa', 'aaa
prenot', 'aaa prenot hotel', 'aaaaaa', 'aaaaaa normal', 'aaaaaa normal inutil',
'aaaaaaaa', 'aaaaaaaa impossibil', 'aaaaaaaa impossibil ser', 'aabout', 'aabout
reception', 'aabout reception dimension', 'aaccoglient', 'aaccoglient non',
'aaccoglient non mil', 'aaccoglit', 'aaccoglit stup', 'aaccoglit stup personal',
'aao', 'aao sacchett', 'aao sacchett lim', 'aapen', 'aapen ago', 'aapen ago
mogl', 'aaron', 'aaron aprir', 'aaron aprir circ', 'aaron mentr', 'aaron mentr
visit', 'aaron nikol', 'aaron nikol molt', 'aaron non', 'aaron non pot', 'aaron
personal', 'aaron personal cordial', 'aaron piuttost', 'aaron piuttost adatt',
'aaron sol', 'aaron sol nott', 'aaron vist', 'aaron vist sol', 'ababst', 'ababst
disponibil', 'ababst disponibil part', 'abacus', 'abacus sest', 'abacus sest
bell', 'abacus sest cost', 'abadjour', 'abadjour tropp', 'abadjour tropp
soffus', 'abajour', 'abajour bagn', 'abajour bagn specc', 'abajour comodin',
'abajour comodin no', 'abajour non', 'abajour non andarsen', 'abajour pessim',
'abajour pessim sconsigl', 'abajour tavolett', 'abajour tavolett comod',
'abajours', 'abajours bagn', 'abajours bagn piccol', 'abajur', 'abajur
irraggiung', 'abajur irraggiung bui', 'abar', 'abar possibil', 'abar possibil
convert', 'abar pot', 'abar pot apprezz', 'abar trov', 'abar trov ospital',
'abas', 'abas urtar', 'abas urtar amic', 'abasciur', 'abasciur piccolissim',
'abasciur piccolissim finestr', 'abass', 'abass fatt', 'abass fatt giorn',
'abat', 'abat jour', 'abat jour chiav', 'abat jour disponibil', 'abat jour
guast', 'abat jour legg', 'abat jour luc', 'abat jour tv', 'abat rumor', 'abat
rumor colazion', 'abatantu']
```

[78]:
```
d = dict(enumerate(df['class'].astype('category').cat.categories))
print (d)
y = df['class'].astype('category').cat.codes
print(y.head(10))
```

```
{0: 'neg', 1: 'pos'}
0    1
1    1
2    1
3    1
4    1
5    1
6    1
7    1
8    1
9    1
dtype: int8
```

3 Algorithm choice

[41]:
```
from sklearn.model_selection import GridSearchCV, train_test_split
from sklearn.metrics import f1_score
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier
from sklearn.neural_network import MLPClassifier
from sklearn.neighbors import KNeighborsClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.linear_model import SGDClassifier
from sklearn.svm import SVC
from sklearn.svm import LinearSVC
```

[42]:
```
X_train, X_test, y_train, y_test = train_test_split(X_tfidf, y, stratify=y,␣
 ↪shuffle=True)
```

[43]:
```
c = Counter(y_train)
print("train")
for i in [0,1]:
    print(d[i], c[i]/len(y_train))
c = Counter(y_test)
print("test")
for i in [0,1]:
    print(d[i], c[i]/len(y_test))
```

```
train
neg 0.320704845814978
pos 0.6792951541850221
test
neg 0.3207678397551815
pos 0.6792321602448185
```

3.1 DecisionTreeClassifier

[ ]:
```
clf = DecisionTreeClassifier()
clf.fit(X_train, y_train)
y_pred = clf.predict(X_test)

print(f1_score(y_test, y_pred, average='weighted'))
```

[ ]:
```
# Classification model that we want to configure:
clf = DecisionTreeClassifier()

# Parameter grid
# Specify in a dictionary a key for each parameter to be configured and the␣
 ↪list of its values
# The keys in the dictionary must match the parameter names of the model␣
 ↪constructor
```

```
param_grid = {'criterion':["gini","entropy"],
              'splitter':["best","random"],
              'max_features':["sqrt","auto","log2",None],
              'class_weight':["balanced",None]}

# Configure grid search with the model and the parameter grid
# The best model is computed based on the scoring function (f1) and with␣
 ↪cross-validation (cv)
gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5, n_jobs=-1)

# Optimize the model parameters with cross-validation on the training data
# The best model configuration is the one with highest f1 score
res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)

# Evaluate on test set
y_pred = final_model.predict(X_test)
f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

3.2 RandomForestClassifier

[ ]:
```
clf = RandomForestClassifier(100, max_features='sqrt',n_jobs=-1)
clf.fit(X_train, y_train)
y_pred = clf.predict(X_test)

print(f1_score(y_test, y_pred, average='weighted'))
```

[ ]:
```
clf = RandomForestClassifier(n_jobs=-1)

param_grid = {'n_estimators':list(range(50,101,10)),
              'criterion':["entropy","gini"],
              'max_features':["sqrt","log2"],
              'class_weight':["balanced","balanced_subsample", None]}

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)
```

```
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
final_model = res.best_estimator_
final_model.fit(X_train, y_train)
y_pred = final_model.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

3.3 MLPClassifier

[ ]:
```
#Initializing the MLPClassifier
classifier = MLPClassifier(hidden_layer_sizes=(150,100,50),␣
 ↪max_iter=300,activation = 'relu',solver='adam',shuffle=True)
#Fitting the training data to the network
classifier.fit(X_train, y_train)
#Predicting y for X_test
y_pred = classifier.predict(X_test)

print(f1_score(y_test, y_pred, average='weighted'))
```

[ ]:
```
# Classifier model that we want to configure:
clf = MLPClassifier(max_iter=300,shuffle=True)

param_grid = {'hidden_layer_sizes':[(150,100,50)],
              'activation': ['relu','identity','logistic','tanh'],
              'solver':['adam'],
              'learning_rate':['constant','invscaling','adaptive']}

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=3,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
y_pred = final_model.predict(X_test)
```

```
f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

3.4 KNeighborsClassifier

[ ]:
```
#create new a knn model
knn = KNeighborsClassifier(n_neighbors=3)

knn.fit(X_train, y_train)
y_pred = knn.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

[ ]:
```
#create new a knn model
knn = KNeighborsClassifier()

param_grid = {'n_neighbors': np.arange(1, 40,5),
              'weights': ['uniform','distance']
             }

gridsearch = GridSearchCV(knn, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
y_pred = final_model.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

3.5 LogisticRegression

[ ]:
```
logreg = LogisticRegression(solver='lbfgs')
logreg.fit(X_train, y_train)
y_pred = logreg.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
```

```
print("f1 (test set): %.5f" % f1)
```

[ ]:
```
# Classifier model that we want to configure:
logreg = LogisticRegression()

param_grid = {'penalty':['l2','none'],
              'solver':['newton-cg','lbfgs','sag','saga'],
              'class_weight':['auto','balanced',None]}

gridsearch = GridSearchCV(logreg, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
y_pred = final_model.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

[ ]:
```
# Classifier model that we want to configure:
logreg = LogisticRegression()

param_grid = {'penalty':['elasticnet'],
              'solver':['saga'],
              'l1_ratio':np.linspace(0,1,num=11)}

gridsearch = GridSearchCV(logreg, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
```

```
y_pred = final_model.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

3.6 SGDClassifier

[ ]:
```
clf = SGDClassifier()
clf.fit(X_train, y_train)
y_pred = clf.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

[ ]:
```
# Classifier model that we want to configure:
clf = SGDClassifier(n_jobs=-1)

param_grid = {'penalty':['l2','l1','elasticnet'],
              'loss':
 ↪['hinge','log','modified_huber','squared_hinge','perceptron'],\
                    ␣
 ↪#'squared_loss','huber','epsilon_insensitive','squared_epsilon_insensitive'],
              'class_weight':['balanced',None],
              'alpha':[0.000001,0.00001,0.0001],#,0.001,0.01,0.1],
              'learning_rate':['constant','optimal','invscaling','adaptive'],
              'eta0':[0.00001]
             }

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
y_pred = final_model.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

3.7 SVC

[ ]:
```
clf = SVC(kernel='linear')
clf.fit(X_train, y_train)
y_pred = clf.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

[ ]:
```
# Classifier model that we want to configure:
clf = SVC(kernel='linear')

param_grid = {'C':np.linspace(0.1,3,num=10)}

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
y_pred = final_model.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

3.8 LinearSVC

[ ]:
```
clf = LinearSVC()
clf.fit(X_train, y_train)
y_pred = clf.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

[ ]:
```
# Classifier model that we want to configure:
clf = LinearSVC()

param_grid = {'penalty':['l2'],
              'loss':['hinge','squared_hinge'],
              'C':np.linspace(0.1,3,num=10),
```

```
              'class_weight':['balanced',None]
             }

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
y_pred = final_model.predict(X_test)

f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

[ ]:
```
# Classifier model that we want to configure:
clf = LinearSVC()

param_grid = {'penalty':['l1'],
              'loss':['squared_hinge'],
              'dual':[False],
              'C':np.linspace(0.1,3,num=10),
              'class_weight':['balanced',None]
             }

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5,n_jobs=-1)

res = gridsearch.fit(X_train, y_train)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

[ ]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_train, y_train)
# Evaluate on test set
y_pred = final_model.predict(X_test)
```

```
f1 = f1_score(y_test, y_pred, average='weighted')
print("f1 (test set): %.5f" % f1)
```

4 Tuning and validation

[59]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import SGDClassifier
from sklearn.svm import LinearSVC
```

4.1 Tuning and validation of LinearSVC

[85]:
```
# Classifier model that we want to configure:
clf = LinearSVC(penalty='l2',dual=True,class_weight='balanced')

param_grid = {'loss':['hinge','squared_hinge'],
              'tol':[1e2,1e1,1,1e-1,1e-2,1e-3,1e-4,1e-5],
              'C':[0.1,1,10,50,100,500,1000,5000,10000]
             }

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5, n_jobs=-1)

res = gridsearch.fit(X_tfidf, y)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

```
Best model configuration is:
{'C': 1000, 'loss': 'hinge', 'tol': 1}
with f1=0.97490
inizio    : 176794.03
fine      : 177169.62
intervallo:    375.59
```

[86]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_tfidf, y)

# Evaluate on test set
y_pred_1 = final_model.predict(X_tfidf_eval)
```

4.2 Tuning and validation of SGDClassifier

[87]:
```
# Classifier model that we want to configure:
clf = SGDClassifier(learning_rate='optimal',n_jobs=-1)

param_grid = {'penalty':['elasticnet'],
              'l1_ratio':np.linspace(0,0.5,num=11),
              'loss':
 ↪['hinge','log','modified_huber','squared_hinge','perceptron'],
              'alpha':[0.000001,0.000005,0.00001,0.00005,0.0001,0.001,0.01,0.1],
              'fit_intercept':[True,False],
              'tol':[1e2,1e1,1,1e-1,1e-2,1e-3,1e-4,1e-5,1e-6]
             }

gridsearch = GridSearchCV(clf, param_grid, scoring='f1', cv=5, n_jobs=-1)

res = gridsearch.fit(X_tfidf, y)

# Print result
print("Best model configuration is:")
print(res.best_params_)
print("with f1=%.5f" % res.best_score_)
```

```
Best model configuration is:
{'alpha': 5e-06, 'fit_intercept': True, 'l1_ratio': 0.45, 'loss': 'hinge',
'penalty': 'elasticnet', 'tol': 0.01}
with f1=0.97621
inizio    : 177170.06
fine      : 194809.86
intervallo:  17639.80
```

[88]:
```
# Take the best model configuration
final_model = res.best_estimator_
# Fit on complete training set
final_model.fit(X_tfidf, y)
# Evaluate on test set
y_pred_2 = final_model.predict(X_tfidf_eval)
```

5 Output

[92]:
```
import csv
```

[93]:
```
filename = "output1.csv"
with open(filename, mode='w') as output_file:
    output_writer = csv.writer(output_file, delimiter=',', lineterminator='\n',␣
 ↪quotechar='"', quoting=csv.QUOTE_MINIMAL)
```

```
    output_writer.writerow(['Id','Predicted'])
    for i in range(X_tfidf_eval.shape[0]):
        output_writer.writerow([i,d[y_pred_1[i]]])
```

[94]:
```
filename = "output2.csv"
with open(filename, mode='w') as output_file:
    output_writer = csv.writer(output_file, delimiter=',', lineterminator='\n',␣
 ↪quotechar='"', quoting=csv.QUOTE_MINIMAL)
    output_writer.writerow(['Id','Predicted'])
    for i in range(X_tfidf_eval.shape[0]):
        output_writer.writerow([i,d[y_pred_2[i]]])
```