# Decision Tree

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.metrics import confusion_matrix
from sklearn.grid_search import GridSearchCV
from sklearn.tree import DecisionTreeClassifier
from sklearn import tree
from sklearn.metrics import roc_curve, auc
```

```
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)
```

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,)
```

In [10]:

```
y_train = np.array(y_train)
y_test = np.array(y_test)
```

In [5]:

```
max_depth = [1, 5, 10, 50, 100, 500, 100]
```

```
print(max_depth)
```

```
[1, 5, 10, 50, 100, 500, 100]
```

# BOW

In [6]:

```
# Performing BOW on review

from sklearn.feature_extraction.text import CountVectorizer
count_vect = CountVectorizer(min_df = 10)
vocabulary = count_vect.fit(X_train)

feature_names = count_vect.get_feature_names()
```

In [7]:

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

```
(70000, 7131)
```

In [8]:

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

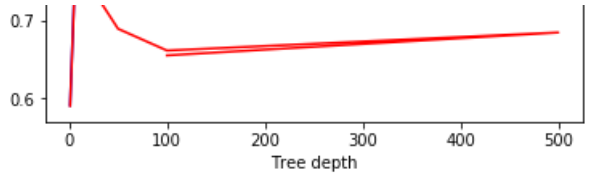
```
(30000, 7131)
```

In [15]:

```
train_score = []
test_score = []

for depth in max_depth:
    model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = depth)
    model.fit(bag_of_words_train, y_train)

    train_pred = model.predict_proba(bag_of_words_train)
    false_positive_rate, true_positive_rate,thresholds = roc_curve(y_train, train_pred[:,1])
    roc_auc = auc(false_positive_rate, true_positive_rate)
    train_score.append(roc_auc)

    test_pred = model.predict_proba(bag_of_words_test)
    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred[:,1])
    roc_auc = auc(false_positive_rate, true_positive_rate)
    test_score.append(roc_auc)
```

In [16]:

```
plt.plot(max_depth, train_score,'b', label='Train AUC')
plt.plot(max_depth, test_score, 'r', label='Test AUC')

plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```

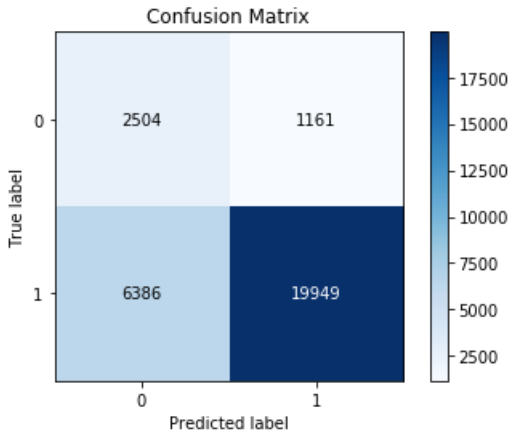



In [25]:

```
bow_grid_model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = 10)
bow_grid_model.fit(bag_of_words_train, y_train)

train_pred = bow_grid_model.predict_proba(bag_of_words_train)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_train,train_pred[:,1])
bow_grid_model_train = auc(false_positive_rate, true_positive_rate)

test_pred = bow_grid_model.predict_proba(bag_of_words_test)
test_predct = bow_grid_model.predict(bag_of_words_test)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred[:,1])
bow_grid_model_test = auc(false_positive_rate, true_positive_rate)

skplt.metrics.plot_confusion_matrix(y_test, test_predct, normalize=False)
```

Out[25]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x17b52eda390>
```




In [26]:

```
import graphviz

dot_data = tree.export_graphviz(bow_grid_model,out_file=None,filled=True, rounded=True, special_charact
ers=False, impurity=False,feature_names = feature_names)
graph = graphviz.Source(dot_data)
graph
```

Out[26]:

In [31]:

```
from wordcloud import WordCloud

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

featurez=(" ").join(features)
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 [37]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
tf_idf_vect = TfidfVectorizer(min_df = 10)
vocabulary = tf_idf_vect.fit(X_train)
```

In [38]:

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

```
(70000, 7131)
```

In [39]:

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

```
(30000, 7131)
```

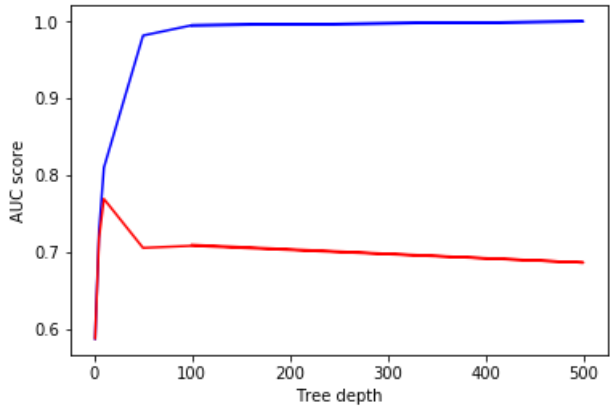
In [41]:

```
train_score = []
test_score = []

for depth in max_depth:
    model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = depth)
    model.fit(tf_idf_train, y_train)
```

```
    train_pred = model.predict_proba(tf_idf_train)
    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_train, train_pred[:,1])
    roc_auc = auc(false_positive_rate, true_positive_rate)
    train_score.append(roc_auc)

    test_pred = model.predict_proba(tf_idf_test)
    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred[:,1])
    roc_auc = auc(false_positive_rate, true_positive_rate)
    test_score.append(roc_auc)
```

In [42]:

```
plt.plot(max_depth, train_score,'b', label='Train AUC')
plt.plot(max_depth, test_score, 'r', label='Test AUC')

plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```



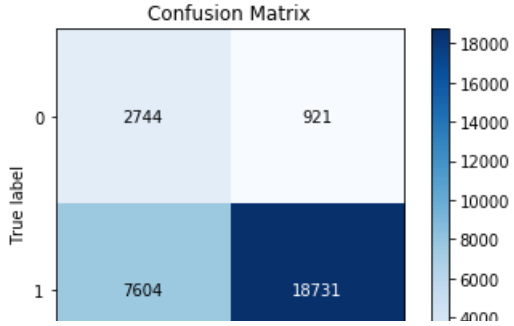

In [45]:

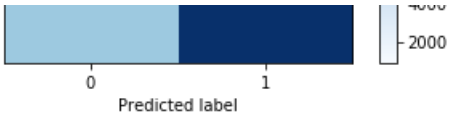
```
tfidf_grid_model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = 10)
tfidf_grid_model.fit(tf_idf_train, y_train)

train_pred = tfidf_grid_model.predict_proba(tf_idf_train)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_train,train_pred[:,1])
tfidf_grid_model_train = auc(false_positive_rate, true_positive_rate)
print(tfidf_grid_model_train)

test_pred = tfidf_grid_model.predict_proba(tf_idf_test)
test_predct = tfidf_grid_model.predict(tf_idf_test)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred[:,1])
tfidf_grid_model_test = auc(false_positive_rate, true_positive_rate)
print(tfidf_grid_model_test)

skplt.metrics.plot_confusion_matrix(y_test,test_predct, normalize=False)
```

```
0.810043223937983
0.7684279709100216
```

Out[45]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x17b58c4f160>
```






In [46]:

```
import graphviz

dot_data = tree.export_graphviz(tfidf_grid_model,out_file=None,filled=True, rounded=True, special_chara
cters=False, impurity=False,feature_names = tf_idf_vect.get_feature_names())
graph = graphviz.Source(dot_data)
graph
```

Out[46]:

In [47]:

```
from wordcloud import WordCloud

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

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

# Avg word2vec

In [85]:

```
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")
WARNING:gensim.models.base_any2vec:consider setting layer size to a multiple of 4 for greater performan
ce
```

In [86]:

```
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)
```

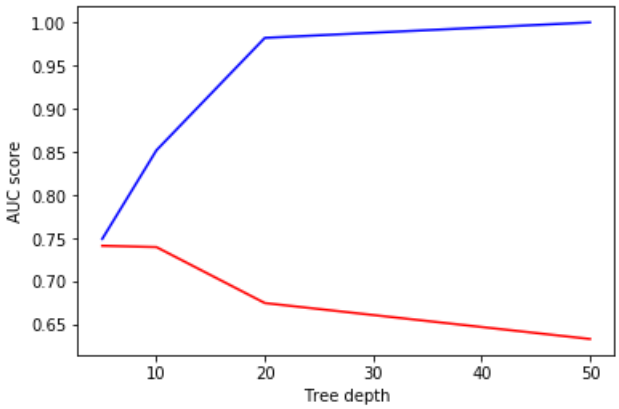
In [87]:

```
train_score = []
test_score = []

for depth in max_depth:
    model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = depth)
    model.fit(sent_vectors_train, y_train)

    train_pred = model.predict(sent_vectors_train)
    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_train, train_pred)
    roc_auc = auc(false_positive_rate, true_positive_rate)
    train_score.append(roc_auc)

    test_pred = model.predict(sent_vectors_test)
    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred)
```

```
    roc_auc = auc(false_positive_rate, true_positive_rate)
    test_score.append(roc_auc)
```

In [88]:

```
plt.plot(max_depth, train_score,'b', label='Train AUC')
plt.plot(max_depth, test_score, 'r', label='Test AUC')

plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```

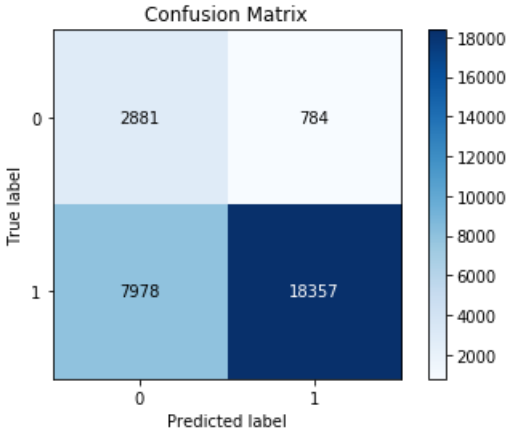



In [94]:

```
avgw2vec_grid_model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = 5)
avgw2vec_grid_model.fit(sent_vectors_train, y_train)

train_pred = avgw2vec_grid_model.predict(sent_vectors_train)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_train,train_pred)
avgw2vec_grid_model_train = auc(false_positive_rate, true_positive_rate)

test_pred = avgw2vec_grid_model.predict(sent_vectors_test)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred)
avgw2vec_grid_model_test = auc(false_positive_rate, true_positive_rate)

skplt.metrics.plot_confusion_matrix(y_test,test_pred, normalize=False)
```

Out[94]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x29718c9d710>
```




In [102]:

```
import graphviz
dot_data = tree.export_graphviz(clf, out_file=None)
graph = graphviz.Source(dot_data)
graph
```

Out[102]:

# tfidf weighted word2vec

In [70]:

```
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 [71]:

```
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[71]:

```
(70000, 50)
```

In [72]:

```
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[72]:

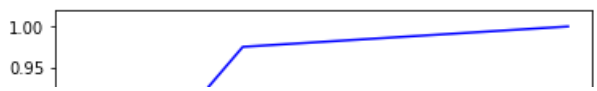
```
(30000, 50)
```

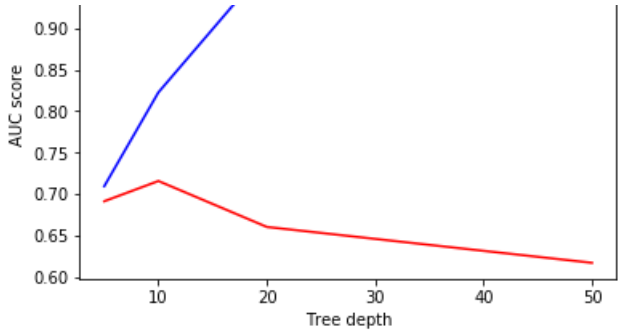
In [75]:

```
train_score = []
test_score = []

for depth in max_depth:
    model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = depth)
    model.fit(tfidf_sent_vectors_train, y_train)

    train_pred = model.predict(tfidf_sent_vectors_train)
    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_train, train_pred)
    roc_auc = auc(false_positive_rate, true_positive_rate)
    train_score.append(roc_auc)

    test_pred = model.predict(tfidf_sent_vectors_test)
    false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred)
    roc_auc = auc(false_positive_rate, true_positive_rate)
    test_score.append(roc_auc)
```

In [76]:

```
plt.plot(max_depth, train_score,'b', label='Train AUC')
plt.plot(max_depth, test_score, 'r', label='Test AUC')

plt.ylabel('AUC score')
plt.xlabel('Tree depth')
plt.show()
```



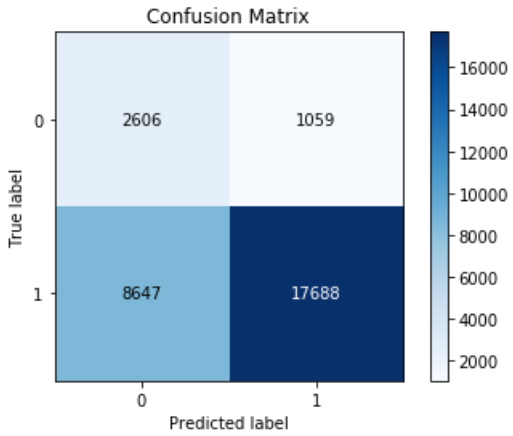



In [83]:

```
w2vec_grid_model = DecisionTreeClassifier(class_weight = 'balanced',max_depth = 5)
w2vec_grid_model.fit(tfidf_sent_vectors_train, y_train)

train_pred = w2vec_grid_model.predict(tfidf_sent_vectors_train)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_train,train_pred)
w2vec_grid_model_train = auc(false_positive_rate, true_positive_rate)

test_pred = w2vec_grid_model.predict(tfidf_sent_vectors_test)
false_positive_rate, true_positive_rate, thresholds = roc_curve(y_test,test_pred)
w2vec_grid_model_test = auc(false_positive_rate, true_positive_rate)

skplt.metrics.plot_confusion_matrix(y_test,test_pred, normalize=False)
```

Out[83]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x297071e0160>
```




In [79]:

```
import graphviz
dot_data = tree.export_graphviz(w2vec_grid_model, out_file=None)
graph = graphviz.Source(dot_data)
graph
```

Out[79]:

# Conclusion

In [48]:

```
from prettytable import PrettyTable

Table = PrettyTable()

Table.field_names  = ["Model", "Train auc-score", "Test auc-score"]
```

```
Table.add_row(["grid_BOW", bow_grid_model_train,bow_grid_model_test])
Table.add_row(["grid_TF_IDF",tfidf_grid_model_train, tfidf_grid_model_test])
Table.add_row(["grid_avgw2vec",avgw2vec_grid_model_train,avgw2vec_grid_model_test])
Table.add_row(["grid_ww2vec",  w2vec_grid_model_train,w2vec_grid_model_test])

print(Table)
```

```
+---------------+--------------------+--------------------+
|     Model     |  Train auc-score   |   Test auc-score   |
+---------------+--------------------+--------------------+
|    grid_BOW   | 0.8080595131739432 | 0.7673781072968167 |
|  grid_TF_IDF  | 0.810043223937983  | 0.7684279709100216 |
| grid_avgw2vec | 0.7494677213974306 | 0.7415708660917639 |
|  grid_ww2vec  | 0.7094475807638189 | 0.6913520851470105 |
+---------------+--------------------+--------------------+
```