t_SNE_visualization_of_Amazon_reviews_with_polarity_based_color_(1)

March 30, 2018

In [7]:
```
%matplotlib inline

        import sqlite3
        import pandas as pd
        import numpy as np
        import nltk
        import matplotlib.pyplot as plt
        import seaborn as sns
        from sklearn.feature_extraction.text import TfidfTransformer
        from sklearn.feature_extraction.text import TfidfVectorizer
        import re

        from sklearn.feature_extraction.text import CountVectorizer
        from sklearn.metrics import confusion_matrix
```

In [8]:
```
con = sqlite3.connect('./final.sqlite') # this is cleaned dataset
        cursor = con.cursor()
        cursor.execute("SELECT name FROM sqlite_master WHERE type='table';")
        print(cursor.fetchall())
```

```
[('Reviews',)]
```

1 Data Cleaning

In [0]:
```
n=25000
```

In [9]:
```
final = pd.read_sql_query("""
        SELECT *
        FROM reviews
        """, con)[:n]
```

In [0]:
```
# Give reviews with Score>3 a positive rating, and reviews with a score<3 a negative rat
        def partition(x):
```

```
            if x < 3:
                return 'negative'
            return 'positive'

        #changing reviews with score less than 3 to be positive and vice-versa
        actualScore = filtered_data['Score']
        positiveNegative = actualScore.map(partition)
        filtered_data['Score'] = positiveNegative
```

```
In [0]: #Sorting data according to ProductId in ascending order
        sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inplace=False

        #Deduplication of entries
        final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep='f

        final=final[final.HelpfulnessNumerator<=final.HelpfulnessDenominator]
```

```
In [10]: # Get a balanced dataset
         negative_1500=final[final['Score']=='negative'][:1500]
         positive_1500=final[final['Score']=='positive'][:1500]
```

```
In [11]: final=pd.concat((negative_1500,positive_1500))
```

2 Text preprocessing

1. Removal of HTML tags
2. Removal of punctuation marks and special characters
3. Conversion to lowercase
4. Removal of 2 letter words
5. Removal of numeric characters
6. Stopword removal
7. Snowball stemming

```
In [12]: def cleanhtml(sentence): #function to clean the word of any html-tags
             cleanr = re.compile('<.*?>')
             cleantext = re.sub(cleanr, ' ', sentence)
             return cleantext
         def cleanpunc(sentence): #function to clean the word of any punctuation or special char
             cleaned = re.sub(r'[?|!|\'|"|#]',r'',sentence)
             cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
             return  cleaned
```

```
In [0]: from nltk.corpus import stopwords
```

```
In [0]: nltk.download()
```

```
showing info https://raw.githubusercontent.com/nltk/nltk_data/gh-pages/index.xml
```

```
Out[0]: True

In [0]: stop_not_excluded = set(stopwords.words('english')) #set of stopwords
        stop_not_included = stop_not_excluded.difference({'not'})
        sno = nltk.stem.SnowballStemmer('english') #initialising the snowball stemmer

In [0]: str1=None
        str2=None
        final_string_not_included=[]
        final_string_not_excluded=[]
        s=''
        for sent in final['Text'].values:
            filtered_sentence_not_included=[]
            filtered_sentence_not_excluded=[]
            sent=cleanhtml(sent) # remove HTMl tags
            for w in sent.split():
                for cleaned_words in cleanpunc(w).split():
                    if((cleaned_words.isalpha()) & (len(cleaned_words)>2)):
                        if cleaned_words.lower() not in stop_not_included:
                            s=(sno.stem(cleaned_words.lower())).encode('utf8')
                            filtered_sentence_not_included.append(s)
                        if cleaned_words.lower() not in stop_not_excluded:
                            s=(sno.stem(cleaned_words.lower())).encode('utf8')
                            filtered_sentence_not_excluded.append(s)
                        else:
                            continue
                    else:
                        continue
            str1 = b" ".join(filtered_sentence_not_included) #final string of cleaned words with
            str2 = b" ".join(filtered_sentence_not_excluded) #final string of cleaned words with
            #print("***********************************************************************")

            final_string_not_included.append(str1)
            final_string_not_excluded.append(str2)

In [0]: final['Text_not_included'] = final_string_not_included
        final['Text_not_excluded'] = final_string_not_excluded

In [0]: # store final table into an SQlLite table for future.
        conn = sqlite3.connect('final.sqlite')
        c=conn.cursor()
        conn.text_factory = str
        final.to_sql('Reviews', conn, flavor=None, schema=None, if_exists='replace', index=True,

In [0]: final.head()['Text_not_included']

Out[0]: 22620    b'dog love chicken product china wont buy anym...
        22621    b'dog love saw pet store tag attach regard mad...
        2547     b'use victor fli bait season cant beat great p...
```

```
2546     b'product avail www amazon com victor trap unr...
1145     b'receiv shipment could hard wait tri product ...
Name: Text_not_included, dtype: object
```

3 Bag of words

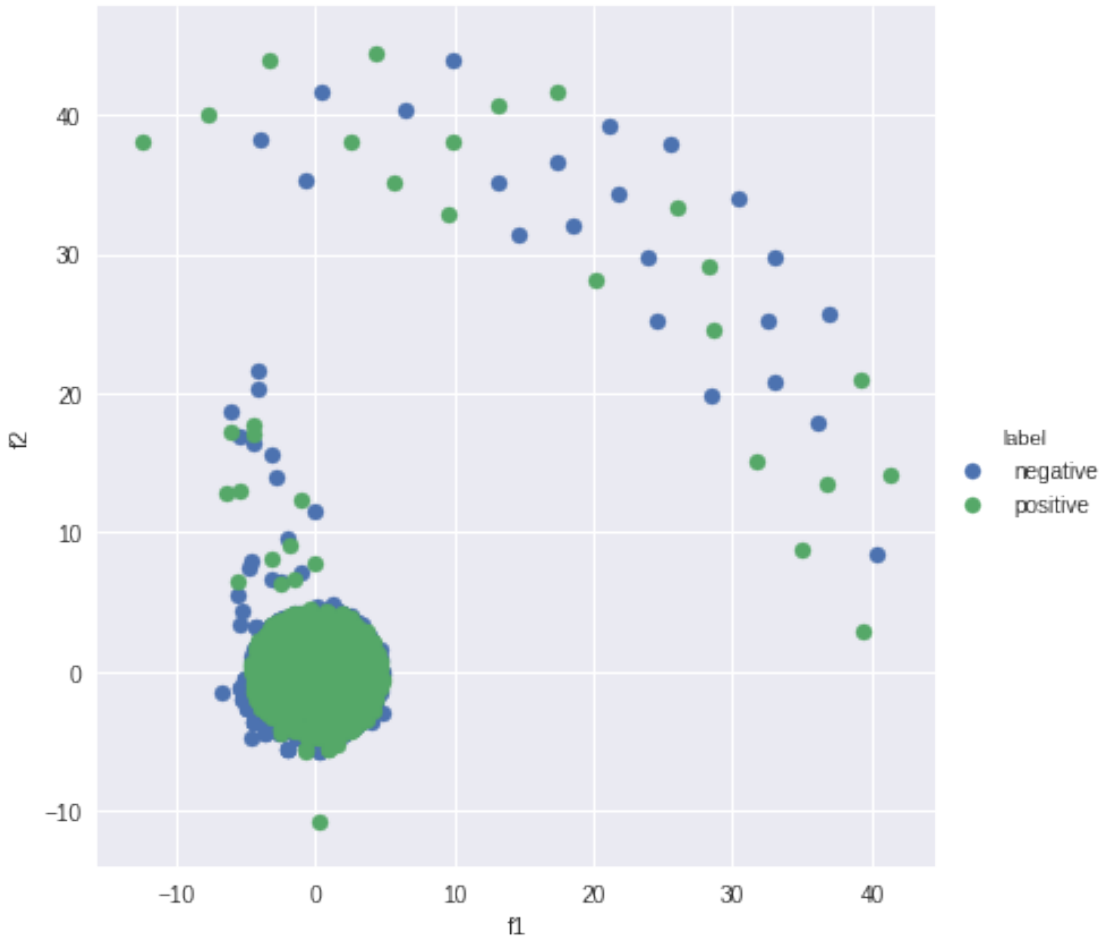
```
In [0]: #bi-gram, tri-gram and n-gram

        #removing stop words like "not" should be avoided before building n-grams
        count_vect = CountVectorizer(ngram_range=(2,2) ) #in scikit-learn
        final_bigram_counts_all_included = count_vect.fit_transform(final['Text'].values)
        final_bigram_counts_not_included = count_vect.fit_transform(final['Text_not_included'].v
        final_bigram_counts_not_excluded = count_vect.fit_transform(final['Text_not_excluded'].v

In [0]: arr=final_bigram_counts_all_included.getrow(6).toarray()
        np.where(arr != 0)

Out[0]: (array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]),
         array([ 30673,  42396,  44201,  73272, 116165, 187575, 198495, 200615,
                249205, 250619, 260768, 302039, 309671, 345857, 358610, 358736,
                372748, 390779, 395244, 397990, 416200, 441422, 441555]))

In [0]: arr[0,358736]

Out[0]: 1

In [0]: num_negative=len(final[final['Score']=='negative'].values)
        num_positive=len(final[final['Score']=='positive'].values)

In [9]: num_negative

Out[9]: 1500

In [10]: num_positive

Out[10]: 1500

In [12]: final_bigram_counts_not_excluded.get_shape()

Out[12]: (3000, 86167)
```

3.1 Observation

Keep p less than 1500

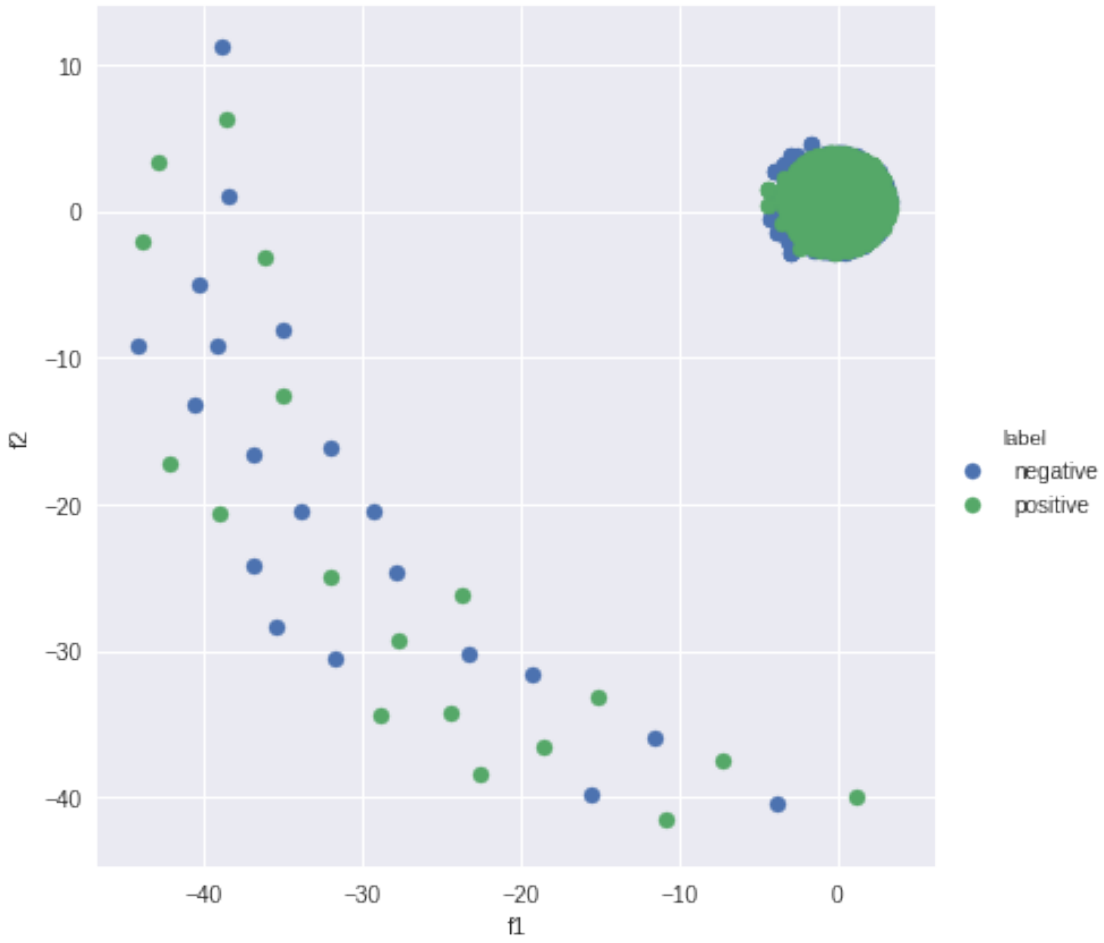
```
In [0]: from sklearn.manifold import TSNE

In [0]: p=100
```

```
In [0]: model_all_included = TSNE(n_components=2, random_state=0, perplexity=p)
        model_not_included = TSNE(n_components=2, random_state=0, perplexity=p)
        model_not_excluded = TSNE(n_components=2, random_state=0, perplexity=p)

        tsne_data_all_included = model_all_included.fit_transform(final_bigram_counts_all_includ
        tsne_data_not_included = model_not_included.fit_transform(final_bigram_counts_not_includ
        tsne_data_not_excluded = model_not_excluded.fit_transform(final_bigram_counts_not_exclud

In [65]: tsne_data_not_excluded

Out[65]: array([[-0.14882955,  0.83684134],
                [-1.0772611 , -0.46872702],
                [-0.7272085 ,  0.877955  ],
                ...,
                [-0.14414746, -0.04727471],
                [-0.11784831,  0.14492744],
                [-0.11721484,  0.14161293]], dtype=float32)

In [0]: plot_all_included=pd.DataFrame(np.concatenate((tsne_data_all_included, np.transpose(np.a
        del tsne_data_all_included
        plot_not_included=pd.DataFrame(np.concatenate((tsne_data_not_included, np.transpose(np.a
        del tsne_data_not_included
        plot_not_excluded=pd.DataFrame(np.concatenate((tsne_data_not_excluded, np.transpose(np.a
        del tsne_data_not_excluded

In [77]: plot_not_excluded.shape

Out[77]: (3000, 3)

In [78]: plot_all_included[:3]

Out[78]:         f1        f2     label
         0 -1.07917   0.52654  negative
         1  1.16047  0.547074  negative
         2 -1.03507  -1.26618  negative

In [0]: %matplotlib inline

In [17]: sns.FacetGrid(plot_all_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_

Out[17]: <seaborn.axisgrid.FacetGrid at 0x7f385c9a2940>
```



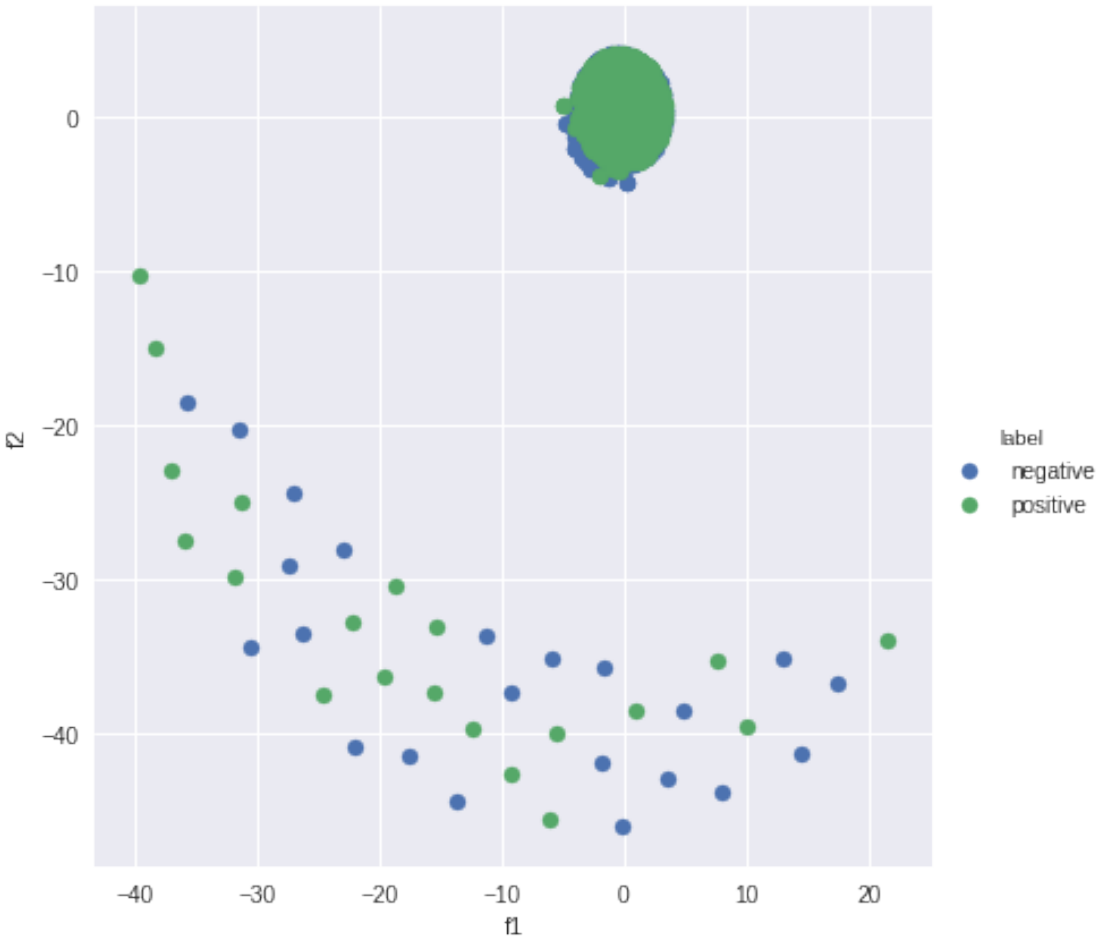

```
In [18]: sns.FacetGrid(plot_not_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[18]: <seaborn.axisgrid.FacetGrid at 0x7f385c9a29b0>
```



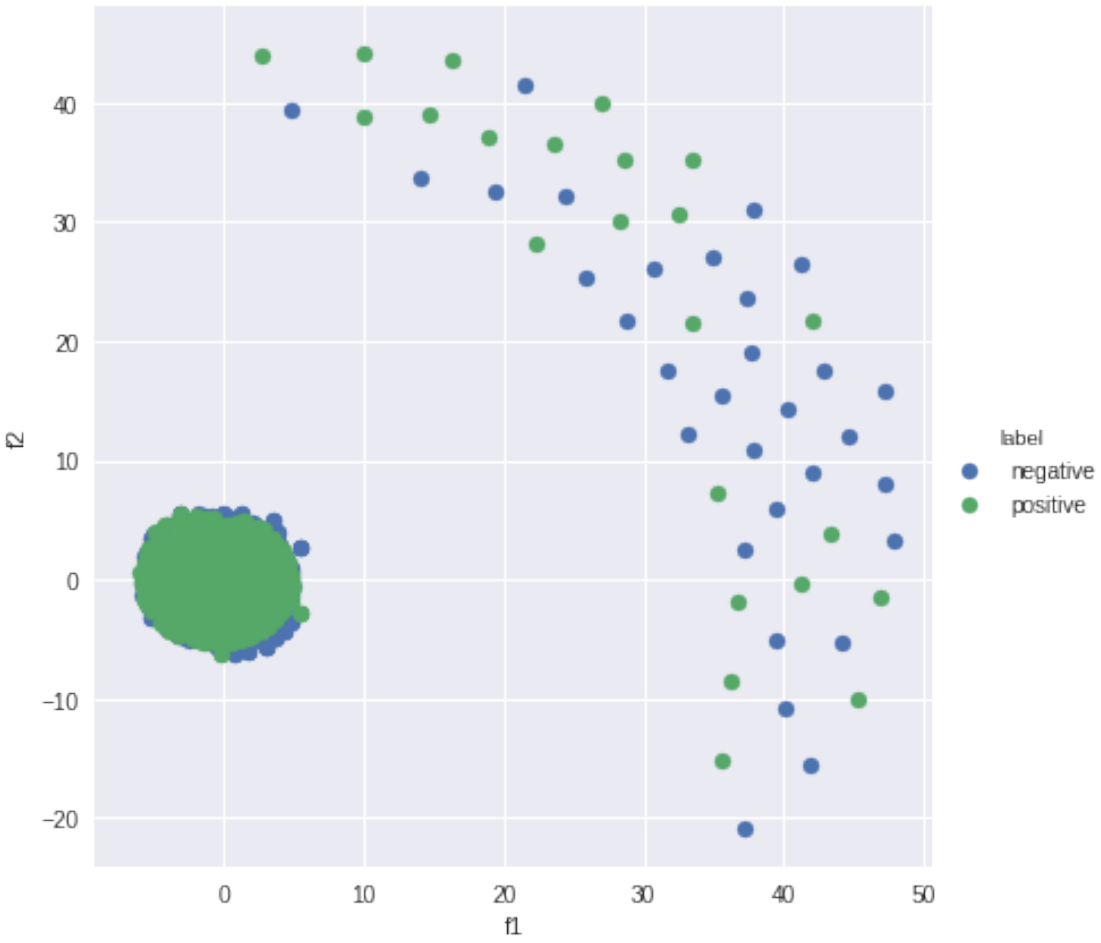

```
In [19]: sns.FacetGrid(plot_not_excluded, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[19]: <seaborn.axisgrid.FacetGrid at 0x7f385c419550>
```

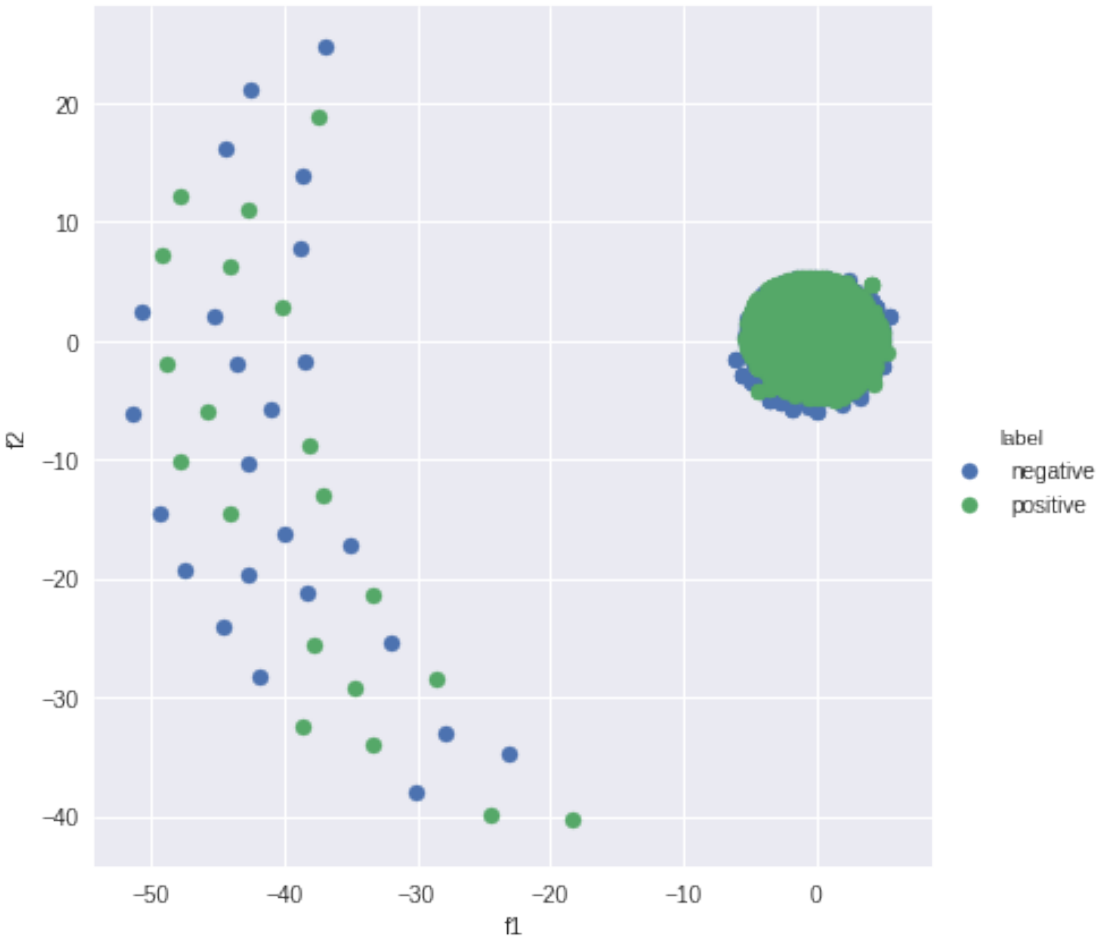



```
In [23]: sns.FacetGrid(plot_all_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[23]: <seaborn.axisgrid.FacetGrid at 0x7f385c8b4400>
```

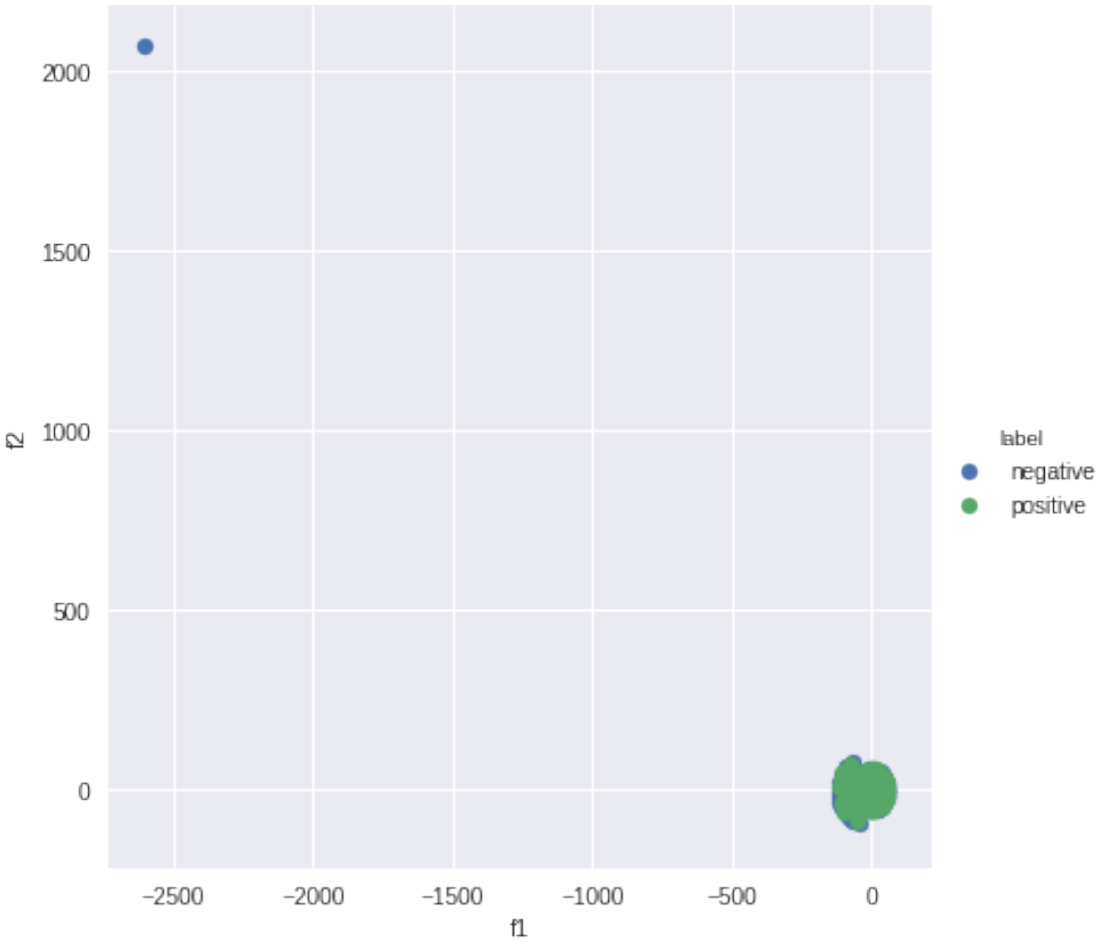



```
In [24]: sns.FacetGrid(plot_not_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_

Out[24]: <seaborn.axisgrid.FacetGrid at 0x7f385cfbfda0>
```




```
In [25]: sns.FacetGrid(plot_not_excluded, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[25]: <seaborn.axisgrid.FacetGrid at 0x7f385c3ea438>
```



4 TF-IDF

```
In [0]: from nltk.stem import SnowballStemmer
        sno=SnowballStemmer('english')
```

```
In [0]: # Stem the words without removing stopwords
        text_stemmed=[]
        for review in final['Text'].values:
            review=cleanhtml(review)
            stemmed_words=[]
            for punc_w in review.split():
                for w in cleanpunc(punc_w).split():
                    if len(w)>2 and w.isalpha():
                        stemmed=sno.stem(w.lower()).encode('utf8')
                        stemmed_words.append(stemmed)
            stemmed_review=b' '.join(stemmed_words)
```

```
            text_stemmed.append(stemmed_review)
        final['stemmed_text']=text_stemmed
```

```
In [41]: final['Text'][1]
```

```
Out[41]: 'Our dogs just love them.  I saw them in a pet store and a tag was attached regarding t
```

```
In [42]: final['stemmed_text'][1]
```

```
Out[42]: b'our dog just love them saw them pet store and tag was attach regard them be made chin
```

```
In [0]: tf_idf_vect_all_words_included = TfidfVectorizer(ngram_range=(2,2))
        final_tf_idf_all_words_included = tf_idf_vect_all_words_included.fit_transform(final['st

        tf_idf_vect_all_stopwords_removed = TfidfVectorizer(ngram_range=(2,2))
        final_tf_idf_not_excluded = tf_idf_vect_all_stopwords_removed.fit_transform(final['Text_

        tf_idf_vect_not_retained = TfidfVectorizer(ngram_range=(2,2))
        final_tf_idf_not_included = tf_idf_vect_not_retained.fit_transform(final['Text_not_inclu
```

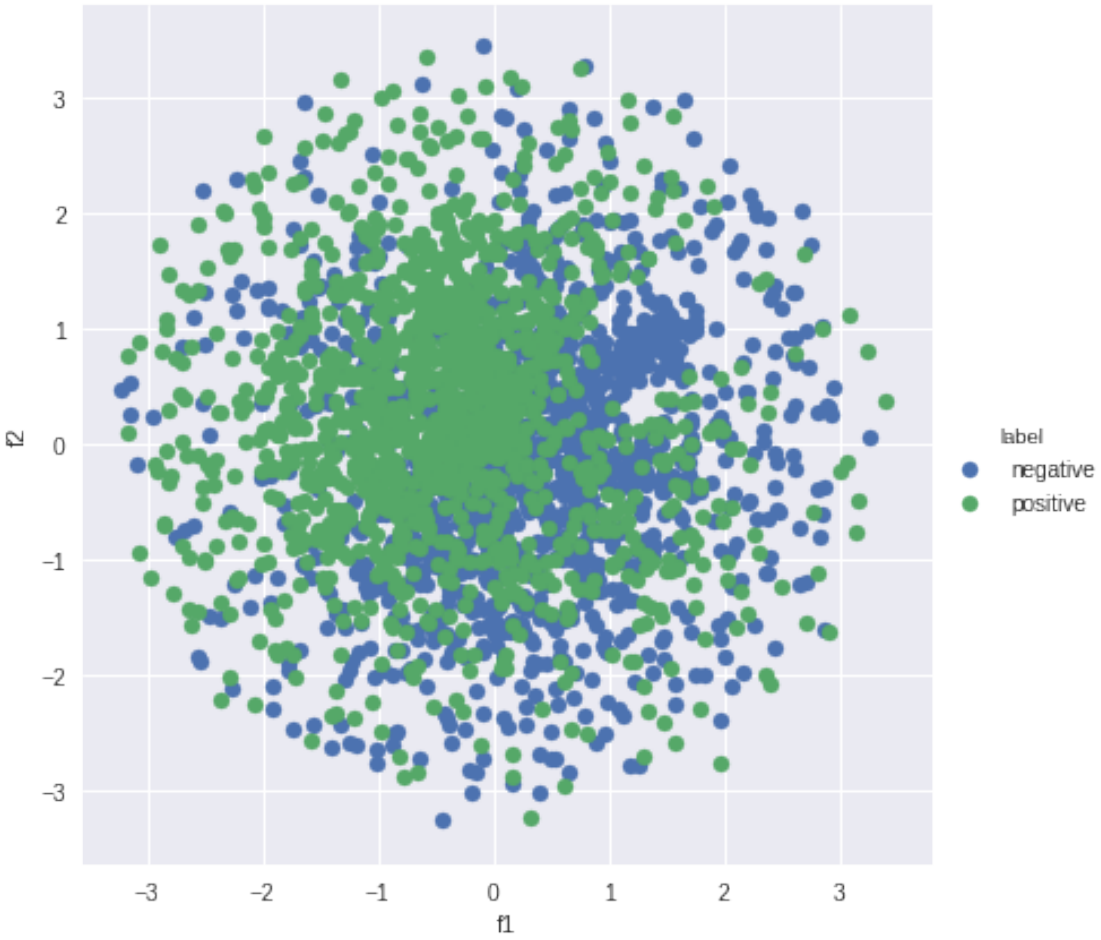
```
In [49]: from sklearn.manifold import TSNE
         p=1400
```

```
In [0]: model_all_included = TSNE(n_components=2, random_state=0, perplexity=p, n_iter=1500)
        model_not_included = TSNE(n_components=2, random_state=0, perplexity=p, n_iter=1500)
        model_not_excluded = TSNE(n_components=2, random_state=0, perplexity=p, n_iter=1500)

        tsne_data_all_included = model_all_included.fit_transform(final_tf_idf_all_words_include
        tsne_data_not_included = model_not_included.fit_transform(final_tf_idf_not_included.toar
        tsne_data_not_excluded = model_not_excluded.fit_transform(final_tf_idf_not_excluded.toar
```

```
In [0]: plot_all_included=pd.DataFrame(np.concatenate((tsne_data_all_included, np.transpose(np.a
        del tsne_data_all_included
        plot_not_included=pd.DataFrame(np.concatenate((tsne_data_not_included, np.transpose(np.a
        del tsne_data_not_included
        plot_not_excluded=pd.DataFrame(np.concatenate((tsne_data_not_excluded, np.transpose(np.a
        del tsne_data_not_excluded
```

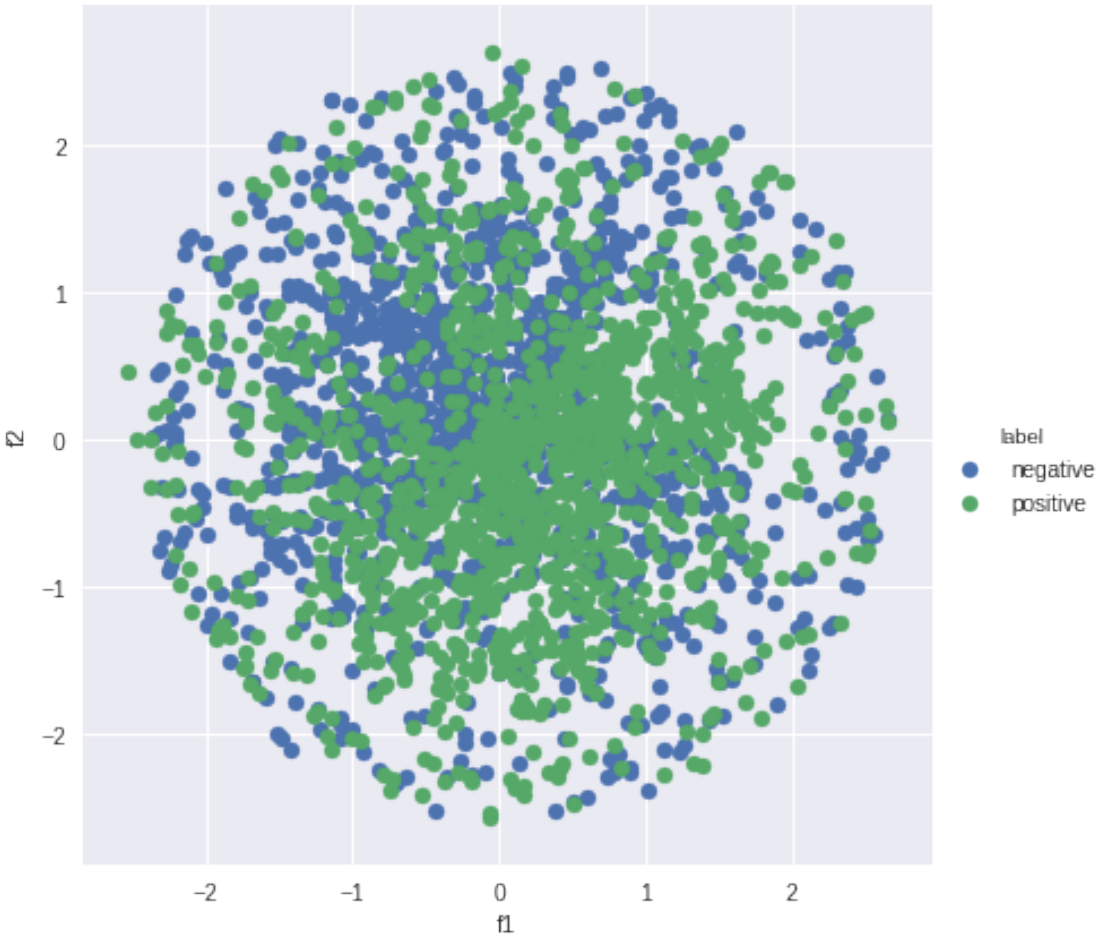
```
In [58]: sns.FacetGrid(plot_all_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[58]: <seaborn.axisgrid.FacetGrid at 0x7f25feea9be0>
```



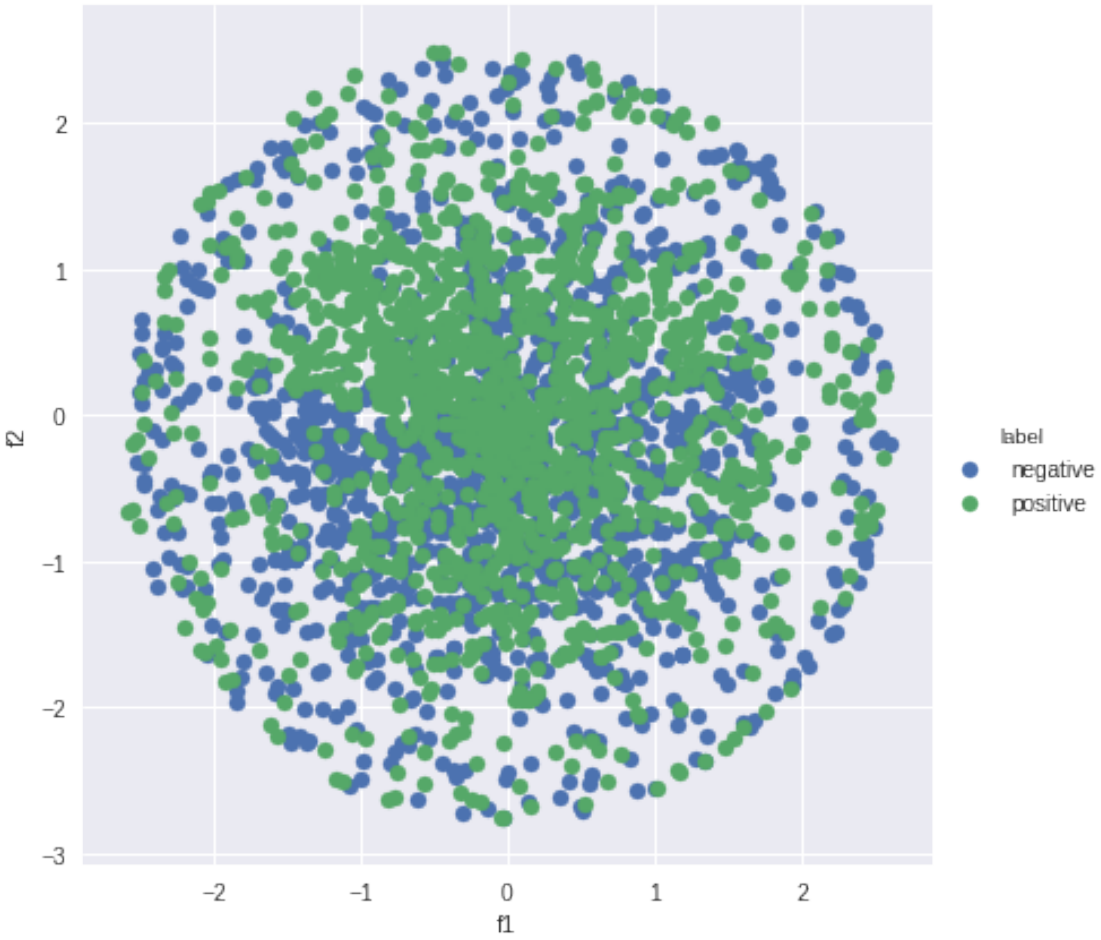

```
In [59]: sns.FacetGrid(plot_not_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[59]: <seaborn.axisgrid.FacetGrid at 0x7f25fe067d30>
```



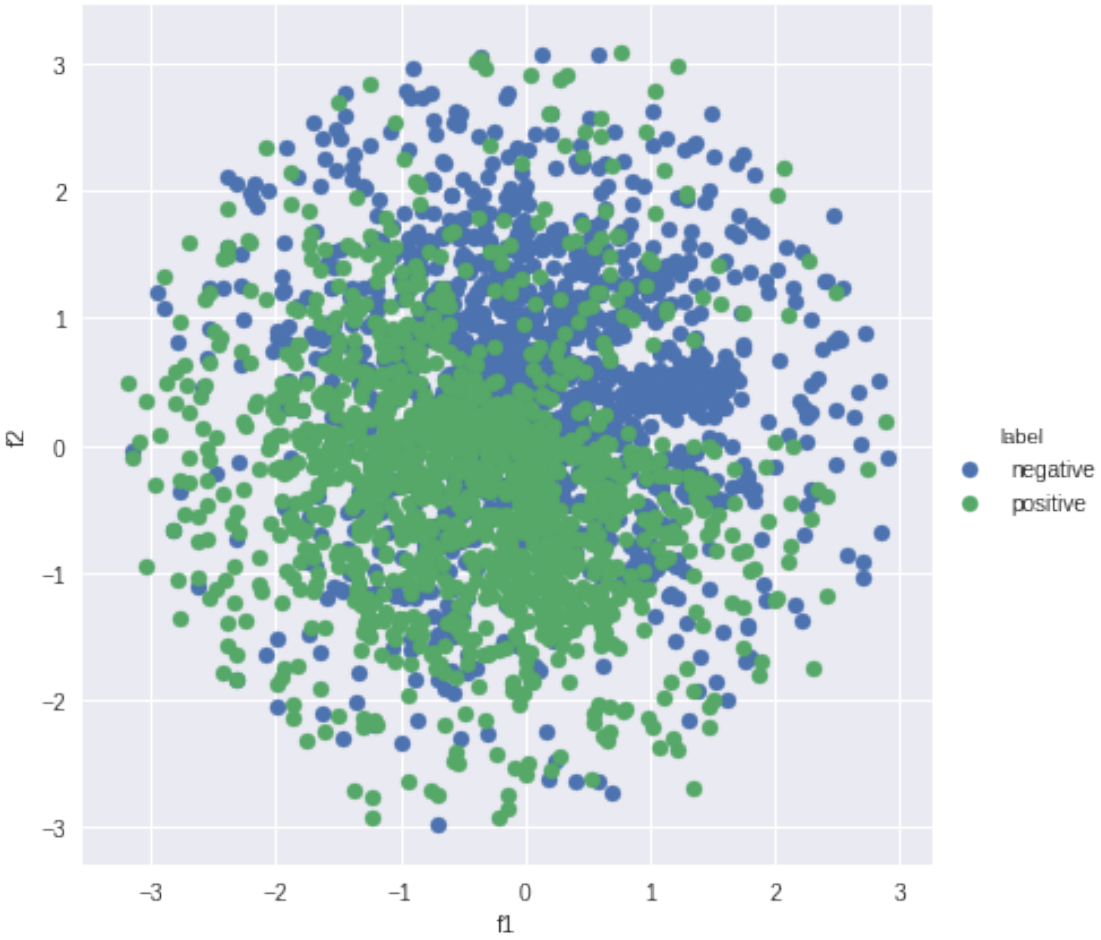

```
In [61]: sns.FacetGrid(plot_not_excluded, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[61]: <seaborn.axisgrid.FacetGrid at 0x7f25fe067e80>
```



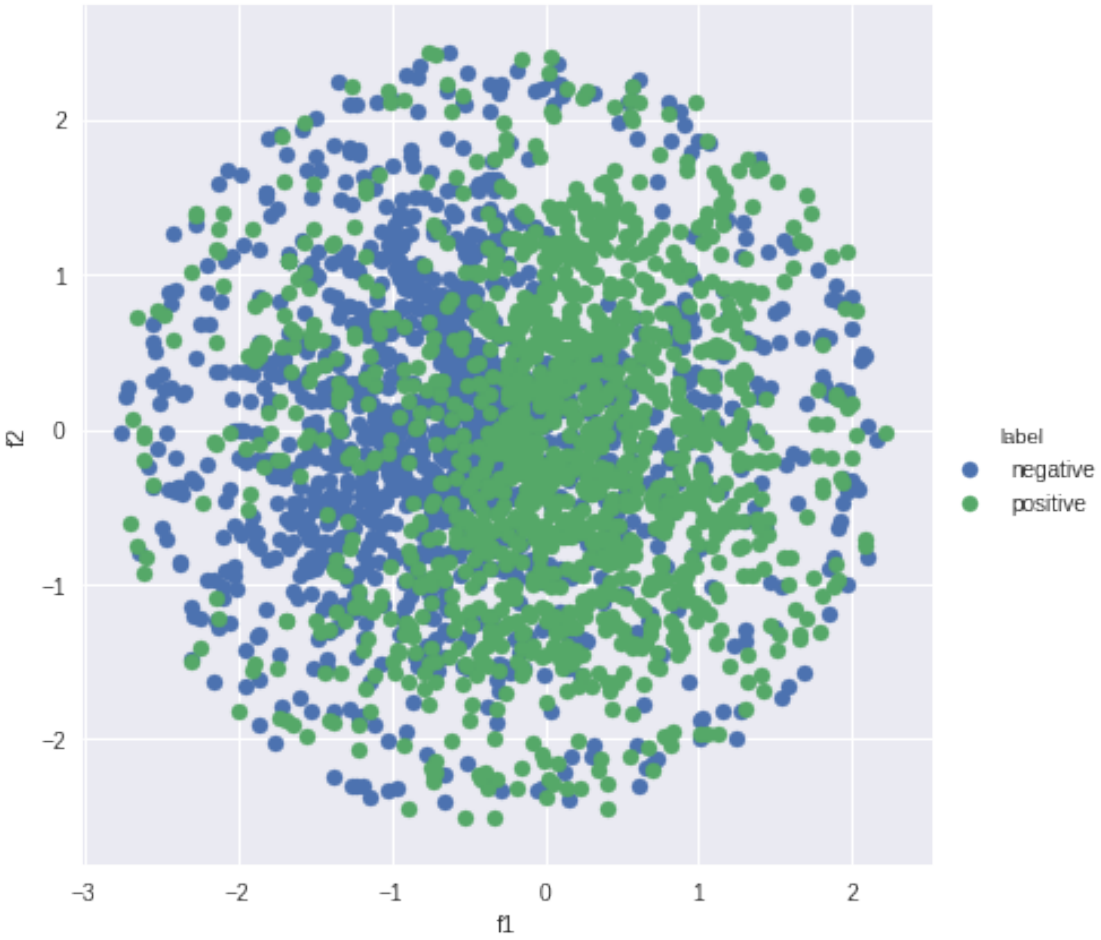

```
In [65]: sns.FacetGrid(plot_all_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[65]: <seaborn.axisgrid.FacetGrid at 0x7f25fed889b0>
```



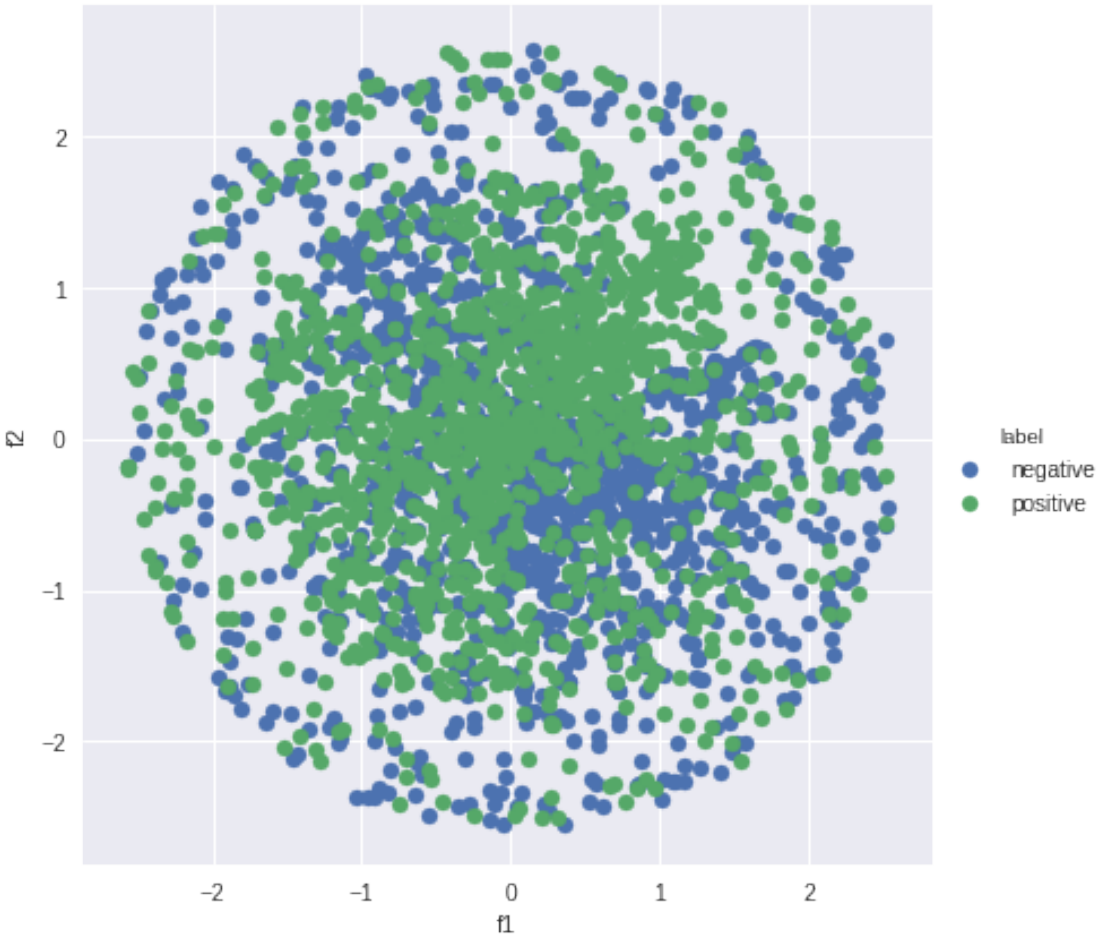

```
In [66]: sns.FacetGrid(plot_not_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[66]: <seaborn.axisgrid.FacetGrid at 0x7f25fe895f60>
```




```
In [67]: sns.FacetGrid(plot_not_excluded, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[67]: <seaborn.axisgrid.FacetGrid at 0x7f25fe6c6470>
```

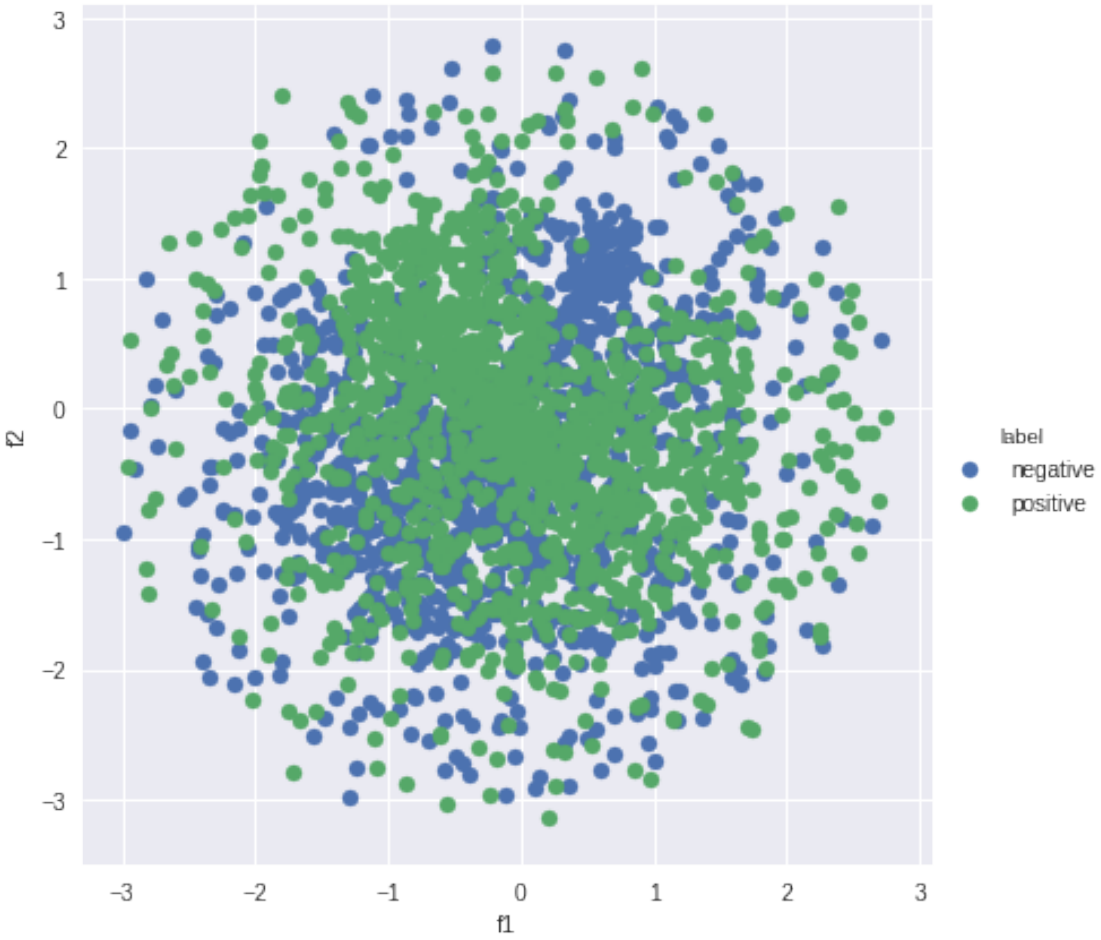


5 Observations

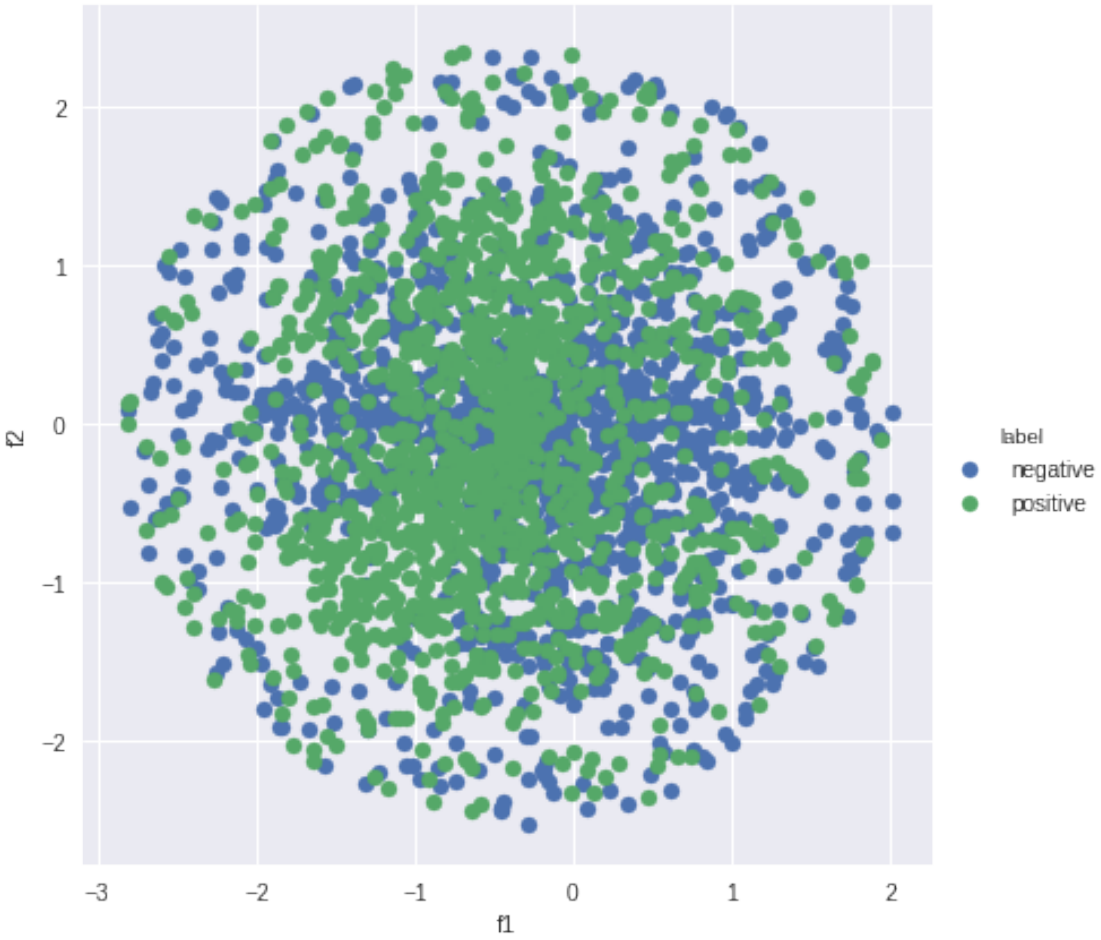
TF-IDF provides better separation of negative from positive reviews as we increase perplexity. It can also be seen that best results obtained when all words are included to form bigrams as compared to bigrams obtained by removing stopwords. If we exclude 'not' from list of stopwords, better results are obtained as compared to when 'not' is included as stopword.

```
In [87]: sns.FacetGrid(plot_all_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[87]: <seaborn.axisgrid.FacetGrid at 0x7f25ff5a8908>
```

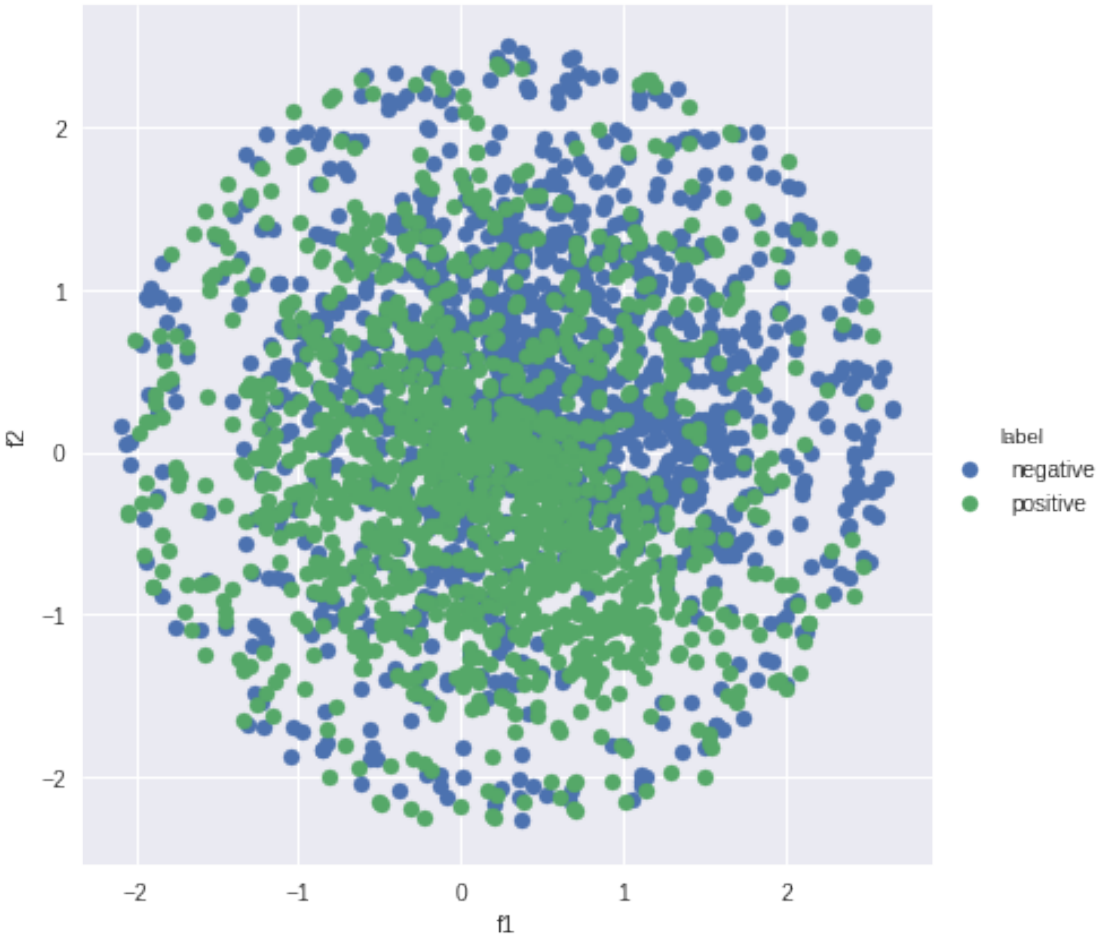



```
In [88]: sns.FacetGrid(plot_not_included, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_

Out[88]: <seaborn.axisgrid.FacetGrid at 0x7f25fe8979e8>
```




```
In [89]: sns.FacetGrid(plot_not_excluded, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_
```

```
Out[89]: <seaborn.axisgrid.FacetGrid at 0x7f25ffafd978>
```



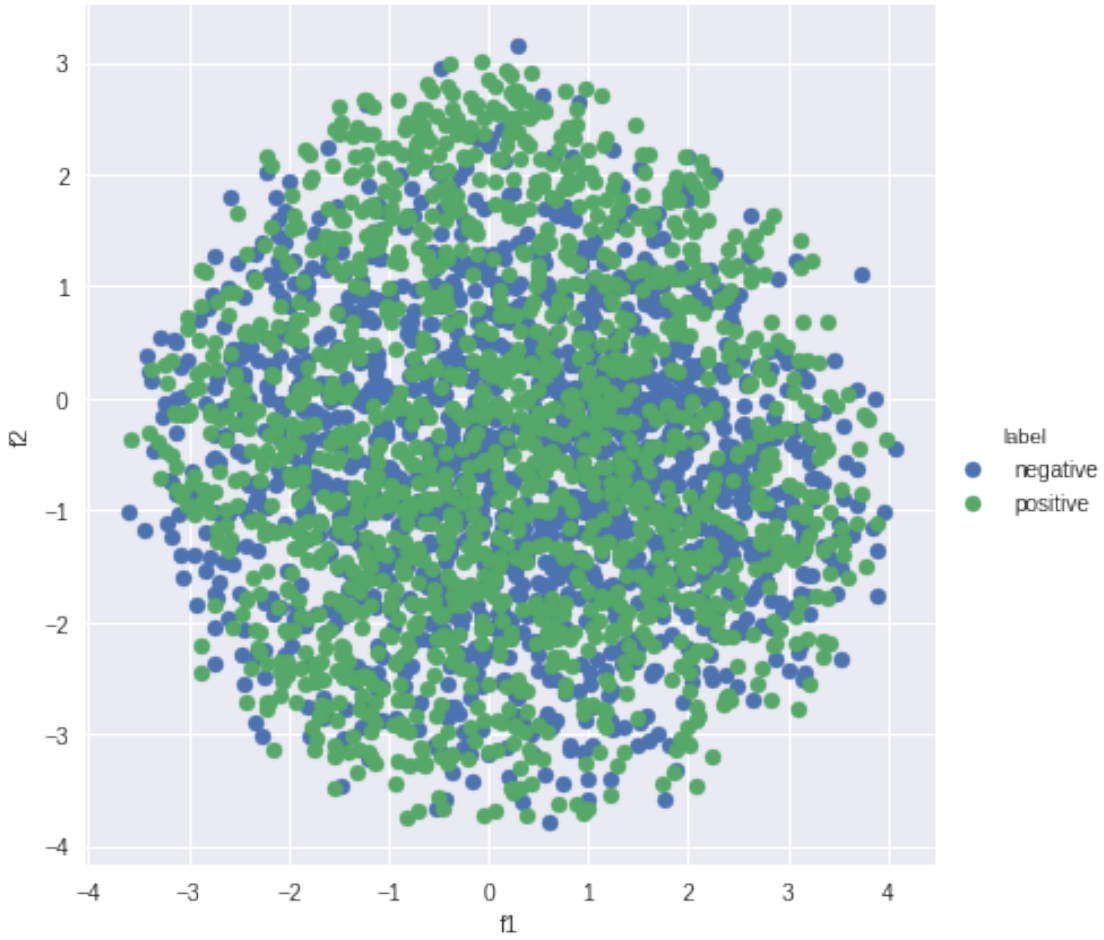
6 Conclusion

Best perplexity 1250 with 1500 iterations

7 Average word2Vec with above obtained parameters for TSNE

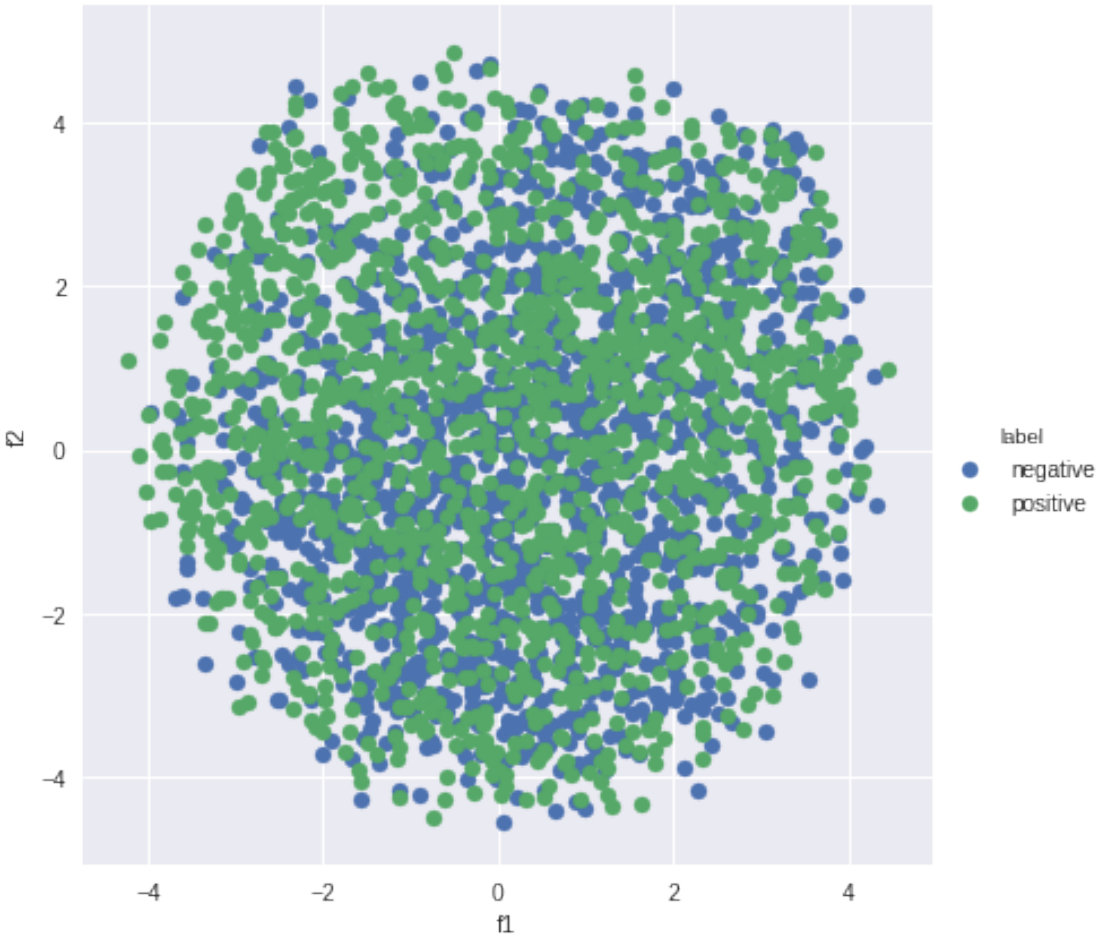
```
In [13]: # Train your own Word2Vec model using your own text corpus
         import gensim
         i=0
         list_of_sent=[]
         for sent in final['Text'].values:
             filtered_sentence=[]
             sent=cleanhtml(sent)
             for w in sent.split():
                 for cleaned_words in cleanpunc(w).split():
                     if(cleaned_words.isalpha()):
```

```
                        filtered_sentence.append(cleaned_words.lower())
                    else:
                        continue
            list_of_sent.append(filtered_sentence)


In [24]: clean_text=[]
         for sent in list_of_sent:
             s=' '.join(sent)
             clean_text.append(s)

In [28]: final['clean_text']=clean_text

In [14]: w2v_model=gensim.models.Word2Vec(list_of_sent,min_count=1,size=50, workers=1)

In [15]: # average Word2Vec
         # compute average word2vec for each review.
         sent_vectors = []; # the avg-w2v for each sentence/review is stored in this list
         for sent in list_of_sent: # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length
             cnt_words =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 try:
                     vec = w2v_model.wv[word]
                     sent_vec += vec
                     cnt_words += 1
                 except:
                     pass
             sent_vec /= cnt_words
             sent_vectors.append(sent_vec)

In [50]: from sklearn.preprocessing import StandardScaler

In [51]: scaler=StandardScaler()

In [134]: np.shape(sent_vectors)

Out[134]: (3000, 50)

In [0]: scaled=scaler.fit_transform(sent_vectors)
        tsne_model=TSNE(perplexity=900, n_iter=1500)
        tsne_data=tsne_model.fit_transform(scaled)

In [0]: plot_tsne=pd.DataFrame(np.concatenate((tsne_data, np.transpose(np.array(final['Score'],

In [137]: sns.FacetGrid(plot_tsne, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_legend(

Out[137]: <seaborn.axisgrid.FacetGrid at 0x7f25f62d6780>
```




```
In [141]: sns.FacetGrid(plot_tsne, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_legend(
```

```
Out[141]: <seaborn.axisgrid.FacetGrid at 0x7f25f62d6eb8>
```



8 Conclusion

Average word2Vec does not yield good results

9 TF-IDF word2Vec

```
In [29]: tf_idf_vect = TfidfVectorizer(ngram_range=(1,1))
         final_tf_idf = tf_idf_vect.fit_transform(final['clean_text'].values)

In [32]: tfidf_feat = tf_idf_vect.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

         tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this lis
         row=0;
         cnt=0
         for sent in list_of_sent: # for each review/sentence
```

```
            sent_vec = np.zeros(50) # as word vectors are of zero length
            weight_sum =0; # num of words with a valid vector in the sentence/review
            for word in sent: # for each word in a review/sentence
                try:
                    vec = w2v_model.wv[word]
                    # obtain the tf_idfidf of a word in a sentence/review
                    tfidf = final_tf_idf[row, tfidf_feat.index(word)]
                    sent_vec += (vec * tfidf)
                    weight_sum += tfidf
                    cnt+=1
                except:
                    pass
            sent_vec /= weight_sum
            tfidf_sent_vectors.append(sent_vec)
            row += 1
```

```
In [48]: tfidf_sent_vectors[1500]
```

```
Out[48]: array([ 0.28067801, -0.19081185, -0.04260838,  0.28642985, -0.64746111,
                -0.64312387,  0.16066378,  0.33372795, -0.19374414, -0.41818326,
                -0.05702171,  0.12379148,  0.45517951, -0.26014962, -0.46599343,
                -0.57293554, -0.22492677,  0.46670954, -0.03482334, -0.99999671,
                -0.38334637,  0.17849195, -0.37276381,  0.99311478,  0.11574649,
                -0.03164939,  0.12387733, -0.31967458,  1.67181607, -0.11203611,
                -0.06784235,  0.69936647,  0.16618147,  0.97755205,  0.18302191,
                 0.72372913,  0.44135196,  0.40731333, -0.9446863 ,  0.36938271,
                 0.81940944,  0.50451965,  0.08794205,  0.39522043, -0.15154316,
                 0.40906625, -0.20931151,  0.45765495,  0.78601216, -0.61179202])
```

```
In [76]: from sklearn.preprocessing import MinMaxScaler
         mmscaler=MinMaxScaler()
```

```
In [82]: p=700
```

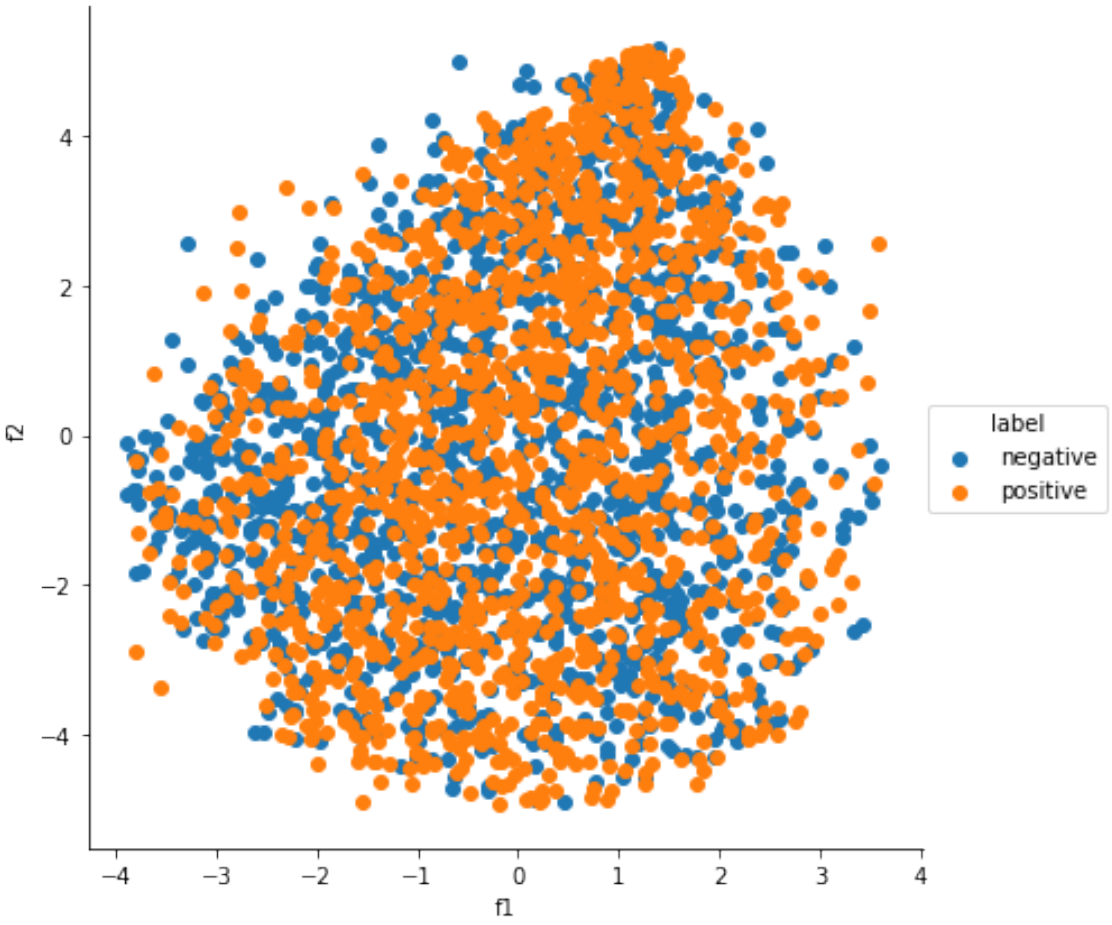
```
In [83]: scaled=scaler.fit_transform(tfidf_sent_vectors)
         model=TSNE(perplexity=p, n_iter=1500)
```

```
In [84]: data=model.fit_transform(scaled)
```

```
In [85]: plot=pd.DataFrame(np.concatenate((data, np.array(final.Score.values, ndmin=2).T), axis=
```

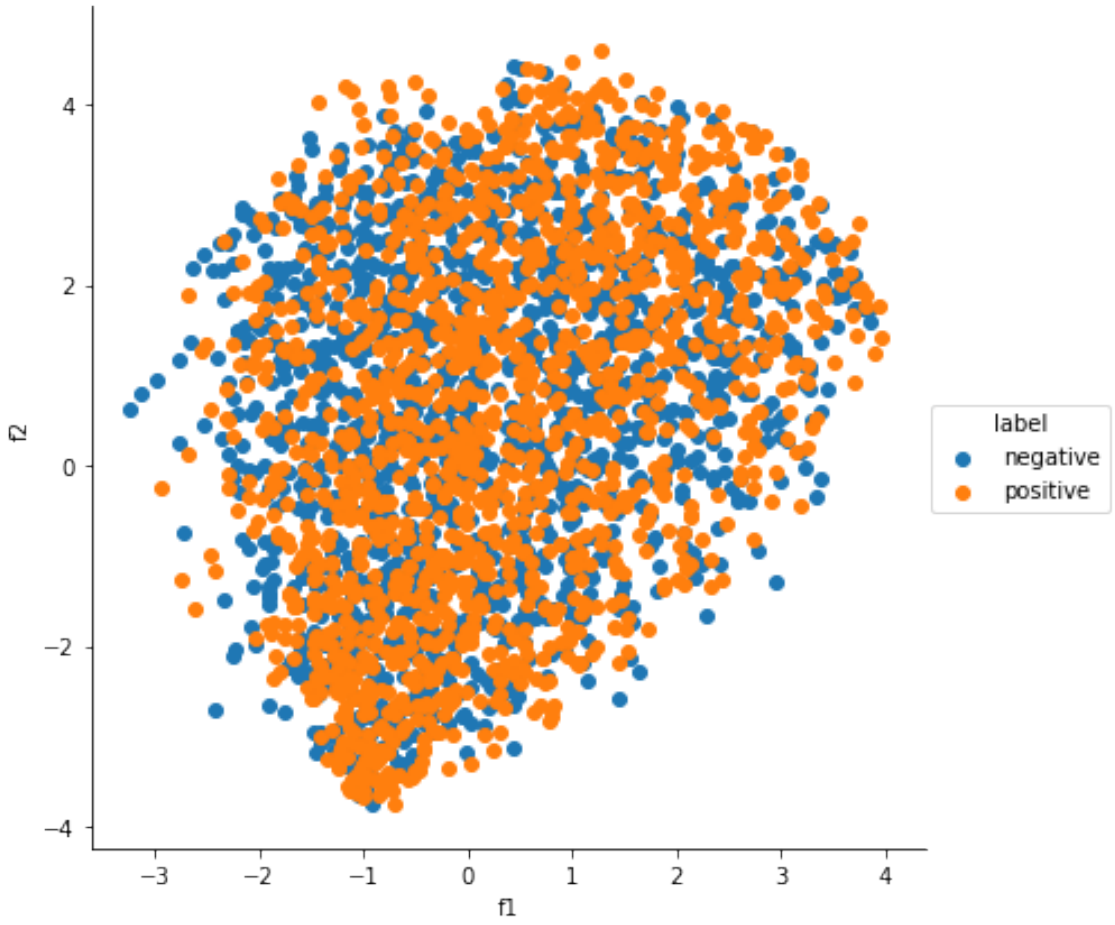
```
In [70]: sns.FacetGrid(plot, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_legend() # p=
```

```
Out[70]: <seaborn.axisgrid.FacetGrid at 0x7f0fb0627b00>
```




```
In [75]: sns.FacetGrid(plot, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_legend() # p=
```

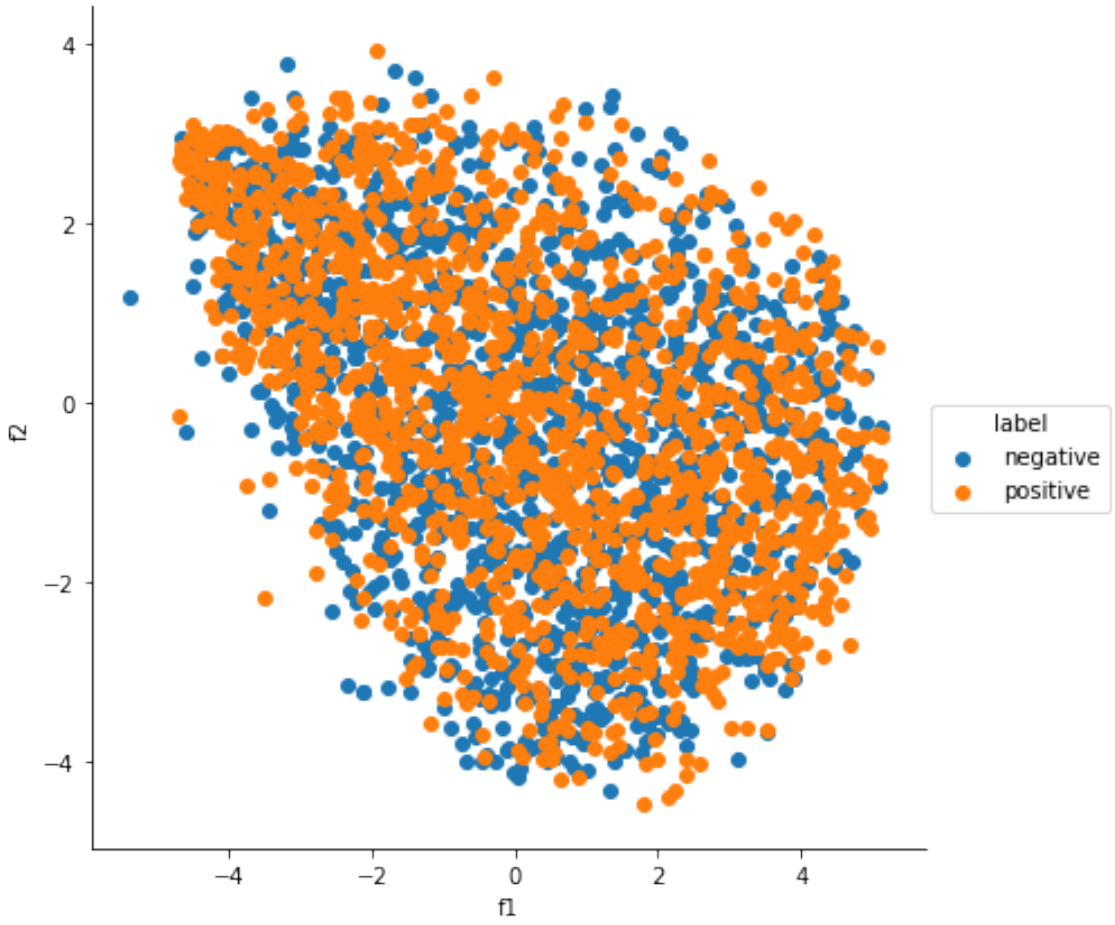
```
Out[75]: <seaborn.axisgrid.FacetGrid at 0x7f0fb078edd8>
```



9.0.1 MinMaxScaled data embedded in 2 dimensions with 1000 p

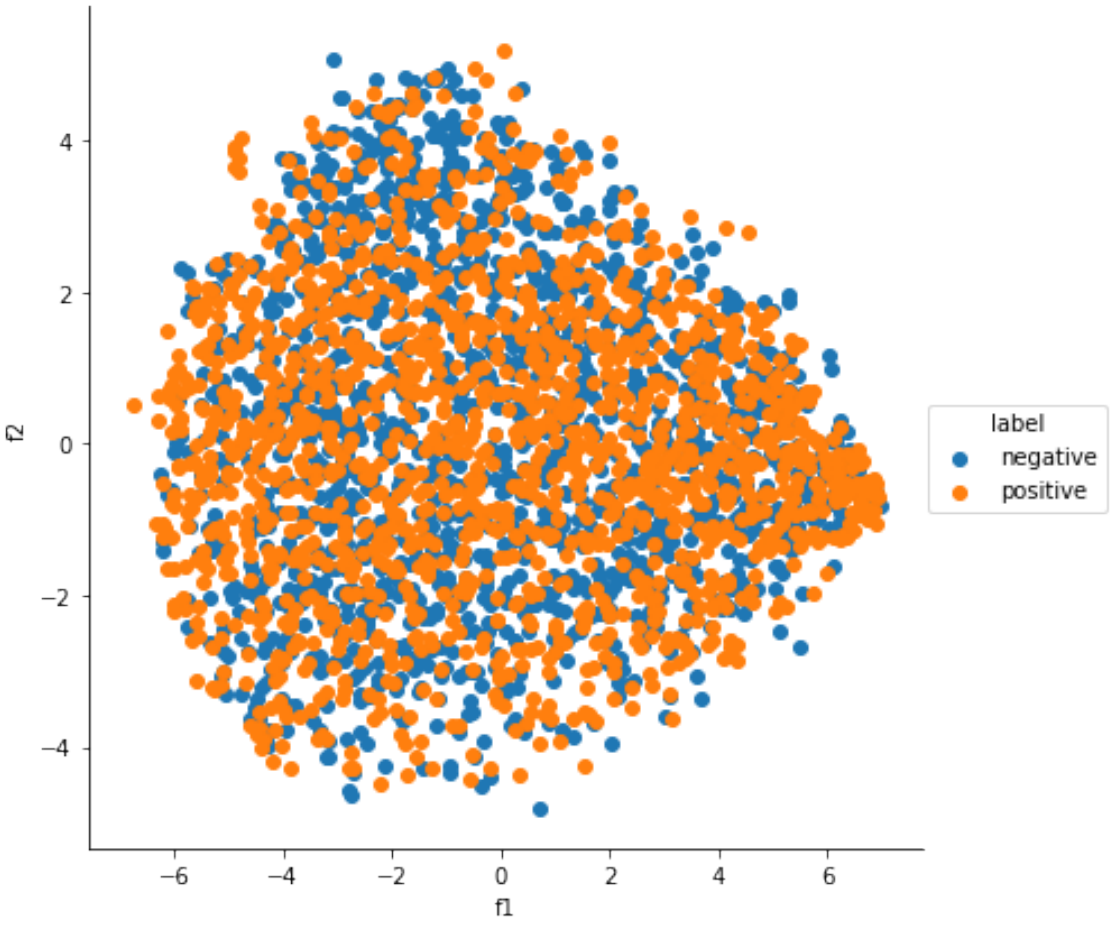
```
In [81]: sns.FacetGrid(plot, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_legend() # p=
```

```
Out[81]: <seaborn.axisgrid.FacetGrid at 0x7f0fb0348e80>
```




```
In [86]: sns.FacetGrid(plot, hue="label", size=6).map(plt.scatter, 'f1', 'f2').add_legend() # p=
```

```
Out[86]: <seaborn.axisgrid.FacetGrid at 0x7f0fb01cb748>
```



10 Conclusion

Best classification can be achieved using TF-IDF