Sentimental Analysis of Amazon Customer Reviews

September 1, 2019

```
In [59]: import pandas as pd
         import numpy as np
         import seaborn as sns
         import matplotlib.pyplot as plt
         %matplotlib inline
         import matplotlib
         import nltk.classify.util
         from sklearn.model_selection import train_test_split
         from sklearn.metrics import confusion_matrix
         from sklearn import metrics
         from sklearn.metrics import roc_curve, auc
         from nltk.classify import NaiveBayesClassifier
         import numpy as np
         import re
         import string
         import nltk
         nltk.download('stopwords')
         from nltk.corpus import stopwords
         from nltk.stem.snowball import SnowballStemmer as ss
         from sklearn.feature_extraction.text import TfidfTransformer
         from sklearn.feature_extraction.text import CountVectorizer
```

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

```
In [8]: data = pd.read_csv('C:/Users/Akshay/Desktop/Akshay_Datasets/Reviews.csv')
```

```
F:\Python\lib\site-packages\IPython\core\interactiveshell.py:3020: DtypeWarning: Columns (1,10)
  interactivity=interactivity, compiler=compiler, result=result)
```

```
In [9]: data.shape
```

```
Out[9]: (34660, 21)
```

```
In [10]: data.head()
```

Out[10]:

	id	name	asins	brand	categories	keys	manufacturer	reviews.date	reviews.dateAdded	reviews.dateSeen	...	reviews.doRecommend	reviews.id	reviews.numHelpful	reviews.rating	reviews.sourceURLs
0	AVqkIhwDv8e3D1O-lebb	All-New Fire HD 8 Tablet, 8 HD Display, Wi-Fi,...	B01AHB9CN2	Amazon	Electronics,iPad & Tablets,All Tablets,Fire Ta...	841667104676,amazon/53004484,amazon/b01ahb9cn2...	Amazon	2017-01-13T00:00:00.000Z	2017-07-03T23:33:15Z	2017-06-07T09:04:00.000Z,2017-04-30T00:45:00.000Z	...	True	NaN	0.0	5.0	http://reviews.bestbuy.com/3545/5620406/review...
1	AVqkIhwDv8e3D1O-lebb	All-New Fire HD 8 Tablet, 8 HD Display, Wi-Fi,...	B01AHB9CN2	Amazon	Electronics,iPad & Tablets,All Tablets,Fire Ta...	841667104676,amazon/53004484,amazon/b01ahb9cn2...	Amazon	2017-01-13T00:00:00.000Z	2017-07-03T23:33:15Z	2017-06-07T09:04:00.000Z,2017-04-30T00:45:00.000Z	...	True	NaN	0.0	5.0	http://reviews.bestbuy.com/3545/5620406/review...
2	AVqkIhwDv8e3D1O-lebb	All-New Fire HD 8 Tablet, 8 HD Display, Wi-Fi,...	B01AHB9CN2	Amazon	Electronics,iPad & Tablets,All Tablets,Fire Ta...	841667104676,amazon/53004484,amazon/b01ahb9cn2...	Amazon	2017-01-13T00:00:00.000Z	2017-07-03T23:33:15Z	2017-06-07T09:04:00.000Z,2017-04-30T00:45:00.000Z	...	True	NaN	0.0	5.0	http://reviews.bestbuy.com/3545/5620406/review...
3	AVqkIhwDv8e3D1O-lebb	All-New Fire HD 8 Tablet, 8 HD Display, Wi-Fi,...	B01AHB9CN2	Amazon	Electronics,iPad & Tablets,All Tablets,Fire Ta...	841667104676,amazon/53004484,amazon/b01ahb9cn2...	Amazon	2017-01-13T00:00:00.000Z	2017-07-03T23:33:15Z	2017-06-07T09:04:00.000Z,2017-04-30T00:45:00.000Z	...	True	NaN	0.0	4.0	http://reviews.bestbuy.com/3545/5620406/review...
4	AVqkIhwDv8e3D1O-lebb	All-New Fire HD 8 Tablet, 8 HD Display, Wi-Fi,...	B01AHB9CN2	Amazon	Electronics,iPad & Tablets,All Tablets,Fire Ta...	841667104676,amazon/53004484,amazon/b01ahb9cn2...	Amazon	2017-01-12T00:00:00.000Z	2017-07-03T23:33:15Z	2017-06-07T09:04:00.000Z,2017-04-30T00:45:00.000Z	...	True	NaN	0.0	5.0	http://reviews.bestbuy.com/3545/5620406/review...

```
                                              reviews.text  \
0  This product so far has not disappointed. My c...
1  great for beginner or experienced person. Boug...
2  Inexpensive tablet for him to use and learn on...
3  I've had my Fire HD 8 two weeks now and I love...
4  I bought this for my grand daughter when she c...

                              reviews.title reviews.userCity  \
0                                    Kindle              NaN
1                                 very fast              NaN
2  Beginner tablet for our 9 year old son.               NaN
3                                   Good!!!              NaN
4                 Fantastic Tablet for kids              NaN

   reviews.userProvince  reviews.username
0                   NaN           Adapter
1                   NaN            truman
2                   NaN             DaveZ
3                   NaN            Shacks
4                   NaN         explore42

[5 rows x 21 columns]
```

```
In [11]: df = data[['reviews.rating' , 'reviews.text' , 'reviews.title' , 'reviews.username']]
```

```
In [12]: df.head()
```

```
Out[12]:    reviews.rating                                       reviews.text  \
         0             5.0  This product so far has not disappointed. My c...
         1             5.0  great for beginner or experienced person. Boug...
         2             5.0  Inexpensive tablet for him to use and learn on...
         3             4.0  I've had my Fire HD 8 two weeks now and I love...
         4             5.0  I bought this for my grand daughter when she c...

                              reviews.title reviews.username
         0                            Kindle          Adapter
         1                         very fast           truman
         2  Beginner tablet for our 9 year old son.            DaveZ
         3                           Good!!!           Shacks
         4         Fantastic Tablet for kids        explore42
```

```
In [13]: #Checking for null values:
```

```
In [14]: print(df.isnull().sum()) #Checking for null values
```

```
reviews.rating      33
reviews.text         1
reviews.title        5
```

```
reviews.username     2
dtype: int64
```

```
In [15]: null = df[df["reviews.rating"].isnull()]
         null.head()
```

```
Out[15]:       reviews.rating                                       reviews.text  \
         2886             NaN  The Kindle is my first e-ink reader. I own an ...
         2887             NaN  I'm a first-time Kindle owner, so I have nothi...
         2888             NaN  UPDATE NOVEMBER 2011:My review is now over a y...
         2889             NaN  I'm a first-time Kindle owner, so I have nothi...
         2890             NaN  I woke up to a nice surprise this morning: a n...

                                                reviews.title reviews.username
         2886  Worth the money. Not perfect, but very very go...  Jeffrey Stanley
         2887  I Wanted a Dedicated E-Reader, and That's What...   Matthew Coenen
         2888                          Kindle vs. Nook (updated)    Ron Cronovich
         2889  I Wanted a Dedicated E-Reader, and That's What...   Matthew Coenen
         2890  Not the perfect do-it-all device, but very clo...        C. Tipton
```

```
In [16]: df = df[df["reviews.rating"].notnull()]
         df.shape
```

```
Out[16]: (34627, 4)
```

```
In [17]: #Classifiying text as positive and negative
```

```
In [18]: df["pos/neg"] = df["reviews.rating"]>=4
         df["pos/neg"] = df["pos/neg"].replace([True , False] , ["pos" , "neg"])
```

```
In [19]: df.head()
```

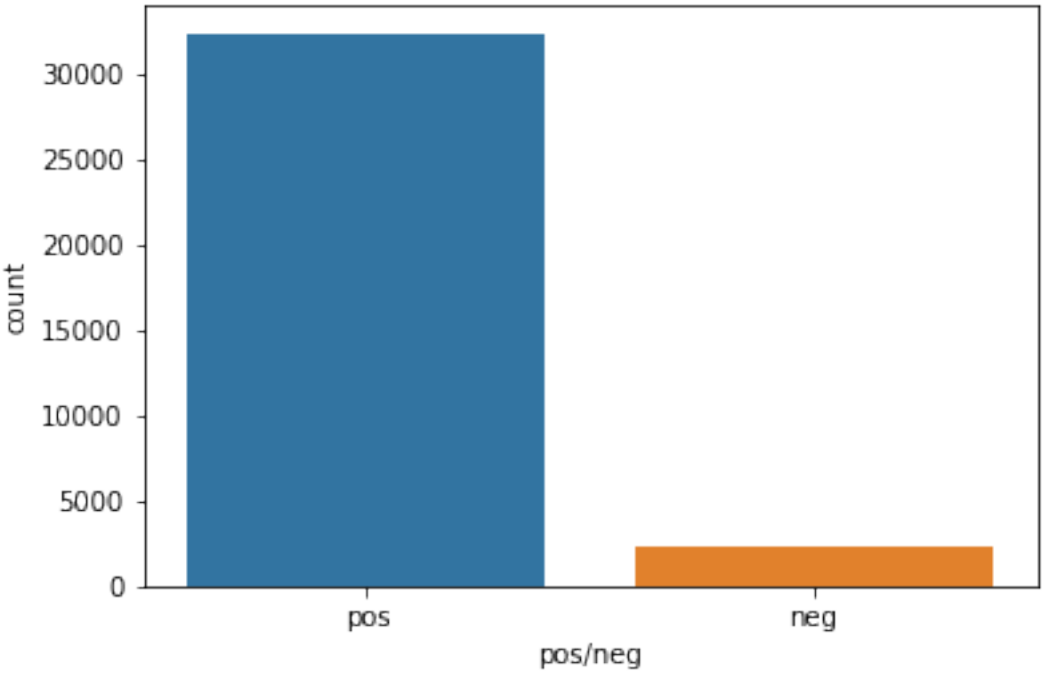
```
Out[19]:    reviews.rating                                       reviews.text  \
         0             5.0  This product so far has not disappointed. My c...
         1             5.0  great for beginner or experienced person. Boug...
         2             5.0  Inexpensive tablet for him to use and learn on...
         3             4.0  I've had my Fire HD 8 two weeks now and I love...
         4             5.0  I bought this for my grand daughter when she c...

                                reviews.title reviews.username pos/neg
         0                             Kindle          Adapter     pos
         1                          very fast           truman     pos
         2  Beginner tablet for our 9 year old son.            DaveZ     pos
         3                            Good!!!           Shacks     pos
         4                Fantastic Tablet for kids        explore42     pos
```

```
In [20]: df.shape
```

```
Out[20]: (34627, 5)
```

```
In [21]: sns.countplot(df['pos/neg'], data = df)
```

```
Out[21]: <matplotlib.axes._subplots.AxesSubplot at 0x1e57026e128>
```




```
In [22]: cleanup_re = re.compile('[^a-z]+')
         def clean_up(review):
             review = str(review)
             review = review.lower()
             review = cleanup_re.sub(' ', review).strip()
             #sentence = " ".join(nltk.word_tokenize(sentence))
             return review

         df["Clean"] = df["reviews.text"].apply(clean_up)
         null["Clean"] = null["reviews.text"].apply(clean_up)
```

1 Splitting the data (only 'Clean' and 'pos/neg' columns) into train and test data:

```
In [23]: split = df[["Clean" , "pos/neg"]]
         train=split.sample(frac=0.8,random_state=50)
         test=split.drop(train.index)
```

```
In [24]: train.head()
```

Out[24]:

	Clean	pos/neg
21922	i bought this for my friends kid it works perf...	pos
22176	i have found alexa echo to be indispensable i ...	pos
16057	grandson plays outside with it love that it ha...	pos
21448	this is a great starter tablet for kids and ad...	pos
22773	we haven t opened ours up yet but a friend of ...	pos

In [25]:
```
test.head()
```

Out[25]:

	Clean	pos/neg
5	this amazon fire inch tablet is the perfect si...	pos
7	i gave this as a christmas gift to my inlaws h...	pos
8	great as a device to read books i like that it...	pos
9	i love ordering books and reading them with th...	pos
15	the kindle is easiest to use graphics and scre...	pos

2 Feature Extracter for NLTK Naive bayes classifier

In [26]:
```
def word_feats(words):
    features = {}
    for word in words:
        features [word] = True
    return features
```

In [27]:
```
train["words"] = train["Clean"].str.lower().str.split()
test["words"] = test["Clean"].str.lower().str.split()
null["words"] = null["Clean"].str.lower().str.split()

train.index = range(train.shape[0])
test.index = range(test.shape[0])
null.index = range(null.shape[0])
prediction =  {}                    # For storing results of different classifiers

train_naive = []
test_naive = []
null_naive = []

for i in range(train.shape[0]):
    train_naive = train_naive +[[word_feats(train["words"][i]) , train["pos/neg"][i]]]
for i in range(test.shape[0]):
    test_naive = test_naive +[[word_feats(test["words"][i]) , test["pos/neg"][i]]]
for i in range(null.shape[0]):
    null_naive = null_naive +[word_feats(null["words"][i])]

classifier = NaiveBayesClassifier.train(train_naive)
print("NLTK Naive bayes Accuracy : {}".format(nltk.classify.util.accuracy(classifier
classifier.show_most_informative_features(5)
```

```
NLTK Naive bayes Accuracy : 0.596101083032491
Most Informative Features
                  poorly = True              neg : pos    =     70.0 : 1.0
               attempted = True              neg : pos    =     60.7 : 1.0
                 deleted = True              neg : pos    =     51.3 : 1.0
              lackluster = True              neg : pos    =     42.0 : 1.0
                decently = True              neg : pos    =     42.0 : 1.0
```

3 Predicting result of nltk classifier

```
In [28]: y =[]
         only_words= [test_naive[i][0] for i in range(test.shape[0])]
         for i in range(test.shape[0]):
             y = y + [classifier.classify(only_words[i])]
         prediction["Naive"]= np.asarray(y)

         y1 = []
         for i in range(null.shape[0]):
             y1 = y1 + [classifier.classify(null_naive[i])]

         null["Naive"] = y1

In [29]: stop_words = set(stopwords.words('english'))
         stop_words.remove("not")

         count_vect = CountVectorizer(min_df=2 , stop_words=stop_words , ngram_range=(1,2))
         tfidf_transformer = TfidfTransformer()

         X_train_counts = count_vect.fit_transform(train["Clean"])
         X_train_tfidf = tfidf_transformer.fit_transform(X_train_counts)

         X_new_counts = count_vect.transform(test["Clean"])
         X_test_tfidf = tfidf_transformer.transform(X_new_counts)

         checkcounts = count_vect.transform(null["Clean"])
         null_tfidf = tfidf_transformer.transform(checkcounts)
```

4 Fitting Multinomial NB

```
In [30]: from sklearn.naive_bayes import MultinomialNB
         model1 = MultinomialNB().fit(X_train_tfidf , train["pos/neg"])
         prediction["MultinomialNB"] = model1.predict_proba(X_test_tfidf)[:,1]
         print("Multinomial Accuracy : {}".format(model1.score(X_test_tfidf , test["pos/neg"]))

         null["multi"] = model1.predict(null_tfidf)
```

```
Multinomial Accuracy : 0.9327075812274368
```

5 Fitiing Bernouli NB

```
In [55]: from sklearn.metrics import classification_report
         from sklearn.naive_bayes import BernoulliNB
         model2 = BernoulliNB().fit(X_train_tfidf, train["pos/neg"])
         prediction['BernoulliNB'] = model2.predict_proba(X_test_tfidf)[:,1]
         print("Bernoulli Accuracy : {}".format(model2.score(X_test_tfidf , test["pos/neg"])))

         null["Bill"] = model2.predict(null_tfidf)
```

```
Bernoulli Accuracy : 0.9218772563176896
```

6 Fitiing LogisticRegression

```
In [32]: from sklearn import linear_model
         logreg = linear_model.LogisticRegression(solver='lbfgs' , C=1000)
         logistic = logreg.fit(X_train_tfidf, train["pos/neg"])
         prediction['LogisticRegression'] = logreg.predict_proba(X_test_tfidf)[:,1]
         print("Logistic Regression Accuracy : {}".format(logreg.score(X_test_tfidf , test["pos

         null["log"] = logreg.predict(null_tfidf)
```

```
Logistic Regression Accuracy : 0.9373285198555956
```

7 Getting most occuring words in train set

```
In [33]: words = count_vect.get_feature_names()
         feature_coefs = pd.DataFrame(
             data = list(zip(words, logistic.coef_[0])),
             columns = ['feature', 'coef'])
         feature_coefs.sort_values(by="coef")
```

Out[33]:

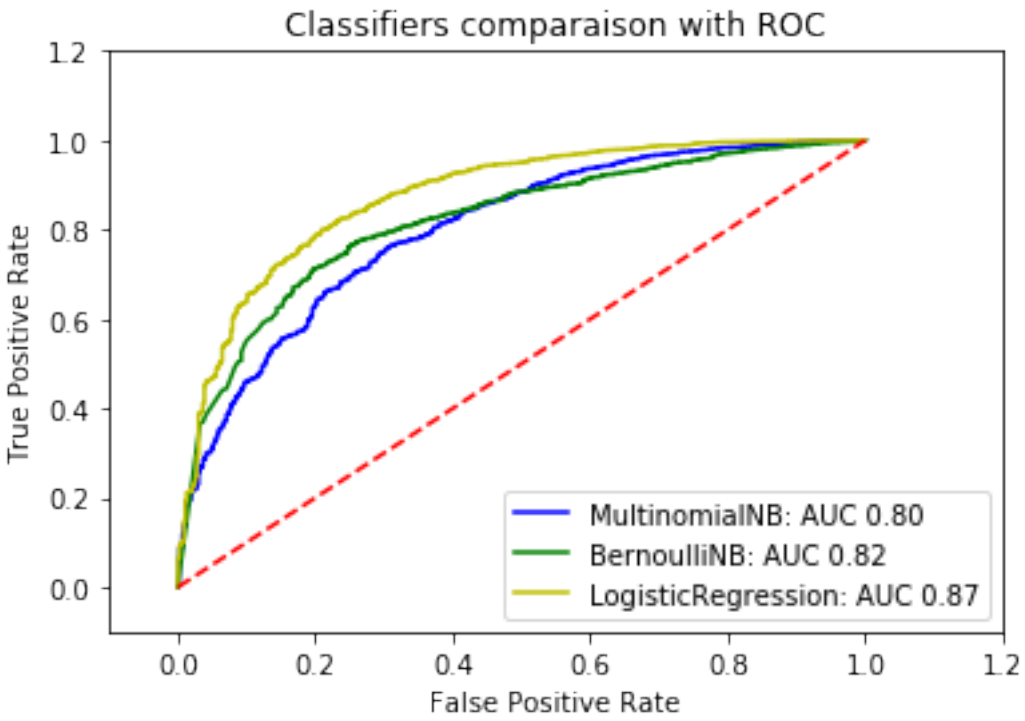
	feature	coef
43337	terrible	-23.926422
25188	love definitely	-23.602749
39563	slow	-21.283460
36918	returning	-20.978637
38656	setup echo	-20.191205
18736	great pictures	-19.734024
33107	price awesome	-18.632944
42544	tablet parents	-17.733764
46735	using firestick	-17.250658

33121	price bought	-17.214045
24151	limited	-16.913033
6967	catch reading	-16.602187
25365	love read	-16.594877
35751	reading watching	-16.111641
40622	spell	-15.973480
18781	great reading	-15.879054
18060	got great	-15.566155
10858	done great	-15.554533
36888	returned	-15.499714
33773	product definitely	-15.400383
30801	ordered several	-14.958086
13176	exactly expected	-14.941317
20095	horrible	-14.815439
29264	not easy	-14.779065
26317	match	-14.709483
41128	still issues	-14.694220
9566	daughter likes	-14.690977
39261	sister christmas	-14.635922
10665	disappointed	-14.593271
19830	holding good	-14.507530
...	...	...
11942	educational	10.691297
49363	works like	10.768287
25548	loves	11.078986
37129	room	11.118407
11589	easy work	11.285991
19436	hd would	11.359604
2575	anywhere	11.427837
47985	weather	11.446421
8	ability	11.462946
19734	highly	11.647976
19239	happy purchase	11.900094
13920	fantastic	12.023716
49544	would definitely	12.059796
32493	pleased	12.126457
29442	not overpriced	12.281549
36125	recomend	12.685598
1781	amazing	12.960128
8225	complaint	13.028854
11551	easy set	13.446272
3555	awesome	13.634829
48217	well	13.807088
15900	fun	14.366011
13211	excellent	14.800321
4053	beat	15.850216
3897	basic amazon	16.295956
11408	easy	16.495187

```
29255    not disappointed  18.110021
31633             perfect  18.225518
18364               great  20.879237
25103                love  23.018234

[50017 rows x 2 columns]
```

8 Lets find out which classifier is doing what

```
In [34]: def formatt(x):
             if x == 'neg':
                 return 0
             if x == 0:
                 return 0
             return 1
         vfunc = np.vectorize(formatt)

         cmp = 0
         colors = ['b', 'g', 'y', 'm', 'k']
         for model, predicted in prediction.items():
             if model not in 'Naive':
                 false_positive_rate, true_positive_rate, thresholds = roc_curve(test["pos/neg'
                 roc_auc = auc(false_positive_rate, true_positive_rate)
                 plt.plot(false_positive_rate, true_positive_rate, colors[cmp], label='%s: AUC
                 cmp += 1

         plt.title('Classifiers comparaison with ROC')
         plt.legend(loc='lower right')
         plt.plot([0,1],[0,1],'r--')
         plt.xlim([-0.1,1.2])
         plt.ylim([-0.1,1.2])
         plt.ylabel('True Positive Rate')
         plt.xlabel('False Positive Rate')
         plt.show()
```



9 Let's see precision and recall of different classifiers

```
In [37]: test.pos_neg = test['pos/neg'].replace(["pos" , "neg"] , [True , False] )
```

```
F:\Python\lib\site-packages\ipykernel_launcher.py:1: UserWarning: Pandas doesn't allow columns
  """Entry point for launching an IPython kernel.
```

```
In [46]: keys = prediction.keys()
         for key in ['Multinomial', 'Bernoulli', 'LogisticRegression']:
             print(" {}:".format(key))
             print(metrics.classification_report(test["pos/neg"], prediction.get(key)>0.5, targ
             print("\n")
```

```
 Multinomial:
```

```
        ---------------------------------------------------------------------------

        TypeError                                 Traceback (most recent call last)

        <ipython-input-46-56b5948e9c27> in <module>
```

```
      2 for key in ['Multinomial', 'Bernoulli', 'LogisticRegression']:
      3     print(" {}:".format(key))
----> 4     print(metrics.classification_report(test["pos/neg"], prediction.get(key)>0.5, t
      5     print("\n")


TypeError: '>' not supported between instances of 'NoneType' and 'float'
```

```
In [56]: def test_sample(model, sample):
             sample_counts = count_vect.transform([sample])
             sample_tfidf = tfidf_transformer.transform(sample_counts)
             result = model.predict(sample_tfidf)[0]
             prob = model.predict_proba(sample_tfidf)[0]
             print("Sample estimated as %s: negative prob %f, positive prob %f" % (result.upper

         test_sample(logreg, "The product was good and easy to  use")
         test_sample(logreg, "the whole experience was horrible and product is worst")
         test_sample(logreg, "product is not good")
```

```
Sample estimated as POS: negative prob 0.000000, positive prob 1.000000
Sample estimated as NEG: negative prob 0.992190, positive prob 0.007810
Sample estimated as NEG: negative prob 0.955710, positive prob 0.044290
```

```
In [57]: null.head(10)
```

Out[57]:

	reviews.rating	reviews.text	reviews.title	reviews.username
0	NaN	The Kindle is my first e-ink reader. I own an ...	Worth the money. Not perfect, but very very go...	Jeffrey Stanley
1	NaN	I'm a first-time Kindle owner, so I have nothi...	I Wanted a Dedicated E-Reader, and That's What...	Matthew Coenen
2	NaN	UPDATE NOVEMBER 2011:My review is now over a y...	Kindle vs. Nook (updated)	Ron Cronovich
3	NaN	I'm a first-time Kindle owner, so I have nothi...	I Wanted a Dedicated E-Reader, and That's What...	Matthew Coenen
4	NaN	I woke up to a nice surprise this morning: a n...	Not the perfect do-it-all device, but very clo...	C. Tipton
5	NaN	The Kindle is my first e-ink reader. I own an ...	Worth the money. Not perfect, but very very go...	Jeffrey Stanley
6	NaN	UPDATE NOVEMBER 2011:br /br /My review is now ...	Kindle vs. Nook (updated)	Ron Cronovich
7	NaN	I woke up to a nice surprise this morning: a n...	Not the perfect do-it-all device, but very clo...	C. Tipton
8	NaN	I use to hate to read but now that I have my K...	Great	D. Tatro
9	NaN	All of them quit working. There's absolutely n...		

```
9                                          I've had 3!  M. Lansford Kindle fave

                                                   Clean  \
0  the kindle is my first e ink reader i own an i...
1  i m a first time kindle owner so i have nothin...
2  update november my review is now over a year o...
3  i m a first time kindle owner so i have nothin...
4  i woke up to a nice surprise this morning a ne...
5  the kindle is my first e ink reader i own an i...
6  update november br br my review is now over a ...
7  i woke up to a nice surprise this morning a ne...
8  i use to hate to read but now that i have my k...
9  all of them quit working there s absolutely no...

                                                  words Naive multi Bill  log
0  [the, kindle, is, my, first, e, ink, reader, i...   neg   pos  neg  pos
1  [i, m, a, first, time, kindle, owner, so, i, h...   neg   pos  neg  pos
2  [update, november, my, review, is, now, over, ...   neg   pos  neg  pos
3  [i, m, a, first, time, kindle, owner, so, i, h...   neg   pos  neg  pos
4  [i, woke, up, to, a, nice, surprise, this, mor...   neg   pos  neg  pos
5  [the, kindle, is, my, first, e, ink, reader, i...   neg   pos  neg  pos
6  [update, november, br, br, my, review, is, now...   neg   pos  neg  pos
7  [i, woke, up, to, a, nice, surprise, this, mor...   neg   pos  neg  pos
8  [i, use, to, hate, to, read, but, now, that, i...   pos   pos  pos  pos
9  [all, of, them, quit, working, there, s, absol...   neg   pos  pos  pos
```

In [61]:
```
from wordcloud import WordCloud, STOPWORDS
stopwords = set(STOPWORDS)


matplotlib.rcParams['font.size']=12
matplotlib.rcParams['savefig.dpi']=100
matplotlib.rcParams['figure.subplot.bottom']=.1


def show_wordcloud(data, title = None):
    wordcloud = WordCloud(
        background_color='white',
        stopwords=stopwords,
        max_words=300,
        max_font_size=40,
        scale=3,
        random_state=1

    ).generate(str(data))

    fig = plt.figure(1, figsize=(15, 15))
    plt.axis('off')
```

```
    if title:
        fig.suptitle(title, fontsize=20)
        fig.subplots_adjust(top=2.3)

    plt.imshow(wordcloud)
    plt.show()

show_wordcloud(df["Clean"])
```

In [66]: `show_wordcloud(df["Clean"][df['pos/neg'] == "pos"] , title="Positive Words")`

Positive Words

In [65]: show_wordcloud(df["Clean"][df['pos/neg'] == "neg"] , title="Negative words")

Negative words

In [ ]: