[5] Assignment 5: Apply Logistic Regression

1. **Apply Logistic Regression on these feature sets**

   - SET 1:Review text, preprocessed one converted into vectors using (BOW)
   - SET 2:Review text, preprocessed one converted into vectors using (TFIDF)
   - SET 3:Review text, preprocessed one converted into vectors using (AVG W2v)
   - SET 4:Review text, preprocessed one converted into vectors using (TFIDF W2v)

2. **Hyper paramter tuning (find best hyper parameters corresponding the algorithm that you choose)**

   - Find the best hyper parameter which will give the maximum AUC (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/receiver-operating-characteristic-curve-roc-curve-and-auc-1/) value
   - Find the best hyper paramter using k-fold cross validation or simple cross validation data
   - Use gridsearch cv or randomsearch cv or you can also write your own for loops to do this task of hyperparameter tuning

3. **Pertubation Test**

   - Get the weights W after fit your model with the data X i.e Train data.
   - Add a noise to the X (X' = X + e) and get the new data set X' (if X is a sparse matrix, X.data+=e)
   - Fit the model again on data X' and get the weights W'
   - Add a small eps value(to eliminate the divisible by zero error) to W and W' i.e W=W+10^-6 and W' = W'+10^-6
   - Now find the % change between W and W' (| (W-W') / (W) |)*100)
   - Calculate the 0th, 10th, 20th, 30th, ...100th percentiles, and observe any sudden rise in the values of percentage_change_vector
   - Ex: consider your 99th percentile is 1.3 and your 100th percentiles are 34.6, there is sudden rise from 1.3 to 34.6, now calculate the 99.1, 99.2, 99.3,..., 100th percentile values and get the proper value after which there is sudden rise the values, assume it is 2.5
   - Print the feature names whose % change is more than a threshold x(in our example it's 2.5)

4. **Sparsity**

   - Calculate sparsity on weight vector obtained after using L1 regularization

   NOTE: Do sparsity and multicollinearity for any one of the vectorizers. Bow or tf-idf is recommended.

5. **Feature importance**

   - Get top 10 important features for both positive and negative classes separately.

6. **Feature engineering**

   - To increase the performance of your model, you can also experiment with with feature engineering like :
     - Taking length of reviews as another feature.
     - Considering some features from review summary as well.

7. **Representation of results**

- You need to plot the performance of model both on train data and cross validation data for each hyper parameter, like shown in the figure.
- Once after you found the best hyper parameter, you need to train your model with it, and find the AUC on test data and plot the ROC curve on both train and test.
- Along with plotting ROC curve, you need to print the confusion matrix (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/confusion-matrix-tpr-fpr-fnr-tnr-1/) with predicted and original labels of test data points. Please visualize your confusion matrices using seaborn heatmaps.
(https://seaborn.pydata.org/generated/seaborn.heatmap.html)
(https://seaborn.pydata.org/generated/seaborn.heatmap.html)
(https://seaborn.pydata.org/generated/seaborn.heatmap.html)

(https://seaborn.pydata.org/generated/seaborn.heatmap.html)

8. **Conclusion** (https://seaborn.pydata.org/generated/seaborn.heatmap.html)

(https://seaborn.pydata.org/generated/seaborn.heatmap.html)

- You need to summarize the results at the end of the notebook, summarize it in the table format. To print out a table please refer to this prettytable library (https://seaborn.pydata.org/generated/seaborn.heatmap.html) link (http://zetcode.com/python/prettytable/)

Applying Logistic Regression

In [1]:

```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")


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.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
from nltk.stem import PorterStemmer
from nltk.stem.snowball import SnowballStemmer

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 Word2Vec
from gensim.models import KeyedVectors
import pickle

from tqdm import tqdm
import os
con = sqlite3.connect(r"D:\AppliedAI\AAIC_Course_handouts\11_Amazon Fine Food Review
s\amazon-fine-food-reviews\database.sqlite")
data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3""",con)

# Change Score with 1 n 2 as -ve and 4 n 5 as +ve

def chng_to_0_or_1 (Score):
    if Score ==4 or Score ==5:
        return 1
    elif Score ==1 or Score ==2:
        return 0
    else:# Thus in case by some mistake any data is their with rating 6 or 7 etc due
to some error is removed
        pass
currentScore = data["Score"]
new_Score = currentScore.map(chng_to_0_or_1)
data["Score"] = new_Score
print ("Number of data points available")
print (data.shape)#Gives original number of data points available


#2 Data Cleaning a.) Getting rid of duplicates and b.) if helpnessdenominator < help
fulnessnumerator
```

```
data = data.drop_duplicates(subset = ["UserId","ProfileName","HelpfulnessNumerator",
"HelpfulnessDenominator","Score","Time","Summary","Text"], keep='first', inplace=Fal
se)
print ("Number of data points after removing duplicates")
print (data.shape)#Gives data points are deduplication

# Reference: Copied from above cell  final=final[final.HelpfulnessNumerator<=final.H
elpfulnessDenominator]
data=data[data.HelpfulnessNumerator<=data.HelpfulnessDenominator]
print ("Number of data points after removing where HelpfulnessNumerator is more than
HelpfulnessDenominator ")
print (data.shape)

#3 Preprocessing begins

#Convert to lower case,convert shortcut words to proper words, remove Special Charac
ter

#i) Convert to lower case:
data["Text"] =  (data["Text"].str.lower())
data["Summary"] =  (data["Summary"].str.lower())

#ii) Convert Shortcuts words to proper words
#List of Words are:https://en.wikipedia.org/wiki/Wikipedia:List_of_English_contracti
ons
#Reference:https://stackoverflow.com/questions/39602824/pandas-replace-string-with-a
nother-string
data['Text'] = data['Text'].replace({"ain't":"am not","amn't":"am not","aren't":"are
not", \
"can't":"cannot","cause":"because","could've":"could have","couldn't":"could not","c
ouldn't've":"could not have", \
"daren't":"dare not","daresn't":"dare not","dasn't":"dare not","didn't":"did not","d
oesn't":"does not", \
"don't":"do not","e'er":"ever","everyone's":"everyone is","finna":"fixing to","gimm
e":"give me", \
"gonna":"going to","gon't":"go not","gotta":"got to","hadn't":"had not","hasn't":"ha
s not","haven't":"have not",\
"he'd":"he had","he'll":"he shall","he's":"he has","he've":"he have","how'd":"how di
d","how'll":"how will",\
"how're":"how are","how's":"how has","I'd":"I had","I'll":"I shall","I'm":"I am",
"I'm'a":"I am about to",\
"I'm'o":"I am going to","I've":"I have","isn't":"is not","it'd":"it would","it'll":
"it shall","it's":"it has",\
"let's":"let us","mayn't":"may not","may've":"may have","mightn't":"might not","migh
t've":"might have",\
"mustn't":"must not","mustn't've":"must not have","must've":"must have","needn't":"n
eed not","ne'er":"never",\
"o'clock":"of the clock","o'er":"","ol'":"old","oughtn't":"ought not","shalln't":"sh
all not","shan't":"shall not",\
"she'd":"she had","she'll":"she shall","she's":"she is","should've":"should have","s
houldn't":"should not",\
"shouldn't've":"should not have","somebody's":"somebody has","someone's":"someone ha
s","something's":"something has",\
"that'll":"that will","that're":"that are","that's":"that is","that'd":"that would",
"there'd":"there had",\
"there'll":"there shall","there're":"there are","there's":"there is","these're":"hes
e are","they'd":"they had",\
"they'll":"they will","they're":"they are","they've":"they have","this's":"","thos
e're":"those are","tis":"it is",\
```

```
"twas":"it was","wasn't":"was not","we'd":"we had","we'd've":"we would have","we'll"
:"we will","we're":"we are",\
"we've":"we have","weren't":"were not","what'd":"what did","what'll":"what will","wh
at're":"what are","what's":"what is",\
"what've":"what have","when's":"when is","where'd":"where did","where're":"where ar
e","where've":"where have",\
"which's":"which has","who'd":"who would","who'd've":"who would have","who'll":"who
 shall","who're":"who are",\
"who's":"who has","who've":"who have","why'd":"why did","why're":"why are","why's":
"why has","won't":"will not",\
"would've":"would have","wouldn't":"would not","y'all":"you all","you'd":"you had",
"you'll":"you shall","you're":"you are",\
"you've":"you have"})
##############Lets do the same for summary Text#################################
data['Summary'] = data['Summary'].replace({"ain't":"am not","amn't":"am not","are
n't":"are not", \
"can't":"cannot","cause":"because","could've":"could have","couldn't":"could not","c
ouldn't've":"could not have", \
"daren't":"dare not","daresn't":"dare not","dasn't":"dare not","didn't":"did not","d
oesn't":"does not", \
"don't":"do not","e'er":"ever","everyone's":"everyone is","finna":"fixing to","gimm
e":"give me", \
"gonna":"going to","gon't":"go not","gotta":"got to","hadn't":"had not","hasn't":"ha
s not","haven't":"have not",\
"he'd":"he had","he'll":"he shall","he's":"he has","he've":"he have","how'd":"how di
d","how'll":"how will",\
"how're":"how are","how's":"how has","I'd":"I had","I'll":"I shall","I'm":"I am",
"I'm'a":"I am about to",\
"I'm'o":"I am going to","I've":"I have","isn't":"is not","it'd":"it would","it'll":
"it shall","it's":"it has",\
"let's":"let us","mayn't":"may not","may've":"may have","mightn't":"might not","migh
t've":"might have",\
"mustn't":"must not","mustn't've":"must not have","must've":"must have","needn't":"n
eed not","ne'er":"never",\
"o'clock":"of the clock","o'er":"","ol'":"old","oughtn't":"ought not","shalln't":"sh
all not","shan't":"shall not",\
"she'd":"she had","she'll":"she shall","she's":"she is","should've":"should have","s
houldn't":"should not",\
"shouldn't've":"should not have","somebody's":"somebody has","someone's":"someone ha
s","something's":"something has",\
"that'll":"that will","that're":"that are","that's":"that is","that'd":"that would",
"there'd":"there had",\
"there'll":"there shall","there're":"there are","there's":"there is","these're":"hes
e are","they'd":"they had",\
"they'll":"they will","they're":"they are","they've":"they have","this's":"","thos
e're":"those are","tis":"it is",\
"twas":"it was","wasn't":"was not","we'd":"we had","we'd've":"we would have","we'll"
:"we will","we're":"we are",\
"we've":"we have","weren't":"were not","what'd":"what did","what'll":"what will","wh
at're":"what are","what's":"what is",\
"what've":"what have","when's":"when is","where'd":"where did","where're":"where ar
e","where've":"where have",\
"which's":"which has","who'd":"who would","who'd've":"who would have","who'll":"who
 shall","who're":"who are",\
"who's":"who has","who've":"who have","why'd":"why did","why're":"why are","why's":
"why has","won't":"will not",\
"would've":"would have","wouldn't":"would not","y'all":"you all","you'd":"you had",
"you'll":"you shall","you're":"you are",\
"you've":"you have"})
################################################################################
####
```

```
# iii) Remove Special Characters except alpahbets and numbers
#The reason i dont want to remove number people might write got five eggs as 5 eggs
 or vice versa and dont want to lose
#that information which could be useful
#Ref:https://stackoverflow.com/questions/33257344/how-to-remove-special-characers-fr
om-a-column-of-dataframe-using-module-re
data["Text"]=data["Text"].map(lambda x: re.sub(r'[^a-zA-Z_0-9 -]', '', x))
data["Summary_copy"]=data["Summary"].map(lambda x: re.sub(r'[^a-zA-Z_0-9 -]', '', x
))

#The Summary are usually so small if we remove few stopwords the meaning itself woul
d be complely lost or chamge
# So let us see what all stopwords we have
#Ref:::::::::https://stackoverflow.com/questions/5511708/adding-words-to-nltk-stopli
st
#https://chrisalbon.com/machine_learning/preprocessing_text/remove_stop_words/

stopwords = nltk.corpus.stopwords.words('english')
newStopWords = ['would','could','br','<br>','<','>']
notstopwords = ['not','no','nor']
stopwords.extend(newStopWords)
stopwords = [word for word in stopwords if word not in notstopwords]

#  iv) For now let us just go with flow will use default stopwords as creating our o
wn stop words is very time consuming
#Rather will use n-gram stratergy to get rid of problem of stopwords removal changin
g the meaning of sentences
#Ref:https://stackoverflow.com/questions/43184364/python-remove-stop-words-from-pand
as-dataframe-give-wrong-output
data["New_Text"]= data['Text'].apply(lambda x: [item for item in str.split(x) if ite
m not in stopwords])
data["Summary"]= data['Summary_copy'].apply(lambda x: [item for item in str.split(x)
if item not in stopwords])

#Ref:https://stackoverflow.com/questions/37347725/converting-a-panda-df-list-into-a-
string/37347837
#we are creating new column New_summary so in case in future we need summary it is i
ntact
data["New_Text"]=data["New_Text"].apply(' '.join)
data["Summary"]=data["Summary"].apply(' '.join)

# v) Now lets do Stemming
#https://stackoverflow.com/questions/48617589/beginner-stemming-in-pandas-produces-l
etters-not-stems
english_stemmer=SnowballStemmer('english', ignore_stopwords=True)
data["New_Text"] = data["New_Text"].apply(english_stemmer.stem)
data["Summary"] = data["Summary"].apply(english_stemmer.stem)
data["New_Text"] = data["New_Text"].astype(str)
data["Summary"] = data["Summary"].astype(str)

#vi) stemming without removing stop words
english_stemmer=SnowballStemmer('english', ignore_stopwords=True)
#https://stackoverflow.com/questions/34724246/attributeerror-float-object-has-no-att
ribute-lower
data["Text_with_stop"]=data["Text"].astype(str)
data["Summary"]=data["Summary"].astype(str)
data["Text_with_stop"]=data["Text_with_stop"].str.lower().map(english_stemmer.stem)
data["Summary"]=data["Summary"].str.lower().map(english_stemmer.stem)
data["Text_with_stop"]=data["Text_with_stop"].apply(''.join)
data["Summary"]=data["Summary"].apply(''.join)
data["Text_with_stop"] = data["Text_with_stop"].astype(str)
```

```
data["Summary"] = data["Summary"].astype(str)
print(data["Score"].value_counts())
print ("Thus we see there are 85% and 15% positive and negative reviews,thus a unbal
anced dataset.So to create a balanced \
dataset we first copy negative dataset 6 times than we sample with same number of ti
mes as positive")
# Let include another feature which is the length of the text
data_neg = data[data["Score"] == 0]
data_pos = data[data["Score"] == 1]
data = pd.concat([data_pos,data_neg])
#https://stackoverflow.com/questions/46429033/how-do-i-count-the-total-number-of-wor
ds-in-a-pandas-dataframe-cell-and-add-thos
data["Text_length"]= (data["New_Text"].str.count(' ') + 1)
data["Summary_length"]= (data["Summary"].str.count(' ') + 1)
data["Time_formatted"]= pd.to_datetime(data["Time"])
data.sort_values(by=['Time_formatted'], inplace=True)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\gensim\utils.py:1212: UserWar
ning: detected Windows; aliasing chunkize to chunkize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_seria
l")

Number of data points available
(525814, 10)
Number of data points after removing duplicates
(366392, 10)
Number of data points after removing where HelpfulnessNumerator is more
than HelpfulnessDenominator
(366390, 10)
1    308679
0     57711
Name: Score, dtype: int64
Thus we see there are 85% and 15% positive and negative reviews,thus a u
nbalanced dataset.So to create a balanced dataset we first copy negative
dataset 6 times than we sample with same number of times as positive
```

In [2]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.train_te
st_split.html
from sklearn.model_selection import train_test_split

Y = data['Score'].values
X_no_stop = data['New_Text'].values
X_summary = data ['Summary'].values

X_no_stop_train, X_no_stop_test, y_train, y_test = train_test_split(X_no_stop, Y, te
st_size=0.33, shuffle=False)
X_no_stop_train, X_no_stop_CV, y_train, y_CV = train_test_split(X_no_stop_train, y_t
rain, test_size=0.33, shuffle=False)

X_summary_train,X_summary_test, y_summary_train, y_summary_test = train_test_split(X
_summary, Y, test_size=0.33, shuffle=False)
X_summary_train,X_summary_CV, y_summary_train, y_summary_CV = train_test_split(X_sum
mary_train,y_summary_train, test_size=0.33, shuffle=False)
```

[5.1] Logistic Regression on BOW, SET 1

In [3]:

```
%time
from sklearn.feature_extraction.text import CountVectorizer
import math

bow_vect = CountVectorizer(ngram_range = (1,2),min_df = 7,max_features=9000)
bow_X_train_no_stop = bow_vect.fit_transform(X_no_stop_train)
bow_X_test_no_stop = bow_vect.transform(X_no_stop_test)
bow_X_CV_no_stop = bow_vect.transform(X_no_stop_CV)
##################################################
bow_X_summary_train = bow_vect.fit_transform(X_summary_train)
bow_X_summary_test = bow_vect.transform(X_summary_test)
bow_X_summary_CV = bow_vect.transform(X_summary_CV)
####################################
from sklearn.model_selection import cross_val_score
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score

# creating odd list of C(i.e. 1/lambda) for BOW Logistic Regression
def tothepower(y):
    return (10**y)
C_LR_BOW = list(map(tothepower, list(range(-4, 5))))
print (C_LR_BOW)
C_LR_BOW_log = [math.log(x) for x in C_LR_BOW]
print (C_LR_BOW_log)
```

```
Wall time: 0 ns
[0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000]
[-9.210340371976182, -6.907755278982137, -4.605170185988091, -2.30258509
29940455, 0.0, 2.302585092994046, 4.605170185988092, 6.907755278982137,
9.210340371976184]
```

In [4]:

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

bow_X_train_txt =StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X_
train_no_stop)
bow_X_test_txt = StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X_
test_no_stop)
bow_X_CV_txt = StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X_CV
_no_stop)
########################################
bow_X_train_sum =StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X_
summary_train)
bow_X_test_sum = StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X_
summary_test)
bow_X_CV_sum = StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X_su
mmary_CV)
print (bow_X_train_txt.shape)
```

```
(164472, 9000)
```

[5.1.1] Applying Logistic Regression with L1 regularization on BOW, SET 1

In [5]:

```
from sklearn.linear_model import LogisticRegression
auc_cv_bow_txt = []
auc_train_bow_txt=[]


for C in tqdm(C_LR_BOW):
    LR_BOW_txt = LogisticRegression(penalty='l1',C=C, fit_intercept=True, intercept_
scaling=1, class_weight='balanced')
    LR_BOW_txt.fit(bow_X_train_txt, y_train)
    proba_pred_train_BOW_txt=(LR_BOW_txt.predict_proba(bow_X_train_txt)[:,1])
    proba_pred_cv_BOW_txt=(LR_BOW_txt.predict_proba(bow_X_CV_txt)[:,1])
    auc_train_bow_txt.append(roc_auc_score(y_train,proba_pred_train_BOW_txt))
    auc_cv_bow_txt.append(roc_auc_score(y_CV,proba_pred_cv_BOW_txt))
```

100%|██
████████████████| 9/9 [00:57<00:00, 10.07s/it]

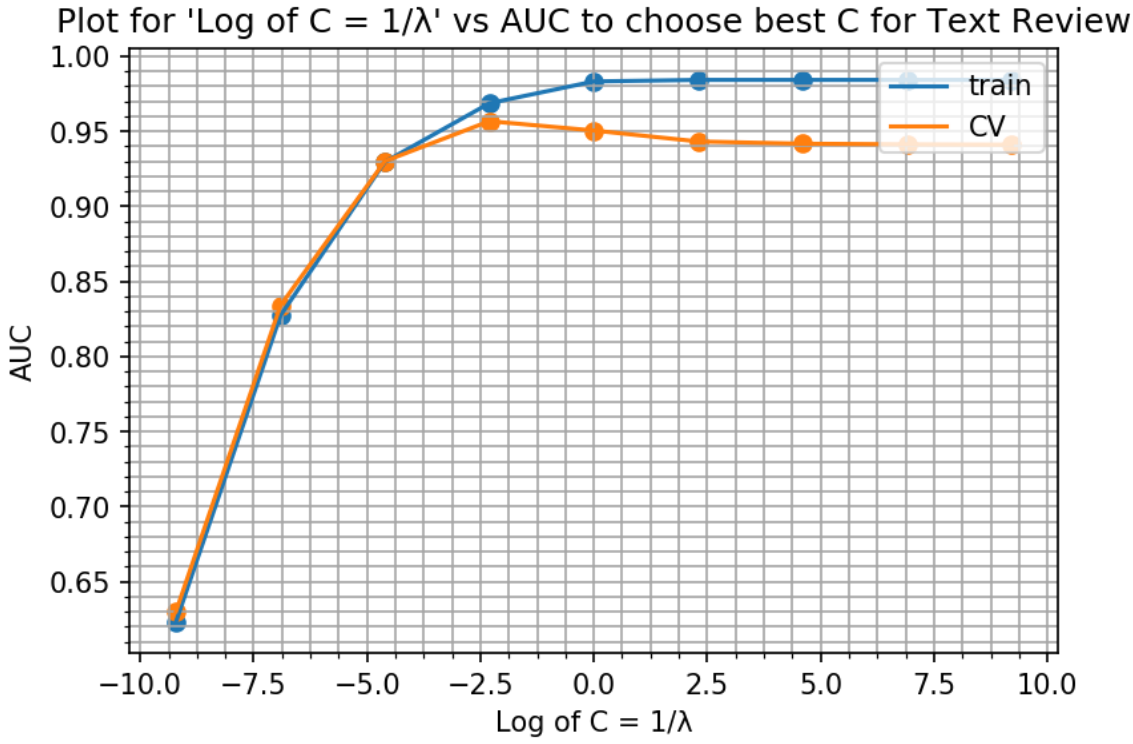
In [6]:

```
l1_auc_cv_bow_summary = []
l1_auc_train_bow_summary=[]

for C in (C_LR_BOW):
    L1_BOW_sum = LogisticRegression(penalty='l1',C=C, fit_intercept=True, intercept_
scaling=1, class_weight='balanced')
    L1_BOW_sum.fit(bow_X_train_sum, y_summary_train)
    l1_proba_pred_train_BOW_sum=(L1_BOW_sum.predict_proba(bow_X_train_sum)[:,1])
    L1_proba_pred_cv_BOW_sum=(L1_BOW_sum.predict_proba(bow_X_CV_sum)[:,1])
    l1_auc_train_bow_summary.append(roc_auc_score(y_summary_train,l1_proba_pred_trai
n_BOW_sum))
    l1_auc_cv_bow_summary.append(roc_auc_score(y_summary_CV,L1_proba_pred_cv_BOW_sum
))
```

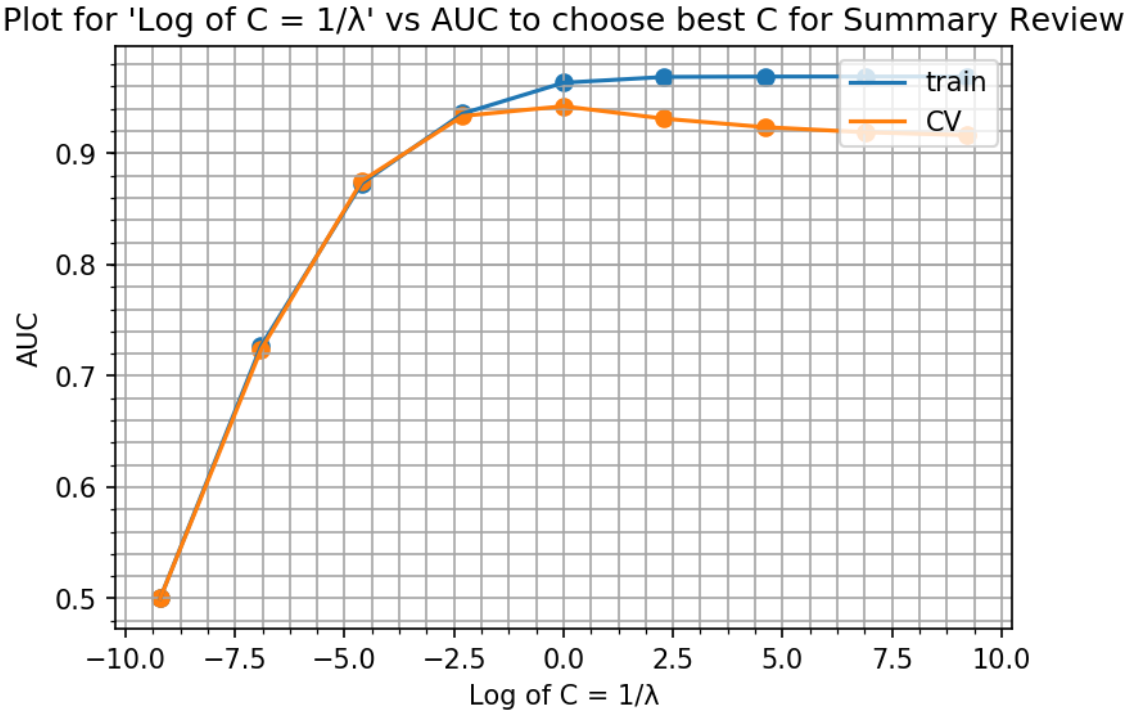
In [7]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_BOW_log, auc_train_bow_txt)
plt.scatter(C_LR_BOW_log, auc_train_bow_txt)
plt.plot(C_LR_BOW_log, auc_cv_bow_txt)
plt.scatter(C_LR_BOW_log, auc_cv_bow_txt)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



In [8]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_BOW_log, l1_auc_train_bow_summary)
plt.scatter(C_LR_BOW_log, l1_auc_train_bow_summary)
plt.plot(C_LR_BOW_log, l1_auc_cv_bow_summary)
plt.scatter(C_LR_BOW_log, l1_auc_cv_bow_summary)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Summary Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



In [9]:

```
import numpy as np
lis = np.arange (.01, 1, .05)
print (lis)
```

```
[0.01 0.06 0.11 0.16 0.21 0.26 0.31 0.36 0.41 0.46 0.51 0.56 0.61 0.66
 0.71 0.76 0.81 0.86 0.91 0.96]
```

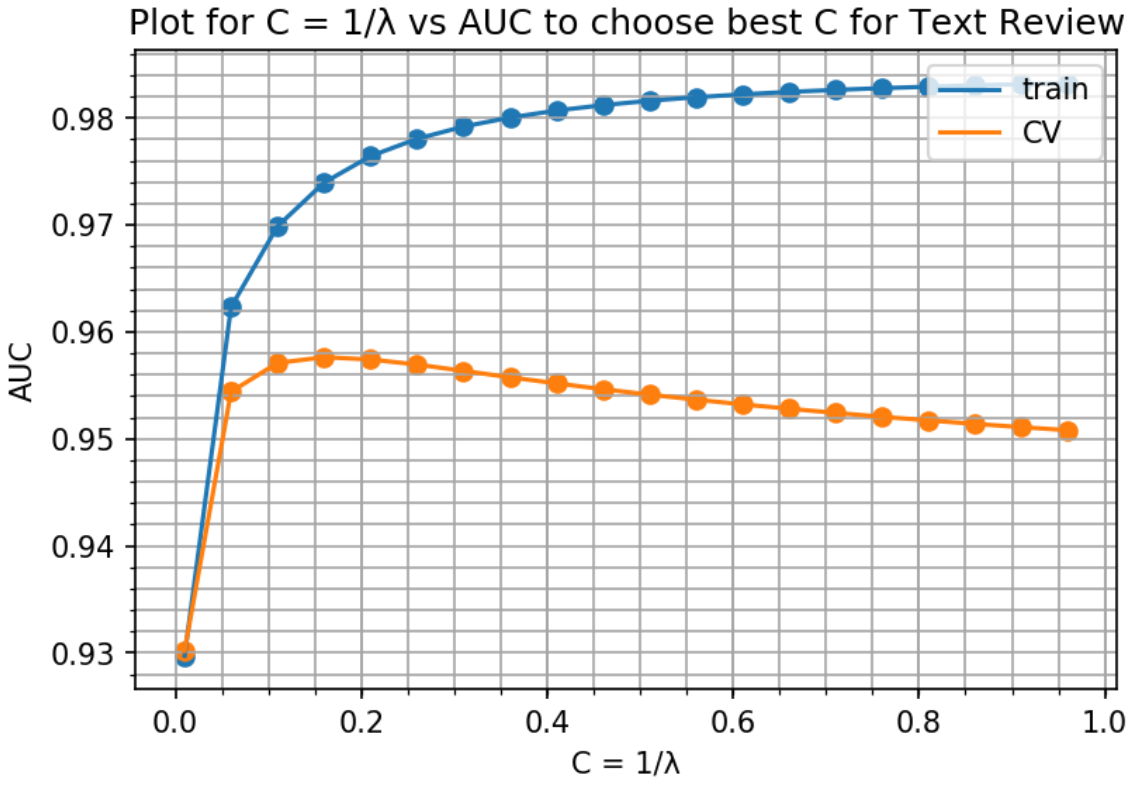
In [10]:

```
from sklearn.linear_model import LogisticRegression
auc_cv_bow_txt = []
auc_train_bow_txt=[]


for C in (lis):
    LR_BOW_txt = LogisticRegression(penalty='l1',C=C, fit_intercept=True, intercept_
scaling=1, class_weight='balanced')
    LR_BOW_txt.fit(bow_X_train_txt, y_train)
    proba_pred_train_BOW_txt=(LR_BOW_txt.predict_proba(bow_X_train_txt)[:,1])
    proba_pred_cv_BOW_txt=(LR_BOW_txt.predict_proba(bow_X_CV_txt)[:,1])
    auc_train_bow_txt.append(roc_auc_score(y_train,proba_pred_train_BOW_txt))
    auc_cv_bow_txt.append(roc_auc_score(y_CV,proba_pred_cv_BOW_txt))
```

In [11]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(lis, auc_train_bow_txt)
plt.scatter(lis, auc_train_bow_txt)
plt.plot(lis, auc_cv_bow_txt)
plt.scatter(lis, auc_cv_bow_txt)
plt.xlabel('C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for C = 1/λ vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



So the best C is 0.16 for Text Review

In [12]:

```
import numpy as np
lis2 = np.arange (.1, 1, .05)
print (lis2)
```

```
[0.1  0.15 0.2  0.25 0.3  0.35 0.4  0.45 0.5  0.55 0.6  0.65 0.7  0.75
 0.8  0.85 0.9  0.95]
```

In [13]:

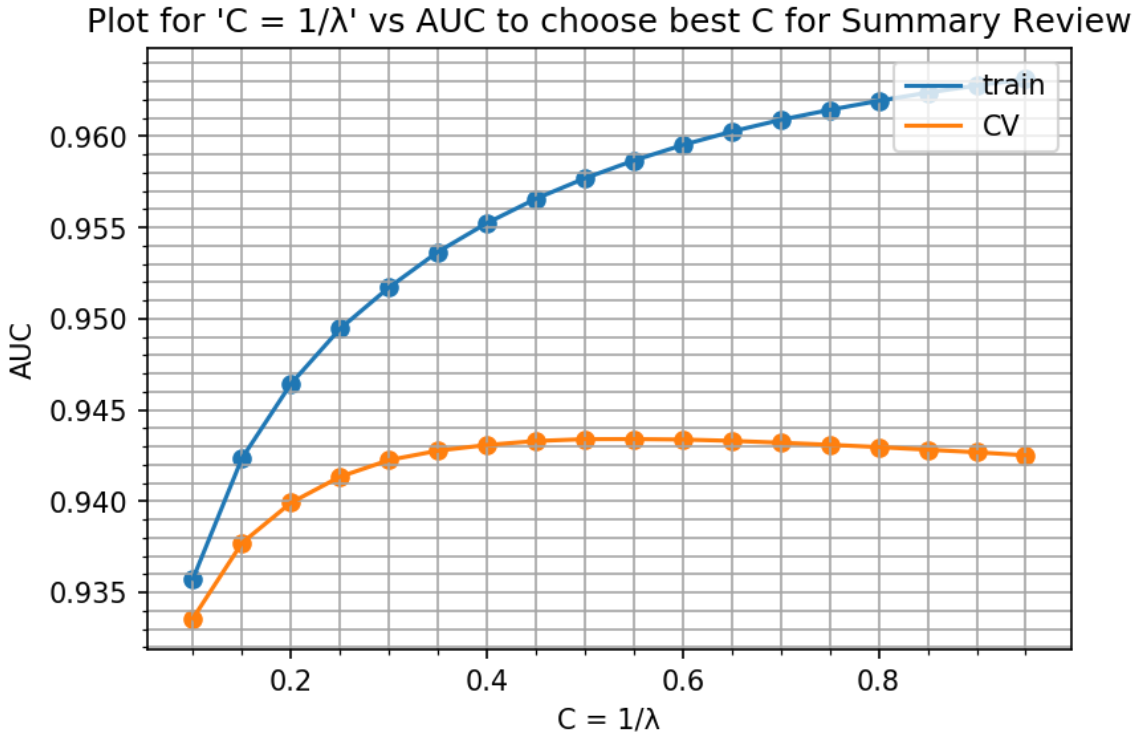
```
auc_cv_bow_summary = []
auc_train_bow_summary=[]

for C in tqdm(lis2):
    LR_BOW_sum = LogisticRegression(penalty='l1',C=C, fit_intercept=True, intercept_
scaling=1, class_weight='balanced')
    LR_BOW_sum.fit(bow_X_train_sum, y_summary_train)
    proba_pred_train_BOW_sum=(LR_BOW_sum.predict_proba(bow_X_train_sum)[:,1])
    proba_pred_cv_BOW_sum=(LR_BOW_sum.predict_proba(bow_X_CV_sum)[:,1])
    auc_train_bow_summary.append(roc_auc_score(y_summary_train,proba_pred_train_BOW_
sum))
    auc_cv_bow_summary.append(roc_auc_score(y_summary_CV,proba_pred_cv_BOW_sum))
```

```
100%|██████████████████████████████████████████████████████████████████
████████████████| 18/18 [00:07<00:00,  2.18it/s]
```

In [14]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(lis2, auc_train_bow_summary)
plt.scatter(lis2, auc_train_bow_summary)
plt.plot(lis2, auc_cv_bow_summary)
plt.scatter(lis2, auc_cv_bow_summary)
plt.xlabel('C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'C = 1/λ' vs AUC to choose best C for Summary Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



Best C for Summary Review is .6

In [15]:

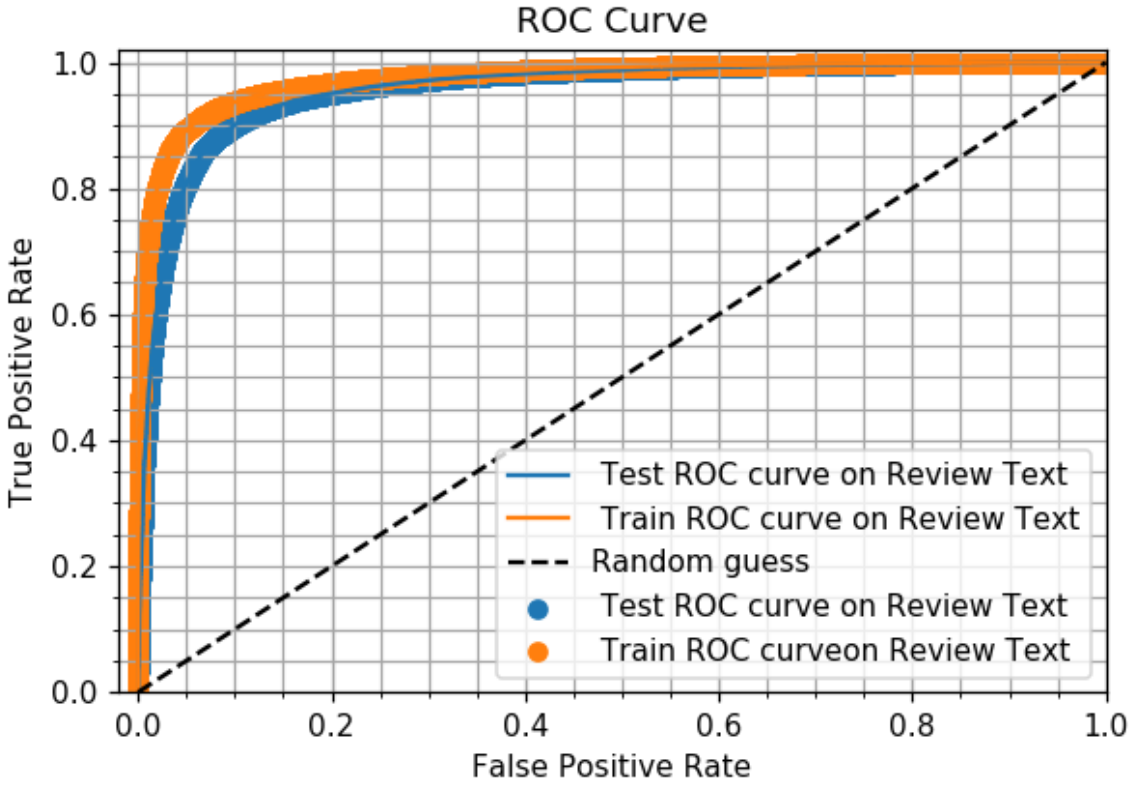
```
bestC_L1_BOW_txt = LogisticRegression(penalty='l1',C=.16, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
bestC_L1_BOW_txt.fit(bow_X_train_txt, y_train)
l1_proba_pred_train_BOW_txt=(bestC_L1_BOW_txt.predict_proba(bow_X_train_txt)[:,1])
l1_proba_pred_test_BOW_txt=(bestC_L1_BOW_txt.predict_proba(bow_X_test_txt)[:,1])

l1_auc_test_BOW  = (roc_auc_score(y_test,l1_proba_pred_test_BOW_txt))
l1_auc_train_BOW  = (roc_auc_score(y_train,l1_proba_pred_train_BOW_txt))
```

In [16]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_bow_l1_txt, tpr_test_bow_l1_txt, thresholds = roc_curve(y_test, l1_proba_pr
ed_test_BOW_txt)
fpr_train_bow_l1_txt, tpr_train_bow_l1_txt, thresholds = roc_curve(y_train, l1_proba
_pred_train_BOW_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_bow_l1_txt, tpr_test_bow_l1_txt, label=' Test ROC curve on Review
 Text')
plt.scatter(fpr_test_bow_l1_txt, tpr_test_bow_l1_txt, label=' Test ROC curve on Revi
ew Text')
plt.plot(fpr_train_bow_l1_txt, tpr_train_bow_l1_txt, label=' Train ROC curve on Revi
ew Text')
plt.scatter(fpr_train_bow_l1_txt, tpr_train_bow_l1_txt, label=' Train ROC curveon Re
view Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [17]:

```
bestC_L1_BOW_txt = LogisticRegression(penalty='l1',C=.16, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
bestC_L1_BOW_txt.fit(bow_X_train_txt, y_train)
l1_pred_train_BOW_txt=(bestC_L1_BOW_txt.predict(bow_X_train_txt))
l1_pred_test_BOW_txt=(bestC_L1_BOW_txt.predict(bow_X_test_txt))
```

In [18]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")

print(classification_report(y_test, l1_pred_test_BOW_txt))


print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, l1_pred_train_BOW_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.66      0.90      0.76     21261
          1       0.98      0.90      0.94     99648

avg / total       0.92      0.90      0.91    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.65      0.93      0.76     22681
          1       0.99      0.92      0.95    141791

avg / total       0.94      0.92      0.93    164472
```

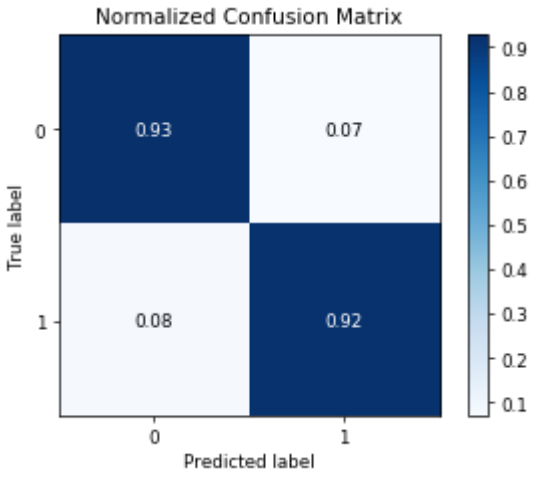
In [19]:

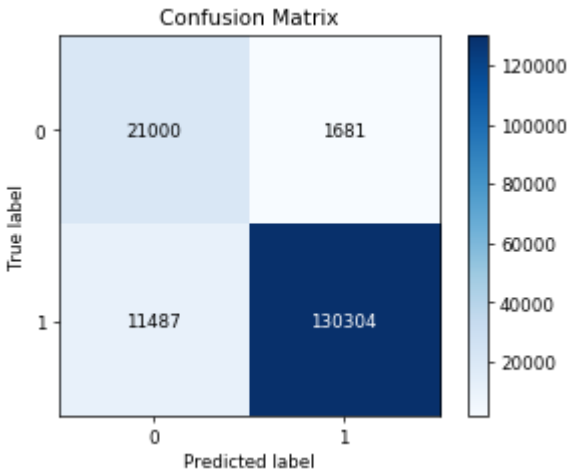
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train,l1_pred_train_BOW_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train,l1_pred_train_BOW_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[19]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1527d321860>
```





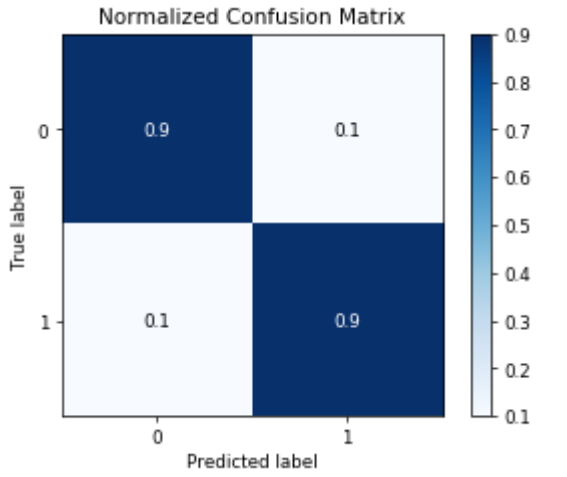
In [20]:

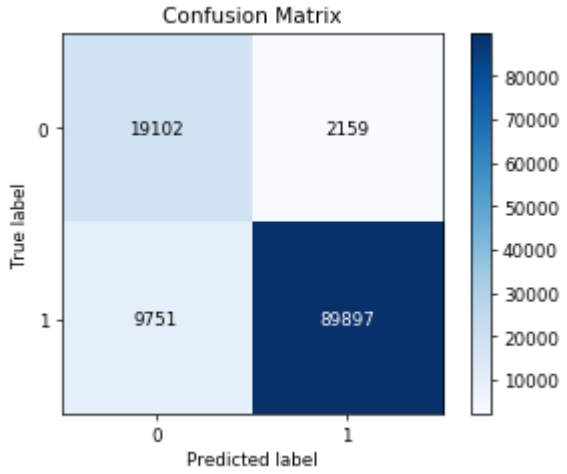
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, l1_pred_test_BOW_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, l1_pred_test_BOW_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[20]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x152766e6eb8>
```





Lets perform the same over Summary Text

In [21]:

```
bestC_L1_BOW_sum = LogisticRegression(penalty='l1',C=.6, fit_intercept=True, interce
pt_scaling=1, class_weight='balanced')
bestC_L1_BOW_sum.fit(bow_X_train_sum, y_summary_train)
L1_proba_pred_train_BOW_sum=(bestC_L1_BOW_sum.predict_proba(bow_X_train_sum)[:,1])
L1_proba_pred_test_BOW_sum=(bestC_L1_BOW_sum.predict_proba(bow_X_test_sum)[:,1])
```

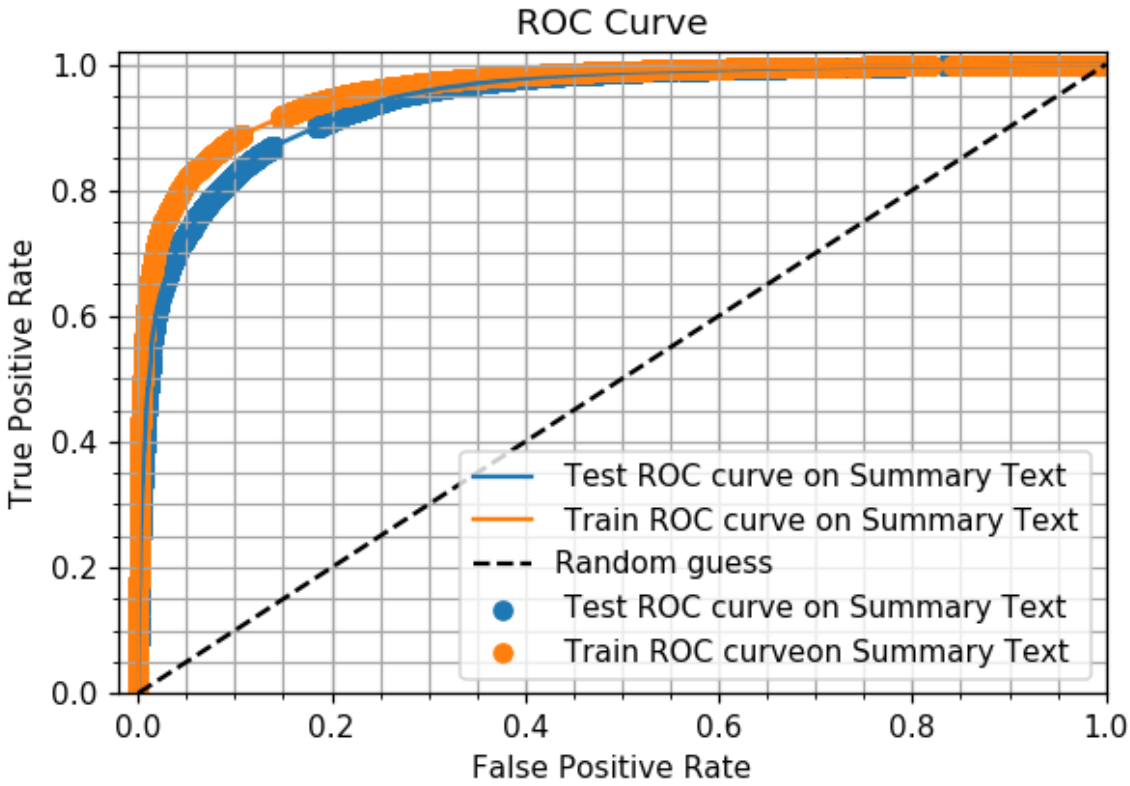
In [22]:

```
l1_auc_test_BOW  = (roc_auc_score(y_test,L1_proba_pred_test_BOW_sum))
l1_auc_train_BOW  = (roc_auc_score(y_train,L1_proba_pred_train_BOW_sum))
```

In [23]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_bow_l1_sum, tpr_test_bow_l1_sum, thresholds = roc_curve(y_summary_test, L1_
proba_pred_test_BOW_sum)
fpr_train_bow_l1_sum, tpr_train_bow_l1_sum, thresholds = roc_curve(y_summary_train,
L1_proba_pred_train_BOW_sum)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_bow_l1_sum, tpr_test_bow_l1_sum, label=' Test ROC curve on Summary
Text')
plt.scatter(fpr_test_bow_l1_sum, tpr_test_bow_l1_sum, label=' Test ROC curve on Summ
ary Text')
plt.plot(fpr_train_bow_l1_sum, tpr_train_bow_l1_sum, label=' Train ROC curve on Summ
ary Text')
plt.scatter(fpr_train_bow_l1_sum, tpr_train_bow_l1_sum, label=' Train ROC curveon Su
mmary Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [24]:

```
bestC_L1_BOW_sum = LogisticRegression(penalty='l1',C=.6, fit_intercept=True, interce
pt_scaling=1, class_weight='balanced')
bestC_L1_BOW_sum.fit(bow_X_train_sum, y_summary_train)
L1_pred_train_BOW_sum=(bestC_L1_BOW_sum.predict(bow_X_train_sum))
L1_pred_test_BOW_sum=(bestC_L1_BOW_sum.predict(bow_X_test_sum))
```

In [25]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")

print(classification_report(y_summary_test, L1_pred_test_BOW_sum))


print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_summary_train, L1_pred_train_BOW_sum))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.56      0.88      0.68     21261
          1       0.97      0.85      0.91     99648

avg / total       0.90      0.86      0.87    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.53      0.91      0.67     22681
          1       0.98      0.87      0.93    141791

avg / total       0.92      0.88      0.89    164472
```

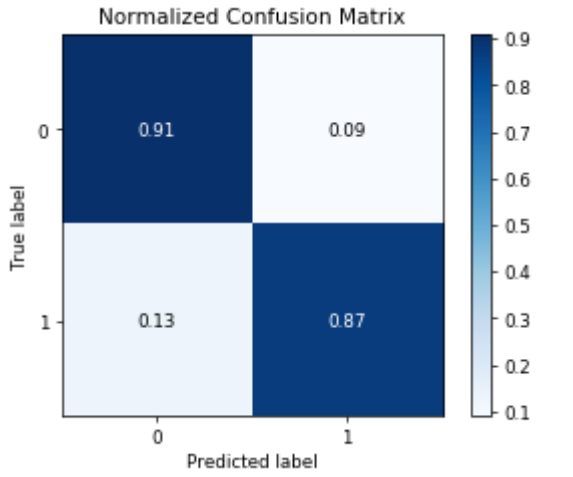
In [26]:

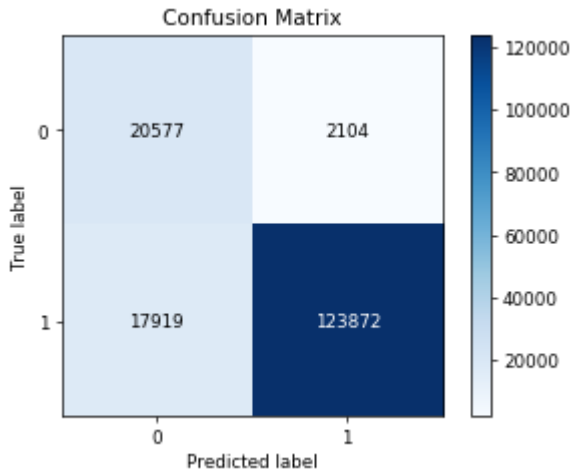
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_summary_train,L1_pred_train_BOW_sum,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_summary_train,L1_pred_train_BOW_sum)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[26]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15245a144a8>
```





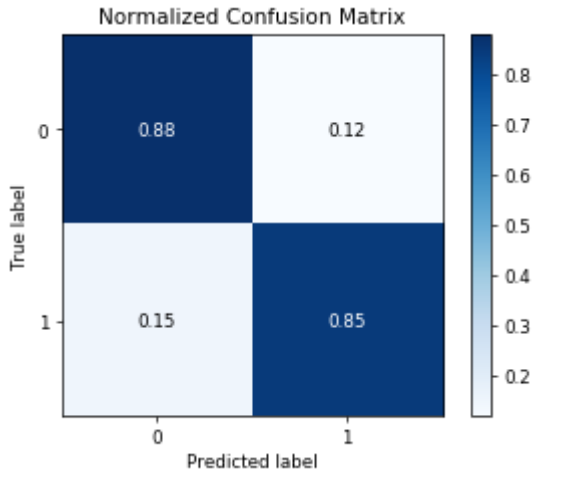
In [27]:

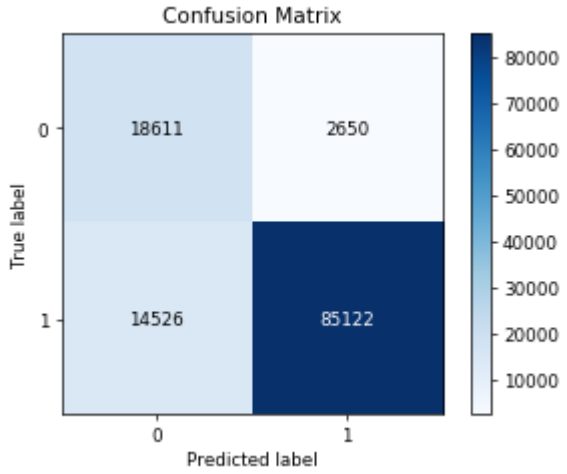
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_summary_test, L1_pred_test_BOW_sum,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_summary_test, L1_pred_test_BOW_sum)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[27]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1526ffb9a20>
```





[5.1.1.1] Calculating sparsity on weight vector obtained using L1 regularization on BOW, SET 1

In [28]:

```
import numpy as np
bestC_L1_BOW_sum = LogisticRegression(penalty='l1',C=.55, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
bestC_L1_BOW_sum.fit(bow_X_summary_train, y_summary_train)
coef_ =bestC_L1_BOW_sum.coef_
bow_features_name_l1_sum = bow_vect.get_feature_names()
sparsity_wght_df = pd.DataFrame(coef_, columns = bow_features_name_l1_sum)
sparsity_wght_df_trans = sparsity_wght_df.T
sparsity_wght_df_trans.columns = ["Weight"]
print (sparsity_wght_df_trans)
```

	Weight
10	-0.182671
10 star	2.205732
100	-0.408930
100 calorie	1.080471
100 juice	0.000000
100 natural	0.000000
100 pure	-0.308794
100 whole	0.000000
11	-1.299526
12	-0.016507
12 ounce	0.000000
12 oz	0.000000
13	0.000000
130	0.000000
14	-0.165057
15	-0.228623
16	0.000000
16 ounce	0.000000
16 oz	0.000000
17	0.000000
18	0.000000
1866	0.000000
19	0.000000
1st	-0.180391
20	-0.997673
2008	-2.081325
2010	0.000000
2011	-1.596866
21	-0.200899
24	0.000000
...	...
yummy good	0.000000
yummy great	0.000000
yummy gummi	0.000000
yummy healthi	0.000000
yummy healthy	0.000000
yummy little	0.000000
yummy low	0.000000
yummy not	0.000000
yummy snack	0.000000
yummy stuff	0.000000
yummy tea	0.000000
yummy treat	0.000000
yummy tummi	0.000000
yummy way	0.000000
yummy yum	0.000000
yummy yummi	-5.402375
yummy yummy	0.000000
yummyearth	0.000000
yumyum	0.061501
zen	0.164548
zero	-1.239981
zero star	-1.405409
zesty	1.472606
zevia	-0.016135
zico	0.129125
zinger	0.000000
zip	0.000000
zoe	0.000000
zotz	0.000000

```
zukes          0.000000

[9000 rows x 1 columns]
```

In [29]:

```
#https://docs.scipy.org/doc/numpy-1.14.0/reference/generated/numpy.count_nonzero.html
sparsity_wght_df_trans_non_zero = np.count_nonzero(sparsity_wght_df_trans)
print (sparsity_wght_df_trans_non_zero)
```

```
3799
```

So we see out of 9000 only 3799 are nonzero weights vectors. That means only 3799 are relevant features to consider and rest (i.e. 9000-3799=5201) words vectors/features could be discarded as per L1 regularization

[5.1.2] Applying Logistic Regression with L2 regularization on BOW, SET 1

In [30]:

```
from sklearn.linear_model import LogisticRegression
l2_auc_cv_bow_txt = []
l2_auc_train_bow_txt=[]


for C in (C_LR_BOW):
    L2_BOW_txt = LogisticRegression(penalty='l2',C=C, fit_intercept=True,intercept_scaling=1,class_weight='balanced')
    L2_BOW_txt.fit(bow_X_train_txt, y_train)
    l2_proba_pred_train_BOW_txt=(L2_BOW_txt.predict_proba(bow_X_train_txt)[:,1])
    l2_proba_pred_cv_BOW_txt=(L2_BOW_txt.predict_proba(bow_X_CV_txt)[:,1])
    l2_auc_train_bow_txt.append(roc_auc_score(y_train,l2_proba_pred_train_BOW_txt))
    l2_auc_cv_bow_txt.append(roc_auc_score(y_CV,l2_proba_pred_cv_BOW_txt))
```

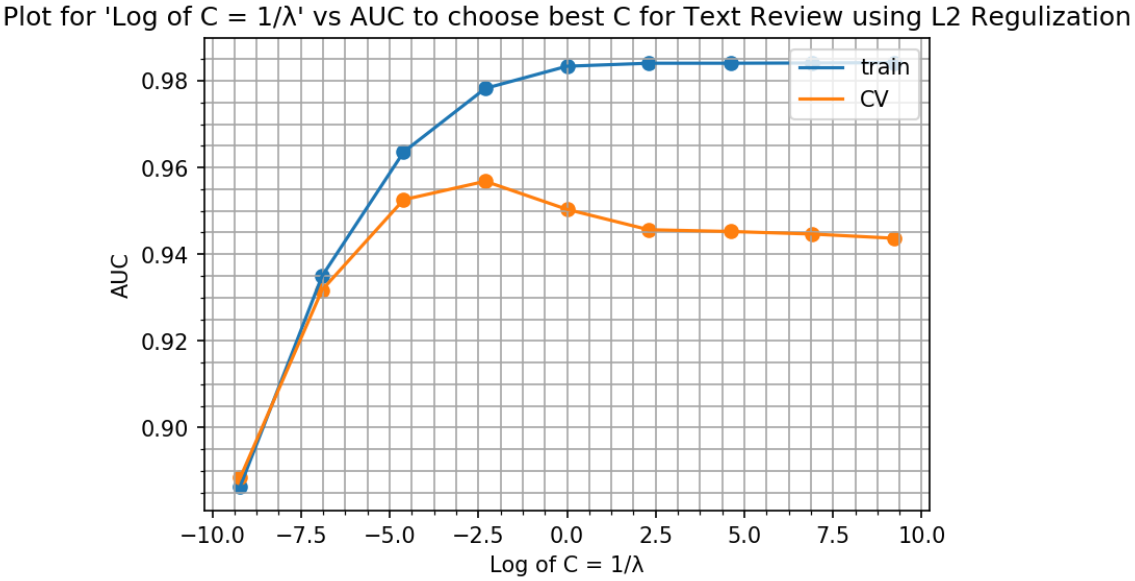
In [31]:

```
print (C_LR_BOW)
print (C_LR_BOW_log)
```

```
[0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000]
[-9.210340371976182, -6.907755278982137, -4.605170185988091, -2.30258509
29940455, 0.0, 2.302585092994046, 4.605170185988092, 6.907755278982137,
9.210340371976184]
```

In [32]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_BOW_log, l2_auc_train_bow_txt)
plt.scatter(C_LR_BOW_log, l2_auc_train_bow_txt)
plt.plot(C_LR_BOW_log, l2_auc_cv_bow_txt)
plt.scatter(C_LR_BOW_log, l2_auc_cv_bow_txt)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Text Review using L
2 Regulization")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



In [33]:

```
import numpy as np
list_l2 = np.arange (.01, 1, .05)
print (list_l2)
```

```
[0.01 0.06 0.11 0.16 0.21 0.26 0.31 0.36 0.41 0.46 0.51 0.56 0.61 0.66
 0.71 0.76 0.81 0.86 0.91 0.96]
```

In [34]:

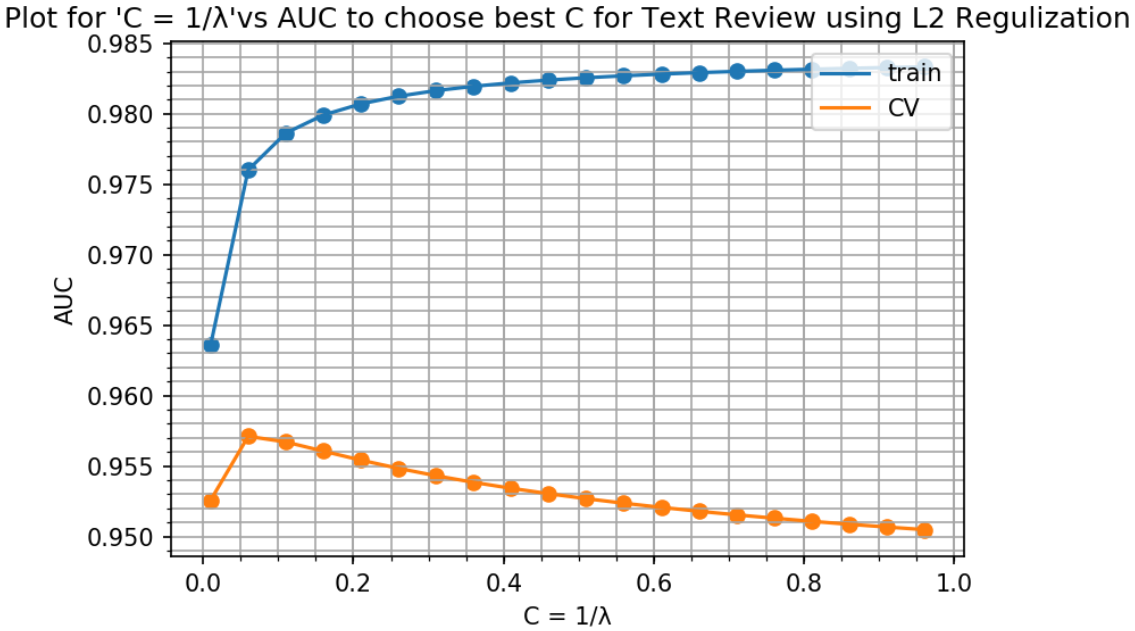
```
from sklearn.linear_model import LogisticRegression
l2_auc_cv_bow_txt = []
l2_auc_train_bow_txt=[]


for C in (list_l2):
    L2_BOW_txt = LogisticRegression(penalty='l2',C=C, fit_intercept=True,intercept_s
caling=1, verbose =1,class_weight='balanced')
    L2_BOW_txt.fit(bow_X_train_txt, y_train)
    l2_proba_pred_train_BOW_txt=(L2_BOW_txt.predict_proba(bow_X_train_txt)[:,1])
    l2_proba_pred_cv_BOW_txt=(L2_BOW_txt.predict_proba(bow_X_CV_txt)[:,1])
    l2_auc_train_bow_txt.append(roc_auc_score(y_train,l2_proba_pred_train_BOW_txt))
    l2_auc_cv_bow_txt.append(roc_auc_score(y_CV,l2_proba_pred_cv_BOW_txt))
```

```
[LibLinear][LibLinear][LibLinear][LibLinear][LibLinear][LibLinear][LibLi
near][LibLinear][LibLinear][LibLinear][LibLinear][LibLinear][LibLinear]
[LibLinear][LibLinear][LibLinear][LibLinear][LibLinear][LibLinear][LibLi
near]
```

In [35]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(list_l2, l2_auc_train_bow_txt)
plt.scatter(list_l2, l2_auc_train_bow_txt)
plt.plot(list_l2, l2_auc_cv_bow_txt)
plt.scatter(list_l2, l2_auc_cv_bow_txt)
plt.xlabel('C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'C = 1/λ'vs AUC to choose best C for Text Review using L2 Reguli
zation")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



Best C is .06 for Text Review using L2 Regulization

In [36]:

```
bestC_l2_proba_pred_train_BOW_txt = []
bestC_l2_proba_pred_test_BOW_txt = []

bestC_L2_BOW_txt = LogisticRegression(penalty='l2',C=.06, fit_intercept=True,interce
pt_scaling=1, verbose =1,class_weight='balanced')
bestC_L2_BOW_txt.fit(bow_X_train_txt, y_train)
bestC_l2_proba_pred_train_BOW_txt=(bestC_L2_BOW_txt.predict_proba(bow_X_train_txt)
[:,1])
bestC_l2_proba_pred_test_BOW_txt=(bestC_L2_BOW_txt.predict_proba(bow_X_test_txt)[:,1
])
```

```
[LibLinear]
```

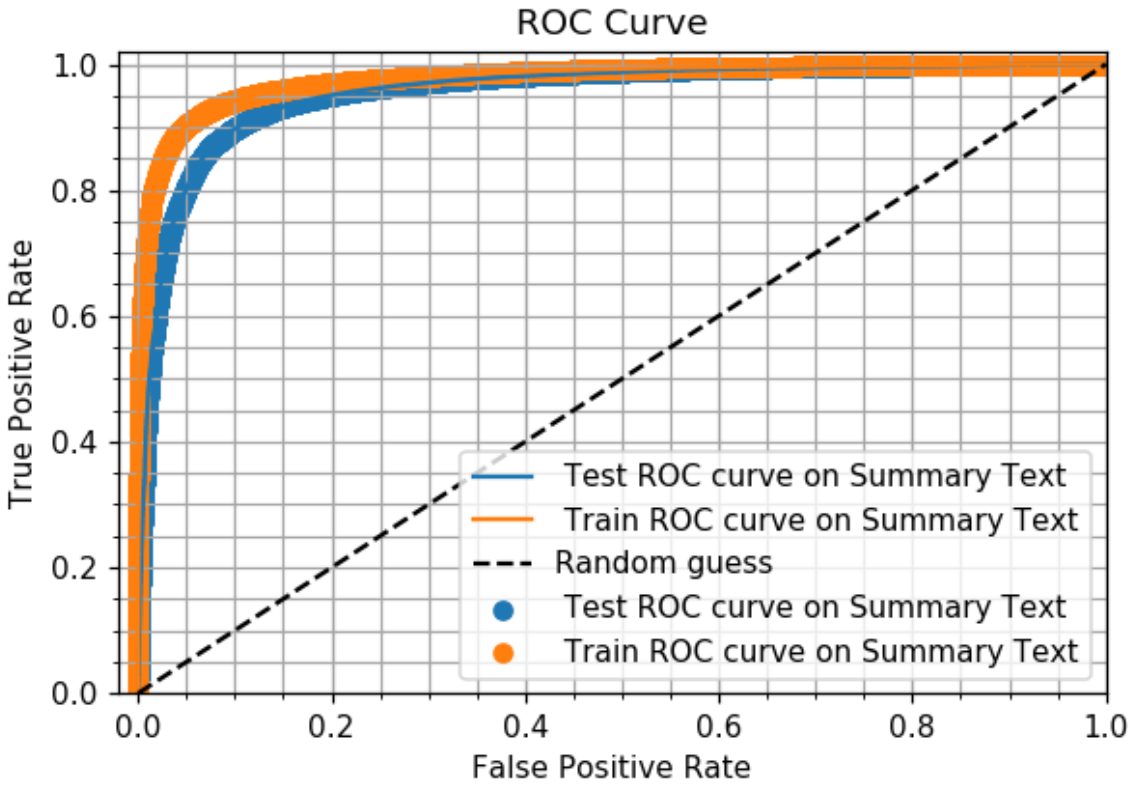
In [37]:

```
l2_auc_test_BOW  = (roc_auc_score(y_test,bestC_l2_proba_pred_test_BOW_txt))
l2_auc_train_BOW  = (roc_auc_score(y_train,bestC_l2_proba_pred_train_BOW_txt))
```

In [38]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_bow_l2_txt, tpr_test_bow_l2_txt, thresholds = roc_curve(y_test, bestC_l2_pr
oba_pred_test_BOW_txt)
fpr_train_bow_l2_txt, tpr_train_bow_l2_txt, thresholds = roc_curve(y_train, bestC_l2
_proba_pred_train_BOW_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_bow_l2_txt, tpr_test_bow_l2_txt, label=' Test ROC curve on Summary
Text')
plt.scatter(fpr_test_bow_l2_txt, tpr_test_bow_l2_txt, label=' Test ROC curve on Summ
ary Text')
plt.plot(fpr_train_bow_l2_txt, tpr_train_bow_l2_txt, label=' Train ROC curve on Summ
ary Text')
plt.scatter(fpr_train_bow_l2_txt, tpr_train_bow_l2_txt, label=' Train ROC curve on S
ummary Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [39]:

```
bestC_L2_BOW_txt = LogisticRegression(penalty='l2',C=.06, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
bestC_L2_BOW_txt.fit(bow_X_train_txt, y_train)
l2_pred_train_BOW_txt=(bestC_L2_BOW_txt.predict(bow_X_train_txt))
l2_pred_test_BOW_txt=(bestC_L1_BOW_txt.predict(bow_X_test_txt))
```

In [40]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")

print(classification_report(y_test, l2_pred_test_BOW_txt))


print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, l2_pred_train_BOW_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.66      0.90      0.76     21261
          1       0.98      0.90      0.94     99648

avg / total       0.92      0.90      0.91    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.65      0.93      0.77     22681
          1       0.99      0.92      0.95    141791

avg / total       0.94      0.92      0.93    164472
```

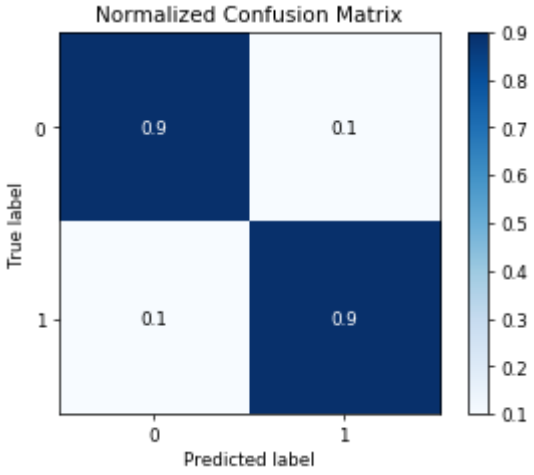
In [41]:

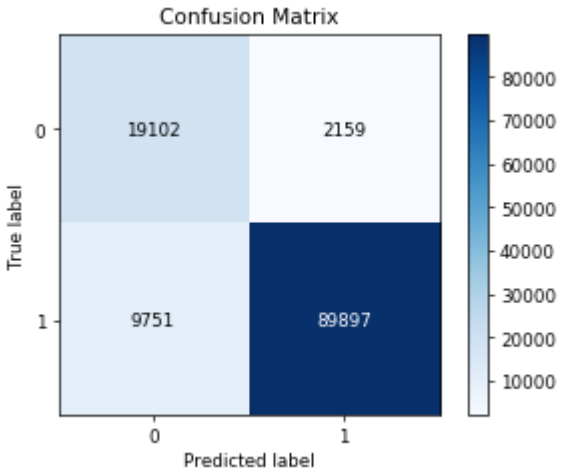
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, l2_pred_test_BOW_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, l2_pred_test_BOW_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[41]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1526cbb9f98>
```





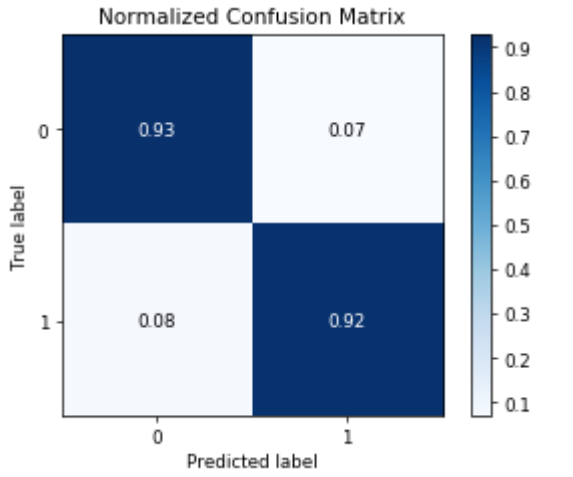
In [42]:

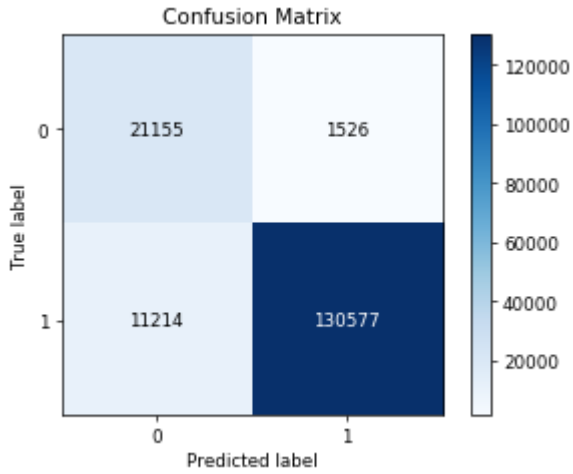
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train, l2_pred_train_BOW_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train, l2_pred_train_BOW_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[42]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15203e54908>
```





In [43]:

```
l2_auc_cv_bow_summary = []
L2_auc_train_bow_summary=[]

for C in tqdm(C_LR_BOW):
    L2_BOW_sum = LogisticRegression(penalty='l2',C=C, fit_intercept=True, intercept_
scaling=1, class_weight='balanced')
    L2_BOW_sum.fit(bow_X_train_sum, y_summary_train)
    proba_pred_train_BOW_sum=(L2_BOW_sum.predict_proba(bow_X_train_sum)[:,1])
    proba_pred_cv_BOW_sum=(L2_BOW_sum.predict_proba(bow_X_CV_sum)[:,1])
    L2_auc_train_bow_summary.append(roc_auc_score(y_summary_train,proba_pred_train_B
OW_sum))
    l2_auc_cv_bow_summary.append(roc_auc_score(y_summary_CV,proba_pred_cv_BOW_sum))
```

```
100%|██████████████████████████████████████████████████████████████████
████████████████| 9/9 [01:00<00:00, 13.93s/it]
```

In [44]:

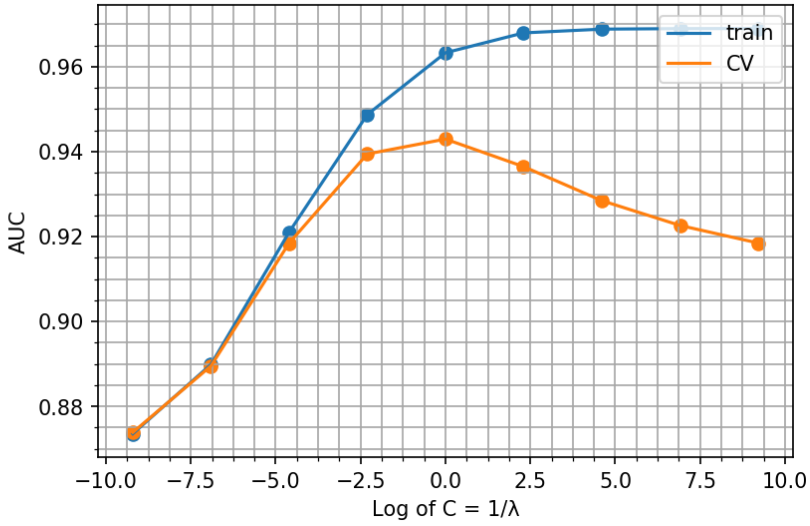
```
print (C_LR_BOW)
```

```
[0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000]
```

In [45]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_BOW_log, L2_auc_train_bow_summary)
plt.scatter(C_LR_BOW_log, L2_auc_train_bow_summary)
plt.plot(C_LR_BOW_log, l2_auc_cv_bow_summary)
plt.scatter(C_LR_BOW_log, l2_auc_cv_bow_summary)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Summary Review with
L2 Regulization")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```

Plot for 'Log of C = 1/λ' vs AUC to choose best C for Summary Review with L2 Regulization



In [46]:

```
import numpy as np
list_l2_sum = np.arange (.1, 10, .2)
print (list_l2_sum)
```

```
[0.1 0.3 0.5 0.7 0.9 1.1 1.3 1.5 1.7 1.9 2.1 2.3 2.5 2.7 2.9 3.1 3.3 3.5
 3.7 3.9 4.1 4.3 4.5 4.7 4.9 5.1 5.3 5.5 5.7 5.9 6.1 6.3 6.5 6.7 6.9 7.1
 7.3 7.5 7.7 7.9 8.1 8.3 8.5 8.7 8.9 9.1 9.3 9.5 9.7 9.9]
```

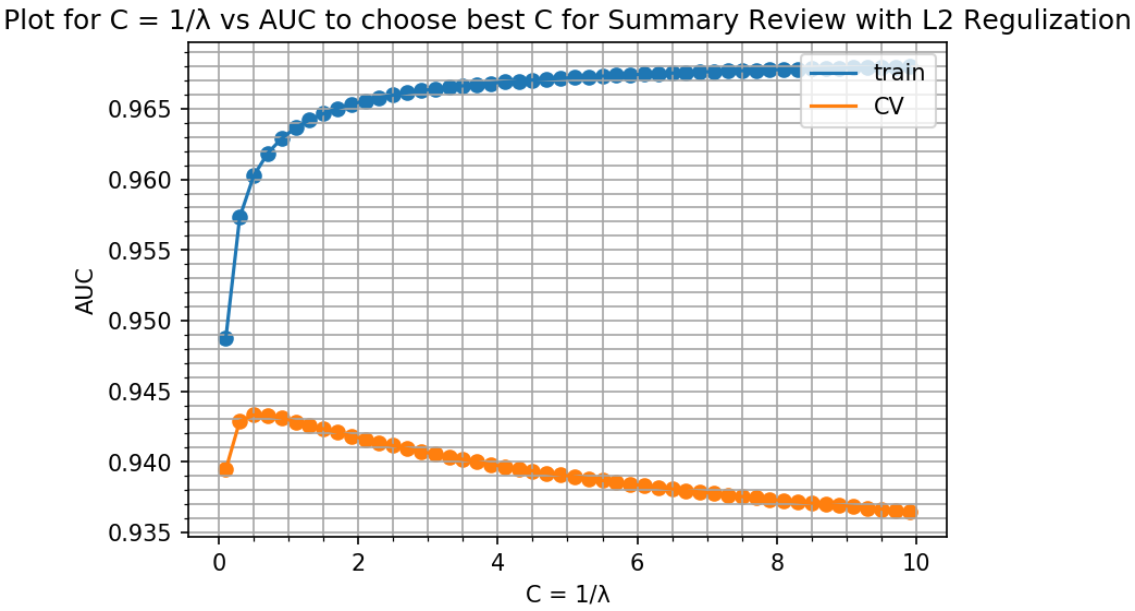
In [47]:

```
l2_auc_cv_bow_summary = []
L2_auc_train_bow_summary=[]

for C in (list_l2_sum):
    L2_BOW_sum = LogisticRegression(penalty='l2',C=C, fit_intercept=True, intercept_
scaling=1, class_weight='balanced')
    L2_BOW_sum.fit(bow_X_train_sum, y_summary_train)
    proba_pred_train_BOW_sum=(L2_BOW_sum.predict_proba(bow_X_train_sum)[:,1])
    proba_pred_cv_BOW_sum=(L2_BOW_sum.predict_proba(bow_X_CV_sum)[:,1])
    L2_auc_train_bow_summary.append(roc_auc_score(y_summary_train,proba_pred_train_B
OW_sum))
    l2_auc_cv_bow_summary.append(roc_auc_score(y_summary_CV,proba_pred_cv_BOW_sum))
```

In [48]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(list_l2_sum, L2_auc_train_bow_summary)
plt.scatter(list_l2_sum, L2_auc_train_bow_summary)
plt.plot(list_l2_sum, l2_auc_cv_bow_summary)
plt.scatter(list_l2_sum, l2_auc_cv_bow_summary)
plt.xlabel('C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for C = 1/λ vs AUC to choose best C for Summary Review with L2 Regul
ization")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



So the best Value of C for summary text using L2 Regulization is .5

In [49]:

```
L2_BOW_sum = LogisticRegression(penalty='l2',C=.5, fit_intercept=True, intercept_sca
ling=1, class_weight='balanced')
L2_BOW_sum.fit(bow_X_train_sum, y_summary_train)
bestC_proba_pred_train_BOW_sum=(L2_BOW_sum.predict_proba(bow_X_train_sum)[:,1])
bestC_proba_pred_test_BOW_sum=(L2_BOW_sum.predict_proba(bow_X_test_sum)[:,1])
```

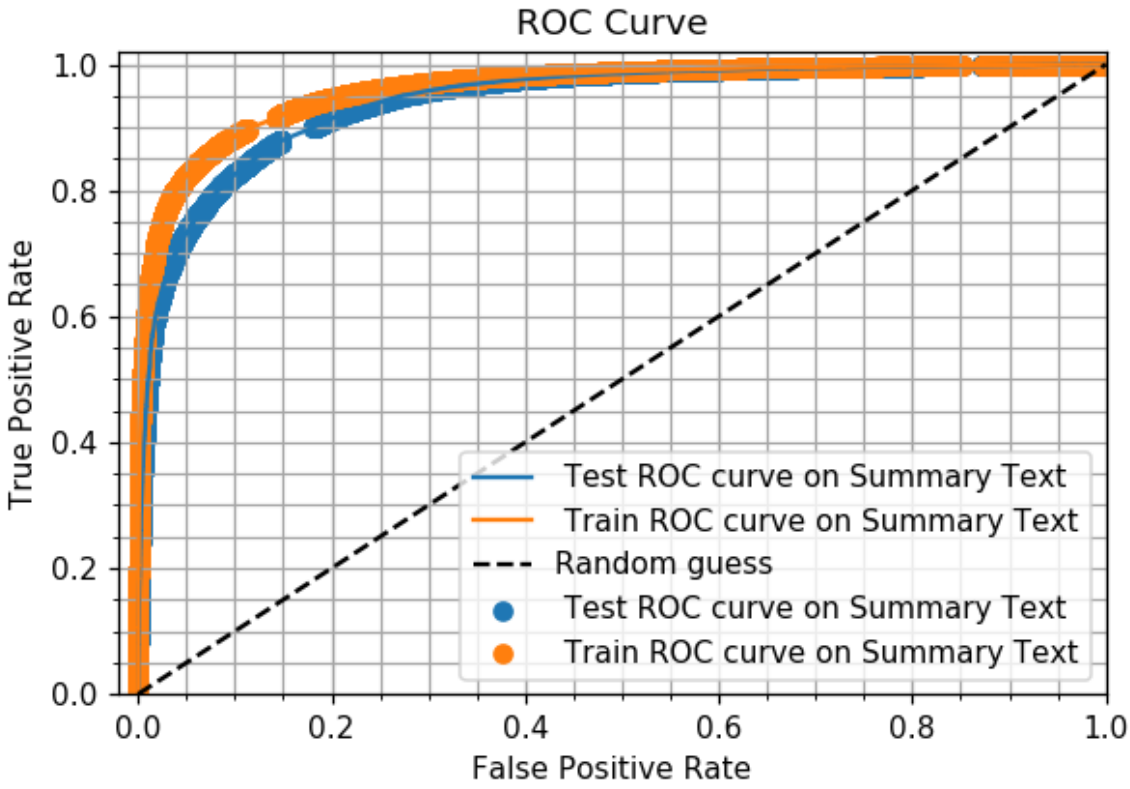
In [50]:

```
l2_auc_test_BOW_sum  = (roc_auc_score(y_summary_test,bestC_proba_pred_test_BOW_sum))
l2_auc_train_BOW_sum  = (roc_auc_score(y_summary_train,bestC_proba_pred_train_BOW_su
m))
```

In [51]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_bow_l2_sum, tpr_test_bow_l2_sum, thresholds = roc_curve(y_summary_test, bes
tC_proba_pred_test_BOW_sum)
fpr_train_bow_l2_sum, tpr_train_bow_l2_sum, thresholds = roc_curve(y_summary_train,
bestC_proba_pred_train_BOW_sum)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_bow_l2_sum, tpr_test_bow_l2_sum, label=' Test ROC curve on Summary
Text')
plt.scatter(fpr_test_bow_l2_sum, tpr_test_bow_l2_sum, label=' Test ROC curve on Summ
ary Text')
plt.plot(fpr_train_bow_l2_sum, tpr_train_bow_l2_sum, label=' Train ROC curve on Summ
ary Text')
plt.scatter(fpr_train_bow_l2_sum, tpr_train_bow_l2_sum, label=' Train ROC curve on S
ummary Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [52]:

```
bestC_L2_BOW_sum = LogisticRegression(penalty='l1',C=.5, fit_intercept=True, interce
pt_scaling=1, class_weight='balanced')
bestC_L2_BOW_sum.fit(bow_X_train_sum, y_summary_train)
L2_pred_train_BOW_sum=(bestC_L2_BOW_sum.predict(bow_X_train_sum))
L2_pred_test_BOW_sum=(bestC_L2_BOW_sum.predict(bow_X_test_sum))
```

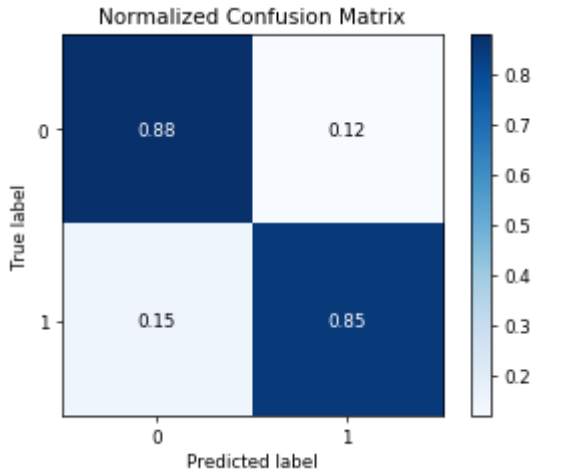
In [53]:

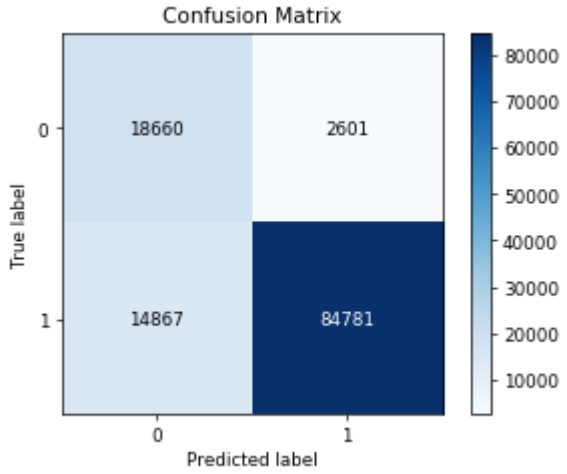
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_summary_test, L2_pred_test_BOW_sum,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_summary_test, L2_pred_test_BOW_sum)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[53]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15206ef8940>
```





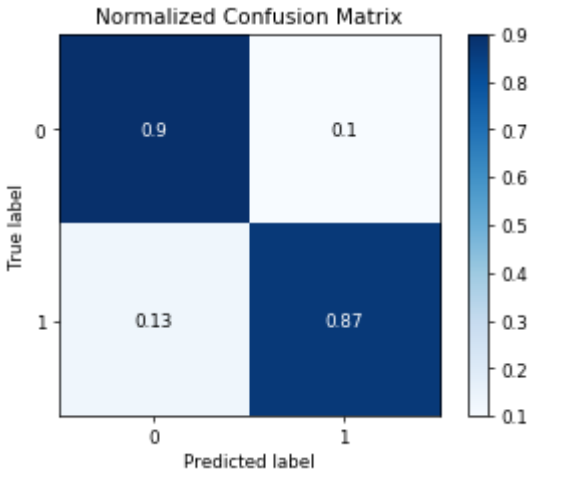
In [54]:

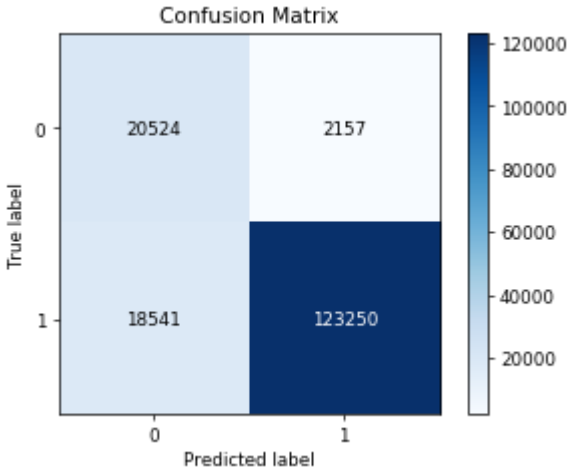
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_summary_train, L2_pred_train_BOW_sum,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_summary_train, L2_pred_train_BOW_sum)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[54]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1524773c630>
```





[5.1.2.1] Performing pertubation test (multicollinearity check) on BOW, SET 1

In [55]:

```
bow_vect2 = CountVectorizer(ngram_range = (1,2),min_df = 7,max_features=4000)
bow_X_train_no_stop_4k = bow_vect2.fit_transform(X_no_stop_train)
bow_X_test_no_stop_4k = bow_vect2.transform(X_no_stop_test)
bow_X_CV_no_stop_4k = bow_vect2.transform(X_no_stop_CV)
################################################
bow_X_summary_train_4k = bow_vect2.fit_transform(X_summary_train)
bow_X_summary_test_4k = bow_vect2.transform(X_summary_test)
bow_X_summary_CV_4k = bow_vect2.transform(X_summary_CV)
#########################################################
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

bow_X_train_txt_4k =StandardScaler(with_mean=False,with_std=False).fit_transform(bow
_X_train_no_stop_4k)
bow_X_test_txt_4k = StandardScaler(with_mean=False,with_std=False).fit_transform(bow
_X_test_no_stop_4k)
bow_X_CV_txt_4k = StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X
_CV_no_stop_4k)
#######################################
bow_X_train_sum_4k =StandardScaler(with_mean=False,with_std=False).fit_transform(bow
_X_summary_train_4k)
bow_X_test_sum_4k = StandardScaler(with_mean=False,with_std=False).fit_transform(bow
_X_summary_test_4k)
bow_X_CV_sum_4k = StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X
_summary_CV_4k)
print (bow_X_train_txt_4k.shape)
########################################
#noise = np.random.normal(0,.03,[164472, 4000]).astype(np.float16)
#bow_X_train_no_stop_float16 = bow_X_train_no_stop.astype(np.float16)
#print (bow_X_train_no_stop_float16.shape)
```

(164472, 4000)

In [56]:

```
import numpy as np
from sklearn.linear_model import LogisticRegression

bestC_L2_BOW_txt_4k = LogisticRegression(penalty='l2',C=.06, fit_intercept=True, int
ercept_scaling=1, class_weight='balanced')
bestC_L2_BOW_txt_4k.fit(bow_X_train_txt_4k, y_train)
coef_l2 =bestC_L2_BOW_txt_4k.coef_
bow_features_name_l2_txt_4k = bow_vect2.get_feature_names()
l2_wght_df = pd.DataFrame(coef_l2, columns = bow_features_name_l2_txt_4k)
l2_wght_df_trans = l2_wght_df.T
l2_wght_df_trans.columns = ["Weight"]
```

In [57]:

```
#https://stackoverflow.com/questions/46093073/adding-gaussian-noise-to-a-dataset-of-
floating-points-and-save-it-python

target_dims = bow_X_train_txt_4k.shape
noise = np.random.normal(scale=.03,size=[164472, 4000])
noisy_bow_X_train_txt = bow_X_train_txt_4k + noise
```

In [58]:

```
#########################################################
#Lets calculate the Weights with noisy training data

bestC_L2_BOW_txt_4k_noisy = LogisticRegression(penalty='l2',C=.06, fit_intercept=True, intercept_scaling=1, class_weight='balanced')
bestC_L2_BOW_txt_4k_noisy.fit(noisy_bow_X_train_txt, y_train)
coef_noisy =bestC_L2_BOW_txt_4k_noisy.coef_
bow_features_name_l2_txt_4k_noisy = bow_vect2.get_feature_names()
l2_wght_df_noisy = pd.DataFrame(coef_noisy, columns = bow_features_name_l2_txt_4k_noisy)
l2_wght_df_trans_noisy = l2_wght_df_noisy.T
l2_wght_df_trans_noisy.columns = ["Weight"]
```

In [59]:

```
print (l2_wght_df_trans)
print (l2_wght_df_trans_noisy)
```

	Weight
10	-0.173259
10 star	-0.083588
100	-0.090209
100 calorie	-0.010128
11	0.059754
12	0.163083
14	-0.023536
15	0.571035
16	-0.079238
17	-0.085166
18	-0.076257
1st	-0.212233
20	-0.143034
24	0.175945
25	-0.134752
2nd	0.427156
30	-0.241678
35	-0.057779
40	-0.096686
45	-0.062449
50	-0.238180
70	0.080523
able	0.138256
absolute	0.051144
absolute best	-0.409328
absolutely	0.152942
absolutely best	-0.157167
absolutely delici	0.019550
absolutely delicious	-0.042098
absolutely lov	-0.308636
...	...
yucky	0.085965
yuk	0.029474
yum	0.146397
yum yum	0.223964
yumm	-0.384353
yummi	0.073282
yummiest	0.034288
yummm	0.707522
yummmm	-0.124221
yummmmm	0.000323
yummo	0.193445
yummy	-0.106688
yummy coff	0.064970
yummy gluten	-0.179816
yummy good	0.258153
yummy gummi	-0.041720
yummy healthi	-0.134163
yummy healthy	0.400718
yummy snack	0.411723
yummy tea	0.329182
yummy treat	0.167446
yummy tummi	0.331882
yummy yummi	-1.027739
yummy yummy	1.012932
yummyearth	0.955496
zero	1.185432
zero star	-0.073555
zesty	-0.062575
zevia	-0.024601

```
zico                  0.438948

[4000 rows x 1 columns]
                        Weight
10                   -0.189408
10 star              -0.060853
100                   0.113841
100 calorie          -0.016100
11                    0.188675
12                    0.235542
14                   -0.012434
15                    0.477481
16                   -0.043354
17                   -0.174088
18                   -0.099039
1st                  -0.095712
20                   -0.172237
24                   -0.007641
25                   -0.132736
2nd                   0.347855
30                   -0.131967
35                   -0.035167
40                   -0.121817
45                   -0.011651
50                   -0.241033
70                    0.092361
able                  0.084357
absolute             -0.021151
absolute best        -0.339500
absolutely            0.157003
absolutely best      -0.198635
absolutely delici     0.138195
absolutely delicious -0.141993
absolutely lov       -0.190338
...                        ...
yucky                -0.020539
yuk                  -0.029091
yum                   0.157603
yum yum               0.238845
yumm                 -0.269705
yummi                 0.070937
yummiest              0.053316
yummm                 0.531062
yummmm               -0.002998
yummmmm              -0.063370
yummo                 0.255305
yummy                 0.001608
yummy coff           -0.048887
yummy gluten         -0.171534
yummy good            0.060444
yummy gummi          -0.058484
yummy healthi        -0.137928
yummy healthy         0.401472
yummy snack           0.449172
yummy tea             0.344808
yummy treat           0.057433
yummy tummi           0.424974
yummy yummi          -0.871268
yummy yummy           0.933309
yummyearth            0.693674
zero                  1.154595
```

```
zero star           -0.120286
zesty                0.019427
zevia               -0.063618
zico                 0.385819

[4000 rows x 1 columns]
```

In [60]:

```
#https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DataFrame.subtract.html
#https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DataFrame.sort_values.html
l2_wght_df_after_subtraction=l2_wght_df_trans.subtract(l2_wght_df_trans_noisy)
l2_wght_df_after_subtraction = l2_wght_df_after_subtraction.sort_values('Weight',ascending=True)
print (l2_wght_df_after_subtraction)
```

	Weight
great variety	-0.479635
hyp	-0.394818
good health	-0.337734
boxes pack	-0.327244
homemade	-0.323224
watermelon	-0.297960
drinking	-0.296387
throw	-0.294883
good earth	-0.287281
formula	-0.271717
didnt	-0.270823
ev	-0.270501
miracle	-0.265171
complex	-0.262315
hazard	-0.259818
fan	-0.256949
lovely tea	-0.256929
dry	-0.253898
season	-0.250691
lentil	-0.245526
smells great	-0.245460
job	-0.244945
tasting green	-0.244550
tahini	-0.242901
noodl	-0.236692
simple	-0.236300
good source	-0.235911
fragrant	-0.235876
chipotle	-0.233437
nothing like	-0.233001
...	...
mini	0.307036
matcha	0.307323
ahmad	0.313447
good stuff	0.315987
almonds	0.320511
ill	0.320779
assorted	0.322816
issues	0.323769
aid	0.324652
soy milk	0.325378
great season	0.328364
gas	0.329067
organic	0.330238
worth buy	0.330955
potato	0.333015
caffe	0.335057
lil	0.338121
decaf	0.344098
good not	0.361458
aspartam	0.363866
buy	0.376821
virgin coconut	0.377614
buying	0.381178
min	0.387682
agave	0.393933
dont	0.403060
everyday tea	0.465168
mmmm	0.513618
mint	0.533985

```
dogs love       0.535314

[4000 rows x 1 columns]
```

In [61]:

```
bestC_L2_BOW_txt_4k_noisy = LogisticRegression(penalty='l2',C=.06, fit_intercept=True, intercept_scaling=1, class_weight='balanced')
bestC_L2_BOW_txt_4k_noisy.fit(noisy_bow_X_train_txt, y_train)
bestC_proba_pred_train_BOW_sum_noisy=(bestC_L2_BOW_txt_4k_noisy.predict_proba(noisy_bow_X_train_txt)[:,1])
bestC_proba_pred_test_BOW_sum_noisy=(bestC_L2_BOW_txt_4k_noisy.predict_proba(bow_X_test_sum_4k)[:,1])
################################################################################################3
l2_auc_test_BOW_sum_noisy  = (roc_auc_score(y_summary_test,bestC_proba_pred_test_BOW_sum_noisy))
l2_auc_train_BOW_sum_noisy  = (roc_auc_score(y_summary_train,bestC_proba_pred_train_BOW_sum_noisy))
print ("AUC for Test Data for Summary Text")
print (l2_auc_test_BOW_sum)
print ("AUC for Train Data for Summary Text")
print (l2_auc_train_BOW_sum)
print ("AUC for Test Data for Summary Text after introducing Noise")
print (l2_auc_test_BOW_sum_noisy)
print ("AUC for Train Data for Summary Text after introducing Noise")
print (l2_auc_train_BOW_sum_noisy)
```

```
AUC for Test Data for Summary Text
0.9424611174771534
AUC for Train Data for Summary Text
0.9602455659988494
AUC for Test Data for Summary Text after introducing Noise
0.49928546116495914
AUC for Train Data for Summary Text after introducing Noise
0.959400814948332
```

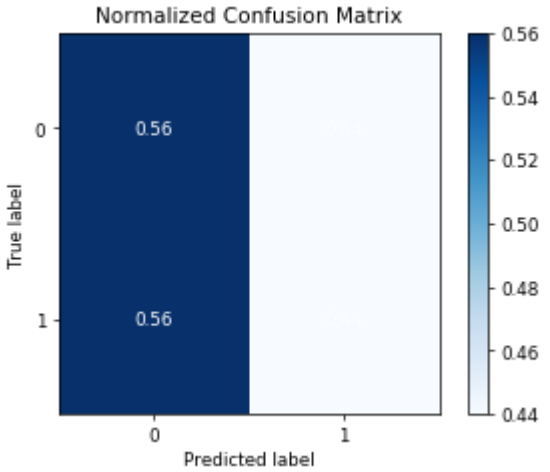
In [62]:

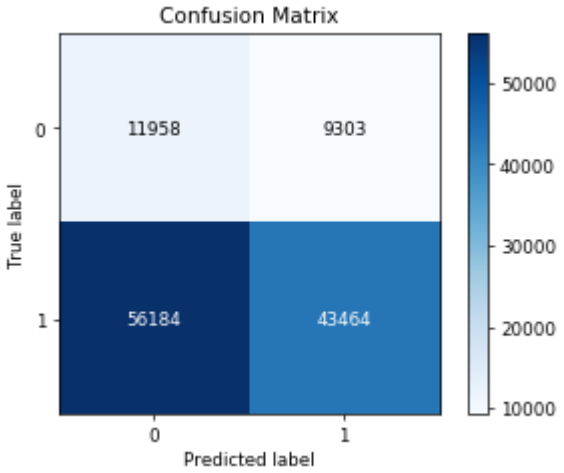
```
#########################################################################################
##########
bestC_pred_train_BOW_sum_noisy=(bestC_L2_BOW_txt_4k_noisy.predict(noisy_bow_X_train_
txt))
bestC_pred_test_BOW_sum_noisy=(bestC_L2_BOW_txt_4k_noisy.predict(bow_X_test_sum_4k))
#########################################################################################
###########
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_summary_test, bestC_pred_test_BOW_sum_noisy,normalize=
True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_summary_test, bestC_pred_test_BOW_sum_noisy)
```

IN NOT NORMALIZED FORMAT BELOW

Out[62]:

<matplotlib.axes._subplots.AxesSubplot at 0x1526ff9ab38>





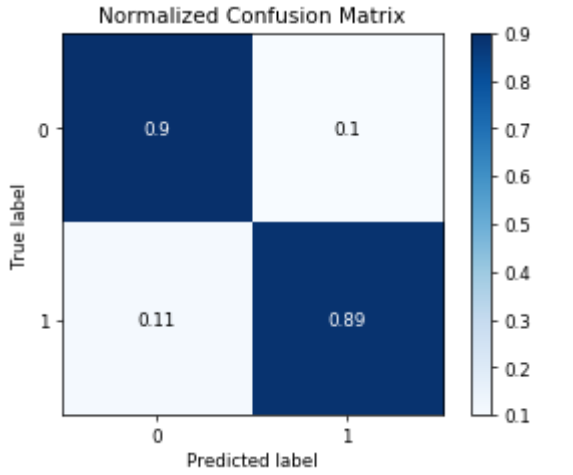
In [63]:

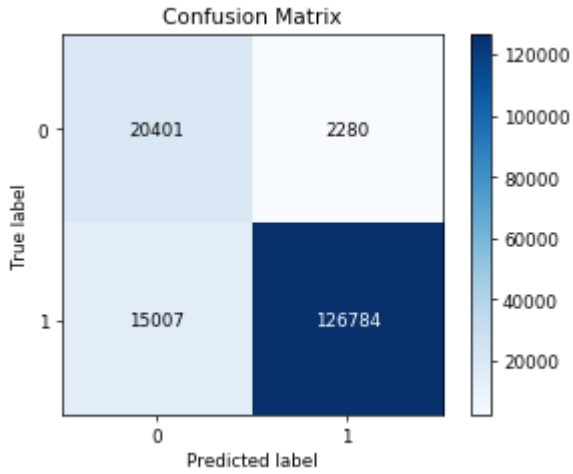
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_summary_train, bestC_pred_train_BOW_sum_noisy,normaliz
e=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_summary_train, bestC_pred_train_BOW_sum_noisy)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[63]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1527ea1c240>
```





Thus we can see the features are very collinear after introducing small noise we can see the TPR and FPR wasnt that much affected for training dataset as compared with TPR and FPR after introduction of noise

[5.1.3] Feature Importance on BOW, SET 1

[5.1.3.1] Top 10 important features of positive class from SET 1

In [64]:

```
import numpy as np
bestC_L1_BOW_sum = LogisticRegression(penalty='l1',C=.55, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
bestC_L1_BOW_sum.fit(bow_X_summary_train, y_summary_train)
coef_ =bestC_L1_BOW_sum.coef_
bow_features_name_l1_sum = bow_vect.get_feature_names()
sparsity_wght_df = pd.DataFrame(coef_, columns = bow_features_name_l1_sum)
sparsity_wght_df_trans = sparsity_wght_df.T
sparsity_wght_df_trans.columns = ["Weight"]
#print (sparsity_wght_df_trans)
#https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DataFrame.abs.htm
l
sparsity_wght_df_trans_abs = sparsity_wght_df_trans.abs()
#print (sparsity_wght_df_trans_abs)
print (sparsity_wght_df_trans.sort_values('Weight',ascending=False).head(10))
```

```
                  Weight
not bitter      8.213487
not bad         7.881789
wont disappoint 5.992895
whats not       5.968882
heaven          5.448181
not salti       5.403594
not bitt        5.366013
no problem      5.019613
fantast         4.987004
go wrong        4.893911
```

[5.1.3.2] Top 10 important features of negative class from SET 1

In [65]:

```
print (sparsity_wght_df_trans.sort_values('Weight',ascending=True).head(10))
```

```
                 Weight
yuck          -6.202488
ruined        -5.496440
mediocre      -5.419876
yummy yummi   -5.402339
worst         -5.233702
least favorite -5.183203
terribl       -4.955913
horribl       -4.943413
aw            -4.730430
taste better  -4.695597
```

[5.2] Logistic Regression on TFIDF, SET 2

[5.2.1] Applying Logistic Regression with L1 regularization on TFIDF, SET 2

In [66]:

```
from sklearn.model_selection import cross_val_score
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')
from sklearn.feature_extraction.text import TfidfVectorizer

tf_idf_vect = TfidfVectorizer(ngram_range=(1,5))
tfidf_X_train = tf_idf_vect.fit_transform(X_no_stop_train)
tfidf_X_test = tf_idf_vect.transform(X_no_stop_test)
tfidf_X_CV = tf_idf_vect.transform(X_no_stop_CV)

tfidf_X_train =StandardScaler(with_mean=False,with_std=False).fit_transform(tfidf_X_
train)
tfidf_X_test = StandardScaler(with_mean=False,with_std=False).fit_transform(tfidf_X_
test)
tfidf_X_CV = StandardScaler(with_mean=False,with_std=False).fit_transform(tfidf_X_CV
)

# creating odd list of C(i.e. 1/lambda) for BOW Logistic Regression
def tothepower(y):
    return (10**y)
C_LR_tfidf = list(map(tothepower, list(range(-4, 5))))
print (C_LR_tfidf)
C_LR_tfidf_log = [math.log(x) for x in C_LR_tfidf]
print (C_LR_tfidf_log)
```

```
[0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000]
[-9.210340371976182, -6.907755278982137, -4.605170185988091, -2.30258509
29940455, 0.0, 2.302585092994046, 4.605170185988092, 6.907755278982137,
9.210340371976184]
```

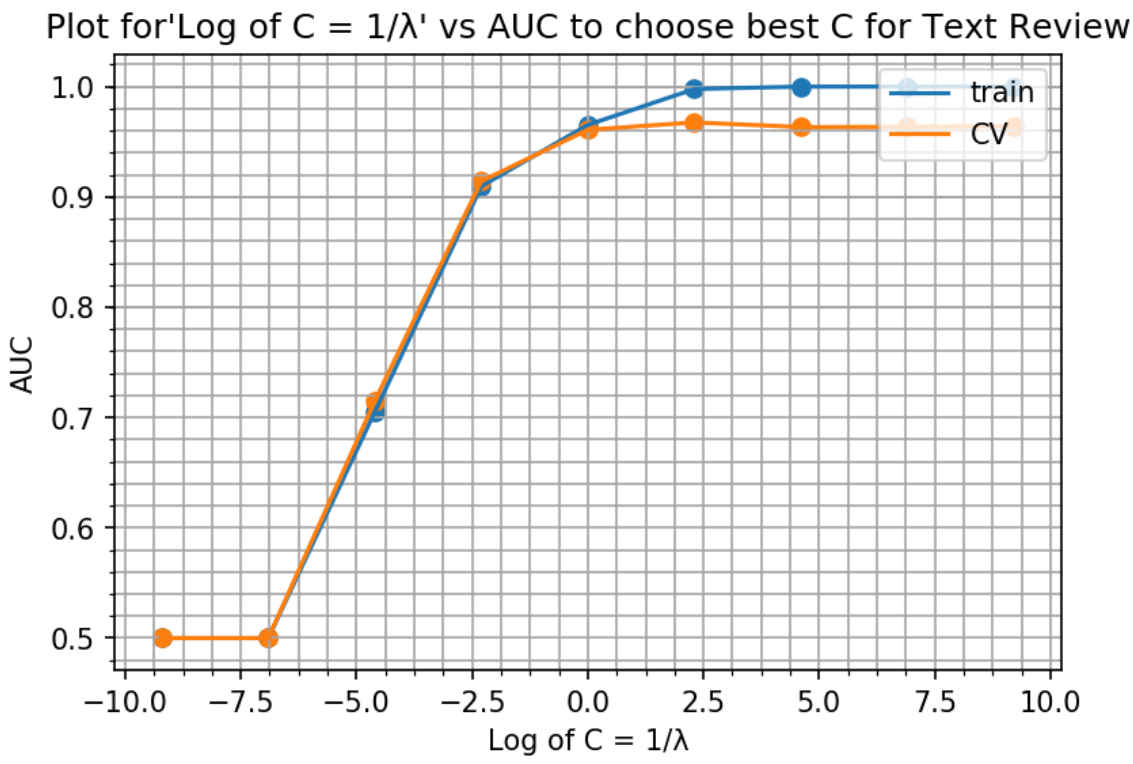
In [67]:

```
from sklearn.linear_model import LogisticRegression
auc_cv_tfidf_txt = []
auc_train_tfidf_txt=[]


for C in tqdm(C_LR_tfidf):
    L1_tfidf_txt = LogisticRegression(penalty='l1',C=C, fit_intercept=True, intercep
t_scaling=1, class_weight='balanced')
    L1_tfidf_txt.fit(tfidf_X_train, y_train)
    proba_pred_train_tfidf_txt=(L1_tfidf_txt.predict_proba(tfidf_X_train)[:,1])
    proba_pred_cv_tfidf_txt=(L1_tfidf_txt.predict_proba(tfidf_X_CV)[:,1])
    auc_train_tfidf_txt.append(roc_auc_score(y_train,proba_pred_train_tfidf_txt))
    auc_cv_tfidf_txt.append(roc_auc_score(y_CV,proba_pred_cv_tfidf_txt))

default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_tfidf_log, auc_train_tfidf_txt)
plt.scatter(C_LR_tfidf_log, auc_train_tfidf_txt)
plt.plot(C_LR_tfidf_log, auc_cv_tfidf_txt)
plt.scatter(C_LR_tfidf_log, auc_cv_tfidf_txt)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for'Log of C = 1/λ' vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```

```
100%|██████████████████████████████████████████████████████████████████
████████████████| 9/9 [05:46<00:00, 51.99s/it]
```



In [68]:

```
import numpy as np
lis_tfidf = np.arange (1, 15, 1)
print (lis_tfidf)
```

```
[ 1  2  3  4  5  6  7  8  9 10 11 12 13 14]
```

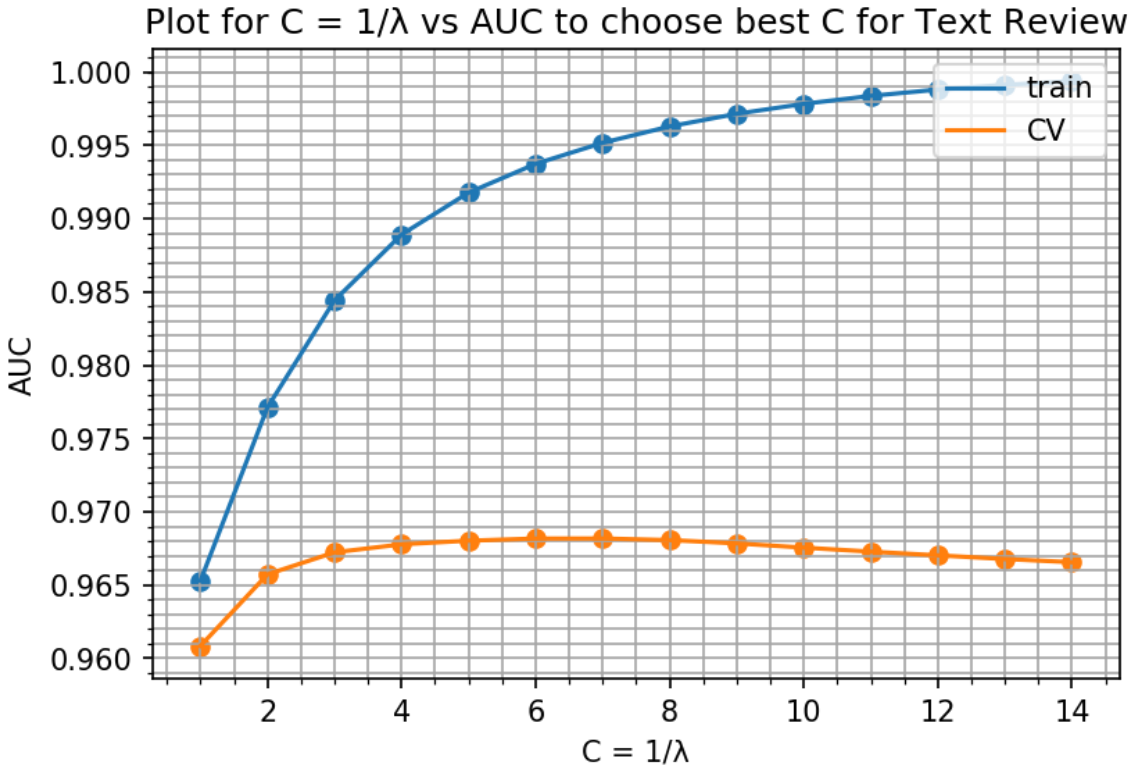
In [69]:

```
l1_auc_train_tfidf_txt = []
l1_auc_cv_tfidf_txt = []
for C in tqdm(lis_tfidf):
    L1_tfidf_txt = LogisticRegression(penalty='l1',C=C, fit_intercept=True, intercep
t_scaling=1, class_weight='balanced')
    L1_tfidf_txt.fit(tfidf_X_train, y_train)
    proba_pred_train_tfidf_txt=(L1_tfidf_txt.predict_proba(tfidf_X_train)[:,1])
    proba_pred_cv_tfidf_txt=(L1_tfidf_txt.predict_proba(tfidf_X_CV)[:,1])
    l1_auc_train_tfidf_txt.append(roc_auc_score(y_train,proba_pred_train_tfidf_txt))
    l1_auc_cv_tfidf_txt.append(roc_auc_score(y_CV,proba_pred_cv_tfidf_txt))
```

```
100%|████████████████████████████████████████████████████████████████
████████████| 14/14 [09:31<00:00, 62.26s/it]
```

In [70]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(lis_tfidf, l1_auc_train_tfidf_txt)
plt.scatter(lis_tfidf, l1_auc_train_tfidf_txt)
plt.plot(lis_tfidf, l1_auc_cv_tfidf_txt)
plt.scatter(lis_tfidf, l1_auc_cv_tfidf_txt)
plt.xlabel('C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for C = 1/λ vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



Best C = 6 when using TFIDF with L1 regulization

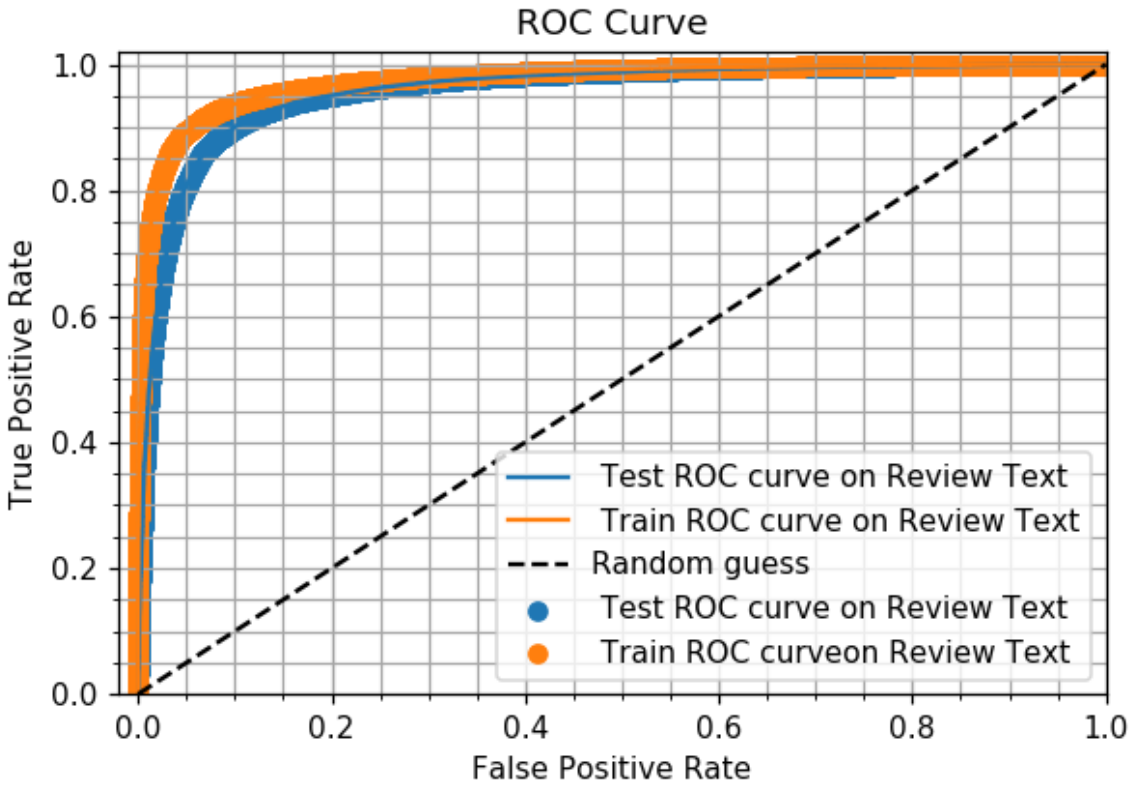
In [71]:

```
bestC_L1_tfidf_txt = LogisticRegression(penalty='l1',C=6, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
bestC_L1_tfidf_txt.fit(tfidf_X_train, y_train)
l1_proba_pred_train_tfidf_txt=(bestC_L1_tfidf_txt.predict_proba(tfidf_X_train)[:,1])
l1_proba_pred_test_tfidf_txt=(bestC_L1_tfidf_txt.predict_proba(tfidf_X_test)[:,1])
l1_auc_test_tfidf = (roc_auc_score(y_test,l1_proba_pred_test_tfidf_txt))
l1_auc_train_tfidf  = (roc_auc_score(y_train,l1_proba_pred_train_tfidf_txt))
```

In [72]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_bow_l1_txt, tpr_test_bow_l1_txt, thresholds = roc_curve(y_test, l1_proba_pr
ed_test_BOW_txt)
fpr_train_bow_l1_txt, tpr_train_bow_l1_txt, thresholds = roc_curve(y_train, l1_proba
_pred_train_BOW_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_bow_l1_txt, tpr_test_bow_l1_txt, label=' Test ROC curve on Review
 Text')
plt.scatter(fpr_test_bow_l1_txt, tpr_test_bow_l1_txt, label=' Test ROC curve on Revi
ew Text')
plt.plot(fpr_train_bow_l1_txt, tpr_train_bow_l1_txt, label=' Train ROC curve on Revi
ew Text')
plt.scatter(fpr_train_bow_l1_txt, tpr_train_bow_l1_txt, label=' Train ROC curveon Re
view Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [73]:

```
bestC_L1_tfidf_txt = LogisticRegression(penalty='l1',C=6, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
bestC_L1_tfidf_txt.fit(tfidf_X_train, y_train)
l1_pred_train_tfidf_txt=(bestC_L1_tfidf_txt.predict(tfidf_X_train))
l1_pred_test_tfidf_txt=(bestC_L1_tfidf_txt.predict(tfidf_X_test))
```

In [74]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")
print(classification_report(y_test, l1_pred_test_tfidf_txt))
print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, l1_pred_train_tfidf_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.71      0.89      0.79     21261
          1       0.97      0.92      0.95     99648

avg / total       0.93      0.92      0.92    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.78      1.00      0.87     22681
          1       1.00      0.95      0.98    141791

avg / total       0.97      0.96      0.96    164472
```

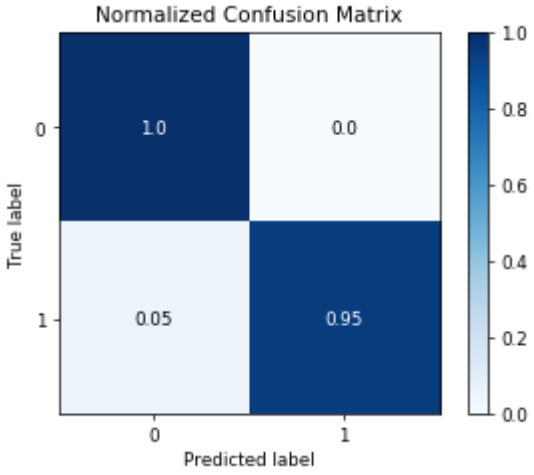
In [75]:

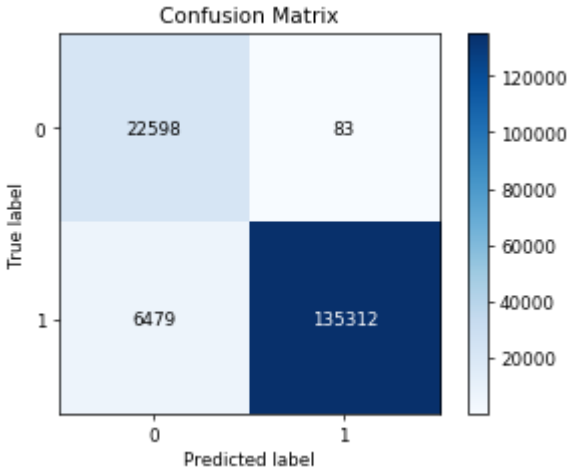
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train, l1_pred_train_tfidf_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train, l1_pred_train_tfidf_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[75]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15796c146d8>
```





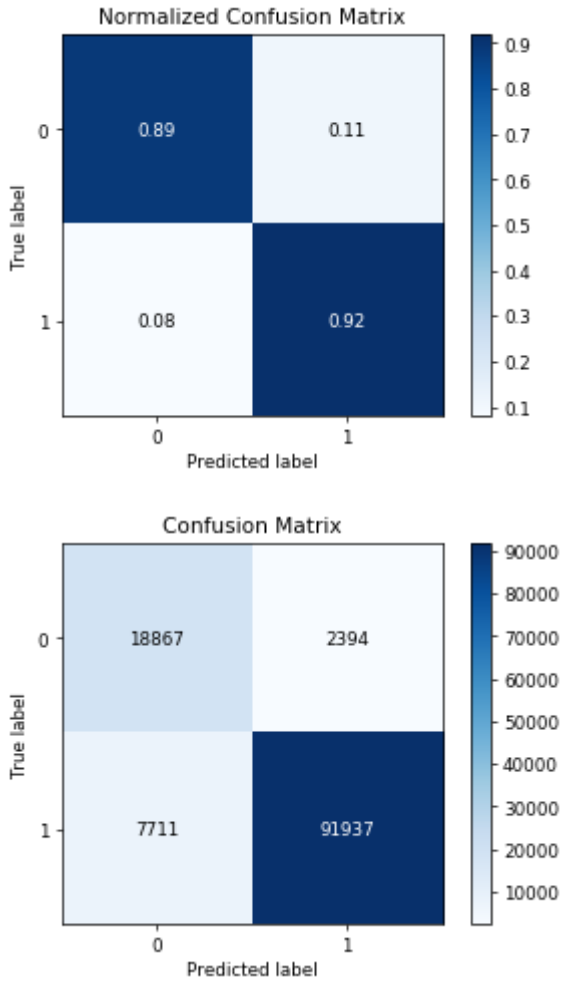
In [76]:

```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, l1_pred_test_tfidf_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, l1_pred_test_tfidf_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[76]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15203808160>
```



[5.2.2] Applying Logistic Regression with L2 regularization on TFIDF, SET 2

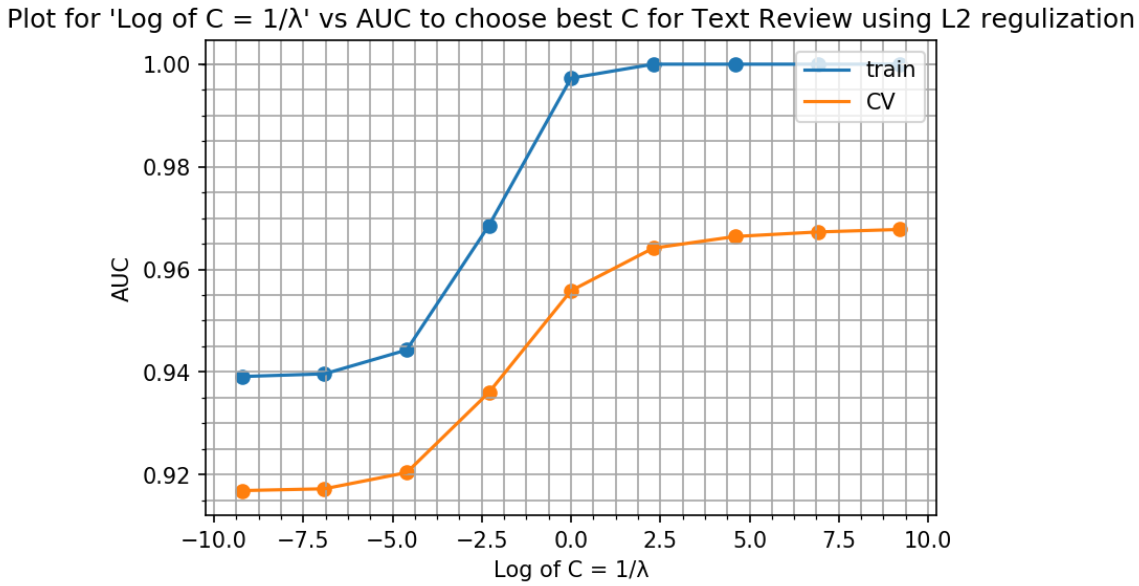
In [77]:

```
from sklearn.linear_model import LogisticRegression
l2_auc_cv_tfidf_txt = []
l2_auc_train_tfidf_txt=[]


for C in (C_LR_tfidf):
    L2_tfidf_txt = LogisticRegression(penalty='l2',C=C, fit_intercept=True, intercep
t_scaling=1, class_weight='balanced')
    L2_tfidf_txt.fit(tfidf_X_train, y_train)
    l2_proba_pred_train_tfidf_txt=(L2_tfidf_txt.predict_proba(tfidf_X_train)[:,1])
    l2_proba_pred_cv_tfidf_txt=(L2_tfidf_txt.predict_proba(tfidf_X_CV)[:,1])
    l2_auc_train_tfidf_txt.append(roc_auc_score(y_train,l2_proba_pred_train_tfidf_tx
t))
    l2_auc_cv_tfidf_txt.append(roc_auc_score(y_CV,l2_proba_pred_cv_tfidf_txt))
```

In [78]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_tfidf_log, l2_auc_train_tfidf_txt)
plt.scatter(C_LR_tfidf_log, l2_auc_train_tfidf_txt)
plt.plot(C_LR_tfidf_log, l2_auc_cv_tfidf_txt)
plt.scatter(C_LR_tfidf_log, l2_auc_cv_tfidf_txt)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Text Review using L
2 regulization")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



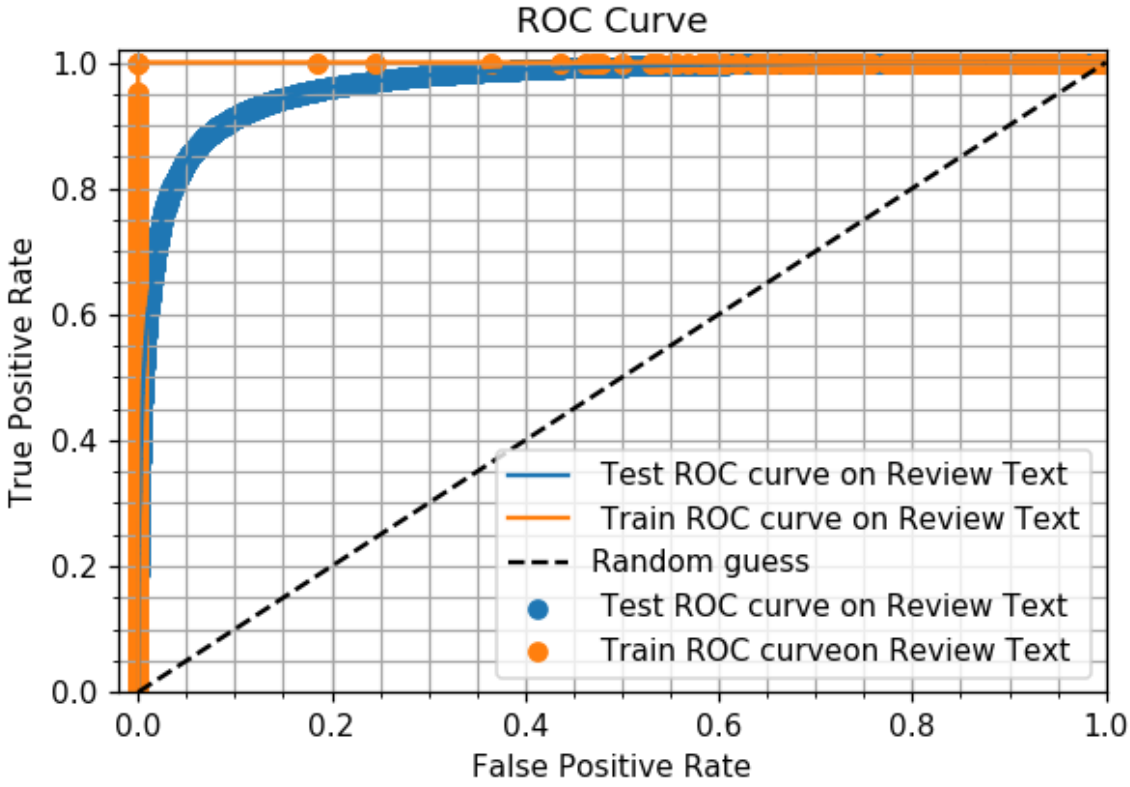
In [79]:

```
bestC_L2_tfidf_txt = LogisticRegression(penalty='l2',C=10000, fit_intercept=True, in
tercept_scaling=1, class_weight='balanced')
bestC_L2_tfidf_txt.fit(tfidf_X_train, y_train)
l2_proba_pred_train_tfidf_txt=(bestC_L2_tfidf_txt.predict_proba(tfidf_X_train)[:,1])
l2_proba_pred_test_tfidf_txt=(bestC_L2_tfidf_txt.predict_proba(tfidf_X_test)[:,1])
l2_auc_test_tfidf = (roc_auc_score(y_test,l2_proba_pred_test_tfidf_txt))
l2_auc_train_tfidf  = (roc_auc_score(y_train,l2_proba_pred_train_tfidf_txt))
```

In [80]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_tfidf_l2_txt, tpr_test_tfidf_l2_txt, thresholds = roc_curve(y_test, l2_prob
a_pred_test_tfidf_txt)
fpr_train_tfidf_l2_txt, tpr_train_tfidf_l2_txt, thresholds = roc_curve(y_train, l2_p
roba_pred_train_tfidf_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_tfidf_l2_txt, tpr_test_tfidf_l2_txt, label=' Test ROC curve on Rev
iew Text')
plt.scatter(fpr_test_tfidf_l2_txt, tpr_test_tfidf_l2_txt, label=' Test ROC curve on
 Review Text')
plt.plot(fpr_train_tfidf_l2_txt, tpr_train_tfidf_l2_txt, label=' Train ROC curve on
 Review Text')
plt.scatter(fpr_train_tfidf_l2_txt, tpr_train_tfidf_l2_txt, label=' Train ROC curveo
n Review Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [81]:

```
bestC_L2_tfidf_txt = LogisticRegression(penalty='l2',C=10000, fit_intercept=True, in
tercept_scaling=1, class_weight='balanced')
bestC_L2_tfidf_txt.fit(tfidf_X_train, y_train)
l2_pred_train_tfidf_txt=(bestC_L2_tfidf_txt.predict(tfidf_X_train))
l2_pred_test_tfidf_txt=(bestC_L2_tfidf_txt.predict(tfidf_X_test))
```

In [82]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")
print(classification_report(y_test, l2_pred_test_tfidf_txt))
print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, l2_pred_train_tfidf_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.80      0.82      0.81     21261
          1       0.96      0.96      0.96     99648

avg / total       0.93      0.93      0.93    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       1.00      1.00      1.00     22681
          1       1.00      1.00      1.00    141791

avg / total       1.00      1.00      1.00    164472
```

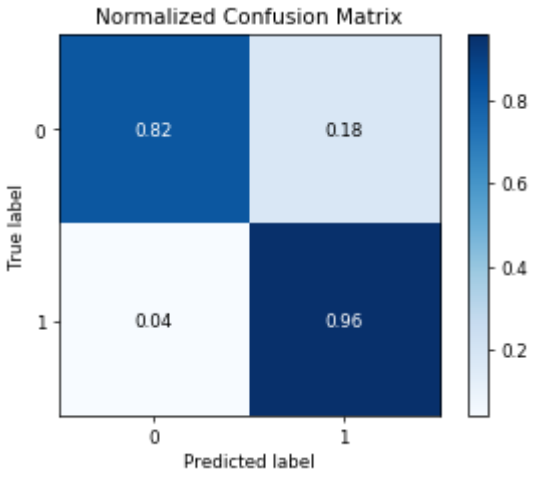
In [83]:

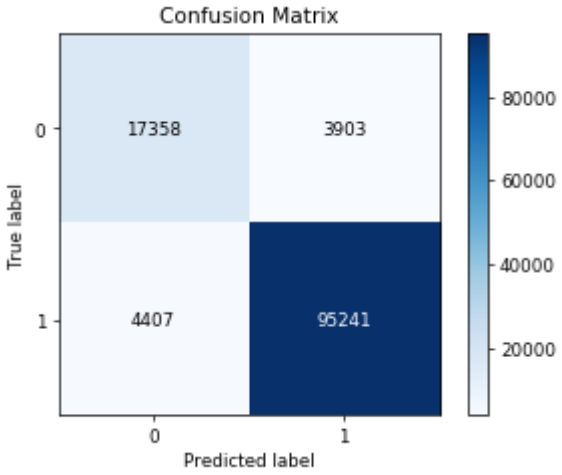
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, l2_pred_test_tfidf_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, l2_pred_test_tfidf_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[83]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x157b4175080>
```





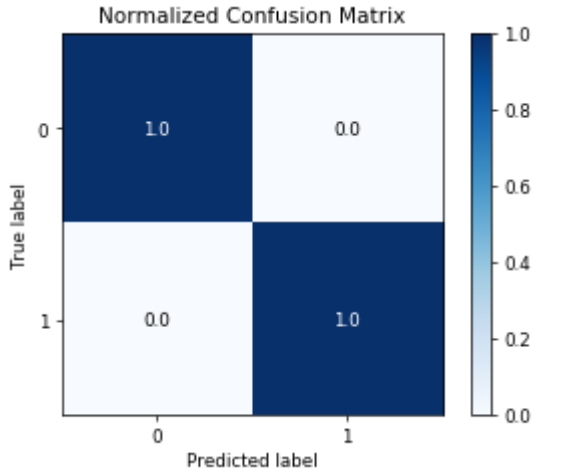
In [84]:

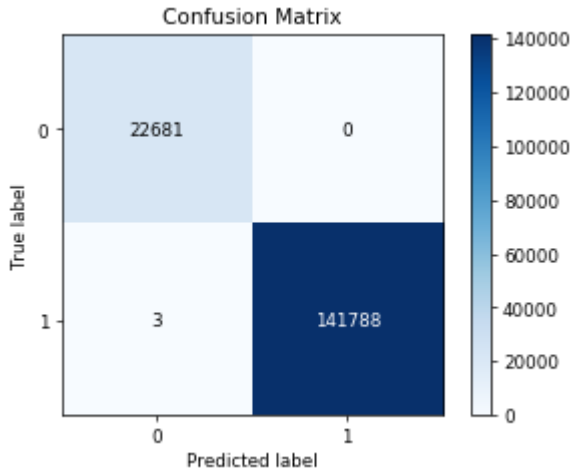
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train, l2_pred_train_tfidf_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train, l2_pred_train_tfidf_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[84]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15203e66e10>
```





[5.2.3] Feature Importance on TFIDF, SET 2

[5.2.3.1] Top 10 important features of positive class from SET 2

In [85]:

```
import numpy as np
bestC_L2_tfidf_txt = LogisticRegression(penalty='l2',C=10000, fit_intercept=True, in
tercept_scaling=1, class_weight='balanced')
bestC_L2_tfidf_txt.fit(tfidf_X_train, y_train)
coef_l2_tfidf =bestC_L2_tfidf_txt.coef_
tfidf_features_name_l2_txt = tf_idf_vect.get_feature_names()
tfidf_l2_wght_df = pd.DataFrame(coef_l2_tfidf, columns = tfidf_features_name_l2_txt)
tfidf_l2_wght_df_trans = tfidf_l2_wght_df.T
tfidf_l2_wght_df_trans.columns = ["Weight"]
print (tfidf_l2_wght_df_trans.sort_values('Weight',ascending=False).head(10))
```

```
              Weight
great      96.471367
best       78.935136
delicious  71.667225
good       66.620629
perfect    61.326061
excellent  58.125593
loves      54.601299
wonderful  54.155668
love       53.792301
nice       46.991667
```

[5.2.3.2] Top 10 important features of negative class from SET 2

In [86]:

```
print (tfidf_l2_wght_df_trans.sort_values('Weight',ascending=True).head(10))
```

```
                 Weight
worst         -82.132212
disappointed  -82.044212
not           -71.219333
not worth     -66.471566
terrible      -64.783386
horrible      -61.847312
awful         -59.813053
not recommend -59.227251
not buy       -55.394758
unfortunately -54.677788
```

[5.3] Logistic Regression on AVG W2V, SET 3

[5.3.1] Applying Logistic Regression with L1 regularization on AVG W2V SET 3

In [ ]:

```
lst_train=[]
lst_test=[]
lst_of_lst_train = []
lst_of_lst_test = []
lst_of_lst_CV =[]
lst_CV = []

for sentance in tqdm(X_no_stop_train):
    lst_train.append(sentance.strip())
for sentance in tqdm(lst_train):
    lst_of_lst_train.append(sentance.split())

for sent in tqdm(X_no_stop_test):
    lst_test.append(sent.strip())
for sent in tqdm(lst_test):
    lst_of_lst_test.append(sent.split())

for sent_CV in tqdm(X_no_stop_CV):
    lst_CV.append(sent_CV.strip())
for sent_CV in tqdm(lst_CV):
    lst_of_lst_CV.append(sent_CV.split())

w2v_model_self_taught_train=Word2Vec(lst_of_lst_train,min_count=1,size=50, workers=4
)
w2v_words_train = list(w2v_model_self_taught_train.wv.vocab)
```

In [ ]:

```
sent_vectors_train_l1 = []
for sent1 in tqdm(lst_of_lst_train): # for each review/sentence
    sent_vec1 = np.zeros(50)
    cnt_words1 = 0
    for word1 in sent1:
        if word1 in w2v_words_train:
            vec1 = w2v_model_self_taught_train.wv[word1]
            sent_vec1 += vec1
            cnt_words1 += 1
    if cnt_words1 != 0:
        sent_vec1 /= cnt_words1
    sent_vectors_train_l1.append(sent_vec1)
```

In [ ]:

```
sent_vectors_test_l1 = []
for sent2 in tqdm(lst_of_lst_test): # for each review/sentence
    sent_vec2 = np.zeros(50)
    cnt_words2 = 0
    for word2 in sent2:
        if word2 in w2v_words_train:
            vec2 = w2v_model_self_taught_train.wv[word2]
            sent_vec2 += vec2
            cnt_words2 += 1
    if cnt_words2 != 0:
        sent_vec2 /= cnt_words2
    sent_vectors_test_l1.append(sent_vec2)
```

In [ ]:

```
sent_vectors_CV_l1 = []
for sent3 in tqdm(lst_of_lst_CV): # for each review/sentence
    sent_vec3 = np.zeros(50)
    cnt_words3 = 0
    for word3 in sent3:
        if word3 in w2v_words_train:
            vec3 = w2v_model_self_taught_train.wv[word3]
            sent_vec3 += vec3
            cnt_words3 += 1
    if cnt_words3 != 0:
        sent_vec3 /= cnt_words3
    sent_vectors_CV_l1.append(sent_vec3)
```

In [91]:

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

sent_vectors_train_l1_std =StandardScaler(with_mean=False,with_std=False).fit_transf
orm(sent_vectors_train_l1)
sent_vectors_test_l1_std = StandardScaler(with_mean=False,with_std=False).fit_transf
orm(sent_vectors_test_l1)
sent_vectors_CV_l1_std = StandardScaler(with_mean=False,with_std=False).fit_transfor
m(sent_vectors_CV_l1)
```

In [92]:

```
def tothepower(y):
    return (10**y)
C_LR_avf_w2V = list(map(tothepower, list(range(-4, 5))))
print (C_LR_avf_w2V)
C_LR_avf_w2V_log = [math.log(x) for x in C_LR_avf_w2V]
print (C_LR_avf_w2V_log)
```

```
[0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000]
[-9.210340371976182, -6.907755278982137, -4.605170185988091, -2.30258509
29940455, 0.0, 2.302585092994046, 4.605170185988092, 6.907755278982137,
9.210340371976184]
```

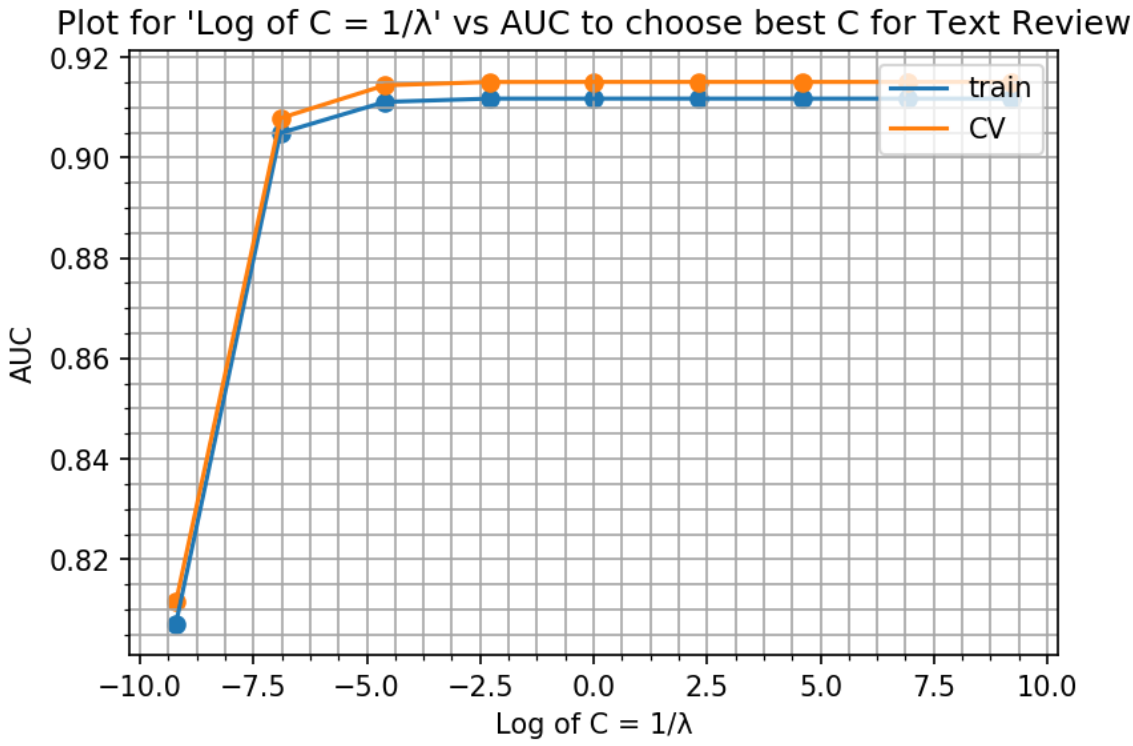
In [ ]:

```
from sklearn.linear_model import LogisticRegression
auc_cv_avg_w2v_txt = []
auc_train_avg_w2v_txt=[]


for C in tqdm(C_LR_avf_w2V):
    L1_avg_w2v_txt = LogisticRegression(penalty='l1',C=C, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
    L1_avg_w2v_txt.fit(sent_vectors_train_l1_std, y_train)
    proba_pred_train_avg_w2v_txt=(L1_avg_w2v_txt.predict_proba(sent_vectors_train_l1
_std)[:,1])
    proba_pred_cv_avg_w2v_txt=(L1_avg_w2v_txt.predict_proba(sent_vectors_CV_l1_std)
[:,1])
    auc_train_avg_w2v_txt.append(roc_auc_score(y_train,proba_pred_train_avg_w2v_txt
))
    auc_cv_avg_w2v_txt.append(roc_auc_score(y_CV,proba_pred_cv_avg_w2v_txt))
```

In [94]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_avf_w2V_log, auc_train_avg_w2v_txt)
plt.scatter(C_LR_avf_w2V_log, auc_train_avg_w2v_txt)
plt.plot(C_LR_avf_w2V_log, auc_cv_avg_w2v_txt)
plt.scatter(C_LR_avf_w2V_log, auc_cv_avg_w2v_txt)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



The best value of C =1 for Avg-W2V against L1 regulization

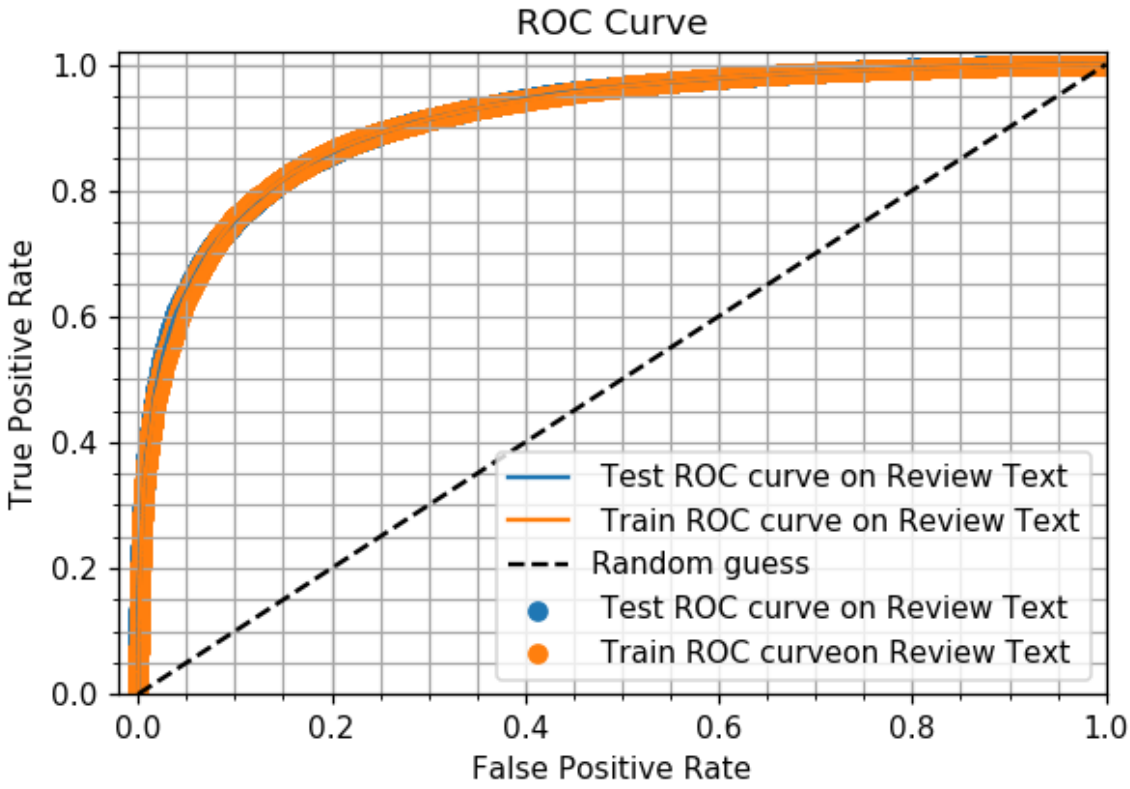
In [95]:

```
bestCl1_auc_train_avg_w2v_txt = []
bestCl1_auc_test_avg_w2v_txt = []
bestC_L1_avg_w2v_txt = LogisticRegression(penalty='l1',C=1, fit_intercept=True, inte
rcept_scaling=1, class_weight='balanced')
bestC_L1_avg_w2v_txt.fit(sent_vectors_train_l1_std, y_train)
bestC_proba_pred_train_avg_w2v_txt=(bestC_L1_avg_w2v_txt.predict_proba(sent_vectors_
train_l1_std)[:,1])
bestC_proba_pred_test_avg_w2v_txt=(bestC_L1_avg_w2v_txt.predict_proba(sent_vectors_t
est_l1_std)[:,1])
bestCl1_auc_train_avg_w2v_txt.append(roc_auc_score(y_train,bestC_proba_pred_train_av
g_w2v_txt))
bestCl1_auc_test_avg_w2v_txt.append(roc_auc_score(y_test,bestC_proba_pred_test_avg_w
2v_txt))
```

In [96]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_avg_w2v_l1_txt, tpr_test_avg_w2v_l1_txt, thresholds = roc_curve(y_test, bes
tC_proba_pred_test_avg_w2v_txt)
fpr_train_avg_w2v_l1_txt, tpr_train_avg_w2v_l1_txt, thresholds = roc_curve(y_train,
bestC_proba_pred_train_avg_w2v_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_avg_w2v_l1_txt, tpr_test_avg_w2v_l1_txt, label=' Test ROC curve on
Review Text')
plt.scatter(fpr_test_avg_w2v_l1_txt, tpr_test_avg_w2v_l1_txt, label=' Test ROC curve
on Review Text')
plt.plot(fpr_train_avg_w2v_l1_txt, tpr_train_avg_w2v_l1_txt, label=' Train ROC curve
on Review Text')
plt.scatter(fpr_train_avg_w2v_l1_txt, tpr_train_avg_w2v_l1_txt, label=' Train ROC cu
rveon Review Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [97]:

```
bestC_pred_train_avg_w2v_txt=(bestC_L1_avg_w2v_txt.predict(sent_vectors_train_l1_std
))
bestC_pred_test_avg_w2v_txt=(bestC_L1_avg_w2v_txt.predict(sent_vectors_test_l1_std))
```

In [98]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")
print(classification_report(y_test, bestC_pred_test_avg_w2v_txt))
print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, bestC_pred_train_avg_w2v_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.48      0.86      0.62     21261
          1       0.97      0.80      0.87     99648

avg / total       0.88      0.81      0.83    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.43      0.85      0.57     22681
          1       0.97      0.82      0.89    141791

avg / total       0.90      0.82      0.84    164472
```

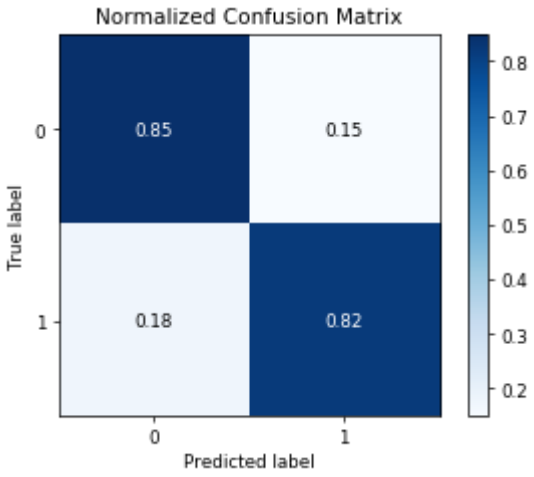
In [99]:

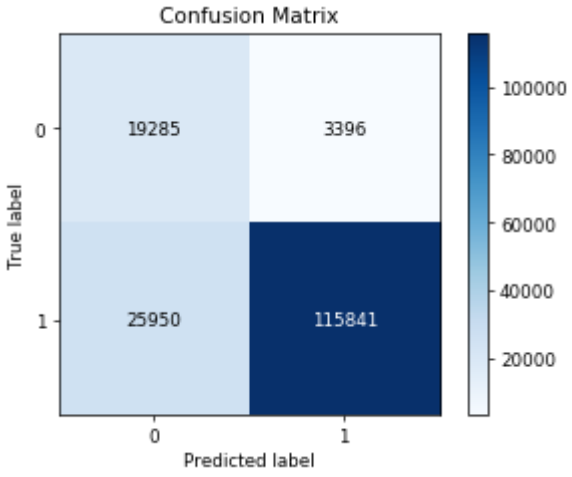
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train, bestC_pred_train_avg_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train, bestC_pred_train_avg_w2v_txt)
```

IN NOT NORMALIZED FORMAT BELOW

Out[99]:

<matplotlib.axes._subplots.AxesSubplot at 0x158714a98d0>





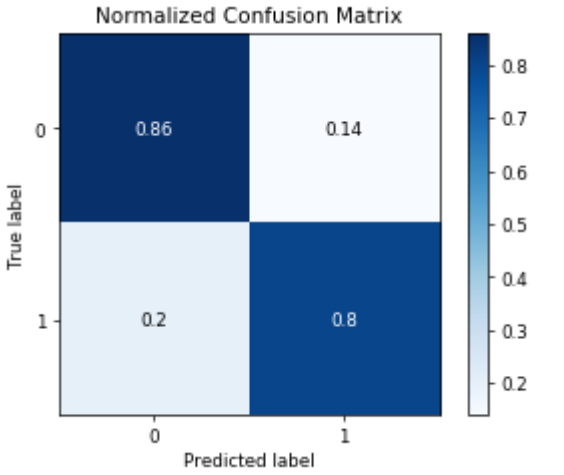
In [100]:

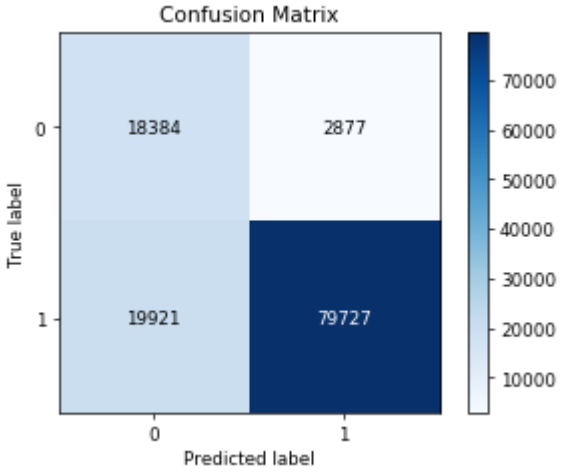
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, bestC_pred_test_avg_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, bestC_pred_test_avg_w2v_txt)
```

IN NOT NORMALIZED FORMAT BELOW

Out[100]:

<matplotlib.axes._subplots.AxesSubplot at 0x1587125ba90>





[5.3.2] Applying Logistic Regression with L2 regularization on AVG W2V, SET 3

In [101]:

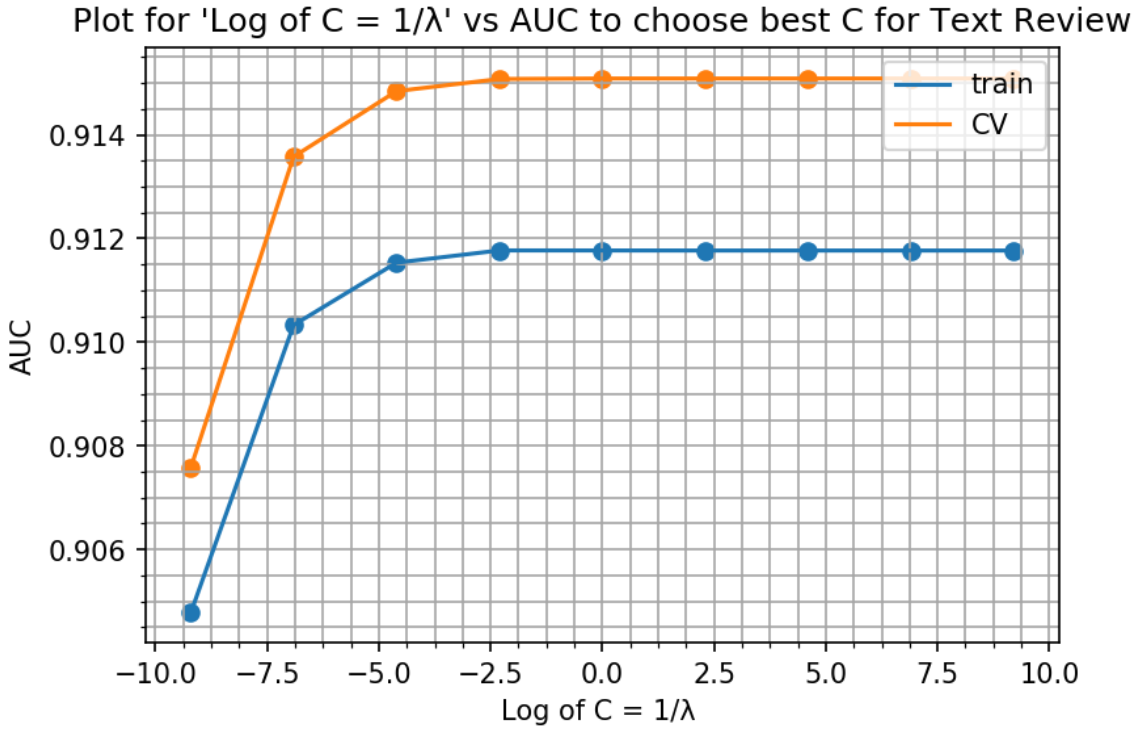
```
from sklearn.linear_model import LogisticRegression
l2_auc_cv_avg_w2v_txt = []
l2_auc_train_avg_w2v_txt=[]


for C in tqdm(C_LR_avf_w2V):
    L2_avg_w2v_txt = LogisticRegression(penalty='l2',C=C, fit_intercept=True, interc
ept_scaling=1, class_weight='balanced')
    L2_avg_w2v_txt.fit(sent_vectors_train_l1_std, y_train)
    l2_proba_pred_train_avg_w2v_txt=(L2_avg_w2v_txt.predict_proba(sent_vectors_train
_l1_std)[:,1])
    l2_proba_pred_cv_avg_w2v_txt=(L2_avg_w2v_txt.predict_proba(sent_vectors_CV_l1_st
d)[:,1])
    l2_auc_train_avg_w2v_txt.append(roc_auc_score(y_train,l2_proba_pred_train_avg_w2
v_txt))
    l2_auc_cv_avg_w2v_txt.append(roc_auc_score(y_CV,l2_proba_pred_cv_avg_w2v_txt))
```

```
100%|██████████████████████████████████████████████████████████████████
██████████████████| 9/9 [00:23<00:00,  2.85s/it]
```

In [102]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_avf_w2V_log, l2_auc_train_avg_w2v_txt)
plt.scatter(C_LR_avf_w2V_log, l2_auc_train_avg_w2v_txt)
plt.plot(C_LR_avf_w2V_log, l2_auc_cv_avg_w2v_txt)
plt.scatter(C_LR_avf_w2V_log, l2_auc_cv_avg_w2v_txt)
plt.xlabel('Log of C = 1/λ ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



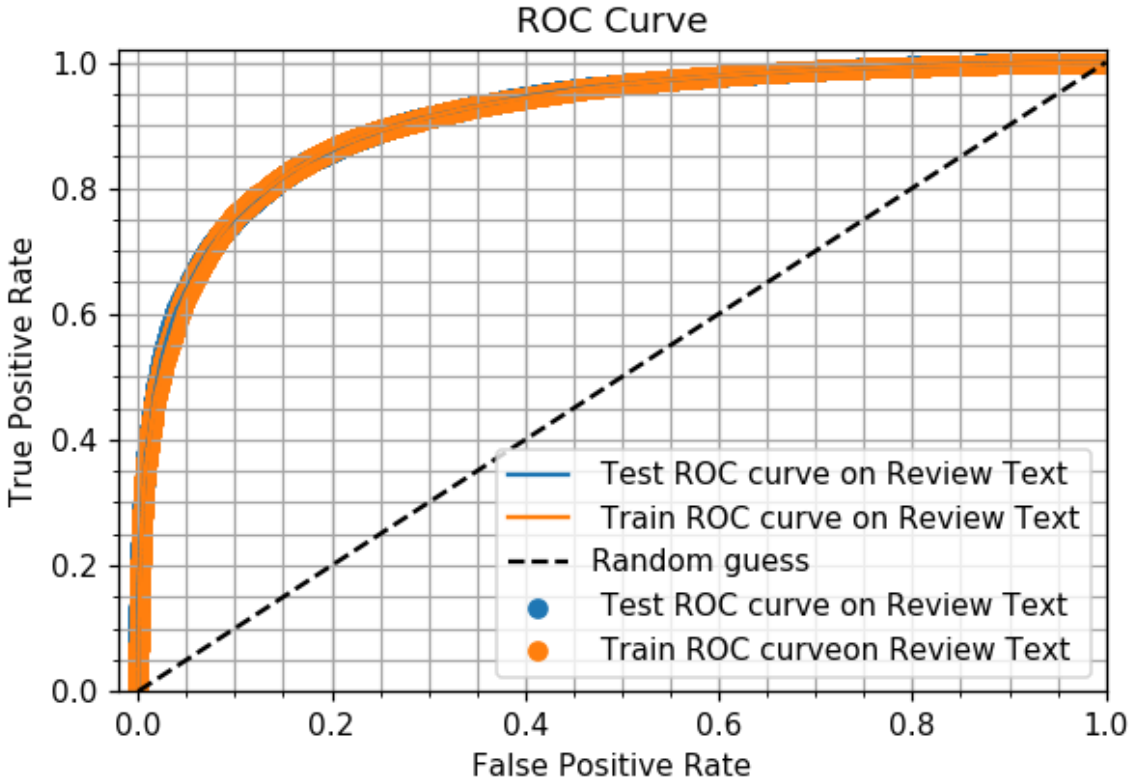
In [103]:

```
l2_bestC_auc_train_avg_w2v_txt = []
l2_bestC_auc_test_avg_w2v_txt = []
bestC_L2_avg_w2v_txt = LogisticRegression(penalty='l2',C=1, fit_intercept=True, inte
rcept_scaling=1, class_weight='balanced')
bestC_L2_avg_w2v_txt.fit(sent_vectors_train_l1_std, y_train)
l2_bestC_proba_pred_train_avg_w2v_txt=(bestC_L2_avg_w2v_txt.predict_proba(sent_vecto
rs_train_l1_std)[:,1])
l2_bestC_proba_pred_test_avg_w2v_txt=(bestC_L2_avg_w2v_txt.predict_proba(sent_vector
s_test_l1_std)[:,1])
l2_bestC_auc_train_avg_w2v_txt.append(roc_auc_score(y_train,l2_bestC_proba_pred_trai
n_avg_w2v_txt))
l2_bestC_auc_test_avg_w2v_txt.append(roc_auc_score(y_test,l2_bestC_proba_pred_test_a
vg_w2v_txt))
```

In [104]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_avg_w2v_l2_txt, tpr_test_avg_w2v_l2_txt, thresholds = roc_curve(y_test, l2_
bestC_proba_pred_test_avg_w2v_txt)
fpr_train_avg_w2v_l2_txt, tpr_train_avg_w2v_l2_txt, thresholds = roc_curve(y_train,
l2_bestC_proba_pred_train_avg_w2v_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_avg_w2v_l2_txt, tpr_test_avg_w2v_l2_txt, label=' Test ROC curve on
Review Text')
plt.scatter(fpr_test_avg_w2v_l2_txt, tpr_test_avg_w2v_l2_txt, label=' Test ROC curve
on Review Text')
plt.plot(fpr_train_avg_w2v_l2_txt, tpr_train_avg_w2v_l2_txt, label=' Train ROC curve
on Review Text')
plt.scatter(fpr_train_avg_w2v_l2_txt, tpr_train_avg_w2v_l2_txt, label=' Train ROC cu
rveon Review Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [105]:

```
l2_bestC_pred_train_avg_w2v_txt=(bestC_L2_avg_w2v_txt.predict(sent_vectors_train_l1_
std))
l2_bestC_pred_test_avg_w2v_txt=(bestC_L2_avg_w2v_txt.predict(sent_vectors_test_l1_st
d))
```

In [106]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")
print(classification_report(y_test, l2_bestC_pred_test_avg_w2v_txt))
print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, l2_bestC_pred_train_avg_w2v_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.48      0.86      0.62     21261
          1       0.97      0.80      0.87     99648

avg / total       0.88      0.81      0.83    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.43      0.85      0.57     22681
          1       0.97      0.82      0.89    141791

avg / total       0.90      0.82      0.84    164472
```

In [107]:

```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train, l2_bestC_pred_train_avg_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train, l2_bestC_pred_train_avg_w2v_txt)
```

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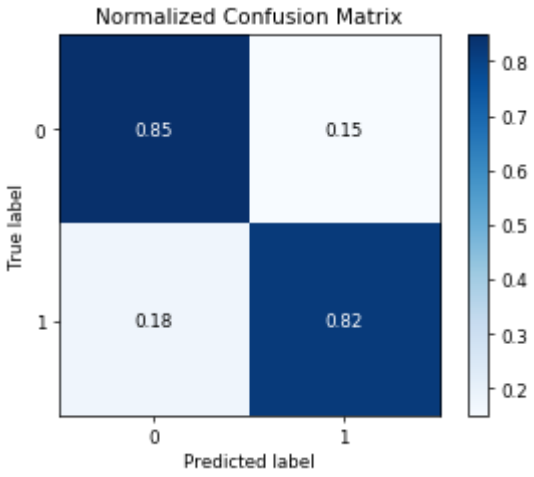
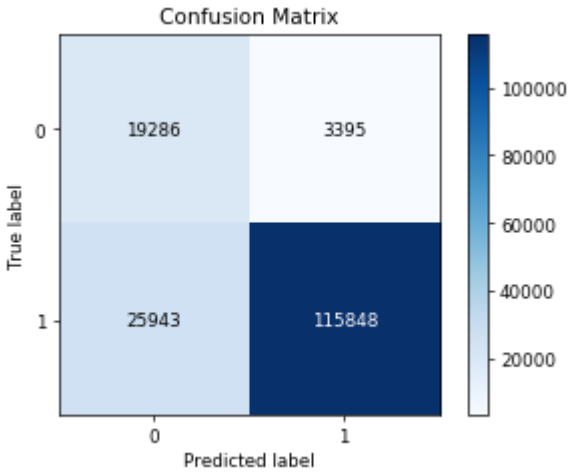
Out[107]:

<matplotlib.axes._subplots.AxesSubplot at 0x15872087f60>





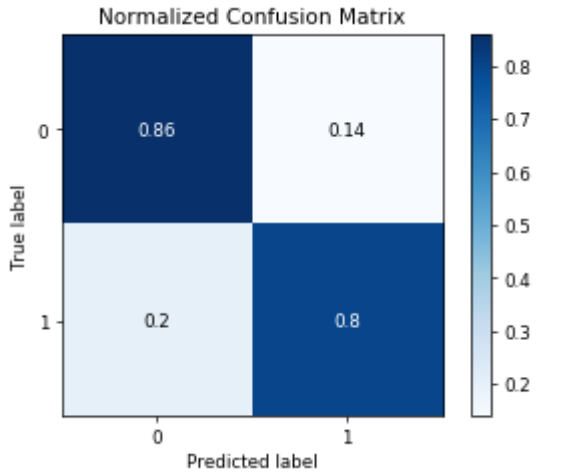
In [108]:

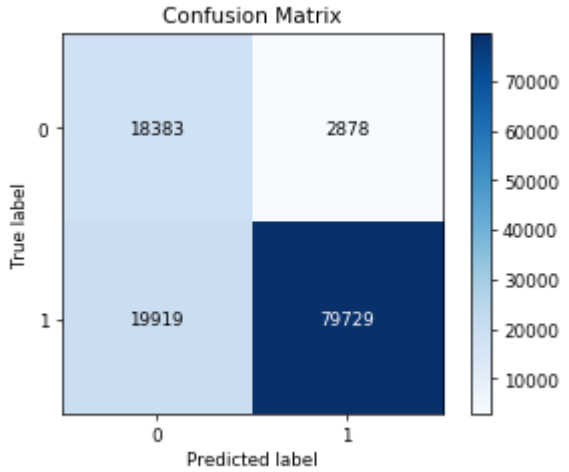
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, l2_bestC_pred_test_avg_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, l2_bestC_pred_test_avg_w2v_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[108]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x158720689e8>
```





In [109]:

```
# Please write all the code with proper documentation
```

[5.4] Logistic Regression on TFIDF W2V, SET 4

[5.4.1] Applying Logistic Regression with L1 regularization on TFIDF W2V, SET 4

In [110]:

```
model = TfidfVectorizer()
model.fit(X_no_stop_train)
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))

tfidf_feat = model.get_feature_names() # tfidf words/col-names

tfidf_w2v_sent_vectors_train = []; # the tfidf-w2v for each sentence/review is store
d in this list
row=0;
for sent4 in tqdm(lst_of_lst_train): # for each review/sentence
    sent_vec4 = np.zeros(50) # as word vectors are of zero length
    weight_sum4 =0; # num of words with a valid vector in the sentence/review
    for word4 in sent4: # for each word in a review/sentence
        if word4 in w2v_words_train and word4 in tfidf_feat:
            vec4 = w2v_model_self_taught_train.wv[word4]
            tf_idf_train = dictionary[word4]*(sent4.count(word4)/len(sent4))
            sent_vec4 += (vec4 * tf_idf_train)
            weight_sum4 += tf_idf_train
    if weight_sum4 != 0:
        sent_vec4 /= weight_sum4
    tfidf_w2v_sent_vectors_train.append(sent_vec4)
    row += 1
```

100%|██████████| 164472/164472 [4:27:41<00:00, 11.27it/s]

In [111]:

```
tfidf_w2v_sent_vectors_test = []; # the tfidf-w2v for each sentence/review is stored
in this list
row=0;
for sent5 in tqdm(lst_of_lst_test): # for each review/sentence
    sent_vec5 = np.zeros(50) # as word vectors are of zero length
    weight_sum5 =0; # num of words with a valid vector in the sentence/review
    for word5 in sent5: # for each word in a review/sentence
        if word5 in w2v_words_train and word5 in tfidf_feat:
            vec5 = w2v_model_self_taught_train.wv[word5]
            tf_idf_test = dictionary[word5]*(sent5.count(word5)/len(sent5))
            sent_vec5 += (vec5 * tf_idf_test)
            weight_sum5 += tf_idf_test
    if weight_sum5 != 0:
        sent_vec5 /= weight_sum5
    tfidf_w2v_sent_vectors_test.append(sent_vec5)
    row += 1
```

100%|██████████| 120909/120909 [3:26:01<00:00, 17.26it/s]

In [112]:

```
tfidf_w2v_sent_vectors_cv = []; # the tfidf-w2v for each sentence/review is stored i
n this list
row=0;
for sent6 in tqdm(lst_of_lst_CV): # for each review/sentence
    sent_vec6 = np.zeros(50) # as word vectors are of zero length
    weight_sum6 =0; # num of words with a valid vector in the sentence/review
    for word6 in sent6: # for each word in a review/sentence
        if word6 in w2v_words_train and word6 in tfidf_feat:
            vec6 = w2v_model_self_taught_train.wv[word6]
            tf_idf_cv = dictionary[word6]*(sent6.count(word6)/len(sent6))
            sent_vec6 += (vec6 * tf_idf_cv)
            weight_sum6 += tf_idf_cv
    if weight_sum6 != 0:
        sent_vec6 /= weight_sum6
    tfidf_w2v_sent_vectors_cv.append(sent_vec6)
    row += 1
```

```
100%|████████████████████████████████████████████████████████████████
███████| 81009/81009 [2:21:53<00:00, 14.37it/s]
```

In [113]:

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

tfidf_w2v_sent_vectors_train_std =StandardScaler(with_mean=False,with_std=False).fit
_transform(tfidf_w2v_sent_vectors_train)
tfidf_w2v_sent_vectors_test_std = StandardScaler(with_mean=False,with_std=False).fit
_transform(tfidf_w2v_sent_vectors_test)
tfidf_w2v_sent_vectors_cv_std = StandardScaler(with_mean=False,with_std=False).fit_t
ransform(tfidf_w2v_sent_vectors_cv)
```

In [114]:

```
def tothepower(y):
    return (10**y)
C_LR_tfidf_w2v = list(map(tothepower, list(range(-4, 5))))
print (C_LR_tfidf_w2v)
C_LR_tfidf_w2v_log = [math.log(x) for x in C_LR_tfidf_w2v]
print (C_LR_tfidf_w2v_log)
```

```
[0.0001, 0.001, 0.01, 0.1, 1, 10, 100, 1000, 10000]
[-9.210340371976182, -6.907755278982137, -4.605170185988091, -2.30258509
29940455, 0.0, 2.302585092994046, 4.605170185988092, 6.907755278982137,
9.210340371976184]
```

In [115]:

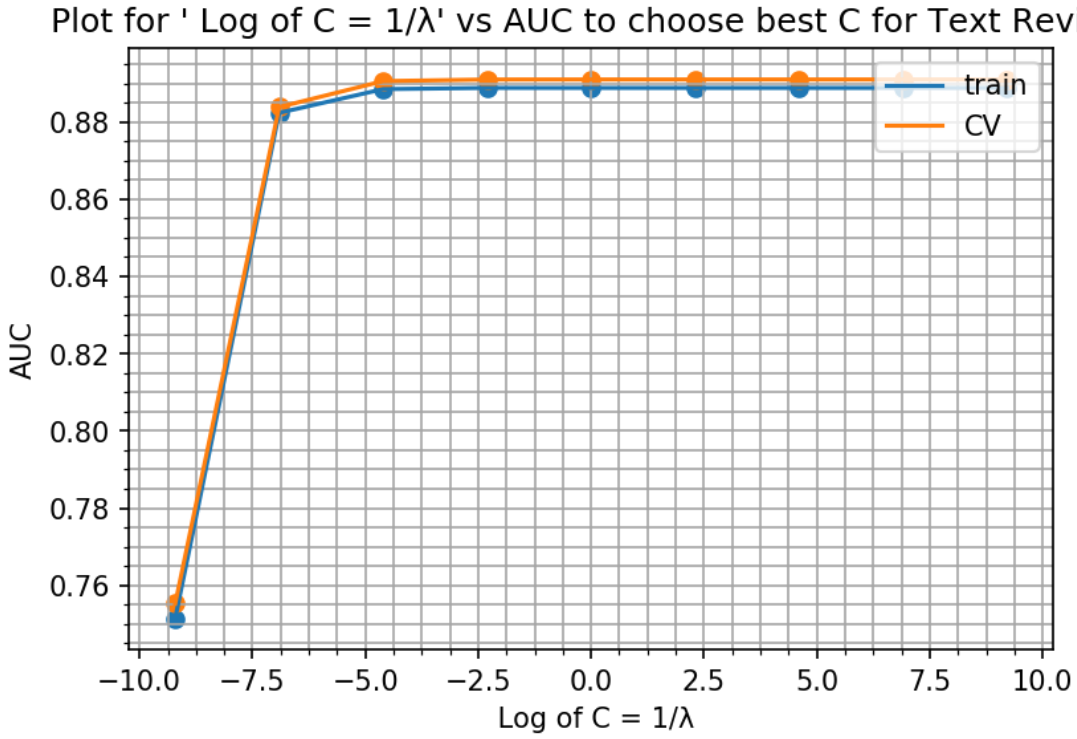
```
from sklearn.linear_model import LogisticRegression
auc_cv_tfidf_w2v_txt = []
auc_train_tfidf_w2v_txt=[]


for C in tqdm(C_LR_tfidf_w2v):
    L1_tfidf_w2v_txt = LogisticRegression(penalty='l1',C=C, fit_intercept=True, inte
rcept_scaling=1, class_weight='balanced')
    L1_tfidf_w2v_txt.fit(tfidf_w2v_sent_vectors_train_std, y_train)
    proba_pred_train_tfidf_w2v_txt=(L1_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent_ve
ctors_train_std)[:,1])
    proba_pred_cv_tfidf_w2v_txt=(L1_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent_vecto
rs_cv_std)[:,1])
    auc_train_tfidf_w2v_txt.append(roc_auc_score(y_train,proba_pred_train_tfidf_w2v_
txt))
    auc_cv_tfidf_w2v_txt.append(roc_auc_score(y_CV,proba_pred_cv_tfidf_w2v_txt))
```

100%|██
████████████████| 9/9 [01:33<00:00, 12.75s/it]

In [116]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_tfidf_w2v_log, auc_train_tfidf_w2v_txt)
plt.scatter(C_LR_tfidf_w2v_log, auc_train_tfidf_w2v_txt)
plt.plot(C_LR_tfidf_w2v_log, auc_cv_tfidf_w2v_txt)
plt.scatter(C_LR_tfidf_w2v_log, auc_cv_tfidf_w2v_txt)
plt.xlabel(' Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for ' Log of C = 1/λ' vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



The value of C is 1 for TFIDF W2V

In [117]:

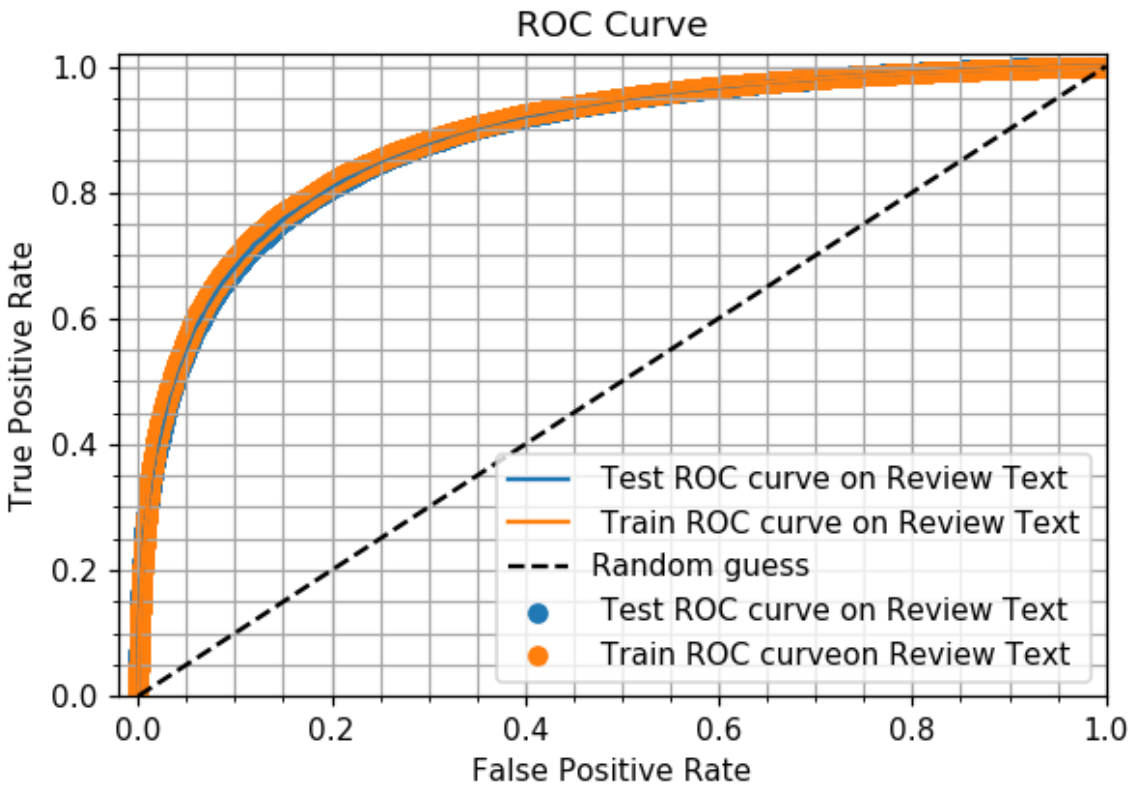
```
l1_bestC_auc_train_tfidf_w2v_txt = []
l1_bestC_auc_test_tfidf_w2v_txt = []
L1_tfidf_w2v_txt = LogisticRegression(penalty='l1',C=1, fit_intercept=True, intercept_scaling=1, class_weight='balanced')
L1_tfidf_w2v_txt.fit(tfidf_w2v_sent_vectors_train_std, y_train)
proba_pred_train_tfidf_w2v_txt=(L1_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent_vectors_train_std)[:,1])
proba_pred_test_tfidf_w2v_txt=(L1_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent_vectors_test_std)[:,1])

l1_bestC_auc_train_tfidf_w2v_txt.append(roc_auc_score(y_train,proba_pred_train_tfidf_w2v_txt))
l1_bestC_auc_test_tfidf_w2v_txt.append(roc_auc_score(y_test,proba_pred_test_tfidf_w2v_txt))
```

In [118]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_avg_tfidf_l1_txt, tpr_test_avg_tfidf_l1_txt, thresholds = roc_curve(y_test,
proba_pred_test_tfidf_w2v_txt)
fpr_train_avg_tfidf_l1_txt, tpr_train_avg_tfidf_l1_txt, thresholds = roc_curve(y_tra
in, proba_pred_train_tfidf_w2v_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_avg_tfidf_l1_txt, tpr_test_avg_tfidf_l1_txt, label=' Test ROC curv
e on Review Text')
plt.scatter(fpr_test_avg_tfidf_l1_txt, tpr_test_avg_tfidf_l1_txt, label=' Test ROC c
urve on Review Text')
plt.plot(fpr_train_avg_tfidf_l1_txt, tpr_train_avg_tfidf_l1_txt, label=' Train ROC c
urve on Review Text')
plt.scatter(fpr_train_avg_tfidf_l1_txt, tpr_train_avg_tfidf_l1_txt, label=' Train RO
C curveon Review Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [119]:

```
l1_pred_train_tfidf_w2v_txt=(L1_tfidf_w2v_txt.predict(tfidf_w2v_sent_vectors_train_std))
l1_pred_test_tfidf_w2v_txt=(L1_tfidf_w2v_txt.predict(tfidf_w2v_sent_vectors_test_std))
```

In [120]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")
print(classification_report(y_test, l1_pred_test_tfidf_w2v_txt))
print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, l1_pred_train_tfidf_w2v_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.45      0.83      0.58     21261
          1       0.96      0.78      0.86     99648

avg / total       0.87      0.79      0.81    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.39      0.82      0.53     22681
          1       0.97      0.79      0.87    141791

avg / total       0.89      0.80      0.82    164472
```

In [121]:

```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train, l1_pred_train_tfidf_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train, l1_pred_train_tfidf_w2v_txt)
```

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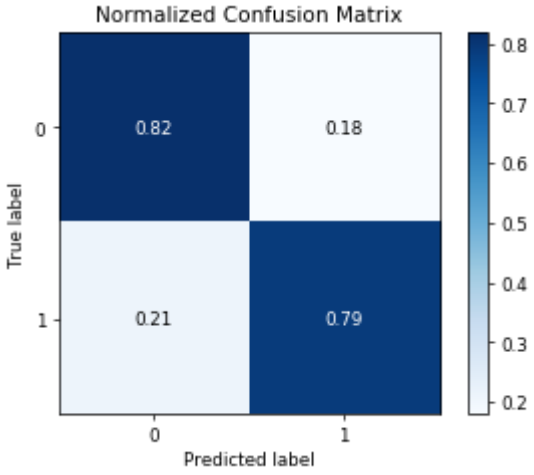
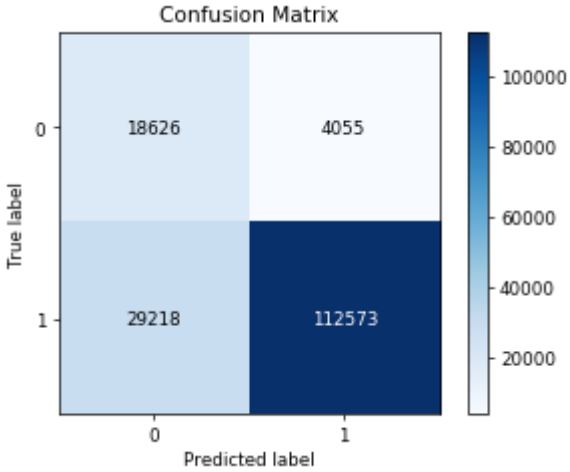
Out[121]:

<matplotlib.axes._subplots.AxesSubplot at 0x15889c9a198>





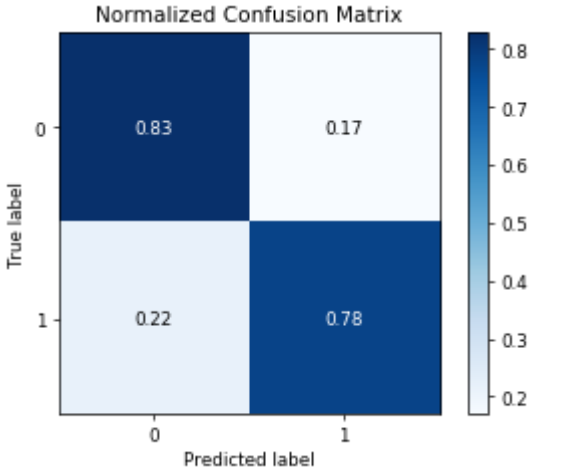
In [122]:

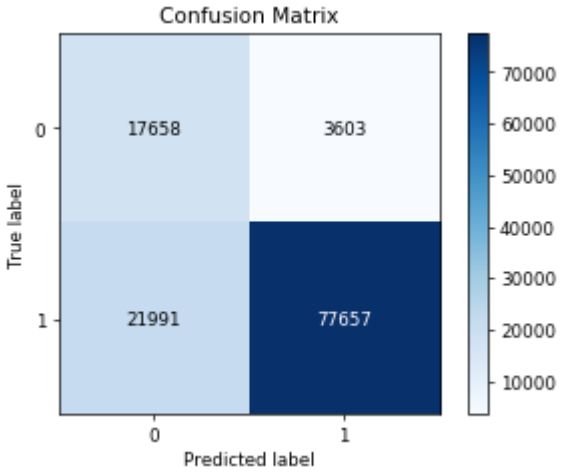
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, l1_pred_test_tfidf_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, l1_pred_test_tfidf_w2v_txt)
```

IN NOT NORMALIZED FORMAT BELOW

Out[122]:

<matplotlib.axes._subplots.AxesSubplot at 0x15889c72710>





[5.4.2] Applying Logistic Regression with L2 regularization on TFIDF W2V, SET 4

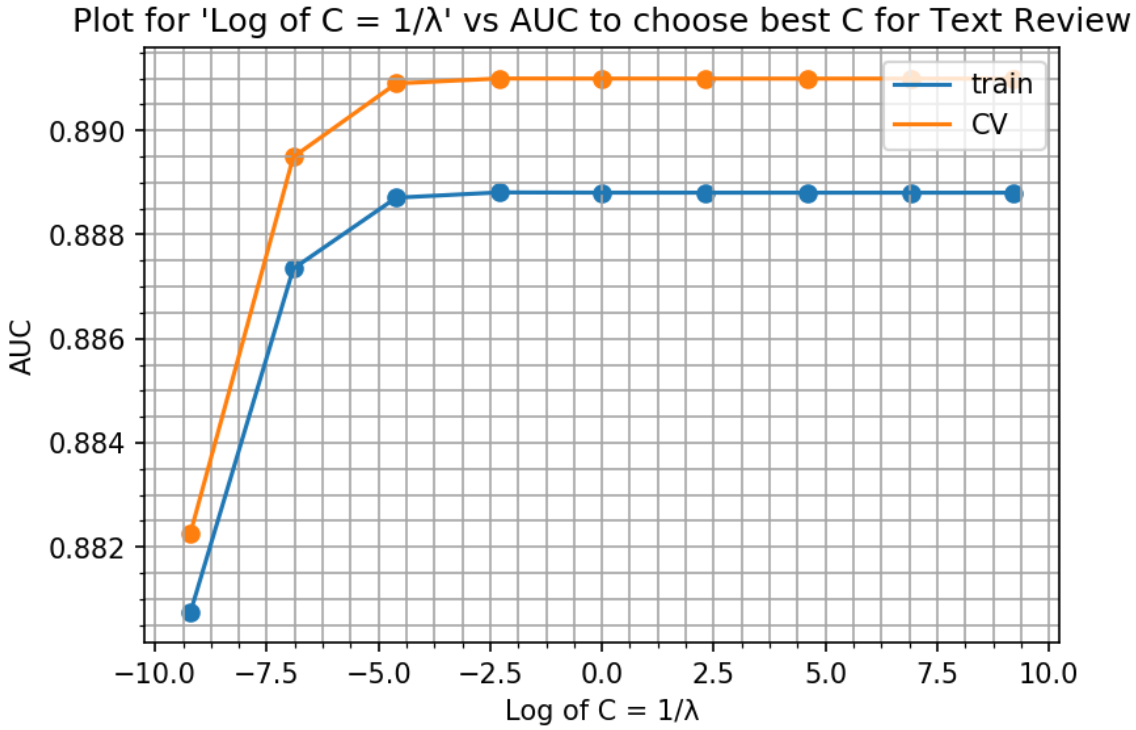
In [123]:

```
from sklearn.linear_model import LogisticRegression
l2_auc_cv_tfidf_w2v_txt = []
L2_auc_train_tfidf_w2v_txt=[]


for C in tqdm(C_LR_tfidf_w2v):
    L2_tfidf_w2v_txt = LogisticRegression(penalty='l2',C=C, fit_intercept=True, inte
rcept_scaling=1, class_weight='balanced')
    L2_tfidf_w2v_txt.fit(tfidf_w2v_sent_vectors_train_std, y_train)
    l2_proba_pred_train_tfidf_w2v_txt=(L2_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent
_vectors_train_std)[:,1])
    L2_proba_pred_cv_tfidf_w2v_txt=(L2_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent_ve
ctors_cv_std)[:,1])
    L2_auc_train_tfidf_w2v_txt.append(roc_auc_score(y_train,l2_proba_pred_train_tfid
f_w2v_txt))
    l2_auc_cv_tfidf_w2v_txt.append(roc_auc_score(y_CV,L2_proba_pred_cv_tfidf_w2v_txt
))
```

```
100%|██████████████████████████████████████████████████████████████████
████████████████| 9/9 [00:25<00:00,  3.04s/it]
```

In [124]:

```
default_dpi = plt.rcParamsDefault['figure.dpi']
plt.rcParams['figure.dpi'] = default_dpi*1.5
plt.plot(C_LR_tfidf_w2v_log, L2_auc_train_tfidf_w2v_txt)
plt.scatter(C_LR_tfidf_w2v_log, L2_auc_train_tfidf_w2v_txt)
plt.plot(C_LR_tfidf_w2v_log, l2_auc_cv_tfidf_w2v_txt)
plt.scatter(C_LR_tfidf_w2v_log, l2_auc_cv_tfidf_w2v_txt)
plt.xlabel('Log of C = 1/λ')
plt.ylabel('AUC')
plt.title("Plot for 'Log of C = 1/λ' vs AUC to choose best C for Text Review")
plt.legend(['train', 'CV'], loc='upper right')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```

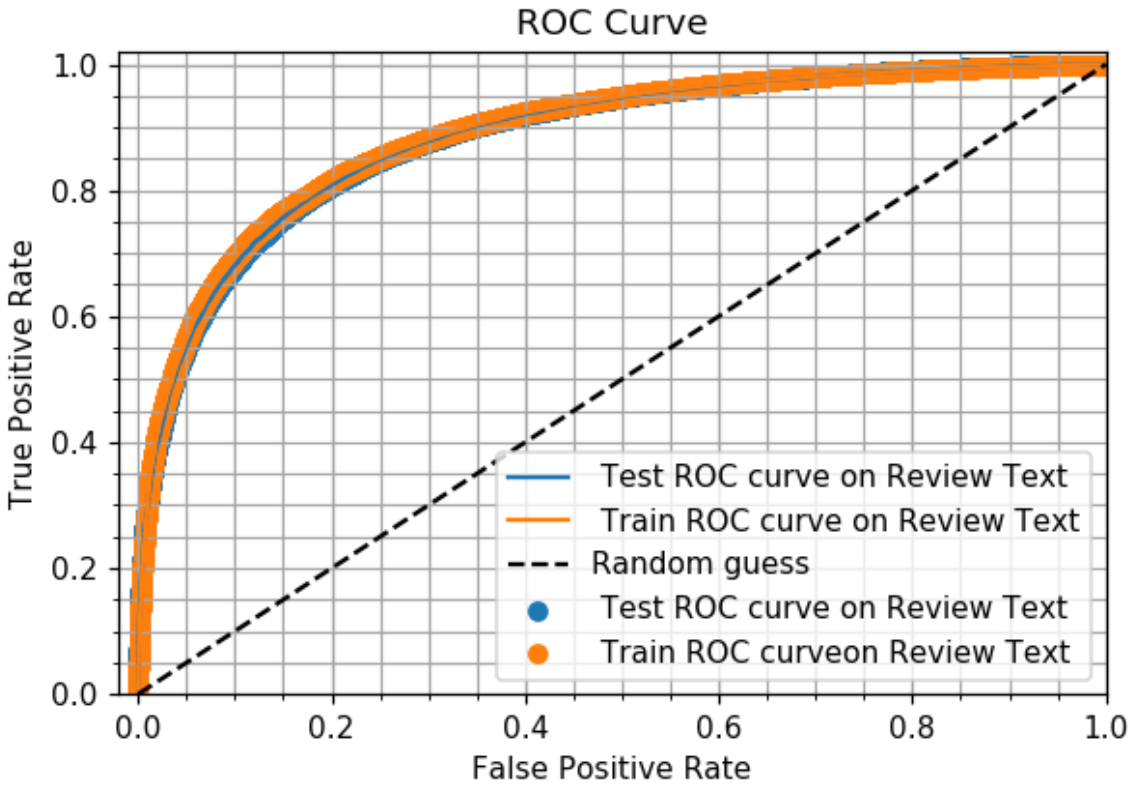


In [125]:

```
l2_bestC_auc_train_tfidf_w2v_txt = []
l2_bestC_auc_test_tfidf_w2v_txt = []

L2_tfidf_w2v_txt = LogisticRegression(penalty='l2',C=1, fit_intercept=True, intercept_scaling=1, class_weight='balanced')
L2_tfidf_w2v_txt.fit(tfidf_w2v_sent_vectors_train_std, y_train)
l2_proba_pred_train_tfidf_w2v_txt=(L2_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent_vectors_train_std)[:,1])
l2_proba_pred_test_tfidf_w2v_txt=(L2_tfidf_w2v_txt.predict_proba(tfidf_w2v_sent_vectors_test_std)[:,1])

l2_bestC_auc_train_tfidf_w2v_txt.append(roc_auc_score(y_train,l2_proba_pred_train_tfidf_w2v_txt))
l2_bestC_auc_test_tfidf_w2v_txt.append(roc_auc_score(y_test,l2_proba_pred_test_tfidf_w2v_txt))
```

In [126]:

```
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline

fpr_test_avg_tfidf_l2_txt, tpr_test_avg_tfidf_l2_txt, thresholds = roc_curve(y_test,
l2_proba_pred_test_tfidf_w2v_txt)
fpr_train_avg_tfidf_l2_txt, tpr_train_avg_tfidf_l2_txt, thresholds = roc_curve(y_tra
in, l2_proba_pred_train_tfidf_w2v_txt)
# create plot
plt.rcParams['figure.dpi'] = default_dpi*1.1
plt.plot(fpr_test_avg_tfidf_l2_txt, tpr_test_avg_tfidf_l2_txt, label=' Test ROC curv
e on Review Text')
plt.scatter(fpr_test_avg_tfidf_l2_txt, tpr_test_avg_tfidf_l2_txt, label=' Test ROC c
urve on Review Text')
plt.plot(fpr_train_avg_tfidf_l2_txt, tpr_train_avg_tfidf_l2_txt, label=' Train ROC c
urve on Review Text')
plt.scatter(fpr_train_avg_tfidf_l2_txt, tpr_train_avg_tfidf_l2_txt, label=' Train RO
C curveon Review Text')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
plt.minorticks_on()
plt.grid(b=True, which='both', color='0.65', linestyle='-')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [127]:

```
l2_pred_train_tfidf_w2v_txt=(L2_tfidf_w2v_txt.predict(tfidf_w2v_sent_vectors_train_s
td))
l2_pred_test_tfidf_w2v_txt=(L2_tfidf_w2v_txt.predict(tfidf_w2v_sent_vectors_test_std
))
```

In [128]:

```
from sklearn.metrics import classification_report

print ("############################################################")
print ("The classification report on Test dataset on Review Text")
print ("############################################################")
print(classification_report(y_test, l2_pred_test_tfidf_w2v_txt))
print ("############################################################")
print ("The classification report on Training dataset Review Text")
print ("############################################################")
print(classification_report(y_train, l2_pred_train_tfidf_w2v_txt))
```

```
############################################################
The classification report on Test dataset on Review Text
############################################################
             precision    recall  f1-score   support

          0       0.45      0.83      0.58     21261
          1       0.96      0.78      0.86     99648

avg / total       0.87      0.79      0.81    120909

############################################################
The classification report on Training dataset Review Text
############################################################
             precision    recall  f1-score   support

          0       0.39      0.82      0.53     22681
          1       0.97      0.79      0.87    141791

avg / total       0.89      0.80      0.82    164472
```

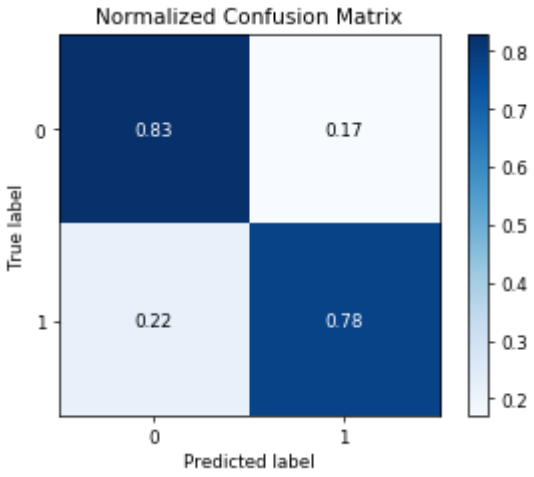
In [129]:

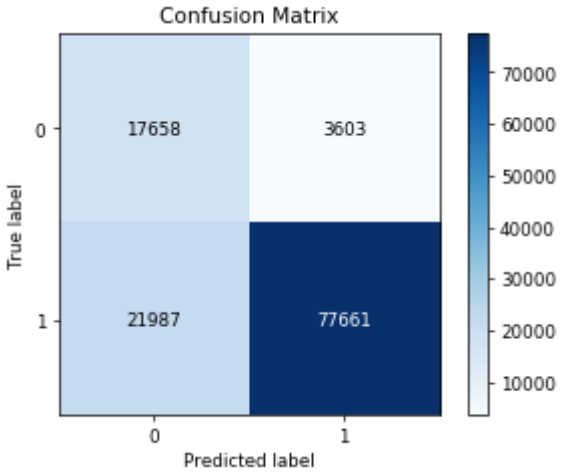
```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_test, l2_pred_test_tfidf_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_test, l2_pred_test_tfidf_w2v_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[129]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15889f9e630>
```





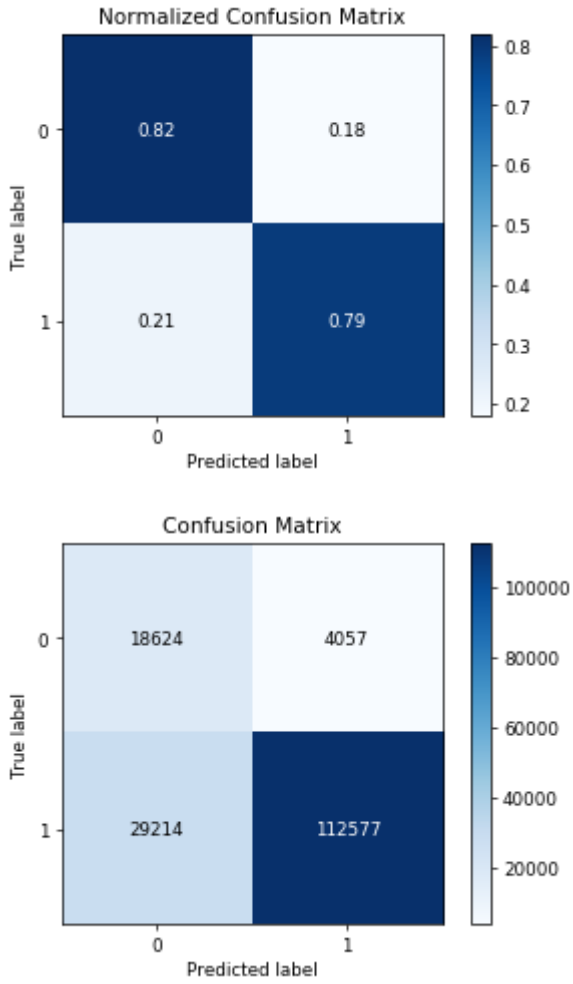
In [130]:

```
from sklearn.metrics import confusion_matrix
import scikitplot.metrics as skplt
plt.rcParams['figure.dpi'] = default_dpi*.63
skplt.plot_confusion_matrix(y_train, l2_pred_train_tfidf_w2v_txt,normalize=True)
print ("IN NOT NORMALIZED FORMAT BELOW")
skplt.plot_confusion_matrix(y_train, l2_pred_train_tfidf_w2v_txt)
```

```
IN NOT NORMALIZED FORMAT BELOW
```

Out[130]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x15889f78d30>
```



[6] Conclusions

In [131]:

```
from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ["Algorithm","Hyper-Parameter C = 1/λ", "AUC"]

x.add_row(["Bag Of Words with L1 (Test Data)",.16,l1_auc_test_BOW ])
x.add_row(["Bag Of Words with L1 (Train Data)",.16,l1_auc_train_BOW ])
x.add_row(["Bag Of Words with L2 (Test Data)",.06,l2_auc_test_BOW ])
x.add_row(["Bag Of Words with L2 (Train Data)",.06,l2_auc_train_BOW])
x.add_row(["TFIDF with L1 (Test Data)",6,l1_auc_test_tfidf ])
x.add_row(["TFIDF with L1 (Train Data)",6,l1_auc_train_tfidf ])
x.add_row(["TFIDF with L2 (Test Data)",10000,l2_auc_test_tfidf ])
x.add_row(["TFIDF with L2 (Train Data)",10000,l2_auc_train_tfidf ])
x.add_row(["Avg-W2V with L1 (Test Data)",1, bestCl1_auc_test_avg_w2v_txt])
x.add_row(["Avg-W2V with L1 (Train Data)",1,bestCl1_auc_train_avg_w2v_txt ])
x.add_row(["Avg-W2V with L2 (Test)",1,l2_bestC_auc_test_avg_w2v_txt ])
x.add_row(["TFIDF-W2V with L2 (Train)",1,l2_bestC_auc_train_avg_w2v_txt ])
x.add_row(["TFIDF-W2V with L1 (Test Data)",1,l1_bestC_auc_test_tfidf_w2v_txt ])
x.add_row(["TFIDF-W2V with L1 (Train Data)",1,l1_bestC_auc_train_tfidf_w2v_txt ])
x.add_row(["TFIDF-W2V with L2 (Test)",1, l2_bestC_auc_test_tfidf_w2v_txt])
x.add_row(["TFIDF-W2V with L2 (Train)",1, l2_bestC_auc_train_tfidf_w2v_txt])

print (x)
```

Algorithm	Hyper-Parameter C = 1/λ	AUC
Bag Of Words with L1 (Test Data)	0.16	0.9422061600108804
Bag Of Words with L1 (Train Data)	0.16	0.9595183466662653
Bag Of Words with L2 (Test Data)	0.06	0.9560466630696771
Bag Of Words with L2 (Train Data)	0.06	0.9760106097669967
TFIDF with L1 (Test Data)	6	0.9672281379423163
TFIDF with L1 (Train Data)	6	0.993729950925152
TFIDF with L2 (Test Data)	10000	0.9668719764414065
TFIDF with L2 (Train Data)	10000	0.9999999992226276
Avg-W2V with L1 (Test Data)	1	[0.912662021187068]
Avg-W2V with L1 (Train Data)	1	[0.9117707026614622]
Avg-W2V with L2 (Test)	1	[0.9126628646621915]
TFIDF-W2V with L2 (Train)	1	[0.9117698456860744]
TFIDF-W2V with L1 (Test Data)	1	[0.886066674226696]
TFIDF-W2V with L1 (Train Data)	1	[0.8888057728658172]
TFIDF-W2V with L2 (Test)	1	[0.8860663844148741]
TFIDF-W2V with L2 (Train)	1	[0.8888051410174906]

Both TFIDF and BOW performed very good. Also it didnt take much time. Also they were better than previous algorithms that we tried like KNN and Naive Bayes

Avg-W2V and TFIDF-W2V takes time in creating model and also it didnt perform that well as compared to Logistic Regression of BOW andTFIDF

Also as mentioned before we saw the features are very collinear after introducing small noise we can see the TPR and FPR wasnt that much affected for training dataset as compared with TPR and FPR after introduction of noise