In [1]:
```
# ============================== Loading libraries ===============================
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")

import pickle
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.cross_validation import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.cross_validation import cross_val_score
from collections import Counter
from sklearn.metrics import accuracy_score
from sklearn import cross_validation
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import f1_score
from sklearn.model_selection import GridSearchCV
from sklearn.datasets import *
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import RandomizedSearchCV
from sklearn.metrics import precision_recall_fscore_support
from sklearn.metrics import classification_report
from prettytable import PrettyTable
import random
from scipy.stats import uniform
from sklearn.metrics import roc_curve, auc
from sklearn.learning_curve import validation_curve
from sklearn.metrics import fbeta_score, make_scorer
from sklearn.metrics import precision_score, recall_score,roc_auc_score
from sklearn.ensemble import ExtraTreesClassifier
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import chi2
from sklearn.feature_selection import SelectFromModel
from sklearn.preprocessing import StandardScaler
from sklearn.calibration import CalibratedClassifierCV
import joblib
from sklearn.svm import SVC
from sklearn import svm
from sklearn import linear_model
from scipy import stats
import scikitplot as skplt
from wordcloud import WordCloud, STOPWORDS

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

from sklearn.ensemble import RandomForestClassifier
```

```
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import roc_curve, auc
from nltk.stem.porter import PorterStemmer

#import nltk
#nltk.download('stopwords')

import re
# Tutorial about Python regular expressions: https://pymotw.com/2/re/
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

#from gensim.models import KeyedVectors
#model = KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin.g

#import gensim
from gensim.models import Word2Vec
from gensim.models import KeyedVectors
from sklearn.decomposition import TruncatedSVD
from sklearn import tree
import graphviz

import xgboost as xgb

# ==============================================================================
```

```
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\cross_validation.py:41: D
eprecationWarning: This module was deprecated in version 0.18 in favor of the m
odel_selection module into which all the refactored classes and functions are m
oved. Also note that the interface of the new CV iterators are different from t
hat of this module. This module will be removed in 0.20.
  "This module will be removed in 0.20.", DeprecationWarning)
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\learning_curve.py:22: Dep
recationWarning: This module was deprecated in version 0.18 in favor of the mod
el_selection module into which all the functions are moved. This module will be
removed in 0.20
  DeprecationWarning)
C:\Users\AbhiShek\Anaconda3\lib\site-packages\gensim\utils.py:1209: UserWarnin
g: detected Windows; aliasing chunkize to chunkize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_serial")
```

In [2]:
```
fileObject = open("./train_to_file.pkl",'rb') # we open the file for reading
X_train = pickle.load(fileObject) # load the object from the file

fileObject = open("./x_cv_to_file.pkl",'rb') # we open the file for reading
X_cv = pickle.load(fileObject) # load the object from the file

fileObject = open("./x_test_to_file.pkl",'rb') # we open the file for reading
X_test = pickle.load(fileObject) # load the object from the file

fileObject = open("./y_train_to_file.pkl",'rb') # we open the file for reading
y_train = pickle.load(fileObject) # load the object from the file

fileObject = open("./y_cv_to_file.pkl",'rb') # we open the file for reading
y_cv = pickle.load(fileObject) # load the object from the file

fileObject = open("./y_test_to_file.pkl",'rb') # we open the file for reading
y_test = pickle.load(fileObject) # load the object from the file
```

BoW

In [3]:
```
#Appling BoW to fit and transform
count_vect =  CountVectorizer()
bow_NB = count_vect.fit(X_train[:,9])
train_bow_nstd = count_vect.transform(X_train[:,9])
cv_bow_nstd = count_vect.transform(X_cv[:,9])
test_bow_nstd = count_vect.transform(X_test[:,9])

print("the type of count vectorizer ",type(train_bow_nstd))
print("the number of unique words ", test_bow_nstd.get_shape()[1])

print(train_bow_nstd.shape)
print(cv_bow_nstd.shape)
print(test_bow_nstd.shape)
print(y_train.shape)
print(y_cv.shape)
print(y_test.shape)
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the number of unique words  37996
(38400, 37996)
(9600, 37996)
(12000, 37996)
(38400,)
(9600,)
(12000,)
```

In [4]:
```
# Column Standardization of the BoW non-standard vector
std_scal = StandardScaler(with_mean=False)
std_scal.fit(train_bow_nstd)
train_bow = std_scal.transform(train_bow_nstd)
cv_bow = std_scal.transform(cv_bow_nstd)
test_bow = std_scal.transform(test_bow_nstd)
```

```
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475:
DataConversionWarning: Data with input dtype int64 was converted to float64 by
StandardScaler.
  warnings.warn(msg, DataConversionWarning)
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475:
DataConversionWarning: Data with input dtype int64 was converted to float64 by
StandardScaler.
  warnings.warn(msg, DataConversionWarning)
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475:
DataConversionWarning: Data with input dtype int64 was converted to float64 by
StandardScaler.
  warnings.warn(msg, DataConversionWarning)
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475:
DataConversionWarning: Data with input dtype int64 was converted to float64 by
StandardScaler.
  warnings.warn(msg, DataConversionWarning)
```

TF-IDF

In [12]:
```
#tf-idf on train data
tf_idf_vect = TfidfVectorizer(ngram_range=(1,1)) #considering only uni-gram as I
train_tf_idf_nstd = tf_idf_vect.fit_transform(X_train[:,9]) #sparse matrix
cv_tfidf_nstd = tf_idf_vect.transform(X_cv[:,9])
test_tfidf_nstd = tf_idf_vect.transform(X_test[:,9])
print(train_tf_idf_nstd.shape)
print(cv_tfidf_nstd.shape)
print(test_tfidf_nstd.shape)
```

```
(38400, 37996)
(9600, 37996)
(12000, 37996)
```

In [13]:
```
# Column Standardization of the tfidf non-standard vector
std_scal = StandardScaler(with_mean=False)
std_scal.fit(train_tf_idf_nstd)
train_tfidf = std_scal.transform(train_tf_idf_nstd)
cv_tfidf = std_scal.transform(cv_tfidf_nstd)
test_tfidf = std_scal.transform(test_tfidf_nstd)
```

Avg W2V

In [26]:
```
fileObject = open("./final_to_file2.pkl",'rb') # we open the file for reading
final = pickle.load(fileObject) # load the object from the file
```

In [27]:
```
#w2v
# Train your own Word2Vec model using your own text corpus
i=0
list_of_sent=[]
for sent in final['CleanedText'].values:
    list_of_sent.append(sent.split())

print(type(list_of_sent))
print(final['CleanedText'].values[0])
print("*****************************************************************")
print(list_of_sent[0])
```

```
<class 'list'>
witti littl book make son laugh loud recit car drive along alway sing refrain h
es learn whale india droop love new word book introduc silli classic book will
bet son still abl recit memori colleg
*****************************************************************
['witti', 'littl', 'book', 'make', 'son', 'laugh', 'loud', 'recit', 'car', 'dri
ve', 'along', 'alway', 'sing', 'refrain', 'hes', 'learn', 'whale', 'india', 'dr
oop', 'love', 'new', 'word', 'book', 'introduc', 'silli', 'classic', 'book', 'w
ill', 'bet', 'son', 'still', 'abl', 'recit', 'memori', 'colleg']
```

In [28]:
```
w2v_model=Word2Vec(list_of_sent,min_count=5,size=50, workers=4)
w2v_words = list(w2v_model.wv.vocab)
```

In [29]:
```
# 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
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    sent_vectors.append(sent_vec)
print(len(sent_vectors))
#print(len(sent_vectors[0]))
print(type(sent_vectors))
```

```
60000
<class 'list'>
```

In [30]:
```
# create design matrix X and target vector y
X = np.array(sent_vectors[::]) # end index is exclusive
y = np.array(final['Score']) # showing you two ways of indexing a pandas df
```

In [31]:
```
X_train_nstd = X[0:38400:1]
X_cv_nstd = X[38400:48000:1]
X_test_nstd = X[48000:60000:1]

y_train_nstd = y[0:38400:1]
y_cv_nstd = y[38400:48000:1]
y_test_nstd =y[48000:60000:1]

print(X_train_nstd.shape)
print(X_cv_nstd.shape)
print(X_test_nstd.shape)
print(y_train_nstd.shape)
print(y_cv_nstd.shape)
print(y_test_nstd.shape)
```

```
(38400, 50)
(9600, 50)
(12000, 50)
(38400,)
(9600,)
(12000,)
```

In [32]:
```
# Column Standardization of the tfidf non-standard vector
std_scal = StandardScaler(with_mean=False)
std_scal.fit(X_train_nstd)
train_avgw2v = std_scal.transform(X_train_nstd)
cv_avgw2v = std_scal.transform(X_cv_nstd)
test_avgw2v = std_scal.transform(X_test_nstd)
```

tfidf-W-w2v

In [46]:
```
fileObject = open("./final_to_file2.pkl",'rb') # we open the file for reading
final = pickle.load(fileObject) # load the object from the file
```

In [47]:

```
#w2v
# Train your own Word2Vec model using your own text corpus
i=0
list_of_sent=[]
for sent in final['CleanedText'].values:
    list_of_sent.append(sent.split())

print(type(list_of_sent))
print(final['CleanedText'].values[0])
print("*****************************************************************")
print(list_of_sent[0])
```

```
<class 'list'>
witti littl book make son laugh loud recit car drive along alway sing refrain h
es learn whale india droop love new word book introduc silli classic book will
bet son still abl recit memori colleg
*****************************************************************
['witti', 'littl', 'book', 'make', 'son', 'laugh', 'loud', 'recit', 'car', 'dri
ve', 'along', 'alway', 'sing', 'refrain', 'hes', 'learn', 'whale', 'india', 'dr
oop', 'love', 'new', 'word', 'book', 'introduc', 'silli', 'classic', 'book', 'w
ill', 'bet', 'son', 'still', 'abl', 'recit', 'memori', 'colleg']
```

In [48]:

```
w2v_model=Word2Vec(list_of_sent,min_count=5,size=50, workers=4)
w2v_words = list(w2v_model.wv.vocab)
```

In [49]:

```
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
model = TfidfVectorizer()
tf_idf_matrix = model.fit_transform(final['CleanedText'].values)
# 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 [50]:

```
# TF-IDF weighted Word2Vec
tfidf_feat = model.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = t

tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in th
row=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
        if word in w2v_words:
            vec = w2v_model.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))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors.append(sent_vec)
    row += 1
```

In [51]:
```
print(len(tfidf_sent_vectors))
print(np.shape(tfidf_sent_vectors))
print(type(tfidf_sent_vectors))
```

```
60000
(60000, 50)
<class 'list'>
```

In [52]:
```
# create design matrix X and target vector y
X = np.array(sent_vectors[::]) # end index is exclusive
y = np.array(final['Score']) # showing you two ways of indexing a pandas df
```

In [53]:
```
X_train_nstd = X[0:38400:1]
X_cv_nstd = X[38400:48000:1]
X_test_nstd = X[48000:60000:1]

y_train_nstd = y[0:38400:1]
y_cv_nstd = y[38400:48000:1]
y_test_nstd =y[48000:60000:1]

print(X_train_nstd.shape)
print(X_cv_nstd.shape)
print(X_test_nstd.shape)
print(y_train_nstd.shape)
print(y_cv_nstd.shape)
print(y_test_nstd.shape)
```

```
(38400, 50)
(9600, 50)
(12000, 50)
(38400,)
(9600,)
(12000,)
```

In [54]:
```
# Column Standardization of the tfidf non-standard vector
std_scal = StandardScaler(with_mean=False)
std_scal.fit(X_train_nstd)
train_tfidfww2v = std_scal.transform(X_train_nstd)
cv_tfidfww2v = std_scal.transform(X_cv_nstd)
test_tfidfww2v = std_scal.transform(X_test_nstd)
```

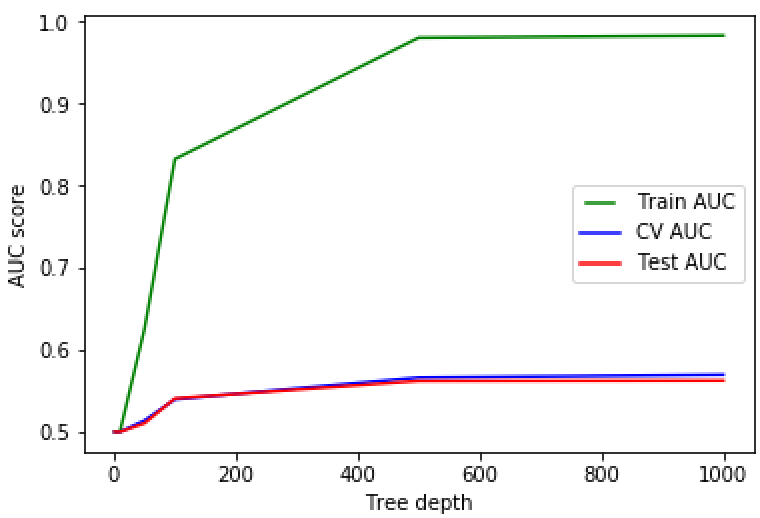
Random Forest on BoW

In [26]:
```
clf_rf = RandomForestClassifier()
clf_rf.fit(train_bow,y_train)
clf_rf
```

Out[26]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=10, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

Max-depth tuning

In [22]:
```
max_depths = [1, 5, 10, 50, 100, 500, 1000]
train_results = []
cv_results = []
test_results = []
for max_depth in max_depths:
    clf_rf_md = RandomForestClassifier(max_depth=max_depth)
    clf_rf_md.fit(train_bow, y_train)
    train_pred = clf_rf_md.predict(train_bow)

    fpr_tr, tpr_tr, thrsh_trn = roc_curve(y_train, train_pred)
    roc_auc = auc(fpr_tr, tpr_tr)
    # Add auc score to previous train results
    train_results.append(roc_auc)
    #train_results

    cv_pred = clf_rf_md.predict(cv_bow)

    false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_cv, cv_
    roc_auc = auc(false_positive_rate, true_positive_rate)
    cv_results.append(roc_auc)

    test_pred = clf_rf_md.predict(test_bow)

    fpr_test, tpr_test, thrsh_test = roc_curve(y_test, test_pred)
    roc_auc = auc(fpr_test, tpr_test)
    # Add auc score to previous test results
    test_results.append(roc_auc)
    #test_results

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(max_depths, train_results, 'g', label="Train AUC")
line2, = plt.plot(max_depths, cv_results, 'b', label="CV AUC")
line3, = plt.plot(max_depths, test_results, 'r', label="Test AUC")
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```



In [24]:
```
print(train_results)
print("\n",cv_results)
print("\n",test_results)
```

```
[0.5, 0.5, 0.5007087172218285, 0.6254283142600721, 0.8322263554898784, 0.980599
1279295465, 0.9833305112834598]

 [0.5, 0.5, 0.5, 0.5138482121462233, 0.5397457999414255, 0.566378897201736, 0.5
698143254612742]

 [0.5, 0.5, 0.5, 0.5104012983937196, 0.5408362459361117, 0.5622176039796629, 0.
5626619275569303]
```

In [25]:
```
test_results_hmap_bow_1 = test_results
joblib.dump(test_results_hmap_bow_1,"test_results_hmap_bow_1.pkl")
```

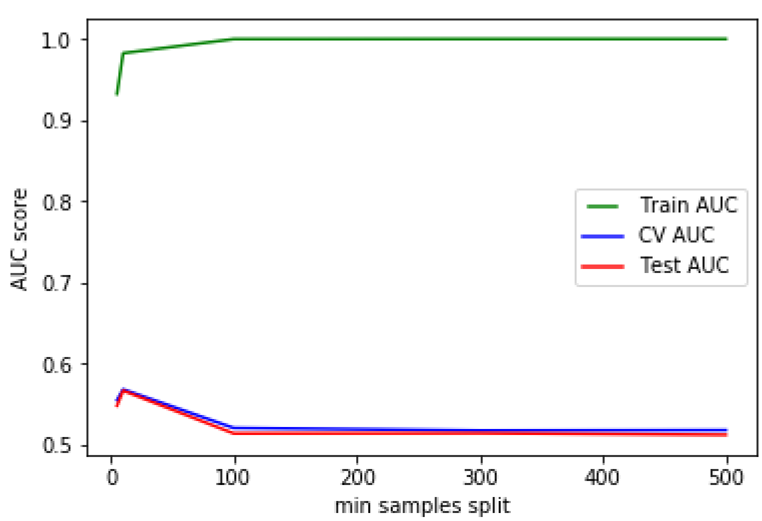
Out[25]:
```
['test_results_hmap_bow_1.pkl']
```

In [26]:
```
test_results_hmap_bow_1 = joblib.load("test_results_hmap_bow_1.pkl")
test_results_hmap_bow_1
```

Out[26]:
```
[0.5,
 0.5,
 0.5,
 0.5104012983937196,
 0.5408362459361117,
 0.5622176039796629,
 0.5626619275569303]
```

n_estimators tuning

In [5]:
```
n_estimators_splits = [5, 10, 100, 300, 500]
train_results = []
cv_results = []
test_results = []
for n_estimators_split in n_estimators_splits:
    clf_rf_nest = RandomForestClassifier(n_estimators=n_estimators_split)
    clf_rf_nest.fit(train_bow, y_train)

    train_pred = clf_rf_nest.predict(train_bow)

    false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, t
    roc_auc = auc(false_positive_rate, true_positive_rate)
    train_results.append(roc_auc)

    cv_pred = clf_rf_nest.predict(cv_bow)

    false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_cv, cv_
    roc_auc = auc(false_positive_rate, true_positive_rate)
    cv_results.append(roc_auc)

    y_pred = clf_rf_nest.predict(test_bow)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, y_pr
    roc_auc = auc(false_positive_rate, true_positive_rate)
    test_results.append(roc_auc)

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(n_estimators_splits, train_results, 'g', label="Train AUC")
line2, = plt.plot(n_estimators_splits, cv_results, 'b', label="CV AUC")
line3, = plt.plot(n_estimators_splits, test_results, 'r', label="Test AUC")
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('min samples split')
plt.show()
```



In [6]:
```
print(train_results)
print("\n",cv_results)
print("\n",test_results)
```

```
[0.9322025283036253, 0.9824744065175185, 0.9998818804630285, 1.0, 1.0]

 [0.5544834460448893, 0.56790898985596, 0.5202464788732395, 0.5171654929577465,
0.5176056338028169]

 [0.5477231973047872, 0.5663640259637733, 0.5134770889487871, 0.513814016172506
7, 0.5117924528301887]
```

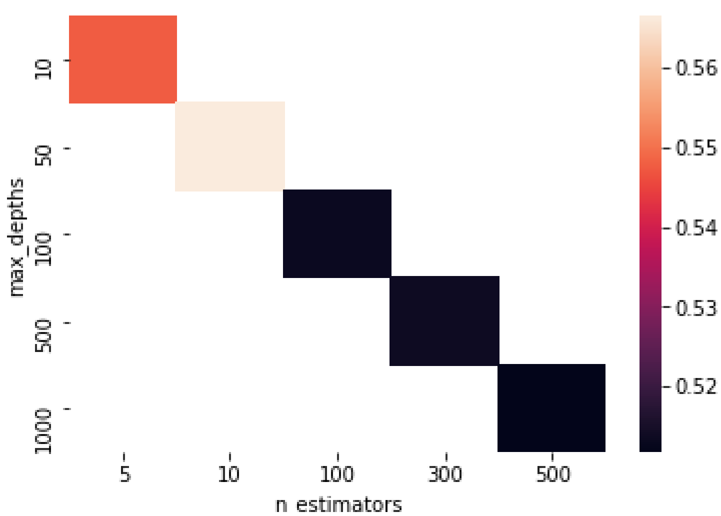
In [8]:
```
test_results_nest_bow_2 = test_results
joblib.dump(test_results_nest_bow_2,"test_results_nest_bow_2.pkl")
```

Out[8]:
```
['test_results_nest_bow_2.pkl']
```

In [9]:
```
test_results_nest_bow_2 = joblib.load("test_results_nest_bow_2.pkl")
test_results_nest_bow_2
```

Out[9]:
```
[0.5477231973047872,
 0.5663640259637733,
 0.5134770889487871,
 0.5138140161725067,
 0.5117924528301887]
```

In [10]:
```
X = [10, 50, 100, 500, 1000]
Y = [5, 10, 100, 300, 500]
Z = test_results_nest_bow_2
data = pd.DataFrame({'max_depths': X, 'n_estimators': Y, 'AUC': Z})
data_pivoted = data.pivot("max_depths", "n_estimators", "AUC")
ax = sns.heatmap(data_pivoted)
plt.show()
```



Random Forest with best parameters

In [39]:
```
clf_rf_best = RandomForestClassifier(n_estimators=5, max_depth=1000)
clf_rf_best.fit(train_bow, y_train)

rf_test_pred_best = clf_rf_best.predict(test_bow)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, rf_test_
roc_auc_rf_best = auc(false_positive_rate, true_positive_rate)

joblib.dump(clf_rf_best,"clf_rf_best.pkl")
joblib.dump(rf_test_pred_best,"rf_test_pred_best.pkl")
joblib.dump(roc_auc_rf_best,"roc_auc_rf_best.pkl")
```

Out[39]:
```
['roc_auc_rf_best.pkl']
```

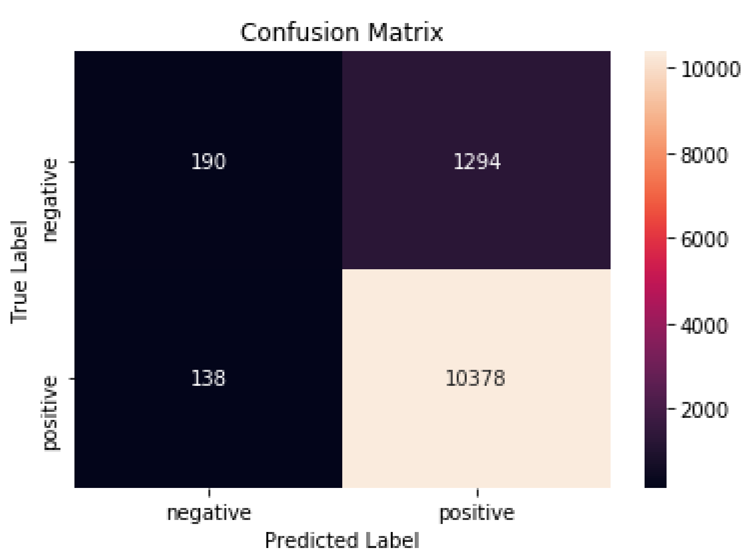
In [7]:
```
clf_rf_best = joblib.load("clf_rf_best.pkl")
rf_test_pred_best = joblib.load("rf_test_pred_best.pkl")
roc_auc_rf_best = joblib.load("roc_auc_rf_best.pkl")
roc_auc_rf_best
```

Out[7]:
```
0.557454742305141
```

In [6]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_bow = confusion_matrix(y_test, rf_test_pred_best)
cm_bow
```

Out[6]:
```
array([[  190,  1294],
       [  138, 10378]], dtype=int64)
```

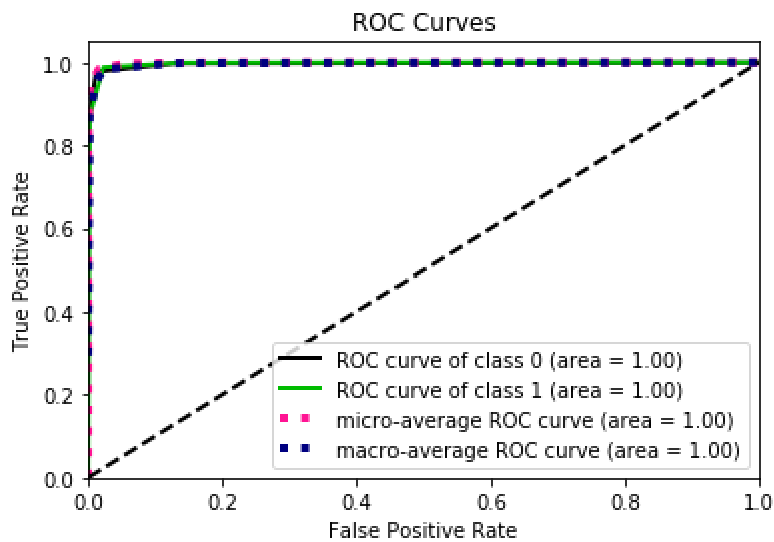
In [7]:
```
# plot confusion matrix to describe the performance of classifier.
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_bow, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [51]:
```
y_pred_train_proba = clf_rf_best.predict_proba(train_bow)
y_pred_cv_proba = clf_rf_best.predict_proba(cv_bow)
y_pred_test_proba = clf_rf_best.predict_proba(test_bow)
```

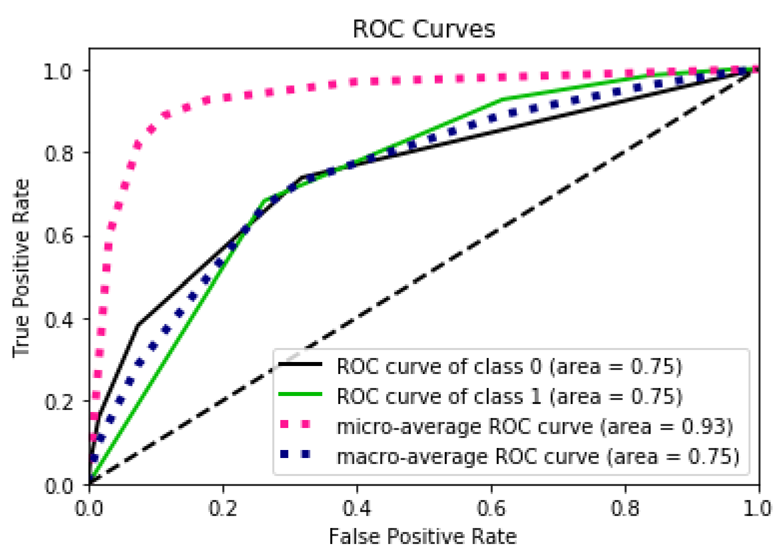
In [44]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_proba)
```

Out[44]: <matplotlib.axes._subplots.AxesSubplot at 0x20033b4bcc0>



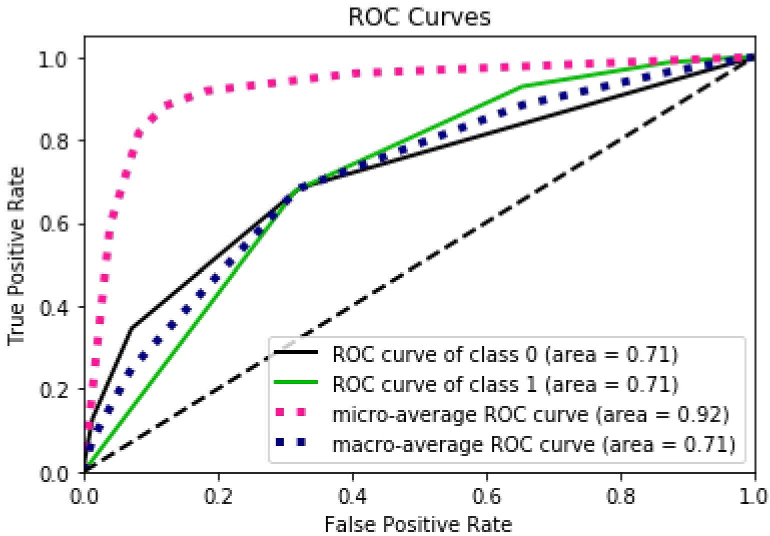
In [52]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_proba)
```

Out[52]: <matplotlib.axes._subplots.AxesSubplot at 0x20035c86be0>



In [45]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_proba)
```

Out[45]: <matplotlib.axes._subplots.AxesSubplot at 0x20035c206a0>



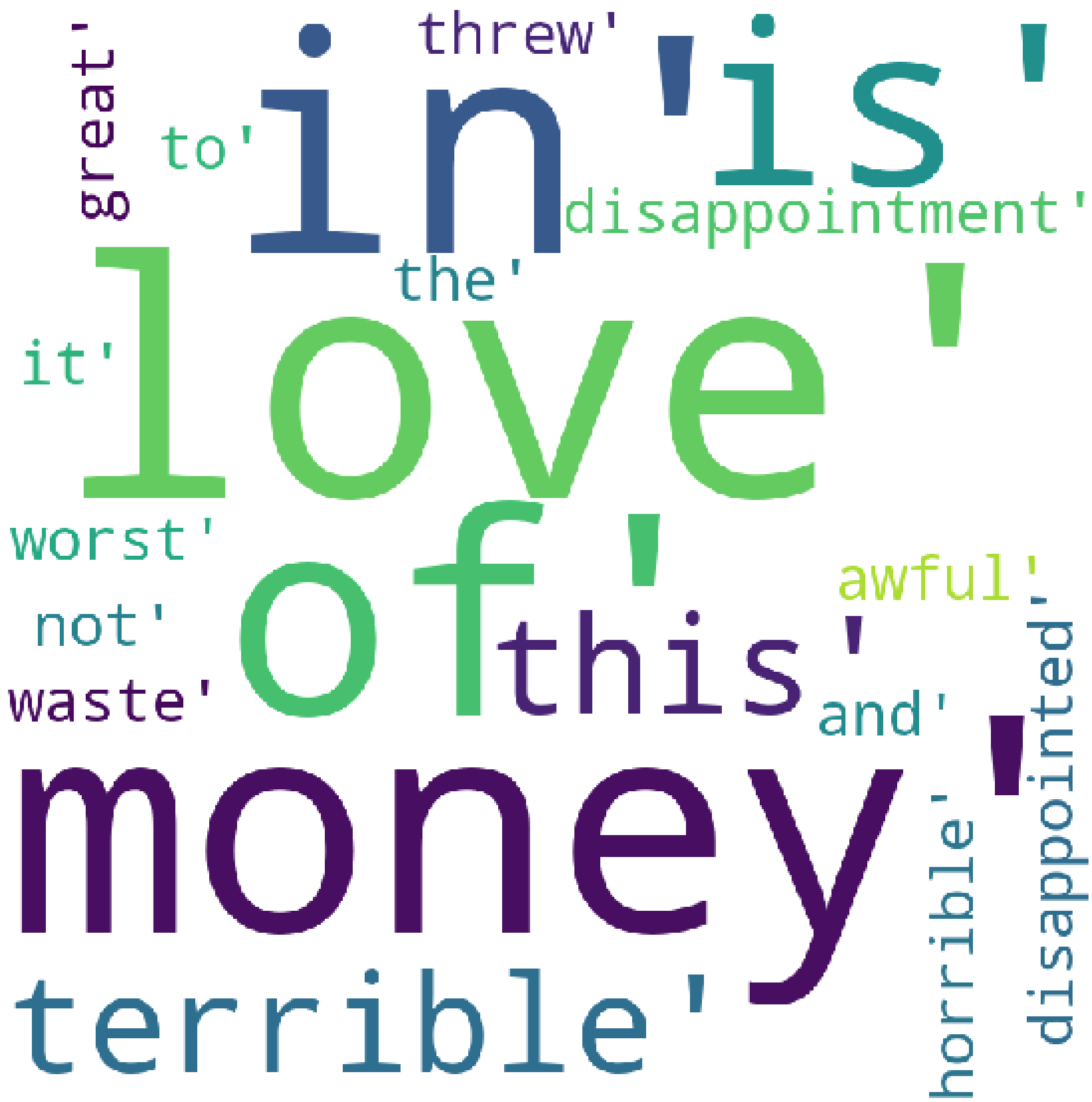
In [13]:

```
def most_informative_feature_for_binary_classification(vectorizer, classifier, n
    class_labels = classifier.classes_
    feature_names = vectorizer.get_feature_names()
    topn_class1 = sorted(zip(classifier.feature_importances_, feature_names))[:n
    topn_class2 = sorted(zip(classifier.feature_importances_, feature_names))[-n
    #print(dict(zip(iris_pd.columns, clf.feature_importances_)))

    print("Class 0: Negatives ")
    for coef, feat in topn_class1:
        print (class_labels[0], coef, feat)

    print("\n")
    print("Class 1: Positives ")
    for coef, feat in reversed(topn_class2):
        print (class_labels[1], coef, feat)

    return topn_class1, topn_class2

topn_class1, topn_class2 = most_informative_feature_for_binary_classification(co
```

```
Class 0: Negatives
0 0.0 0000
0 0.0 0002251337
0 0.0 000kwh
0 0.0 000s
0 0.0 00100
0 0.0 00493
0 0.0 00703
0 0.0 00704
0 0.0 0071499849
0 0.0 00am
0 0.0 00pm
0 0.0 01
0 0.0 01317
0 0.0 01318
0 0.0 0188
0 0.0 03510
0 0.0 04
0 0.0 040
0 0.0 0451155505
0 0.0 04830


Class 1: Positives
1 0.006464756664894693 horrible
1 0.006344989452627727 not
1 0.006296199356599379 threw
1 0.005714733120633534 the
1 0.005411848461667918 worst
1 0.005111784712554101 waste
1 0.004806677584199558 great
1 0.0045857003562174l and
1 0.004336409336054188 disappointed
1 0.004327732434471427 it
1 0.004253828779103582 awful
1 0.004221493912713712 to
1 0.003988319303083825 disappointment
```

```
1 0.003957576836128013 this
1 0.003948889941997886 terrible
1 0.0037895785950280377 is
1 0.0036764848713530503 of
1 0.003597981861716877 in
1 0.0035523088844358897 money
1 0.003544583353870712 love
```

In [14]:
```
#source: https://www.geeksforgeeks.org/generating-word-cloud-python/
comment_words = ' '
stopwords = set(STOPWORDS)

# iterate through the csv file
for val in topn_class2:

    # typecaste each val to string
    val = str(val)

    # split the value
    tokens = val.split()

    # Converts each token into lowercase
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()

    for words in tokens:
        comment_words = comment_words + words + ' '


wordcloud = WordCloud(width = 800, height = 800,
                background_color ='white',
                stopwords = stopwords,
                min_font_size = 10).generate(comment_words)

# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



In [ ]:

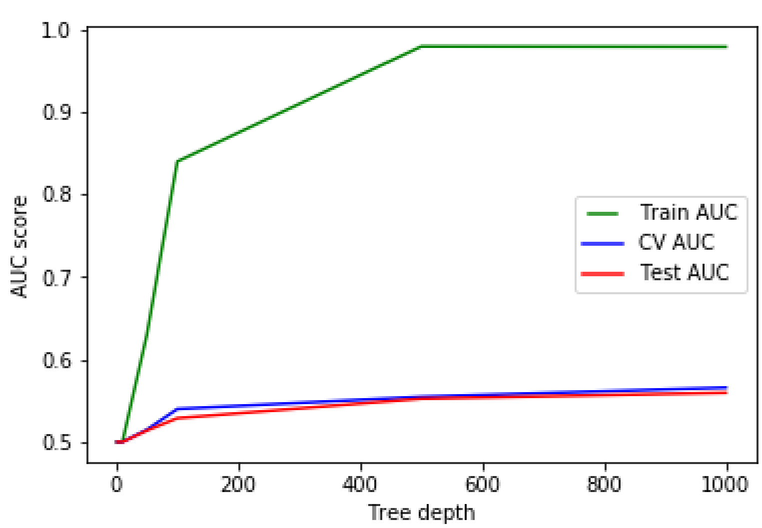
Random Forest on tfidf

In [18]:
```
clf_rf_tfidf = RandomForestClassifier()
clf_rf_tfidf.fit(train_tfidf,y_train)
clf_rf_tfidf
```

Out[18]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=10, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

Max-depth tuning

In [14]:
```
max_depths = [1, 5, 10, 50, 100, 500, 1000]
train_results_tfidf = []
cv_results_tfidf = []
test_results_tfidf = []

for max_depth in max_depths:
    clf_rf_tfidf_md = RandomForestClassifier(max_depth=max_depth)
    clf_rf_tfidf_md.fit(train_tfidf, y_train)
    train_pred_tfidf = clf_rf_tfidf_md.predict(train_tfidf)

    fpr_tr, tpr_tr, thrsh_trn = roc_curve(y_train, train_pred_tfidf)
    roc_auc_tfidf_md = auc(fpr_tr, tpr_tr)
    # Add auc score to previous train results
    train_results_tfidf.append(roc_auc_tfidf_md)
    #train_results


    cv_pred = clf_rf_tfidf_md.predict(cv_tfidf)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_cv, cv_pre
    roc_auc_tfidf_md = auc(false_positive_rate, true_positive_rate)
    cv_results_tfidf.append(roc_auc_tfidf_md)


    test_pred_tfidf = clf_rf_tfidf_md.predict(test_tfidf)

    fpr_test, tpr_test, thrsh_test = roc_curve(y_test, test_pred_tfidf)
    roc_auc_tfidf_md = auc(fpr_test, tpr_test)
    # Add auc score to previous test results
    test_results_tfidf.append(roc_auc_tfidf_md)
    #test_results

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(max_depths, train_results_tfidf, 'g', label="Train AUC")
line2, = plt.plot(max_depths, cv_results_tfidf, 'b', label="CV AUC")
line3, = plt.plot(max_depths, test_results_tfidf, 'r', label="Test AUC")
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```



In [15]:
```
print(train_results_tfidf)
print("\n",cv_results_tfidf)
print("\n",test_results_tfidf)
```

```
[0.5, 0.5, 0.5003543586109143, 0.630049610205528, 0.8395936687928183, 0.9791670
594823187, 0.9786945813344332]

 [0.5, 0.5, 0.5, 0.5147875675603717, 0.5399288452834208, 0.5546781397268298, 0.
565858882025613]

 [0.5, 0.5, 0.5, 0.5138181172265801, 0.5287544124778671, 0.5523950668420551, 0.
5595697327855692]
```

In [17]:
```
test_results_hmap_tfidf_1 = test_results_tfidf
joblib.dump(test_results_hmap_tfidf_1,"test_results_hmap_tfidf_1.pkl")
```

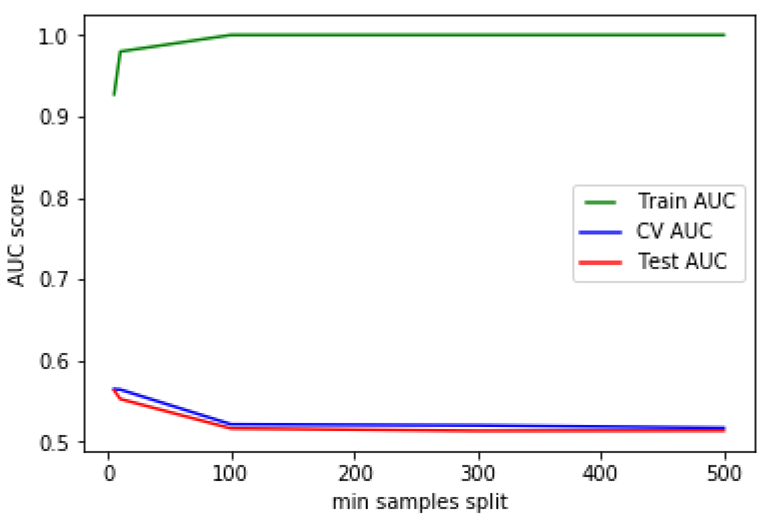
Out[17]:
```
['test_results_hmap_tfidf_1.pkl']
```

In [18]:
```
test_results_hmap_tfidf_1 = joblib.load("test_results_hmap_tfidf_1.pkl")
test_results_hmap_tfidf_1
```

Out[18]:
```
[0.5,
 0.5,
 0.5,
 0.5138181172265801,
 0.5287544124778671,
 0.5523950668420551,
 0.5595697327855692]
```

n_estimator tuning

In [19]:
```
n_estimators_splits = [5, 10, 100, 300, 500]
train_results_tfidf = []
cv_results_tfidf = []
test_results_tfidf = []
for n_estimators_split in n_estimators_splits:
    clf_dtree_nest_tfidf = RandomForestClassifier(n_estimators=n_estimators_spli
    clf_dtree_nest_tfidf.fit(train_tfidf, y_train)

    train_pred_tfidf = clf_dtree_nest_tfidf.predict(train_tfidf)

    false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, t
    roc_auc_train_tfidf = auc(false_positive_rate, true_positive_rate)
    train_results_tfidf.append(roc_auc_train_tfidf)


    cv_pred_tfidf = clf_dtree_nest_tfidf.predict(cv_tfidf)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_cv, cv_pre
    roc_auc_cv_tfidf = auc(false_positive_rate, true_positive_rate)
    cv_results_tfidf.append(roc_auc_cv_tfidf)


    y_pred_tfidf = clf_dtree_nest_tfidf.predict(test_tfidf)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, y_pre
    roc_auc_test_tfidf = auc(false_positive_rate, true_positive_rate)
    test_results_tfidf.append(roc_auc_test_tfidf)

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(n_estimators_splits, train_results_tfidf, 'g', label="Train AUC
line2, = plt.plot(n_estimators_splits, cv_results_tfidf, 'b', label="CV AUC")
line3, = plt.plot(n_estimators_splits, test_results_tfidf, 'r', label="Test AUC"
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('min samples split')
plt.show()
```



In [20]:
```
print(train_results_tfidf)
print("\n",cv_results_tfidf)
print("\n",test_results_tfidf)
```

```
[0.9270042211684771, 0.9796395376302044, 1.0, 1.0, 1.0]

 [0.5649078782715194, 0.564275539817354, 0.5215078276844431, 0.520187405149231
9, 0.5171654929577465]

 [0.5633128417331464, 0.5526885485241845, 0.5165094339622642, 0.513477088948787
1, 0.5138140161725067]
```

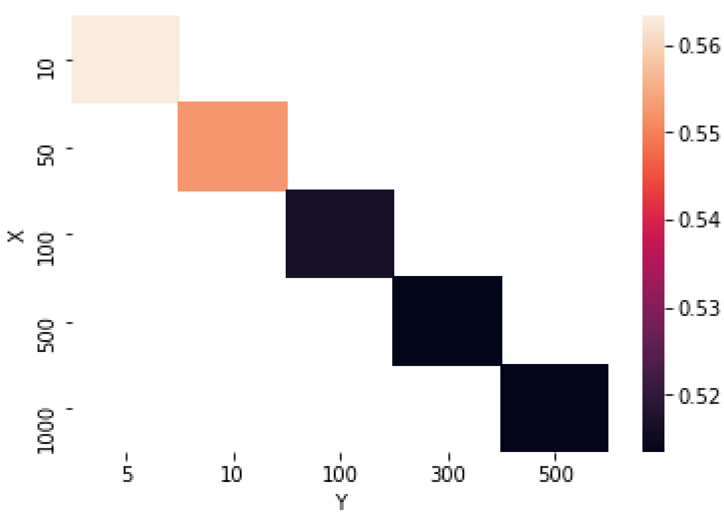
In [22]:
```
test_results_hmap_tfidf_2 = test_results_tfidf
joblib.dump(test_results_hmap_tfidf_2,"test_results_hmap_tfidf_2.pkl")
```

Out[22]:
```
['test_results_hmap_tfidf_2.pkl']
```

In [23]:
```
test_results_hmap_tfidf_2 = joblib.load("test_results_hmap_tfidf_2.pkl")
test_results_hmap_tfidf_2
```

Out[23]:
```
[0.5633128417331464,
 0.5526885485241845,
 0.5165094339622642,
 0.5134770889487871,
 0.5138140161725067]
```

In [24]:
```
X = [10, 50, 100, 500, 1000]
Y = n_estimators_splits
Z = test_results_hmap_tfidf_2
data = pd.DataFrame({'X': X, 'Y': Y, 'Z': Z})
data_pivoted = data.pivot("X", "Y", "Z")
ax = sns.heatmap(data_pivoted)
plt.show()
```



Random Forest with best parameters on tfidf

In [26]:
```
clf_rf_best_tfidf = RandomForestClassifier(n_estimators=5, max_depth=1000)
clf_rf_best_tfidf.fit(train_tfidf, y_train)

rf_test_pred_best_tfidf = clf_rf_best_tfidf.predict(test_tfidf)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, rf_test_
roc_auc_rf_best_tfidf = auc(false_positive_rate, true_positive_rate)

joblib.dump(clf_rf_best_tfidf,"clf_rf_best_tfidf.pkl")
joblib.dump(rf_test_pred_best_tfidf,"rf_test_pred_best_tfidf.pkl")
joblib.dump(roc_auc_rf_best_tfidf,"roc_auc_rf_best_tfidf.pkl")
```

Out[26]:
```
['roc_auc_rf_best_tfidf.pkl']
```

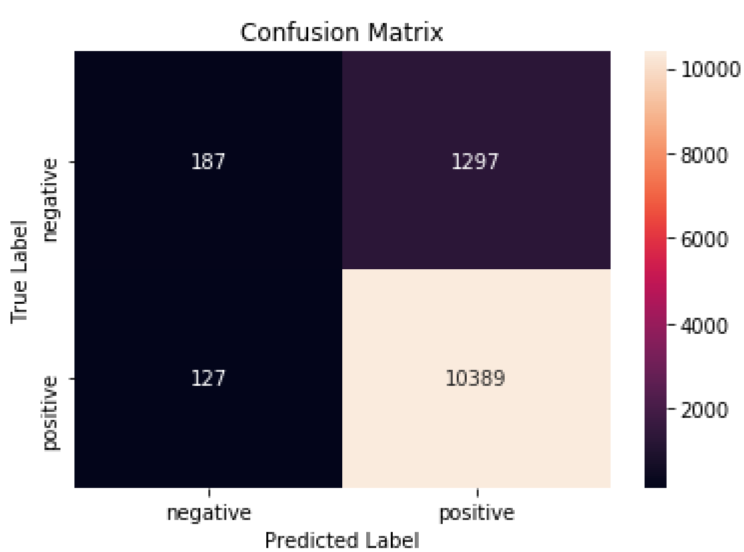
In [27]:
```
clf_rf_best_tfidf = joblib.load("clf_rf_best_tfidf.pkl")
rf_test_pred_best_tfidf = joblib.load("rf_test_pred_best_tfidf.pkl")
roc_auc_rf_best_tfidf = joblib.load("roc_auc_rf_best_tfidf.pkl")
roc_auc_rf_best_tfidf
```

Out[27]:
```
0.5569669731862832
```

In [28]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_tfidf = confusion_matrix(y_test, rf_test_pred_best_tfidf)
cm_tfidf
```

Out[28]:
```
array([[  187,  1297],
       [  127, 10389]], dtype=int64)
```

In [29]:
```
# plot confusion matrix to describe the performance of classifier.
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_tfidf, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```

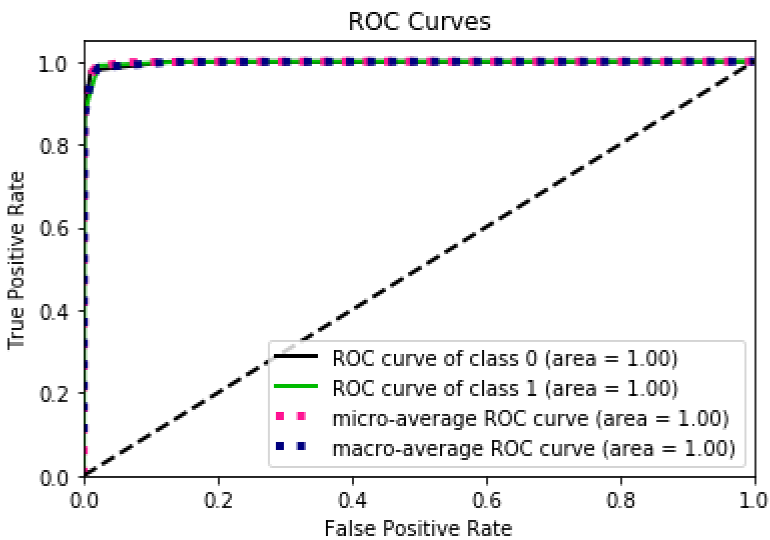


In [30]:
```
y_pred_train_proba_tfidf = clf_rf_best_tfidf.predict_proba(train_tfidf)
y_pred_cv_proba_tfidf = clf_rf_best_tfidf.predict_proba(cv_tfidf)
y_pred_test_proba_tfidf = clf_rf_best_tfidf.predict_proba(test_tfidf)
```

In [31]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_proba_tfidf)
```

```
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\utils\deprecation.py:77:
DeprecationWarning: Function plot_roc_curve is deprecated; This will be removed
in v0.5.0. Please use scikitplot.metrics.plot_roc instead.
  warnings.warn(msg, category=DeprecationWarning)
```

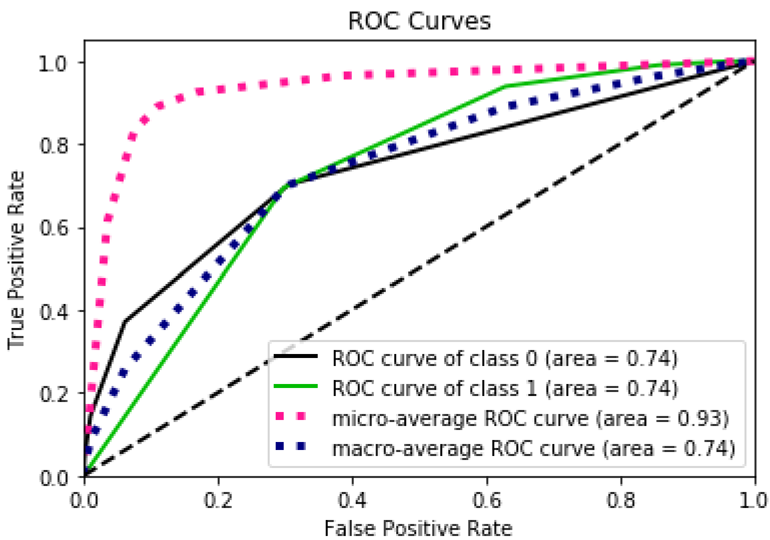
Out[31]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2b502deb5c0>
```



In [32]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_proba_tfidf)
```

```
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\utils\deprecation.py:77:
DeprecationWarning: Function plot_roc_curve is deprecated; This will be removed
in v0.5.0. Please use scikitplot.metrics.plot_roc instead.
  warnings.warn(msg, category=DeprecationWarning)
```

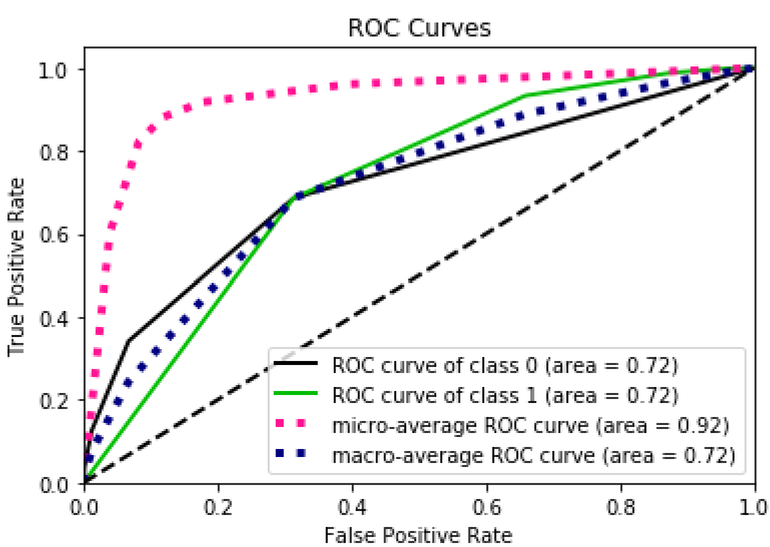
Out[32]: `<matplotlib.axes._subplots.AxesSubplot at 0x2b57a18e128>`



In [33]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_proba_tfidf)
```

```
C:\Users\AbhiShek\Anaconda3\lib\site-packages\sklearn\utils\deprecation.py:77:
DeprecationWarning: Function plot_roc_curve is deprecated; This will be removed
in v0.5.0. Please use scikitplot.metrics.plot_roc instead.
  warnings.warn(msg, category=DeprecationWarning)
```

Out[33]: `<matplotlib.axes._subplots.AxesSubplot at 0x2b500d76cc0>`



In [34]:
```
def most_informative_feature_for_binary_classification(vectorizer, classifier, n
    class_labels = classifier.classes_
    feature_names = vectorizer.get_feature_names()
    topn_class1 = sorted(zip(classifier.feature_importances_, feature_names))[:n
    topn_class2 = sorted(zip(classifier.feature_importances_, feature_names))[-n
    #print(dict(zip(iris_pd.columns, clf.feature_importances_)))

    print("Class 0: Negatives ")
    for coef, feat in topn_class1:
        print (class_labels[0], coef, feat)

    print("\n")
    print("Class 1: Positives ")
    for coef, feat in reversed(topn_class2):
        print (class_labels[1], coef, feat)

    return topn_class1, topn_class2

topn_class1, topn_class2 = most_informative_feature_for_binary_classification(tf_
```

```
Class 0: Negatives
0 0.0 0000
0 0.0 0002251337
0 0.0 000kwh
0 0.0 000s
0 0.0 00100
0 0.0 00493
0 0.0 00703
0 0.0 00704
0 0.0 0071499849
0 0.0 00am
0 0.0 00pm
0 0.0 01
0 0.0 01317
0 0.0 01318
0 0.0 0188
0 0.0 02
0 0.0 03
0 0.0 03510
0 0.0 040
0 0.0 0451155505


Class 1: Positives
1 0.009282769794714003 not
1 0.006555962434710588 worst
1 0.005716172801675299 refund
1 0.005439548152300956 waste
1 0.005265606089995259 horrible
1 0.004880998727353923 and
1 0.004809270837563668 but
1 0.0047917003443453355 stale
1 0.004633933066295158 best
1 0.004579498578241138 the
1 0.00420107490047982 threw
1 0.0041973357019790295 awful
1 0.003978878647139356 was
```

```
1 0.003932286961871653 is
1 0.003791469366952388 in
1 0.0037094673904496805 to
1 0.003613197043892577 disappointing
1 0.0035467393341620775 of
1 0.0035152110371905257 my
1 0.003508831865443538 it
```

In [35]:
```
#source: https://www.geeksforgeeks.org/generating-word-cloud-python/
comment_words = ' '
stopwords = set(STOPWORDS)

# iterate through the csv file
for val in topn_class2:

    # typecaste each val to string
    val = str(val)

    # split the value
    tokens = val.split()

    # Converts each token into lowercase
    for i in range(len(tokens)):
        tokens[i] = tokens[i].lower()

    for words in tokens:
        comment_words = comment_words + words + ' '


wordcloud = WordCloud(width = 800, height = 800,
                background_color ='white',
                stopwords = stopwords,
                min_font_size = 10).generate(comment_words)

# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```

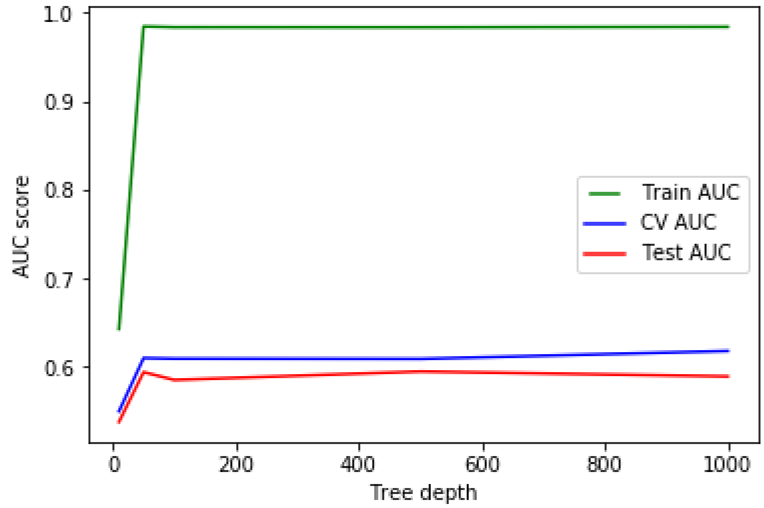
Random Forest on avgW2V

In [46]:
```
clf_rf_avgw2v = RandomForestClassifier()
clf_rf_avgw2v.fit(train_avgw2v,y_train)
clf_rf_avgw2v
```

Out[46]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=10, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

max_depth tuning

In [33]:
```
max_depths = [10, 50, 100, 500, 1000]

train_results_avgw2v = []
cv_results_avgw2v = []
test_results_avgw2v = []

for max_depth in max_depths:
    clf_rf_avgw2v_md = RandomForestClassifier(max_depth=max_depth)
    clf_rf_avgw2v_md.fit(train_avgw2v, y_train)
    train_pred_avgw2v = clf_rf_avgw2v_md.predict(train_avgw2v)

    fpr_tr, tpr_tr, thrsh_trn = roc_curve(y_train, train_pred_avgw2v)
    roc_auc_train_avgw2v = auc(fpr_tr, tpr_tr)
    # Add auc score to previous train results
    train_results_avgw2v.append(roc_auc_train_avgw2v)
    #train_results


    cv_pred_avgw2v = clf_rf_avgw2v_md.predict(cv_avgw2v)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_cv, cv_pre
    roc_auc_avgw2v_md = auc(false_positive_rate, true_positive_rate)
    cv_results_avgw2v.append(roc_auc_avgw2v_md)


    test_pred_avgw2v = clf_rf_avgw2v_md.predict(test_avgw2v)

    fpr_test, tpr_test, thrsh_test = roc_curve(y_test, test_pred_avgw2v)
    roc_auc_test_avgw2v = auc(fpr_test, tpr_test)
    # Add auc score to previous test results
    test_results_avgw2v.append(roc_auc_test_avgw2v)
    #test_results

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(max_depths, train_results_avgw2v, 'g', label="Train AUC")
line2, = plt.plot(max_depths, cv_results_avgw2v, 'b', label="CV AUC")
line3, = plt.plot(max_depths, test_results_avgw2v, 'r', label="Test AUC")
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```



In [34]:
```
print(train_results_avgw2v)
print("\n",cv_results_avgw2v)
print("\n",test_results_avgw2v)
```

```
[0.642869246246347, 0.984720772736787, 0.983893935977987, 0.983761182437445, 0.9842786101044486]

 [0.5497833408770202, 0.6099977701749248, 0.6093213344338242, 0.6090584147607764, 0.61801182805719]

 [0.5377645564351178, 0.5940945846606225, 0.5852352825985099, 0.5948077835955787, 0.589278409283146]
```

In [37]:
```
test_results_hmap_avgw2v_1 = test_results_avgw2v
joblib.dump(test_results_hmap_avgw2v_1,"test_results_hmap_avgw2v_1.pkl")
```

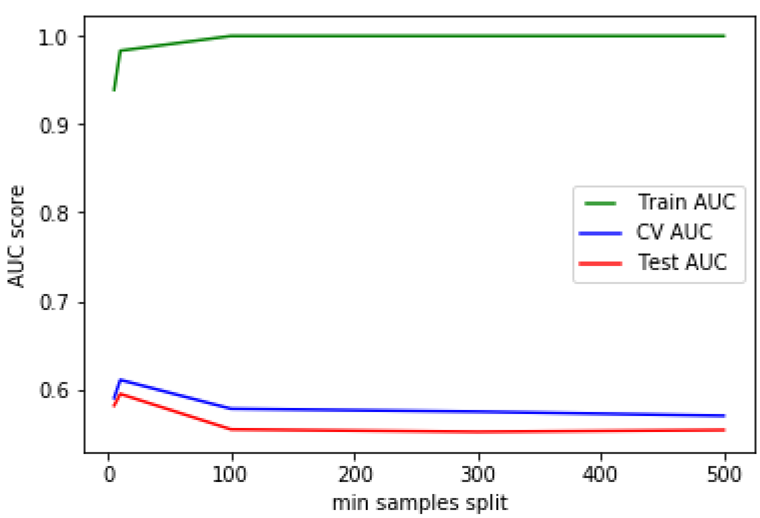
Out[37]:
```
['test_results_hmap_avgw2v_1.pkl']
```

In [38]:
```
test_results_hmap_avgw2v_1 = joblib.load("test_results_hmap_avgw2v_1.pkl")
test_results_hmap_avgw2v_1
```

Out[38]:
```
[0.5377645564351178,
 0.5940945846606225,
 0.5852352825985099,
 0.5948077835955787,
 0.589278409283146]
```

n_estimator tuning

In [39]:
```
n_estimators_splits = [5, 10, 100, 300, 500]

train_results_avgw2v = []
cv_results_avgw2v = []
test_results_avgw2v = []

for n_estimators_split in n_estimators_splits:
    clf_rf_avgw2v_nest = RandomForestClassifier(n_estimators=n_estimators_split)
    clf_rf_avgw2v_nest.fit(train_avgw2v, y_train)

    train_pred_avgw2v = clf_rf_avgw2v_nest.predict(train_avgw2v)

    false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, t
    roc_auc_avgw2v = auc(false_positive_rate, true_positive_rate)
    train_results_avgw2v.append(roc_auc_avgw2v)


    cv_pred_avgw2v = clf_rf_avgw2v_nest.predict(cv_avgw2v)

    false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_cv, cv_p
    roc_auc_avgw2v = auc(false_positive_rate, true_positive_rate)
    cv_results_avgw2v.append(roc_auc_avgw2v)


    y_pred_avgw2v = clf_rf_avgw2v_nest.predict(test_avgw2v)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, y_pre
    roc_auc_avgw2v = auc(false_positive_rate, true_positive_rate)
    test_results_avgw2v.append(roc_auc_avgw2v)

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(n_estimators_splits, train_results_avgw2v, 'g', label="Train AU
line2, = plt.plot(n_estimators_splits, cv_results_avgw2v, 'b', label="CV AUC")
line3, = plt.plot(n_estimators_splits, test_results_avgw2v, 'r', label="Test AUC"
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('min samples split')
plt.show()
```



In [40]:
```
print(train_results_avgw2v)
print("\n",cv_results_avgw2v)
print("\n",test_results_avgw2v)
```

```
[0.939030478491261, 0.98330333829313, 1.0, 1.0, 1.0]

 [0.5901148859128305, 0.6105560584680103, 0.5777751337895045, 0.574490301924971
4, 0.5698525985782369]

 [0.5814110496750426, 0.5946257993210705, 0.5543772856968563, 0.551626119203288
3, 0.55369522914127]
```

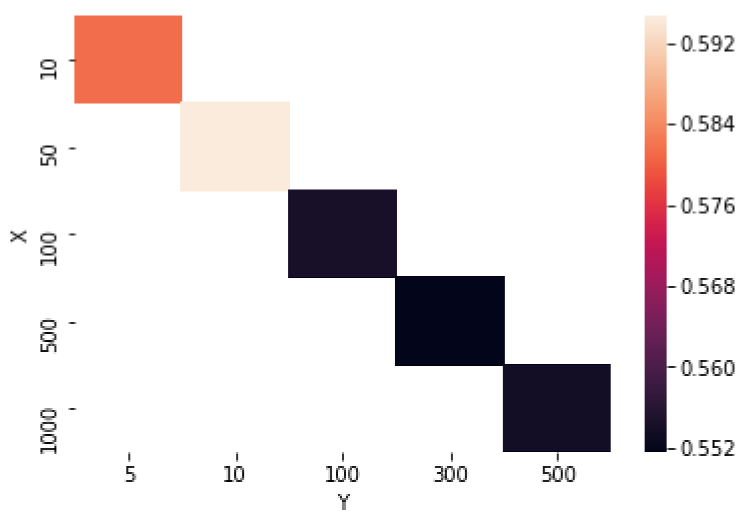
In [42]:
```
test_results_hmap_avgw2v_2 = test_results_avgw2v
joblib.dump(test_results_hmap_avgw2v_2,"test_results_hmap_avgw2v_2.pkl")
```

Out[42]:
```
['test_results_hmap_avgw2v_2.pkl']
```

In [43]:
```
test_results_hmap_avgw2v_2 = joblib.load("test_results_hmap_avgw2v_2.pkl")
test_results_hmap_avgw2v_2
```

Out[43]:
```
[0.5814110496750426,
 0.5946257993210705,
 0.5543772856968563,
 0.5516261192032883,
 0.55369522914127]
```

In [44]:
```
X = [10, 50, 100, 500, 1000]
Y = n_estimators_splits
Z = test_results_hmap_avgw2v_2
data = pd.DataFrame({'X': X, 'Y': Y, 'Z': Z})
data_pivoted = data.pivot("X", "Y", "Z")
ax = sns.heatmap(data_pivoted)
plt.show()
```



Random Forest with best parameters on avgW2V

In [51]:
```
clf_rf_avgw2v_best = RandomForestClassifier(n_estimators=10, max_depth=50)
clf_rf_avgw2v_best.fit(train_avgw2v, y_train)

rf_test_pred_avgw2v_best = clf_rf_avgw2v_best.predict(test_avgw2v)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, rf_test_
roc_auc_rf_avgw2v_best = auc(false_positive_rate, true_positive_rate)

joblib.dump(clf_rf_avgw2v_best,"clf_rf_avgw2v_best.pkl")
joblib.dump(rf_test_pred_avgw2v_best,"rf_test_pred_avgw2v_best.pkl")
joblib.dump(roc_auc_rf_avgw2v_best,"roc_auc_rf_avgw2v_best.pkl")
```

Out[51]:
```
['roc_auc_rf_avgw2v_best.pkl']
```

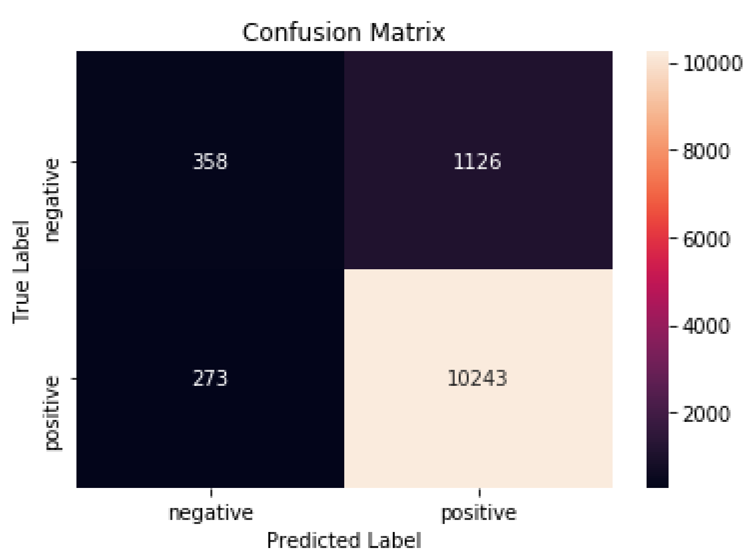
In [52]:
```
clf_rf_avgw2v_best = joblib.load("clf_rf_avgw2v_best.pkl")
rf_test_pred_avgw2v_best = joblib.load("rf_test_pred_avgw2v_best.pkl")
roc_auc_rf_avgw2v_best = joblib.load("roc_auc_rf_avgw2v_best.pkl")
roc_auc_rf_avgw2v_best
```

Out[52]:
```
0.6076397254754404
```

In [53]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_avgw2v = confusion_matrix(y_test, rf_test_pred_avgw2v_best)
cm_avgw2v
```

Out[53]:
```
array([[  358,  1126],
       [  273, 10243]], dtype=int64)
```

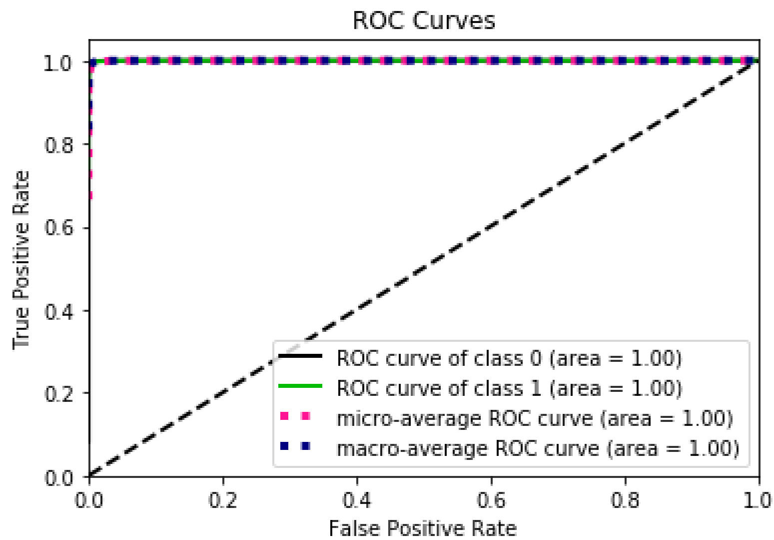
In [54]:
```
# plot confusion matrix to describe the performance of classifier.
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_avgw2v, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [55]:
```
y_pred_train_avgw2v_proba = clf_rf_avgw2v_best.predict_proba(train_avgw2v)
y_pred_cv_avgw2v_proba = clf_rf_avgw2v_best.predict_proba(cv_avgw2v)
y_pred_test_avgw2v_proba = clf_rf_avgw2v_best.predict_proba(test_avgw2v)
```

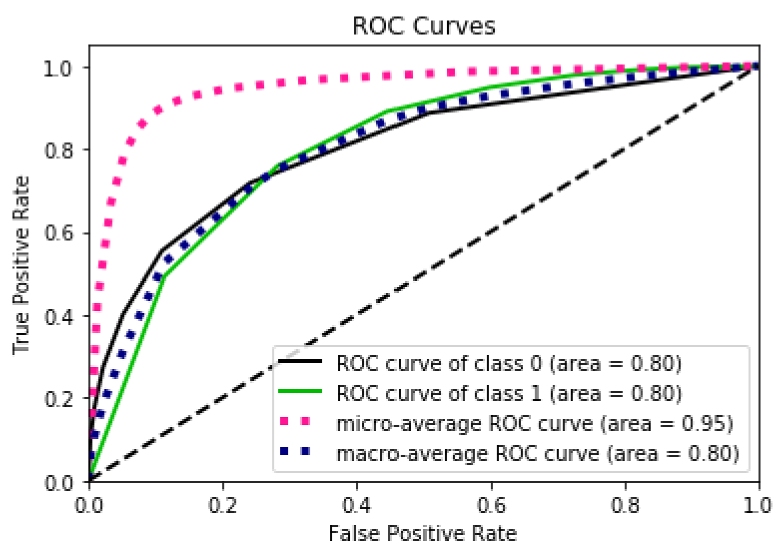
In [56]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_avgw2v_proba)
```

Out[56]: <matplotlib.axes._subplots.AxesSubplot at 0x2b5318a3ba8>



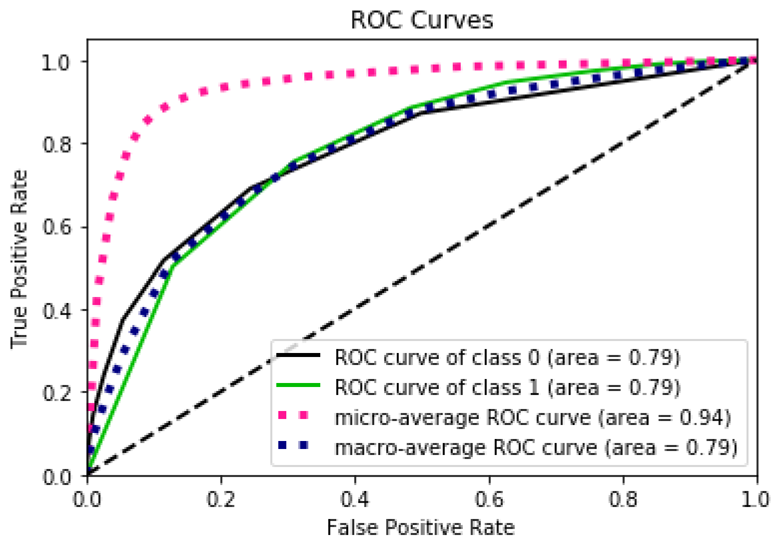
In [57]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_avgw2v_proba)
```

Out[57]: <matplotlib.axes._subplots.AxesSubplot at 0x2b531a3c048>



In [58]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_avgw2v_proba)
```

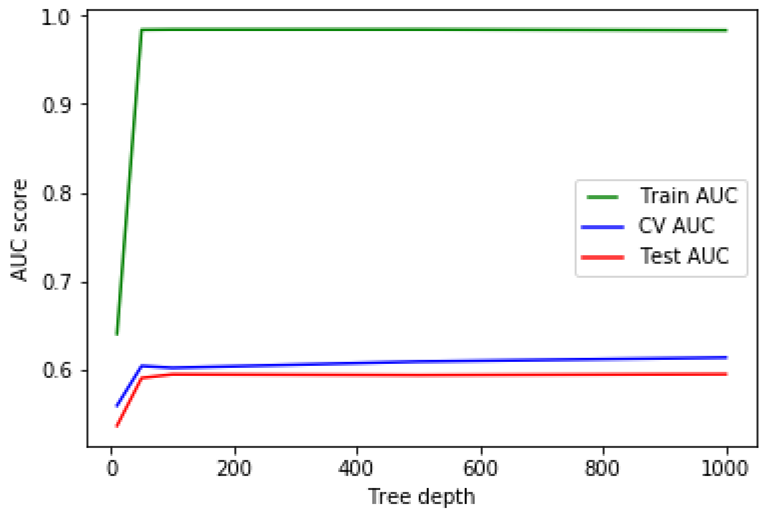
Out[58]: <matplotlib.axes._subplots.AxesSubplot at 0x2b531a3c588>



Random Forest on tfidf-W-w2v

max_depth tuning

In [55]:
```
max_depths = [10, 50, 100, 500, 1000]

train_results_tfidfww2v = []
cv_results_tfidfww2v = []
test_results_tfidfww2v = []

for max_depth in max_depths:
    clf_rf_tfidfww2v_md = RandomForestClassifier(max_depth=max_depth)
    clf_rf_tfidfww2v_md.fit(train_tfidfww2v, y_train)
    train_pred_tfidfww2v = clf_rf_tfidfww2v_md.predict(train_tfidfww2v)

    fpr_tr, tpr_tr, thrsh_trn = roc_curve(y_train, train_pred_tfidfww2v)
    roc_auc_train_tfidfww2v = auc(fpr_tr, tpr_tr)
    # Add auc score to previous train results
    train_results_tfidfww2v.append(roc_auc_train_tfidfww2v)
    #train_results


    cv_pred_tfidfww2v = clf_rf_tfidfww2v_md.predict(cv_tfidfww2v)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_cv, cv_pred
    roc_auc_tfidfww2v_md = auc(false_positive_rate, true_positive_rate)
    cv_results_tfidfww2v.append(roc_auc_tfidfww2v_md)


    test_pred_tfidfww2v = clf_rf_tfidfww2v_md.predict(test_tfidfww2v)

    fpr_test, tpr_test, thrsh_test = roc_curve(y_test, test_pred_tfidfww2v)
    roc_auc_test_tfidfww2v = auc(fpr_test, tpr_test)
    # Add auc score to previous test results
    test_results_tfidfww2v.append(roc_auc_test_tfidfww2v)
    #test_results

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(max_depths, train_results_tfidfww2v, 'g', label="Train AUC")
line2, = plt.plot(max_depths, cv_results_tfidfww2v, 'b', label="CV AUC")
line3, = plt.plot(max_depths, test_results_tfidfww2v, 'r', label="Test AUC")
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```



In [56]:
```
print(train_results_tfidfww2v)
print("\n",cv_results_tfidfww2v)
print("\n",test_results_tfidfww2v)
```

```
[0.6403897834783531, 0.9837758164410156, 0.9840559575256705, 0.984070591529241
3, 0.9831998527597292]

 [0.5591710708485317, 0.6040396442929791, 0.6018655648446444, 0.608972716259751
4, 0.6135396975425331]

 [0.5363693009445754, 0.5903801830915592, 0.5945225040215962, 0.593646160029281
5, 0.5947684391080618]
```

In [57]:
```
test_results_hmap_tfidfww2v_1 = test_results_tfidfww2v
joblib.dump(test_results_hmap_tfidfww2v_1,"test_results_hmap_tfidfww2v_1.pkl")
```

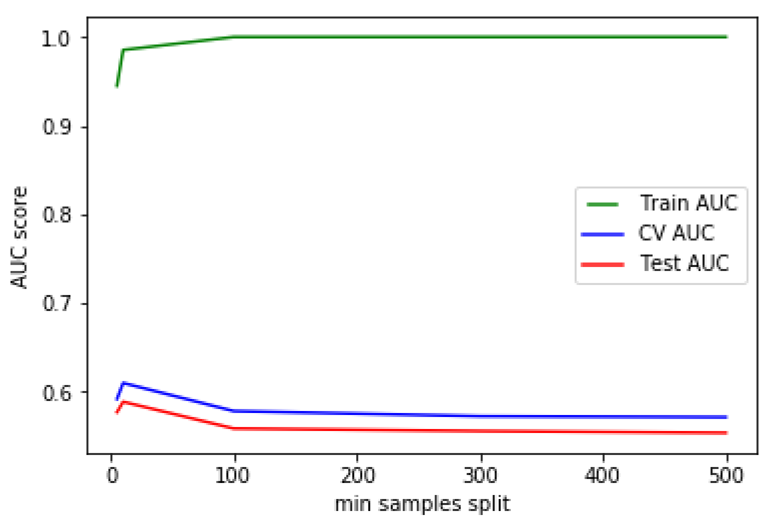
Out[57]:
```
['test_results_hmap_tfidfww2v_1.pkl']
```

In [58]:
```
test_results_hmap_tfidfww2v_1 = joblib.load("test_results_hmap_tfidfww2v_1.pkl")
test_results_hmap_tfidfww2v_1
```

Out[58]:
```
[0.5363693009445754,
 0.5903801830915592,
 0.5945225040215962,
 0.593646160029281 5,
 0.5947684391080618]
```

n_estimator tuning

In [59]:
```
n_estimators_splits = [5, 10, 100, 300, 500]

train_results_tfidfww2v = []
cv_results_tfidfww2v = []
test_results_tfidfww2v = []

for n_estimators_split in n_estimators_splits:
    clf_dtree_tfidfww2v_nest = RandomForestClassifier(n_estimators=n_estimators_s
    clf_dtree_tfidfww2v_nest.fit(train_tfidfww2v, y_train)

    train_pred_tfidfww2v = clf_dtree_tfidfww2v_nest.predict(train_tfidfww2v)

    false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, t
    roc_auc_train_tfidfww2v = auc(false_positive_rate, true_positive_rate)
    train_results_tfidfww2v.append(roc_auc_train_tfidfww2v)


    cv_pred_tfidfww2v = clf_dtree_tfidfww2v_nest.predict(cv_tfidfww2v)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_cv, cv_pred
    roc_auc_tfidfww2v_nest = auc(false_positive_rate, true_positive_rate)
    cv_results_tfidfww2v.append(roc_auc_tfidfww2v_nest)


    y_pred_tfidfww2v = clf_dtree_tfidfww2v_nest.predict(test_tfidfww2v)

    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, y_pre
    roc_auc_test_tfidfww2v = auc(false_positive_rate, true_positive_rate)
    test_results_tfidfww2v.append(roc_auc_test_tfidfww2v)

from matplotlib.legend_handler import HandlerLine2D
line1, = plt.plot(n_estimators_splits, train_results_tfidfww2v, 'g', label="Trai
line2, = plt.plot(n_estimators_splits, cv_results_tfidfww2v, 'b', label="CV AUC"
line3, = plt.plot(n_estimators_splits, test_results_tfidfww2v, 'r', label="Test A
plt.legend(handler_map={line1: HandlerLine2D(numpoints=2)})
plt.ylabel('AUC score')
plt.xlabel('min samples split')
plt.show()
```



In [60]:
```
print(train_results_tfidfww2v)
print("\n",cv_results_tfidfww2v)
print("\n",test_results_tfidfww2v)
```

```
[0.9448925533291196, 0.9853699064359268, 1.0, 1.0, 1.0]

 [0.5919669719641097, 0.6100243949519423, 0.5783009731356, 0.5724934436486594,
0.571468389733486]

 [0.5769957523332434, 0.5887906401642882, 0.5586105987641473, 0.555764339079251
8, 0.5537427757369338]
```

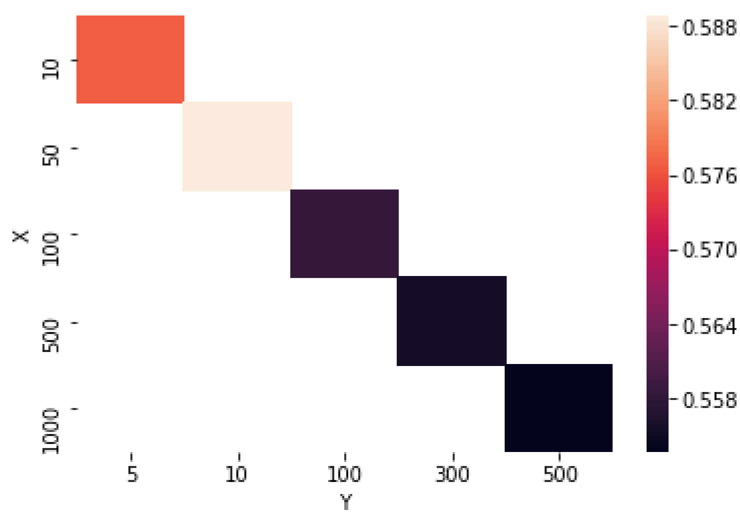
In [61]:
```
test_results_hmap_tfidfww2v_2 = test_results_tfidfww2v
joblib.dump(test_results_hmap_tfidfww2v_2,"test_results_hmap_tfidfww2v_2.pkl")
```

Out[61]:
```
['test_results_hmap_tfidfww2v_2.pkl']
```

In [62]:
```
test_results_hmap_tfidfww2v_2 = joblib.load("test_results_hmap_tfidfww2v_2.pkl")
test_results_hmap_tfidfww2v_2
```

Out[62]:
```
[0.5769957523332434,
 0.5887906401642882,
 0.5586105987641473,
 0.5557643390792518,
 0.5537427757369338]
```

In [63]:
```
X = [10, 50, 100, 500, 1000]
Y = n_estimators_splits
Z = test_results_hmap_tfidfww2v_2
data = pd.DataFrame({'X': X, 'Y': Y, 'Z': Z})
data_pivoted = data.pivot("X", "Y", "Z")
ax = sns.heatmap(data_pivoted)
plt.show()
```



Random Forest with best parameters on tfidfww2v

In [75]:
```
clf_rf_tfidfww2v_best = RandomForestClassifier(n_estimators=10, max_depth=1000)
clf_rf_tfidfww2v_best.fit(train_tfidfww2v, y_train)

rf_test_pred_tfidfww2v_best = clf_rf_tfidfww2v_best.predict(test_tfidfww2v)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, rf_test_
roc_auc_rf_tfidfww2v_best = auc(false_positive_rate, true_positive_rate)

joblib.dump(clf_rf_tfidfww2v_best,"clf_rf_tfidfww2v_best.pkl")
joblib.dump(rf_test_pred_tfidfww2v_best,"rf_test_pred_tfidfww2v_best.pkl")
joblib.dump(roc_auc_rf_tfidfww2v_best,"roc_auc_rf_tfidfww2v_best.pkl")
```

Out[75]:
```
['roc_auc_rf_tfidfww2v_best.pkl']
```

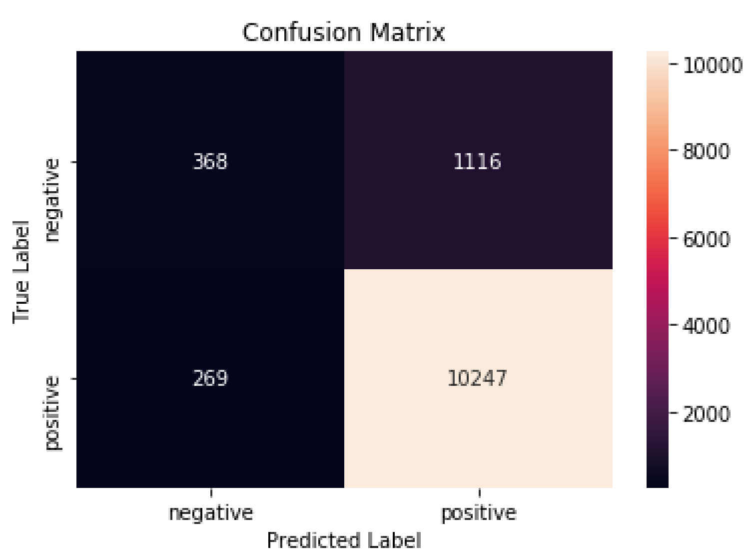
In [76]:
```
clf_rf_tfidfww2v_best = joblib.load("clf_rf_tfidfww2v_best.pkl")
rf_test_pred_tfidfww2v_best = joblib.load("rf_test_pred_tfidfww2v_best.pkl")
roc_auc_rf_tfidfww2v_best = joblib.load("roc_auc_rf_tfidfww2v_best.pkl")
roc_auc_rf_tfidfww2v_best
```

Out[76]:
```
0.6111991840952922
```

In [77]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_tfidfww2v = confusion_matrix(y_test, rf_test_pred_tfidfww2v_best)
cm_tfidfww2v
```

Out[77]:
```
array([[  368,  1116],
       [  269, 10247]], dtype=int64)
```

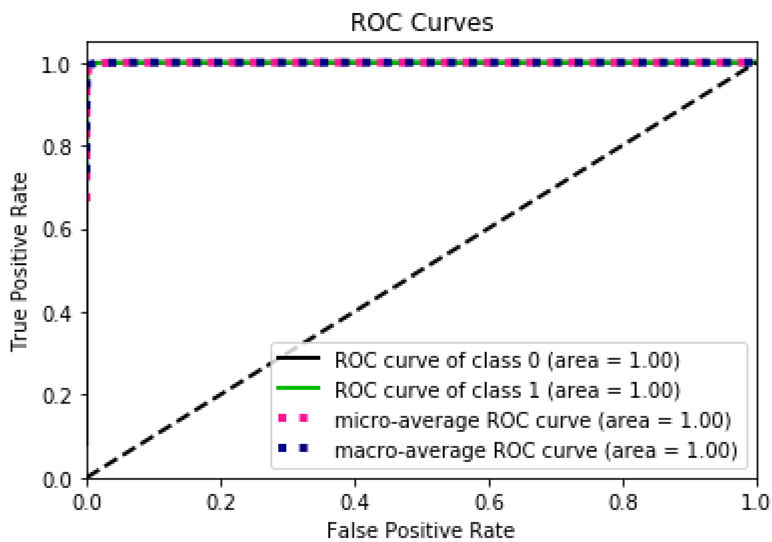
In [78]:
```
# plot confusion matrix to describe the performance of classifier.
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_tfidfww2v, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [79]:
```
y_pred_train_tfidfww2v_proba = clf_rf_tfidfww2v_best.predict_proba(train_tfidfww2
y_pred_cv_tfidfww2v_proba = clf_rf_tfidfww2v_best.predict_proba(cv_tfidfww2v)
y_pred_test_tfidfww2v_proba = clf_rf_tfidfww2v_best.predict_proba(test_tfidfww2v
```

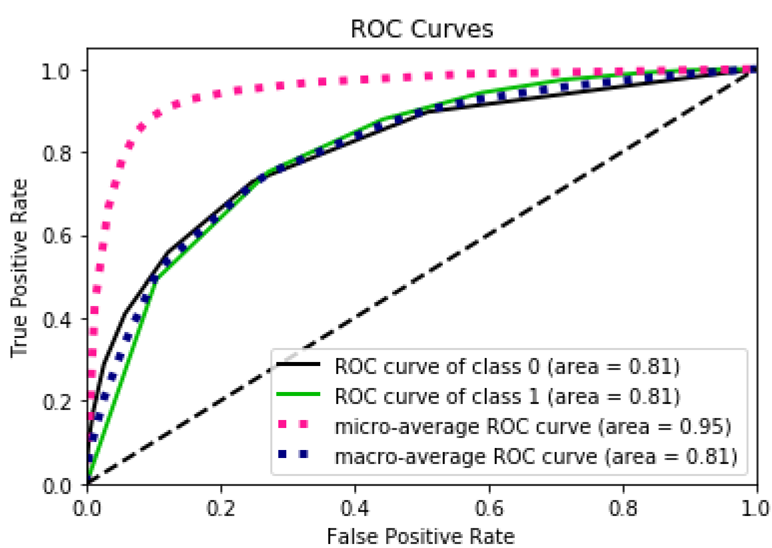
In [80]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_tfidfww2v_proba)
```

Out[80]: <matplotlib.axes._subplots.AxesSubplot at 0x2b526e47e80>



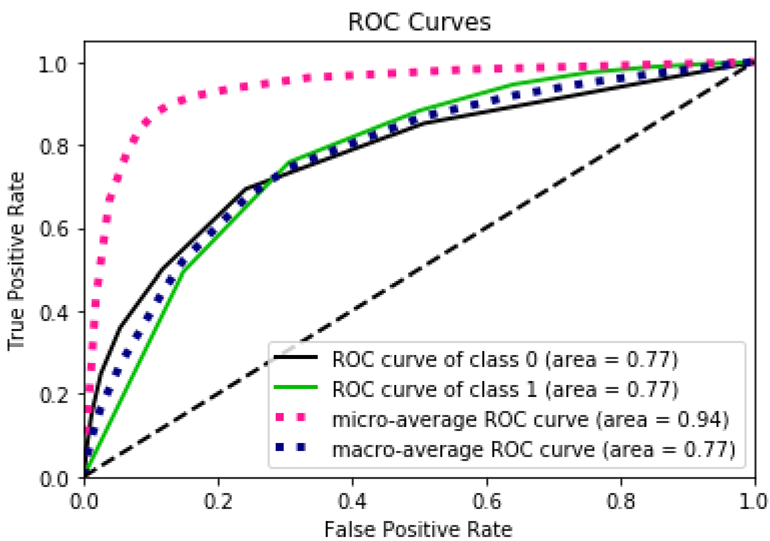
In [81]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_tfidfww2v_proba)
```

Out[81]: <matplotlib.axes._subplots.AxesSubplot at 0x2b52b926a58>



In [82]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_tfidfww2v_proba)
```

Out[82]: <matplotlib.axes._subplots.AxesSubplot at 0x2b52b987470>



Applying GBDT using XGBOOST on BoW

In [89]:
```
xgb_model = xgb.XGBClassifier()
xgb_model.fit(train_bow,y_train)
xgb_model
```

Out[89]:
```
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=100,
       n_jobs=1, nthread=None, objective='binary:logistic', random_state=0,
       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
       silent=True, subsample=1)
```

In [96]:
```
train_results = []
cv_results = []
test_results = []

train_pred = xgb_model.predict(train_bow)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, trai
roc_auc_train = auc(false_positive_rate, true_positive_rate)
train_results.append(roc_auc_train)

cv_pred = xgb_model.predict(cv_bow)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_cv, cv_pred
roc_auc_cv = auc(false_positive_rate, true_positive_rate)
cv_results.append(roc_auc_cv)


test_pred = xgb_model.predict(test_bow)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, test_pre
roc_auc_test = auc(false_positive_rate, true_positive_rate)
test_results.append(roc_auc_test)
```

In [97]:
```
print(train_results)
print(cv_results)
print(test_results)
```

```
[0.5759853678217906]
[0.5677758659708726]
[0.5572382835448282]
```

In [102]:
```
# Confusion Matrix on Train Data
#y_pred = np.argmax(pred_test, axis=1)
cm_train_bow = confusion_matrix(y_train, train_pred)
cm_train_bow
```

Out[102]:
```
array([[  648,  3585],
       [   38, 34129]], dtype=int64)
```

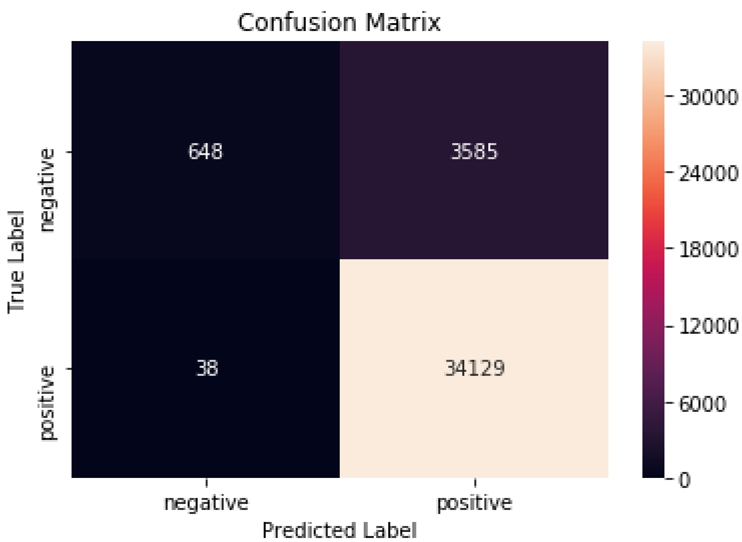
In [103]:
```
# Confusion Matrix on CV Data
#y_pred = np.argmax(pred_test, axis=1)
cm_cv_bow = confusion_matrix(y_cv, cv_pred)
cm_cv_bow
```

Out[103]:
```
array([[ 156,  980],
       [  15, 8449]], dtype=int64)
```

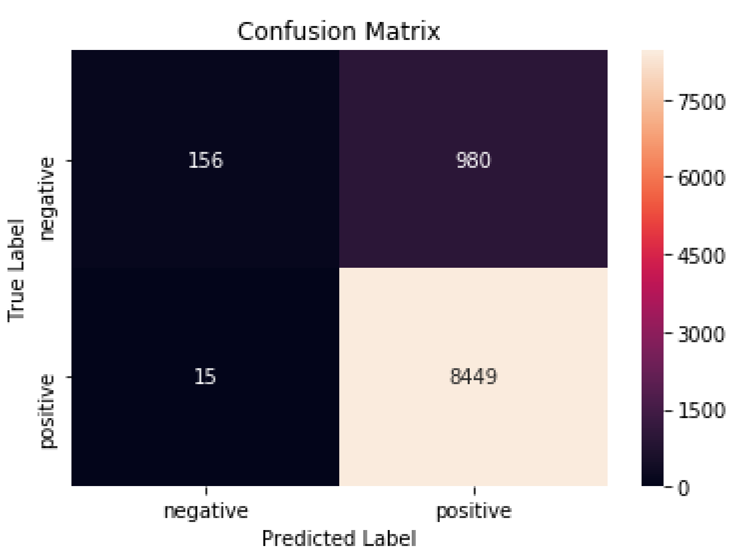
In [104]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_test_bow = confusion_matrix(y_test, test_pred)
cm_test_bow
```

Out[104]:
```
array([[  172,  1312],
       [   15, 10501]], dtype=int64)
```

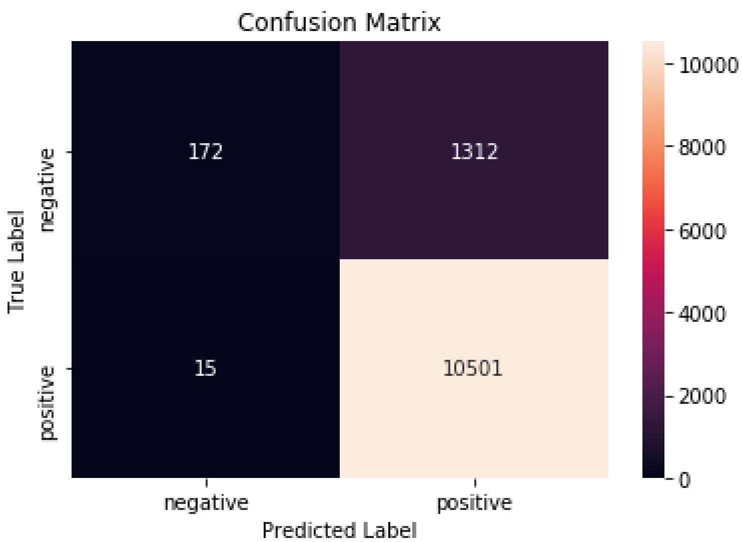
In [105]:
```
# plot confusion matrix to describe the performance of classifier for Train Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_train_bow, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [106]:
```
# plot confusion matrix to describe the performance of classifier for CV Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_cv_bow, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



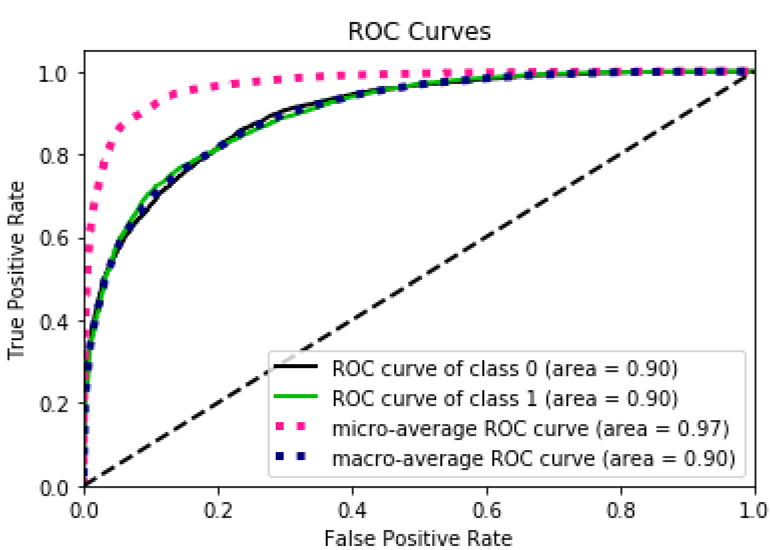
In [107]:
```
# plot confusion matrix to describe the performance of classifier for Test Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_test_bow, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [110]:
```
y_pred_train_proba = xgb_model.predict_proba(train_bow)
y_pred_cv_proba = xgb_model.predict_proba(cv_bow)
y_pred_test_proba = xgb_model.predict_proba(test_bow)
```

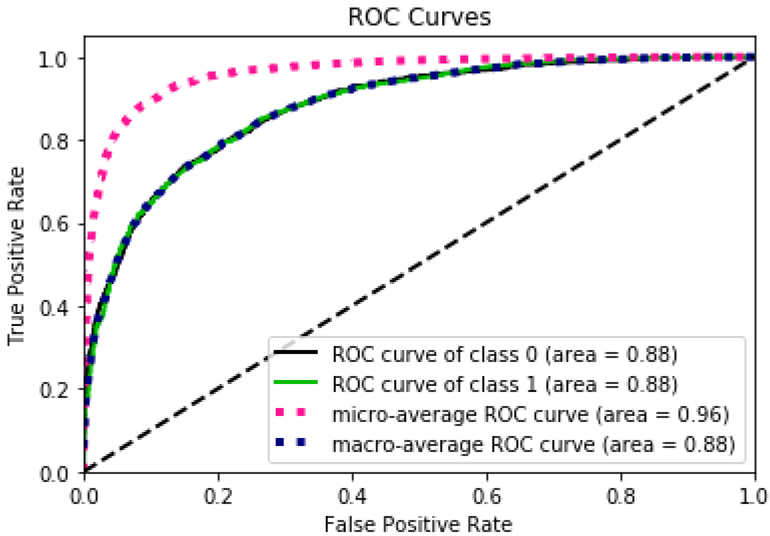
In [111]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_proba)
```

Out[111]: <matplotlib.axes._subplots.AxesSubplot at 0x2b50821a860>



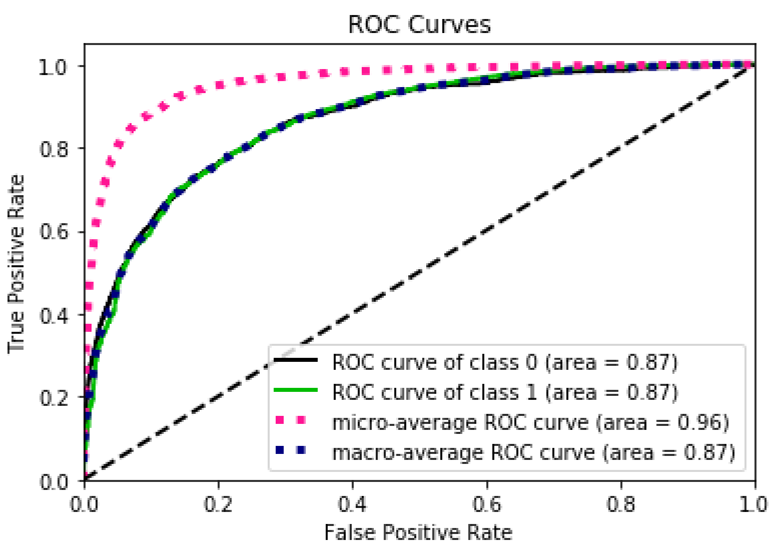
In [112]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_proba)
```

Out[112]: <matplotlib.axes._subplots.AxesSubplot at 0x2b5083042b0>



In [113]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_proba)
```

Out[113]: <matplotlib.axes._subplots.AxesSubplot at 0x2b508372b70>



Applying GBDT using XGBOOST on tfidf

In [114]:
```
xgb_model_tfidf = xgb.XGBClassifier()
xgb_model_tfidf.fit(train_tfidf,y_train)
xgb_model_tfidf
```

Out[114]:
```
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=100,
       n_jobs=1, nthread=None, objective='binary:logistic', random_state=0,
       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
       silent=True, subsample=1)
```

In [115]:
```
train_results_tfidf = []
cv_results_tfidf = []
test_results_tfidf = []

train_pred_tfidf = xgb_model.predict(train_tfidf)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, trai
roc_auc_train_tfidf = auc(false_positive_rate, true_positive_rate)
train_results_tfidf.append(roc_auc_train_tfidf)

cv_pred_tfidf = xgb_model.predict(cv_tfidf)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_cv, cv_pred_
roc_auc_cv_tfidf = auc(false_positive_rate, true_positive_rate)
cv_results_tfidf.append(roc_auc_cv_tfidf)


test_pred_tfidf = xgb_model.predict(test_tfidf)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, test_pre
roc_auc_test_tfidf = auc(false_positive_rate, true_positive_rate)
test_results_tfidf.append(roc_auc_test_tfidf)
```

In [116]:
```
print(train_results_tfidf)
print(cv_results_tfidf)
print(test_results_tfidf)
```

```
[0.5730773289166231]
[0.5638736720892462]
[0.5578645913966037]
```

In [117]:
```
# Confusion Matrix on Train Data
#y_pred = np.argmax(pred_test, axis=1)
cm_train_tfidf = confusion_matrix(y_train, train_pred_tfidf)
cm_train_tfidf
```

Out[117]:
```
array([[  624,  3609],
       [   43, 34124]], dtype=int64)
```

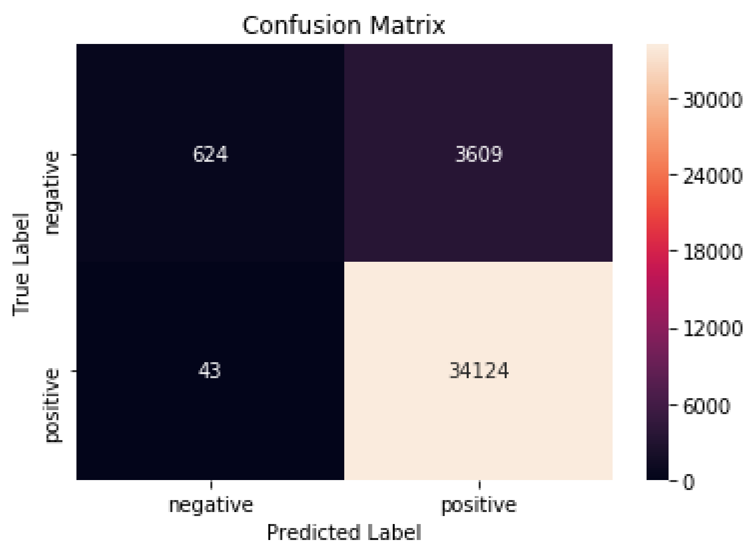
In [118]:
```
# Confusion Matrix on CV Data
#y_pred = np.argmax(pred_test, axis=1)
cm_cv_tfidf = confusion_matrix(y_cv, cv_pred_tfidf)
cm_cv_tfidf
```

Out[118]:
```
array([[ 147,  989],
       [  14, 8450]], dtype=int64)
```

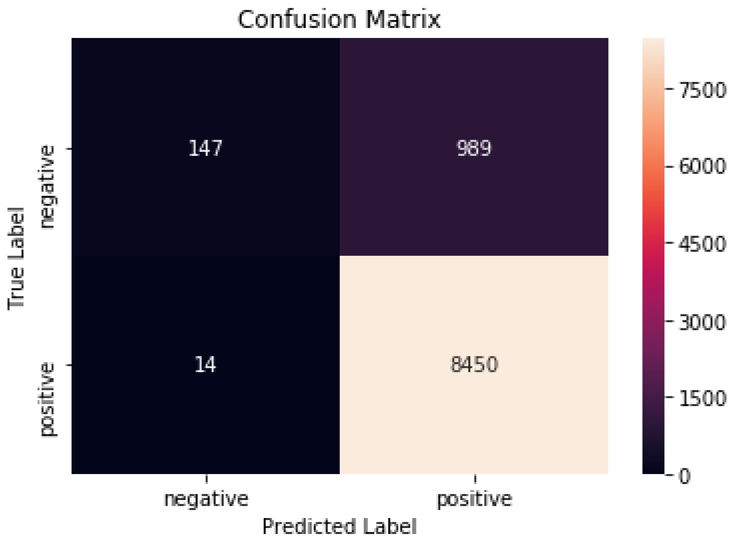
In [119]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_test_tfidf = confusion_matrix(y_test, test_pred_tfidf)
cm_test_tfidf
```

Out[119]:
```
array([[  174,  1310],
       [   16, 10500]], dtype=int64)
```

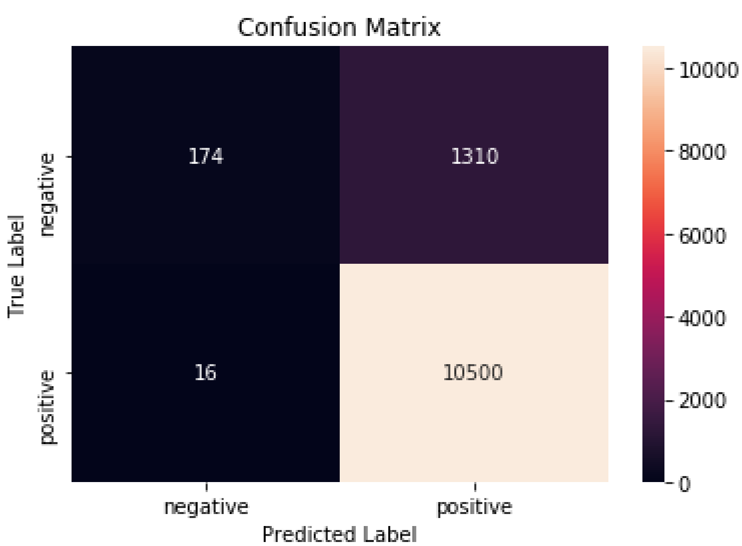
In [120]:
```
# plot confusion matrix to describe the performance of classifier for Train Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_train_tfidf, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [121]:
```
# plot confusion matrix to describe the performance of classifier for CV Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_cv_tfidf, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



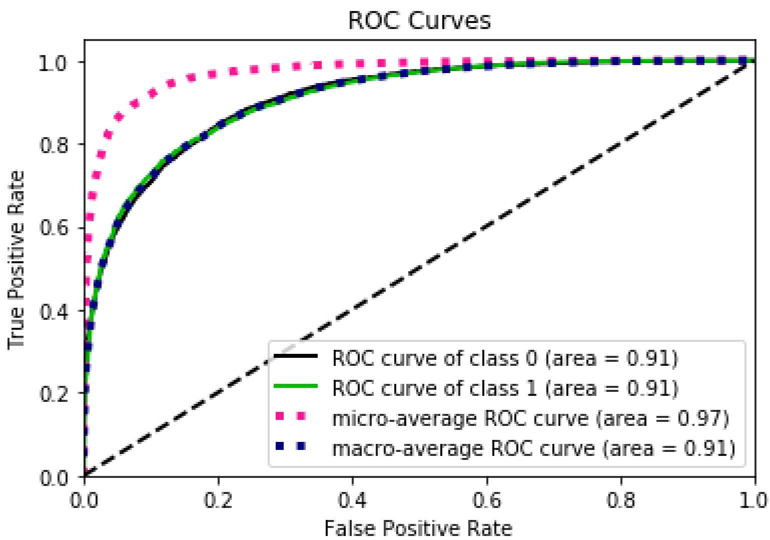
In [122]:
```
# plot confusion matrix to describe the performance of classifier for Test Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_test_tfidf, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [123]:
```
y_pred_train_proba_tfidf = xgb_model_tfidf.predict_proba(train_tfidf)
y_pred_cv_proba_tfidf = xgb_model_tfidf.predict_proba(cv_tfidf)
y_pred_test_proba_tfidf = xgb_model_tfidf.predict_proba(test_tfidf)
```

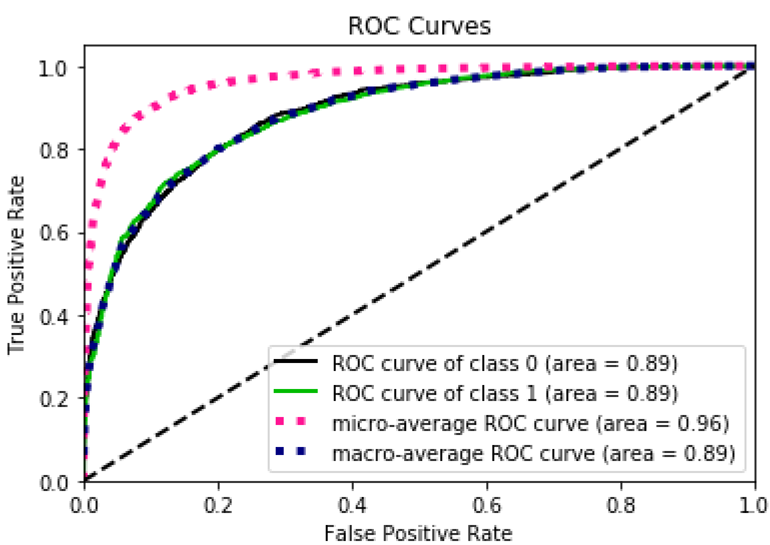
In [124]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_proba_tfidf)
```

Out[124]: <matplotlib.axes._subplots.AxesSubplot at 0x2b50860b4a8>



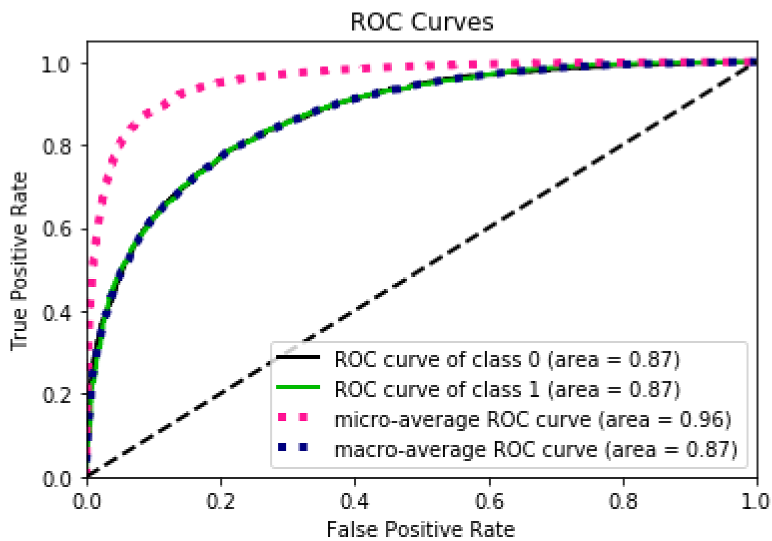
In [125]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_proba_tfidf)
```

Out[125]: <matplotlib.axes._subplots.AxesSubplot at 0x2b5087e4080>



In [126]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_proba_tfidf)
```

Out[126]: <matplotlib.axes._subplots.AxesSubplot at 0x2b50884b3c8>



Applying GBDT using XGBOOST on avgW2V

In [127]:
```
xgb_model_avgw2v = xgb.XGBClassifier()
xgb_model_avgw2v.fit(train_avgw2v,y_train)
xgb_model_avgw2v
```

Out[127]:
```
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=100,
       n_jobs=1, nthread=None, objective='binary:logistic', random_state=0,
       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
       silent=True, subsample=1)
```

In [130]:
```
train_results_avgw2v = []
cv_results_avgw2v = []
test_results_avgw2v = []

train_pred_avgw2v = xgb_model_avgw2v.predict(train_avgw2v)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, trai
roc_auc_train_avgw2v = auc(false_positive_rate, true_positive_rate)
train_results_avgw2v.append(roc_auc_train_avgw2v)

cv_pred_avgw2v = xgb_model_avgw2v.predict(cv_avgw2v)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_cv, cv_pred_
roc_auc_cv_avgw2v = auc(false_positive_rate, true_positive_rate)
cv_results_avgw2v.append(roc_auc_cv_avgw2v)


test_pred_avgw2v = xgb_model_avgw2v.predict(test_avgw2v)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, test_pre
roc_auc_test_avgw2v = auc(false_positive_rate, true_positive_rate)
test_results_avgw2v.append(roc_auc_test_avgw2v)
```

In [131]:
```
print(train_results_avgw2v)
print(cv_results_avgw2v)
print(test_results_avgw2v)
```

```
[0.6472502064265699]
[0.6277772970526372]
[0.6044302661891673]
```

In [132]:
```
# Confusion Matrix on Train Data
#y_pred = np.argmax(pred_test, axis=1)
cm_train_avgw2v = confusion_matrix(y_train, train_pred_avgw2v)
cm_train_avgw2v
```

Out[132]:
```
array([[ 1288,  2945],
       [  334, 33833]], dtype=int64)
```

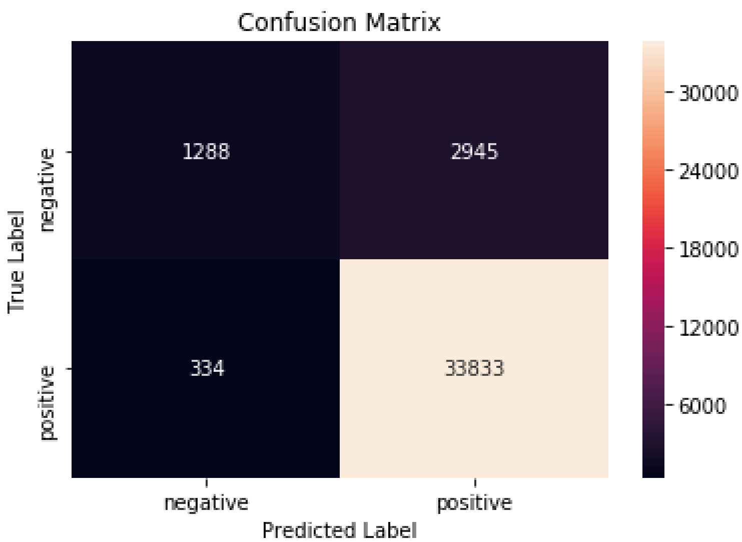
In [133]:
```
# Confusion Matrix on CV Data
#y_pred = np.argmax(pred_test, axis=1)
cm_cv_avgw2v = confusion_matrix(y_cv, cv_pred_avgw2v)
cm_cv_avgw2v
```

Out[133]:
```
array([[ 304,  832],
       [ 102, 8362]], dtype=int64)
```

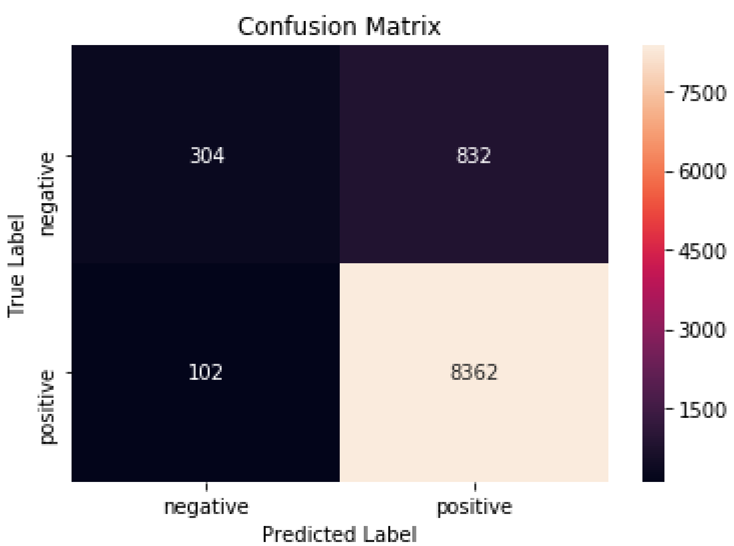
In [134]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_test_avgw2v = confusion_matrix(y_test, test_pred_avgw2v)
cm_test_avgw2v
```

Out[134]:
```
array([[  329,  1155],
       [  135, 10381]], dtype=int64)
```

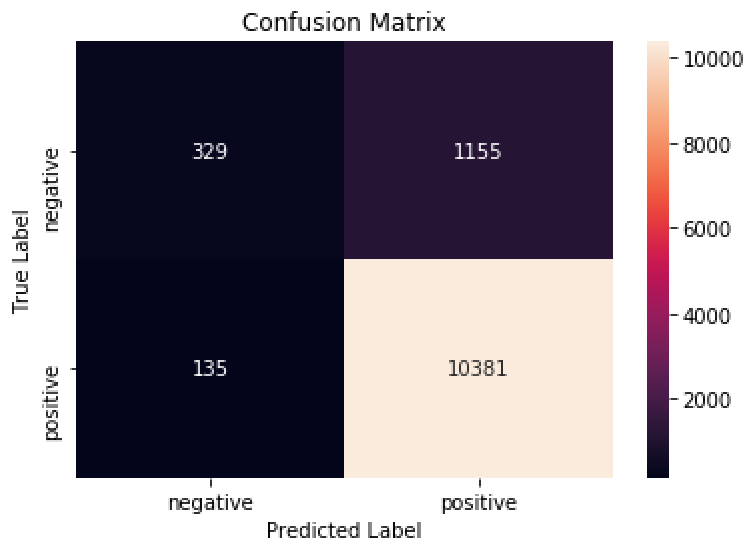
In [135]:
```
# plot confusion matrix to describe the performance of classifier for Train Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_train_avgw2v, index = class_label, columns = class_label
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [136]:
```
# plot confusion matrix to describe the performance of classifier for CV Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_cv_avgw2v, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



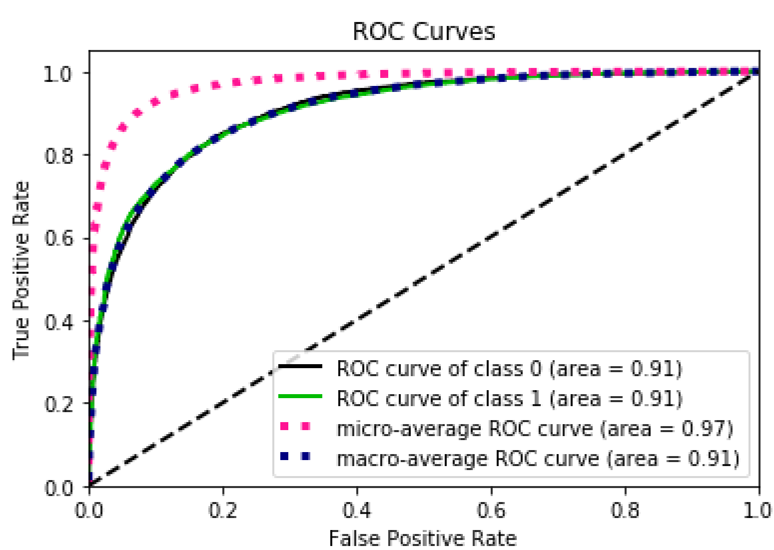
In [137]:
```
# plot confusion matrix to describe the performance of classifier for Test Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_test_avgw2v, index = class_label, columns = class_label)
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [138]:
```
y_pred_train_proba_avgw2v = xgb_model_avgw2v.predict_proba(train_avgw2v)
y_pred_cv_proba_avgw2v = xgb_model_avgw2v.predict_proba(cv_avgw2v)
y_pred_test_proba_avgw2v = xgb_model_avgw2v.predict_proba(test_avgw2v)
```

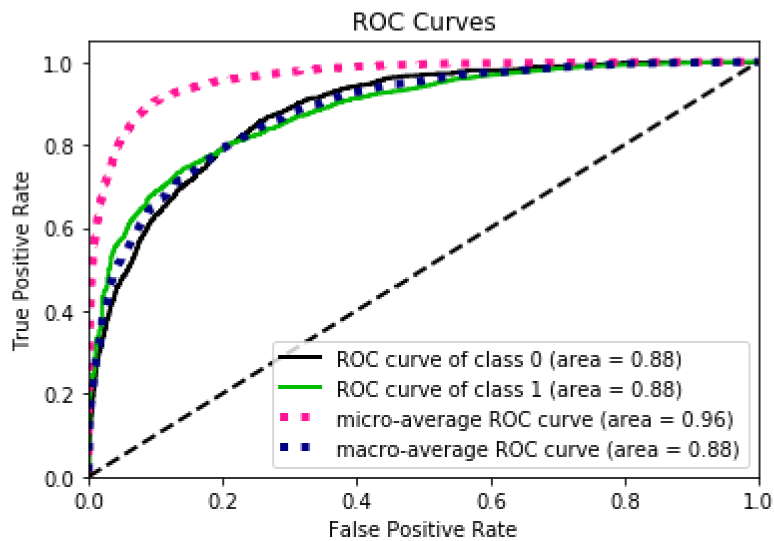
In [139]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_proba_avgw2v)
```

Out[139]: <matplotlib.axes._subplots.AxesSubplot at 0x2b5088dd9e8>



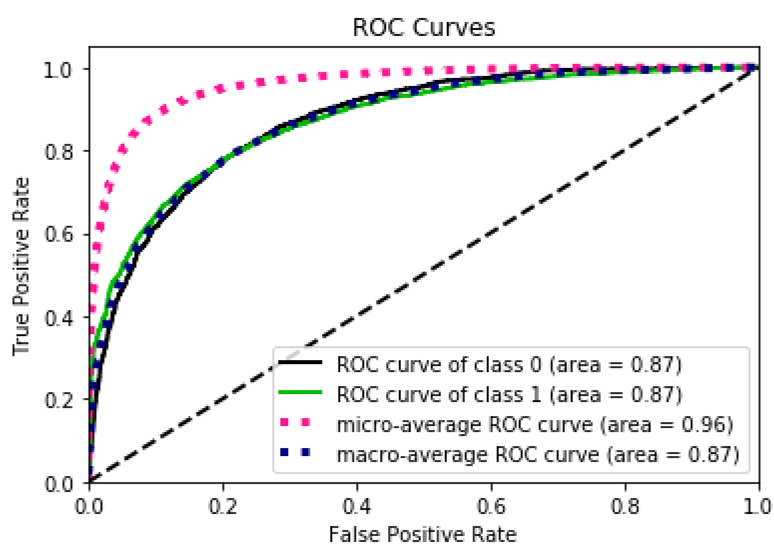
In [140]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_proba_avgw2v)
```

Out[140]: <matplotlib.axes._subplots.AxesSubplot at 0x2b529f7c978>



In [141]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_proba_avgw2v)
```

Out[141]: <matplotlib.axes._subplots.AxesSubplot at 0x2b52a7f2fd0>



Applying GBDT using XGBOOST on tfidf-W-W2V

In [142]:
```
xgb_model_tfidfww2v = xgb.XGBClassifier()
xgb_model_tfidfww2v.fit(train_tfidfww2v,y_train)
xgb_model_tfidfww2v
```

Out[142]:
```
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=100,
       n_jobs=1, nthread=None, objective='binary:logistic', random_state=0,
       reg_alpha=0, reg_lambda=1, scale_pos_weight=1, seed=None,
       silent=True, subsample=1)
```

In [143]:
```
train_results_tfidfww2v = []
cv_results_tfidfww2v = []
test_results_tfidfww2v = []

train_pred_tfidfww2v = xgb_model_tfidfww2v.predict(train_tfidfww2v)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_train, trai
roc_auc_train_tfidfww2v = auc(false_positive_rate, true_positive_rate)
train_results_tfidfww2v.append(roc_auc_train_tfidfww2v)

cv_pred_tfidfww2v = xgb_model_tfidfww2v.predict(cv_tfidfww2v)

false_positive_rate, true_positive_rate, thresholds =    roc_curve(y_cv, cv_pred_
roc_auc_cv_tfidfww2v = auc(false_positive_rate, true_positive_rate)
cv_results_tfidfww2v.append(roc_auc_cv_tfidfww2v)


test_pred_tfidfww2v = xgb_model_tfidfww2v.predict(test_tfidfww2v)

false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test, test_pred
roc_auc_test_tfidfww2v = auc(false_positive_rate, true_positive_rate)
test_results_tfidfww2v.append(roc_auc_test_tfidfww2v)
```

In [144]:
```
print(train_results_tfidfww2v)
print(cv_results_tfidfww2v)
print(test_results_tfidfww2v)
```

```
[0.6472502064265699]
[0.6277772970526372]
[0.6044302661891673]
```

In [145]:
```
# Confusion Matrix on Train Data
#y_pred = np.argmax(pred_test, axis=1)
cm_train_tfidfww2v = confusion_matrix(y_train, train_pred_tfidfww2v)
cm_train_tfidfww2v
```

Out[145]:
```
array([[ 1288,  2945],
       [  334, 33833]], dtype=int64)
```

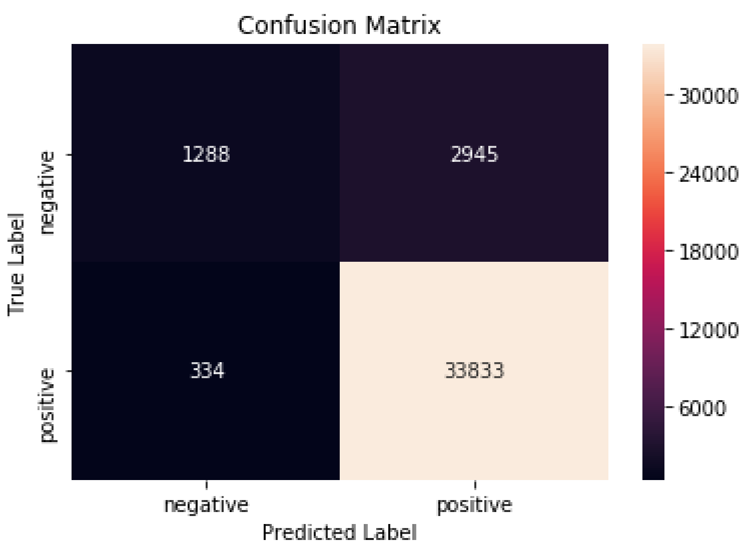
In [146]:
```
# Confusion Matrix on CV Data
#y_pred = np.argmax(pred_test, axis=1)
cm_cv_tfidfww2v = confusion_matrix(y_cv, cv_pred_tfidfww2v)
cm_cv_tfidfww2v
```

Out[146]:
```
array([[ 304,  832],
       [ 102, 8362]], dtype=int64)
```

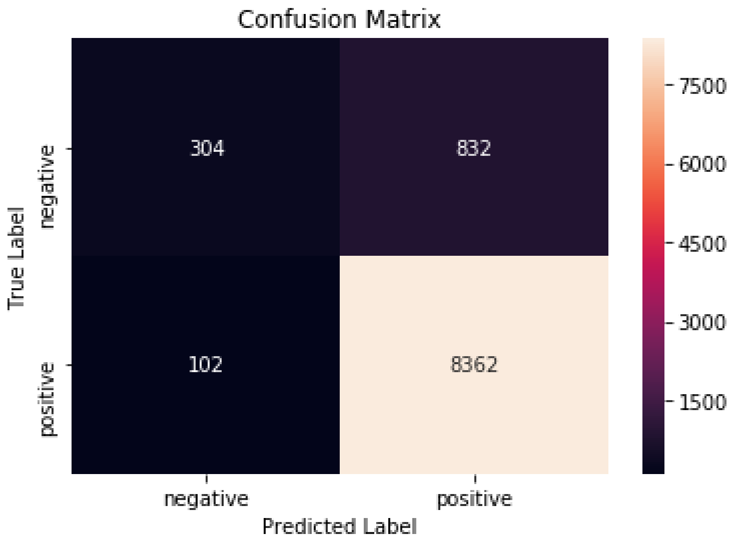
In [147]:
```
# Confusion Matrix on Test Data
#y_pred = np.argmax(pred_test, axis=1)
cm_test_tfidfww2v = confusion_matrix(y_test, test_pred_tfidfww2v)
cm_test_tfidfww2v
```

Out[147]:
```
array([[  329,  1155],
       [  135, 10381]], dtype=int64)
```

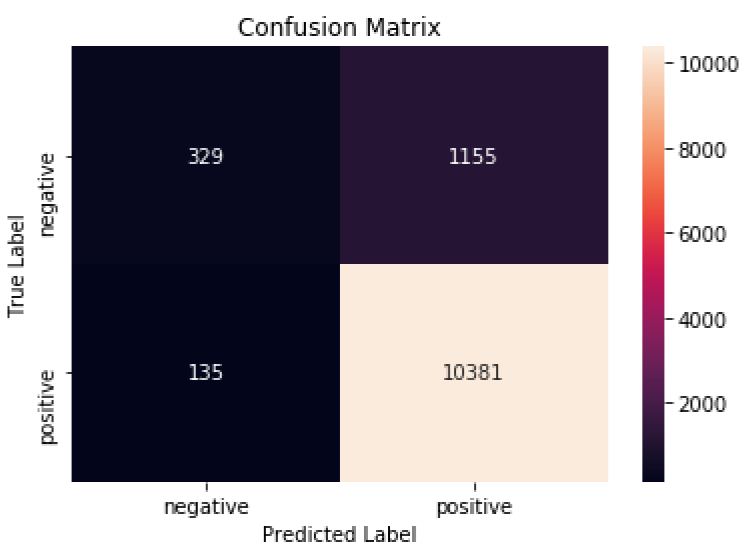
In [148]:
```
# plot confusion matrix to describe the performance of classifier for Train Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_train_tfidfww2v, index = class_label, columns = class_lal
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [149]:
```
# plot confusion matrix to describe the performance of classifier for CV Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_cv_tfidfww2v, index = class_label, columns = class_label
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



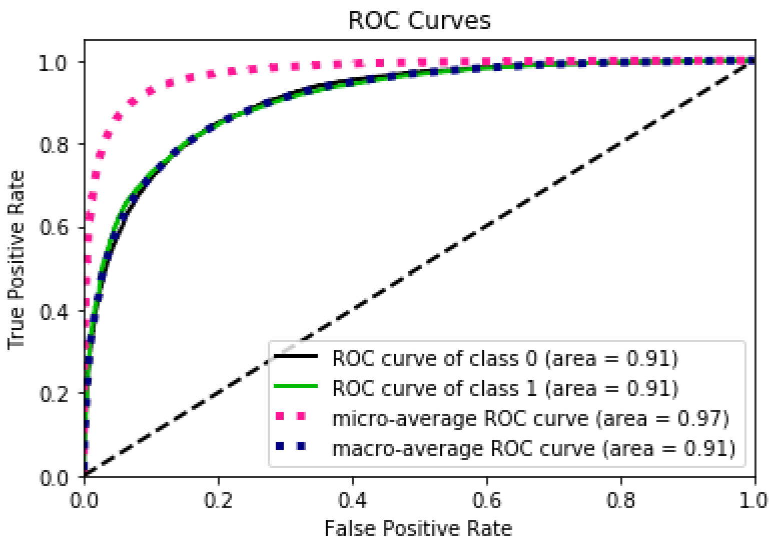
In [150]:
```
# plot confusion matrix to describe the performance of classifier for Test Data
import seaborn as sns
class_label = ["negative", "positive"]
df_cm = pd.DataFrame(cm_test_tfidfww2v, index = class_label, columns = class_labe
sns.heatmap(df_cm, annot = True, fmt = "d")
plt.title("Confusion Matrix")
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.show()
```



In [151]:
```
y_pred_train_proba_tfidfww2v = xgb_model_tfidfww2v.predict_proba(train_tfidfww2v
y_pred_cv_proba_tfidfww2v = xgb_model_tfidfww2v.predict_proba(cv_tfidfww2v)
y_pred_test_proba_tfidfww2v = xgb_model_tfidfww2v.predict_proba(test_tfidfww2v)
```

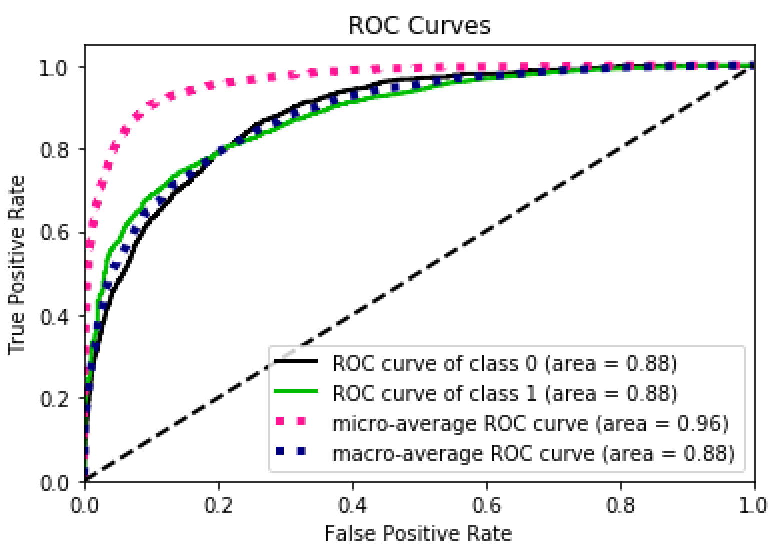
In [152]:
```
#Plotting ROC curve over Train Data
skplt.metrics.plot_roc_curve(y_train,y_pred_train_proba_tfidfww2v)
```

Out[152]: <matplotlib.axes._subplots.AxesSubplot at 0x2b52a7e54e0>



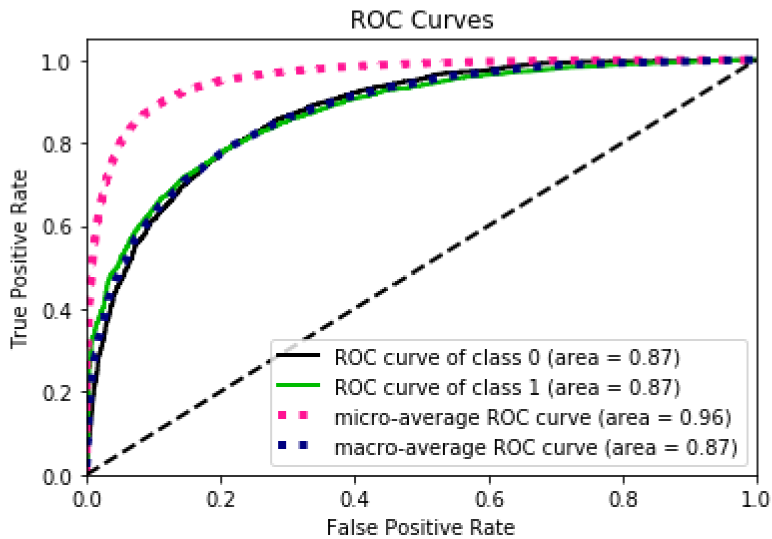
In [153]:
```
#Plotting ROC curve over CV Data
skplt.metrics.plot_roc_curve(y_cv,y_pred_cv_proba_tfidfww2v)
```

Out[153]: <matplotlib.axes._subplots.AxesSubplot at 0x2b508269cf8>



In [154]:
```
#Plotting ROC curve over Test Data
skplt.metrics.plot_roc_curve(y_test,y_pred_test_proba_tfidfww2v)
```

Out[154]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2b50813fb70>
```



In [ ]:

In [ ]: