Amazon Fine Food Reviews with Linear SVM

In SVM, We have hyperplanes that are seperated from +π and -π parallel to plane π.Points on +π and -π are support vectors.We would be finding the hyperparameter C with the help of SGD which will give us alpha.

If C increases, tendency to make mistakes on Dtrain decreases.Model becomes Overfit with High Variance.

If C decreases,Underfit with High Bias. ¶

In [28]:
```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
import sqlite3
import pandas as pd
import numpy as np
from sklearn.cross_validation import train_test_split
import string
from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import matplotlib.pyplot as plt
from sklearn import datasets, neighbors
from sklearn.metrics import accuracy_score
from sklearn.feature_extraction.text import CountVectorizer
```

In [29]:
```
conn = sqlite3.connect('final.sqlite')#Loading the Data set
final = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3 """, conn)
```

In [30]:
```
final = final.sort_values('Time', axis=0, ascending=True, inplace=False, kind='qu
```

In [31]:
```
x = final['CleanedText'].values[0:100000]#Taking 100K Values
y = final['Score'].values[0:100000]
```

In [32]:
```
from sklearn.model_selection import train_test_split#Splitting the dataset with 7
x_train, x_test, y_train, y_test = train_test_split( x, y, test_size=0.3, random_
```

In [33]:
```
#Plot Confusion Matrix for the dataset
from sklearn.metrics import confusion_matrix
import itertools
def plot_confusion_matrix(cm, classes,

                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):
    """
    This function prints and plots the confusion matrix.
    Normalization can be applied by setting `normalize=True`.
    """
    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized confusion matrix")
     #else:
      #  print('Confusion matrix, without normalization')

    #print(cm)

    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    fmt = '.2f' if normalize else 'd'
    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, format(cm[i, j], fmt),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.ylabel('True label')
    plt.xlabel('Predicted label')
    plt.tight_layout()
```

In [72]:
```
import matplotlib.pyplot as plt

def plot_coefficients(classifier, feature_names, top_features=20):

    coef = classifier.coef_.ravel()
    top_positive_coefficients = np.argsort(coef)[-top_features:]
    top_negative_coefficients = np.argsort(coef)[:top_features]
    top_coefficients = np.hstack([top_negative_coefficients, top_positive_coeffic
 # create plot
    plt.figure(figsize=(15, 5))
    colors = ['red' if c < 0 else 'blue' for c in coef[top_coefficients]]
    plt.bar(np.arange(2 * top_features), coef[top_coefficients], color=colors)
    feature_names = np.array(feature_names)
    plt.xticks(np.arange(1, 1 + 2 * top_features), feature_names[top_coefficients
    plt.show()
```

Bag of Words

In [8]:
```
from sklearn.feature_extraction.text import CountVectorizer
count_vect = CountVectorizer() #Vectorization for BOW
X_train = count_vect.fit_transform(x_train)# Fitting and training our dataset on
X_test = count_vect.transform(x_test)
print("Train Data Size: ",X_train.shape)
print("Test Data Size: ",X_test.shape)
```

```
Train Data Size:  (70000, 31419)
Test Data Size:  (30000, 31419)
```

In [10]:
```
from sklearn import preprocessing
#Column Standardization of the values with Mean deviation
scaler = preprocessing.StandardScaler(copy=True, with_mean=False, with_std=True)
X1_train = scaler.fit_transform(X_train)
X1_test = scaler.fit_transform(X_test)
```

In [33]:
```
from sklearn.linear_model import SGDClassifier
from sklearn.grid_search import GridSearchCV
from sklearn.datasets import *
from sklearn.model_selection import GridSearchCV, TimeSeriesSplit

tscv=TimeSeriesSplit(n_splits=10)

tuned_parameters = {'alpha': [1e-6, 1e-5, 1e-2, 1e-1, 1e0, 1e1, 1e2, 1e3]}

clf = SGDClassifier(loss="hinge", penalty="l2", max_iter=5)# using gridsearch on
model = GridSearchCV(clf, tuned_parameters, cv=tscv, n_jobs=-1, verbose=1)#Gridse
model.fit(X1_train, y_train)#fitting the train dataset
```

```
Fitting 10 folds for each of 8 candidates, totalling 80 fits

[Parallel(n_jobs=-1)]: Done  42 tasks      | elapsed:   11.9s
[Parallel(n_jobs=-1)]: Done  80 out of  80 | elapsed:   16.7s finished
```

Out[33]:
```
GridSearchCV(cv=TimeSeriesSplit(max_train_size=None, n_splits=10),
       error_score='raise',
       estimator=SGDClassifier(alpha=0.0001, average=False, class_weight=None,
epsilon=0.1,
       eta0=0.0, fit_intercept=True, l1_ratio=0.15,
       learning_rate='optimal', loss='hinge', max_iter=5, n_iter=None,
       n_jobs=1, penalty='l2', power_t=0.5, random_state=None,
       shuffle=True, tol=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=-1,
       param_grid={'alpha': [1e-06, 1e-05, 0.01, 0.1, 1.0, 10.0, 100.0, 1000.
0]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=1)
```

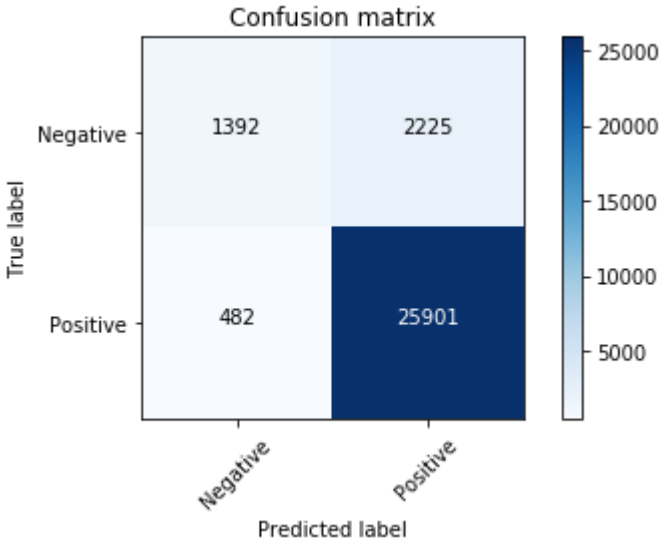
In [11]:
```
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score

clf = SVC(C=0.0001, kernel='linear',probability=True)#Applying Linear SVC with Va
clf.fit(X1_train, y_train)
y_pred = clf.predict(X1_test)
print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred)*100))# accu
```

```
Accuracy        on test set: 90.977%
```

In [38]:
```
from sklearn.metrics import precision_recall_fscore_support
precision_recall_fscore_support(y_test, y_pred, average='weighted')#Generating Va
```

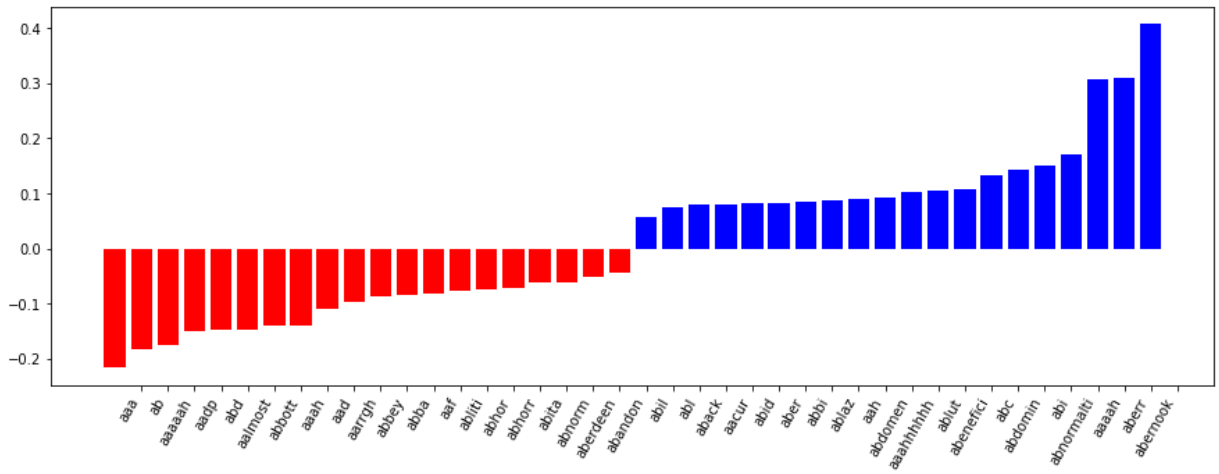
Out[38]:
```
(0.8994193155790051, 0.9097666666666666, 0.8968880172325682, None)
```

In [39]:
```
plot_confusion_matrix(confusion_matrix(y_test, y_pred), classes=["Negative","Posi
```



Printing Top Features

In [73]:
```
plot_coefficients(clf, count_vect.get_feature_names())
```



TFIDF

In [41]:
```
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer
tf_idf_vect = TfidfVectorizer(ngram_range=(1,2))#Vectorizering the data
X_train_tfidf = tf_idf_vect.fit_transform(x_train)
X_test_tfidf = tf_idf_vect.transform(x_test)
print("the type of count vectorizer ",type(X_train_tfidf))
print("Train Data Size: ",X_train_tfidf.shape)
print("Test Data Size: ",X_test_tfidf.shape)
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
Train Data Size:  (70000, 931334)
Test Data Size:  (30000, 931334)
```

In [42]:
```
scaler = preprocessing.StandardScaler(copy=True, with_mean=False, with_std=True)#
X2_train = scaler.fit_transform(X_train_tfidf)
X2_test = scaler.fit_transform(X_test_tfidf)
```

In [44]:
```
from sklearn.linear_model import SGDClassifier
from sklearn.grid_search import GridSearchCV
from sklearn.datasets import *
from sklearn.model_selection import GridSearchCV, TimeSeriesSplit

tscv=TimeSeriesSplit(n_splits=10)

tuned_parameters = {'alpha': [1e-3, 1e-2, 1e-1, 1e0, 1e1, 1e2, 1e3]}

clf = SGDClassifier(loss="hinge", penalty="l2", max_iter=5)#Applying SGD on range
model = GridSearchCV(clf, tuned_parameters, cv=tscv, n_jobs=-1, verbose=1)# Apply
model.fit(X2_train, y_train)# fitting the model
```

```
Fitting 10 folds for each of 7 candidates, totalling 70 fits

[Parallel(n_jobs=-1)]: Done  42 tasks      | elapsed:   13.8s
[Parallel(n_jobs=-1)]: Done  70 out of  70 | elapsed:   22.6s finished
```

Out[44]:
```
GridSearchCV(cv=TimeSeriesSplit(max_train_size=None, n_splits=10),
       error_score='raise',
       estimator=SGDClassifier(alpha=0.0001, average=False, class_weight=None,
epsilon=0.1,
       eta0=0.0, fit_intercept=True, l1_ratio=0.15,
       learning_rate='optimal', loss='hinge', max_iter=5, n_iter=None,
       n_jobs=1, penalty='l2', power_t=0.5, random_state=None,
       shuffle=True, tol=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=-1,
       param_grid={'alpha': [0.001, 0.01, 0.1, 1.0, 10.0, 100.0, 1000.0]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=1)
```

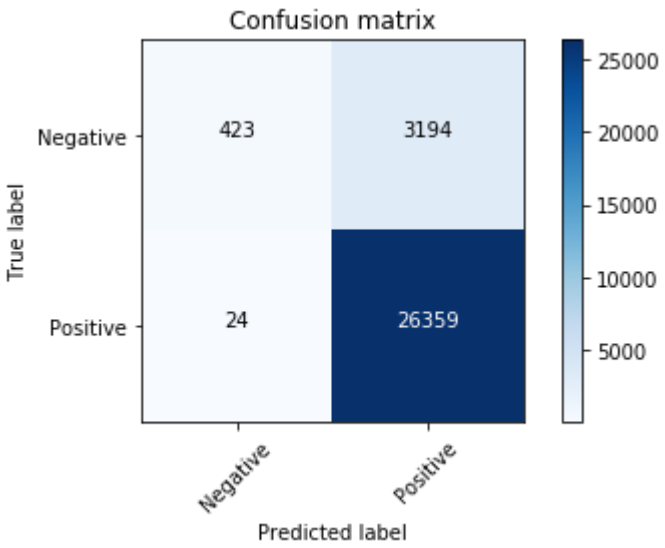
In [45]:
```
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score

clf2 = SVC(C=0.0001, kernel='linear')#Applying Linear SVC with Values implemented
clf2.fit(X2_train, y_train)
y_pred_tfidf = clf2.predict(X2_test)
print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred_tfidf)*100))
```

```
Accuracy        on test set: 89.273%
```

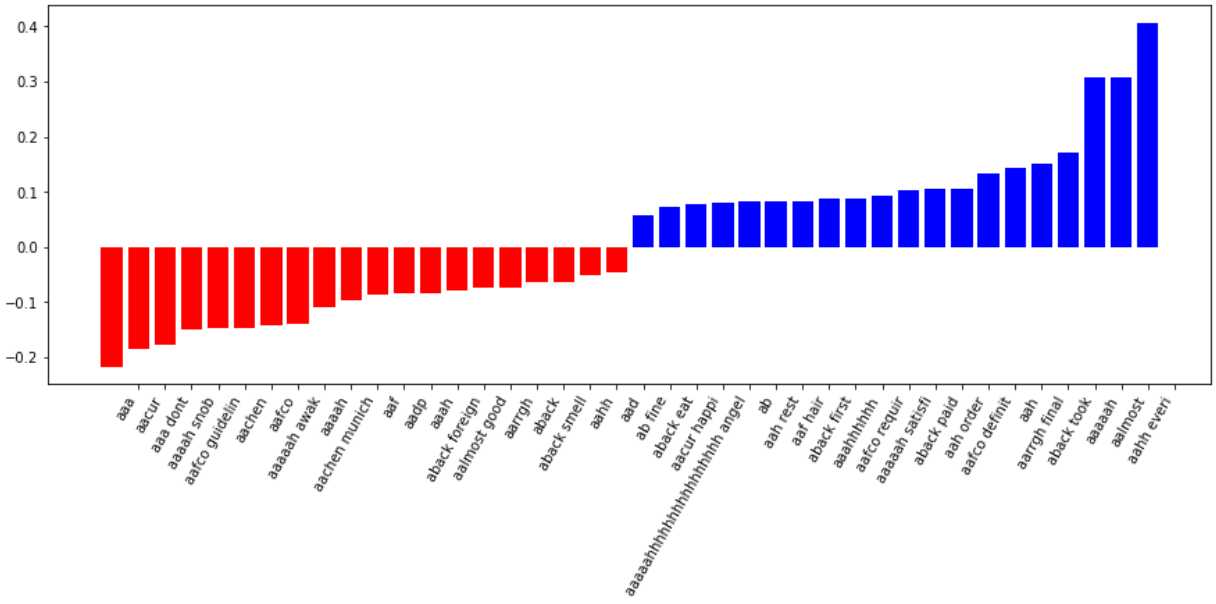
In [46]:
```
from sklearn.metrics import precision_recall_fscore_support
precision_recall_fscore_support(y_test, y_pred_tfidf, average='weighted')#Generat
```

Out[46]:
```
(0.8984800930887373, 0.8927333333333334, 0.8539377810392228, None)
```

In [47]:
```
plot_confusion_matrix(confusion_matrix(y_test, y_pred_tfidf), classes=["Negative"
```



In [74]:
```
plot_coefficients(clf, tf_idf_vect.get_feature_names())
```



AVGW2V

In [35]:
```
#Word 2 Vector for train corpus
list_of_sent_train=[]#Stored in a list
for sent in x_train:
    list_of_sent_train.append(sent.split())

w2v_model_train=Word2Vec(list_of_sent_train,min_count=5,size=50, workers=4)
print(w2v_model_train)

w2v_words_train = list(w2v_model_train.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words_train))
print("sample words ", w2v_words_train[0:50])
```

```
Word2Vec(vocab=10698, size=50, alpha=0.025)
number of words that occured minimum 5 times  10698
sample words  ['decid', 'roll', 'dice', 'bought', 'spring', 'onion', 'split',
'pea', 'soup', 'sinc', 'like', 'drink', 'wasnt', 'disappoint', 'littl', 'scar
e', 'first', 'time', 'order', 'food', 'type', 'item', 'amazon', 'sister', 'thou
ght', 'crazi', 'someth', 'normal', 'dont', 'far', 'favorit', 'tri', 'bland', 't
ast', 'compar', 'ambrosia', 'tomorrow', 'season', 'perfect', 'light', 'good',
'expect', 'come', 'cup', 'noodl', 'best', 'microwav', 'ever', 'know', 'might']
```

In [36]:
```
#Word 2 Vector for test corpus
list_of_sent_test=[]
for sent in x_test:
    list_of_sent_test.append(sent.split())

w2v_model_test=Word2Vec(list_of_sent_test,min_count=5,size=50, workers=4)
print(w2v_model_test)

w2v_words_test = list(w2v_model_test.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words_test))
print("sample words ", w2v_words_test[0:50])
```

```
Word2Vec(vocab=7458, size=50, alpha=0.025)
number of words that occured minimum 5 times  7458
sample words  ['like', 'organ', 'whole', 'grain', 'brown', 'rice', 'take', 'loo
k', 'label', 'milk', 'product', 'two', 'thing', 'dont', 'often', 'see', 'find',
'togeth', 'one', 'made', 'favorit', 'far', 'three', 'boy', 'love', 'even', 'mi
x', 'unsweeten', 'soy', 'cut', 'sugar', 'high', 'recommend', 'anyon', 'want',
'need', 'avoid', 'dairi', 'that', 'posit', 'say', 'arent', 'lot', 'choic', 'dec
af', 'tassimo', 'moment', 'make', 'brew', 'cup']
```

In [37]:
```
#train corpus
sent_vectors_train = []; # the avg-w2v for each sentence/review is stored in this
for sent in list_of_sent_train: # 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
        if word in w2v_words_train:
            #print(word)
            vec = w2v_model_train.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    sent_vectors_train.append(sent_vec)
print(len(sent_vectors_train))
print(len(sent_vectors_train[0]))
```

```
70000
50
```

In [38]:
```
#test Corpus
sent_vectors_test = []; # the avg-w2v for each sentence/review is stored in this
for sent in list_of_sent_test: # 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
        if word in w2v_words_test:

            vec = w2v_model_test.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    sent_vectors_test.append(sent_vec)
print(len(sent_vectors_test))
print(len(sent_vectors_test[0]))
```

```
30000
50
```

In [39]:
```
scaler = preprocessing.StandardScaler(copy=True, with_mean=True, with_std=True)# .
X_train_avgw2v = scaler.fit_transform(sent_vectors_train)
X_test_avgw2v = scaler.fit_transform(sent_vectors_test)
```

In [49]:
```
from sklearn.linear_model import SGDClassifier
from sklearn.grid_search import GridSearchCV
from sklearn.datasets import *
from sklearn.model_selection import GridSearchCV, TimeSeriesSplit

tscv=TimeSeriesSplit(n_splits=10)

tuned_parameters = {'alpha': [0.00001,0.0001,0.001,0.1,1,10,100,100]}

clf = SGDClassifier(loss="hinge", penalty="l2", max_iter=5, class_weight = 'balan
model = GridSearchCV(clf, tuned_parameters, cv=3, n_jobs=-1, verbose=1)
model.fit(X_train_avgw2v, y_train)
```

```
Fitting 3 folds for each of 8 candidates, totalling 24 fits

[Parallel(n_jobs=-1)]: Done  24 out of  24 | elapsed:   11.9s finished
```

Out[49]:
```
GridSearchCV(cv=3, error_score='raise',
       estimator=SGDClassifier(alpha=0.0001, average=False, class_weight='balan
ced',
       epsilon=0.1, eta0=0.0, fit_intercept=True, l1_ratio=0.15,
       learning_rate='optimal', loss='hinge', max_iter=5, n_iter=None,
       n_jobs=1, penalty='l2', power_t=0.5, random_state=None,
       shuffle=True, tol=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=-1,
       param_grid={'alpha': [1e-05, 0.0001, 0.001, 0.1, 1, 10, 100, 100]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=1)
```

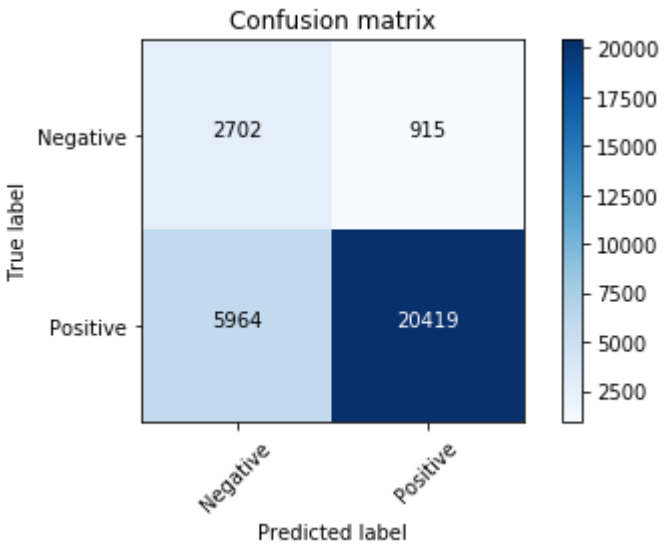
In [54]:
```
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score

clf = SVC(C=0.0001, kernel='linear', class_weight='balanced')
clf.fit(X_train_avgw2v, y_train)
y_pred_avgw2v = clf.predict(X_test_avgw2v)
print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred_avgw2v)*100)
```

```
Accuracy on test set: 77.070%
```

In [55]:
```
from sklearn.metrics import precision_recall_fscore_support
precision_recall_fscore_support(y_test, y_pred_avgw2v, average='weighted')#Genera
```

Out[55]:
```
(0.8793069353219424, 0.7707, 0.805696291658824, None)
```

In [56]:
```
plot_confusion_matrix(confusion_matrix(y_test, y_pred_avgw2v), classes=["Negative
```



TFIDF AVGW2V

In [43]:
```
model = TfidfVectorizer()
tf_idf_matrix = model.fit_transform(x_train)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))
```

In [44]:
```
tfidf_feat = tf_idf_vect.get_feature_names()#getting feature list
```

In [45]:
```
from tqdm import tqdm
tfidf_sent_vectors_train = []; # the tfidf-w2v for each sentence/review is stored
row=0;
for sent in tqdm(list_of_sent_train): # 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
        if word in w2v_words_train:
            vec = w2v_model_train.wv[word]
#             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
            # to reduce the computation we are
            # dictionary[word] = idf value of word in whole courpus
            # sent.count(word) = tf valeus of word in this review
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))#taking the dic
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors_train.append(sent_vec)
    row += 1

print(len(tfidf_sent_vectors_train))
print(len(tfidf_sent_vectors_train[0]))
```

```
100%|████████████████████████████████████████████████████████████████
█| 70000/70000 [02:33<00:00, 454.81it/s]

70000
50
```

In [46]:
```
model = TfidfVectorizer(ngram_range=(1,2))
tf_idf_matrix = model.fit_transform(x_test)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary_test = dict(zip(model.get_feature_names(), list(model.idf_)))
```

In [47]:
```
#test corpus
tfidf_sent_vectors_test = []; # the tfidf-w2v for each sentence/review is stored
row=0;
for sent in tqdm(list_of_sent_test): # 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
        if word in w2v_words_test:
            vec = w2v_model_test.wv[word]
#             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
            # to reduce the computation we are
            # dictionary[word] = idf value of word in whole courpus
            # sent.count(word) = tf valeus of word in this review
            tf_idf = dictionary_test[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors_test.append(sent_vec)
    row += 1

print(len(tfidf_sent_vectors_test))
print(len(tfidf_sent_vectors_test[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████████████
| 30000/30000 [00:56<00:00, 533.57it/s]

30000
50
```

In [48]:
```
scaler = preprocessing.StandardScaler(copy=True, with_mean=False, with_std=True)
X_train_avgw2v_tfidf = scaler.fit_transform(tfidf_sent_vectors_train)
X_test_avgw2v_tfidf = scaler.fit_transform(tfidf_sent_vectors_test)
```

In [121]:
```
from sklearn.linear_model import SGDClassifier
from sklearn.grid_search import GridSearchCV
from sklearn.datasets import *
from sklearn.model_selection import GridSearchCV, TimeSeriesSplit

tscv=TimeSeriesSplit(n_splits=10)

tuned_parameters = {'alpha': [1e-1, 1e0, 1e1, 1e2, 1e3]}

clf = SGDClassifier(loss="hinge", penalty="l2", max_iter=5, class_weight = 'balan
model = GridSearchCV(clf, tuned_parameters, cv=tscv, n_jobs=-1, verbose=1)
model.fit(X_train_avgw2v_tfidf, y_train)
```

```
Fitting 10 folds for each of 5 candidates, totalling 50 fits

[Parallel(n_jobs=-1)]: Done  42 tasks      | elapsed:    6.8s
[Parallel(n_jobs=-1)]: Done  50 out of  50 | elapsed:    7.8s finished
```

Out[121]:
```
GridSearchCV(cv=TimeSeriesSplit(max_train_size=None, n_splits=10),
       error_score='raise',
       estimator=SGDClassifier(alpha=0.0001, average=False, class_weight=None,
epsilon=0.1,
       eta0=0.0, fit_intercept=True, l1_ratio=0.15,
       learning_rate='optimal', loss='hinge', max_iter=5, n_iter=None,
       n_jobs=1, penalty='l2', power_t=0.5, random_state=None,
       shuffle=True, tol=None, verbose=0, warm_start=False),
       fit_params=None, iid=True, n_jobs=-1,
       param_grid={'alpha': [0.1, 1.0, 10.0, 100.0, 1000.0]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring=None, verbose=1)
```

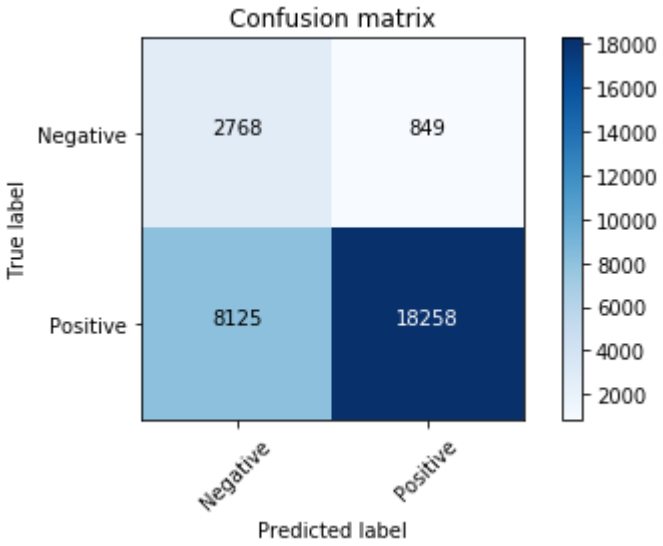
In [57]:
```
from sklearn.svm import SVC
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score

clf = SVC(C=0.0001, kernel='linear', class_weight='balanced')
clf.fit(X_train_avgw2v_tfidf, y_train)
y_pred_avgw2v_tfidf = clf.predict(X_test_avgw2v_tfidf)
print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred_avgw2v_tfidf
```

```
Accuracy        on test set: 70.087%
```

In [58]:
```
from sklearn.metrics import precision_recall_fscore_support
precision_recall_fscore_support(y_test, y_pred_avgw2v_tfidf, average='weighted')#
```

Out[58]:
```
(0.8709935845152833, 0.7008666666666666, 0.7519436888056169, None)
```

In [59]:
```
plot_confusion_matrix(confusion_matrix(y_test, y_pred_avgw2v_tfidf), classes=["Ne
```



Classifier	Feature Name	Value of C	Accuracy
Linear SVM	BOW	0.0001	90.97
Linear SVM	TFIDF	0.0001	89.27
Linear SVM	AVGW2VEC	0.0001	77.07
Linear SVM	TFIDF AVGW2VEC	0.0001	70.08

Observation : 1. The Best Model is Bag of Words with High accuracy.Though the Value of C which is the hyperparameter is same for all.

Conclusion : As the value of n is very large, we would not use SVM for Internet applications as the latency is very high.