AmazonReviews_RF_GBDT

September 2, 2018

1 Amazon Reviews Classification Using Random Forest and Gradient-Boosting

```
In [10]: %matplotlib inline

          import pandas as pd #for data frames
          import numpy as np #numpy array operations
          import string
          import matplotlib.pyplot as plt
          from sklearn.feature_extraction.text import TfidfTransformer
          from sklearn.feature_extraction.text import TfidfVectorizer
          from sklearn.feature_extraction.text import CountVectorizer
          import pickle
          from sklearn.cross_validation import train_test_split
          import seaborn as sn
          from sklearn.metrics import accuracy_score
          from sklearn.cross_validation import cross_val_score
          from sklearn import cross_validation
          from sklearn.model_selection import train_test_split
          from sklearn.metrics import average_precision_score,f1_score,precision_score,recall_s
          from sklearn.grid_search import GridSearchCV
          from sklearn.model_selection import RandomizedSearchCV
          from sklearn.metrics import roc_curve, auc

          from scipy.stats import expon
          import random

          from sklearn.ensemble import RandomForestClassifier
          from sklearn.ensemble import GradientBoostingClassifier
          from xgboost import XGBClassifier
```

```
In [2]: pickle_in=open("cleanedData.pickle","rb")
        final = pickle.load(pickle_in)

        import pickle
        pickle_in = open("BOW_tfidf_avgW2V_Train_test_data.pickle","rb")
        count_vect = pickle.load(pickle_in) #BOW
        final_counts_train = pickle.load(pickle_in) #BOW
        final_counts_test = pickle.load(pickle_in) #BOW
        tf_idf_vect = pickle.load(pickle_in) #tfidf
        final_tf_idf_train = pickle.load(pickle_in) #tfidf
        final_tf_idf_test = pickle.load(pickle_in) #tfidf
        features = pickle.load(pickle_in)
        sent_vectors_train = pickle.load(pickle_in) #avgW2v Vectors
        sent_vectors_test = pickle.load(pickle_in) #avgW2v Vectors

C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\base.py:315: UserWarning: Trying to unpickle
  UserWarning)
C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\base.py:315: UserWarning: Trying to unpickle
  UserWarning)
C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\base.py:315: UserWarning: Trying to unpickle
  UserWarning)
```

```
In [3]: train_data = final.head(int(0.80*final.shape[0]))
        test_data = final.head(int(0.20*final.shape[0])+1)

        scores = final['Score'].get_values()
        len(scores)

Out[3]: 364171
```

```
In [28]: def convScores(scores):
             li = lambda x: 1 if x=='positive'  else 0
             final_scores = []
             for i in range(0,len(scores)):
                 final_scores.append(li(scores[i]))
             return final_scores

         def convToNpArray(arr):
             if(type(arr) == list):
                 arr = np.array(arr)
                 return arr
             else:
                 return arr;
         def confusionMatrix(y_test,pred):
             df_cm = pd.DataFrame(confusion_matrix(y_test, pred), index = ['False','True'],
                               columns = ['False','True'])
             sn.heatmap(df_cm, annot=True)
             plt.title('Confusion Matrix')
             plt.ylabel('Actual')
             plt.xlabel('Predicted')
             plt.show()
         def auc_roc(y_test,pred):
             fpr, tpr, thresholds = roc_curve(y_test,pred)
             acc = auc(fpr, tpr)
             print("Area Under The Curve is : ",acc)
             plt.figure()

             plt.plot(fpr, tpr, color='darkorange',
                       label='ROC curve (area/auc = %0.2f)' % acc)
             plt.xlabel('False Positive Rate')
             plt.ylabel('True Positive Rate')
             plt.title('Receiver operating characteristic Curve')
             plt.legend(loc="lower right")
             plt.show()
         def show_most_informative_features(vectorizer, clf, n=20):
             feature_names = vectorizer.get_feature_names()
             coefs_with_fns = sorted(zip(clf.feature_importances_, feature_names))
             top = zip(coefs_with_fns[:n], coefs_with_fns[:-(n + 1):-1])
             print("These are the top {} important Features Which are most widely used in Posi
             print("")
             print("\tPositive: \t\t\tNegative:")
             for (coef_1, fn_1), (coef_2, fn_2) in top:
                 print("")
                 print("\t%-15s\t\t\t%-15s" % (fn_2,fn_1))
```

2 RF

2.1 Avg W2V RF

```
In [29]: x_1 = sent_vectors_train[0:50000]


         # this is only Score/rating  of data

         y_1 = convScores(train_data['Score'].get_values())[0:50000]

         x_test = sent_vectors_test[0:6000]
         y_test = convScores(test_data['Score'].get_values())[0:6000]


         x_1 = convToNpArray(x_1)
         x_test = convToNpArray(x_test)
         y_1 = convToNpArray(y_1)
         y_test = convToNpArray(y_test)
```

Considering n_estimators/k and max_depth as hyperparameters

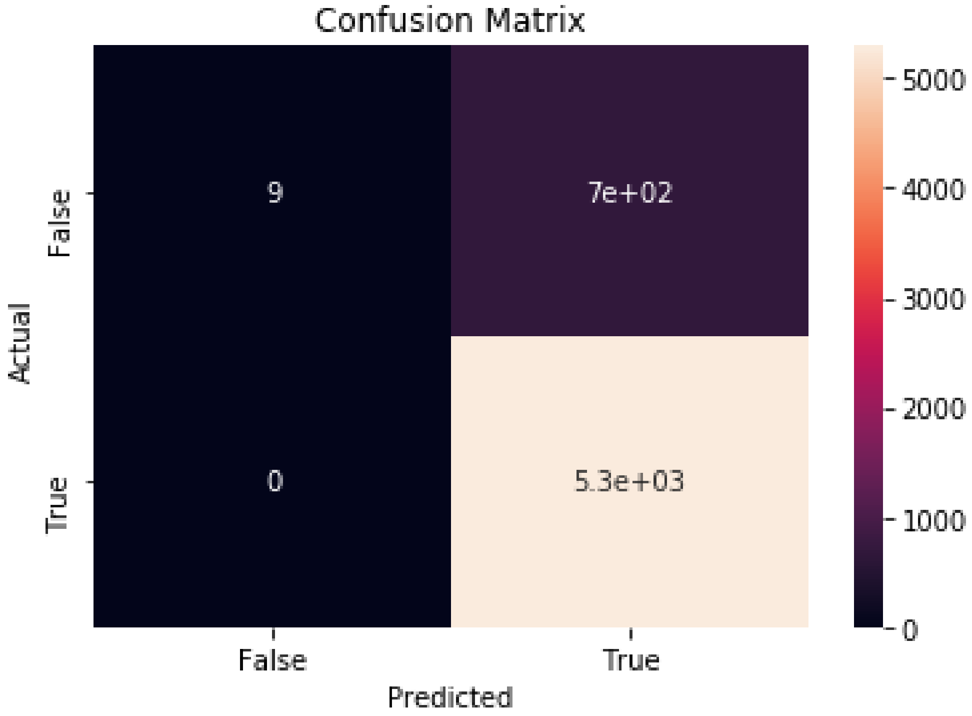
```
In [30]: tuned_parameters = {'n_estimators':[10,20,40,50],
                            'max_depth':[20,50,100]}
```

```
         rf_model = RandomForestClassifier(n_jobs=-1,oob_score=True,class_weight='balanced')
         model = GridSearchCV(rf_model,tuned_parameters,
                              scoring='accuracy',cv=3,n_jobs=-1)

         model.fit(x_1,y_1)

         print(model.best_estimator_)
         print("Score: ",model.score(x_test,y_test))
```

```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
            criterion='gini', max_depth=20, max_features='auto',
            max_leaf_nodes=None, min_impurity_split=1e-07,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=40, n_jobs=-1,
            oob_score=True, random_state=None, verbose=0, warm_start=False)
Score:  0.882833333333
```

```
C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\grid_search.py:438: ChangedBehaviorWarning: T
  ChangedBehaviorWarning)
```

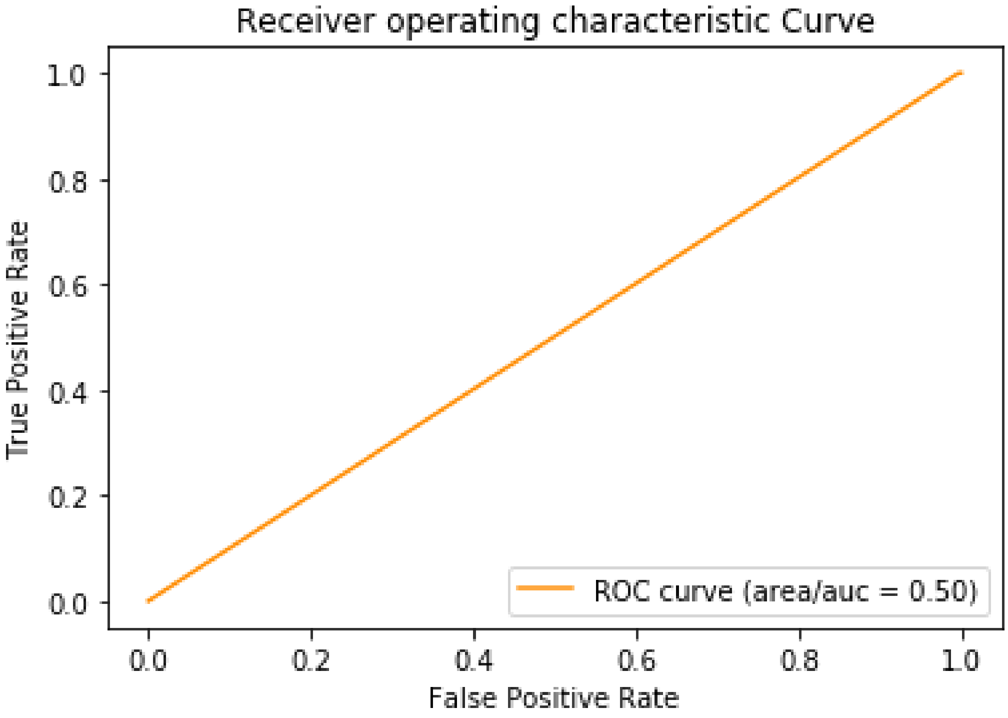
```
In [31]: best_rf_model = model.best_estimator_
         best_rf_model.fit(x_1,y_1)
         pred = best_rf_model.predict(x_test)
         confusionMatrix(y_test,pred)
```



AUC

```
In [16]: auc_roc(y_test,pred)
```

```
Area Under The Curve is :  0.50131996277
```



2.2 BOW RF

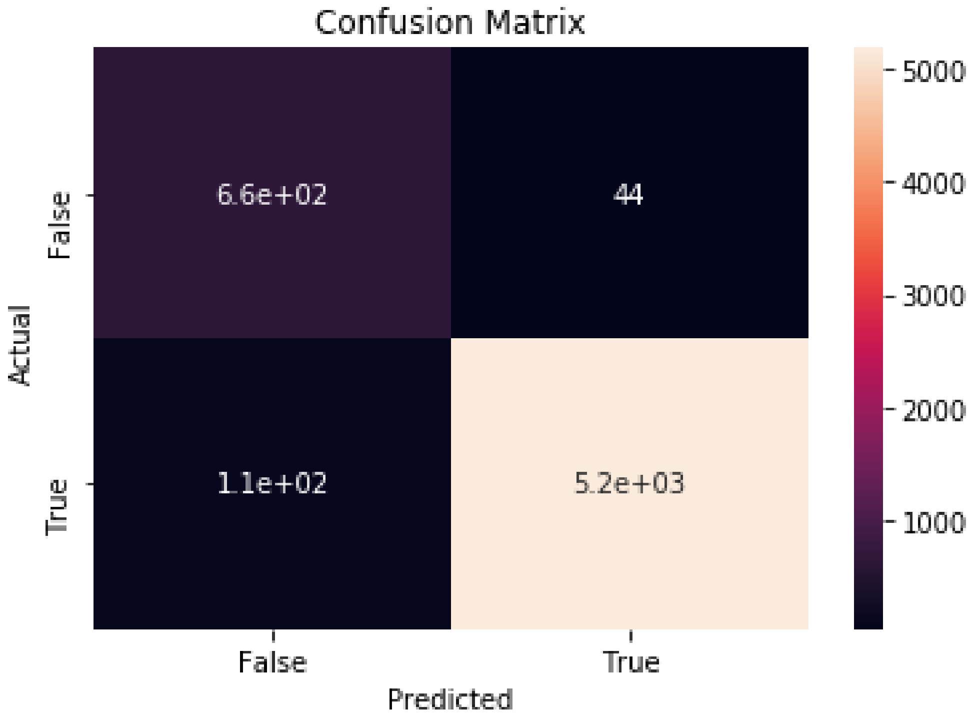
```
In [33]: # Total data frame

         x_1 = final_counts_train[0:50000]


         # this is only Score/rating  of data

         y_1 = convScores(train_data['Score'].get_values())[0:50000]

         x_test = final_counts_test[0:6000]
         y_test = convScores(test_data['Score'].get_values())[0:6000]

         #x_1, x_test, y_1, y_test = train_test_split(x,y, test_size=0.3, random_state=0)
         x_1 = convToNpArray(x_1)
         x_test = convToNpArray(x_test)
         y_1 = convToNpArray(y_1)
         y_test = convToNpArray(y_test)
```

```
In [34]: tuned_parameters = {'n_estimators':[10,20,40,50],
                             'max_depth':[20,50,100]}



         rf_model = RandomForestClassifier(n_jobs=-1,oob_score=True,class_weight='balanced')
         model = GridSearchCV(rf_model,tuned_parameters,
                              scoring='accuracy',cv=3,n_jobs=-1)

         model.fit(x_1,y_1)

         print(model.best_estimator_)
         print("Score: ",model.score(x_test,y_test))
```

```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
            criterion='gini', max_depth=50, max_features='auto',
            max_leaf_nodes=None, min_impurity_split=1e-07,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=50, n_jobs=-1,
            oob_score=True, random_state=None, verbose=0, warm_start=False)
Score:  0.974
```

```
C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\grid_search.py:438: ChangedBehaviorWarning: T
  ChangedBehaviorWarning)
```

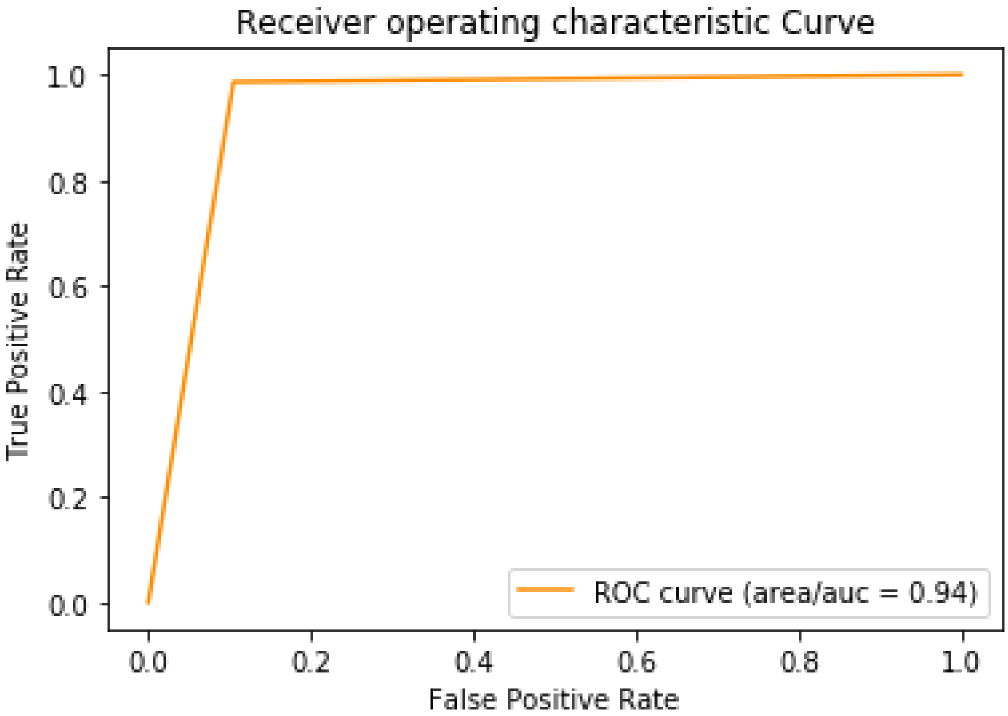
```
In [35]: best_rf_model = model.best_estimator_
         best_rf_model.fit(x_1,y_1)
         pred = best_rf_model.predict(x_test)
         confusionMatrix(y_test,pred)
```



AUC

```
In [21]: auc_roc(y_test,pred)
```

```
Area Under The Curve is :  0.940581366171
```



```
In [37]: show_most_informative_features(count_vect,best_rf_model,10)
```

```
These are the top 10 important Features Which are most widely used in Positive and Negative Re

        Positive:                                 Negative:

        great                                          aa

        love                                           aaa

        disappoint                                     aaaa

        best                                           aaaaa

        delici                                         aaaaaaaaaaaaaa

        would                                          aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa

        perfect                                        aaaaaaaaaaaaaaaaaaaaargh

        wast                                           aaaaaaaaagghh

        favorit                                        aaaaaaahhhhhh
```

```
    worst                                       aaaaaaarrrrrggghhh
```

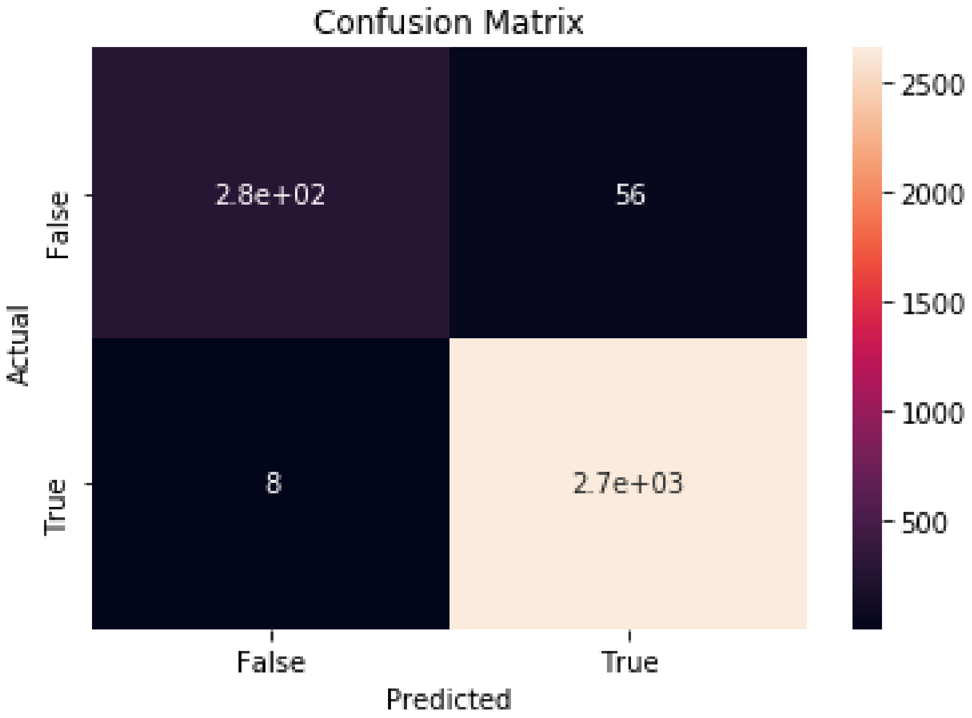
2.3 TFIdf

```
In [22]: x_1 = final_tf_idf_train[0:10000]

         y_1 = convScores(train_data['Score'].get_values())[0:10000]

         x_test = final_tf_idf_test[0:3000]
         y_test = convScores(test_data['Score'].get_values())[0:3000]

         x_1 = convToNpArray(x_1)
         x_test = convToNpArray(x_test)
         y_1 = convToNpArray(y_1)
         y_test = convToNpArray(y_test)
```

```
In [23]: tuned_parameters = {'n_estimators':[10,20,40,50],
                             'max_depth':[20,50,100]}



         rf_model = RandomForestClassifier(n_jobs=-1,oob_score=True,class_weight='balanced')
         model = GridSearchCV(rf_model,tuned_parameters,
                              scoring='accuracy',cv=3,n_jobs=-1)

         model.fit(x_1,y_1)

         print(model.best_estimator_)
         print("Score: ",model.score(x_test,y_test))
```

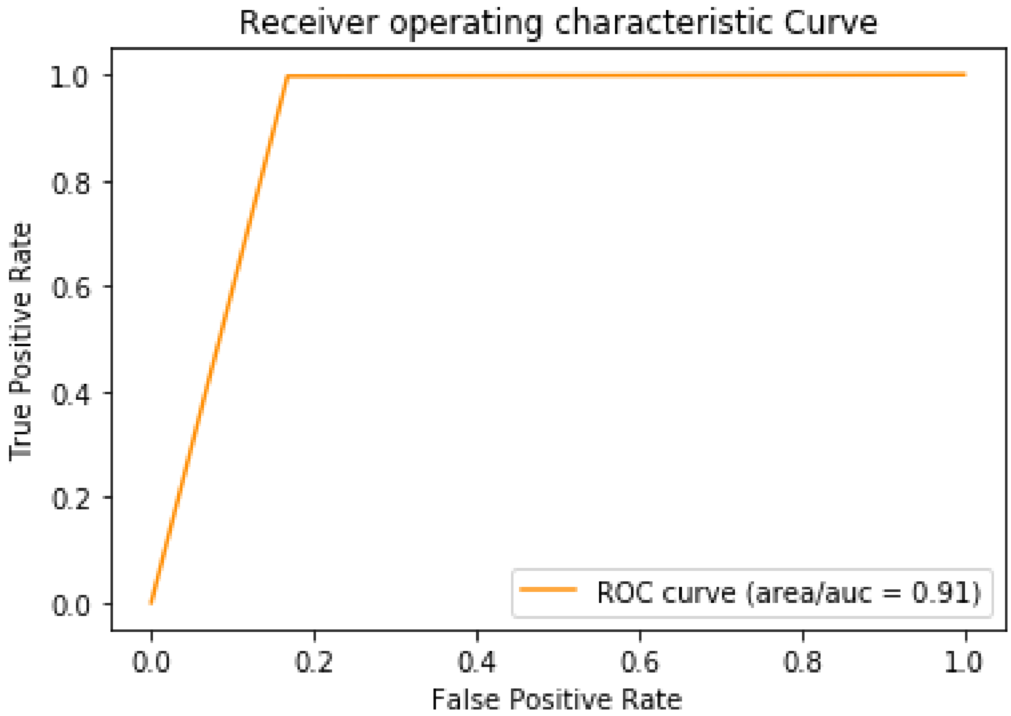
```
RandomForestClassifier(bootstrap=True, class_weight='balanced',
            criterion='gini', max_depth=50, max_features='auto',
            max_leaf_nodes=None, min_impurity_split=1e-07,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=50, n_jobs=-1,
            oob_score=True, random_state=None, verbose=0, warm_start=False)


C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\grid_search.py:438: ChangedBehaviorWarning: T
  ChangedBehaviorWarning)


Score:  0.982
```

```
In [24]: best_rf_model = model.best_estimator_
         best_rf_model.fit(x_1,y_1)
         pred = best_rf_model.predict(x_test)
         confusionMatrix(y_test,pred)
```



```
In [25]: auc_roc(y_test,pred)
```

```
Area Under The Curve is :  0.914667289577
```



2.4 Important Features

```
In [27]: show_most_informative_features(tf_idf_vect,best_rf_model,10)
```

```
These are the top 10important Features Which are most widely used in Positive and Negative Revi

        Positive:                         Negative:

        money                                  aa

        order                                  aa pleas

        return                                 aa state

        great                                  aaa

        horribl                                aaa aaa

        away                                   aaa condit

        snack                                  aaa dont

        love                                   aaa hockey
        high recommend                          aaa job

        bland                                   aaa magazin
```

3 GBDT

3.1 Avg W2V

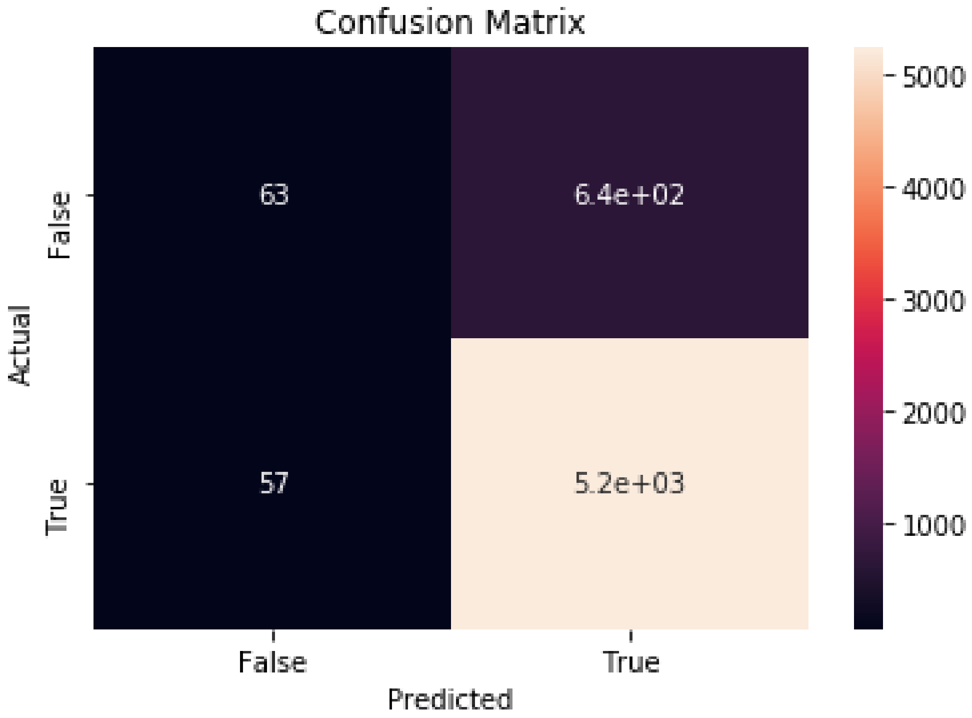
```
In [48]: x_1 = sent_vectors_train[0:30000]


         # this is only Score/rating  of data

         y_1 = convScores(train_data['Score'].get_values())[0:30000]

         x_test = sent_vectors_test[0:6000]
         y_test = convScores(test_data['Score'].get_values())[0:6000]


         x_1 = convToNpArray(x_1)
         x_test = convToNpArray(x_test)
         y_1 = convToNpArray(y_1)
         y_test = convToNpArray(y_test)
```

```
In [49]: tuned_parameters = {'n_estimators':[50,75,100,125],
                             'learning_rate':[0.01,0.1,0.5],
                             'max_depth':[3,5,7]}


         #using 70% of data to train the base models (Row Sampling)
         gb_model = GradientBoostingClassifier(subsample=0.7)
         model = GridSearchCV(gb_model,tuned_parameters,
                              scoring='accuracy',cv=3,n_jobs=-1)

         model.fit(x_1,y_1)

         print(model.best_estimator_)
         print("Score: ",model.score(x_test,y_test))
```

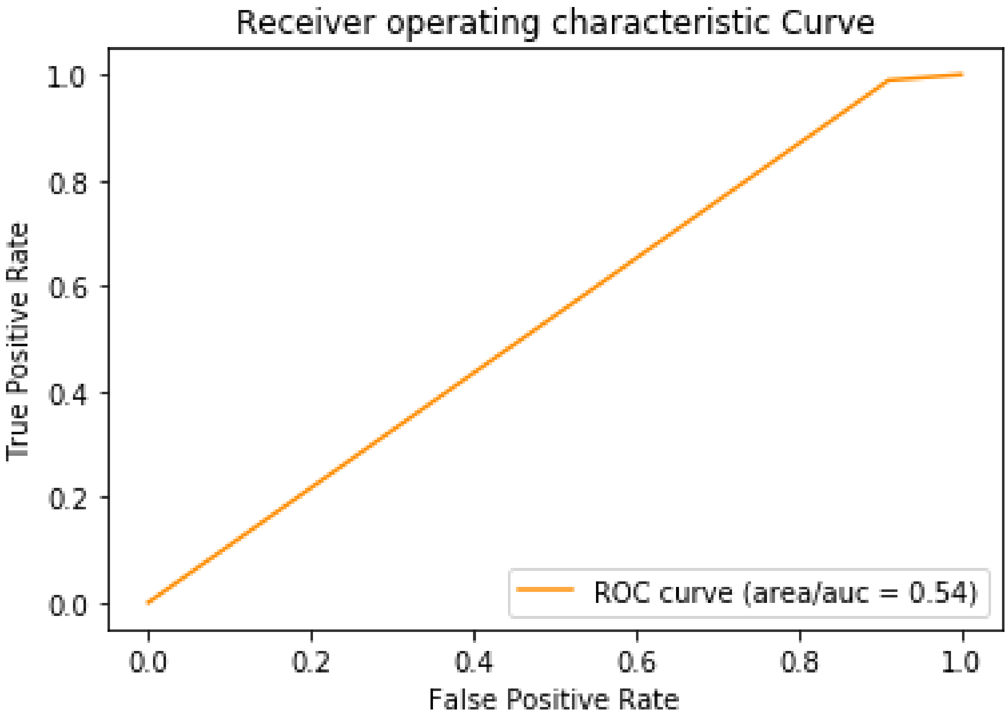
```
GradientBoostingClassifier(criterion='friedman_mse', init=None,
              learning_rate=0.1, loss='deviance', max_depth=7,
              max_features=None, max_leaf_nodes=None,
              min_impurity_split=1e-07, min_samples_leaf=1,
              min_samples_split=2, min_weight_fraction_leaf=0.0,
              n_estimators=100, presort='auto', random_state=None,
              subsample=0.7, verbose=0, warm_start=False)
Score:  0.887666666667
```

```
C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\grid_search.py:438: ChangedBehaviorWarning: T
  ChangedBehaviorWarning)
```

```
In [50]: best_gb_model = model.best_estimator_
         best_gb_model.fit(x_1,y_1)
         pred = best_gb_model.predict(x_test)
         confusionMatrix(y_test,pred)
```



```
In [51]: auc_roc(y_test,pred)

Area Under The Curve is :  0.539169985391
```



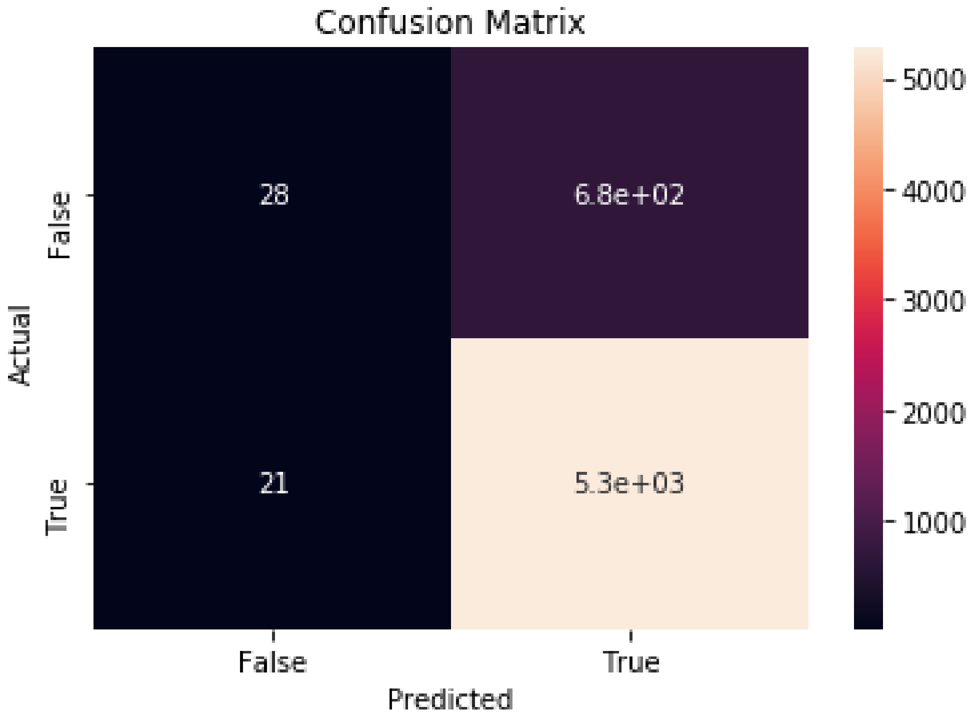
3.1.1 Using XGBClassifier

```
In [54]: tuned_parameters = {'n_estimators':[75,100,120],
                             'learning_rate':[0.01,0.1,0.5]}


         #using 70% of data to train the base models (Row Sampling)
         gb_model = XGBClassifier(subsample=0.7,n_jobs=4)
         model = GridSearchCV(gb_model,tuned_parameters,
                                scoring='accuracy',cv=3,n_jobs=-1)

         model.fit(x_1,y_1)

         print(model.best_estimator_)
         print("Score: ",model.score(x_test,y_test))
```

```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
       colsample_bytree=1, gamma=0, learning_rate=0.1, max_delta_step=0,
       max_depth=3, min_child_weight=1, missing=None, n_estimators=120,
       n_jobs=4, nthread=None, objective='binary:logistic', random_state=0,
       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
       silent=True, subsample=0.7)
Score:  0.883333333333
```

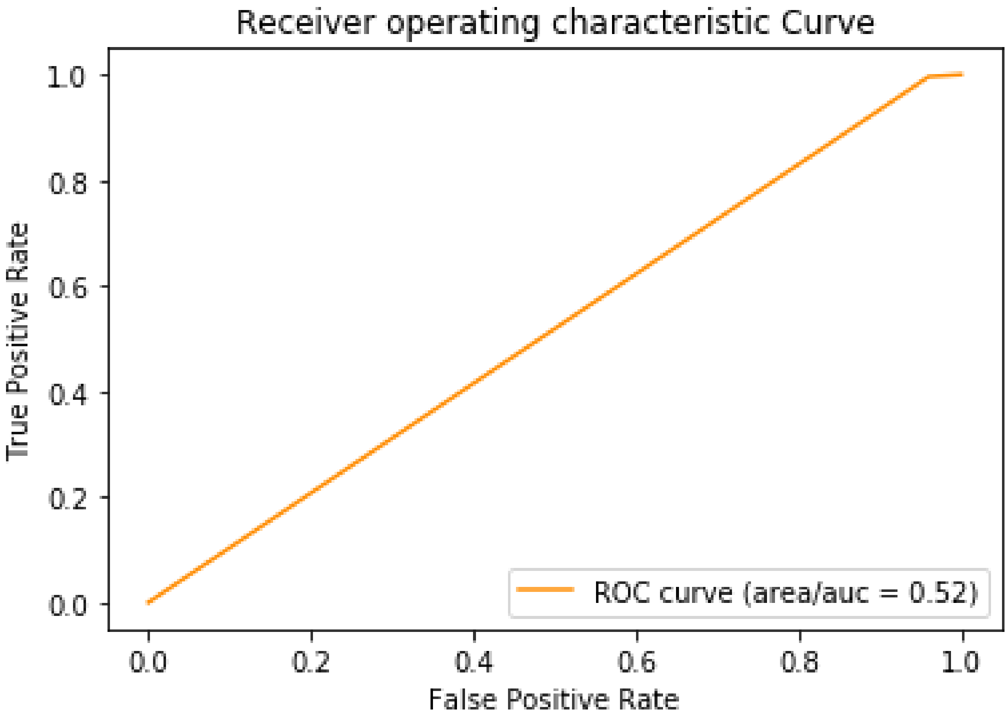
```
C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\grid_search.py:438: ChangedBehaviorWarning: T
  ChangedBehaviorWarning)
```

```
In [55]: best_gb_model = model.best_estimator_
         best_gb_model.fit(x_1,y_1)
         pred = best_gb_model.predict(x_test)
         confusionMatrix(y_test,pred)
```



```
In [56]: auc_roc(y_test,pred)
```

```
Area Under The Curve is :  0.517818228073
```



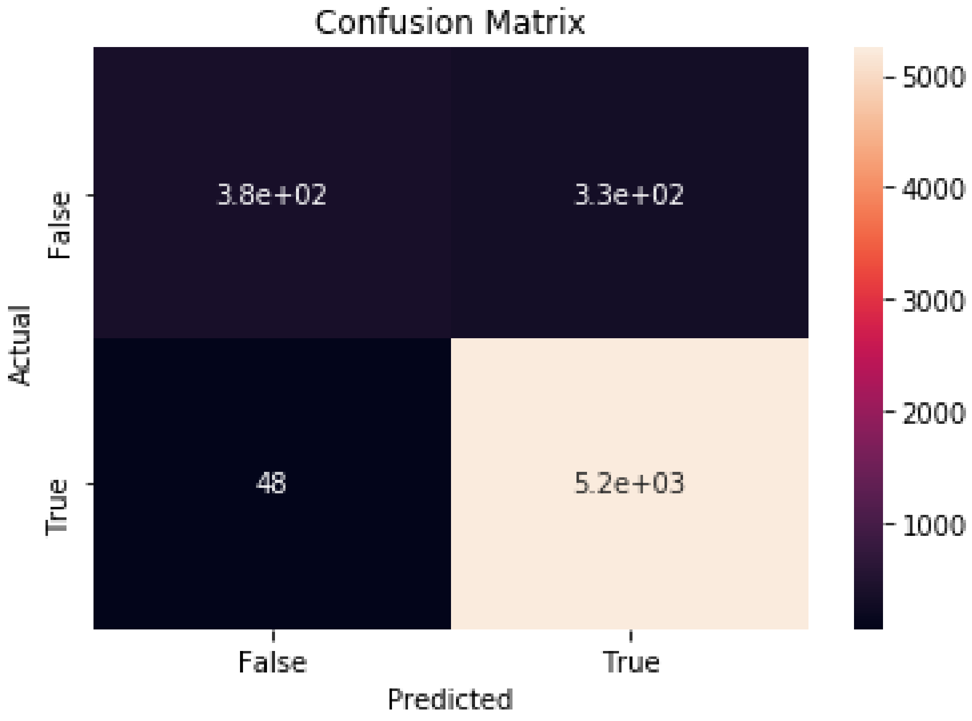
4 BOW

```
In [38]: # Total data frame

         x_1 = final_counts_train[0:30000]


         # this is only Score/rating  of data

         y_1 = convScores(train_data['Score'].get_values())[0:30000]

         x_test = final_counts_test[0:6000]
         y_test = convScores(test_data['Score'].get_values())[0:6000]

         #x_1, x_test, y_1, y_test = train_test_split(x,y, test_size=0.3, random_state=0)

         x_1 = convToNpArray(x_1)
         x_test = convToNpArray(x_test)
         y_1 = convToNpArray(y_1)
         y_test = convToNpArray(y_test)

In [39]: tuned_parameters = {'n_estimators':[75,100,120],
                             'learning_rate':[0.01,0.1,0.5]}
         #using 70% of data to train the base models (Row Sampling)
         gb_model = XGBClassifier(subsample=0.7,n_jobs=4)
         model = GridSearchCV(gb_model,tuned_parameters,
                              scoring='accuracy',cv=3,n_jobs=-1)

         model.fit(x_1,y_1)

         print(model.best_estimator_)
         print("Score: ",model.score(x_test,y_test))
```

```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
       colsample_bytree=1, gamma=0, learning_rate=0.5, max_delta_step=0,
       max_depth=3, min_child_weight=1, missing=None, n_estimators=120,
       n_jobs=4, nthread=None, objective='binary:logistic', random_state=0,
       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
       silent=True, subsample=0.7)
Score:  0.9375
```

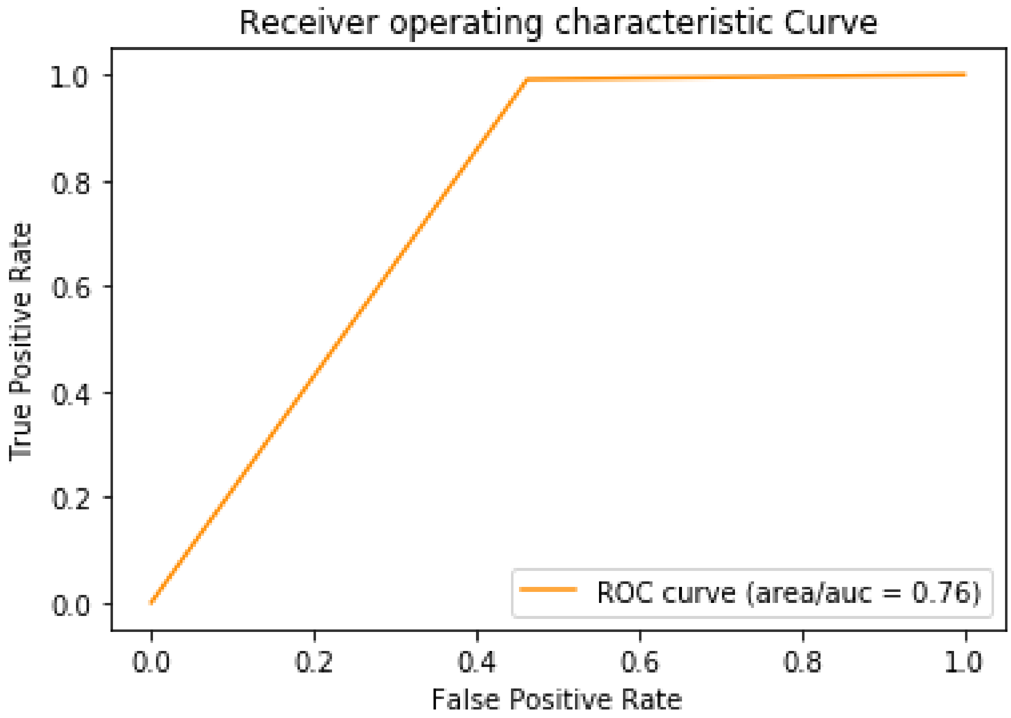
```
C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\grid_search.py:438: ChangedBehaviorWarning: T
  ChangedBehaviorWarning)
```

```
In [40]: best_gb_model = model.best_estimator_
         best_gb_model.fit(x_1,y_1)
         pred = best_gb_model.predict(x_test)
         confusionMatrix(y_test,pred)
```



```
In [41]: auc_roc(y_test,pred)
```

```
Area Under The Curve is :  0.764206869258
```



4.1 Important Features

```
In [42]: show_most_informative_features(count_vect,best_gb_model,10)
```

```
These are the top 10 important Features Which are most widely used in Positive and Negative Re

        Positive:                         Negative:

        like                                   aa

        great                                  aaa

        tast                                   aaaa

        product                                aaaaa

        love                                   aaaaaaaaaaaaaa

        best                                   aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa

        tri                                    aaaaaaaaaaaaaaaaaaaargh

        littl                                  aaaaaaaaagghh
```

```
    good                                        aaaaaaahhhhhh

    flavor                                      aaaaaaarrrrrggghhh
```

4.2 TFIdf

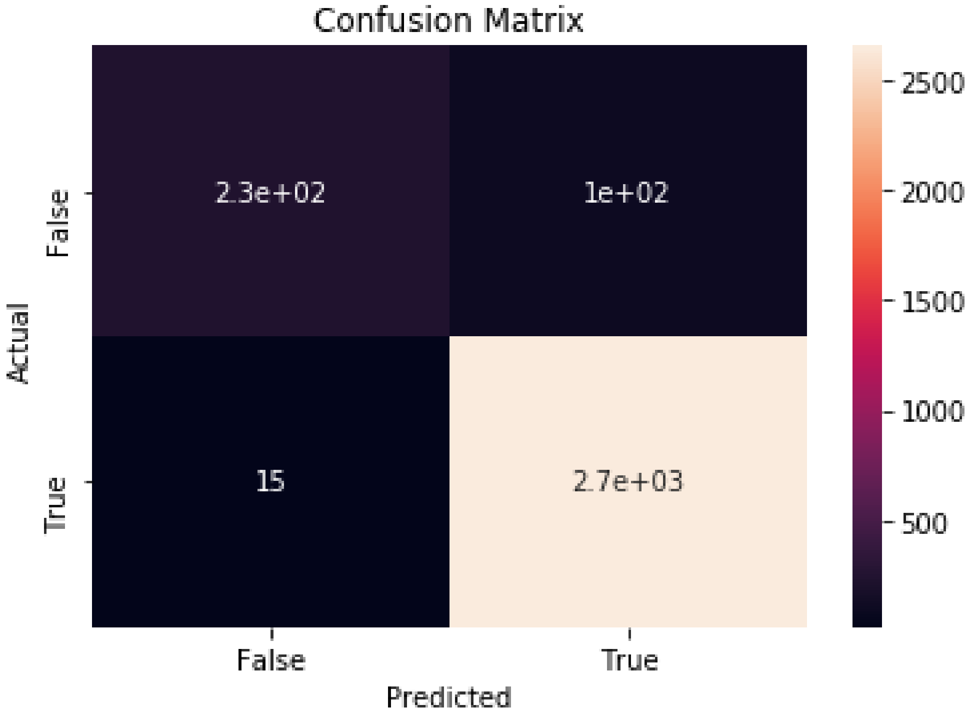
```
In [43]: x_1 = final_tf_idf_train[0:10000]

         y_1 = convScores(train_data['Score'].get_values())[0:10000]

         x_test = final_tf_idf_test[0:3000]
         y_test = convScores(test_data['Score'].get_values())[0:3000]

         x_1 = convToNpArray(x_1)
         x_test = convToNpArray(x_test)
         y_1 = convToNpArray(y_1)
         y_test = convToNpArray(y_test)
```

```
In [44]: tuned_parameters = {'n_estimators':[75,100,120],
                             'learning_rate':[0.01,0.1,0.5]}


         #using 70% of data to train the base models (Row Sampling)
         gb_model = XGBClassifier(subsample=0.7,n_jobs=4)
         model = GridSearchCV(gb_model,tuned_parameters,
                              scoring='accuracy',cv=3,n_jobs=-1)

         model.fit(x_1,y_1)

         print(model.best_estimator_)
         print("Score: ",model.score(x_test,y_test))
```

```
XGBClassifier(base_score=0.5, booster='gbtree', colsample_bylevel=1,
       colsample_bytree=1, gamma=0, learning_rate=0.5, max_delta_step=0,
       max_depth=3, min_child_weight=1, missing=None, n_estimators=120,
       n_jobs=4, nthread=None, objective='binary:logistic', random_state=0,
       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
       silent=True, subsample=0.7)


C:\Users\Dell\Anaconda3\lib\site-packages\sklearn\grid_search.py:438: ChangedBehaviorWarning:
  ChangedBehaviorWarning)


Score:  0.961666666667
```

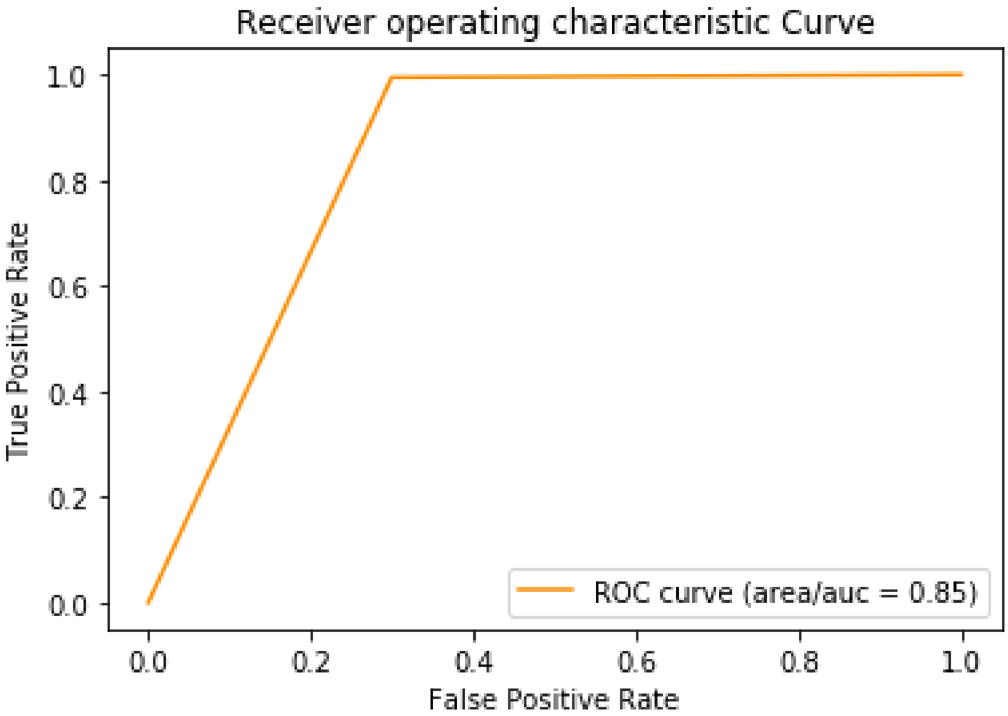
```
In [45]: best_gb_model = model.best_estimator_
         best_gb_model.fit(x_1,y_1)
```

```
pred = best_gb_model.predict(x_test)
confusionMatrix(y_test,pred)
```



```
In [46]: auc_roc(y_test,pred)
```

```
Area Under The Curve is :  0.847486197897
```



4.3 Important Features

```
In [47]: show_most_informative_features(tf_idf_vect,best_gb_model,10)
```

```
These are the top 10 important Features Which are most widely used in Positive and Negative Re

        Positive:                          Negative:

        good                                    aa

        like                                    aa pleas

        one                                     aa state

        tast                                    aaa

        tri                                     aaa aaa

        product                                 aaa condit

        get                                     aaa dont

        use                                     aaa hockey
        love                                   aaa job

        great                                  aaa magazin
```

Summary:

```
<tr>
    <th>Classifier</th>
    <th>Vectorizer</th>
    <th>Hyper Parameters</th>
    <th>Confusion Matrix</th>
    <th>Accuracy</th>
    <th>AUC</th>
</tr>
<tr>
    <td>Random Forest</td>
    <td>Avg W2v</td>
    <td>
        n_estimators: 40<br>
        max_depth: 20
    </td>
    <td>
        TPR :0.999622    TNR : 0.004243<br>
        FPR : 0.995757   FNR: 0.000378
    </td>
    <td>88%<br></td>
    <td>0.5</td>

</tr>
<tr>
    <td>Random Forest</td>
    <td>BOW</td>
    <td>n_estimators: 40<br>
        max_depth: 50</td>

    <td>
        TPR :0.983374    TNR : 0.903819<br>
        FPR : 0.096181   FNR: 0.016626
    </td>
    <td>97.5%</td>
    <td>0.94</td>

</tr>
<tr>
    <td>Random Forest</td>
    <td>TfIdf</td>
    <td>n_estimators: 50<br>
```

```
        max_depth: 50</td>
    <td>
        TPR :0.999625    TNR : 0.847305<br>
        FPR : 0.152695   FNR: 0.000375
    </td>
    <td>97.9%</td>
    <td>0.91</td>
</tr>
<tr>
    <td>Gradient Boost / XGBClassifier</td>
    <td>Avg W2v</td>
    <td>
        n_estimators: 100<br>
        learning_rate: 0.1<br>
        max_depth: 7<br>

        <b>Using XGBClassifier</b><br>
        n_estimators: 120<br>
        learning_rate: 0.1
    </td>
    <td>
        TPR :0.983374    TNR : 0.128713<br>
        FPR : 0.871287   FNR: 0.016626
    </td>
    <td>88.33%</td>
    <td>0.54</td>

</tr>
<tr>
    <td>Gradient Boost / XGBClassifier</td>
    <td>BOW</td>
    <td>n_estimators: 120<br>
        learning_rate: 0.5</td>
    <td>
        TPR :0.990931    TNR : 0.537482<br>
        FPR : 0.462518   FNR: 0.009069
    </td>
    <td>93.75%</td>
    <td>0.76</td>
</tr>
<tr>
    <td>Gradient Boost / XGBClassifier</td>
    <td>TfIdf</td>
    <td>n_estimators: 120<br>
        learning_rate: 0.5<br></td>
    <td>
        TPR :0.994374    TNR : 0.700599<br>
        FPR : 0.299401   FNR: 0.005626
    </td>
    <td>96.2%</td>
    <td>0.85</td>
</tr>
```

-> With Both the classifiers BOW and Tfidf have given Good Results in terms of TPR TNR and Accuracy. -> Even Interms of AUC also BOW and Tfidf Have performed well. -> Interms of AUC Random Forest has Performed well when compared to Gradient Boost.

Note: -> Didnt use Sklearn's GradientBoost Classifier for Tfidf and BOW because fit() method is expecting dense array, as there is large amount of data with more no.of dimensions it requires more Memory, So used XGBClassifier().

-> XGBClassifier took very Less time to execute when compared to GradientBoostingClassifier() because XGBClassifier supports Parallel Execution.