DonorsChoose

DonorsChoose.org receives hundreds of thousands of project proposals each year for classroom projects in need of funding. Right now, a large number of volunteers is needed to manually screen each submission before it's approved to be posted on the DonorsChoose.org website.

Next year, DonorsChoose.org expects to receive close to 500,000 project proposals. As a result, there are three main problems they need to solve:

- How to scale current manual processes and resources to screen 500,000 projects so that they can be posted as quickly and as efficiently as possible
- How to increase the consistency of project vetting across different volunteers to improve the experience for teachers
- How to focus volunteer time on the applications that need the most assistance

The goal of the competition is to predict whether or not a DonorsChoose.org project proposal submitted by a teacher will be approved, using the text of project descriptions as well as additional metadata about the project, teacher, and school. DonorsChoose.org can then use this information to identify projects most likely to need further review before approval.

About the DonorsChoose Data Set

The `train.csv` data set provided by DonorsChoose contains the following features:

Feature	De
`project_id`	A unique identifier for the proposed project. **Example:**
`project_title`	Title of the project. **E** - `Art Will Make You` - `First Gr`
`project_grade_category`	Grade level of students for which the project is targeted. One of the enumerate - `Grades` - `Gra` - `Gra` - `Grad`
`project_subject_categories`	One or more (comma-separated) subject categories for the projec following enumerated list - `Applied L` - `Care &` - `Health &` - `History &` - `Literacy & L` - `Math &` - `Music & T` - `Specia` - **Ex** - `Music & T` - `Literacy & Language, Math &`
`school_state`	State where school is located (Two-letter U.S. p (https://en.wikipedia.org/wiki/List_of_U.S._state_abbreviations#Posta **Exa**
`project_subject_subcategories`	One or more (comma-separated) subject subcategories for th **Ex** - `L` - `Literature & Writing, Social S`
`project_resource_summary`	An explanation of the resources needed for the project. **E** - `My students need hands on literacy materials to sensory`
`project_essay_1`	First applicat
`project_essay_2`	Second applicat
`project_essay_3`	Third applicat
`project_essay_4`	Fourth applicat
`project_submitted_datetime`	Datetime when project application was submitted. **Example:** `201 12:43`
`teacher_id`	A unique identifier for the teacher of the proposed project. `bdf8baa8fedef6bfeec7ae4f1`

Feature	De
teacher_prefix	Teacher's title. One of the following enumerate • • • • • •
teacher_number_of_previously_posted_projects	Number of project applications previously submitted by the sam **Exa**

* See the section **Notes on the Essay Data** for more details about these features.

Additionally, the `resources.csv` data set provides more data about the resources required for each project. Each line in this file represents a resource required by a project:

Feature	Description
id	A `project_id` value from the `train.csv` file. **Example:** `p036502`
description	Desciption of the resource. **Example:** `Tenor Saxophone Reeds, Box of 25`
quantity	Quantity of the resource required. **Example:** `3`
price	Price of the resource required. **Example:** `9.95`

Note: Many projects require multiple resources. The `id` value corresponds to a `project_id` in train.csv, so you use it as a key to retrieve all resources needed for a project:

The data set contains the following label (the value you will attempt to predict):

Label	Description
project_is_approved	A binary flag indicating whether DonorsChoose approved the project. A value of `0` indicates the

Notes on the Essay Data

Prior to May 17, 2016, the prompts for the essays were as follows:

- __project_essay_1:__ "Introduce us to your classroom"
- __project_essay_2:__ "Tell us more about your students"
- __project_essay_3:__ "Describe how your students will use the materials you're requesting"
- __project_essay_3:__ "Close by sharing why your project will make a difference"

Starting on May 17, 2016, the number of essays was reduced from 4 to 2, and the prompts for the first 2 essays were changed to the following:

- __project_essay_1:__ "Describe your students: What makes your students special? Specific details about their background, your neighborhood, and your school are all helpful."
- __project_essay_2:__ "About your project: How will these materials make a difference in your students' learning and improve their school lives?"

For all projects with project_submitted_datetime of 2016-05-17 and later, the values of project_essay_3 and project_essay_4 will be NaN.

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

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

from plotly import plotly
import plotly.offline as offline
import plotly.graph_objs as go
offline.init_notebook_mode()
from collections import Counter
```

```
C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\smart_open\ssh.py:34: Use
rWarning: paramiko missing, opening SSH/SCP/SFTP paths will be disabled.
`pip install paramiko` to suppress
  warnings.warn('paramiko missing, opening SSH/SCP/SFTP paths will be disa
bled.  `pip install paramiko` to suppress')
```

1.1 Reading Data

In [2]:

```
project_data = pd.read_csv(r'D:\Rashu Studies\AppliedAICourse\Assignments\Mandatory Ass
ignments\Mandatory Assignment 3 Donors Choose KNN\train_data.csv')
resource_data = pd.read_csv(r'D:\Rashu Studies\AppliedAICourse\Assignments\Mandatory As
signments\Mandatory Assignment 3 Donors Choose KNN\resources.csv')
```

In [3]:

```
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 (109248, 17)
--------------------------------------------------
The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix'
'school_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 [4]:

```
# how to replace elements in list python: https://stackoverflow.com/a/2582163/4084039
cols = ['Date' if x=='project_submitted_datetime' else x for x in list(project_data.col
umns)]


#sort dataframe based on time pandas python: https://stackoverflow.com/a/49702492/40840
39
project_data['Date'] = pd.to_datetime(project_data['project_submitted_datetime'])
project_data.drop('project_submitted_datetime', axis=1, inplace=True)
project_data.sort_values(by=['Date'], inplace=True)


# how to reorder columns pandas python: https://stackoverflow.com/a/13148611/4084039
project_data = project_data[cols]


project_data.head(2)
```

Out[4]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT

In [5]:

```
print("Number of data points in train data", resource_data.shape)
print(resource_data.columns.values)
resource_data.head(2)
```

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

Out[5]:

	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.00
1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95

NOW THE MOST IMPORTANT THING HERE IS THAT YOU SHOULD SPLIT OUR DATA INTO TRAIN AND TEST BEFORE APPLYING ANY FIT TECHNIQUE LIKE BOW OR TFIDF BECAUSE OTHEREWISE THERE WILL BE DATA LEAKAGE PROBLEM.ALSO FOR PREPROCESSING LIKE STANDARDIZATION AND NORMALIZATION ALSO WE SHOULD KEEP IN MIND THAT TRAIN TEST SPLIT SHOULD BE DONE BEFORE APPLYING THOSE PREPROCESSING TECHNIQUES

In [6]:

```
# REFER THIS SOUNDCLOUD LINK : https://soundcloud.com/applied-ai-course/leakage-bow-and-tfidf
```

Train_Test Split

In [7]:

```
# train test split
# note that here This stratify parameter makes a split so that the proportion of values in the sample produced will be the same as the proportion of values provided to parameter stratify.
#For example, if variable y is a binary categorical variable with values 0 and 1 and there are 25% of zeros and 75% of ones, stratify=y will make sure that your random split has 25% of 0's and 75% of 1's.

from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(project_data, project_data['project_is_approved'], test_size=0.33, stratify = project_data['project_is_approved'])

# now getting the crossvalidation data from our train data
X_train, X_cv, y_train, y_cv = train_test_split(X_train, y_train, test_size=0.33, stratify=y_train)
```

In [8]:

```
# Now we will be removing the column "project_is_approved" because that is the only one which our model needs to predict

X_train.drop(['project_is_approved'], axis=1, inplace=True)
X_test.drop(['project_is_approved'], axis=1, inplace=True)
X_cv.drop(['project_is_approved'], axis=1, inplace=True)
```

Now we will do all kind of preprocessing required for the train data ,test data,crossvalidation data separately

FOR TRAIN DATA

Preprocessing of `project_subject_categories'

In [9]:

```
catogories = list(X_train['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039

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

X_train['clean_categories'] = cat_list
X_train.drop(['project_subject_categories'], axis=1, inplace=True)

from collections import Counter
my_counter = Counter()
for word in X_train['clean_categories'].values:
    my_counter.update(word.split())

cat_dict = dict(my_counter)
sorted_cat_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
```

Preprocessing of project_subject_subcategories

In [10]:

```
sub_catogories = list(X_train['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039

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

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", "Warmt
h", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "M
ath & Science"=> "Math","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace
 it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"M
ath & Science"=>"Math&Science"
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spa
ces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())

X_train['clean_subcategories'] = sub_cat_list
X_train.drop(['project_subject_subcategories'], axis=1, inplace=True)

# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
my_counter = Counter()
for word in X_train['clean_subcategories'].values:
    my_counter.update(word.split())

sub_cat_dict = dict(my_counter)
sorted_sub_cat_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv: kv[1]))
```

Text preprocessing

In [11]:

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

In [12]:

```
X_train.head(2)
```

Out[12]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state
64340	2186	p159565	25da59ec5fe57907b2920b00469619f9	Ms.	AZ
7989	627	p123727	689637c98999b1450274046befb77b51	Ms.	LA

In [13]:

```
# printing some random reviews
print(X_train['essay'].values[0])
print("="*50)
print(X_train['essay'].values[150])
print("="*50)
print(X_train['essay'].values[1000])
print("="*50)
print(X_train['essay'].values[20000])
print("="*50)
print(X_train['essay'].values[9999])
print("="*50)
```

```
As a teacher in a low-income/high poverty school, I see that my students a
re faced with challenges both in and out of the classroom. Despite the man
y challenges they face, I strive to create meaningful and engaging learnin
g experiences for each of my students.  The students come with a wide vari
ety of interests and abilities, and I am always searching for ways to fost
er their learning and ignite their natural curiosity.\r\n\r\nMy students a
re curious, intelligent, and kind individuals that love coming to school e
ach day.  \r\n\r\nThis project requests a plethora of seating options.  Th
ese include... Flexible seating will allow students to choose what seat he
lps them learn best.  These seats will be more comfortable than traditiona
l seating in order for students to stay on task and engaged in their daily
learning.  \r\nStudents will have a larger ownership for their learning an
d feel empowered to have more control in their school day.  \r\nThese stud
ents work so hard each and everyday and have hardships and challenges many
students have never had to face.  I want to create a learning environment
students are eager to enter; a learning environment that draws the learner
in. \r\nThese seating options will impact the classroom climate and academ
ic achievement.  Students will be able to choose where they learn best, be
more engaged in their learning, and will therefore improve their overall a
cademic experience.nannan
==================================================
My students do not have the opportunity to go on field trips to the planet
arium, the science museum, or state parks. However, with your help, they c
ould connect their classroom learning with the natural world.\r\n\r\nMy st
udents have attitude, humor, and drive. They are musicians, artists, engin
eers, poets, song-writers, athletes, scientists, and entrepreneurs. My stu
dents were not born into privileged families. Basic resources like noteboo
ks and calculators can be hard for their families to purchase. Less aesthe
tically, time and adult support are resources bereft to them.\r\n\r\nWe ar
e committed to excellence in teaching, improvement through ongoing profess
ional development, and serving our community of learners. In my world, it
is not a matter of imparting information to students, but meeting their em
otional needs by creating a safe space for them to learn.Chemistry is a to
ol that has been used as a vehicle for war. Grenades using explosive combi
nations of chemicals and chemical warfare using the toxic properties of ch
emicals were developed during World War 1. Understanding of the nuclear at
om paved the way for the atom bomb during World War 2. \r\nIn this projec
t, students will study historical uses of chemistry in conflict and artist
ically represent their understanding using cyanotyping. Cyanotyping is a p
hotographic printing process developed in the late 1800's that uses light
sensitive inks to produce a cyan blue print. This technology was used well
into the 19th century and throughout the historical period of time the stu
dents will be studying.\r\n\r\nnannan
==================================================
My students are inquisitive, hard-working 10th, 11th and 12th graders.  Th
ey are motivated by hands-on learning, especially projects in which they c
an see real-world applications.  These students are globally conscious and
are motivated not only by doing interesting work, but in discovering (or i
nventing) solutions to complex problems.  \r\nMy students are respectful,
kind, and thoughtful.  I will be honored to provide these young men and wo
men with experiences that will bring out the best in each of them.  It is
hoped that many will have the opportunity to share their discoveries with
the community of Laguna Beach.Our project this year will be the exploratio
n of biomedical engineering.  We will be utilizing \"click\" chemistry to
connect therapeutic peptides to various scaffolds in order to protect thes
e peptides from degradation by proteases.  The tubing, clamps, and capilla
ry pipets will enable students to perform sophisticated experiments throug
hout the year.  \r\nThis project will train students how to be true scient
ists.  They will be exploring areas in which the answers are not known.  T
hrough creative experiments and frequent trouble-shooting, my students wil
l discover the nature of scientific research and master the question of
```

```
\"How do we know?\"  \r\nThis is an open-ended project that has enough dep
th to last for several years, engaging many students in the pursuit of sci
entific discovery.nannan
==================================================
Our little school is proud, energetic, and positive, but my 5th grade stud
ents face some serious difficulties. \r\nMore than 85% of them qualify for
free or reduced-price lunch. These kids are eager to learn and are dedicat
ed to their education, but they need a fighting chance to get there. They
need some decent science materials to help our units come alive! Not only
that, we need experimental and investigation materials that address the Ne
xt Generation Science Standards that they are supposed to become proficien
t in.Let's face it. With Smart Phones, fast-paced video games, and lots of
intense stimuli, today's kids are hard to impress. Keeping them engaged ca
n be tricky! \r\nWith this interactive white board system, I'll be able to
make every lesson and presentation an engaging experience! This simple sys
tem can turn any flat surface into a responding presentation screen! I can
\"write\" on the presentation, highlight, and annotate. Cursor movements,
mouse clicks, and drags can all happen in real time. I can control what’s
on screen as if I was at the computer. Additionally, you can capture and i
mage or record the screen as you go!\r\nNow imagine children at the helm o
f it! After creating a presentation, they can use the interactive whiteboa
rd system to bring oral presentations to a new level of engagement. Studen
ts will be thrilled to demonstrate their learning using this \"wand\"!nann
an
==================================================
Our school is located in a rural community with predominantly low income t
o middle class families.  There are approximately 500 students in our pre-
K to 5th grade elementary school. We have a very active Parent Teacher Ass
ociation. Our students enjoy sports as well as writing, reading, and scien
ce clubs here at our school.\r\n\r\nA typical day in my classroom is fille
d with learning, listening, and laughter.  My students are comfortable ask
ing questions and sharing ideas, but they often have trouble sitting for a
ny extended length of time.  The wobble cushions will allow the students t
o move within the space of their desks without getting up and roaming arou
nd the classroom.\r\n\r\nThird graders are very active children who need t
o be able to move around during the day.  They have a lot of energy and of
ten lose focus on the lesson when they feel the need to \"get their wiggle
s out.\"  \r\n\r\nThe wobble cushions will give my third graders the oppor
tunity to tune into the instruction without leaving their seats.  They can
move with the wobble cushions whenever they need to expend energy and \"ge
t the wiggles out\" while still paying attention to the instruction in the
classroom.  This will help students who have trouble staying involved in w
hat's going on in the classroom and be an active participant without leavi
ng their seats.nannan
==================================================
```

In [14]:

```
# creating a function named as decontracted which does the job of decontraction

# 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 [15]:

```
sent = decontracted(X_train['essay'].values[20000])
print(sent)
print("="*50)
```

```
Our little school is proud, energetic, and positive, but my 5th grade stud
ents face some serious difficulties. \r\nMore than 85% of them qualify for
free or reduced-price lunch. These kids are eager to learn and are dedicat
ed to their education, but they need a fighting chance to get there. They
need some decent science materials to help our units come alive! Not only
that, we need experimental and investigation materials that address the Ne
xt Generation Science Standards that they are supposed to become proficien
t in.Let is face it. With Smart Phones, fast-paced video games, and lots o
f intense stimuli, today is kids are hard to impress. Keeping them engaged
can be tricky! \r\nWith this interactive white board system, I will be abl
e to make every lesson and presentation an engaging experience! This simpl
e system can turn any flat surface into a responding presentation screen!
I can \"write\" on the presentation, highlight, and annotate. Cursor movem
ents, mouse clicks, and drags can all happen in real time. I can control w
hat’s on screen as if I was at the computer. Additionally, you can capture
and image or record the screen as you go!\r\nNow imagine children at the h
elm of it! After creating a presentation, they can use the interactive whi
teboard system to bring oral presentations to a new level of engagement. S
tudents will be thrilled to demonstrate their learning using this \"wand
\"!nannan
==================================================
```

In [16]:

```
#\r \n \t remove from string python: http://texthandler.com/info/remove-line-breaks-pyt
hon/
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\"', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
Our little school is proud, energetic, and positive, but my 5th grade stud
ents face some serious difficulties.   More than 85% of them qualify for f
ree or reduced-price lunch. These kids are eager to learn and are dedicate
d to their education, but they need a fighting chance to get there. They n
eed some decent science materials to help our units come alive! Not only t
hat, we need experimental and investigation materials that address the Nex
t Generation Science Standards that they are supposed to become proficient
in.Let is face it. With Smart Phones, fast-paced video games, and lots of
intense stimuli, today is kids are hard to impress. Keeping them engaged c
an be tricky!   With this interactive white board system, I will be able t
o make every lesson and presentation an engaging experience! This simple s
ystem can turn any flat surface into a responding presentation screen! I c
an  write  on the presentation, highlight, and annotate. Cursor movements,
mouse clicks, and drags can all happen in real time. I can control what’s
on screen as if I was at the computer. Additionally, you can capture and i
mage or record the screen as you go!  Now imagine children at the helm of
it! After creating a presentation, they can use the interactive whiteboard
system to bring oral presentations to a new level of engagement. Students
will be thrilled to demonstrate their learning using this  wand !nannan
```

In [17]:

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

```
Our little school is proud energetic and positive but my 5th grade student
s face some serious difficulties More than 85 of them qualify for free or
reduced price lunch These kids are eager to learn and are dedicated to the
ir education but they need a fighting chance to get there They need some d
ecent science materials to help our units come alive Not only that we need
experimental and investigation materials that address the Next Generation
Science Standards that they are supposed to become proficient in Let is fa
ce it With Smart Phones fast paced video games and lots of intense stimuli
today is kids are hard to impress Keeping them engaged can be tricky With
this interactive white board system I will be able to make every lesson an
d presentation an engaging experience This simple system can turn any flat
surface into a responding presentation screen I can write on the presentat
ion highlight and annotate Cursor movements mouse clicks and drags can all
happen in real time I can control what s on screen as if I was at the comp
uter Additionally you can capture and image or record the screen as you go
Now imagine children at the helm of it After creating a presentation they
can use the interactive whiteboard system to bring oral presentations to a
new level of engagement Students will be thrilled to demonstrate their lea
rning using this wand nannan
```

In [18]:

```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
# because although they are in this list but they matter a lot because
# they change the meaning of the entire sentence.
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you'r
e", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him',
'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 't
hey', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "th
at'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'ha
d', 'having', 'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as'
, 'until', 'while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through'
, 'during', 'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'ov
er', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'an
y', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too'
, 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'no
w', 'd', 'll', 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't",
'doesn', "doesn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'migh
tn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'w
asn', "wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

In [19]:

```
# Combining all the above preprocessing techniques for all the project essays
from tqdm import tqdm
preprocessed_essays_Train = []
# tqdm is for printing the status bar
for sentance in tqdm(X_train['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.lower() not in stopwords)
    preprocessed_essays_Train.append(sent.lower().strip())
```

```
100%|████████████████████████████████████████
█████| 49041/49041 [00:21<00:00, 2304.29it/s]
```

In [20]:

```
# after preprocesing of project essays
preprocessed_essays_Train[20000]
```

Out[20]:

```
'little school proud energetic positive 5th grade students face serious di
fficulties 85 qualify free reduced price lunch kids eager learn dedicated
education need fighting chance get need decent science materials help unit
s come alive not need experimental investigation materials address next ge
neration science standards supposed become proficient let face smart phone
s fast paced video games lots intense stimuli today kids hard impress keep
ing engaged tricky interactive white board system able make every lesson p
resentation engaging experience simple system turn flat surface responding
presentation screen write presentation highlight annotate cursor movements
mouse clicks drags happen real time control screen computer additionally c
apture image record screen go imagine children helm creating presentation
use interactive whiteboard system bring oral presentations new level engag
ement students thrilled demonstrate learning using wand nannan'
```

Preprocessing of project_title

Now we will simply apply the above preprocessing steps on the project title for the train data as well,as it is also a text feature

In [21]:

```
# printing some random titles.
print(X_train['project_title'].values[0])
print("="*50)
print(X_train['project_title'].values[150])
print("="*50)
print(X_train['project_title'].values[1000])
print("="*50)
print(X_train['project_title'].values[20000])
print("="*50)
print(X_train['project_title'].values[9999])
print("="*50)
```

```
Flexible Seating!
==================================================
Chemistry and Conflict
==================================================
Project Based Learning in Laguna Beach
==================================================
Interactive Wand Makes Interactive Lessons
==================================================
Move, Wiggle, and Learn Too!
==================================================
```

We have already written the preprocessing codes for different preprocessing approaches now we will simply use those codes on the project titles

In [24]:

```
preprocessed_project_titles_Train = []

for t in tqdm(X_train["project_title"]):
    title = decontracted(t)
    title = title.replace('\\r', ' ')
    title = title.replace('\\"', ' ')
    title = title.replace('\\n', ' ')
    title = re.sub('[^A-Za-z0-9]+', ' ', title)
    title = ' '.join(f for f in title.split() if f not in stopwords)
    preprocessed_project_titles_Train.append(title.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████████████
████| 49041/49041 [00:01<00:00, 48732.30it/s]
```

In [25]:

```
# printing some random titles of train dataset after preprocessing

print(preprocessed_project_titles_Train[5000])
print("="*50)
print(preprocessed_project_titles_Train[7000])
print("="*50)
print(preprocessed_project_titles_Train[10000])
print("="*50)
print(preprocessed_project_titles_Train[45000])
print("="*50)
print(preprocessed_project_titles_Train[22000])
print("="*50)
```

```
going magic carpet ride
==================================================
robotics coding ipad
==================================================
read2learn everyone wins
==================================================
seating other needs
==================================================
rotate google chrome
==================================================
```

Test Data

Preprocessing of project_subject_categories

In [26]:

```
catogories = list(X_test['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-stri
ng
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-pyth
on
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", "Warmt
h", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "M
ath & Science"=> "Math","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace
 it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"M
ath & Science"=>"Math&Science"
        temp+=j.strip()+" " #" abc ".strip() will return "abc", remove the trailing spa
ces
        temp = temp.replace('&','_') # we are replacing the & value into
    cat_list.append(temp.strip())

X_test['clean_categories'] = cat_list
X_test.drop(['project_subject_categories'], axis=1, inplace=True)

from collections import Counter
my_counter = Counter()
for word in X_test['clean_categories'].values:
    my_counter.update(word.split())

cat_dict = dict(my_counter)
sorted_cat_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
```

Preprocessing of project_subject_subcategories

In [27]:

```
sub_catogories = list(X_test['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039

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

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", "Warmth", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "Math & Science"=> "Math","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math & Science"=>"Math&Science"
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spaces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())

X_test['clean_subcategories'] = sub_cat_list
X_test.drop(['project_subject_subcategories'], axis=1, inplace=True)

# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
my_counter = Counter()
for word in X_test['clean_subcategories'].values:
    my_counter.update(word.split())

sub_cat_dict = dict(my_counter)
sorted_sub_cat_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv: kv[1]))
```

Text Preprocessing

In [28]:

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

In [29]:

```
X_test.head(5)
```

Out[29]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state
74982	22493	p070060	1cf3f78b96eb1bd06298442900ccd754	Mrs.	TX
42830	172543	p027437	aa826b54027d8de6736a27387b06132d	Ms.	CA
95774	153245	p043170	fdab7ef1d919edb810cd6f92a91cbd00	Mrs.	GA
31615	64860	p249944	e541a113d749bb8823f28dd3307c46d0	Ms.	CO
64601	40127	p018436	c6b9dee43d84007033aa8d4bcb522fbe	Ms.	MO

In [30]:

```
# printing some random reviews
print(X_test['essay'].values[0])
print("="*50)
print(X_test['essay'].values[150])
print("="*50)
print(X_test['essay'].values[1000])
print("="*50)
print(X_test['essay'].values[20000])
print("="*50)
print(X_test['essay'].values[9999])
print("="*50)
```

```
I love my school and the students I have the pleasure of teaching. The env
ironment when you walk in the door at Stephens is one that is inviting and
comforting. You have a sense of being \"home\" that I strive to continue w
ithin my classroom. My school is a low socio-economic Title 1 school. My s
tudents are amazing individuals, but most face hardships that a child shou
ld not have to deal with. \r\nIt is so important that students have a comf
ortable and engaging learning environment. This is even more essential for
my sweet students that do not have a stable and comforting home life. They
come to school every day excited and ready to learn.\r\nMy students need t
o move! I will not expect them to sit in chairs all day long. Instead, we 
have researched some alternative ways for them to learn while being up and
active. After much discussion, my students decided having some flexible se
ating within the classroom would help them focus and stay on task. \r\nStu
dents learn so much more when they are up and actively engaged in the less
on. The majority of our day consists of small group lessons so I pull stud
ents to the back table while others are at workstations on the floor or at
the computer station. Having he rug and the \"sit upons\" will help the st
udents have a more comfortable place to choose to sit. The wobble stools w
ill be at my small group table to allow them to still move around while wo
rking in a smaller teacher to student ratio setting. Please consider helpi
ng my students have a more engaging and active classroom this year!nannan
==================================================
My students are special because they come from a low income community. Som
e students only have one parent, while others are raised by grandparents, 
other family members, or even have one parent in jail. The students I have
work very hard, even though the educational level that the are being raise
d in is low. The neighbor is not a middle level collar neighborhood, many 
walk or ride their broken down bike to school.\r\n As a school, we, the te
achers, provide backpacks, a Christmas angle project, where we give Money 
to under privileged children and even a winter coat give away. I've been a
t my school for 24 years, and every year I buy supplies for my students, s
o no one ever has to go without. \r\nThank you, \r\nKaren M. Bryan\r\n5th 
grade teacherReading helps students with vocabulary and make them become i
nterested in a topic or have a favorite author or novel series.  Reading a
lso make students life long readers if they are exposed to the different g
enres. In my room, when students read a book & are able to tell be about t
he book, they are able to put their name on a \"paw\" and hang it up in th
e classroom, these paws hang all year & then at the end of the year studen
ts can take them home. This project also gives the students a chance to sh
are with others about books they have read.nannan
==================================================
The students I serve are from low income families and receive free lunch. 
These 62 innovative third graders are eager to learn. However, they lack t
he financial support needed in order to purchase the necessary materials a
nd supplies teachers are in need of to support instruction for all student
s.  Without the necessary materials, activities are limited and behaviors 
increase.  \r\n\r\nThe majority of my students are tactile learners.  They
learn best by being actively engaged while working collaboratively and usi
ng various manipulatives, rather than listening to a lecture from the teac
her or watching demonstrations.   \r\n\r\nThe 2015-2016 data reveals readi
ng comprehension and history as areas of weakness for the students I teac
h.  Integration of the skills is an effective teaching strategy I will use
to help build upon the schema of all students.  I will utilize the readers
to conduct close reading instruction with my students.  This will allow op
portunity for students to read and re-read the text.  Thus, reading fluenc
y and reading comprehension will improve.\r\n\r\nWhile utilizing the books
as close reads, I will also build upon the students' knowledge of famous A
merican Heroes and emphasize how these American heroes overcame their obst
acles through diligence and perseverance.  Students will build upon their 
social and emotional skills by sharing the books and encouraging one anoth
er as they come across words they are unfamiliar with.  As a result, readi
```

```
ng comprehension, reading fluency, and social studies/history skills will
improve.nannan
==================================================
As a teacher from an extremely rural district in Oregon I teach in a ranch
ing community with a group of students that are in an economically depress
ed area.  Added to the mix are a group of students from four different con
tinents, at least three different religious backgrounds and several differ
ent socio-economic backgrounds.  \r\nThis mix makes the school year very i
nteresting.  It also makes teaching very difficult, as the teaching materi
al must be at different levels due to the large differences between the di
fferent ranges of English levels.  It can get complicated quickly.Students
learn a lot while reading novels.  The subject of the holocaust is one tha
t cannot get enough attention.  Both the Lost Boys and the Holocaust are s
ubjects that need attention in our world today.\r\nLong Way Gone and A Lon
g Way to Water will give my students a chance to see what life is like for
those less fortunate than themselves.  They will get to experience what ot
her children had to suffer through and understand that not everyone has a
life that is easy or safe.  \r\nBy shedding light on the experiences of th
e Lost Boys, we can hopefully prevent the future acts of genocide.nannan
==================================================
My students attend a school that is high poverty/ 100%.  The school is abl
e to offer free breakfast and lunch due to the amount of free and reduced
students that attend our school. Students love to come to school, I hear g
ood morning and I'm happy to be here in the morning. I want to continue th
e excitement for learning. \r\n\r\nIt is important for children to have a
variety of materials to manipulate and the opportunity to sort, classify,
weigh, stack and explore if they are to construct mathematical knowledge t
his is why the carpet included in my order is so important. “In order to h
ave opportunities to learn math, children need firsthand experiences relat
ed to math, interaction with other children and adults concerning these ex
periences and time to reflect on the experiences” (Seefeldt & Wasik, 2006,
p. 250, Principles and Standards for School Mathematics).\r\n\r\nKids lear
n by doing, which is why manipulatives are perfect tools for teaching and
reinforcing math and reading concepts. They are useful for hands-on, small
group activities; and for letting students explore and develop reasoning a
nd problem-solving skills.\r\n\r\nUsing manipulatives to teach math works!
\r\n\r\nEvery student deserves to have nice materials in the classroom to
learn with. This will help to give exactly that to our students.\r\nThe Na
tional Council of Teachers of Mathematics (N C T M) Principles and Standar
ds for School Mathematics emphasizes the importance of using manipulatives
and visual representation for teaching.   Our school is considered high po
verty. I have included some items that will create both math and reading c
enters with manipulatives. \r\n\r\n Students will gain the benefits of hea
lthy attitudes toward mathematics and reading. As a discipline, manipulati
ves and models are valuable resource tools for engaging students in the la
nguage and communication of mathematical ideas and concepts.nannan
==================================================
```

In [31]:

```
# creating a function named as decontracted which does the job of decontraction

# 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 [32]:

```
sent = decontracted(X_test['essay'].values[20000])
print(sent)
print("="*50)
```

```
As a teacher from an extremely rural district in Oregon I teach in a ranch
ing community with a group of students that are in an economically depress
ed area.  Added to the mix are a group of students from four different con
tinents, at least three different religious backgrounds and several differ
ent socio-economic backgrounds.  \r\nThis mix makes the school year very i
nteresting.  It also makes teaching very difficult, as the teaching materi
al must be at different levels due to the large differences between the di
fferent ranges of English levels.  It can get complicated quickly.Students
learn a lot while reading novels.  The subject of the holocaust is one tha
t cannot get enough attention.  Both the Lost Boys and the Holocaust are s
ubjects that need attention in our world today.\r\nLong Way Gone and A Lon
g Way to Water will give my students a chance to see what life is like for
those less fortunate than themselves.  They will get to experience what ot
her children had to suffer through and understand that not everyone has a
life that is easy or safe.  \r\nBy shedding light on the experiences of th
e Lost Boys, we can hopefully prevent the future acts of genocide.nannan
==================================================
```

In [33]:

```
#\r \n \t remove from string python: http://texthandler.com/info/remove-line-breaks-pyt
hon/
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\"', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
As a teacher from an extremely rural district in Oregon I teach in a ranch
ing community with a group of students that are in an economically depress
ed area.  Added to the mix are a group of students from four different con
tinents, at least three different religious backgrounds and several differ
ent socio-economic backgrounds.    This mix makes the school year very int
eresting.  It also makes teaching very difficult, as the teaching material
must be at different levels due to the large differences between the diffe
rent ranges of English levels.  It can get complicated quickly.Students le
arn a lot while reading novels.  The subject of the holocaust is one that
cannot get enough attention.  Both the Lost Boys and the Holocaust are sub
jects that need attention in our world today.  Long Way Gone and A Long Wa
y to Water will give my students a chance to see what life is like for tho
se less fortunate than themselves.  They will get to experience what other
children had to suffer through and understand that not everyone has a life
that is easy or safe.    By shedding light on the experiences of the Lost
Boys, we can hopefully prevent the future acts of genocide.nannan
```

In [34]:

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

```
As a teacher from an extremely rural district in Oregon I teach in a ranch
ing community with a group of students that are in an economically depress
ed area Added to the mix are a group of students from four different conti
nents at least three different religious backgrounds and several different
socio economic backgrounds This mix makes the school year very interesting
It also makes teaching very difficult as the teaching material must be at
different levels due to the large differences between the different ranges
of English levels It can get complicated quickly Students learn a lot whil
e reading novels The subject of the holocaust is one that cannot get enoug
h attention Both the Lost Boys and the Holocaust are subjects that need at
tention in our world today Long Way Gone and A Long Way to Water will give
my students a chance to see what life is like for those less fortunate tha
n themselves They will get to experience what other children had to suffer
through and understand that not everyone has a life that is easy or safe B
y shedding light on the experiences of the Lost Boys we can hopefully prev
ent the future acts of genocide nannan
```

In [35]:

```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
# because although they are in this list but they matter a lot because
# they change the meaning of the entire sentence.
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you'r
e", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him',
'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 't
hey', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "th
at'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'ha
d', 'having', 'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as'
, 'until', 'while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through'
, 'during', 'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'ov
er', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'an
y', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too'
, 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'no
w', 'd', 'll', 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't",
'doesn', "doesn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'migh
tn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'w
asn', "wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

In [36]:

```
# Combining all the above preprocessing techniques for all the project essays
from tqdm import tqdm
preprocessed_essays_Test = []
# tqdm is for printing the status bar
for sentance in tqdm(X_test['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.lower() not in stopwords)
    preprocessed_essays_Test.append(sent.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████████
█████| 36052/36052 [00:15<00:00, 2317.95it/s]
```

In [37]:

```
# after preprocesing of project essays
preprocessed_essays_Test[20000]
```

Out[37]:

```
'teacher extremely rural district oregon teach ranching community group st
udents economically depressed area added mix group students four different
continents least three different religious backgrounds several different s
ocio economic backgrounds mix makes school year interesting also makes tea
ching difficult teaching material must different levels due large differen
ces different ranges english levels get complicated quickly students learn
lot reading novels subject holocaust one cannot get enough attention lost
boys holocaust subjects need attention world today long way gone long way
water give students chance see life like less fortunate get experience chi
ldren suffer understand not everyone life easy safe shedding light experie
nces lost boys hopefully prevent future acts genocide nannan'
```

Preprocessing of project_title

Now we will simply apply the above preprocessing steps on the project title for the test data as well,as it is also a text feature

In [38]:

```
# printing some random titles.
print(X_test['project_title'].values[0])
print("="*50)
print(X_test['project_title'].values[150])
print("="*50)
print(X_test['project_title'].values[1000])
print("="*50)
print(X_test['project_title'].values[20000])
print("="*50)
print(X_test['project_title'].values[9999])
print("="*50)
```

```
Moving and Learning!
==================================================
Read a PAW Perfect Book!Reading
==================================================
Through It All...READ!
==================================================
Looking at the world of Genocide through literature
==================================================
For the Kids classroom supplies
==================================================
```

We have already written the preprocessing codes for different preprocessing approaches now we will simply use those codes on the project titles

In [39]:

```
preprocessed_project_titles_Test = []

for t in tqdm(X_test["project_title"]):
    title = decontracted(t)
    title = title.replace('\\r', ' ')
    title = title.replace('\\"', ' ')
    title = title.replace('\\n', ' ')
    title = re.sub('[^A-Za-z0-9]+', ' ', title)
    title = ' '.join(f for f in title.split() if f not in stopwords)
    preprocessed_project_titles_Test.append(title.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████████
████| 36052/36052 [00:00<00:00, 47877.00it/s]
```

In [40]:

```
# printing some random titles of train dataset after preprocessing

print(preprocessed_project_titles_Test[5000])
print("="*50)
print(preprocessed_project_titles_Test[7000])
print("="*50)
print(preprocessed_project_titles_Test[10000])
print("="*50)
print(preprocessed_project_titles_Test[4500])
print("="*50)
print(preprocessed_project_titles_Test[22000])
print("="*50)
```

```
after school fire kids need supplies
==================================================
graphic novels reach success english
==================================================
keep swimmin
==================================================
balance balls keep our minds and bodies active all day
==================================================
wicincala okolakiciye gathering girls
==================================================
```

Cross validation data

Preprocessing of project_subject_categories

In [41]:

```
catogories = list(X_cv['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039

# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-stri
ng
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-pyth
on
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", "Warmt
h", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "M
ath & Science"=> "Math","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace
 it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"M
ath & Science"=>"Math&Science"
        temp+=j.strip()+" " #" abc ".strip() will return "abc", remove the trailing spa
ces
        temp = temp.replace('&','_') # we are replacing the & value into
    cat_list.append(temp.strip())

X_cv['clean_categories'] = cat_list
X_cv.drop(['project_subject_categories'], axis=1, inplace=True)

from collections import Counter
my_counter = Counter()
for word in X_test['clean_categories'].values:
    my_counter.update(word.split())

cat_dict = dict(my_counter)
sorted_cat_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
```

Preprocessing of project_subject_subcategories

In [42]:

```
sub_catogories = list(X_cv['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039

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

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", "Warmt
h", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "M
ath & Science"=> "Math","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace
 it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"M
ath & Science"=>"Math&Science"
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spa
ces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())

X_cv['clean_subcategories'] = sub_cat_list
X_cv.drop(['project_subject_subcategories'], axis=1, inplace=True)

# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
my_counter = Counter()
for word in X_cv['clean_subcategories'].values:
    my_counter.update(word.split())

sub_cat_dict = dict(my_counter)
sorted_sub_cat_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv: kv[1]))
```

Text Preprocessing

In [43]:

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

In [44]:

```
X_cv.head(5)
```

Out[44]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state
72057	180194	p102427	0fbd66ea0f5bed9572b083d99638dbe9	Mrs.	IN
103938	67487	p151048	c528f613b3cd623047f317512945fa89	Mrs.	AZ
9764	109956	p059337	df41db79d57143576a2cdaa3ff00b646	Mr.	NM
54591	166133	p058268	2b334e87aa695b068c47614fdfd5ff26	Ms.	CA
25907	54069	p104194	88fb05940c51dbf6a367a132ad6a9359	Mrs.	TN

In [45]:

```
# printing some random reviews
print(X_cv['essay'].values[0])
print("="*50)
print(X_cv['essay'].values[150])
print("="*50)
print(X_cv['essay'].values[1000])
print("="*50)
print(X_cv['essay'].values[20000])
print("="*50)
print(X_cv['essay'].values[9999])
print("="*50)
```

```
Our students come from a variety of different economic backgrounds with ov
er 50% of our students receiving free or reduced lunch. Our school is also
very ethnically diverse. The school is located approximately 3 miles from
Purdue University.  Because of our proximity to Purdue, we have students r
epresenting 53 nations from around the world.  \r\n\r\nWe are a Title I sc
hool and we strive to meet individual student needs through daily guided r
eading instruction for every child.  We believe every child deserves the g
ift of reading!  \r\n\r\n\r\nWe need to replenish our Guided Reading Book 
Room.  We are a Title I school, and we use  a portion of our funding to hi
re reading specialists so that all students in grades K-3 get daily guided
reading instruction.  We have a large number of K-3 students in reading gr
oups that require multiple guided reading sets each week.  We need to add 
book sets at various reading levels to make sure these groups can continue
to help students excel in their reading abilities.  \r\n\r\nWhat better ac
complishment[ is there than to be able to give a child the gift of readin
g!  This is best done in small group instruction consisting of no more tha
n 6 children per group.  In these small groups, students work on reading a
book at their current reading level to hone their reading skills with the 
assistance of a reading instructor.    With the books we have selected to 
add to our current Guided Reading Book Room, we can help to make the dream
of becoming a life long reader a reality for hundreds of children for year
s to come.nannan
==================================================
Our students come from high poverty, low socioeconomic, inner city apartme
nts.  Our school is 100% free and reduced lunch.  Most of our children com
e from Spanish speaking homes and are enrolled in ELL classes.  However, t
hese obstacles do not deter their love for learning!\r\n\r\nThese students
know the importance of a good education.   They are excited about learning
and eager to soak up new concepts and knowledge each day.  Their determina
tion and hard work is inspiring and something to behold.These materials wi
ll be used for a variety of purposes.  One of our focuses in school this y
ear is Cause and Effect.  The Cause and Effect activities will be help stu
dents of all levels to be able to identify this reading skill.\r\nSince ou
r school is high English language learners, we try to focus on learning ab
out life in the United States of America.  The enclosed activities will he
lp our students identify various parts of the United States, important sym
bols, and land forms and geographical areas through out our great natio
n.\r\nThese activities will be stored in area for use by teachers, parent
s, students, and tutors.nannan
==================================================
Every year I get a new bunch of faces, but the struggles they face are sti
ll the same: poverty, hunger, lack of home support, survival. I teach on a
notorious side of town that substitutes avoid and people respond with, \"O
oohh.\" when they hear where my school is. Statistics say that my students
will continue in this environment, but I choose to believe that they can o
vercome.\r\n\r\nDespite these challenges, they come to school (most) every
day with smiles on their faces, hugs for their teacher, with a curiosity a
nd willingness to do the best they know how at that moment. I want to fost
er that natural curiosity.It has become clear in the recent past that asse
ssments are much more than paper, pencil, and regurgitation of knowledge;
especially when you're in kindergarten! Also, I have not met a kid yet tha
t is not engaged by LEGOs or something similar. Engagement is key when wor
king in early childhood grades.\r\n\r\nAssessments and practicing concepts
can be done in various ways, but I believe this will be one of the most fu
n and exciting for my kids to keep that engagement yet still show me what 
they know! Aside from that, this also helps build fine motor skills; somet
hing desperately needed to get their little fingers ready for writing.\r\n
\r\nWe are introducing all sorts of math concepts in kindergarten - algebr
a, geometry, number sense, etc. LEGOs are a great way to assess geometry a
nd number sense. All of this happens while they THINK they are playing. Al
so, we have units such as farms, colonial times, and kings and queens that
```

```
allow for them to build representations of their knowledge gained during l
earning about these social study units. I've seen an entire farm built fro
m LEGOs. It blew my mind, and I knew I would want to do this with my kids
next year. This is where I need your help!nannan
==================================================
Every morning I greet my students at the door and then we see where the le
arning for the day will take us.  My students come to school everyday exci
ted to learn and want to do their best.\r\n\r\nI work in a title one schoo
l with a high poverty rate.  The school library and my classroom library a
re the only places many of my students are able to get books to read.\r\n
\r\nI have twenty-one highly active fourth graders. I work in a high-pover
ty area where school is a safe place for many of my students.   My student
s enjoy coming to school and learning.My students enjoy reading about fact
ual concepts but struggle to find books at their nonfiction reading level.
By having these book in my room, my students will have a number of nonfict
ion books at their fingertips.  These books will be put my classroom libra
ry for my students to read.  \r\n\r\nYour donation will help strengthen my
classroom library's nonfiction section, which in turn will give my student
s more options on what to read.  Nonfiction books can also be used to lear
n about Science and Social Studies concepts.  My students love to learn ab
out different Science and Social Studies concepts and these books will be
a great way for them to read about something that interests them.nannan
==================================================
I teach in a kindergarten classroom where we are developing innovative way
s to incorporate core curriculum while keeping the \"whole child\" at the
center of all ideas.   I have 23 students that are from various background
s; absolutely no schooling, to enriched preschools where children are look
ing to be challenged. Many of the students are English learners.\r\nOur sc
hool is a Title 1 School.  This is a high poverty area where some families
cannot afford the basic school supplies.  The majority of the students rec
eive free and reduced lunch.  School is the only learning outlet for many
of the children.  Kindergarten is an amazing age to work with, where they
are excited to learn and progress.  We are trying to instill a love of sch
ool and learning that they will carry on to higher grades!The durable CD p
layers and headphones will enable the kindergarteners to listen to engagin
g and interesting books during independent work time.  These players are s
imple enough for kindergartners to operate with minimal to no help from ad
ults.  The CD players and the heavy duty headphones will last for years in
our kindergarten classroom.  \r\n    Children need to see and hear hundred
s of books before they are ready to learn to read.  Independent listening
centers provide an opportunity for our young students to hear quality lite
rature during the few hours they attend school.  The kindergartners will g
ain pre-reading skills, increased vocabulary, and be connected to famous a
uthors and illustrators.      \r\n\r\nnannan
==================================================
```

In [46]:

```
# creating a function named as decontracted which does the job of decontraction

# 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 [47]:

```
sent = decontracted(X_cv['essay'].values[20000])
print(sent)
print("="*50)
```

```
Every morning I greet my students at the door and then we see where the le
arning for the day will take us.  My students come to school everyday exci
ted to learn and want to do their best.\r\n\r\nI work in a title one schoo
l with a high poverty rate.  The school library and my classroom library a
re the only places many of my students are able to get books to read.\r\n
\r\nI have twenty-one highly active fourth graders. I work in a high-pover
ty area where school is a safe place for many of my students.   My student
s enjoy coming to school and learning.My students enjoy reading about fact
ual concepts but struggle to find books at their nonfiction reading level.
By having these book in my room, my students will have a number of nonfict
ion books at their fingertips.  These books will be put my classroom libra
ry for my students to read.  \r\n\r\nYour donation will help strengthen my
classroom library is nonfiction section, which in turn will give my studen
ts more options on what to read.  Nonfiction books can also be used to lea
rn about Science and Social Studies concepts.  My students love to learn a
bout different Science and Social Studies concepts and these books will be
a great way for them to read about something that interests them.nannan
==================================================
```

In [48]:

```
#\r \n \t remove from string python: http://texthandler.com/info/remove-line-breaks-pyt
hon/
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\"', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
Every morning I greet my students at the door and then we see where the le
arning for the day will take us.  My students come to school everyday exci
ted to learn and want to do their best.    I work in a title one school wi
th a high poverty rate.  The school library and my classroom library are t
he only places many of my students are able to get books to read.    I hav
e twenty-one highly active fourth graders. I work in a high-poverty area w
here school is a safe place for many of my students.   My students enjoy c
oming to school and learning.My students enjoy reading about factual conce
pts but struggle to find books at their nonfiction reading level.  By havi
ng these book in my room, my students will have a number of nonfiction boo
ks at their fingertips.  These books will be put my classroom library for
my students to read.      Your donation will help strengthen my classroom
library is nonfiction section, which in turn will give my students more op
tions on what to read.  Nonfiction books can also be used to learn about S
cience and Social Studies concepts.  My students love to learn about diffe
rent Science and Social Studies concepts and these books will be a great w
ay for them to read about something that interests them.nannan
```

In [49]:

```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
# because although they are in this list but they matter a lot because
# they change the meaning of the entire sentence.
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you'r
e", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him',
'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 't
hey', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "th
at'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'ha
d', 'having', 'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as'
, 'until', 'while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through'
, 'during', 'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'ov
er', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'an
y', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too'
, 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'no
w', 'd', 'll', 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't",
'doesn', "doesn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'migh
tn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'w
asn', "wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

In [50]:

```
# Combining all the above preprocessing techniques for all the project essays
from tqdm import tqdm
preprocessed_essays_Cv = []
# tqdm is for printing the status bar
for sentance in tqdm(X_cv['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.lower() not in stopwords)
    preprocessed_essays_Cv.append(sent.lower().strip())
```

```
100%|█████████████████████████████████████████████████████████████████████
█████| 24155/24155 [00:11<00:00, 2139.81it/s]
```

In [51]:

```
# after preprocesing of project essays
preprocessed_essays_Test[20000]
```

Out[51]:

```
'teacher extremely rural district oregon teach ranching community group st
udents economically depressed area added mix group students four different
continents least three different religious backgrounds several different s
ocio economic backgrounds mix makes school year interesting also makes tea
ching difficult teaching material must different levels due large differen
ces different ranges english levels get complicated quickly students learn
lot reading novels subject holocaust one cannot get enough attention lost
boys holocaust subjects need attention world today long way gone long way
water give students chance see life like less fortunate get experience chi
ldren suffer understand not everyone life easy safe shedding light experie
nces lost boys hopefully prevent future acts genocide nannan'
```

Preprocessing of project_title

Now we will simply apply the above preprocessing steps on the project title for the Cross Validation data as well,as it is also a text feature

In [52]:

```
# printing some random titles.
print(X_cv['project_title'].values[0])
print("="*50)
print(X_cv['project_title'].values[150])
print("="*50)
print(X_cv['project_title'].values[1000])
print("="*50)
print(X_cv['project_title'].values[20000])
print("="*50)
print(X_cv['project_title'].values[9999])
print("="*50)
```

```
Guided Reading to Create Lifelong Readers
==================================================
Where in The World is Fox Oklahoma?
==================================================
LEGOs for Creative Assessment and Math Concepts!
==================================================
Factual Finds
==================================================
Kindergarten Listening Center for Independent Work Time
==================================================
```

In [53]:

```
preprocessed_project_titles_Cv = []

for t in tqdm(X_cv["project_title"]):
    title = decontracted(t)
    title = title.replace('\\r', ' ')
    title = title.replace('\\"', ' ')
    title = title.replace('\\n', ' ')
    title = re.sub('[^A-Za-z0-9]+', ' ', title)
    title = ' '.join(f for f in title.split() if f not in stopwords)
    preprocessed_project_titles_Cv.append(title.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████
████| 24155/24155 [00:00<00:00, 48054.80it/s]
```

In [54]:

```
# printing some random titles of crossvalidation dataset after preprocessing

print(preprocessed_project_titles_Cv[5000])
print("="*50)
print(preprocessed_project_titles_Cv[7000])
print("="*50)
print(preprocessed_project_titles_Cv[10000])
print("="*50)
print(preprocessed_project_titles_Cv[4500])
print("="*50)
print(preprocessed_project_titles_Cv[22000])
print("="*50)
```

```
guided reading galore
==================================================
help amazing kids get new books
==================================================
creating techno world wizards
==================================================
scientist mathematicians need library
==================================================
help my students move while they work
==================================================
```

Preparing Data For Models

In [60]:

```
project_data.columns
```

Out[60]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'Date', '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_approve
d'],
      dtype='object')
```

we are going to consider

- school_state : categorical data
- clean_categories : categorical data
- clean_subcategories : categorical data
- project_grade_category : categorical data
- teacher_prefix : categorical data
- project_title : text data
- text : text data
- project_resource_summary: text data (optinal)
- quantity : numerical (optinal)
- teacher_number_of_previously_posted_projects : numerical
- price : numerical

Now firstly we will be vectorizing the categorical data

For vectorizing the categorical data we will be using One Hot Encoding Technique

One Hot Encoding Of Project Clean Categories

Checking if the characters like (. , _ , -) are present in myu dictionary keys or not if they are present I need to reemove them as they don't make any sense for the vocabolary

In [70]:

```
message = "yes . is present " if '.' in sorted_cat_dict else "not . is not present"
print(message)
```

```
not . is not present
```

In [71]:

```
message = "yes - is present " if '-' in sorted_cat_dict else "not - is not present"
print(message)
```

```
not - is not present
```

In [72]:

```
message = "yes _ is present " if '_' in sorted_cat_dict else "not _ is not present"
print(message)
```

```
not _ is not present
```

In [73]:

```
# we use count vectorizer to convert the values into one hot encoded features


from sklearn.feature_extraction.text import CountVectorizer

vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False,
binary=True)

# we will be using the X_train for fitting our model because that is the only data a us
er knows rest all are for testing purposes
vectorizer.fit(X_train['clean_categories'].values)

print(vectorizer.get_feature_names())

categories_one_hot_train = vectorizer.transform(X_train['clean_categories'].values)

categories_one_hot_test = vectorizer.transform(X_test['clean_categories'].values)

categories_one_hot_cv = vectorizer.transform(X_cv['clean_categories'].values)
```

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearnin
g', 'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Literacy_Language']
```

In [74]:

```
print("Shape of  Train data matrix after one hot encoding ",categories_one_hot_train.sh
ape)
print("Shape of  Test data matrix after one hot encoding ",categories_one_hot_test.shap
e)
print("Shape of  CV data matrix after one hot encoding ",categories_one_hot_cv.shape)
```

```
Shape of  Train data matrix after one hot encoding  (49041, 9)
Shape of  Test data matrix after one hot encoding  (36052, 9)
Shape of  CV data matrix after one hot encoding  (24155, 9)
```

One Hot Encoding Of Cleaned Project Sub Category

Checking if the characters like (. , _ , -) are present in myu dictionary keys or not if they are present I need to reemove them as they don't make any sense for the vocabolary

In [77]:

```
message = "yes . is present " if '.' in sorted_sub_cat_dict else "not . is not present"
print(message)
```

```
not . is not present
```

In [78]:

```
message = "yes - is present " if '-' in sorted_sub_cat_dict else "not - is not present"
print(message)
```

```
not - is not present
```

In [79]:

```
message = "yes _ is present " if '_' in sorted_sub_cat_dict else "not _ is not present"
print(message)
```

```
not _ is not present
```

In [80]:

```
# we use count vectorizer to convert the values into one hot encoded features


from sklearn.feature_extraction.text import CountVectorizer

vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=Fal
se, binary=True)

# we will be using the X_train for fitting our model because that is the only data a us
er knows rest all are for testing purposes
vectorizer.fit(X_train['clean_subcategories'].values)

print(vectorizer.get_feature_names())

subcategories_one_hot_train = vectorizer.transform(X_train['clean_subcategories'].value
s)

subcategories_one_hot_test = vectorizer.transform(X_test['clean_subcategories'].values)

subcategories_one_hot_cv = vectorizer.transform(X_cv['clean_subcategories'].values)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvemen
t', 'Extracurricular', 'ForeignLanguages', 'Civics_Government', 'Nutrition
Education', 'Warmth', 'Care_Hunger', 'PerformingArts', 'SocialSciences',
'CharacterEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Musi
c', 'History_Geography', 'EarlyDevelopment', 'Health_LifeScience', 'ESL',
'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'A
ppliedSciences', 'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Lit
eracy']
```

In [81]:

```
print("Shape of  Train data matrix after one hot encoding ",subcategories_one_hot_train
.shape)
print("Shape of  Test data matrix after one hot encoding ",subcategories_one_hot_test.s
hape)
print("Shape of  CV data matrix after one hot encoding ",subcategories_one_hot_cv.shape
)
```

```
Shape of  Train data matrix after one hot encoding  (49041, 30)
Shape of  Test data matrix after one hot encoding  (36052, 30)
Shape of  CV data matrix after one hot encoding  (24155, 30)
```

One hot encoding of teacher prefix

In [83]:

```
mylist_teacher_prefix = list(X_train['teacher_prefix'])
```

In [84]:

```
# We are removing the duplicate values from our list of the teacher prefix

# Source :- https://www.w3schools.com/python/python_howto_remove_duplicates.asp

mylist_teacher_prefix_actual_Train = list(dict.fromkeys(mylist_teacher_prefix))
```

In [85]:

```
# removing the nan from the teacher prefix category as there is no such category of tea
cher which exists

mylist_teacher_prefix_actual_Train = [p for p in mylist_teacher_prefix_actual_Train if
str(p) != 'nan']
mylist_teacher_prefix_actual_Train
```

Out[85]:

```
['Ms.', 'Mr.', 'Mrs.', 'Teacher', 'Dr.']
```

Removing '.' from all the teacher prefixes.

In [89]:

```
# code for this from here --> https://stackoverflow.com/questions/8282553/removing-char
acter-in-list-of-strings

mylist_teacher_prefix_actual_Train = ' '.join(mylist_teacher_prefix_actual_Train).repla
ce('8','').split()

print(mylist_teacher_prefix_actual_Train)
```

```
['Ms', 'Mr', 'Mrs', 'Teacher', 'Dr']
```

In [90]:

```
# we use count vectorizer to convert the values into one hot encoded features

# now we are working on teacher prefix data

from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=mylist_teacher_prefix_actual_Train, lowercase=False, binary=True)

# I was getting an error like "np.nan is an invalid document, expected byte or unicode string."
# below is the solution

# https://stackoverflow.com/questions/39303912/tfidfvectorizer-in-scikit-learn-valueerror-np-nan-is-an-invalid-document


vectorizer.fit(X_train['teacher_prefix'].values.astype('U'))
print(vectorizer.get_feature_names())

teacher_prefix_one_hot_train = vectorizer.transform(X_train['teacher_prefix'].values.astype('U'))
teacher_prefix_one_hot_test = vectorizer.transform(X_test['teacher_prefix'].values.astype('U'))
teacher_prefix_one_hot_cv = vectorizer.transform(X_cv['teacher_prefix'].values.astype('U'))
```

```
['Ms', 'Mr', 'Mrs', 'Teacher', 'Dr']
```

In [91]:

```
print("Shape of matrix of Train data after one hot encoding ",teacher_prefix_one_hot_train.shape)
print("Shape of matrix of Test data after one hot encoding ",teacher_prefix_one_hot_test.shape)
print("Shape of matrix of Cross Validation data after one hot encoding ",teacher_prefix_one_hot_cv.shape)
```

```
Shape of matrix of Train data after one hot encoding  (49041, 5)
Shape of matrix of Test data after one hot encoding  (36052, 5)
Shape of matrix of Cross Validation data after one hot encoding  (24155, 5)
```

One Hot encoding of project grade category

In [95]:

```
mylist_project_grade_category = list(X_train['project_grade_category'])
```

In [96]:

```
# We are removing the duplicate values from our list of the project grade category

# Source :- https://www.w3schools.com/python/python_howto_remove_duplicates.asp

mylist_project_grade_category_actual = list(dict.fromkeys(mylist_project_grade_category))
```

In [98]:

```
type(mylist_project_grade_category_actual)
print(mylist_project_grade_category_actual[0])

n = len(mylist_project_grade_category_actual)
print(n)

# I already saw by running the code that the word Grades is unnecessarily present in th
e elements of list hence trying to remove that word
# how to remove a word from a sentence --> https://codescracker.com/python/program/pyth
on-program-remove-word-from-sentence.htm
for m in range(0,4,1):
    words = mylist_project_grade_category_actual[m].split()
    mylist_project_grade_category_actual[m] = ''.join([j for j in words if j not in "Gr
ades"])
print(mylist_project_grade_category_actual)
```

```
3-5
4
['3-5', '6-8', 'PreK-2', '9-12']
```

Replacing '-' with '_' as it is the convention to write

In [99]:

```
# code for this from here --> https://stackoverflow.com/questions/8282553/removing-char
acter-in-list-of-strings

mylist_project_grade_category_actual = ' '.join(mylist_project_grade_category_actual).r
eplace('-','_').split()

print(mylist_project_grade_category_actual)
```

```
['3_5', '6_8', 'PreK_2', '9_12']
```

In [100]:

```
# we use count vectorizer to convert the values into one hot encoded features

# now we are working on project grade category data

from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=mylist_project_grade_category_actual, lowercase
=False, binary=True)


vectorizer.fit(X_train['project_grade_category'].values)
print(vectorizer.get_feature_names())

project_grade_categories_one_hot_train = vectorizer.transform(X_train['project_grade_ca
tegory'].values)
project_grade_categories_one_hot_test = vectorizer.transform(X_test['project_grade_cate
gory'].values)
project_grade_categories_one_hot_cv = vectorizer.transform(X_cv['project_grade_categor
y'].values)
```

```
['3_5', '6_8', 'PreK_2', '9_12']
```

In [101]:

```
print("Shape of matrix of Train data after one hot encoding ",project_grade_categories_one_hot_train.shape)
print("Shape of matrix of Test data after one hot encoding ",project_grade_categories_one_hot_test.shape)
print("Shape of matrix of Cross Validation data after one hot encoding ",project_grade_categories_one_hot_cv.shape)
```

```
Shape of matrix of Train data after one hot encoding  (49041, 4)
Shape of matrix of Test data after one hot encoding  (36052, 4)
Shape of matrix of Cross Validation data after one hot encoding  (24155,
4)
```

One hot encoding of School States

In [102]:

```
type(list(project_data['school_state']))
```

Out[102]:

```
list
```

In [103]:

```
mylist = list(X_train['school_state'])
```

In [104]:

```
# We are removing the duplicate values from our list of the state codes

# Source :- https://www.w3schools.com/python/python_howto_remove_duplicates.asp

mylist_actual = list(dict.fromkeys(mylist))
```

In [105]:

```
# we use count vectorizer to convert the values into one hot encoded features

# now we are working on school state data

from sklearn.feature_extraction.text import CountVectorizer

vectorizer = CountVectorizer(vocabulary=mylist_actual, lowercase=False, binary=True)

vectorizer.fit(X_train['school_state'].values)

print(vectorizer.get_feature_names())

school_state_categories_one_hot_train = vectorizer.transform(X_train['school_state'].va
lues)
school_state_categories_one_hot_test = vectorizer.transform(X_test['school_state'].valu
es)
school_state_categories_one_hot_cv = vectorizer.transform(X_cv['school_state'].values)
```

```
['AZ', 'LA', 'TX', 'CA', 'AR', 'FL', 'NY', 'KY', 'KS', 'NC', 'TN', 'SC',
'UT', 'GA', 'NJ', 'NV', 'WA', 'CT', 'OH', 'PA', 'MA', 'IN', 'IL', 'VA', 'M
I', 'OR', 'AL', 'MN', 'WI', 'DC', 'MO', 'MS', 'VT', 'ME', 'MD', 'NM', 'A
K', 'ID', 'WV', 'OK', 'MT', 'CO', 'NE', 'DE', 'RI', 'IA', 'HI', 'SD', 'N
D', 'WY', 'NH']
```

In [106]:

```
print("Shape of matrix of Train data after one hot encoding ",school_state_categories_o
ne_hot_train.shape)
print("Shape of matrix of Test data after one hot encoding ",school_state_categories_on
e_hot_test.shape)
print("Shape of matrix of Cross Validation data after one hot encoding ",school_state_c
ategories_one_hot_cv.shape)
```

```
Shape of matrix of Train data after one hot encoding  (49041, 51)
Shape of matrix of Test data after one hot encoding  (36052, 51)
Shape of matrix of Cross Validation data after one hot encoding  (24155, 5
1)
```

Now as we have done the vectorizing of categorical data now we will be vectorizing the text data using different techniques

Vectorizing the text data

Technique -1 Bag of words(BOW)

Essays

Essays Train Data

In [107]:

```
# I am not setting the value of min_df here because i read here
# https://stackoverflow.com/questions/27697766/understanding-min-df-and-max-df-in-scikit-countvectorizer
# that min_df helps in better performance but might also give poor clusters hence am trying without it this time



vectorizer = CountVectorizer(ngram_range=(1, 2),min_df = 10,max_features = 5000)
vectorizer.fit(preprocessed_essays_Train)

essay_bow_train = vectorizer.transform(preprocessed_essays_Train)

print("Shape of matrix after bag of words ",essay_bow_train.shape)
```

```
Shape of matrix after bag of words  (49041, 5000)
```

Essay Test Data

In [108]:

```
# I am not setting the value of min_df here because i read here
# https://stackoverflow.com/questions/27697766/understanding-min-df-and-max-df-in-scikit-countvectorizer
# that min_df helps in better performance but might also give poor clusters hence am trying without it this time


# now note that the below two lines are wrong because we have already trained the
# model on the training data now using that model we should get the bow representation
# of test data. After all training from test data only and then cecking for its accuracy will ofcourse give
# good accuracy.

# lines not to be used (I used them but then going through the code realised the mistake)

#vectorizer = CountVectorizer()
#vectorizer.fit(preprocessed_essays_Test)

essay_bow_test = vectorizer.transform(preprocessed_essays_Test)

print("Shape of matrix after bag of words ",essay_bow_test.shape)
```

```
Shape of matrix after bag of words  (36052, 5000)
```

Essay Cross Validation data

In [109]:

```
# I am not setting the value of min_df here because i read here
# https://stackoverflow.com/questions/27697766/understanding-min-df-and-max-df-in-sciki
t-countvectorizer
# that min_df helps in better performance but might also give poor clusters hence am tr
ying without it this time

# similarly below two lines should not be used

#vectorizer = CountVectorizer()
#vectorizer.fit(preprocessed_essays_Cv)

essay_bow_cv = vectorizer.transform(preprocessed_essays_Cv)

print("Shape of matrix after bag of words ",essay_bow_cv.shape)
```

```
Shape of matrix after bag of words  (24155, 5000)
```

Project Title

In [110]:

```
# we are imposing no min_df or ngram_range constraint on project title vectorization
vectorizer = CountVectorizer()
```

Bag of words on Project Title Train data

In [111]:

```
vectorizer.fit(preprocessed_project_titles_Train)
project_title_bow_train = vectorizer.transform(preprocessed_project_titles_Train)
print("Shape of matrix after bag of words ",project_title_bow_train.shape)
```

```
Shape of matrix after bag of words  (49041, 11612)
```

Bag of words on Project Title Test data

In [112]:

```
project_title_bow_test = vectorizer.transform(preprocessed_project_titles_Test)
print("Shape of matrix after bag of words ",project_title_bow_test.shape)
```

```
Shape of matrix after bag of words  (36052, 11612)
```

Bag of words on Project Title Cross Validation data

In [113]:

```
project_title_bow_cv = vectorizer.transform(preprocessed_project_titles_Cv)
print("Shape of matrix after bag of words ",project_title_bow_cv.shape)
```

```
Shape of matrix after bag of words  (24155, 11612)
```

Technique-2 TFIDF

Essay Data

Essay Train Data

In [114]:

```
from sklearn.feature_extraction.text import TfidfVectorizer

vectorizer_tfidf = TfidfVectorizer(max_features = 5000,ngram_range = (1,2), min_df = 10
)
vectorizer_tfidf.fit(preprocessed_essays_Train)

text_tfidf_train = vectorizer_tfidf.transform(preprocessed_essays_Train)
print("Shape of matrix after tfidf ",text_tfidf_train.shape)

print(type(text_tfidf_train))

# we are converting a dictionary with word as a key, and the idf as a value

dictionary = dict(zip(vectorizer_tfidf.get_feature_names(), list(vectorizer_tfidf.idf_
)))
tfidf_words = set(dictionary.keys())
```

```
Shape of matrix after tfidf  (49041, 5000)
<class 'scipy.sparse.csr.csr_matrix'>
```

Essay Test data

In [117]:

```
text_tfidf_test = vectorizer_tfidf.transform(preprocessed_essays_Test)
print("Shape of matrix after tfidf ",text_tfidf_test.shape)
```

```
Shape of matrix after tfidf  (36052, 5000)
```

Essay Cross Validation Data

In [118]:

```
text_tfidf_cv = vectorizer_tfidf.transform(preprocessed_essays_Cv)
print("Shape of matrix after tfidf ",text_tfidf_cv.shape)
```

```
Shape of matrix after tfidf  (24155, 5000)
```

Project Title

Project title train data

In [183]:

```
vectorizer = TfidfVectorizer(max_features = 3000,ngram_range = (1,2), min_df = 10)

vectorizer.fit(preprocessed_project_titles_Train)

project_title_tfidf_train = vectorizer.transform(preprocessed_project_titles_Train)

print("Shape of matrix after tfidf ",project_title_tfidf_train.shape)

# we are converting a dictionary with word as a key, and the idf as a value

dictionary = dict(zip(vectorizer.get_feature_names(), list(vectorizer.idf_)))
tfidf_project_title_words = set(dictionary.keys())
```

```
Shape of matrix after tfidf  (49041, 3000)
```

Project title test data

In [184]:

```
project_title_tfidf_test = vectorizer.transform(preprocessed_project_titles_Test)
print("Shape of matrix after tfidf ",project_title_tfidf_test.shape)
```

```
Shape of matrix after tfidf  (36052, 3000)
```

Project title cross validation data

In [185]:

```
title_tfidf_cv = vectorizer.transform(preprocessed_project_titles_Cv)
print("Shape of matrix after tfidf ",title_tfidf_cv.shape)
```

```
Shape of matrix after tfidf  (24155, 3000)
```

Technique-3 Average Word to Vector

Using pretrained w2v model in the file glove

In [122]:

```
# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-p
ickle-to-save-and-load-variables-in-python/
# make sure you have the glove_vectors file
with open('glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

Essay Train data

In [123]:

```
# average Word2Vec
# compute average word2vec for each preprocessed essay.

avg_w2v_vectors_train = []; # the avg-w2v for each essay is stored in this list
for sentence in tqdm(preprocessed_essays_Train): # for each essay
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the essay
    for word in sentence.split(): # for each word in a essay
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_train.append(vector)

print(len(avg_w2v_vectors_train))
print(len(avg_w2v_vectors_train[0]))
```

```
100%|█████████████████████████████████████████████████████████████████████
█████| 49041/49041 [00:10<00:00, 4495.02it/s]

49041
300
```

Essay Test data

In [124]:

```
# average Word2Vec
# compute average word2vec for each preprocessed essay.

avg_w2v_vectors_test = []; # the avg-w2v for each essay is stored in this list
for sentence in tqdm(preprocessed_essays_Test): # for each essay
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the essay
    for word in sentence.split(): # for each word in a essay
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_test.append(vector)

print(len(avg_w2v_vectors_test))
print(len(avg_w2v_vectors_test[0]))
```

```
100%|█████████████████████████████████████████████████████████████████████
█████| 36052/36052 [00:07<00:00, 4510.29it/s]

36052
300
```

Essay Cross Validation data

In [125]:

```
# average Word2Vec
# compute average word2vec for each preprocessed essay.

avg_w2v_vectors_cv = []; # the avg-w2v for each essay is stored in this list
for sentence in tqdm(preprocessed_essays_Cv): # for each essay
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the essay
    for word in sentence.split(): # for each word in a essay
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_cv.append(vector)

print(len(avg_w2v_vectors_cv))
print(len(avg_w2v_vectors_cv[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
█████| 24155/24155 [00:05<00:00, 4509.31it/s]

24155
300
```

Project Title train data

In [126]:

```
# average Word2Vec
# compute average word2vec for each preprocessed essay.

avg_w2v_vectors_project_title_train = []; # the avg-w2v for each essay is stored in thi
s list
for sentence in tqdm(preprocessed_project_titles_Train): # for each essay
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the essay
    for word in sentence.split(): # for each word in a essay
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_project_title_train.append(vector)

print(len(avg_w2v_vectors_project_title_train))
print(len(avg_w2v_vectors_project_title_train[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
████| 49041/49041 [00:00<00:00, 83321.19it/s]

49041
300
```

Project Title test data

In [127]:

```
# average Word2Vec
# compute average word2vec for each preprocessed essay.

avg_w2v_vectors_project_title_test = []; # the avg-w2v for each essay is stored in this
list
for sentence in tqdm(preprocessed_project_titles_Test): # for each essay
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the essay
    for word in sentence.split(): # for each word in a essay
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_project_title_test.append(vector)

print(len(avg_w2v_vectors_project_title_test))
print(len(avg_w2v_vectors_project_title_test[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
████| 36052/36052 [00:00<00:00, 83179.38it/s]

36052
300
```

Project title Cross Validation data

In [128]:

```
# average Word2Vec
# compute average word2vec for each preprocessed essay.

avg_w2v_vectors_project_title_cv = []; # the avg-w2v for each essay is stored in this l
ist
for sentence in tqdm(preprocessed_project_titles_Cv): # for each essay
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the essay
    for word in sentence.split(): # for each word in a essay
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_project_title_cv.append(vector)

print(len(avg_w2v_vectors_project_title_cv))
print(len(avg_w2v_vectors_project_title_cv[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
████| 24155/24155 [00:00<00:00, 80885.01it/s]

24155
300
```

Technique-4 TFIDF weighted Word To Vector

Essay train data

In [129]:

```
# tfidf Word2Vec
# computing average word2vec for each Project Title is stored in this list

tfidf_w2v_vectors_text_train = []; # the tfidf-w2v for each essay
for sentence in tqdm(preprocessed_essays_Train): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the title
    for word in sentence.split(): # for each word in a title
        if (word in glove_words) and (word in dictionary):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            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_text_train.append(vector)

print(len(tfidf_w2v_vectors_text_train))
print(len(tfidf_w2v_vectors_text_train[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
██████| 49041/49041 [00:56<00:00, 860.80it/s]

49041
300
```

Essay test data

In [130]:

```
# tfidf Word2Vec
# computing average word2vec for each Project Title is stored in this list

tfidf_w2v_vectors_text_test = []; # the tfidf-w2v for each essay
for sentence in tqdm(preprocessed_essays_Test): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the title
    for word in sentence.split(): # for each word in a title
        if (word in glove_words) and (word in dictionary):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tfidf value for each word
            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_text_test.append(vector)

print(len(tfidf_w2v_vectors_text_test))
print(len(tfidf_w2v_vectors_text_test[0]))
```

```
100%|█████████████████████████████████████████████████████████████████████
██████| 36052/36052 [00:41<00:00, 861.81it/s]

36052
300
```

Essay cross validation

In [131]:

```
# tfidf Word2Vec
# computing average word2vec for each Project Title is stored in this list

tfidf_w2v_vectors_text_cv = []; # the tfidf-w2v for each essay
for sentence in tqdm(preprocessed_essays_Cv): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the title
    for word in sentence.split(): # for each word in a title
        if (word in glove_words) and (word in dictionary):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tfidf value for each word
            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_text_cv.append(vector)

print(len(tfidf_w2v_vectors_text_cv))
print(len(tfidf_w2v_vectors_text_cv[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
██████| 24155/24155 [00:27<00:00, 865.93it/s]

24155
300
```

Project Title Train data

In [132]:

```
vectorizer = TfidfVectorizer(max_features = 2000, min_df = 10)

vectorizer.fit(preprocessed_project_titles_Train)

project_title_tfidf_train = vectorizer.transform(preprocessed_project_titles_Train)

print("Shape of matrix after tfidf ",project_title_tfidf_train.shape)

# we are converting a dictionary with word as a key, and the idf as a value

dictionary = dict(zip(vectorizer.get_feature_names(), list(vectorizer.idf_)))
tfidf_project_title_words = set(dictionary.keys())
```

```
Shape of matrix after tfidf  (49041, 2000)
```

In [133]:

```
# tfidf Word2Vec
# computing average word2vec for each Project Title is stored in this list

tfidf_w2v_vectors_project_title_train = []; # the tfidf-w2v for each essay
for sentence in tqdm(preprocessed_project_titles_Train): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the title
    for word in sentence.split(): # for each word in a title
        if (word in glove_words) and (word in dictionary):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            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_project_title_train.append(vector)

print(len(tfidf_w2v_vectors_project_title_train))
print(len(tfidf_w2v_vectors_project_title_train[0]))
```

```
100%|█████████████████████████████████████████████████████████████████████
████| 49041/49041 [00:01<00:00, 44151.79it/s]

49041
300
```

Project title test data

In [134]:

```
# tfidf Word2Vec
# computing average word2vec for each Project Title is stored in this list

tfidf_w2v_vectors_project_title_test = []; # the tfidf-w2v for each essay
for sentence in tqdm(preprocessed_project_titles_Test): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the title
    for word in sentence.split(): # for each word in a title
        if (word in glove_words) and (word in dictionary):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tfidf value for each word
            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_project_title_test.append(vector)

print(len(tfidf_w2v_vectors_project_title_test))
print(len(tfidf_w2v_vectors_project_title_test[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
████| 36052/36052 [00:00<00:00, 43694.39it/s]


36052
300
```

project title cross validation data

In [135]:

```
# tfidf Word2Vec
# computing average word2vec for each Project Title is stored in this list

tfidf_w2v_vectors_project_title_cv = []; # the tfidf-w2v for each essay
for sentence in tqdm(preprocessed_project_titles_Cv): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the title
    for word in sentence.split(): # for each word in a title
        if (word in glove_words) and (word in dictionary):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            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_project_title_cv.append(vector)

print(len(tfidf_w2v_vectors_project_title_cv))
print(len(tfidf_w2v_vectors_project_title_cv[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████
████| 24155/24155 [00:00<00:00, 44387.04it/s]

24155
300
```

Numerical Features

vectorizing numerical features

Price for projects

In [136]:

```
# now firstly we will try to add the price and the quantity of the items required from
 the resource dataframe

price_quantity_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'
}).reset_index()

price_quantity_data.head(2)
```

Out[136]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

now we need to join the above dataframe with our train,test,cv data that we already have

In [137]:

```
X_train = pd.merge(X_train, price_quantity_data, on='id', how='left')
X_test = pd.merge(X_test, price_quantity_data, on='id', how='left')
X_cv = pd.merge(X_cv, price_quantity_data, on='id', how='left')
```

we will be performing the normalization of the numerical data here

Normalizing the price data

In [138]:

```
from sklearn.preprocessing import Normalizer

normalizer = 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))

price_train = normalizer.transform(X_train['price'].values.reshape(-1,1))
price_cv = normalizer.transform(X_cv['price'].values.reshape(-1,1))
price_test = normalizer.transform(X_test['price'].values.reshape(-1,1))

print("After vectorizations")
print(price_train.shape, y_train.shape)
print(price_cv.shape, y_cv.shape)
print(price_test.shape, y_test.shape)
```

```
After vectorizations
(49041, 1) (49041,)
(24155, 1) (24155,)
(36052, 1) (36052,)
```

In [139]:

```
from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()

scaler.fit(X_train['price'].values.reshape(-1,1))

price_train = scaler.transform(X_train['price'].values.reshape(-1,1))
price_cv = scaler.transform(X_cv['price'].values.reshape(-1,1))
price_test = scaler.transform(X_test['price'].values.reshape(-1,1))

print("After vectorizations")
print(price_train.shape, y_train.shape)
print(price_cv.shape, y_cv.shape)
print(price_test.shape, y_test.shape)
```

```
After vectorizations
(49041, 1) (49041,)
(24155, 1) (24155,)
(36052, 1) (36052,)
```

Normalizing the quantity data

In [140]:

```
from sklearn.preprocessing import Normalizer

normalizer = Normalizer()

# normalizer.fit(X_train['quantity'].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['quantity'].values.reshape(-1,1))

quantity_train = normalizer.transform(X_train['quantity'].values.reshape(-1,1))
quantity_test = normalizer.transform(X_test['quantity'].values.reshape(-1,1))
quantity_cv = normalizer.transform(X_cv['quantity'].values.reshape(-1,1))

print("After vectorizations")
print(quantity_train.shape, y_train.shape)
print(quantity_test.shape, y_test.shape)
print(quantity_cv.shape, y_cv.shape)
```

```
After vectorizations
(49041, 1) (49041,)
(36052, 1) (36052,)
(24155, 1) (24155,)
```

In [141]:

```
scaler = StandardScaler()

scaler.fit(X_train['quantity'].values.reshape(-1,1))

quantity_train = scaler.transform(X_train['quantity'].values.reshape(-1,1))
quantity_test = scaler.transform(X_test['quantity'].values.reshape(-1,1))
quantity_cv = scaler.transform(X_cv['quantity'].values.reshape(-1,1))

print("After vectorizations")

print(quantity_train.shape, y_train.shape)
print(quantity_test.shape, y_test.shape)
print(quantity_cv.shape, y_cv.shape)
```

```
C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.
py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.
py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.
py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.
py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.


After vectorizations
(49041, 1) (49041,)
(36052, 1) (36052,)
(24155, 1) (24155,)
```

Normalizing the number of previously posted projects by a teacher

In [142]:

```
normalizer = 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.reshape(-1,1))

prev_projects_train = normalizer.transform(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
prev_projects_cv = normalizer.transform(X_cv['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
prev_projects_test = normalizer.transform(X_test['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))

print("After converting into vectors form")
print(prev_projects_train.shape, y_train.shape)
print(prev_projects_cv.shape, y_cv.shape)
print(prev_projects_test.shape, y_test.shape)
```

```
After converting into vectors form
(49041, 1) (49041,)
(24155, 1) (24155,)
(36052, 1) (36052,)
```

In [143]:

```
scaler = StandardScaler()

scaler.fit(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))

prev_projects_train = scaler.transform(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
prev_projects_cv = scaler.transform(X_cv['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
prev_projects_test = scaler.transform(X_test['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))

print("After converting into vectors form")
print(prev_projects_train.shape, y_train.shape)
print(prev_projects_cv.shape, y_cv.shape)
print(prev_projects_test.shape, y_test.shape)
```

```
C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\utils\validation.py:595: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.


After converting into vectors form
(49041, 1) (49041,)
(24155, 1) (24155,)
(36052, 1) (36052,)
```

Applying Logistic regression

Set 1: categorical, numerical features + project_title(BOW) + preprocessed_essay (BOW)

Note that we are using the BOW with bigrams here and min_df value = 10 and max features = 5000 i am mentioning this here specially because trying different values of these will for sure give differeent results and may be better also but will require good computational resources.

Now we need to merge all the numerical vectors(categorical features,text features,numerical features) given above for set-1 which we created using different methods

In [144]:

```
from scipy.sparse import hstack

X_train_merge = hstack((categories_one_hot_train,subcategories_one_hot_train,teacher_prefix_one_hot_train,project_grade_categories_one_hot_train,school_state_categories_one_hot_train,essay_bow_train,project_title_bow_train,price_train,quantity_train,prev_projects_train)).tocsr()
X_test_merge = hstack((categories_one_hot_test,subcategories_one_hot_test,teacher_prefix_one_hot_test,project_grade_categories_one_hot_test,school_state_categories_one_hot_test,essay_bow_test,project_title_bow_test,price_test,quantity_test,prev_projects_test)).tocsr()
X_cv_merge = hstack((categories_one_hot_cv,subcategories_one_hot_cv,teacher_prefix_one_hot_cv,project_grade_categories_one_hot_cv,school_state_categories_one_hot_cv,essay_bow_cv,project_title_bow_cv,price_cv,quantity_cv,prev_projects_cv)).tocsr()
```

In [145]:

```
# this will be our finally created data matrix dimensions

print(X_train_merge.shape, y_train.shape)
print(X_test_merge.shape, y_test.shape)
print(X_cv_merge.shape, y_cv.shape)
```

```
(49041, 16714) (49041,)
(36052, 16714) (36052,)
(24155, 16714) (24155,)
```

Now there are three methods to apply logistic regression

1.) Using LogisticRegression() classifier

2.) Using GridSearchCv()

3.) Using RandomSearch.

Let us use the GridSearchCv for the purpose of Logistic regression

Importing the required modules

In [146]:

```
#code source: http://occam.olin.edu/sites/default/files/DataScienceMaterials/machine_le
arning_lecture_2/Machine%20Learning%20Lecture%202.html

from sklearn.model_selection import learning_curve, GridSearchCV
from sklearn.linear_model import LogisticRegression
```

Giving a set of values of 'C'(1/lamda) to get which works best.

In [147]:

```
#tuned_parameters = [{'C': [10**-4, 10**-2, 10**0, 10**2, 10**4]}]

# using the above values the model was giving the error as - Liblinear failed to conver
ge, increase the number of iterations.

# hence  number of values increased in this set
```

In [148]:

```
#model_lr = GridSearchCV(LogisticRegression(),tuned_parameters,cv=10,scoring = 'roc_au
c')
#model_lr.fit(X_train_merge,y_train)
```

In [149]:

```
# i have increased the values of C because i was getting lot of less iteration warnings
using the less number of values of C
```

In [150]:

```
tuned_parameters = {'C': [10**-4,10**-3.10**-2,10**-1,10**0,10**1,10**2,10**3,10**4]}
```

In [154]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge,y_train)
```

```
C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.

C:\Users\RASHU TYAGI\Anaconda3\lib\site-packages\sklearn\svm\base.py:931:
ConvergenceWarning:

Liblinear failed to converge, increase the number of iterations.
```

Out[154]:

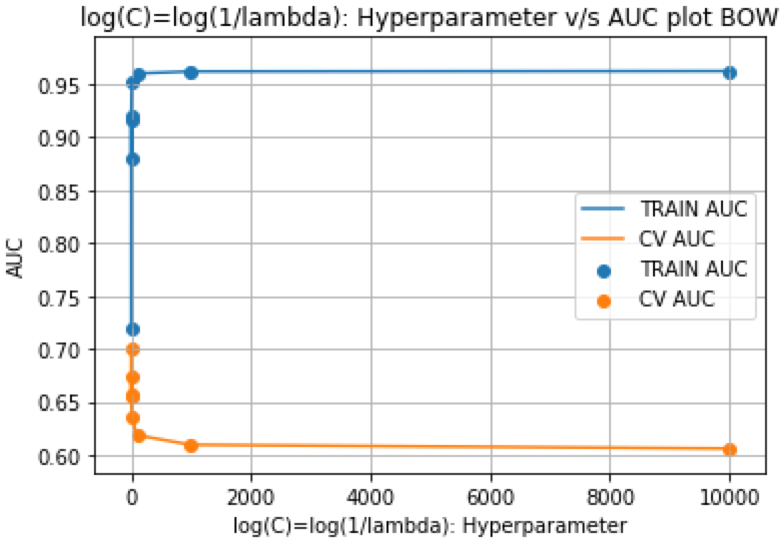
```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.0001, 0.7869401927894549, 0.1, 1, 10, 100, 100
0, 10000]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

In [155]:

```
#https://stackoverflow.com/questions/44947574/what-is-the-meaning-of-mean-test-score-in
-cv-result

train_auc= model_lr.cv_results_['mean_train_score']
cv_auc = model_lr.cv_results_['mean_test_score']
```

In [156]:

```
plt.scatter(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.scatter(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.plot(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.plot(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.legend()
plt.xlabel("log(C)=log(1/lambda): Hyperparameter")
plt.ylabel("AUC")
plt.title("log(C)=log(1/lambda): Hyperparameter v/s AUC plot BOW")
plt.grid()
plt.show()
```



As we can see the major problem we are seeing in our above plot is that the values we took for C are either very close or very very far away hence it is not that easy to infer anything from here so now i will try some other set of values of C

In [157]:

```
tuned_parameters = {'C': [0.0075,0.015,0.03,0.06,0.15,0.3,0.75]}
```

In [158]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge,y_train)
```

Out[158]:

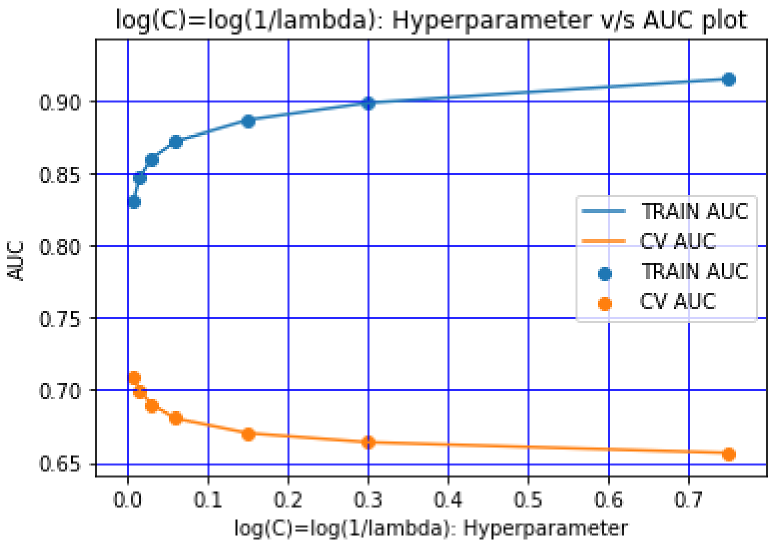
```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.0075, 0.015, 0.03, 0.06, 0.15, 0.3, 0.75]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

In [159]:

```
#https://stackoverflow.com/questions/44947574/what-is-the-meaning-of-mean-test-score-in
-cv-result

train_auc= model_lr.cv_results_['mean_train_score']
cv_auc = model_lr.cv_results_['mean_test_score']
```

In [160]:

```
plt.scatter(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.scatter(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.plot(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.plot(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.legend()
plt.xlabel("log(C)=log(1/lambda): Hyperparameter")
plt.ylabel("AUC")
plt.title("log(C)=log(1/lambda): Hyperparameter v/s AUC plot")
plt.grid(b=True, which='major', color='b', linestyle='-')
plt.show()
```



From above we can say that the best hyperparameter value(C) based on the cv auc is at c = 0.0075

Now our task is to Train the Logistic Regression model based on the best hyperparameter value we received from above i.e. C=0.0075

Training the Logistic Regression model using the best hyperparameter value from above

In [161]:

```
tuned_parameters = {'C': [0.0075]}
```

In [162]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge,y_train)
```

Out[162]:

```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.0075]}, pre_dispatch='2*n_jobs', refit=True,
       return_train_score='warn', scoring='roc_auc', verbose=0)
```

Model training done for the best hyperparameter now drawing the roc curve for the same.

In [163]:

```
from sklearn.metrics import roc_auc_score
import math
```

In [164]:

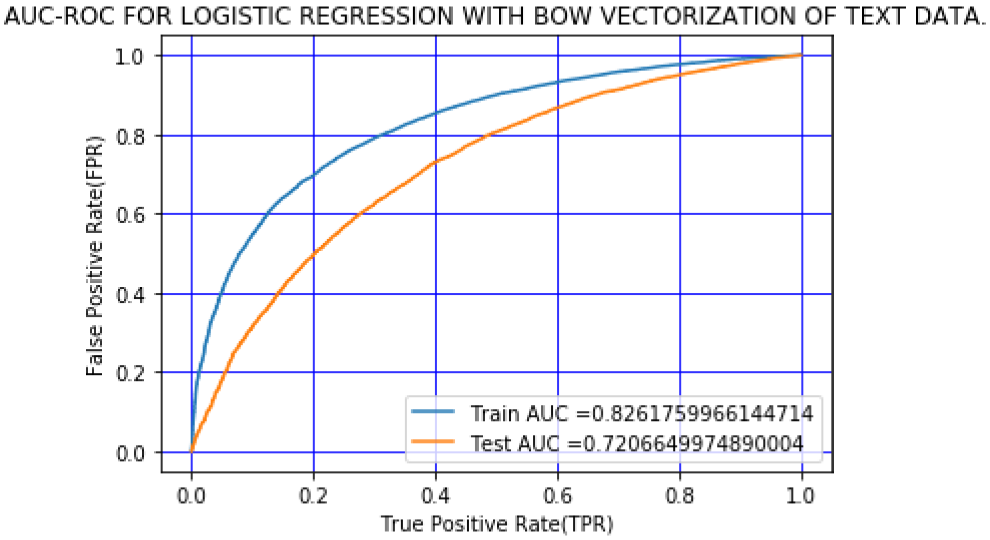
```
y_train_pred =  model_lr.predict_proba(X_train_merge)[:,1]

y_test_pred =  model_lr.predict_proba(X_test_merge)[:,1]
```

In [165]:

```
train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
```

In [166]:

```
plt.plot(train_fpr, train_tpr, label="Train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="Test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.grid(b=True, which='major', color='b', linestyle='-')
plt.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC-ROC FOR LOGISTIC REGRESSION WITH BOW VECTORIZATION OF TEXT DATA.")

plt.show()
```



We received the train accuracy of 0.82 and test accuracy of 0.72 which is not that bad actually.

Confusion matrix for above data

In [167]:

```
# we are writing our own function for predict, with defined thresould
# we will pick a threshold that will give the least fpr
def predict(proba, threshould, fpr, tpr):

    t = threshould[np.argmax(tpr*(1-fpr))]

    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high

    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.rou
nd(t,3))
    predictions = []
    for i in proba:
        if i>=t:
            predictions.append(1)
        else:
            predictions.append(0)
    return predictions
```

Confusion matrix for train and test data for BOW vectorization

In [168]:

```
print("="*100)
from sklearn.metrics import confusion_matrix
print("Train confusion matrix")
print(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_fpr)))
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr)))
```

```
====================================================================================================
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.353
[[ 3713  3713]
 [ 4181 37434]]
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.417
[[ 2617  2842]
 [ 5563 25030]]
```

Visually plotting the confusion matrix for training data

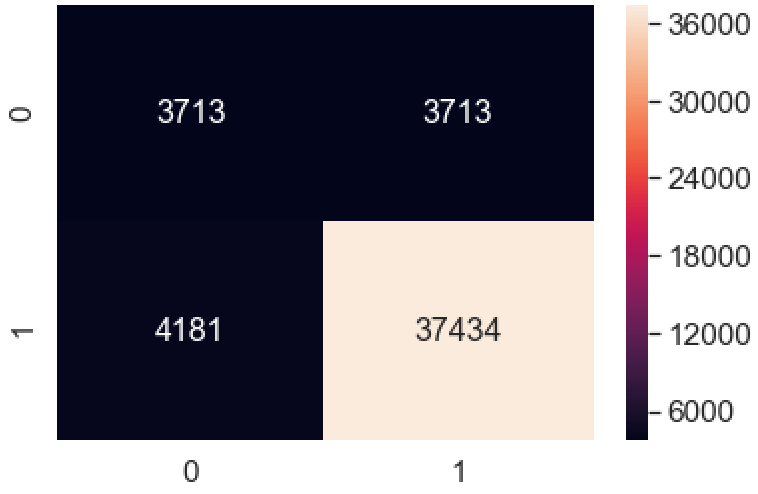
In [169]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt


df_cm = pd.DataFrame(confusion_matrix(y_train,predict(y_train_pred, tr_thresholds, train_fpr, train_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.353
```

Out[169]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a69dc55320>
```



Visually plotting the confusion matrix for test data

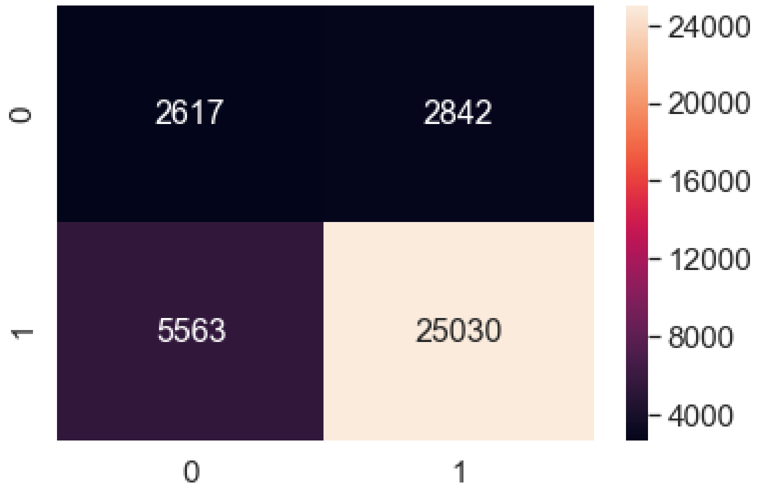
In [170]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt

df_cm_test = pd.DataFrame(confusion_matrix(y_test,predict(y_test_pred, tr_thresholds, t
est_fpr, test_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm_test, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.417
```

Out[170]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a69ef3df98>
```



Set 2 : categorical, numerical features + project_title(TFIDF) + preprocessed_essay (TFIDF)

Note that we are using the tfidf with bigrams here and min_df value = 10 and max features = 5000 i am mentioning this here specially because trying different values of these will for sure give differeent results and may be better also but will require good computational resources.

Now we need to merge all the numerical vectors(categorical features,text features,numerical features) given above for set-2 which we created using different methods

In [186]:

```
from scipy.sparse import hstack

X_train_merge_set_2 = hstack((categories_one_hot_train,subcategories_one_hot_train,teac
her_prefix_one_hot_train,project_grade_categories_one_hot_train,school_state_categories
_one_hot_train,text_tfidf_train,project_title_tfidf_train,price_train,quantity_train,pr
ev_projects_train)).tocsr()
X_test_merge_set_2 = hstack((categories_one_hot_test,subcategories_one_hot_test,teacher
_prefix_one_hot_test,project_grade_categories_one_hot_test,school_state_categories_one_
hot_test,text_tfidf_test,project_title_tfidf_test,price_test,quantity_test,prev_project
s_test)).tocsr()
X_cv_merge_set_2 = hstack((categories_one_hot_cv,subcategories_one_hot_cv,teacher_prefi
x_one_hot_cv,project_grade_categories_one_hot_cv,school_state_categories_one_hot_cv,tex
t_tfidf_cv,title_tfidf_cv,price_cv,quantity_cv,prev_projects_cv)).tocsr()
```

In [187]:

```
# this will be our finally created data matrix dimensions

print(X_train_merge_set_2.shape, y_train.shape)
print(X_test_merge_set_2.shape, y_test.shape)
print(X_cv_merge_set_2.shape, y_cv.shape)
```

```
(49041, 8102) (49041,)
(36052, 8102) (36052,)
(24155, 8102) (24155,)
```

Giving a set of values of 'C'(1/lamda) to get which works best.

In [188]:

```
tuned_parameters = {'C': [0.0075,0.015,0.03,0.06,0.15,0.3,0.75]}
```

In [189]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_2,y_train)
```

Out[189]:

```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.0075, 0.015, 0.03, 0.06, 0.15, 0.3, 0.75]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

In [190]:

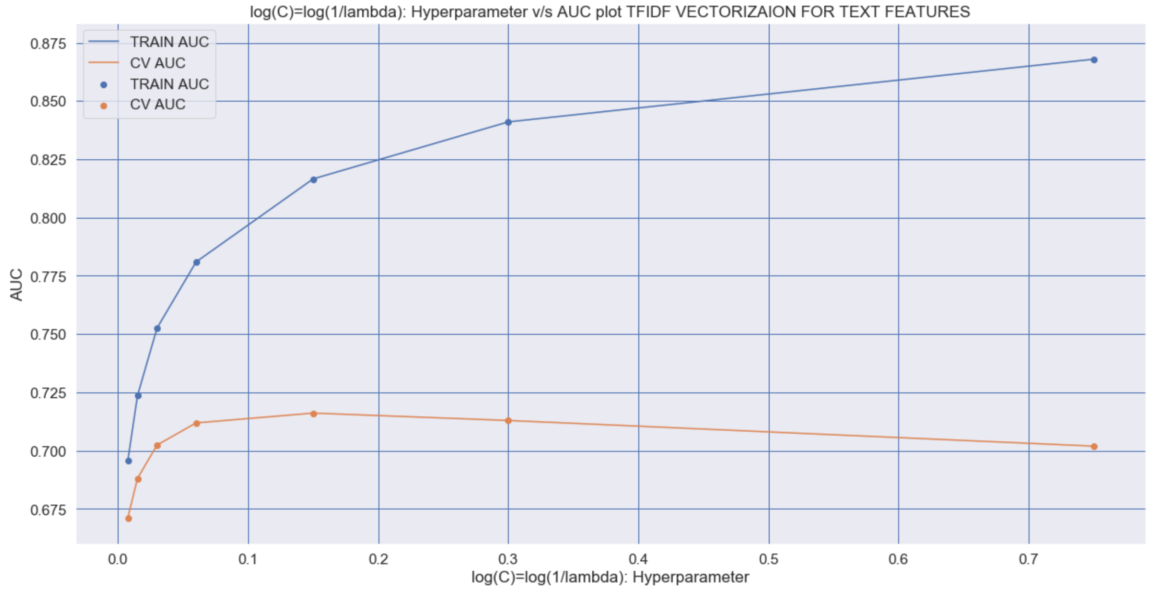
```
#https://stackoverflow.com/questions/44947574/what-is-the-meaning-of-mean-test-score-in-cv-result

train_auc= model_lr.cv_results_['mean_train_score']
cv_auc = model_lr.cv_results_['mean_test_score']
```

In [ ]:

```

```

In [191]:

```
plt.figure(figsize=(20,10))
plt.scatter(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.scatter(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.plot(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.plot(tuned_parameters['C'],cv_auc,label = 'CV AUC')

plt.grid(b=True, which='major', color='b', linestyle='-')
plt.legend()
plt.xlabel("log(C)=log(1/lambda): Hyperparameter")
plt.ylabel("AUC")
plt.title("log(C)=log(1/lambda): Hyperparameter v/s AUC plot TFIDF VECTORIZAION FOR TEXT FEATURES")
plt.show()
```



From above we can say that the best hyperparameter value(C) based on the cv auc is at c = 0.15

Now our task is to Train the Logistic Regression model based on the best hyperparameter value we received from above i.e. C=0.15

Training the Logistic Regression model using the best hyperparameter value from above

In [192]:

```
tuned_parameters = {'C': [0.15]}
```

In [193]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_2,y_train)
```

Out[193]:

```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None, param_grid={'C': [0.15]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

Model training done for the best hyperparameter now drawing the roc curve for the same.

In [194]:

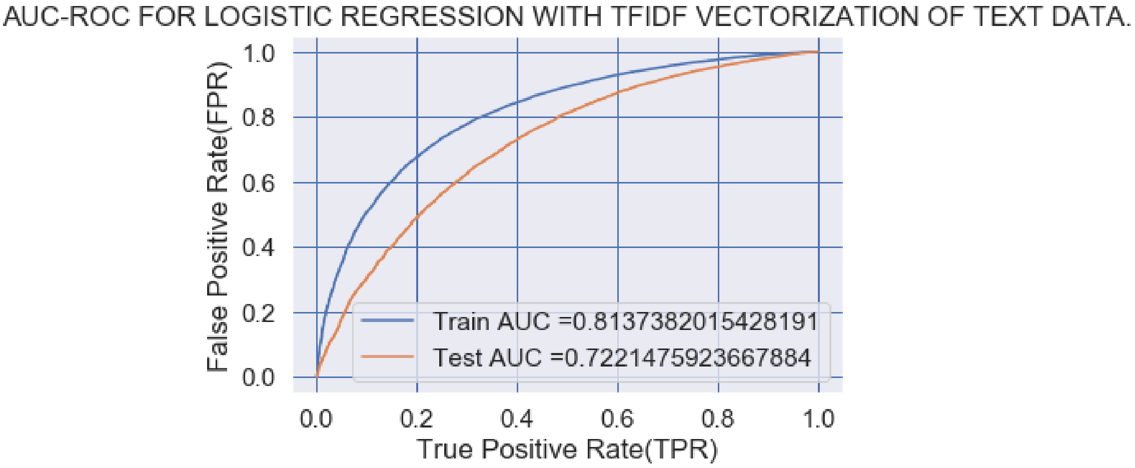
```
y_train_pred =  model_lr.predict_proba(X_train_merge_set_2)[:,1]

y_test_pred =  model_lr.predict_proba(X_test_merge_set_2)[:,1]
```

In [195]:

```
train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
```

In [196]:

```
plt.plot(train_fpr, train_tpr, label="Train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="Test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.grid(b=True, which='major', color='b', linestyle='-')
plt.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC-ROC FOR LOGISTIC REGRESSION WITH TFIDF VECTORIZATION OF TEXT DATA.")

plt.show()
```



We received the train accuracy of 0.81 and test accuracy of 0.72 which is not that bad actually.

Confusion matrix for above data

Confusion matrix for train and test data for TFIDF vectorization

In [197]:

```
print("="*100)
from sklearn.metrics import confusion_matrix
print("Train confusion matrix")
print(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_f
pr)))
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr
)))
```

```
==========================================================================
==========================
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.39
[[ 3713  3713]
 [ 4476 37139]]
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.439
[[ 2716  2743]
 [ 5748 24845]]
```

Visually plotting the confusion matrix for training data

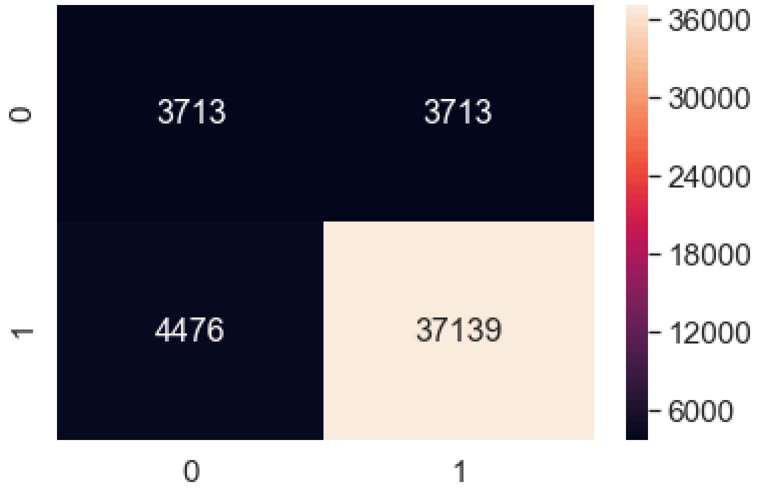
In [198]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt


df_cm = pd.DataFrame(confusion_matrix(y_train,predict(y_train_pred, tr_thresholds, trai
n_fpr, train_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.39
```

Out[198]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a68d4b46d8>
```



Visually plotting the confusion matrix for testdata

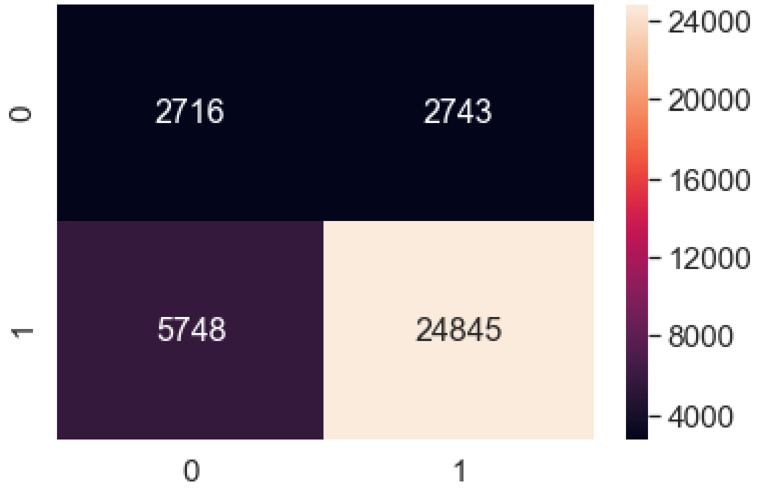
In [199]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt

df_cm_test = pd.DataFrame(confusion_matrix(y_test,predict(y_test_pred, tr_thresholds, t
est_fpr, test_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm_test, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.439
```

Out[199]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a6c1a2ecc0>
```



Set 3 : categorical, numerical features + project_title(AVG W2V) + preprocessed_essay (AVG W2V)

Now we need to merge all the numerical vectors(categorical features,text features,numerical features) given above for set-3 which we created using different methods

In [200]:

```
from scipy.sparse import hstack

X_train_merge_set_3 = hstack((categories_one_hot_train,subcategories_one_hot_train,teac
her_prefix_one_hot_train,project_grade_categories_one_hot_train,school_state_categories
_one_hot_train,avg_w2v_vectors_train,avg_w2v_vectors_project_title_train,price_train,qu
antity_train,prev_projects_train)).tocsr()
X_test_merge_set_3 = hstack((categories_one_hot_test,subcategories_one_hot_test,teacher
_prefix_one_hot_test,project_grade_categories_one_hot_test,school_state_categories_one_
hot_test,avg_w2v_vectors_test,avg_w2v_vectors_project_title_test,price_test,quantity_te
st,prev_projects_test)).tocsr()
X_cv_merge_set_3 = hstack((categories_one_hot_cv,subcategories_one_hot_cv,teacher_prefi
x_one_hot_cv,project_grade_categories_one_hot_cv,school_state_categories_one_hot_cv,avg
_w2v_vectors_cv,avg_w2v_vectors_project_title_cv,price_cv,quantity_cv,prev_projects_cv
)).tocsr()
```

In [201]:

```
# this will be our finally created data matrix dimensions

print(X_train_merge_set_3.shape, y_train.shape)
print(X_test_merge_set_3.shape, y_test.shape)
print(X_cv_merge_set_3.shape, y_cv.shape)
```

```
(49041, 702) (49041,)
(36052, 702) (36052,)
(24155, 702) (24155,)
```

Giving a set of values of 'C'(1/lamda) to get which works best.

In [203]:

```
tuned_parameters = {'C': [0.0075,0.015,0.03,0.06,0.15,0.3,0.75]}
```

In [204]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_3,y_train)
```

Out[204]:

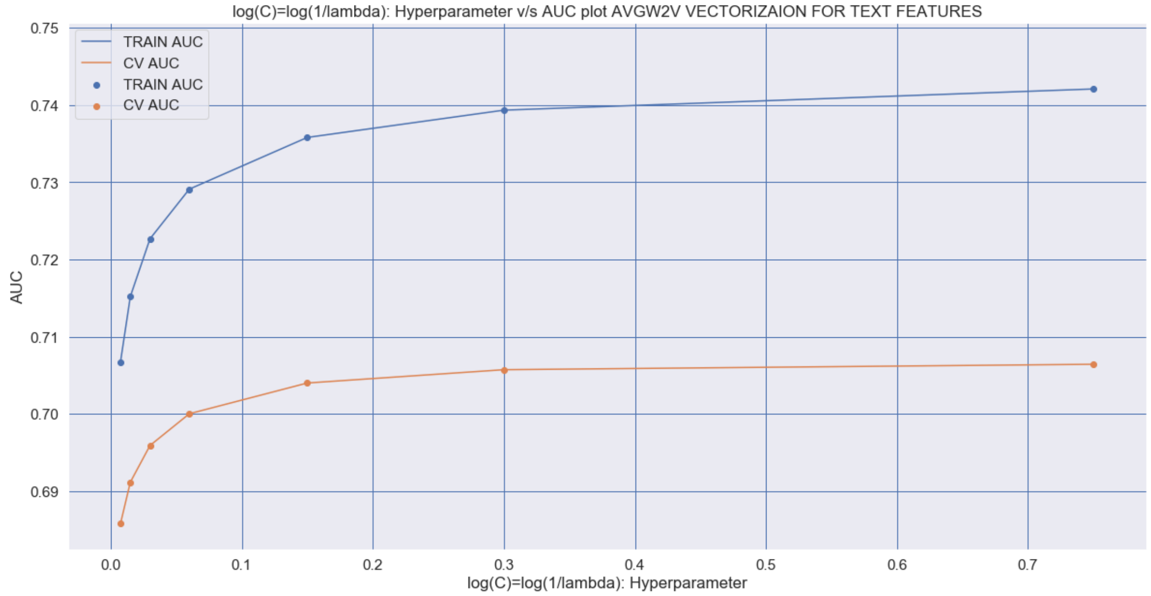
```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.0075, 0.015, 0.03, 0.06, 0.15, 0.3, 0.75]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

In [206]:

```
#https://stackoverflow.com/questions/44947574/what-is-the-meaning-of-mean-test-score-in-cv-result

train_auc= model_lr.cv_results_['mean_train_score']
cv_auc = model_lr.cv_results_['mean_test_score']
```

In [207]:

```
plt.figure(figsize=(20,10))
plt.scatter(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.scatter(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.plot(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.plot(tuned_parameters['C'],cv_auc,label = 'CV AUC')

plt.grid(b=True, which='major', color='b', linestyle='-')
plt.legend()
plt.xlabel("log(C)=log(1/lambda): Hyperparameter")
plt.ylabel("AUC")
plt.title("log(C)=log(1/lambda): Hyperparameter v/s AUC plot AVGW2V VECTORIZAION FOR TEXT FEATURES")
plt.show()
```



In [288]:

```
# we can also do like this using model_lr.best_estimator_ but lets try by making graphs only


#print(model_lr.best_estimator_)
```

```
LogisticRegression(C=0.75, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='warn',
          tol=0.0001, verbose=0, warm_start=False)
```

From above we can say that the best hyperparameter value(C) based on the cv auc is at c = 0.75

Now our task is to Train the Logistic Regression model based on the best hyperparameter value we received from above i.e. C=0.3

Training the Logistic Regression model using the best hyperparameter value from above

In [222]:

```
tuned_parameters = {'C': [0.3]}
```

In [223]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_3,y_train)
```

Out[223]:

```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None, param_grid={'C': [0.3]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

Model training done for the best hyperparameter now drawing the roc curve for the same.

In [210]:

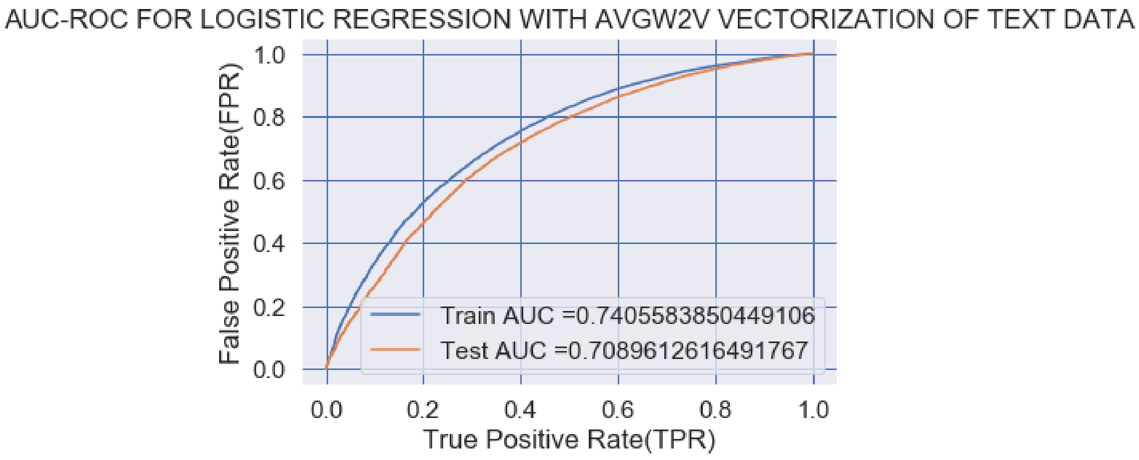
```
y_train_pred =  model_lr.predict_proba(X_train_merge_set_3)[:,1]

y_test_pred =  model_lr.predict_proba(X_test_merge_set_3)[:,1]
```

In [211]:

```
train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
```

In [212]:

```
plt.plot(train_fpr, train_tpr, label="Train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="Test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.grid(b=True, which='major', color='b', linestyle='-')
plt.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC-ROC FOR LOGISTIC REGRESSION WITH AVGW2V VECTORIZATION OF TEXT DATA")

plt.show()
```



We received the train accuracy of 0.74 and test accuracy of 0.71 which is not that bad actually.

Confusion matrix for above data

Confusion matrix for train and test data for AVGW2V vectorization

In [213]:

```
print("="*100)
from sklearn.metrics import confusion_matrix
print("Train confusion matrix")
print(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_f
pr)))
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr
)))
```

```
==========================================================================
==========================
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.399
[[ 3713  3713]
 [ 7085 34530]]
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.474
[[ 3307  2152]
 [ 8789 21804]]
```

Visually plotting the confusion matrix for training data

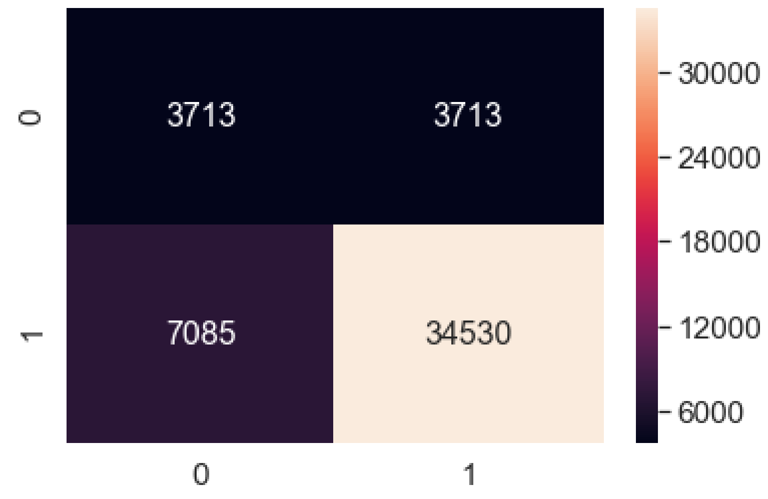
In [214]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt


df_cm = pd.DataFrame(confusion_matrix(y_train,predict(y_train_pred, tr_thresholds, trai
n_fpr, train_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.399
```

Out[214]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a6bfae05c0>
```



Visually plotting the confusion matrix for testdata

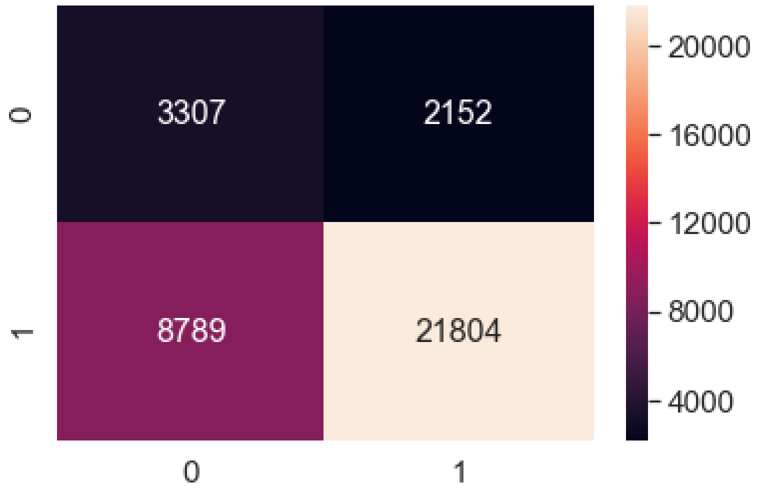
In [215]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt

df_cm_test = pd.DataFrame(confusion_matrix(y_test,predict(y_test_pred, tr_thresholds, t
est_fpr, test_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm_test, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.474
```

Out[215]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a6bd0f9518>
```



Set 4 : Categorical, Numerical features + Project_title(TFIDF W2V) + Preprocessed_essay (TFIDF W2V)

Now we need to merge all the numerical vectors(categorical features,text features,numerical features) given above for set-3 which we created using different methods

In [216]:

```
from scipy.sparse import hstack

X_train_merge_set_4 = hstack((categories_one_hot_train,subcategories_one_hot_train,teac
her_prefix_one_hot_train,project_grade_categories_one_hot_train,school_state_categories
_one_hot_train,tfidf_w2v_vectors_text_train,tfidf_w2v_vectors_project_title_train,price
_train,quantity_train,prev_projects_train)).tocsr()
X_test_merge_set_4 = hstack((categories_one_hot_test,subcategories_one_hot_test,teacher
_prefix_one_hot_test,project_grade_categories_one_hot_test,school_state_categories_one_
hot_test,tfidf_w2v_vectors_text_test,tfidf_w2v_vectors_project_title_test,price_test,qu
antity_test,prev_projects_test)).tocsr()
X_cv_merge_set_4 = hstack((categories_one_hot_cv,subcategories_one_hot_cv,teacher_prefi
x_one_hot_cv,project_grade_categories_one_hot_cv,school_state_categories_one_hot_cv,tfi
df_w2v_vectors_text_cv,tfidf_w2v_vectors_project_title_cv,price_cv,quantity_cv,prev_pro
jects_cv)).tocsr()
```

In [217]:

```
# this will be our finally created data matrix dimensions

print(X_train_merge_set_4.shape, y_train.shape)
print(X_test_merge_set_4.shape, y_test.shape)
print(X_cv_merge_set_4.shape,y_cv.shape)
```

```
(49041, 702) (49041,)
(36052, 702) (36052,)
(24155, 702) (24155,)
```

Giving a set of values of 'C'(1/lamda) to get which works best.

In [218]:

```
tuned_parameters = {'C': [0.0075,0.015,0.03,0.06,0.15,0.3,0.75]}
```

In [219]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_4,y_train)
```

Out[219]:

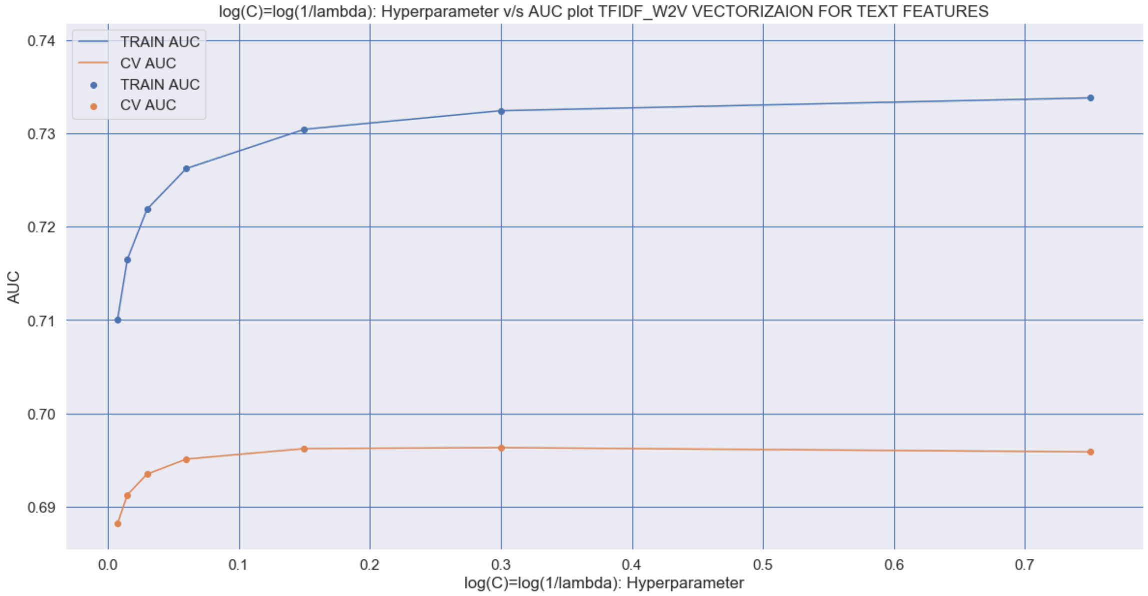
```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.0075, 0.015, 0.03, 0.06, 0.15, 0.3, 0.75]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

In [220]:

```
#https://stackoverflow.com/questions/44947574/what-is-the-meaning-of-mean-test-score-in
-cv-result

train_auc= model_lr.cv_results_['mean_train_score']
cv_auc = model_lr.cv_results_['mean_test_score']
```

In [221]:

```
plt.figure(figsize=(20,10))
plt.scatter(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.scatter(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.plot(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.plot(tuned_parameters['C'],cv_auc,label = 'CV AUC')

plt.grid(b=True, which='major', color='b', linestyle='-')
plt.legend()
plt.xlabel("log(C)=log(1/lambda): Hyperparameter")
plt.ylabel("AUC")
plt.title("log(C)=log(1/lambda): Hyperparameter v/s AUC plot TFIDF_W2V VECTORIZAION FOR
TEXT FEATURES")
plt.show()
```



From above we can say that the best hyperparameter value(C) based on the cv auc is at c = 0.3

Now our task is to Train the Logistic Regression model based on the best hyperparameter value we received from above i.e. C=0.3

Training the Logistic Regression model using the best hyperparameter value from above

In [224]:

```
tuned_parameters = {'C': [0.3]}
```

In [225]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_4,y_train)
```

Out[225]:

```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None, param_grid={'C': [0.3]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

Model training done for the best hyperparameter now drawing the roc curve for the same.

In [226]:

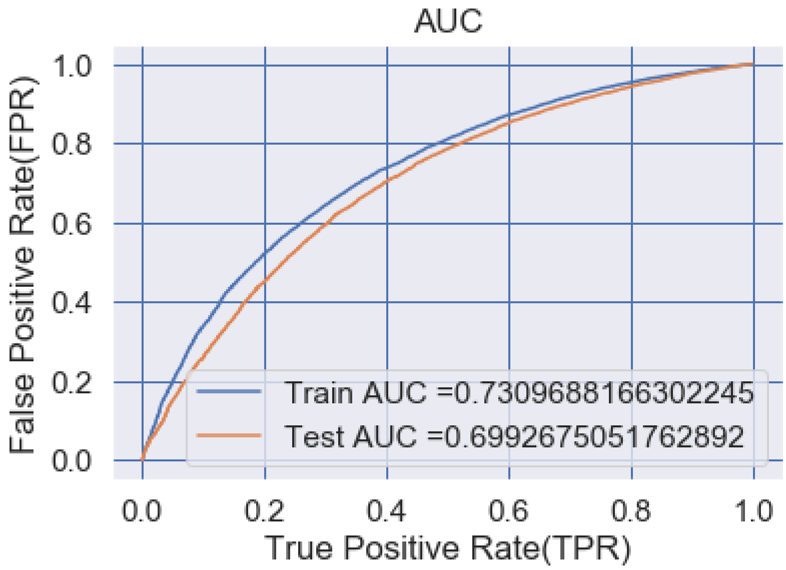
```
y_train_pred =  model_lr.predict_proba(X_train_merge_set_4)[:,1]

y_test_pred =  model_lr.predict_proba(X_test_merge_set_4)[:,1]
```

In [227]:

```
train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
```

In [228]:

```
plt.plot(train_fpr, train_tpr, label="Train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="Test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.grid(b=True, which='major', color='b', linestyle='-')
plt.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC")

plt.show()
```



We received the train accuracy of 0.73 and test accuracy of 0.70 which is not that bad actually.

Confusion matrix for above data

Confusion matrix for train and test data for TFIDF-W2V vectorization

In [229]:

```
print("="*100)
from sklearn.metrics import confusion_matrix
print("Train confusion matrix")
print(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_f
pr)))
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr
)))
```

```
==========================================================================
==========================
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.41
[[ 3713  3713]
 [ 7939 33676]]
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.468
[[ 3222  2237]
 [ 8819 21774]]
```

Visually plotting the confusion matrix for training data

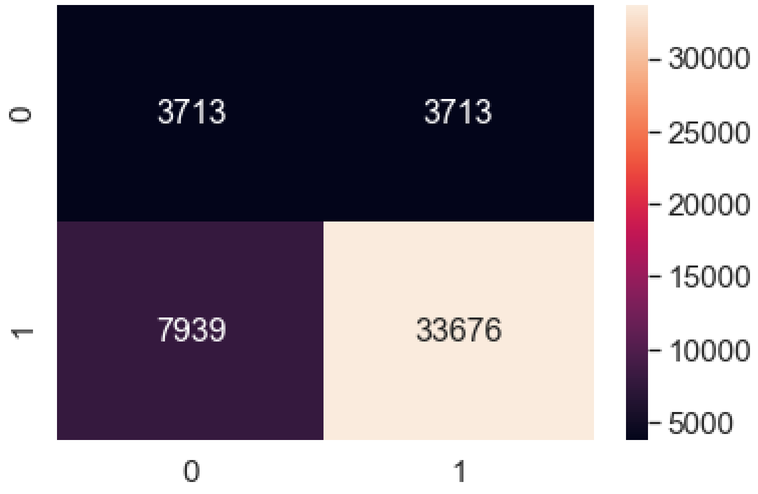
In [230]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt


df_cm = pd.DataFrame(confusion_matrix(y_train,predict(y_train_pred, tr_thresholds, trai
n_fpr, train_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.41
```

Out[230]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a68d54f518>
```



Visually plotting the confusion matrix for testdata

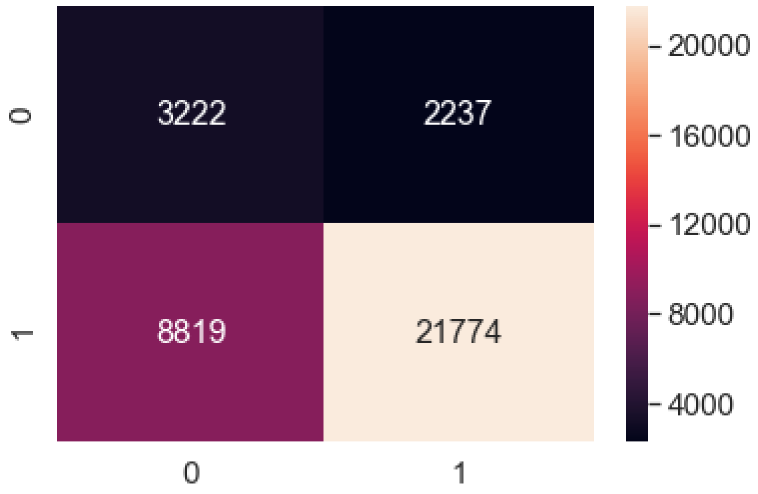
In [231]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt

df_cm_test = pd.DataFrame(confusion_matrix(y_test,predict(y_test_pred, tr_thresholds, t
est_fpr, test_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm_test, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.468
```

Out[231]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a69c751ac8>
```



Logistic Regression with added Features `Set 5`

- **[Task-2] Apply Logistic Regression on the below feature set Set 5 by finding the best hyper parameter as suggested in step 2 and step 3.**
- Consider these set of features Set 5 :

  - **school_state** : categorical data
  - **clean_categories** : categorical data
  - **clean_subcategories** : categorical data
  - **project_grade_category** :categorical data
  - **teacher_prefix** : categorical data
  - **quantity** : numerical data
  - **teacher_number_of_previously_posted_projects** : numerical data
  - **price** : numerical data
  - **sentiment score's of each of the essay** : numerical data
  - **number of words in the title** : numerical data
  - **number of words in the combine essays** : numerical data
    </ul> And apply the Logistic regression on these features by finding the best hyper paramter as suggested in step 2 and step 3
    </li>

We have not calculated the three things from the above mentioned list rest all we have those three things are basically 1.) sentiment score's of each of the essay 2.) number of words in the title 3.) number of words in the combine essays

So let's calculate them first

Project Title Word Count

training data

In [232]:

```
project_title_word_count_train = []
for i in range(0,len(preprocessed_project_titles_Train),1):
    project_title_word_count_train.append(len((preprocessed_project_titles_Train[i]).sp
lit()))
```

In [233]:

```
len(project_title_word_count_train)
```

Out[233]:

```
49041
```

In [234]:

```
project_title_word_count_train[49040]
```

Out[234]:

```
6
```

In [235]:

```
import numpy as np
project_title_word_count_train = np.asarray(project_title_word_count_train).reshape(len
(project_title_word_count_train),1)
project_title_word_count_train.shape
```

Out[235]:

```
(49041, 1)
```

Crossvalidation data

In [236]:

```
project_title_word_count_cv = []
for i in range(0,len(preprocessed_project_titles_Cv),1):
    project_title_word_count_cv.append(len((preprocessed_project_titles_Cv[i]).split
()))
```

In [237]:

```
project_title_word_count_cv[490]
```

Out[237]:

```
5
```

In [238]:

```
import numpy as np
project_title_word_count_cv = np.asarray(project_title_word_count_cv).reshape(len(proje
ct_title_word_count_cv),1)
project_title_word_count_cv.shape
```

Out[238]:

```
(24155, 1)
```

Test data

In [239]:

```
project_title_word_count_test = []
for i in range(0,len(preprocessed_project_titles_Test),1):
    project_title_word_count_test.append(len((preprocessed_project_titles_Test[i]).spli
t()))
```

In [240]:

```
project_title_word_count_test[490]
```

Out[240]:

```
2
```

In [241]:

```
import numpy as np
project_title_word_count_test = np.asarray(project_title_word_count_test).reshape(len(p
roject_title_word_count_test),1)
project_title_word_count_test.shape
```

Out[241]:

```
(36052, 1)
```

Project essay word count

training data

In [242]:

```
project_essay_word_count_train = []
for i in range(0,len(preprocessed_essays_Train),1):
    project_essay_word_count_train.append(len((preprocessed_essays_Train[i]).split()))
```

In [243]:

```
project_essay_word_count_train[490]
```

Out[243]:

```
170
```

In [244]:

```
import numpy as np
project_essay_word_count_train = np.asarray(project_essay_word_count_train).reshape(len
(project_essay_word_count_train),1)
project_essay_word_count_train.shape
```

Out[244]:

```
(49041, 1)
```

cross validation data

In [245]:

```
project_essay_word_count_cv = []
for i in range(0,len(preprocessed_essays_Cv),1):
    project_essay_word_count_cv.append(len((preprocessed_essays_Cv[i]).split()))
```

In [246]:

```
 project_essay_word_count_cv[490]
```

Out[246]:

```
145
```

In [247]:

```
import numpy as np
project_essay_word_count_cv = np.asarray(project_essay_word_count_cv).reshape(len(proje
ct_essay_word_count_cv),1)
project_essay_word_count_cv.shape
```

Out[247]:

```
(24155, 1)
```

test data

In [248]:

```
project_essay_word_count_test = []
for i in range(0,len(preprocessed_essays_Test),1):
    project_essay_word_count_test.append(len((preprocessed_essays_Test[i]).split()))
```

In [249]:

```
 project_essay_word_count_test[490]
```

Out[249]:

```
110
```

In [250]:

```
import numpy as np
project_essay_word_count_test = np.asarray(project_essay_word_count_test).reshape(len(p
roject_essay_word_count_test),1)
project_essay_word_count_test.shape
```

Out[250]:

```
(36052, 1)
```

Sentiment score of each essay

In [251]:

```
# sample working of sentiment analyser

import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer

# import nltk
# nltk.download('vader_lexicon')

sid = SentimentIntensityAnalyzer()

for_sentiment = 'a person is a person no matter how small dr seuss i teach the smallest
students with the biggest enthusiasm \
for learning my students learn in many different ways using all of our senses and multi
ple intelligences i use a wide range\
of techniques to help all my students succeed students in my class come from a variety
 of different backgrounds which makes\
for wonderful sharing of experiences and cultures including native americans our school
is a caring community of successful \
learners which can be seen through collaborative student project based learning in and
 out of the classroom kindergarteners \
in my class love to work with hands on materials and have many different opportunities
 to practice a skill before it is\
mastered having the social skills to work cooperatively with friends is a crucial aspec
t of the kindergarten curriculum\
montana is the perfect place to learn about agriculture and nutrition my students love
 to role play in our pretend kitchen\
in the early childhood classroom i have had several kids ask me can we try cooking with
real food i will take their idea \
and create common core cooking lessons where we learn important math and writing concep
ts while cooking delicious healthy \
food for snack time my students will have a grounded appreciation for the work that wen
t into making the food and knowledge \
of where the ingredients came from as well as how it is healthy for their bodies this p
roject would expand our learning of \
nutrition and agricultural cooking recipes by having us peel our own apples to make hom
emade applesauce make our own bread \
and mix up healthy plants from our classroom garden in the spring we will also create o
ur own cookbooks to be printed and \
shared with families students will gain math and literature skills as well as a life lo
ng enjoyment for healthy cooking \
nannan'
ss = sid.polarity_scores(for_sentiment)

for k in ss:
    print('{0}: {1}, '.format(k, ss[k]), end='')

# we can use these 4 things as features/attributes (neg, neu, pos, compound)
# neg: 0.0, neu: 0.753, pos: 0.247, compound: 0.93
```

```
neg: 0.01, neu: 0.745, pos: 0.245, compound: 0.9975,
```

In [252]:

```
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer
```

In [253]:

```
nltk.download('vader_lexicon')
```

```
[nltk_data] Downloading package vader_lexicon to C:\Users\RASHU
[nltk_data]     TYAGI\AppData\Roaming\nltk_data...
[nltk_data]   Package vader_lexicon is already up-to-date!
```

Out[253]:

```
True
```

In [254]:

```
len(preprocessed_essays_Train)
```

Out[254]:

```
49041
```

Training data

In [255]:

```
sid = SentimentIntensityAnalyzer()
```

In [256]:

```
positive_train = []
negative_train = []
neutral_train = []
compound_train = []
for i in tqdm(preprocessed_essays_Train):
    positive_train.append(sid.polarity_scores(i)['pos'])
    negative_train.append(sid.polarity_scores(i)['neg'])
    neutral_train.append(sid.polarity_scores(i)['neu'])
    compound_train.append(sid.polarity_scores(i)['compound'])
```

```
100%|█████████████████████████████████████████████████████████████████████
██████| 49041/49041 [04:23<00:00, 186.01it/s]
```

In [257]:

```
sid = SentimentIntensityAnalyzer()
```

In [258]:

```
positive_cv = []
negative_cv = []
neutral_cv = []
compound_cv = []
for i in tqdm(preprocessed_essays_Cv):
    positive_cv.append(sid.polarity_scores(i)['pos'])
    negative_cv.append(sid.polarity_scores(i)['neg'])
    neutral_cv.append(sid.polarity_scores(i)['neu'])
    compound_cv.append(sid.polarity_scores(i)['compound'])
```

```
100%|██████████████████████████████████████████████████████████████████████
██████| 24155/24155 [02:10<00:00, 185.56it/s]
```

Test data

In [259]:

```
sid = SentimentIntensityAnalyzer()
```

In [260]:

```
positive_test = []
negative_test = []
neutral_test = []
compound_test = []
for i in tqdm(preprocessed_essays_Test):
    positive_test.append(sid.polarity_scores(i)['pos'])
    negative_test.append(sid.polarity_scores(i)['neg'])
    neutral_test.append(sid.polarity_scores(i)['neu'])
    compound_test.append(sid.polarity_scores(i)['compound'])
```

```
100%|██████████████████████████████████████████████████████████████████████
██████| 36052/36052 [03:13<00:00, 186.03it/s]
```

In [ ]:

In [261]:

```
import numpy as np
neutral_train = np.asarray(neutral_train).reshape(len(preprocessed_essays_Train),1)
positive_train = np.asarray(positive_train).reshape(len(preprocessed_essays_Train),1)
negative_train = np.asarray(negative_train).reshape(len(preprocessed_essays_Train),1)
compound_train = np.asarray(compound_train).reshape(len(preprocessed_essays_Train),1)

print(neutral_train.shape)
print(positive_train.shape)
print(negative_train.shape)
print(compound_train.shape)
```

```
(49041, 1)
(49041, 1)
(49041, 1)
(49041, 1)
```

In [262]:

```
import numpy as np
neutral_cv = np.asarray(neutral_cv).reshape(len(preprocessed_essays_Cv),1)
positive_cv = np.asarray(positive_cv).reshape(len(preprocessed_essays_Cv),1)
negative_cv = np.asarray(negative_cv).reshape(len(preprocessed_essays_Cv),1)
compound_cv = np.asarray(compound_cv).reshape(len(preprocessed_essays_Cv),1)

print(neutral_cv.shape)
print(positive_cv.shape)
print(negative_cv.shape)
print(compound_cv.shape)
```

```
(24155, 1)
(24155, 1)
(24155, 1)
(24155, 1)
```

In [263]:

```
import numpy as np
neutral_test = np.asarray(neutral_test).reshape(len(preprocessed_essays_Test),1)
positive_test = np.asarray(positive_test).reshape(len(preprocessed_essays_Test),1)
negative_test = np.asarray(negative_test).reshape(len(preprocessed_essays_Test),1)
compound_test = np.asarray(compound_test).reshape(len(preprocessed_essays_Test),1)

print(neutral_test.shape)
print(positive_test.shape)
print(negative_test.shape)
print(compound_test.shape)
```

```
(36052, 1)
(36052, 1)
(36052, 1)
(36052, 1)
```

In [264]:

```
type(project_title_word_count_train)
```

Out[264]:

```
numpy.ndarray
```

Now merging all those features which are required for set-5

In [265]:

```
from scipy.sparse import hstack

X_train_merge_set_5 = hstack((categories_one_hot_train,subcategories_one_hot_train,teac
her_prefix_one_hot_train,project_grade_categories_one_hot_train,school_state_categories
_one_hot_train,price_train,quantity_train,prev_projects_train,project_title_word_count_
train,project_essay_word_count_train,positive_train,negative_train,neutral_train,compou
nd_train)).tocsr()
X_test_merge_set_5 = hstack((categories_one_hot_test,subcategories_one_hot_test,teacher
_prefix_one_hot_test,project_grade_categories_one_hot_test,school_state_categories_one_
hot_test,price_test,quantity_test,prev_projects_test,project_title_word_count_test,proj
ect_essay_word_count_test,positive_test,negative_test,neutral_test,compound_test)).tocs
r()
X_cv_merge_set_5 = hstack((categories_one_hot_cv,subcategories_one_hot_cv,teacher_prefi
x_one_hot_cv,project_grade_categories_one_hot_cv,school_state_categories_one_hot_cv,pri
ce_cv,quantity_cv,prev_projects_cv,project_title_word_count_cv,project_essay_word_count
_cv,positive_cv,negative_cv,neutral_cv,compound_cv)).tocsr()
```

In [266]:

```
# this will be our finally created data matrix dimensions

print(X_train_merge_set_5.shape, y_train.shape)
print(X_test_merge_set_5.shape, y_test.shape)
print(X_cv_merge_set_5.shape,y_cv.shape)
```

```
(49041, 108) (49041,)
(36052, 108) (36052,)
(24155, 108) (24155,)
```

Giving a set of values of 'C'(1/lamda) to get which works best.

In [267]:

```
tuned_parameters = {'C': [0.0075,0.015,0.03,0.06,0.15,0.3,0.75]}
```

In [268]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_5,y_train)
```

Out[268]:

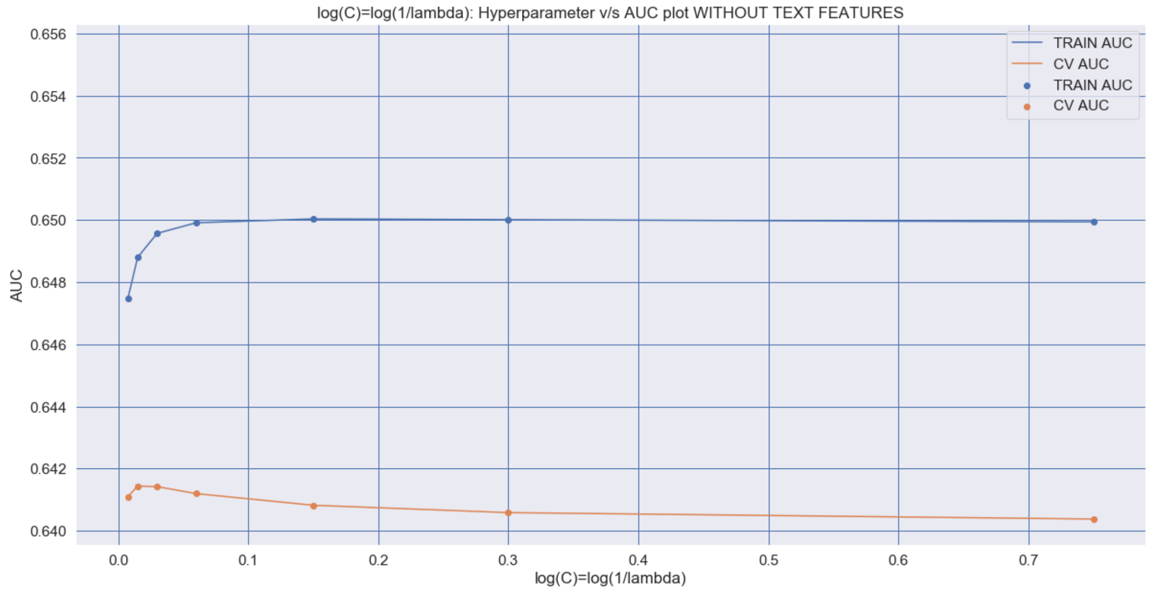
```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None,
       param_grid={'C': [0.0075, 0.015, 0.03, 0.06, 0.15, 0.3, 0.75]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

In [269]:

```
#https://stackoverflow.com/questions/44947574/what-is-the-meaning-of-mean-test-score-in
-cv-result

train_auc= model_lr.cv_results_['mean_train_score']
cv_auc = model_lr.cv_results_['mean_test_score']
```

In [270]:

```
plt.figure(figsize=(20,10))
plt.scatter(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.scatter(tuned_parameters['C'],cv_auc,label = 'CV AUC')
plt.plot(tuned_parameters['C'],train_auc,label = 'TRAIN AUC')
plt.plot(tuned_parameters['C'],cv_auc,label = 'CV AUC')

plt.grid(b=True, which='major', color='b', linestyle='-')
plt.legend()
plt.xlabel("log(C)=log(1/lambda)")
plt.ylabel("AUC")
plt.title("log(C)=log(1/lambda): Hyperparameter v/s AUC plot WITHOUT TEXT FEATURES")
plt.show()
```



From above we can say that the best hyperparameter value(C) based on the cv auc is at c = 0.015

Now our task is to Train the Logistic Regression model based on the best hyperparameter value we received from above i.e. C=0.015

Training the Logistic Regression model using the best hyperparameter value from above

In [271]:

```
tuned_parameters = {'C': [0.015]}
```

In [272]:

```
model_lr = GridSearchCV(LogisticRegression(class_weight='balanced'),tuned_parameters,cv
=10,scoring = 'roc_auc')
model_lr.fit(X_train_merge_set_5,y_train)
```

Out[272]:

```
GridSearchCV(cv=10, error_score='raise-deprecating',
       estimator=LogisticRegression(C=1.0, class_weight='balanced', dual=F
alse,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='warn', n_jobs=None, penalty='l2', random_state=Non
e,
          solver='warn', tol=0.0001, verbose=0, warm_start=False),
       fit_params=None, iid='warn', n_jobs=None, param_grid={'C': [0.01
5]},
       pre_dispatch='2*n_jobs', refit=True, return_train_score='warn',
       scoring='roc_auc', verbose=0)
```

Model training done for the best hyperparameter now drawing the roc curve for the same.

In [273]:

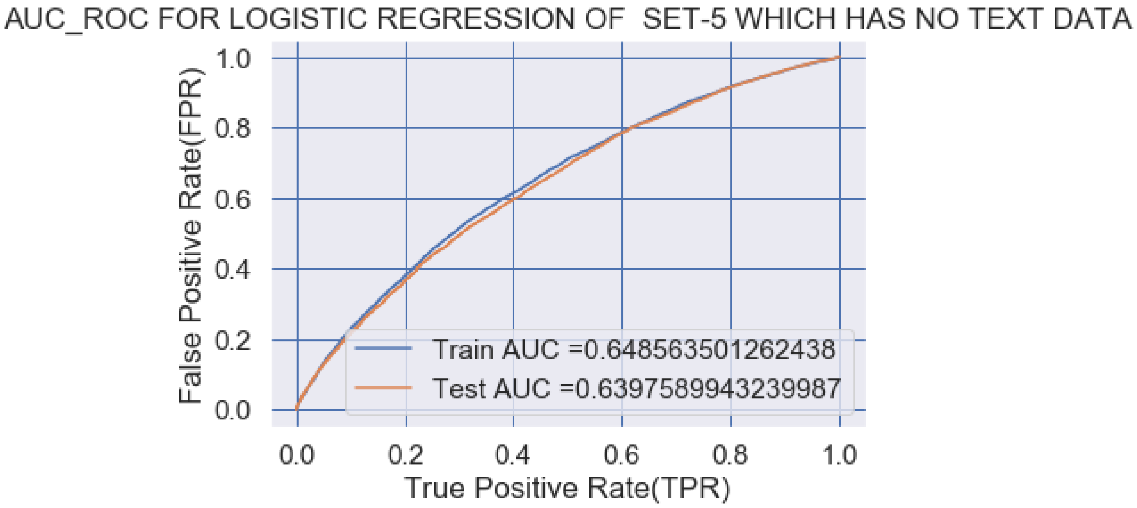
```
y_train_pred =  model_lr.predict_proba(X_train_merge_set_5)[:,1]

y_test_pred =  model_lr.predict_proba(X_test_merge_set_5)[:,1]
```

In [274]:

```
train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
```

In [275]:

```
plt.plot(train_fpr, train_tpr, label="Train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="Test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.grid(b=True, which='major', color='b', linestyle='-')
plt.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC_ROC FOR LOGISTIC REGRESSION OF  SET-5 WHICH HAS NO TEXT DATA")

plt.show()
```



We received the train accuracy of 0.64 and test accuracy of 0.64 which is quite fine

Confusion matrix for above data

Confusion matrix for train and test data for set-5

In [276]:

```
print("="*100)
from sklearn.metrics import confusion_matrix
print("Train confusion matrix")
print(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_f
pr)))
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr
)))
```

```
==========================================================================
==========================
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.47
[[ 3713  3713]
 [12047 29568]]
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.506
[[ 3367  2092]
 [12864 17729]]
```

Visually plotting the confusion matrix for training data

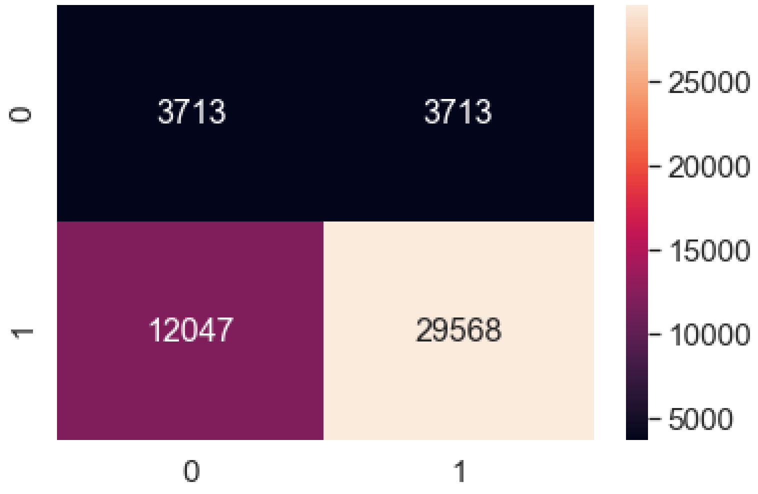
In [277]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt


df_cm = pd.DataFrame(confusion_matrix(y_train,predict(y_train_pred, tr_thresholds, trai
n_fpr, train_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.47
```

Out[277]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a6a2f51cf8>
```



Visually plotting the confusion matrix for testdata

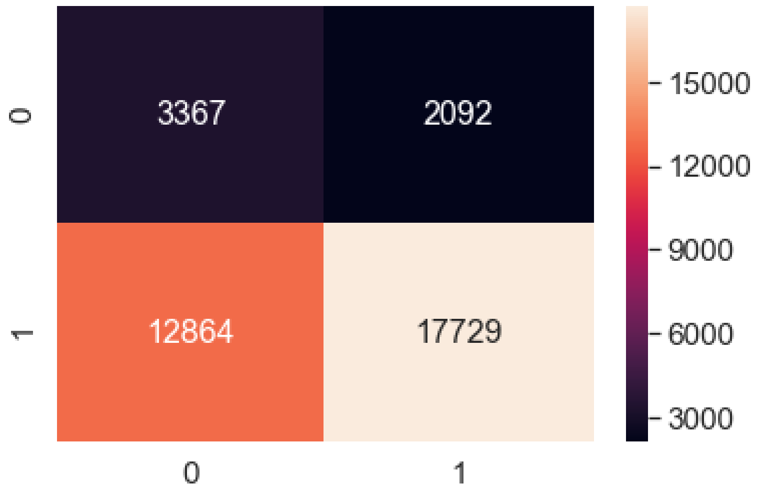
In [278]:

```
# Code for this segment from here -->> https://stackoverflow.com/questions/35572000/how
-can-i-plot-a-confusion-matrix

import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt

df_cm_test = pd.DataFrame(confusion_matrix(y_test,predict(y_test_pred, tr_thresholds, t
est_fpr, test_fpr)), range(2),
                  range(2))
#plt.figure(figsize = (10,7))
sn.set(font_scale=1.4)#for label size
sn.heatmap(df_cm_test, annot=True,annot_kws={"size": 16},fmt='g')# font size
```

```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.506
```

Out[278]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1a68bfc35c0>
```



Final Conclusions

In [279]:

```
# http://zetcode.com/python/prettytable/

from prettytable import PrettyTable

#If you get a ModuleNotFoundError error , install prettytable using: pip3 install prett
ytable

x = PrettyTable()

x.field_names = ["Vectorization Used", "Model Applied", "C also equal to (1/lambda):Hyp
er Parameter", " TEST AUC"]

x.add_row(["BOW", "Logistic Regression", 0.0075, 0.72])
x.add_row(["TFIDF", "Logistic Regression", 0.3, 0.72])
x.add_row(["AVG W2V", "Logistic Regression", 0.75, 0.71])
x.add_row(["TFIDF W2V", "Logistic Regression", 0.75, 0.71])
x.add_row(["WITHOUT TEXT DATA", "Logistic Regression", 0.015, 0.64])
print(x)
```

```
+--------------------+---------------------+-------------------------------
-------------+-----------+
| Vectorization Used |    Model Applied    | C also equal to (1/lambda):Hy
per Parameter |  TEST AUC |
+--------------------+---------------------+-------------------------------
-------------+-----------+
|        BOW         | Logistic Regression |                   0.0075
|    0.72   |
|       TFIDF        | Logistic Regression |                    0.3
|    0.72   |
|      AVG W2V       | Logistic Regression |                    0.75
|    0.71   |
|     TFIDF W2V      | Logistic Regression |                    0.75
|    0.71   |
| WITHOUT TEXT DATA  | Logistic Regression |                   0.015
|    0.64   |
+--------------------+---------------------+-------------------------------
-------------+-----------+
```

SUMMARY

From above analysis we can clearly state that text data matters a lot for the purpose of classifying whether the project sumitted will get the approval or not because we can clearly see that as soon as we dropped all the text data our accuracy was highly dropped hence it directly corresponds to the fact that text data is very important for the purpose of classification while using logistic regression model as well

In [ ]: