Ensemble Model

In [1]:

```
import sqlite3
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import scikitplot as skplt
from sklearn import cross_validation
from sklearn.metrics import confusion_matrix
from sklearn.grid_search import GridSearchCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.ensemble import GradientBoostingClassifier
```

```
C:\Users\Friend\Anaconda3\lib\site-packages\sklearn\cross_validation.py:41: DeprecationWarning: This mo
dule was deprecated in version 0.18 in favor of the model_selection module into which all the refactore
d classes and functions are moved. Also note that the interface of the new CV iterators are different f
rom that of this module. This module will be removed in 0.20.
  "This module will be removed in 0.20.", DeprecationWarning)
C:\Users\Friend\Anaconda3\lib\site-packages\sklearn\grid_search.py:42: DeprecationWarning: This module
was deprecated in version 0.18 in favor of the model_selection module into which all the refactored cla
sses and functions are moved. This module will be removed in 0.20.
  DeprecationWarning)
```

Load and Sample data

In [3]:

```
#Data here used is preprocessed(deduplication,removal of html tags,punctuation,stop words,stemming)
con =sqlite3.connect(r'C:\Users\Friend\AI\AI_datasets\Amazon\cleaned_database.sqlite')
filtered_data  = pd.read_sql_query('SELECT * FROM Reviews WHERE Score != 3',con)
filtered_data = filtered_data.drop('index',axis = 1)
filtered_data['Score'] = filtered_data['Score'].map(lambda x: 1 if x == 'positive' else 0)
filtered_data = filtered_data.sort_values('Time')
```

In [4]:

```
data = filtered_data.head(100000)
data.columns
```

Out[4]:

```
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text',
       'CleanedText'],
      dtype='object')
```

In [5]:

```
X_train, X_test, y_train, y_test = cross_validation.train_test_split(data['CleanedText'], data['Score']
, test_size=0.3, random_state=0)
print(X_train.shape,y_train.shape,X_test.shape,y_test.shape)
```

```
(70000,) (70000,) (30000,) (30000,)
```

Featurization

- BOW

In [6]:

```
# Performing BOW on review
from sklearn.feature_extraction.text import CountVectorizer
count_vect = CountVectorizer()
vocabulary = count_vect.fit(X_train)
```

In [7]:

```
bag_of_words_train = count_vect.transform(X_train)
print(bag_of_words_train.shape)
```

```
(70000, 31572)
```

In [8]:

```
bag_of_words_test = count_vect.transform(X_test)
print(bag_of_words_test.shape)
```

```
(30000, 31572)
```

- tfidf

In [41]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
tf_idf_vect = TfidfVectorizer(ngram_range=(1,2))
vocabulary = tf_idf_vect.fit(X_train)
```

In [42]:

```
tf_idf_train = tf_idf_vect.transform(X_train)
print(tf_idf_train.shape)
```

```
(70000, 932590)
```

In [43]:

```
tf_idf_test = tf_idf_vect.transform(X_test)
print(tf_idf_test.shape)
```

```
(30000, 932590)
```

- avgword2vec

In [49]:

```
from gensim.models import Word2Vec

list_of_sent=[]
for sent in X_train:
    list_of_sent.append(sent.split())

#word2vec
w2v_model=Word2Vec(list_of_sent,min_count=5,size=50, workers=4)
w2v_words = list(w2v_model.wv.vocab)

#Average word2vec
sent_vectors_train = [];
for sent in list_of_sent:
    sent_vec = np.zeros(50)
    cnt_words =0;
    for word in sent:
        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_train.append(sent_vec)
```

```
C:\Users\Friend\Anaconda3\lib\site-packages\gensim\utils.py:1209: UserWarning: detected Windows; aliasi
ng chunkize to chunkize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_serial")
```

In [54]:

```
from gensim.models import Word2Vec

i=0
list_of_sent=[]
for sent in X_test:
    list_of_sent.append(sent.split())

#Average word2vec
sent_vectors_test = [];
for sent in list_of_sent:
    sent_vec = np.zeros(50)
    cnt_words =0;
    for word in sent:
        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_test.append(sent_vec)
```

- tfidf weighted word2vec

In [57]:

```
cons = sqlite3.connect(r'C:\Users\Friend\AI\AI_datasets\Amazon\featurizations.sqlite')
cursor = cons.cursor()
cursor.execute("SELECT name FROM sqlite_master WHERE type='table';")
print(cursor.fetchall())
```

```
[('Reviews',), ('check',), ('df',), ('tfidfword2vec_train',), ('tf_idf_test',)]
```

In [58]:

```
cons =sqlite3.connect(r'C:\Users\Friend\AI\AI_datasets\Amazon\featurizations.sqlite')
tfidf_sent_vectors_train  = pd.read_sql_query('SELECT * FROM tfidfword2vec_train',cons)
tfidf_sent_vectors_train = tfidf_sent_vectors_train.drop('index',axis = 1)
tfidf_sent_vectors_train.shape
```

Out[58]:

```
(70000, 50)
```

In [59]:

```
cons =sqlite3.connect(r'C:\Users\Friend\AI\AI_datasets\Amazon\featurizations.sqlite')
tfidf_sent_vectors_test  = pd.read_sql_query('SELECT * FROM tf_idf_test',cons)
tfidf_sent_vectors_test = tfidf_sent_vectors_test.drop('index',axis = 1)
tfidf_sent_vectors_test.shape
```

Out[59]:

```
(30000, 50)
```

Random Forest

In [14]:

```
grid_hyperparameter = [{'n_estimators'  : [100, 200, 500, 1000, 2000],'max_depth':[5,10]}]
grid_hyperparameter
```

Out[14]:

```
[{'n_estimators': [100, 200, 500, 1000, 2000], 'max_depth': [5, 10]}]
```

- BOW

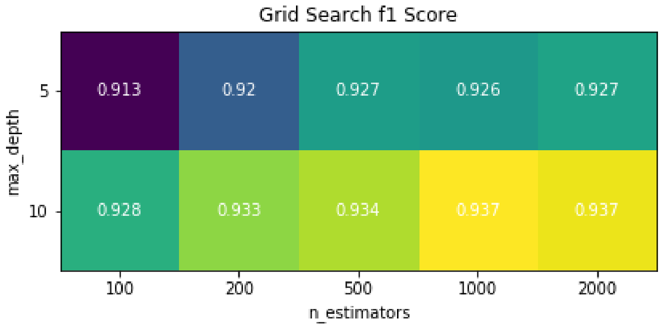
In [13]:

```
clf = GridSearchCV(RandomForestClassifier(class_weight = 'balanced',criterion='gini'), grid_hyperparame
ter, scoring = 'f1', cv=2)
clf.fit(bag_of_words_train, y_train)

clf_n = clf.best_estimator_.get_params()['n_estimators']
clf_depth = clf.best_estimator_.get_params()['max_depth']

print(clf_n)
print(clf_depth)
```

```
1000
10
```

In [25]:

```
n_estimators = grid_hyperparameter[0]['n_estimators']
max_depth = grid_hyperparameter[0]['max_depth']
df = pd.DataFrame(clf.grid_scores_)
scores = np.array(df['mean_validation_score']).reshape(2,5)
fig, ax = plt.subplots()
plt.imshow(scores, interpolation='nearest')
plt.colorbar()
for i in range(len(max_depth)):
    for j in range(len(n_estimators)):
        text = ax.text(j, i, np.round(scores[i, j],3),
                       ha="center", va="center", color="w")
ax.set_xticks(np.arange(len(n_estimators)))
ax.set_yticks(np.arange(len(max_depth)))
ax.set_xticklabels(n_estimators)
ax.set_yticklabels(max_depth)
plt.xlabel('n_estimators')
plt.ylabel('max_depth')
ax.set_title("Grid Search f1 Score")
fig.tight_layout()
plt.show()
```



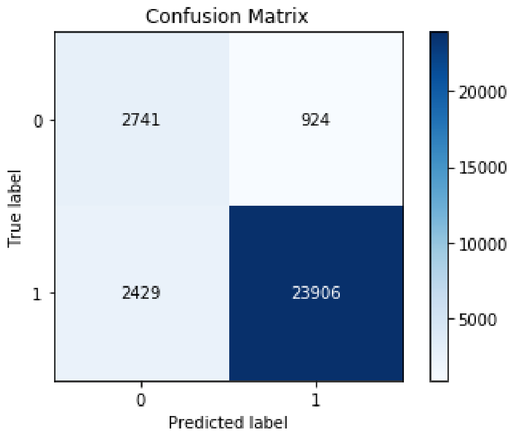
In [28]:

```
clf = RandomForestClassifier(class_weight = 'balanced',n_estimators=1000, criterion='gini', max_depth=1
0, random_state=42, n_jobs=-1)
clf.fit(bag_of_words_train, y_train)

pred = clf.predict(bag_of_words_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```

Out[28]:

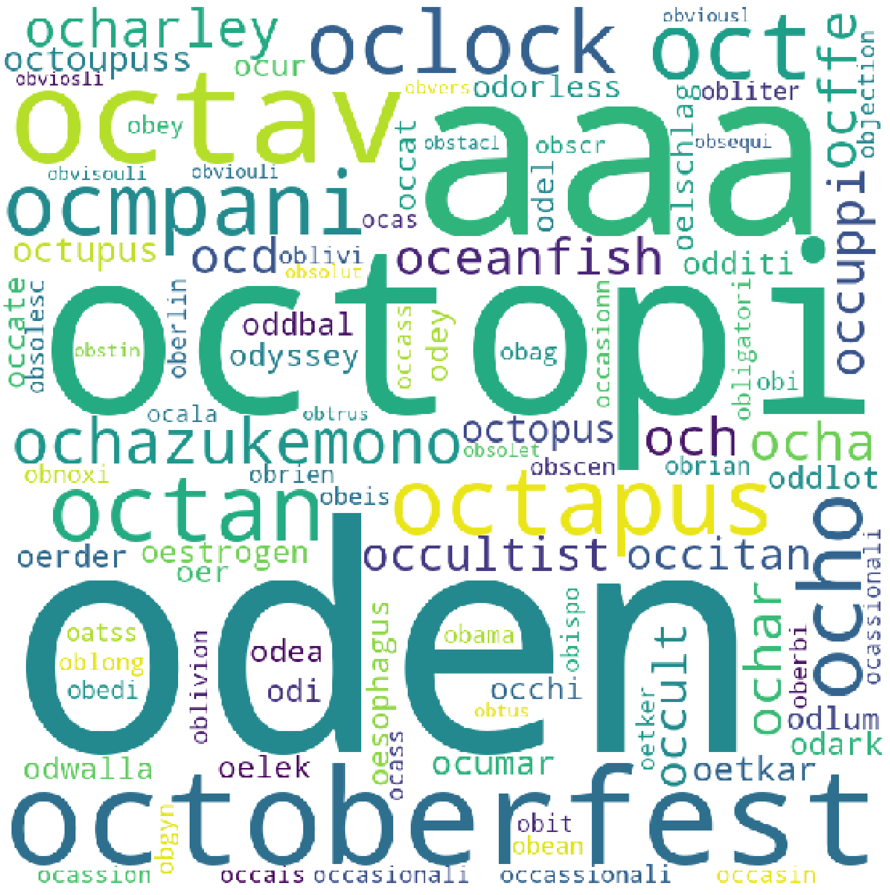
Out[26]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1c8e2a0f6a0>
```



In [40]:

```
indices = np.argsort(clf.feature_importances_)

indices = np.argsort(clf.feature_importances_)
feature_importance = [np.take(count_vect.get_feature_names(),index)  for index in indices[0:100]]

from wordcloud import WordCloud

featurez=(" ").join(feature_importance)
wordcloud = WordCloud(width = 800, height = 800,background_color ='white',min_font_size = 10).generate(
featurez)
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



- tfidf

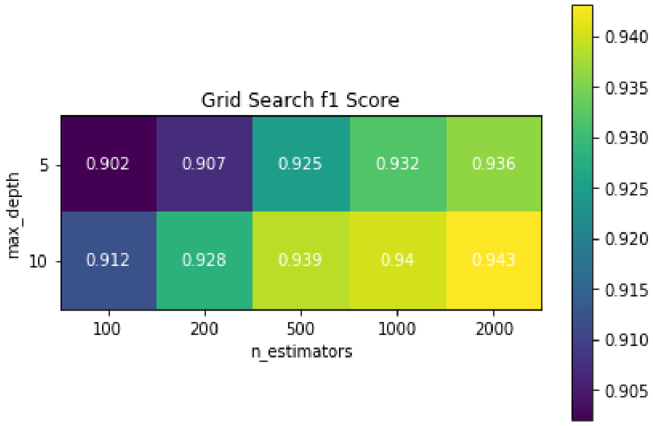
In [45]:

```
clf = GridSearchCV(RandomForestClassifier(class_weight = 'balanced',criterion='gini'), grid_hyperparame
ter, scoring = 'f1', cv=2)
clf.fit(tf_idf_train, y_train)

clf_n = clf.best_estimator_.get_params()['n_estimators']
clf_depth = clf.best_estimator_.get_params()['max_depth']

print(clf_n)
print(clf_depth)
```

```
2000
10
```

In [46]:

```
n_estimators = grid_hyperparameter[0]['n_estimators']
max_depth = grid_hyperparameter[0]['max_depth']
df = pd.DataFrame(clf.grid_scores_)
scores = np.array(df['mean_validation_score']).reshape(2,5)
fig, ax = plt.subplots()
plt.imshow(scores, interpolation='nearest')
plt.colorbar()
for i in range(len(max_depth)):
    for j in range(len(n_estimators)):
        text = ax.text(j, i, np.round(scores[i, j],3),
                       ha="center", va="center", color="w")
ax.set_xticks(np.arange(len(n_estimators)))
ax.set_yticks(np.arange(len(max_depth)))
ax.set_xticklabels(n_estimators)
ax.set_yticklabels(max_depth)
plt.xlabel('n_estimators')
plt.ylabel('max_depth')
ax.set_title("Grid Search f1 Score")
fig.tight_layout()
plt.show()
```

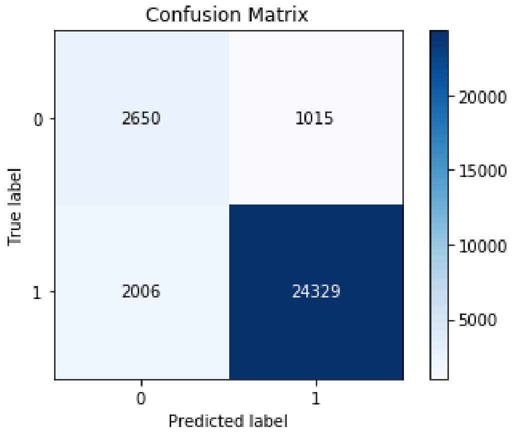


In [47]:

```
clf = RandomForestClassifier(class_weight = 'balanced',n_estimators=clf_n, criterion='gini', max_depth=
clf_depth, random_state=42, n_jobs=-1)
clf.fit(tf_idf_train, y_train)

pred = clf.predict(tf_idf_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```

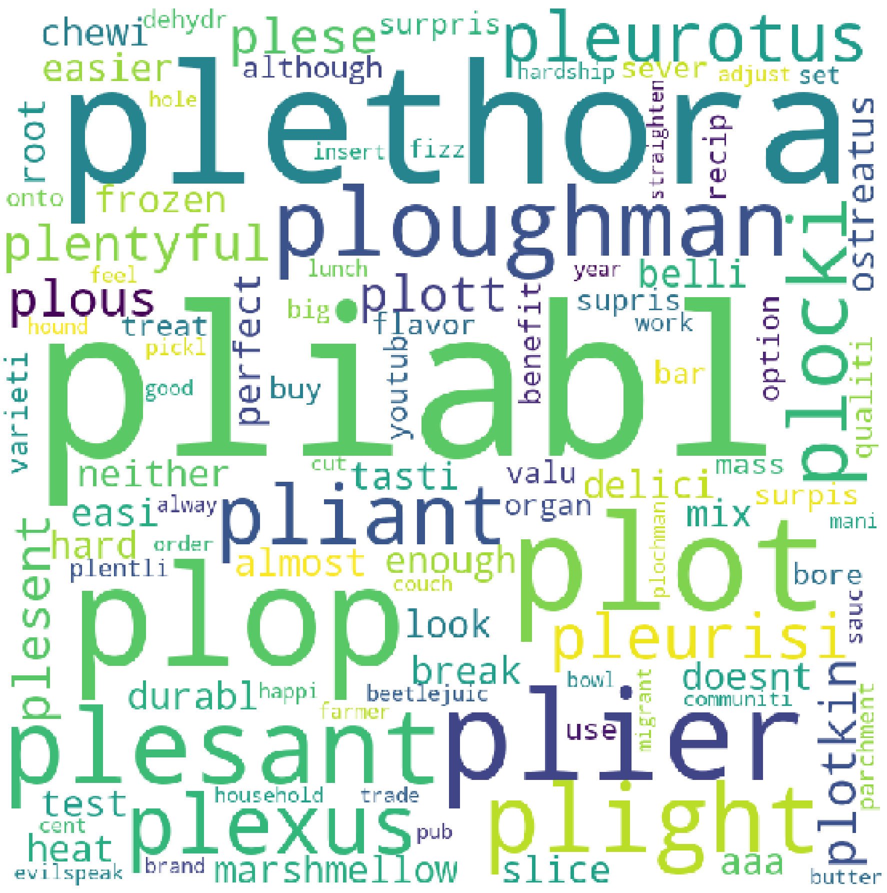
Out[47]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1c8e2d116a0>
```



In [50]:

```
indices = np.argsort(clf.feature_importances_)

indices = np.argsort(clf.feature_importances_)
feature_importance = [np.take(tf_idf_vect.get_feature_names(),index)  for index in indices[0:100]]

from wordcloud import WordCloud

featurez=(" ").join(feature_importance)
wordcloud = WordCloud(width = 800, height = 800,background_color ='white',min_font_size = 10).generate(
featurez)
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



- avgword2vec

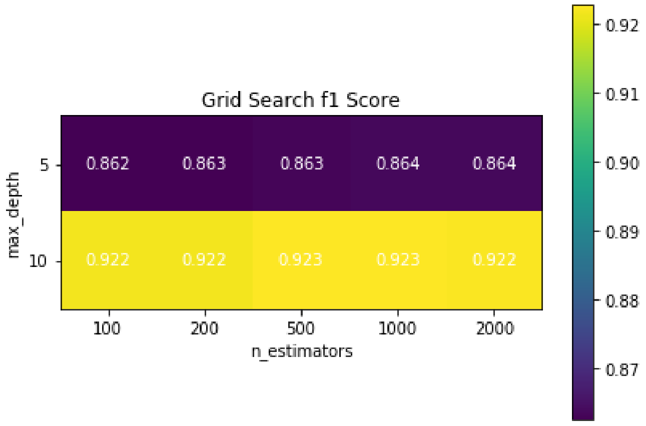
In [51]:

```
clf = GridSearchCV(RandomForestClassifier(class_weight = 'balanced'), grid_hyperparameter, scoring = 'f
1', cv=2)
clf.fit(sent_vectors_train, y_train)


clf_n = clf.best_estimator_.get_params()['n_estimators']
clf_depth = clf.best_estimator_.get_params()['max_depth']

print(clf_n)
print(clf_depth)
```

```
500
10
```

In [52]:

```
n_estimators = grid_hyperparameter[0]['n_estimators']
max_depth = grid_hyperparameter[0]['max_depth']
df = pd.DataFrame(clf.grid_scores_)
scores = np.array(df['mean_validation_score']).reshape(2,5)
fig, ax = plt.subplots()
plt.imshow(scores, interpolation='nearest')
plt.colorbar()
for i in range(len(max_depth)):
    for j in range(len(n_estimators)):
        text = ax.text(j, i, np.round(scores[i, j],3),
                       ha="center", va="center", color="w")
ax.set_xticks(np.arange(len(n_estimators)))
ax.set_yticks(np.arange(len(max_depth)))
ax.set_xticklabels(n_estimators)
ax.set_yticklabels(max_depth)
plt.xlabel('n_estimators')
plt.ylabel('max_depth')
ax.set_title("Grid Search f1 Score")
fig.tight_layout()
plt.show()
```

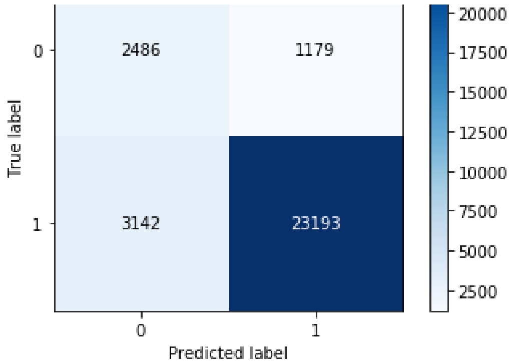


In [56]:

```
clf = RandomForestClassifier(class_weight = 'balanced',n_estimators=clf_n, criterion='gini', max_depth=
clf_depth, random_state=42, n_jobs=-1)
clf.fit(sent_vectors_train, y_train)

pred = clf.predict(sent_vectors_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```

Out[56]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1c8e7b56908>
```



- tfidf weighted word2vec

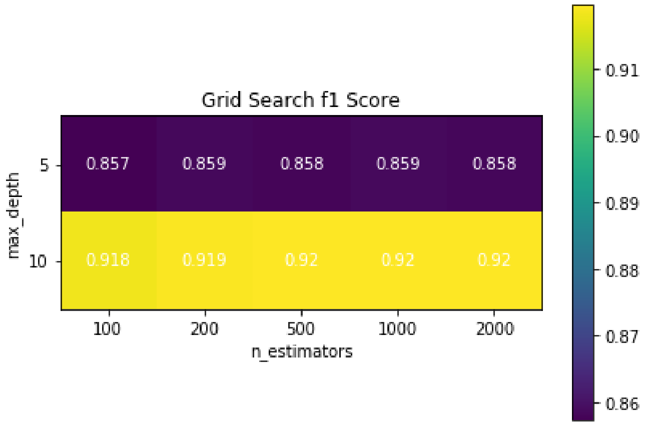
In [60]:

```
#train model
clf = GridSearchCV(RandomForestClassifier(class_weight = 'balanced'), grid_hyperparameter, scoring = 'f
1', cv=2)
clf.fit(tfidf_sent_vectors_train, y_train)

clf_n = clf.best_estimator_.get_params()['n_estimators']
clf_depth = clf.best_estimator_.get_params()['max_depth']

print(clf_n)
print(clf_depth)
```

```
1000
10
```

In [61]:

```
n_estimators = grid_hyperparameter[0]['n_estimators']
max_depth = grid_hyperparameter[0]['max_depth']
df = pd.DataFrame(clf.grid_scores_)
scores = np.array(df['mean_validation_score']).reshape(2,5)
fig, ax = plt.subplots()
plt.imshow(scores, interpolation='nearest')
plt.colorbar()
for i in range(len(max_depth)):
    for j in range(len(n_estimators)):
        text = ax.text(j, i, np.round(scores[i, j],3),
                       ha="center", va="center", color="w")
ax.set_xticks(np.arange(len(n_estimators)))
ax.set_yticks(np.arange(len(max_depth)))
ax.set_xticklabels(n_estimators)
ax.set_yticklabels(max_depth)
plt.xlabel('n_estimators')
plt.ylabel('max_depth')
ax.set_title("Grid Search f1 Score")
fig.tight_layout()
plt.show()
```

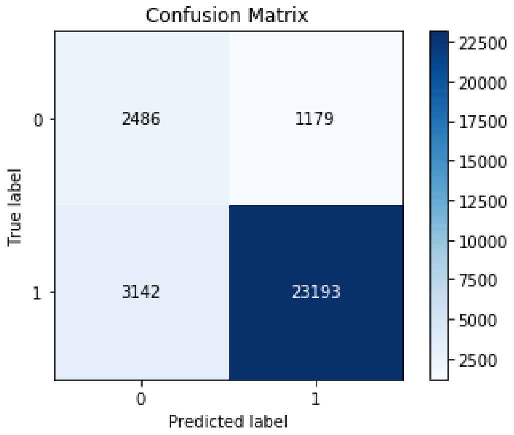


In [56]:

```
clf = RandomForestClassifier(class_weight = 'balanced',n_estimators=clf_n, criterion='gini', max_depth=
clf_depth, random_state=42, n_jobs=-1)
clf.fit(tfidf_sent_vectors_train, y_train)

pred = clf.predict(sent_vectors_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```

Out[56]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1c8e7b56908>
```



Light Gradient Boosting decision tree

In [9]:

```
grid_parameter = [{'num_leaves': [20,40,60,80],'min_data_in_leaf': [30, 50, 100, 300, 400],'max_depth':
[4,6,8,10,12]}]
grid_parameter
```

Out[9]:

```
[{'num_leaves': [20, 40, 60, 80],
  'min_data_in_leaf': [30, 50, 100, 300, 400],
  'max_depth': [4, 6, 8, 10, 12]}]
```

In [ ]:

```
clf_boost = GridSearchCV(lgb.LGBMClassifier(),grid_parameter, cv=3)
clf_boost.fit(sent_vectors_train, y_train)
```

In [13]:

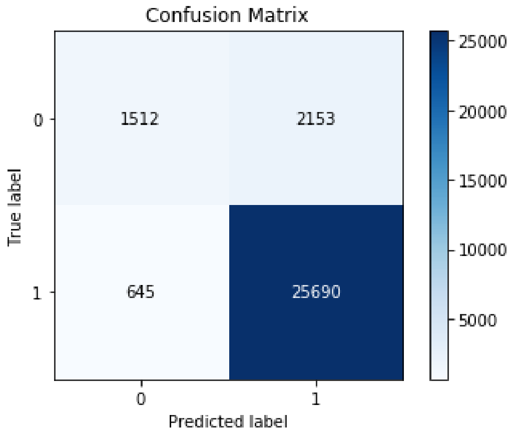
```
#f1 score
clf_boost_f1_train = clf_boost.score(sent_vectors_train, y_train)
clf_boost_f1_test = clf_boost.score(sent_vectors_test, y_test)

#predict values
pred = clf_boost.predict(sent_vectors_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```

```
C:\Users\Friend\Anaconda3\lib\site-packages\sklearn\preprocessing\label.py:151: DeprecationWarning: The
truth value of an empty array is ambiguous. Returning False, but in future this will result in an error
. Use `array.size > 0` to check that an array is not empty.
  if diff:
C:\Users\Friend\Anaconda3\lib\site-packages\sklearn\preprocessing\label.py:151: DeprecationWarning: The
truth value of an empty array is ambiguous. Returning False, but in future this will result in an error
. Use `array.size > 0` to check that an array is not empty.
  if diff:
C:\Users\Friend\Anaconda3\lib\site-packages\sklearn\preprocessing\label.py:151: DeprecationWarning: The
truth value of an empty array is ambiguous. Returning False, but in future this will result in an error
```

```
. Use `array.size > 0` to check that an array is not empty.
  if diff:
```

Out[13]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x147d3ea4908>
```



In [11]:

```
clf_boost_n = clf_boost.best_estimator_.get_params()['num_leaves']
clf_boost_l = clf_boost.best_estimator_.get_params()['min_data_in_leaf']
clf_boost_d = clf_boost.best_estimator_.get_params()['max_depth']
```

In [12]:

```
print(clf_boost_n)
print(clf_boost_l)
print(clf_boost_d)
```

```
80
300
12
```

In [14]:

```
print(clf_boost_f1_train)
print(clf_boost_f1_test)
```

```
0.9432428571428572
0.9067333333333333
```