## Autoimmune Tweets using the mostly preprocessed file from R and testing on Lemmatized Tweets with 8 categories of autoimmune diseases[¶](#Autoimmune-Tweets-using-the-mostly-prep)

Those being: 0:Leukemia, 1: Fibromyalgia, 2:Kidney Disease, 3: Celiac Disease, 4: MS, 5: Hashimoto, 6: RA, 7: Chron's Disease

Tweets were taken from respective diseases in early December 2019 from 13 to 119 tweets for each disease, as many as were found that weren't mostly marketing, using '' treatment' in the search

In [1]:

%matplotlib inline

import pandas as pd

import matplotlib.pyplot as plt

from textblob import TextBlob

import sklearn

import numpy as np

from sklearn.feature\_extraction.text import CountVectorizer

from sklearn.naive\_bayes import MultinomialNB

from sklearn.metrics import classification\_report, f1\_score, accuracy\_score, confusion\_matrix

np.random.seed(47)

In [2]:

reviews = pd.read\_csv('LemmaPythonRead.csv', encoding = 'unicode\_escape')

#the encoding needed for python3 handling nonASCII chars

In [3]:

reviews.head()

Out[3]:

|  | **LemmatizedTweets** | **StemmedTweets** | **AutoImmuneDisorder** |
| --- | --- | --- | --- |
| 0 | unknown research unknownresearch the center fo... | unknown research\r\nunknownresearch\r\nthe cen... | Celiac\_Disease |
| 1 | lynn barter abc mc lbarter · dec reply to thre... | lynn barter abc mc\r\nlbarter\r\n·\r\ndec \r\n... | Celiac\_Disease |
| 2 | theona layne theonawrites · dec unknown diseas... | theona layne\r\ntheonawrites\r\n·\r\ndec \r\nu... | Celiac\_Disease |
| 3 | bob simonoff simonoffbob · dec there be eviden... | bob simonoff\r\nsimonoffbob\r\n·\r\ndec \r\nth... | Celiac\_Disease |
| 4 | gfdenver gfdenver · nov hm interest research n... | gfdenver\r\ngfdenver\r\n·\r\nnov \r\nhm intere... | Celiac\_Disease |

In [4]:

reviews.tail()

Out[4]:

|  | **LemmatizedTweets** | **StemmedTweets** | **AutoImmuneDisorder** |
| --- | --- | --- | --- |
| 502 | pharmabot thepharmabot · nov codessly effectiv... | pharmabot\r\nthepharmabot\r\n·\r\nnov \r\ncode... | Leukemia\_Disease |
| 503 | wcm lymphoma wcmclymphoma · dec select initial... | wcm lymphoma\r\nwcmclymphoma\r\n·\r\ndec \r\ns... | Leukemia\_Disease |
| 504 | medivizor medivizor · dec cope with cml check ... | medivizor\r\nmedivizor\r\n·\r\ndec \r\ncoping ... | Leukemia\_Disease |
| 505 | abi brokenleadheart · dec reply to rickyspurs ... | abi\r\nbrokenleadheart\r\n·\r\ndec \r\nreplyin... | Leukemia\_Disease |
| 506 | brooke xbrooke · dec reply to itsjojosiwa dear... | brooke\r\n\r\n\r\nxbrooke\r\n·\r\ndec \r\nrepl... | Leukemia\_Disease |

In [5]:

reviews.shape

Out[5]:

(507, 3)

In [6]:

reviews = reviews.reindex(np.random.permutation(reviews.index))

print(reviews.head())

print(reviews.tail())

LemmatizedTweets \

407 medivizor medivizor · nov cope with cml check ...

196 medical news bulletin mednewsbulletin · jun a ...

359 drtharanga kumari wickramasooriya drtharanga ·...

39 nola unknown unknowndiary · sep reply to nolan...

245 christine blome blomechristine · jan our new t...

StemmedTweets AutoImmuneDisorder

407 medivizor\r\nmedivizor\r\n·\r\nnov \r\ncoping ... Leukemia\_Disease

196 medical news bulletin\r\nmednewsbulletin\r\n·\... Fibromyalgia

359 drtharanga kumari wickramasooriya\r\ndrtharang... Kidney\_Disease

39 nola unknown\r\nunknowndiary\r\n·\r\nsep \r\n... Celiac\_Disease

245 christine blome\r\nblomechristine\r\n·\r\njan ... MS\_Disease

LemmatizedTweets \

72 r unknownunknown runknownunknown · h chronic o...

264 lorilynn lorilynn · nov multiple unknown be a ...

327 unknown guild theunknownguild · nov fridayfin...

390 drug topic drugtopics · dec the fda have appro...

135 fms news bot fmsbot · nov unknown treatment ma...

StemmedTweets AutoImmuneDisorder

72 r unknownunknown\r\nrunknownunknown\r\n·\r\nh\... Hashimoto\_Disease

264 lorilynn\r\nlorilynn\r\n·\r\nnov \r\nmultiple ... MS\_Disease

327 unknown guild\r\ntheunknownguild\r\n·\r\nnov ... MS\_Disease

390 drug topics\r\ndrugtopics\r\n·\r\ndec \r\nthe ... Leukemia\_Disease

135 fms news bot\r\nfmsbot\r\n·\r\nnov \r\nunknown... Fibromyalgia

In [7]:

reviews.groupby('AutoImmuneDisorder').describe()

Out[7]:

|  | **LemmatizedTweets** | | | | **StemmedTweets** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **count** | **unique** | **top** | **freq** | **count** | **unique** | **top** | **freq** |
| **AutoImmuneDisorder** |  |  |  |  |  |  |  |  |
| Celiac\_Disease | 50 | 50 | blake parson blakepparsons · dec need help for... | 1 | 50 | 50 | np agarwal\r\nnpgrwl\r\n·\r\nnov \r\ntreatment... | 1 |
| Chron\_Disease | 19 | 19 | thomas and ethel bakery thomasandethel · nov r... | 1 | 19 | 19 | tyler daniel\r\ntylerdaniel\r\n·\r\naug \r\nb... | 1 |
| Fibromyalgia | 99 | 95 | fibro bloggers fibrobloggers · nov unknown tre... | 2 | 99 | 95 | chronic disease coalition\r\nchronicrights\r\n... | 2 |
| Hashimoto\_Disease | 30 | 29 | colorado natural med drgravesco · dec naturopa... | 2 | 30 | 29 | colorado natural med\r\ndrgravesco\r\n·\r\ndec... | 2 |
| Kidney\_Disease | 43 | 43 | stock shark stocksharks · dec today announce p... | 1 | 43 | 43 | eclinic diagnostics\r\neclinicnigeria\r\nyour... | 1 |
| Leukemia\_Disease | 119 | 116 | medivizor medivizor · nov cope with cml check ... | 3 | 119 | 116 | medivizor\r\nmedivizor\r\n·\r\nnov \r\ncoping ... | 3 |
| MS\_Disease | 119 | 119 | uonresearch uonresearch · jan fund signal new ... | 1 | 119 | 119 | multiple sclerosis\r\nunknownbio\r\n·\r\nnov \... | 1 |
| RA\_Disease | 28 | 28 | gse health blog gsehealth · sep what be the tr... | 1 | 28 | 28 | frontiers medicine\r\nfrontmedicine\r\n·\r\noc... | 1 |

In [8]:

reviews.groupby('AutoImmuneDisorder').describe()

Out[8]:

|  | **LemmatizedTweets** | | | | **StemmedTweets** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **count** | **unique** | **top** | **freq** | **count** | **unique** | **top** | **freq** |
| **AutoImmuneDisorder** |  |  |  |  |  |  |  |  |
| Celiac\_Disease | 50 | 50 | blake parson blakepparsons · dec need help for... | 1 | 50 | 50 | np agarwal\r\nnpgrwl\r\n·\r\nnov \r\ntreatment... | 1 |
| Chron\_Disease | 19 | 19 | thomas and ethel bakery thomasandethel · nov r... | 1 | 19 | 19 | tyler daniel\r\ntylerdaniel\r\n·\r\naug \r\nb... | 1 |
| Fibromyalgia | 99 | 95 | fibro bloggers fibrobloggers · nov unknown tre... | 2 | 99 | 95 | chronic disease coalition\r\nchronicrights\r\n... | 2 |
| Hashimoto\_Disease | 30 | 29 | colorado natural med drgravesco · dec naturopa... | 2 | 30 | 29 | colorado natural med\r\ndrgravesco\r\n·\r\ndec... | 2 |
| Kidney\_Disease | 43 | 43 | stock shark stocksharks · dec today announce p... | 1 | 43 | 43 | eclinic diagnostics\r\neclinicnigeria\r\nyour... | 1 |
| Leukemia\_Disease | 119 | 116 | medivizor medivizor · nov cope with cml check ... | 3 | 119 | 116 | medivizor\r\nmedivizor\r\n·\r\nnov \r\ncoping ... | 3 |
| MS\_Disease | 119 | 119 | uonresearch uonresearch · jan fund signal new ... | 1 | 119 | 119 | multiple sclerosis\r\nunknownbio\r\n·\r\nnov \... | 1 |
| RA\_Disease | 28 | 28 | gse health blog gsehealth · sep what be the tr... | 1 | 28 | 28 | frontiers medicine\r\nfrontmedicine\r\n·\r\noc... | 1 |

In [9]:

reviews['length'] = reviews['LemmatizedTweets'].map(lambda text: len(text))

print(reviews.head())

LemmatizedTweets \

407 medivizor medivizor · nov cope with cml check ...

196 medical news bulletin mednewsbulletin · jun a ...

359 drtharanga kumari wickramasooriya drtharanga ·...

39 nola unknown unknowndiary · sep reply to nolan...

245 christine blome blomechristine · jan our new t...

StemmedTweets AutoImmuneDisorder \

407 medivizor\r\nmedivizor\r\n·\r\nnov \r\ncoping ... Leukemia\_Disease

196 medical news bulletin\r\nmednewsbulletin\r\n·\... Fibromyalgia

359 drtharanga kumari wickramasooriya\r\ndrtharang... Kidney\_Disease

39 nola unknown\r\nunknowndiary\r\n·\r\nsep \r\n... Celiac\_Disease

245 christine blome\r\nblomechristine\r\n·\r\njan ... MS\_Disease

length

407 126

196 245

359 312

39 319

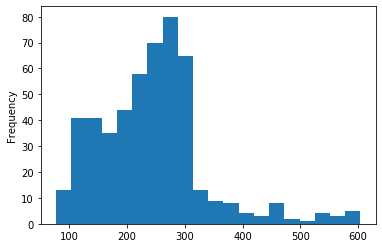
245 196

In [10]:

reviews.length.plot(bins=20, kind='hist')

Out[10]:

<matplotlib.axes.\_subplots.AxesSubplot at 0x18f59ff4128>



In [11]:

reviews.length.describe()

Out[11]:

count 507.000000

mean 243.998028

std 92.843285

min 77.000000

25% 175.500000

50% 244.000000

75% 287.000000

max 604.000000

Name: length, dtype: float64

In [12]:

print(list(reviews.LemmatizedTweets[reviews.length > 500].index)) #near the max for length of LemmatizedTweets

print(list(reviews.AutoImmuneDisorder[reviews.length > 500]))

[75, 432, 105, 104, 58, 145, 26, 82, 109, 111, 99, 167, 149]

['Hashimoto\_Disease', 'Leukemia\_Disease', 'Fibromyalgia', 'Fibromyalgia', 'Hashimoto\_Disease', 'Fibromyalgia', 'Celiac\_Disease', 'Chron\_Disease', 'Fibromyalgia', 'Fibromyalgia', 'Fibromyalgia', 'Fibromyalgia', 'Fibromyalgia']

In [13]:

%%time

reviews.hist(column='length', by='AutoImmuneDisorder', bins=10)

Wall time: 516 ms

Out[13]:

array([[<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A1780B8>,

<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A1C4E48>,

<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A1FA438>],

[<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A22C9E8>,

<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A25DF28>,

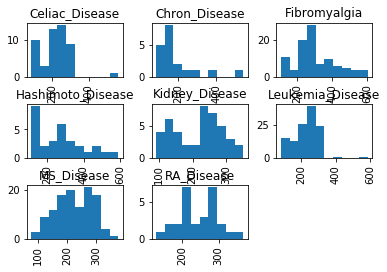
<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A29A518>],

[<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A2CCAC8>,

<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A3090F0>,

<matplotlib.axes.\_subplots.AxesSubplot object at 0x0000018F5A309128>]],

dtype=object)



In [14]:

def split\_into\_tokens(review):

#review = unicode(review, 'iso-8859-1')# in python 3 the default of str() previously python2 as unicode() is utf-8

return TextBlob(review).words

In [15]:

reviews.LemmatizedTweets.head().apply(split\_into\_tokens)

Out[15]:

407 [medivizor, medivizor, ·, nov, cope, with, cml...

196 [medical, news, bulletin, mednewsbulletin, ·, ...

359 [drtharanga, kumari, wickramasooriya, drtharan...

39 [nola, unknown, unknowndiary, ·, sep, reply, t...

245 [christine, blome, blomechristine, ·, jan, our...

Name: LemmatizedTweets, dtype: object

In [16]:

TextBlob("hello world, how is it going?").tags

Out[16]:

[('hello', 'JJ'),

('world', 'NN'),

('how', 'WRB'),

('is', 'VBZ'),

('it', 'PRP'),

('going', 'VBG')]

In [17]:

import nltk

nltk.download('stopwords')

[nltk\_data] Downloading package stopwords to

[nltk\_data] C:\Users\m\AppData\Roaming\nltk\_data...

[nltk\_data] Package stopwords is already up-to-date!

Out[17]:

True

In [18]:

from nltk.corpus import stopwords

stop = stopwords.words('english')

stop = stop + [u'a',u'b',u'c',u'd',u'e',u'f',u'g',u'h',u'i',u'j',u'k',u'l',u'm',u'n',u'o',u'p',u'q',u'r',u's',u't',u'v',u'w',u'x',u'y',u'z']

In [19]:

def split\_into\_lemmas(review):

#review = unicode(review, 'iso-8859-1')

review = review.lower()

#review = unicode(review, 'utf8').lower()

#review = str(review).lower()

words = TextBlob(review).words

# for each word, take its "base form" = lemma

return [word.lemma for word in words if word not in stop]

reviews.LemmatizedTweets.head().apply(split\_into\_lemmas)

Out[19]:

407 [medivizor, medivizor, ·, nov, cope, cml, chec...

196 [medical, news, bulletin, mednewsbulletin, ·, ...

359 [drtharanga, kumari, wickramasooriya, drtharan...

39 [nola, unknown, unknowndiary, ·, sep, reply, n...

245 [christine, blome, blomechristine, ·, jan, new...

Name: LemmatizedTweets, dtype: object

In [20]:

%%time

bow\_transformer = CountVectorizer(analyzer=split\_into\_lemmas).fit(reviews['LemmatizedTweets'])

print(len(bow\_transformer.vocabulary\_))

4208

Wall time: 734 ms

In [21]:

review4 = reviews['LemmatizedTweets'][42]

print(review4)

purna purnamusic · jun gluten shouldn  t be so painful no sleep night two advice try antihistamine ginger tea ibuprofen and activate charcoal over the last hour unknown treatment

In [22]:

bow4 = bow\_transformer.transform([review4])

print(bow4)

(0, 49) 1

(0, 81) 1

(0, 214) 1

(0, 628) 1

(0, 1458) 1

(0, 1476) 1

(0, 1665) 1

(0, 1871) 1

(0, 2113) 1

(0, 2191) 1

(0, 2713) 1

(0, 2848) 1

(0, 3129) 1

(0, 3130) 1

(0, 3473) 1

(0, 3702) 1

(0, 3845) 1

(0, 3873) 1

(0, 3890) 1

(0, 3944) 1

(0, 4199) 1

(0, 4206) 1

In [23]:

%%time

reviews\_bow = bow\_transformer.transform(reviews['LemmatizedTweets'])

print('sparse matrix shape:', reviews\_bow.shape)

print('number of non-zeros:', reviews\_bow.nnz)

print('sparsity: %.2f%%' % (100.0 \* reviews\_bow.nnz / (reviews\_bow.shape[0] \* reviews\_bow.shape[1])))

sparse matrix shape: (507, 4208)

number of non-zeros: 11902

sparsity: 0.56%

Wall time: 781 ms

In [24]:

# Split/splice into training ~ 80% and testing ~ 20%

reviews\_bow\_train = reviews\_bow[:400]

reviews\_bow\_test = reviews\_bow[400:]

reviews\_sentiment\_train = reviews['AutoImmuneDisorder'][:400]

reviews\_sentiment\_test = reviews['AutoImmuneDisorder'][400:]

print(reviews\_bow\_train.shape)

print(reviews\_bow\_test.shape)

(400, 4208)

(107, 4208)

In [25]:

%time review\_sentiment = MultinomialNB().fit(reviews\_bow\_train, reviews\_sentiment\_train)

Wall time: 78.1 ms

In [26]:

print('predicted:', review\_sentiment.predict(bow4)[0])

print('expected:', reviews.AutoImmuneDisorder[42])

predicted: Celiac\_Disease

expected: Celiac\_Disease

In [27]:

predictions = review\_sentiment.predict(reviews\_bow\_test)

print(predictions)

['Fibromyalgia' 'Fibromyalgia' 'MS\_Disease' 'Leukemia\_Disease'

'MS\_Disease' 'Fibromyalgia' 'Leukemia\_Disease' 'Kidney\_Disease'

'Hashimoto\_Disease' 'Fibromyalgia' 'Fibromyalgia' 'Leukemia\_Disease'

'Fibromyalgia' 'Fibromyalgia' 'MS\_Disease' 'MS\_Disease' 'MS\_Disease'

'Fibromyalgia' 'Fibromyalgia' 'Leukemia\_Disease' 'Leukemia\_Disease'

'Fibromyalgia' 'Fibromyalgia' 'Leukemia\_Disease' 'Fibromyalgia'

'Celiac\_Disease' 'Leukemia\_Disease' 'Fibromyalgia' 'Leukemia\_Disease'

'Leukemia\_Disease' 'Fibromyalgia' 'Leukemia\_Disease' 'Leukemia\_Disease'

'MS\_Disease' 'MS\_Disease' 'Fibromyalgia' 'Leukemia\_Disease' 'MS\_Disease'

'MS\_Disease' 'Fibromyalgia' 'Hashimoto\_Disease' 'MS\_Disease' 'MS\_Disease'

'MS\_Disease' 'MS\_Disease' 'Leukemia\_Disease' 'MS\_Disease' 'MS\_Disease'

'Celiac\_Disease' 'Fibromyalgia' 'Fibromyalgia' 'Fibromyalgia'

'MS\_Disease' 'Leukemia\_Disease' 'Fibromyalgia' 'MS\_Disease'

'Leukemia\_Disease' 'MS\_Disease' 'Leukemia\_Disease' 'Kidney\_Disease'

'MS\_Disease' 'Fibromyalgia' 'Fibromyalgia' 'MS\_Disease'

'Leukemia\_Disease' 'Leukemia\_Disease' 'Fibromyalgia' 'Fibromyalgia'

'Leukemia\_Disease' 'Fibromyalgia' 'Celiac\_Disease' 'MS\_Disease'

'Fibromyalgia' 'MS\_Disease' 'Hashimoto\_Disease' 'Leukemia\_Disease'

'MS\_Disease' 'MS\_Disease' 'Celiac\_Disease' 'MS\_Disease' 'Fibromyalgia'

'MS\_Disease' 'MS\_Disease' 'Fibromyalgia' 'Leukemia\_Disease'

'Leukemia\_Disease' 'MS\_Disease' 'RA\_Disease' 'Hashimoto\_Disease'

'Celiac\_Disease' 'MS\_Disease' 'Hashimoto\_Disease' 'Celiac\_Disease'

'Fibromyalgia' 'Fibromyalgia' 'Celiac\_Disease' 'MS\_Disease'

'Fibromyalgia' 'Hashimoto\_Disease' 'Celiac\_Disease' 'MS\_Disease'

'Fibromyalgia' 'Fibromyalgia' 'MS\_Disease' 'MS\_Disease'

'Leukemia\_Disease' 'Fibromyalgia']

In [28]:

print('accuracy', accuracy\_score(reviews\_sentiment\_test, predictions))

print('confusion matrix\n', confusion\_matrix(reviews\_sentiment\_test, predictions))

print('(row=expected, col=predicted)')

accuracy 0.6635514018691588

confusion matrix

[[ 2 0 1 0 1 0 3 0]

[ 2 0 0 0 0 0 2 1]

[ 0 0 23 0 0 0 2 0]

[ 2 0 3 6 0 0 0 0]

[ 1 0 0 0 1 1 1 0]

[ 0 0 0 0 0 21 1 0]

[ 1 0 2 0 0 1 18 0]

[ 0 0 5 0 0 0 6 0]]

(row=expected, col=predicted)

In [29]:

print(classification\_report(reviews\_sentiment\_test, predictions))

#The F1 score can be interpreted as a weighted average of the precision and recall,

#where an F1 score reaches its best value at 1 and worst score at 0.

precision recall f1-score support

Celiac\_Disease 0.25 0.29 0.27 7

Chron\_Disease 0.00 0.00 0.00 5

Fibromyalgia 0.68 0.92 0.78 25

Hashimoto\_Disease 1.00 0.55 0.71 11

Kidney\_Disease 0.50 0.25 0.33 4

Leukemia\_Disease 0.91 0.95 0.93 22

MS\_Disease 0.55 0.82 0.65 22

RA\_Disease 0.00 0.00 0.00 11

accuracy 0.66 107

macro avg 0.49 0.47 0.46 107

weighted avg 0.60 0.66 0.61 107

c:\users\m\anaconda2\envs\python36\lib\site-packages\sklearn\metrics\classification.py:1437: UndefinedMetricWarning: Precision and F-score are ill-defined and being set to 0.0 in labels with no predicted samples.

'precision', 'predicted', average, warn\_for)

In [40]:

def predict\_review(new\_review):

new\_sample = bow\_transformer.transform([new\_review])

p = np.around(review\_sentiment.predict\_proba(new\_sample), decimals=2)

print(new\_review, '\t', p, '\tMax: ', np.max(p), '\n')

The respective probabilities correspond to those diseases alphebatized as

[[1-Celiac Disease, 2-Chron's Disease, 3-Fibromyalgia, 4-Hashimoto, 5-Kidney Disease, 6-Leukemia, 7-Multiple Sclerosis, 8-Rheumatoid Arthritis]]

In [39]:

predict\_review('sick. pain. sleepless. anxious.')

predict\_review('digestive. hungry.')

predict\_review('bruising. sleepy. tired. headache.')

predict\_review('energy. crazy. manic. depressed. angry.')

sick. pain. sleepless. anxious. [[0.01 0. 0.88 0.01 0.01 0.01 0.07 0.01]] Max: 0.88

digestive. hungry. [[0.11 0.03 0.19 0.05 0.1 0.24 0.24 0.04]] Max: 0.24

bruising. sleepy. tired. headache. [[0.09 0.08 0.39 0.05 0.09 0.13 0.13 0.05]] Max: 0.39

energy. crazy. manic. depressed. angry. [[0.1 0.05 0.17 0.06 0.1 0.22 0.24 0.06]] Max: 0.24

In [ ]: