Logistic Regression on Amazon Reviews

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.grid_search import GridSearchCV
from sklearn.grid_search import RandomizedSearchCV
from sklearn.linear_model import LogisticRegression
from scipy.sparse import csr_matrix
```

```
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 [2]:

```
#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 [3]:

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

Out[3]:

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

In [4]:

```
from sklearn import cross_validation

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,)
```

Converting words to vectors(BOW,TFIDF,Average Word2Vec,TFIDF Weighted Word2Vec)

- 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 [5]:

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

In [6]:

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

```
(70000, 932590)
```

In [7]:

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

```
(30000, 932590)
```

- Average Word2Vec

In [18]:

```
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]
            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 [19]:

```
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)
```

- Tf_Idf Weighted word2Vector

In [22]:

```
from gensim.models import Word2Vec

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

#get tf_idf feature names
tfidf_feat = tf_idf_vect.get_feature_names()

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

#tfidf wieghted vector
tfidf_sent_vectors_train = [];
row=0;
for sent in list_of_sent:
    sent_vec = np.zeros(50)
    weight_sum =0;
    for word in sent:
        if word in w2v_words:
            vec = w2v_model.wv[word]
            tf_idf = tf_idf_train[row, tfidf_feat.index(word)]
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
        else:
            continue
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors_train.append(sent_vec)
    row += 1
```

In [ ]:

In [ ]:

```
import gensim

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

#get tf_idf
tfidf_feat = tf_idf_vect.get_feature_names()
tfidf_sent_vectors_test = [];

#tfidf wieghted vector
row=0;
for sent in list_of_sent:
    sent_vec = np.zeros(50)
    weight_sum =0;
    for word in sent:
        if word in w2v_words:
            vec = w2v_model.wv[word]
            tf_idf = tf_idf_test[row, tfidf_feat.index(word)]
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
        else:
            continue
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors_test.append(sent_vec)
    row += 1
```

Grid Search using L1 regularization

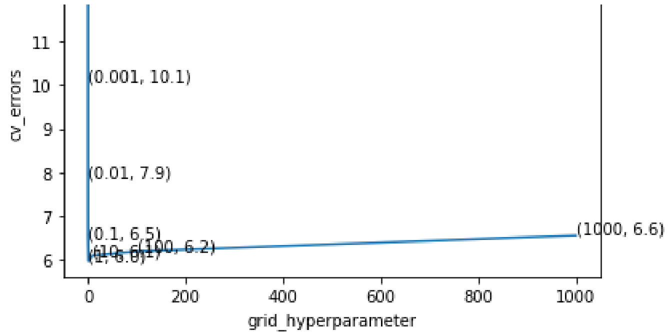
In [9]:

```
grid_hyperparameter = [{'C':[0.0001,0.001,0.01,0.1,1,10,100,1000]}]
print(grid_hyperparameter)
```

```
[{'C': [0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000]}]
```

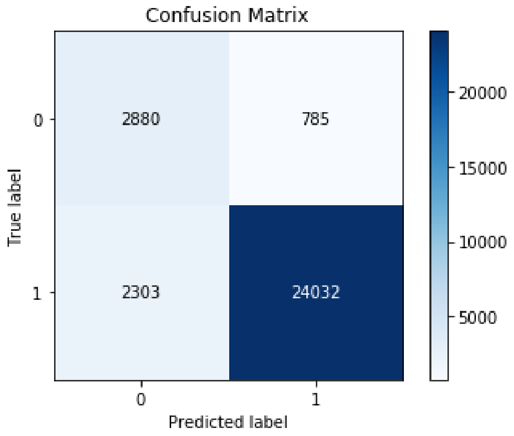
In [10]:

```
#train model
bow_grid_model = GridSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), grid_hyperpar
ameter, scoring = 'f1', cv=3)
bow_grid_model.fit(bag_of_words_train, y_train)

#plot cv errors
bow_grid_cv_errors = [(1-x[1])*100 for x in bow_grid_model.grid_scores_]
plt.plot(grid_hyperparameter[0]['C'],bow_grid_cv_errors)
for xy in zip(grid_hyperparameter[0]['C'],np.round(bow_grid_cv_errors,1)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('grid_hyperparameter')
plt.ylabel('cv_errors')
plt.title('grid_hyperparameter vs cv_errors')
plt.show()

#Best C value
bow_grid_c = bow_grid_model.best_estimator_.get_params()['C']

#f1 score
bow_grid_f1_train = bow_grid_model.score(bag_of_words_train, y_train)
bow_grid_f1_test = bow_grid_model.score(bag_of_words_test, y_test)

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



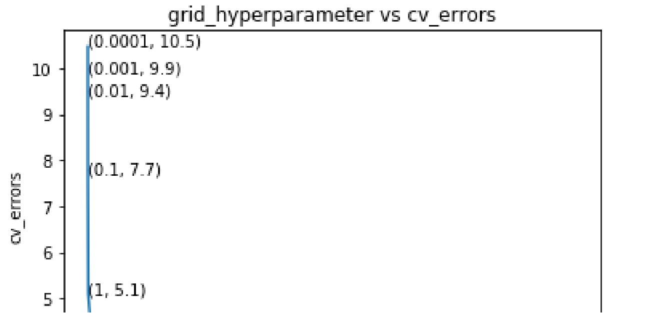
Out[10]:

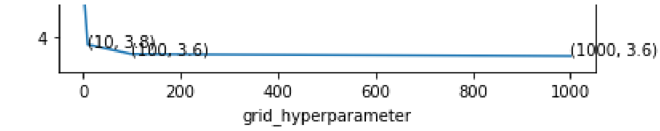
```
<matplotlib.axes._subplots.AxesSubplot at 0x24c2fba19e8>
```



In [17]:

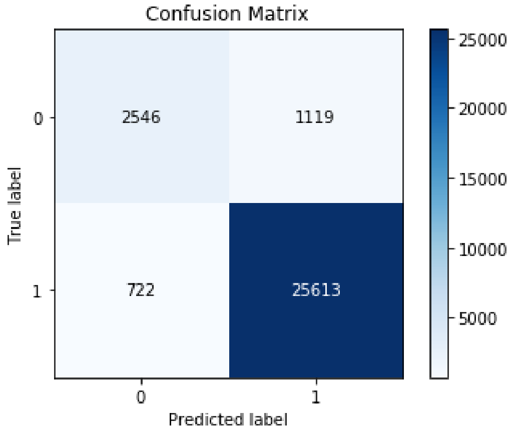
```
#train model
tfidf_grid_model = GridSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), grid_hyperparameter, scoring = 'f1', cv=5)
tfidf_grid_model.fit(tf_idf_train, y_train)

#plot cv errors
tfidf_grid_cv_errors = [(1-x[1])*100 for x in tfidf_grid_model.grid_scores_]
plt.plot(grid_hyperparameter[0]['C'],tfidf_grid_cv_errors)
for xy in zip(grid_hyperparameter[0]['C'],np.round(tfidf_grid_cv_errors,1)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('grid_hyperparameter')
plt.ylabel('cv_errors')
plt.title('grid_hyperparameter vs cv_errors')
plt.show()

#Best c value
tfidf_grid_c = tfidf_grid_model.best_estimator_.get_params()['C']

#f1 score
tfidf_grid_f1_train = tfidf_grid_model.score(tf_idf_train, y_train)
tfidf_grid_f1_test = tfidf_grid_model.score(tf_idf_test, y_test)

#confusion matrix
pred = tfidf_grid_model.predict(tf_idf_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```





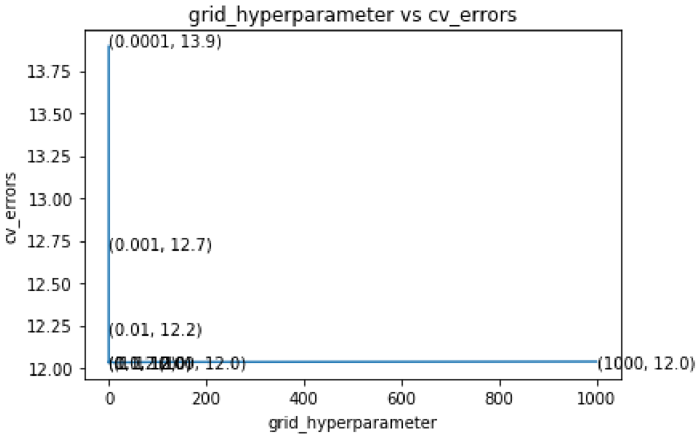
Out[17]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x24c4d939630>
```



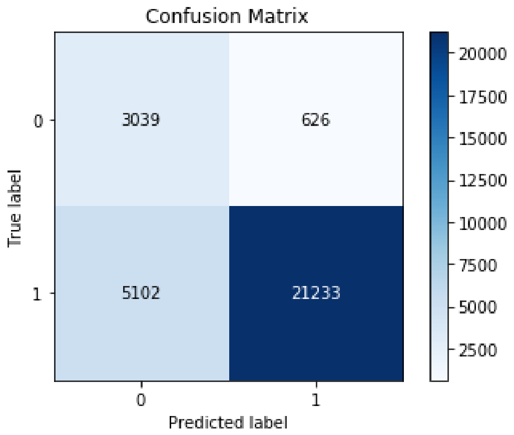
In [20]:

```
#train model
avgw2vec_grid_model = GridSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), grid_hyperparameter, scoring = 'f1', cv=5)
avgw2vec_grid_model.fit(sent_vectors_train, y_train)

#plot cv errors
avgw2vec_grid_cv_errors = [(1-x[1])*100 for x in avgw2vec_grid_model.grid_scores_]
plt.plot(grid_hyperparameter[0]['C'],avgw2vec_grid_cv_errors)
for xy in zip(grid_hyperparameter[0]['C'],np.round(avgw2vec_grid_cv_errors,1)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('grid_hyperparameter')
plt.ylabel('cv_errors')
plt.title('grid_hyperparameter vs cv_errors')
plt.show()

#Best c value
avgw2vec_grid_c = avgw2vec_grid_model.best_estimator_.get_params()['C']

#f1-score
avgw2vec_grid_f1_train = avgw2vec_grid_model.score(sent_vectors_train, y_train)
avgw2vec_grid_f1_test = avgw2vec_grid_model.score(sent_vectors_test, y_test)

#Confusion matrix
pred = avgw2vec_grid_model.predict(sent_vectors_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```



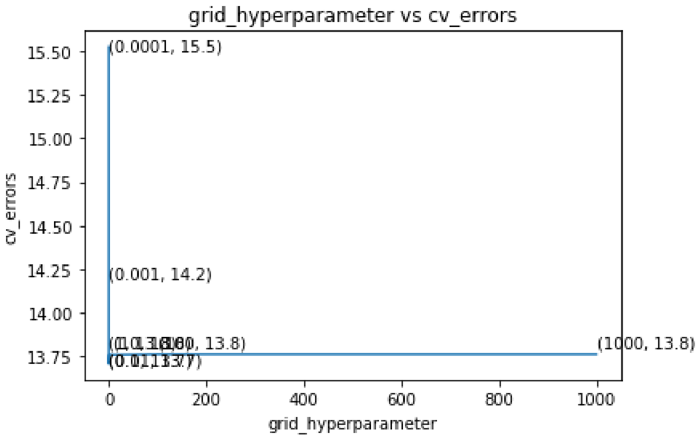
Out[20]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x24c65f1ac18>
```



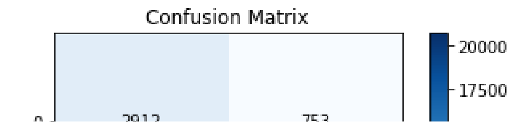
In [133]:

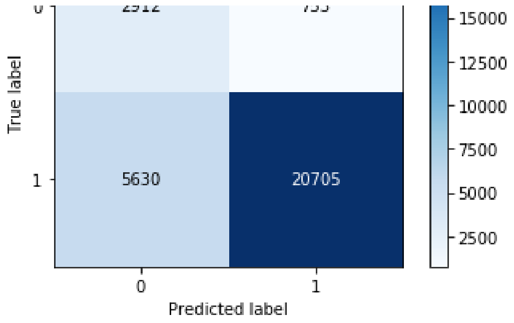
```
#train model
ww2vec_grid_model = GridSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), grid_hyper
parameter, scoring = 'f1', cv=5)
ww2vec_grid_model.fit(tfidf_sent_vectors_train, y_train)

#plot cv errors
w2vec_grid_cv_errors = [(1-x[1])*100 for x in ww2vec_grid_model.grid_scores_]
plt.plot(grid_hyperparameter[0]['C'],w2vec_grid_cv_errors)
for xy in zip(grid_hyperparameter[0]['C'],np.round(w2vec_grid_cv_errors,1)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('grid_hyperparameter')
plt.ylabel('cv_errors')
plt.title('grid_hyperparameter vs cv_errors')
plt.show()

#best c value
ww2vec_grid_c = ww2vec_grid_model.best_estimator_.get_params()['C']

#f1 score
ww2vec_grid_f1_train = ww2vec_grid_model.score(tfidf_sent_vectors_train, y_train)
ww2vec_grid_f1_test = ww2vec_grid_model.score(tfidf_sent_vectors_test, y_test)

#Confusion Matrix
pred = ww2vec_grid_model.predict(tfidf_sent_vectors_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```



Out[133]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1b7e1904e10>
```





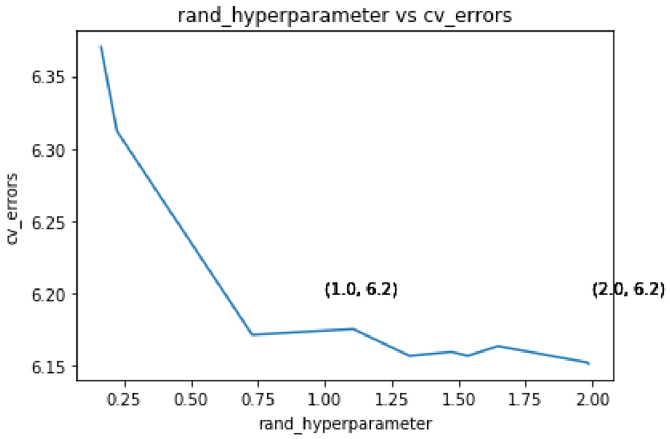
Random Search using L2 regularization

In [11]:

```
from numpy.random import uniform
rand_hyperparameter ={'C' : uniform(0.1,2, size=10)}
rand_hyperparameter['C'].sort()
```

In [12]:

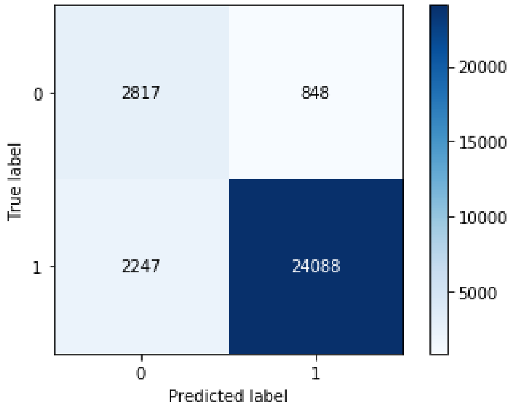
```
#train model
bow_rand_model = RandomizedSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), rand_hy
perparameter, scoring = 'f1', cv=5)
bow_rand_model.fit(bag_of_words_train, y_train)

#plot cv errors
bow_rand_cv_errors = [(1-x[1])*100 for x in bow_rand_model.grid_scores_]
plt.plot(rand_hyperparameter['C'],bow_rand_cv_errors)
for xy in zip(np.round(rand_hyperparameter['C']),np.round(bow_rand_cv_errors,1)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('rand_hyperparameter')
plt.ylabel('cv_errors')
plt.title('rand_hyperparameter vs cv_errors')
plt.show()

#Best C value
bow_rand_c = bow_rand_model.best_estimator_.get_params()['C']

#f1 score
bow_rand_f1_train = bow_rand_model.score(bag_of_words_train, y_train)
bow_rand_f1_test = bow_rand_model.score(bag_of_words_test, y_test)

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



Out[12]:

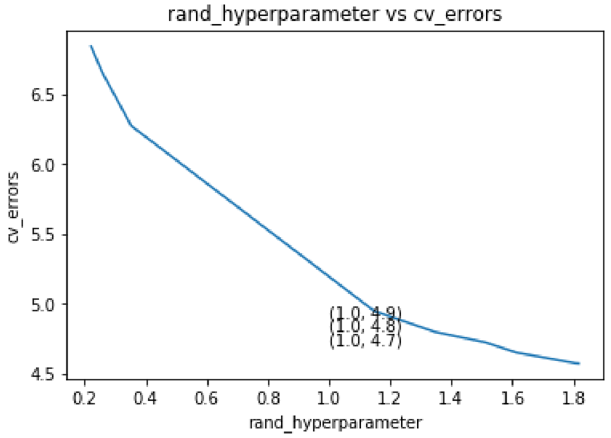
```
<matplotlib.axes._subplots.AxesSubplot at 0x24c32fca630>
```

Confusion Matrix



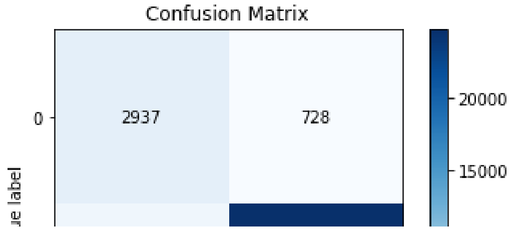
In [109]:

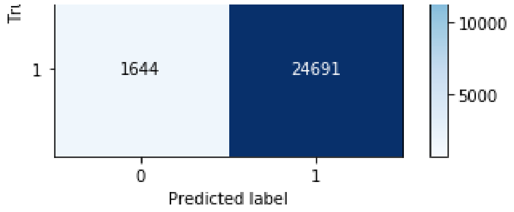
```
#train model
tfidf_rand_model = RandomizedSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), rand_
hyperparameter, scoring = 'f1', cv=5)
tfidf_rand_model.fit(tf_idf_train, y_train)

#plot cv errors
tfidf_rand_cv_errors = [(1-x[1])*100 for x in tfidf_rand_model.grid_scores_]
plt.plot(rand_hyperparameter['C'],tfidf_rand_cv_errors)
for xy in zip(np.round(rand_hyperparameter['C']),np.round(tfidf_rand_cv_errors,1)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('rand_hyperparameter')
plt.ylabel('cv_errors')
plt.title('rand_hyperparameter vs cv_errors')
plt.show()

#Best c value
tfidf_rand_c = tfidf_rand_model.best_estimator_.get_params()['C']

#f1 score
tfidf_rand_f1_train = tfidf_rand_model.score(tf_idf_train, y_train)
tfidf_rand_f1_test = tfidf_rand_model.score(tf_idf_test, y_test)

#confusion matrix
pred = tfidf_rand_model.predict(tf_idf_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```



Out[109]:

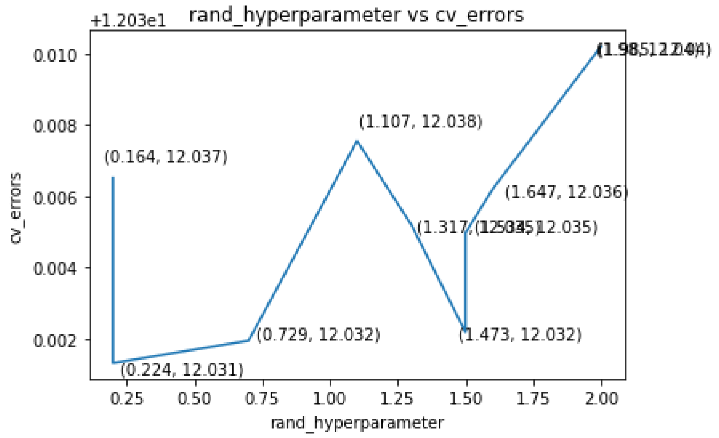
```
<matplotlib.axes._subplots.AxesSubplot at 0x1b79c937b70>
```





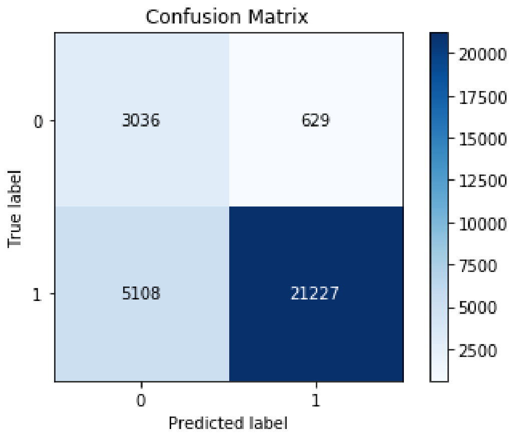
In [21]:

```
#train model
avgw2vec_rand_model = RandomizedSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), ra
nd_hyperparameter, scoring = 'f1', cv=5)
avgw2vec_rand_model.fit(sent_vectors_train, y_train)

#plot cv errors
avgw2vec_rand_cv_errors = [(1-x[1])*100 for x in avgw2vec_rand_model.grid_scores_]
plt.plot(np.round(rand_hyperparameter['C'],1),avgw2vec_rand_cv_errors)
for xy in zip(np.round(rand_hyperparameter['C'],3),np.round(avgw2vec_rand_cv_errors,3)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('rand_hyperparameter')
plt.ylabel('cv_errors')
plt.title('rand_hyperparameter vs cv_errors')
plt.show()

#Best c value
avgw2vec_rand_c= avgw2vec_rand_model.best_estimator_.get_params()['C']

#f1-score
avgw2vec_rand_f1_train = avgw2vec_rand_model.score(sent_vectors_train, y_train)
avgw2vec_rand_f1_test = avgw2vec_rand_model.score(sent_vectors_test, y_test)

#Confusion matrix
pred = avgw2vec_rand_model.predict(sent_vectors_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```



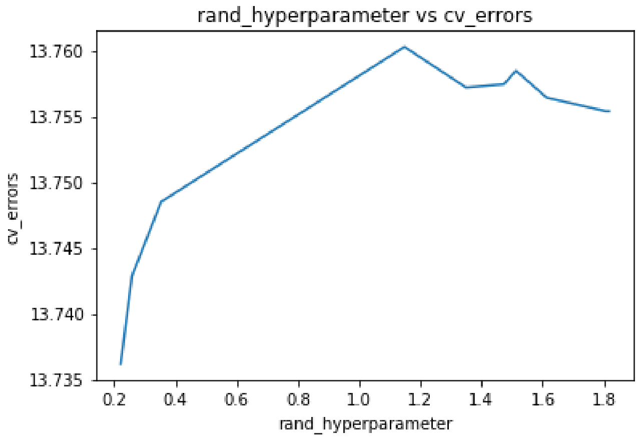
Out[21]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x24c664a0cf8>
```



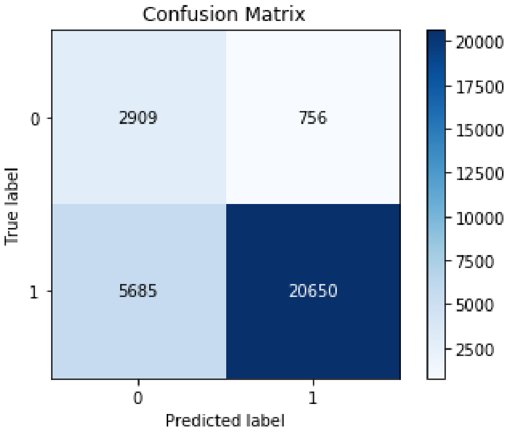
In [134]:

```
#train model
ww2vec_rand_model = RandomizedSearchCV(LogisticRegression(penalty='l2',class_weight = 'balanced'), rand
_hyperparameter, scoring = 'f1', cv=5)
ww2vec_rand_model.fit(tfidf_sent_vectors_train, y_train)

#plot cv errors
w2vec_rand_cv_errors = [(1-x[1])*100 for x in ww2vec_rand_model.grid_scores_]
plt.plot(rand_hyperparameter['C'],w2vec_rand_cv_errors)
for xy in zip(np.round(rand_hyperparameter['C'],1),np.round(w2vec_rand_cv_errors,1)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('rand_hyperparameter')
plt.ylabel('cv_errors')
plt.title('rand_hyperparameter vs cv_errors')
plt.show()

#best c value
ww2vec_rand_c = ww2vec_rand_model.best_estimator_.get_params()['C']

#f1 score
ww2vec_rand_f1_train = ww2vec_rand_model.score(tfidf_sent_vectors_train, y_train)
ww2vec_rand_f1_test = ww2vec_rand_model.score(tfidf_sent_vectors_test, y_test)

#Confusion Matrix
pred = ww2vec_rand_model.predict(tfidf_sent_vectors_test)
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=False)
```



Out[134]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1b7dce34828>
```



In [135]:

```
from prettytable import PrettyTable

Table = PrettyTable()
```

```
Table.field_names  = ["Model", "Hyper_parameter(C)", "Train f1-score", "Test f1-score"]

Table.add_row(["grid_BOW", bow_grid_c, bow_grid_f1_train,bow_grid_f1_test])
Table.add_row(["grid_TF_IDF", tfidf_grid_c,tfidf_grid_f1_train, tfidf_grid_f1_test])
Table.add_row(["grid_avgw2vec", avgw2vec_grid_c, avgw2vec_grid_f1_train,avgw2vec_grid_f1_test])
Table.add_row(["grid_ww2vec", ww2vec_grid_c, ww2vec_grid_f1_train,ww2vec_grid_f1_test])
Table.add_row(["rand_BOW", bow_rand_c, bow_rand_f1_train,bow_rand_f1_test])
Table.add_row(["rand_TF_IDF", tfidf_rand_c, tfidf_rand_f1_train,tfidf_rand_f1_test])
Table.add_row(["rand_avgw2vec", avgw2vec_rand_c, avgw2vec_rand_f1_train,avgw2vec_rand_f1_test])
Table.add_row(["rand_ww2vec", ww2vec_rand_c, ww2vec_rand_f1_train,ww2vec_rand_f1_test])

print(Table)
```

```
+---------------+---------------------+--------------------+--------------------+
|     Model     |  Hyper_parameter(C) |   Train f1-score   |   Test f1-score    |
+---------------+---------------------+--------------------+--------------------+
|    grid_BOW   |          1          | 0.9642443665162167 | 0.9396309039724742 |
|  grid_TF_IDF  |         1000        | 0.9999918558153551 | 0.9653080068592534 |
| grid_avgw2vec |         0.1         | 0.8805440673131775 | 0.8805164611616225 |
|  grid_ww2vec  |         0.01        | 0.8627956446495529 | 0.8664448768648129 |
|    rand_BOW   |  1.349544480197799  | 0.9667247211709147 | 0.9395797531635681 |
|  rand_TF_IDF  |  1.816945741505411  | 0.9818932155494601 | 0.9541677937937165 |
| rand_avgw2vec |  0.257604623640196  | 0.8803481300494016 | 0.8804916535171498 |
|  rand_ww2vec  | 0.22082248356008288 | 0.8625781369798761 | 0.8650845185479985 |
+---------------+---------------------+--------------------+--------------------+
```

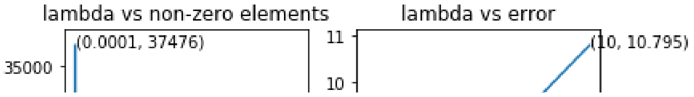
Error and sparsity using L1 Regularization

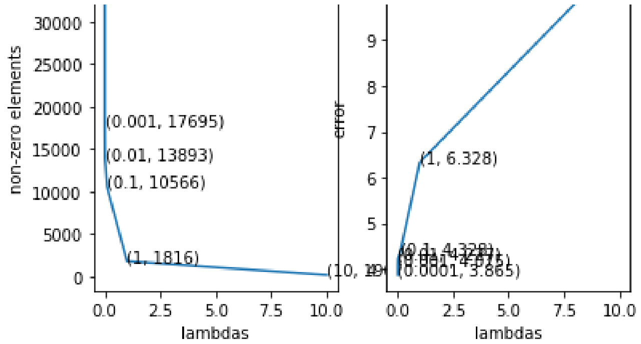
In [136]:

```
from sklearn.metrics import confusion_matrix
lambdas = [0.0001,0.001,0.01,0.1,1,10]
sparsities = []
error = []
for lambd in lambdas:
    C = (1/lambd)
    clf = LogisticRegression(C=C, penalty='l1',class_weight = 'balanced');
    clf.fit(tf_idf_train, y_train);
    w = clf.coef_
    sparsity = np.count_nonzero(w)
    sparsities.append(sparsity)
    pred = clf.predict(tf_idf_test)
    tn, fp, fn, tp = confusion_matrix(y_test, pred).ravel()
    pr,re = (tp)/(tp+fp),(tp)/(tp+fn)
    f1_score_tfidf_ww_test = (2*pr*re)/(pr+re)
    error.append((1-f1_score_tfidf_ww_test)*100)
```

In [137]:

```
fig = plt.figure()
plt.subplot(1,2,1)
plt.plot(lambdas,sparsities)
for xy in zip(lambdas,sparsities):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('lambdas')
plt.ylabel('non-zero elements')
plt.title('lambda vs non-zero elements')

plt.subplot(1,2,2)
plt.plot(lambdas,error)
for xy in zip(lambdas,np.round(error,3)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('lambdas')
plt.ylabel('error')
plt.title('lambda vs error')
plt.show()
```





Pertubation Test

In [8]:

```
from sklearn.preprocessing import StandardScaler

#Standardize train data
Standardized_data_train = StandardScaler(with_mean=False).fit(tf_idf_train)
standard_tf_idf_train = Standardized_data_train.transform(tf_idf_train)

#train model to find weight vector
clf_before = LogisticRegression(C=1000,penalty='l2',class_weight = 'balanced');
clf_before.fit(standard_tf_idf_train, y_train);
w_before_ptrb = clf_before.coef_

#add noise
noise = 0.1
standard_tf_idf_train_prtb = csr_matrix(standard_tf_idf_train)
standard_tf_idf_train_prtb.data = standard_tf_idf_train_prtb.data + noise

#train model using pertubated data to find weight vector
clf_after = LogisticRegression(C=1000, penalty='l2',class_weight = 'balanced');
clf_after.fit(standard_tf_idf_train_prtb, y_train);
w_after_prtb = clf_after.coef_
```

In [15]:

```
delta = abs(w_before_ptrb - w_after_prtb)+100
denom = w_before_ptrb+100

diff_weights = delta/denom
percent_change = diff_weights*100
percent_change
```

Out[15]:

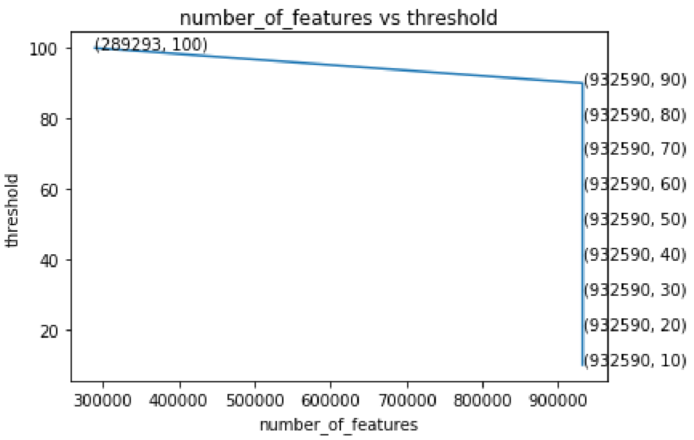
```
array([[100.00039017,  99.99836499, 100.00363008, ...,  99.9990006 ,
         99.9990006 ,  99.99890121]])
```

In [32]:

```
threshold = [10,20,30,40,50,60,70,80,90,100]
number_of_features = []
for x in threshold:
    feat = len(percent_change[percent_change >= x])
    number_of_features.append(feat)
```

In [33]:

```
plt.plot(number_of_features,threshold)
for xy in zip(number_of_features,threshold):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')
plt.xlabel('number_of_features')
plt.ylabel('threshold')
plt.title('number_of_features vs threshold')
plt.show()
```



Feature Importance

In [39]:

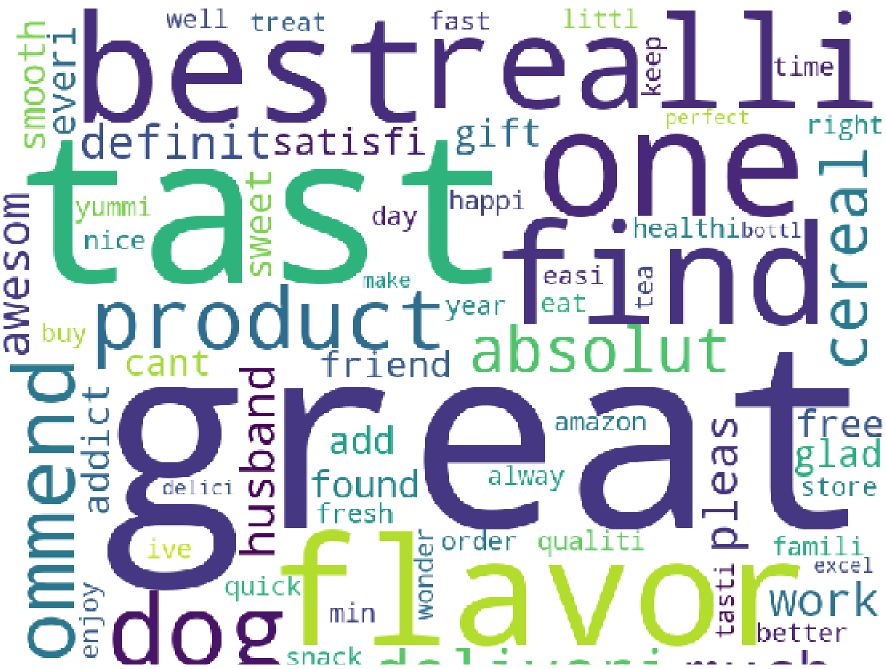
```
#using weight vector to find important feature
indx = w_before_ptrb.argsort()
neg_indxs = indx[0,:100]
pos_indxs = indx[0,(w_before_ptrb.shape[1]-100):(w_before_ptrb.shape[1]-1)]
```

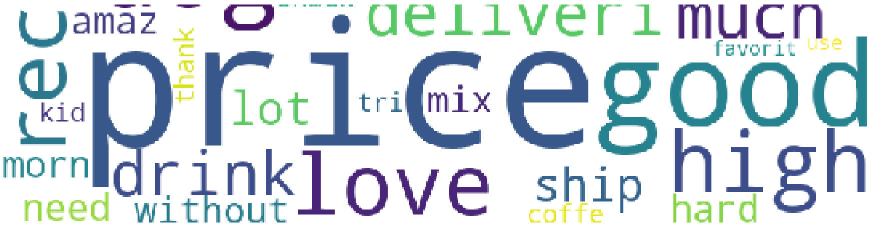
In [40]:

```
feature_importance_neg = [np.take(tf_idf_vect.get_feature_names(),neg_indx)  for neg_indx in neg_indxs]
feature_importance_pos = [np.take(tf_idf_vect.get_feature_names(),pos_indx)  for pos_indx in pos_indxs]
```

In [41]:

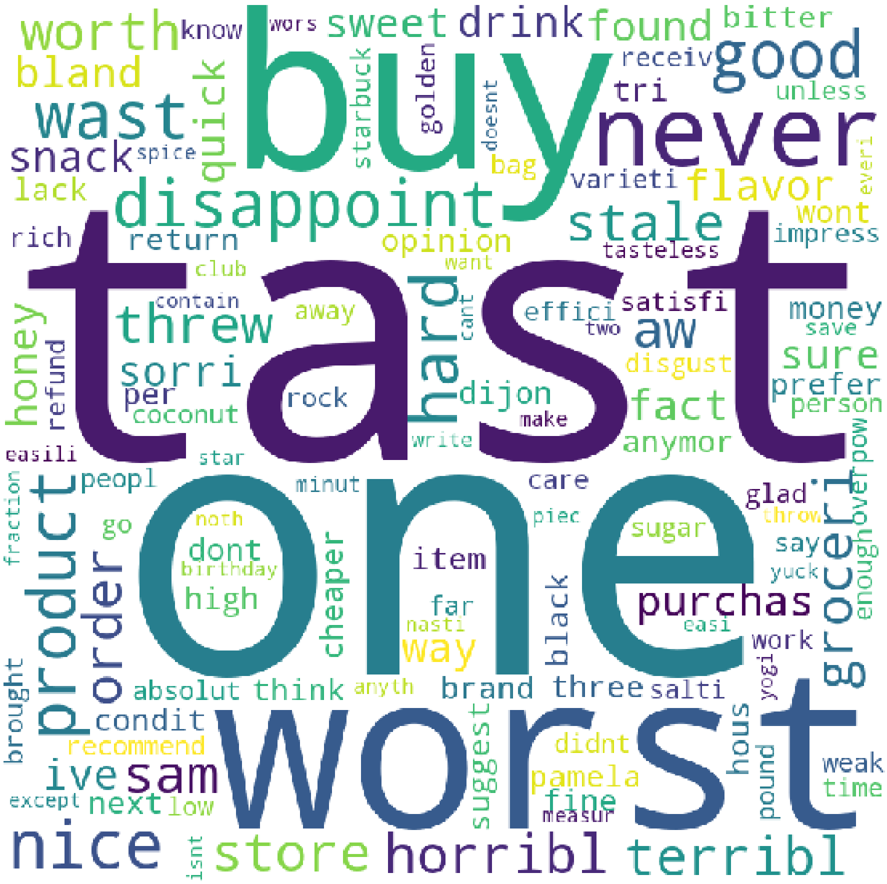
```
from wordcloud import WordCloud

featurez=(" ").join(feature_importance_pos)
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()
```





In [42]:

```
from wordcloud import WordCloud

featurez=(" ").join(feature_importance_neg)
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()
```


worth
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wors
sweet
drink
found
bitter
bland
buy
receiv
good
tri
unless
wast
quick
starbuck
golden
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never
snack
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bag
everi
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varieti
flavor
disappoint
stale
wont
rich
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impress
club
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