Random Forest and GBDT Algorithm on Donors_Choose dataset

In [0]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_i
d=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redi
rect_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aoob&response_type=code&scope=email%20h
ttps%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleap
is.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.
readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly (http
s://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdgf4n4g3pf
ee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3aietf%3awg%3aoauth%
3a2.0%3aoob&response_type=code&scope=email%20https%3a%2f%2fwww.googleapis.com%2
fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%
2f%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f%2fwww.goog
leapis.com%2fauth%2fpeopleapi.readonly)

Enter your authorization code:
··········
Mounted at /content/drive
```

In [0]:
```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
import sqlite3
import pandas as pd
import numpy as np
import nltk
import gc
gc.enable()
gc.DEBUG_SAVEALL
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

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
import math
# from plotly import plotly
# import plotly.offline as offline
# import plotly.graph_objs as go
# offline.init_notebook_mode()
from collections import Counter
gc.set_threshold(2, 1, 1)
```

2.1 Loading Input Data

In [0]:
```
# %load_ext memory_profiler
s=0
# We are taking samples of 0's and 1's and appending them to overcome memory erro
project_data = pd.read_csv('/content/drive/My Drive/train_data.csv')
# project_data=project_data.dropna(how='any')
project_data_1 = project_data[project_data['project_is_approved'] == s+1]
project_data_0 = project_data[project_data['project_is_approved'] == s]
project_data=project_data.fillna("")
project_data_1=project_data_1.head(10000)
project_data_0=project_data_0.tail(10000)
project_data_1=project_data_1.append(project_data_0)
project_data=project_data_1
resource_data = pd.read_csv('/content/drive/My Drive/resources.csv')

#Sorting them by columns to spread the zeros and one's unevenly in the 'project_
project_data.sort_values(by=['project_essay_1'])
project_data.sort_values(by=['project_essay_2'], ascending=False)
project_data.sort_values(by=['project_essay_3'])
project_data.sort_values(by=['project_essay_4'], ascending=False)
project_data_1=None
project_data_0=None
```

In [0]:
```
print("Number of data points in train data", project_data.shape)
print('-'*50)
print("The attributes of data :", project_data.columns.values)
```

```
Number of data points in train data (20000, 17)
--------------------------------------------------
The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix' 'scho
ol_state'
 'project_submitted_datetime' 'project_grade_category'
 'project_subject_categories' 'project_subject_subcategories'
 'project_title' 'project_essay_1' 'project_essay_2' 'project_essay_3'
 'project_essay_4' 'project_resource_summary'
 'teacher_number_of_previously_posted_projects' 'project_is_approved']
```

In [0]:
```
print("Number of data points in resource data", resource_data.shape)
print(resource_data.columns.values)
resource_data.head(1)
# project_data.head(2)
```

```
Number of data points in resource data (1541272, 4)
['id' 'description' 'quantity' 'price']
```

Out[5]:

	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.0

In [0]:
```
y = project_data['project_is_approved'].values
X = project_data.drop(['project_is_approved'], axis=1)
X.head(1)
project_data=None
gc.collect()
gc.enable()
gc.DEBUG_SAVEALL
```

Out[6]:
```
32
```

2.2 Getting the Data Model Ready:Preprocessing and Vectorizing categorical features

2.2.1 Preprocessing:project_grade_category

In [0]:
```
sub_catogories = list(X['project_grade_category'].values)
# remove special characters from list of strings python: https://stackoverflow.co

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-

sub_cat_list = []
for i in sub_catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(','): # it will split it in three parts ["Math & Science",
        if 'The' in j.split(): # this will split each of the catogory based on sp
            j=j.replace('The','') # if we have the words "The" we are going to re
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trail
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())
X['project_grade_category'] = sub_cat_list
```

In [0]:
```
sub_catogories=None
sub_cat_list=None
temp=None
i=None
j=None
catogories=None
cat_list=None
temp=None
my_counter=None
word=None
cat_dict=None
gc.collect()
gc.enable()
gc.DEBUG_SAVEALL
```

Out[8]:
```
32
```

2.2.2 Preprocessing:project_subject_categories

In [0]:
```
catogories = list(X['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.co

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-
cat_list = []
for i in catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(','): # it will split it in three parts ["Math & Science",
        if 'The' in j.split(): # this will split each of the catogory based on sp
            j=j.replace('The','') # if we have the words "The" we are going to re
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty
        temp+=j.strip()+" " #" abc ".strip() will return "abc", remove the trail
        temp = temp.replace('&','_') # we are replacing the & value into
    cat_list.append(temp.strip())

X['clean_categories'] = cat_list
X.drop(['project_subject_categories'], axis=1, inplace=True)
X.head(2)
```

Out[9]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_sul
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	

2.2.3 Preprocessing:project_subject_subcategories

In [0]:
```
sub_catogories = list(X['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.co

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-

sub_cat_list = []
for i in sub_catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(','): # it will split it in three parts ["Math & Science",
        if 'The' in j.split(): # this will split each of the catogory based on sp
            j=j.replace('The','') # if we have the words "The" we are going to re
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trail
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())
```

In [0]:
```
X['clean_subcategories'] = sub_cat_list
X.drop(['project_subject_subcategories'], axis=1, inplace=True)
X.head(2)
```

Out[11]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_sul
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	

2.2.4 New Column:digits in summary

In [0]:
```
# Creating a new column 'digits_in_summary' which contains flags of 1 for /
# 'project_resource_summary' containing numeric specification in their requiremn
project_resource_summary = []
new=[]

project_resource_summary = list(X['project_resource_summary'].values)

for i in project_resource_summary:
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(' '):
        if j.isdigit():
            new.append(1)
            break
        else:
            continue
    else:
        new.append(0)


X['digits_in_summary']=new
```

In [0]:
```
#To make best use of the memory we are setting the variable names to 'None' and p
project_resource_summary=None
new=None
new1=None
i=None
j=None
a=None

gc.collect()
gc.enable()
gc.DEBUG_SAVEALL
```

Out[13]:
```
32
```

2.2.5 Preprocessing:Text features (Project Essay's)

In [0]:
```
# merge two column text dataframe:
X["essay"] = X["project_essay_1"].map(str) +\
                        X["project_essay_2"].map(str) + \
                        X["project_essay_3"].map(str) + \
                        X["project_essay_4"].map(str)
```

In [0]:
```
X = X.drop(['project_essay_1', 'project_essay_2','project_essay_3', 'project_essa
X.shape
```

Out[15]:
```
(20000, 14)
```

2.2.6 Adding column Cost per project in dataset

In [0]:
```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframes-indexes
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).
price_data.head(2)
type(price_data)
```

Out[16]:
```
pandas.core.frame.DataFrame
```

In [0]:
```
# join two dataframes in python:
X = pd.merge(X, price_data, on='id', how='left')
X.head(2)
```

Out[17]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_sul
0	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	
1	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	

In [0]:
```
#To make best use of the memory we are setting the variable names to 'None' and 
resource_data=None
price_data=None
gc.collect()
gc.enable()
gc.DEBUG_SAVEALL
```

Out[18]:
```
32
```

2.2.7 Text Preprocessing:Essay Text

In [0]:
```
# https://stackoverflow.com/a/47091490/4084039
import re

def decontracted(phrase):
    # specific
    phrase = re.sub(r"won't", "will not", phrase)
    phrase = re.sub(r"can\'t", "can not", phrase)

    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    return phrase
```

In [0]:
```
sent = decontracted(X['essay'].values[99])
print(sent)
print("="*50)
```

```
What does \"The message in the music\" mean to you? To my kids, it means so muc
h more! Music is not just for entertainment!  My kids are learning how music ca
n be used as a human rights tool! They are learning to express their feelings o
f the world around them in positive ways.\r\n\r\nMy kids are every stereotype y
ou can think of: poor, underprivileged, rough, angry.  Turn that same prism aro
und there is also joy, happiness, intelligence and creativity. They are learnin
g to navigate the world around them and we are working on showing them how to u
se this energy in a positive way.Our piano lab is aging.  We have 3 classes of 
35 kids that are bursting at the gills, which is a great problem to have!  BUT 
keyboards are beginning to have the keys break off making them unuseable. We al
so do not have enough keyboards for every student in class, even if you counted
the slightly broken ones!\r\n\r\nWe are in desperate need of more keyboards for
our labs to meet the needs of our students.  A keyboard for each student in cla
ss will facilitate their love of music and help them grow and appreciate the wo
rld around them.  We are down to 24 semi working keyboards and 35 kids in each 
piano class.  These keyboards are needed sooner rather than later for our kids 
to have a successful year in class.nannan
==================================================
```

In [0]:
```
# \r \n \t remove from string python: http://texthandler.com/info/remove-line-bre
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\"', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
What does  The message in the music  mean to you? To my kids, it means so much
more! Music is not just for entertainment!  My kids are learning how music can
be used as a human rights tool! They are learning to express their feelings of
the world around them in positive ways.    My kids are every stereotype you can
think of: poor, underprivileged, rough, angry.  Turn that same prism around the
re is also joy, happiness, intelligence and creativity. They are learning to na
vigate the world around them and we are working on showing them how to use this
energy in a positive way.Our piano lab is aging.  We have 3 classes of 35 kids
that are bursting at the gills, which is a great problem to have!  BUT keyboard
s are beginning to have the keys break off making them unuseable. We also do no
t have enough keyboards for every student in class, even if you counted the sli
ghtly broken ones!    We are in desperate need of more keyboards for our labs t
o meet the needs of our students.  A keyboard for each student in class will fa
cilitate their love of music and help them grow and appreciate the world around
them.  We are down to 24 semi working keyboards and 35 kids in each piano clas
s.  These keyboards are needed sooner rather than later for our kids to have a
successful year in class.nannan
```

In [0]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
What does The message in the music mean to you To my kids it means so much more
Music is not just for entertainment My kids are learning how music can be used
as a human rights tool They are learning to express their feelings of the world
around them in positive ways My kids are every stereotype you can think of poor
underprivileged rough angry Turn that same prism around there is also joy happi
ness intelligence and creativity They are learning to navigate the world around
them and we are working on showing them how to use this energy in a positive wa
y Our piano lab is aging We have 3 classes of 35 kids that are bursting at the
gills which is a great problem to have BUT keyboards are beginning to have the
keys break off making them unuseable We also do not have enough keyboards for e
very student in class even if you counted the slightly broken ones We are in de
sperate need of more keyboards for our labs to meet the needs of our students A
keyboard for each student in class will facilitate their love of music and help
them grow and appreciate the world around them We are down to 24 semi working k
eyboards and 35 kids in each piano class These keyboards are needed sooner rath
er than later for our kids to have a successful year in class nannan
```

In [0]:
```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', 
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itse
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'tha
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'ha
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 't
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'of
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than'
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should'v
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "d
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma'
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn
            'won', "won't", 'wouldn', "wouldn't"]
```

In [0]:
```
# Combining all the above statemennts
from tqdm import tqdm
preprocessed_essays = []
# tqdm is for printing the status bar
for sentance in tqdm(X['essay'].values):
    sent = decontracted(sentance)
    sent = sent.replace('\\r', ' ')
    sent = sent.replace('\\"', ' ')
    sent = sent.replace('\\n', ' ')
    sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
    # https://gist.github.com/sebleier/554280
    sent = ' '.join(e for e in sent.split() if e not in stopwords)
    preprocessed_essays.append(sent.lower().strip())
```

```
100%|██████████| 20000/20000 [00:12<00:00, 1627.24it/s]
```

In [0]:
```
# after preprocesing

# X['essay'] = None
X['essay'] = preprocessed_essays

X.head(2)
```

Out[25]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_sul
0	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	
1	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	

In [0]:
```
# Combining all the above statemennts
from tqdm import tqdm
preprocessed_project_title = []
# tqdm is for printing the status bar
for sentance in tqdm(X['project_title'].values):
    sent = decontracted(sentance)
    sent = sent.replace('\\r', ' ')
    sent = sent.replace('\\"', ' ')
    sent = sent.replace('\\n', ' ')
    sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
    # https://gist.github.com/sebleier/554280
    sent = ' '.join(e for e in sent.split() if e not in stopwords)
    preprocessed_project_title.append(sent.lower().strip())
```

```
100%|██████████| 20000/20000 [00:00<00:00, 29477.35it/s]
```

In [0]:
```
preprocessed_project_title[4999]
# after preprocesing

# X['project_title'] = None
X['project_title'] = preprocessed_project_title

X.head(2)
```

Out[27]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_sul
0	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	
1	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	

2.2.8 Splitting the data into Train and Test

In [0]:
```
# train test split(67:33)
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33, strati
# X_train, X_cv, y_train, y_cv = train_test_split(X_train, y_train, test_size=0.
X=None
gc.collect()
```

Out[28]:
```
11
```

2.2.9 Response Coding Categorical data:

In [0]:
```
def res_code(X_tr,y_tr,cc,cc_0,cc_1):
    #We are concatinating train data and its classes to create a base table while
    df=pd.DataFrame(X_tr,columns=[cc]) #Train data
    df1=pd.DataFrame(y_tr,columns=['y']) #Train class
    df.reset_index(drop=True, inplace=True)
    df1.reset_index(drop=True, inplace=True)
    df_row = df.assign(y=df1) #concatenating of the train and  train class
#     df_row.to_csv('file2.csv')
    #========================*************************===========================
    #To create response table for the given category
    group_data = df_row.groupby([cc]).count() #We groupby with respect to the ca
    df_row['id'] = df_row[cc].str.cat(df_row['y'].values.astype(str)) #We concat
    group_data1 = df_row.groupby(['id'])['y'].count() #We are obtaining the count
    group_data1=group_data1.to_frame() #Converting to dataframe
    #========================*************************===========================
    #We have two tables group_data which holds the category count and group_data1
    df_row = pd.merge(df_row,group_data, on=cc, how='left') #On the base data we
    df_row = pd.merge(df_row,group_data1,on='id', how='left') #On the base data w
    #======================*************************==============================
    #Final Response table creation wrt class 0 and class 0
    df_row_1 = df_row[df_row['y_x']==1] #Breaking the table wrt class 1
    df_row_0 = df_row[df_row['y_x']==0] #Breaking the table wrt class 0
    df_row_0[cc_0]=df_row_0['y']/df_row_0['y_y'] #We are taking the percentage o
    df_row_1[cc_1]=df_row_1['y']/df_row_1['y_y'] #We are taking the percentage o
    df_row_0=df_row_0.drop(['y_x', 'id','y_y','y'], axis=1) #Dropping unwanted c
    df_row_1=df_row_1.drop(['y_x', 'id','y_y','y'], axis=1) #Dropping unwanted c
    df_row=df_row.drop(['y_x', 'id','y_y','y'], axis=1) #Dropping unwanted colum
    #=====================*************************==============================
    df_row_0=df_row_0.drop_duplicates() #Dropping the duplicates
    df_row_1=df_row_1.drop_duplicates() #Dropping the duplicates
    X_tr = pd.merge(X_tr,df_row_1, on=cc, how='left') #Merging the class 1 perce
    X_tr = pd.merge(X_tr,df_row_0, on=cc, how='left') #Merging the class 0 perce
    X_tr[cc_0]=round((X_tr[cc_0])*100,2) #We are multiplying the percentage and
    X_tr[cc_1]=round((X_tr[cc_1])*100,2) #We are multiplying the percentage and
    X_tr=X_tr.drop([cc], axis=1) #We are dropping the category column
    X_tra=X_tr
    return X_tra
```

In [0]:
```
#  Response Coding Categorical data: clean_subcategories(Project subject categor
CC='clean_categories'
CC_0='St_0_cl_cat'
CC_1='St_1_cl_cat'

X_train=res_code(X_train,y_train,CC,CC_0,CC_1)
X_test=res_code(X_test,y_test,CC,CC_0,CC_1)

#  Response Coding Categorical data: clean_subcategories(Project subject subcateg
CC = 'clean_subcategories'
CC_0='St_0_sub_cat'
CC_1='St_1_sub_cat'
X_train=res_code(X_train,y_train,CC,CC_0,CC_1)
X_test=res_code(X_test,y_test,CC,CC_0,CC_1)

#  Response Coding Categorical data:(school_state)
CC = 'school_state'
CC_0='St_0_sc_st'
CC_1='St_1_sc_st'
X_train=res_code(X_train,y_train,CC,CC_0,CC_1)
X_test=res_code(X_test,y_test,CC,CC_0,CC_1)

#  Response Coding Categorical data: (project_grade_category)
CC = 'project_grade_category'
CC_0='St_0_pgc'
CC_1='St_1_pgc'
X_train=res_code(X_train,y_train,CC,CC_0,CC_1)
X_test=res_code(X_test,y_test,CC,CC_0,CC_1)

#  Response Coding Categorical data: (project_grade_category)
CC = 'teacher_prefix'
CC_0='St_0_tp'
CC_1='St_1_tp'
X_train=res_code(X_train,y_train,CC,CC_0,CC_1)
X_test=res_code(X_test,y_test,CC,CC_0,CC_1)
# X_train.to_csv('train_cc.csv')
# X_test.to_csv('test_cc.csv')
```

In [0]:
```
X_train = X_train.fillna(0)
X_test = X_test.fillna(0)
X_train.head(3)
```

Out[31]:

	Unnamed: 0	id	teacher_id	project_submitted_datetime	project_title
0	109407	p005384	9028768cdb5a9fcd858c3912ea914ed4	9/27/2016 21:16	listening to great books in our new listening ...
1	113334	p072953	fe73585bb6e72c42733013a09f096430	8/24/2016 21:11	food brain
2	82705	p165525	63e5c5d2346a370d186f3800cb54fe4a	11/13/2016 16:07	tortoise friends enriched classroom

2.3 Make Data Model Ready: Vectorizing Numerical features

2.3.1 Vectorizing Numerical features--Price

In [0]:
```
from sklearn.preprocessing import Normalizer
from sklearn.preprocessing import StandardScaler
normalizer = StandardScaler() #Normalizer()
# normalizer_test = Normalizer()
# normalizer.fit(X_train['price'].values)
# this will rise an error Expected 2D array, got 1D array instead:
# array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
# Reshape your data either using
# array.reshape(-1, 1) if your data has a single feature
# array.reshape(1, -1)  if it contains a single sample.
normalizer.fit(X_train['price'].values.reshape(-1,1))
# normalizer_test.fit(X_test['price'].values.reshape(1,-1))

X_train_price_norm = normalizer.transform(X_train['price'].values.reshape(-1,1))
# X_cv_price_norm = normalizer.transform(X_cv['price'].values.reshape(-1,1))
X_test_price_norm = normalizer.transform(X_test['price'].values.reshape(-1,1))


# X_train_price_norm=np.reshape(X_train_price_norm,(1,-1))
# X_test_price_norm=np.reshape(X_test_price_norm,(1,-1))

print("After vectorizations")

# np.reshape(X_train_price_norm,
print(X_train_price_norm.shape, y_train.shape)
# print(X_cv_price_norm.shape, y_cv.shape)
print(X_test_price_norm.shape, y_test.shape)
print("="*100)
```

```
After vectorizations
(13400, 1) (13400,)
(6600, 1) (6600,)
================================================================================
====================
```

2.3.2 Vectorizing Numerical features--teacher_number_of_previously_posted_projects

In [0]:
```
from sklearn.preprocessing import Normalizer
normalizer_train = StandardScaler() #Normalizer()
normalizer_test = StandardScaler() #Normalizer()
# normalizer.fit(X_train['teacher_number_of_previously_posted_projects'].values)
# this will rise an error Expected 2D array, got 1D array instead:
# array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
# Reshape your data either using
# array.reshape(-1, 1) if your data has a single feature
# array.reshape(1, -1)  if it contains a single sample.
normalizer.fit(X_train['teacher_number_of_previously_posted_projects'].values.re

X_train_teacher_number_of_previously_posted_projects_norm = normalizer.transform
# X_cv_teacher_number_of_previously_posted_projects_norm = normalizer.transform(X
X_test_teacher_number_of_previously_posted_projects_norm = normalizer.transform(X



# X_train_teacher_number_of_previously_posted_projects_norm=np.reshape(X_train_te
# X_test_teacher_number_of_previously_posted_projects_norm=np.reshape(X_test_teac


print("After vectorizations")
print(X_train_teacher_number_of_previously_posted_projects_norm.shape, y_train.sh
# print(X_cv_teacher_number_of_previously_posted_projects_norm.shape, y_cv.shape,
print(X_test_teacher_number_of_previously_posted_projects_norm.shape, y_test.sha
print("="*100)
```

```
After vectorizations
(13400, 1) (13400,)
(6600, 1) (6600,)
================================================================================
====================
```

2.3.3 Vectorizing Numerical features--digits_in_summary

In [0]:
```
X_train['digits_in_summary'].fillna(X_train['digits_in_summary'].mean(), inplace=
# X_cv['digits_in_summary'].fillna(X_cv['digits_in_summary'].mean(), inplace=True
X_test['digits_in_summary'].fillna(X_test['digits_in_summary'].mean(), inplace=Tr
```

In [0]:
```
from sklearn.preprocessing import Normalizer
normalizer_train = StandardScaler() #Normalizer()
normalizer_test = StandardScaler() #Normalizer()
# normalizer.fit(X_train['digits_in_summary'].values)
# this will rise an error Expected 2D array, got 1D array instead:
# array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
# Reshape your data either using
# array.reshape(-1, 1) if your data has a single feature
# array.reshape(1, -1)  if it contains a single sample.
normalizer.fit(X_train['digits_in_summary'].values.reshape(-1,1))

X_train_digits_in_summary_norm = normalizer.transform(X_train['digits_in_summary
# X_cv_digits_in_summary_norm = normalizer.transform(X_cv['digits_in_summary'].va
X_test_digits_in_summary_norm = normalizer.transform(X_test['digits_in_summary']


# X_train_digits_in_summary_norm=np.reshape(X_train_digits_in_summary_norm,(1,-1,
# X_test_digits_in_summary_norm=np.reshape(X_test_digits_in_summary_norm,(1,-1))

print("After vectorizations")
print(X_train_digits_in_summary_norm.shape, y_train.shape)
# print(X_cv_digits_in_summary_norm.shape, y_cv.shape)
print(X_test_digits_in_summary_norm.shape, y_test.shape)
print("="*100)
```

```
After vectorizations
(13400, 1) (13400,)
(6600, 1) (6600,)
================================================================================
====================
```

2.4 Make Data Model Ready: Vectorizing Essay and Project_title feature into BOW & TFIDF

Vectorizing Text data

2.4.1 Bag of words:Essays

In [0]:
```
print(X_train.shape, y_train.shape)
# print(X_cv.shape, y_cv.shape)
print(X_test.shape, y_test.shape)

print("="*100)

# We are considering only the words which appeared in at least 10 documents(rows

vectorizer = CountVectorizer(min_df=10,ngram_range=(2,2), max_features=5000)
vectorizer.fit(X_train['essay'].values) # fit has to happen only on train data

# we use the fitted Countvectorizer to convert the text to vector
X_train_essay_bow = vectorizer.transform(X_train['essay'].values)
# X_cv_essay_bow = vectorizer.transform(X_cv['essay'].values)
X_test_essay_bow = vectorizer.transform(X_test['essay'].values)

print("After vectorizations")
print(X_train_essay_bow.shape, y_train.shape)
# print(X_cv_essay_bow.shape, y_cv.shape)
print(X_test_essay_bow.shape, y_test.shape)
print("="*100)
```

```
(13400, 21) (13400,)
(6600, 21) (6600,)
===============================================================================
=====================
After vectorizations
(13400, 5000) (13400,)
(6600, 5000) (6600,)
===============================================================================
=====================
```

2.4.2 Bag of words:Project Title

In [0]:

```python
print(X_train.shape, y_train.shape)
# print(X_cv.shape, y_cv.shape)
print(X_test.shape, y_test.shape)

print("="*100)


vectorizer = CountVectorizer(min_df=10,ngram_range=(2,2), max_features=5000)
vectorizer.fit(X_train['project_title'].values) # fit has to happen only on trai

# we use the fitted Countvectorizer to convert the text to vector
X_train_project_title_bow = vectorizer.transform(X_train['project_title'].values
# X_cv_project_title_bow = vectorizer.transform(X_cv['project_title'].values)
X_test_project_title_bow = vectorizer.transform(X_test['project_title'].values)

print("After vectorizations")
print(X_train_project_title_bow.shape, y_train.shape)
# print(X_cv_project_title_bow.shape, y_cv.shape)
print(X_test_project_title_bow.shape, y_test.shape)

print("="*100)
```

```
(13400, 21) (13400,)
(6600, 21) (6600,)
================================================================================
====================
After vectorizations
(13400, 311) (13400,)
(6600, 311) (6600,)
================================================================================
====================
```

2.4.3 Converting Columns into array before merging into hstack

In [0]:
```
X_train_St_0_cl_cat = X_train['St_0_cl_cat'].values.reshape(-1,1)
X_train_St_1_cl_cat = X_train['St_1_cl_cat'].values.reshape(-1,1)

X_train_St_0_sub_cat = X_train['St_0_sub_cat'].values.reshape(-1,1)
X_train_St_1_sub_cat = X_train['St_1_sub_cat'].values.reshape(-1,1)

X_train_St_0_sc_st = X_train['St_0_sc_st'].values.reshape(-1,1)
X_train_St_1_sc_st = X_train['St_1_sc_st'].values.reshape(-1,1)

X_train_St_0_pgc = X_train['St_0_pgc'].values.reshape(-1,1)
X_train_St_1_pgc = X_train['St_1_pgc'].values.reshape(-1,1)

X_train_St_0_tp = X_train['St_0_tp'].values.reshape(-1,1)
X_train_St_1_tp = X_train['St_1_tp'].values.reshape(-1,1)


# ==========================**************============================

X_test_St_0_cl_cat = X_test['St_0_cl_cat'].values.reshape(-1,1)
X_test_St_1_cl_cat = X_test['St_1_cl_cat'].values.reshape(-1,1)

X_test_St_0_sub_cat = X_test['St_0_sub_cat'].values.reshape(-1,1)
X_test_St_1_sub_cat = X_test['St_1_sub_cat'].values.reshape(-1,1)

X_test_St_0_sc_st = X_test['St_0_sc_st'].values.reshape(-1,1)
X_test_St_1_sc_st = X_test['St_1_sc_st'].values.reshape(-1,1)

X_test_St_0_pgc = X_test['St_0_pgc'].values.reshape(-1,1)
X_test_St_1_pgc = X_test['St_1_pgc'].values.reshape(-1,1)

X_test_St_0_tp = X_test['St_0_tp'].values.reshape(-1,1)
X_test_St_1_tp = X_test['St_1_tp'].values.reshape(-1,1)
```

In [0]:
```
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix and a dense
X_BOW_TRAIN = hstack((X_train_digits_in_summary_norm,X_train_teacher_number_of_pr
))
X_BOW_TRAIN=X_BOW_TRAIN.todense()
X_BOW_TRAIN=np.array(X_BOW_TRAIN)

# X_BOW_cv = hstack((X_cv_project_title_bow,X_cv_essay_bow ,X_cv_digits_in_summar
# X_BOW_cv=X_BOW_cv.todense()
# X_BOW_cv=np.array(X_BOW_cv)

X_BOW_test = hstack((X_test_digits_in_summary_norm,X_test_teacher_number_of_prev
))
X_BOW_test=X_BOW_test.todense()
X_BOW_test=np.array(X_BOW_test)

# X_train_project_title_bow=None
# X_train_essay_bow =None

# X_test_project_title_bow=None
# X_test_essay_bow =None
```

In [0]:
```
print(X_train_digits_in_summary_norm.shape)
print(X_train_teacher_number_of_previously_posted_projects_norm.shape)
print(X_train_price_norm.shape)
print(X_train_project_title_bow.shape)
print(X_train_essay_bow.shape)
print(X_train_St_0_cl_cat.shape)
print(X_train_St_1_cl_cat.shape)
print(X_train_St_0_sub_cat.shape)
print(X_train_St_1_sub_cat.shape)
print(X_train_St_0_sc_st.shape)
print(X_train_St_1_sc_st.shape)
print(X_train_St_0_pgc.shape)
print(X_train_St_1_pgc.shape)
print(X_train_St_0_tp.shape)
print(X_train_St_1_tp.shape)
```

```
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 311)
(13400, 5000)
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 1)
(13400, 1)
```

2.8 TFIDF weighted W2V-Essay

2.8.1 Using Pretrained Models: TFIDF weighted W2V-Essay

In [0]:
```
# train test split
from sklearn.model_selection import train_test_split

Xtfidf_w2v_vectors_train_, Xtfidf_w2v_vectors_test_, y_train, y_test = train_tes

# Xtfidf_w2v_vectors_train, Xtfidf_w2v_vectors_cv, y_train, y_cv = train_test_sp
```

In [0]:
```
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
tfidf_model = TfidfVectorizer()
tfidf_model.fit(Xtfidf_w2v_vectors_train_)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [0]:
```
# stronging variables into pickle files python: http://www.jessicayung.com/how-t
# make sure you have the glove_vectors file
import pickle
with open('/content/drive/My Drive/glove_vectors', 'rb') as f:
    model_ = pickle.load(f)
    glove_words =  set(model_.keys())
```

In [0]:
```
# average Word2Vec
# compute average word2vec for each review.

tfidf_w2v_vectors_essay_train = []; # the avg-w2v for each sentence/review is st
for sentence in tqdm(Xtfidf_w2v_vectors_train_): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model_[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf val
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split()
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_essay_train.append(vector)

print(len(tfidf_w2v_vectors_essay_train))
print(len(tfidf_w2v_vectors_essay_train[0]))
```

```
100%|██████████| 13400/13400 [00:29<00:00, 456.69it/s]

13400
300
```

In [0]:
```
# average Word2Vec
# compute average word2vec for each review.

tfidf_w2v_vectors_essay_test = []; # the avg-w2v for each sentence/review is stor
for sentence in tqdm(Xtfidf_w2v_vectors_test_): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model_[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf valu
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split()
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_essay_test.append(vector)

print(len(tfidf_w2v_vectors_essay_test))
print(len(tfidf_w2v_vectors_essay_test[0]))
```

```
100%|██████████| 6600/6600 [00:14<00:00, 451.32it/s]

6600
300
```

In [0]:
```
import scipy
tfidf_w2v_vectors_essay_train=scipy.sparse.csr_matrix(tfidf_w2v_vectors_essay_tra
type(tfidf_w2v_vectors_essay_train)

tfidf_w2v_vectors_essay_test=scipy.sparse.csr_matrix(tfidf_w2v_vectors_essay_tes
type(tfidf_w2v_vectors_essay_test)

# Xtfidf_w2v_vectors_cv=scipy.sparse.csr_matrix(Xtfidf_w2v_vectors_cv)
# type(Xtfidf_w2v_vectors_cv)
```

Out[46]:
```
scipy.sparse.csr.csr_matrix
```

2.8.2 Using Pretrained Models: TFIDF weighted W2V on project_title

In [0]:
```
# train test split
from sklearn.model_selection import train_test_split

tfidf_w2v_vectors_Pro_title_train_, tfidf_w2v_vectors_Pro_title_test_, y_train, y

# tfidf_w2v_vectors_Pro_title_train, tfidf_w2v_vectors_Pro_title_cv, y_train, y_c
```

In [0]:
```
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
tfidf_model = TfidfVectorizer()
tfidf_model.fit(tfidf_w2v_vectors_Pro_title_train_)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [0]:
```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_Pro_title_train = []; # the avg-w2v for each sentence/review i
for sentence in tqdm(tfidf_w2v_vectors_Pro_title_train_): # for each review/sente
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model_[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf valu
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split()
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_Pro_title_train.append(vector)

print(len(tfidf_w2v_vectors_Pro_title_train))
print(len(tfidf_w2v_vectors_Pro_title_train[0]))
```

```
100%|██████████| 13400/13400 [00:00<00:00, 26230.32it/s]

13400
300
```

In [0]:
```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_Pro_title_test = []; # the avg-w2v for each sentence/review is
for sentence in tqdm(tfidf_w2v_vectors_Pro_title_test_): # for each review/sente
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model_[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf val
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split()
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_Pro_title_test.append(vector)

print(len(tfidf_w2v_vectors_Pro_title_test))
print(len(tfidf_w2v_vectors_Pro_title_test[0]))
```

```
100%|██████████| 6600/6600 [00:00<00:00, 18540.05it/s]

6600
300
```

In [0]:
```
import scipy
tfidf_w2v_vectors_Pro_title_train=scipy.sparse.csr_matrix(tfidf_w2v_vectors_Pro_
type(tfidf_w2v_vectors_Pro_title_train)

tfidf_w2v_vectors_Pro_title_test=scipy.sparse.csr_matrix(tfidf_w2v_vectors_Pro_t
type(tfidf_w2v_vectors_Pro_title_test)

# tfidf_w2v_vectors_Pro_title_cv=scipy.sparse.csr_matrix(tfidf_w2v_vectors_Pro_t
# type(tfidf_w2v_vectors_Pro_title_cv)
```

Out[51]:
```
scipy.sparse.csr.csr_matrix
```

In [0]:
```
X_tfidf_w2v_train = hstack((tfidf_w2v_vectors_essay_train,tfidf_w2v_vectors_Pro_
))
X_tfidf_w2v_train=X_tfidf_w2v_train.todense()
X_tfidf_w2v_train=np.array(X_tfidf_w2v_train)

# X_tfidf_w2v_cv = hstack((Xtfidf_w2v_vectors_cv,tfidf_w2v_vectors_Pro_title_cv ,
# X_tfidf_w2v_cv=X_tfidf_w2v_cv.todense()
# X_tfidf_w2v_cv=np.array(X_tfidf_w2v_cv)

X_tfidf_w2v_test = hstack((tfidf_w2v_vectors_essay_test,tfidf_w2v_vectors_Pro_ti
))
X_tfidf_w2v_test=X_tfidf_w2v_test.todense()
X_tfidf_w2v_test=np.array(X_tfidf_w2v_test)
# X_All = hstack((categories_one_hot,sub_categories_one_hot,school_state_one_hot,
```

2.8.3 Applying Random Forest on `TFIDF W2V`, `SET 4`

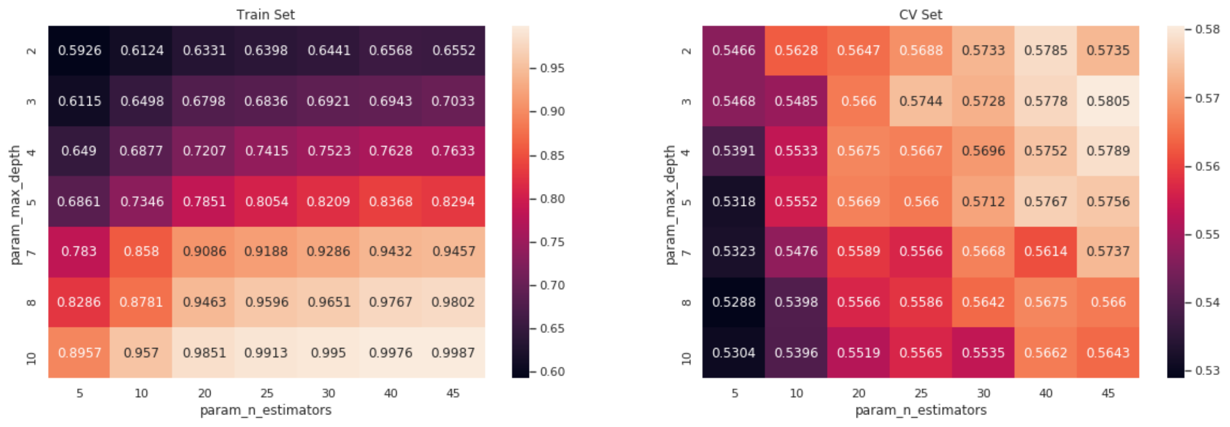
2.5.1 Applying Random Forest GridSearchCV on Train data to obtain the best `C`

In [0]:
```
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import cross_val_score
# from sklearn.multioutput import MultiOutputClassifier
# from sklearn.datasets import make_multilabel_classification
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier

Gt1 = RandomForestClassifier(class_weight='balanced',min_samples_split=5)
parameters = {'n_estimators': [5,10,20,25,30,40,45], 'max_depth':[2, 3, 4, 5, 7,
clf1 = GridSearchCV(Gt1, parameters, cv=2, scoring='roc_auc',return_train_score=
se1 = clf1.fit(X_tfidf_w2v_train, y_train)

import seaborn as sns; sns.set()
max_scores1 = pd.DataFrame(clf1.cv_results_).groupby(['param_max_depth','param_n
fig, ax = plt.subplots(1,2, figsize=(20,6))
sns.heatmap(max_scores1.mean_train_score, annot = True, fmt='.4g', ax=ax[0])
sns.heatmap(max_scores1.mean_test_score, annot = True, fmt='.4g', ax=ax[1])
ax[0].set_title('Train Set')
ax[1].set_title('CV Set')
plt.show()

# clf1.cv_results_.keys()
```



In [0]:
```
#Best Estimator and Best tune parameters
print(clf1.best_estimator_)
#Mean cross-validated score of the best_estimator
print(clf1.score(X_tfidf_w2v_train,y_train))
print(clf1.score(X_tfidf_w2v_test,y_test))
```

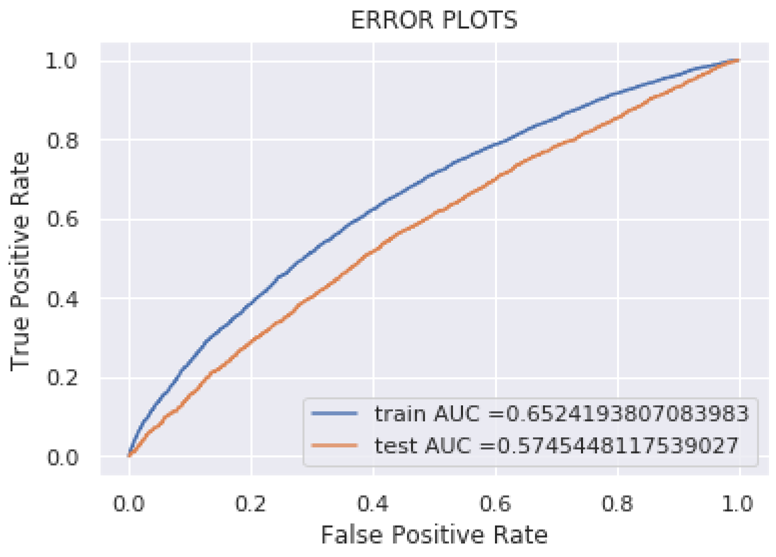
```
RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight='balanced',
                       criterion='gini', max_depth=3, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=5,
                       min_weight_fraction_leaf=0.0, n_estimators=45,
                       n_jobs=None, oob_score=False, random_state=None,
                       verbose=0, warm_start=False)
0.6576095121407887
0.5805747474747475
```

In [0]:
```
best_tune_parameters=[{'n_estimators':[45], 'max_depth':[3] } ]
```

2.5.2 Receiver Operating Characteristic- (`Tfidf_W2V`)

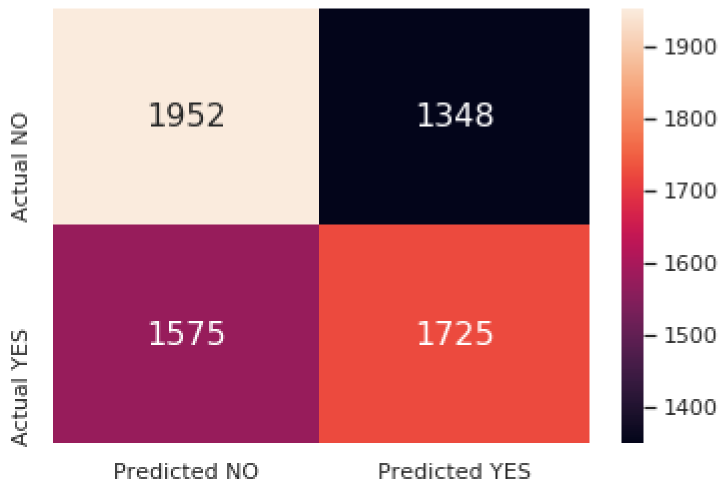
In [0]:
```
# https://scikitlearn.org/stable/modules/generated/sklearn.metrics.roc_curve.htm
from sklearn.metrics import roc_curve, auc
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import roc_curve, auc

clf11= RandomForestClassifier(class_weight = 'balanced',max_depth=3,n_estimators
# clfV1=DecisionTreeClassifier (class_weight = 'balanced',max_depth=10,min_sampl
clf11.fit(X_tfidf_w2v_train, y_train)
# for visulation
# clfV1.fit(X_Tfidf_train, y_train)
#https://scikitlearn.org/stable/modules/generated/sklearn.linear_model.SGDClassi
y_train_pred1 = clf11.predict_proba(X_tfidf_w2v_train) [:,1]
y_test_pred1 = clf11.predict_proba(X_tfidf_w2v_test) [:,1]
train_fpr1, train_tpr1, tr_thresholds1 = roc_curve(y_train, y_train_pred1)
test_fpr1, test_tpr1, te_thresholds1 = roc_curve(y_test, y_test_pred1)
plt.plot(train_fpr1, train_tpr1, label="train AUC ="+str(auc(train_fpr1, train_t
plt.plot(test_fpr1, test_tpr1, label="test AUC ="+str(auc(test_fpr1, test_tpr1))
plt.legend()
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()
```

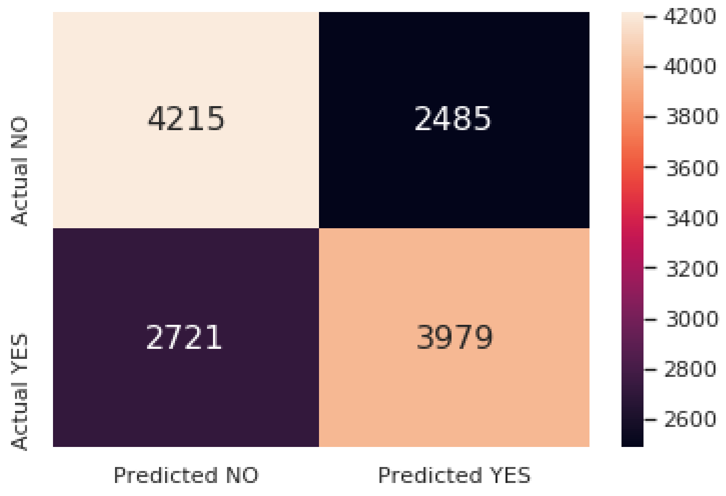


2.5.3 Confusion matrix- `Tfidf_W2V`

In [0]:
```
# https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#function to get heatmap confusion matrix
def get_confusion_matrix(clf,X_te,y_test):
    y_pred = clf.predict(X_te)
    df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), index =['Actual NO','
    sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
# %%time
get_confusion_matrix(clf11,X_tfidf_w2v_test,y_test)
```



In [0]:
```
# https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#function to get heatmap confusion matrix
def get_confusion_matrix(clf,X_te,y_test):
    y_pred = clf.predict(X_te)
    df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), index =['Actual NO','
    sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
# %%time
get_confusion_matrix(clf11,X_tfidf_w2v_train,y_train)
```



Selecting the Best features from the `Tfidf_W2V` model

In [0]:
```
# from sklearn.feature_selection import SelectFromModel
# from sklearn.linear_model import LogisticRegression
# from sklearn.linear_model import SGDClassifier

# selector = SelectFromModel(estimator=SGDClassifier(max_depth=None,class_weight
# # selector.estimator_.coef_
# selector.threshold_
# selector.get_support()
```

In [0]:
```
x=X_tfidf_w2v_train
x1=X_tfidf_w2v_test
X_tfidf_w2v_train=None
X_tfidf_w2v_test=None
# X_Tfidf_train.shape
# X_Tfidf_test.shape
```

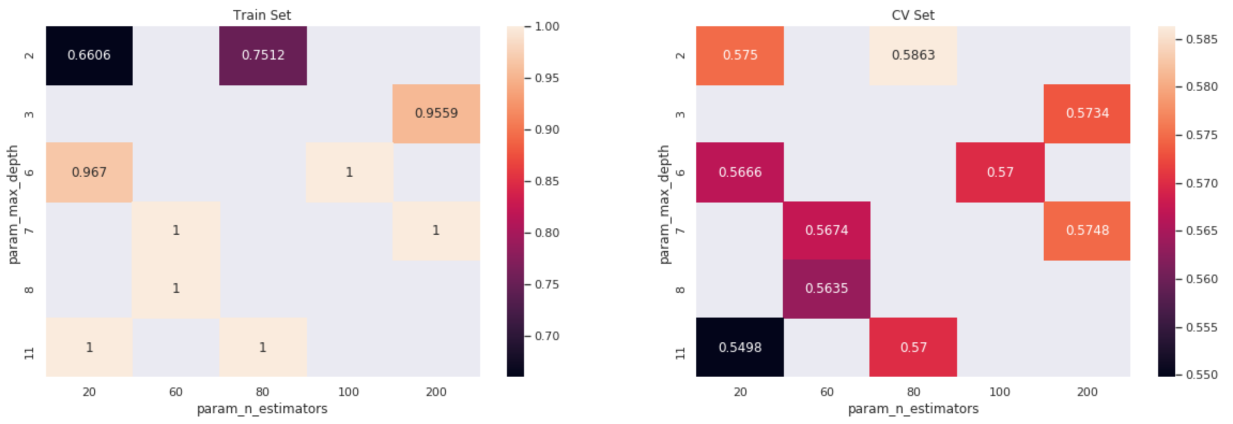
2.5.4 Applying GBDT & GridSearchCV on Train data to obtain the best `C`

In [0]:
```
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split
from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import cross_val_score
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import GradientBoostingClassifier
from sklearn.model_selection import RandomizedSearchCV

Gt1 = GradientBoostingClassifier(min_samples_split=15)
parameters = {'n_estimators': [20,40,60,80,100,200], 'max_depth':[2,3,5,6,7,8,10
clf1 = RandomizedSearchCV(Gt1, parameters, cv=2, scoring='roc_auc',return_train_
se1 = clf1.fit(x, y_train)

import seaborn as sns; sns.set()
max_scores1 = pd.DataFrame(clf1.cv_results_).groupby(['param_max_depth','param_n
fig, ax = plt.subplots(1,2, figsize=(20,6))
sns.heatmap(max_scores1.mean_train_score, annot = True, fmt='.4g', ax=ax[0])
sns.heatmap(max_scores1.mean_test_score, annot = True, fmt='.4g', ax=ax[1])
ax[0].set_title('Train Set')
ax[1].set_title('CV Set')
plt.show()

# clf1.cv_results_.keys()
```



In [0]:
```python
#Best Estimator and Best tune parameters
print(clf1.best_estimator_)
#Mean cross-validated score of the best_estimator
print(clf1.score(x,y_train))
print(clf1.score(x1,y_test))
```

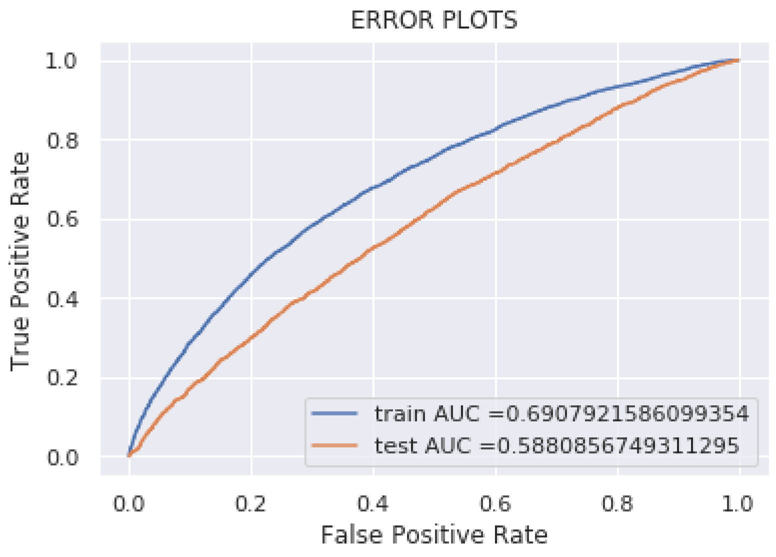
```
GradientBoostingClassifier(ccp_alpha=0.0, criterion='friedman_mse', init=None,
                           learning_rate=0.1, loss='deviance', max_depth=2,
                           max_features=None, max_leaf_nodes=None,
                           min_impurity_decrease=0.0, min_impurity_split=None,
                           min_samples_leaf=1, min_samples_split=15,
                           min_weight_fraction_leaf=0.0, n_estimators=80,
                           n_iter_no_change=None, presort='deprecated',
                           random_state=None, subsample=1.0, tol=0.0001,
                           validation_fraction=0.1, verbose=0,
                           warm_start=False)
0.6907921586099354
0.5880856749311295
```

In [0]:
```python
best_tune_parameters=[{'n_estimators':[80], 'max_depth':[2] } ]
```

2.5.5 Receiver Operating Characteristic- (`Tfidf_W2V`)

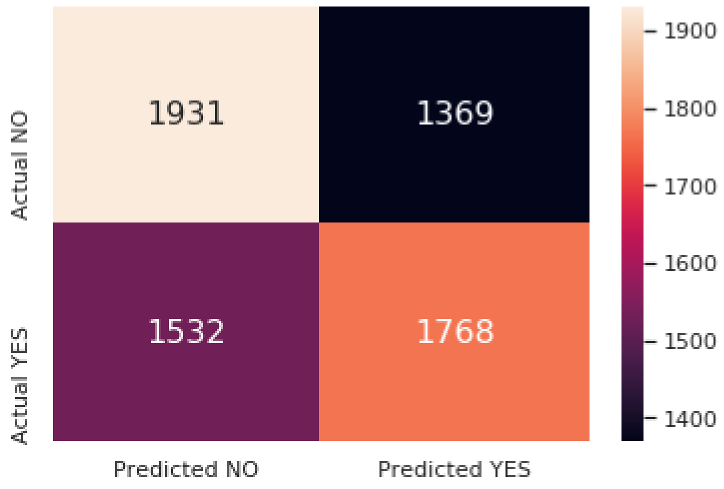
In [0]:
```
# https://scikitlearn.org/stable/modules/generated/sklearn.metrics.roc_curve.htm
from sklearn.metrics import roc_curve, auc
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import roc_curve, auc

clf11= GradientBoostingClassifier(max_depth=2,n_estimators=80)
# clfV1=DecisionTreeClassifier (class_weight = 'balanced',max_depth=10,min_sampl
clf11.fit(x, y_train)
# for visulation
# clfV1.fit(X_Tfidf_train, y_train)
#https://scikitlearn.org/stable/modules/generated/sklearn.linear_model.SGDClassi
y_train_pred1 = clf11.predict_proba(x) [:,1]
y_test_pred1 = clf11.predict_proba(x1) [:,1]
train_fpr1, train_tpr1, tr_thresholds1 = roc_curve(y_train, y_train_pred1)
test_fpr1, test_tpr1, te_thresholds1 = roc_curve(y_test, y_test_pred1)
plt.plot(train_fpr1, train_tpr1, label="train AUC ="+str(auc(train_fpr1, train_t
plt.plot(test_fpr1, test_tpr1, label="test AUC ="+str(auc(test_fpr1, test_tpr1))
plt.legend()
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()
```

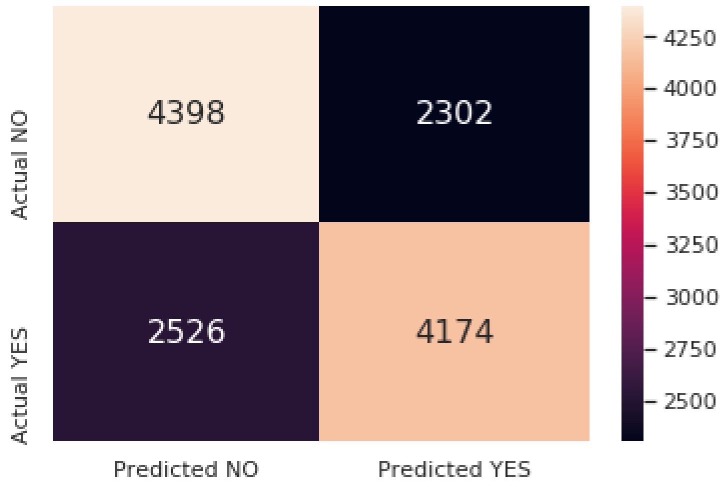


2.5.6 Confusion matrix- `Tfidf_W2V`

In [0]:
```
# https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#function to get heatmap confusion matrix
def get_confusion_matrix(clf,X_te,y_test):
    y_pred = clf.predict(X_te)
    df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), index =['Actual NO','A
    sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
# %%time
get_confusion_matrix(clf11,x1,y_test)
```



In [0]:
```
# https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#function to get heatmap confusion matrix
def get_confusion_matrix(clf,X_te,y_test):
    y_pred = clf.predict(X_te)
    df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), index =['Actual NO','
    sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
# %%time
get_confusion_matrix(clf11,x,y_train)
```



In [0]:
```
#To make best use of the memory we are setting the variable names to 'None' and p
# X_tfidf_w2v_test=None
# X_tfidf_w2v_train=None
# y_tfidf_w2v_train=None
x=None
x1=None
gc.collect()
```

2.10 Pretty table summary

In [4]:
```
#http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ["Vectorizer","Model", "n_estimators","max_depth","Test-AUC"]


x.add_row(["BOW ","RF", '40','8', 68.16])
x.add_row(["BOW ","GBDT", '200','2', 70.16])
x.add_row(["TFIDF","RF", '60','7', 68.16])
x.add_row(["TFIDF","GBDT", '80','5', 69.67])
x.add_row(["TFIDF_weighted_W2V","RF", '45','3', 57.45])
x.add_row(["TFIDF_weighted_W2V","GBDT", '80','2', 58.80])
x.add_row(["AVG_W2V","RF", '45','5', 58.07])
x.add_row(["AVG_W2V","GBDT", '60','4', 58.20])

print(x)
```

```
+--------------------+-------+--------------+-----------+----------+
|     Vectorizer     | Model | n_estimators | max_depth | Test-AUC |
+--------------------+-------+--------------+-----------+----------+
|        BOW         |   RF  |      40      |     8     |  68.16   |
|        BOW         |  GBDT |     200      |     2     |  70.16   |
|       TFIDF        |   RF  |      60      |     7     |  68.16   |
|       TFIDF        |  GBDT |      80      |     5     |  69.67   |
| TFIDF_weighted_W2V |   RF  |      45      |     3     |  57.45   |
| TFIDF_weighted_W2V |  GBDT |      80      |     2     |   58.8   |
|      AVG_W2V       |   RF  |      45      |     5     |  58.07   |
|      AVG_W2V       |  GBDT |      60      |     4     |   58.2   |
+--------------------+-------+--------------+-----------+----------+
```