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	Descri
`project_id`	A unique identifier for the proposed project. **Example:** `p03`
`project_title`	Title of the project. **Exam** • `Art Will Make You Ha` • `First Grade`
`project_grade_category`	Grade level of students for which the project is targeted. One of the follo enumerated va • `Grades Pr` • `Grades` • `Grades` • `Grades`

Feature	Descri
project_subject_categories	One or more (comma-separated) subject categories for the project fro following enumerated list of va • Applied Lear • Care & Hu • Health & Sp • History & Ci • Literacy & Lang • Math & Sci • Music & The • Special N • Wa **Exam** • Music & The • Literacy & Language, Math & Sci
school_state	State where school is located (Two-letter U.S. postal (https://en.wikipedia.org/wiki/List_of_U.S._state_abbreviations#Postal_co **Exampl**
project_subject_subcategories	One or more (comma-separated) subject subcategories for the pr **Exam** • Lite • Literature & Writing, Social Scie
project_resource_summary	An explanation of the resources needed for the project. **Exan** • My students need hands on literacy materials to mar sensory ne
project_essay_1	First application e
project_essay_2	Second application e
project_essay_3	Third application e
project_essay_4	Fourth application e
project_submitted_datetime	Datetime when project application was submitted. **Example:** 2016-04 12:43:56
teacher_id	A unique identifier for the teacher of the proposed project. **Exar** bdf8baa8fedef6bfeec7ae4ff1c1
teacher_prefix	Teacher's title. One of the following enumerated va • • • • • • Teac
teacher_number_of_previously_posted_projects	Number of project applications previously submitted by the same tea **Exam**

* 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`

Feature	Description
`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 project was not approved, and a value of `1` indicates the project was approved.

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
```

```
IOPub data rate exceeded.
The notebook server will temporarily stop sending output
to the client in order to avoid crashing it.
To change this limit, set the config variable
`--NotebookApp.iopub_data_rate_limit`.
```

1.1 Reading Data

In [2]:

```
project_data = pd.read_csv('train_data.csv')
resource_data = pd.read_csv('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' 's
chool_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]:

```
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[4]:

	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

In [5]:

```
# 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.columns


#sort dataframe based on time pandas python: https://stackoverflow.com/a/49702492/4084039
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[5]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	00:
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	00:

In [6]:

```
project_grade_category = []

for i in range(len(project_data)):
    a = project_data["project_grade_category"][i].replace(" ", "_")
    project_grade_category.append(a)

project_data.drop(['project_grade_category'], axis=1, inplace=True)
project_data["project_grade_category"] = project_grade_category
project_data.head(5)
```

Out[6]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	00:
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	00:
51140	74477	p189804	4a97f3a390bfe21b99cf5e2b81981c73	Mrs.	CA	00:
473	100660	p234804	cbc0e38f522143b86d372f8b43d4cff3	Mrs.	GA	00:
41558	33679	p137682	06f6e62e17de34fcf81020c77549e1d5	Mrs.	WA	01:

1.2 preprocessing of `project_subject_categories`

In [7]:

```
catogories = list(project_data['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/473019

# 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", "
        if 'The' in j.split(): # this will split each of the catogory based on space "Math
            j=j.replace('The','') # if we have the words "The" we are going to replace it w
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math
        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())

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

from collections import Counter
my_counter = Counter()
for word in project_data['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]))
```

1.3 preprocessing of `project_subject_subcategories`

In [8]:

```
sub_catogories = list(project_data['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/473019

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

project_data['clean_subcategories'] = sub_cat_list
project_data.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 project_data['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]))
```

Clean Titles (Text preprocessing)

In [9]:

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

In [10]:

```
# 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 [11]:

```
clean_titles = []

for titles in tqdm(project_data["project_title"]):
    title = decontracted(titles)
    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)
    clean_titles.append(title.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████████████████
| 109248/109248 [00:05<00:00, 20950.70it/s]
```

In [12]:

```
project_data["clean_titles"] = clean_titles
```

In [13]:

```
project_data.drop(['project_title'], axis=1, inplace=True)
```

Feature "Number of Words in Title"

In [14]:

```
title_word_count = []
for a in project_data["clean_titles"] :
    b = len(a.split())
    title_word_count.append(b)

project_data["title_word_count"] = title_word_count
project_data.head(5)
```

Out[14]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	00:
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	00:
51140	74477	p189804	4a97f3a390bfe21b99cf5e2b81981c73	Mrs.	CA	00:
473	100660	p234804	cbc0e38f522143b86d372f8b43d4cff3	Mrs.	GA	00:
41558	33679	p137682	06f6e62e17de34fcf81020c77549e1d5	Mrs.	WA	01:

1.3 Text preprocessing

In [15]:

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

In [16]:

```
project_data.head(2)
```

Out[16]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	
55660						
	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	00:
76127						
	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	00:

Clean Essays (Text preprocessing)

In [17]:

```
clean_essay = []

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

100%|██
██| 109248/109248 [01:55<00:00, 942.75it/s]

In [18]:

```
project_data["clean_essays"] = clean_essay
```

In [19]:

```
project_data.drop(['essay'], axis=1, inplace=True)
```

Number of Words in Essay

In [20]:

```
essay_word_count = []
for ess in project_data["clean_essays"] :
    c = len(ess.split())
    essay_word_count.append(c)

project_data["essay_word_count"] = essay_word_count

project_data.head(5)
```

Out[20]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	00:
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	00:
51140	74477	p189804	4a97f3a390bfe21b99cf5e2b81981c73	Mrs.	CA	00:
473	100660	p234804	cbc0e38f522143b86d372f8b43d4cff3	Mrs.	GA	00:
41558	33679	p137682	06f6e62e17de34fcf81020c77549e1d5	Mrs.	WA	01:

1.9 Calculate Sentiment Scores for the essays

In [21]:

```
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer
analyser = SentimentIntensityAnalyzer()

neg = []
pos = []
neu = []
compound = []

for a in tqdm(project_data["clean_essays"]) :
    b = analyser.polarity_scores(a)['neg']
    c = analyser.polarity_scores(a)['pos']
    d = analyser.polarity_scores(a)['neu']
    e = analyser.polarity_scores(a)['compound']
    neg.append(b)
    pos.append(c)
    neu.append(d)
    compound.append(e)
```

```
100%|██████████████████████████████████████████████████████████████
███| 109248/109248 [26:32<00:00, 68.61it/s]
```

In [22]:

```
project_data["pos"] = pos
```

In [23]:

```
project_data["neg"] = neg
```

In [24]:

```
project_data["neu"] = neu
```

In [25]:

```
project_data["compound"] = compound
```

In [26]:

```
project_data.head(5)
```

Out[26]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	00:
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	00:
51140	74477	p189804	4a97f3a390bfe21b99cf5e2b81981c73	Mrs.	CA	00:
473	100660	p234804	cbc0e38f522143b86d372f8b43d4cff3	Mrs.	GA	00:
41558	33679	p137682	06f6e62e17de34fcf81020c77549e1d5	Mrs.	WA	01:

5 rows × 24 columns

Type *Markdown* and LaTeX: α^2

In [27]:

```
# train test split

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_
X_train, X_cv, y_train, y_cv = train_test_split(X_train, y_train, test_size=0.33, stratify=
```

In [28]:

```
# printing some random reviews
print(project_data['clean_essays'].values[0])
print("="*50)
print(project_data['clean_essays'].values[150])
print("="*50)
print(project_data['clean_essays'].values[1000])
print("="*50)
print(project_data['clean_essays'].values[20000])
print("="*50)
print(project_data['clean_essays'].values[99999])
print("="*50)
```

```
i fortunate enough use fairy tale stem kits classroom well stem journals stu
dents really enjoyed i would love implement lakeshore stem kits classroom ne
xt school year provide excellent engaging stem lessons my students come vari
ety backgrounds including language socioeconomic status many not lot experie
nce science engineering kits give materials provide exciting opportunities s
tudents each month i try several science stem steam projects i would use kit
s robot help guide science instruction engaging meaningful ways i adapt kits
current language arts pacing guide already teach material kits like tall tal
es paul bunyan johnny appleseed the following units taught next school year
i implement kits magnets motion sink vs float robots i often get units not k
now if i teaching right way using right materials the kits give additional i
deas strategies lessons prepare students science it challenging develop high
quality science activities these kits give materials i need provide students
science activities go along curriculum classroom although i things like magn
ets classroom i not know use effectively the kits provide right amount mater
ials show use appropriate way
==================================================
i teach high school english students learning behavioral disabilities my stu
dents vary ability level however ultimate goal increase students literacy le
vels this includes reading writing communication levels i teach really dynam
ic group students however students face lot challenges my students live pove
rty dangerous neighborhood despite challenges i students desire defeat chall
enges my students learning disabilities currently performing grade level my
students visual learners benefit classroom fulfills preferred learning style
the materials i requesting allow students prepared classroom necessary suppl
ies too often i challenged students come school unprepared class due economi
c challenges i want students able focus learning not able get school supplie
s the supplies last year students able complete written assignments maintain
classroom journal the chart paper used make learning visual class create pos
ters aid students learning the students access classroom printer the toner u
sed print student work completed classroom chromebooks i want try remove bar
riers students learning create opportunities learning one biggest barriers s
tudents not resources get pens paper folders my students able increase liter
acy skills project
==================================================
life moves pretty fast if not stop look around awhile could miss movie ferri
s bueller day off think back remember grandparents how amazing would able fl
ip book see day lives my second graders voracious readers they love read fic
tion nonfiction books their favorite characters include pete cat fly guy pig
gie elephant mercy watson they also love read insects space plants my studen
ts hungry bookworms my students eager learn read world around my kids love s
chool like little sponges absorbing everything around their parents work lon
g hours usually not see children my students usually cared grandparents fami
ly friend most students not someone speaks english home thus difficult stude
nts acquire language now think forward would not mean lot kids nieces nephew
s grandchildren able see day life today 30 years memories precious us able s
hare memories future generations rewarding experience as part social studies
```

curriculum students learning changes time students studying photos learn com
munity changed time in particular look photos study land buildings clothing
schools changed time as culminating activity students capture slice history
preserve scrap booking key important events young lives documented date loca
tion names students using photos home school create second grade memories th
eir scrap books preserve unique stories future generations enjoy your donati
on project provide second graders opportunity learn social studies fun creat
ive manner through scrapbooks children share story others historical documen
t rest lives

==========

a person person no matter small dr seuss i teach smallest students biggest e
nthusiasm learning my students learn many different ways using senses multip
le intelligences i use wide range techniques help students succeed students
class come variety different backgrounds makes wonderful sharing experiences
cultures including native americans our school caring community successful l
earners seen collaborative student project based learning classroom kinderga
rteners class love work hands materials many different opportunities practic
e skill mastered having social skills work cooperatively friends crucial asp
ect kindergarten curriculum montana perfect place learn agriculture nutritio
n my students love role play pretend kitchen early childhood classroom i sev
eral kids ask can try cooking real food i take idea create common core cooki
ng lessons learn important math writing concepts cooking delicious healthy f
ood snack time my students grounded appreciation work went making food knowl
edge ingredients came well healthy bodies this project would expand learning
nutrition agricultural cooking recipes us peel apples make homemade applesau
ce make bread mix healthy plants classroom garden spring we also create cook
books printed shared families students gain math literature skills well life
long enjoyment healthy cooking nannan

==========

my classroom consists twenty two amazing sixth graders different cultures ba
ckgrounds they social bunch enjoy working partners working groups they hard
working eager head middle school next year my job get ready make transition
make smooth possible in order students need come school every day feel safe
ready learn because getting ready head middle school i give lots choice choi
ce sit work order complete assignments choice projects etc part students fee
ling safe ability come welcoming encouraging environment my room colorful at
mosphere casual i want take ownership classroom all share together because t
ime limited i want ensure get time enjoy best abilities currently twenty two
desks differing sizes yet desks similar ones students use middle school we a
lso kidney table crates seating i allow students choose spots working indepe
ndently groups more often not move desks onto crates believe not proven succ
essful making stay desks it i looking toward flexible seating option classro
om the students look forward work time move around room i would like get rid
constricting desks move toward fun seating options i requesting various seat
ing students options sit currently i stool papasan chair i inherited previou
s sixth grade teacher well five milk crate seats i made i would like give op
tions reduce competition good seats i also requesting two rugs not seating o
ptions make classroom welcoming appealing in order students able write compl
ete work without desks i requesting class set clipboards finally due curricu
lum requires groups work together i requesting tables fold not using leave r
oom flexible seating options i know seating options much excited coming scho
ol thank support making classroom one students remember forever nannan

==========

In [29]:

```
# 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 [30]:

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

```
a person person no matter small dr seuss i teach smallest students biggest e
nthusiasm learning my students learn many different ways using senses multip
le intelligences i use wide range techniques help students succeed students
class come variety different backgrounds makes wonderful sharing experiences
cultures including native americans our school caring community successful l
earners seen collaborative student project based learning classroom kinderga
rteners class love work hands materials many different opportunities practic
e skill mastered having social skills work cooperatively friends crucial asp
ect kindergarten curriculum montana perfect place learn agriculture nutritio
n my students love role play pretend kitchen early childhood classroom i sev
eral kids ask can try cooking real food i take idea create common core cooki
ng lessons learn important math writing concepts cooking delicious healthy f
ood snack time my students grounded appreciation work went making food knowl
edge ingredients came well healthy bodies this project would expand learning
nutrition agricultural cooking recipes us peel apples make homemade applesau
ce make bread mix healthy plants classroom garden spring we also create cook
books printed shared families students gain math literature skills well life
long enjoyment healthy cooking nannan
==================================================
```

In [31]:

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

```
a person person no matter small dr seuss i teach smallest students biggest e
nthusiasm learning my students learn many different ways using senses multip
le intelligences i use wide range techniques help students succeed students 
class come variety different backgrounds makes wonderful sharing experiences
cultures including native americans our school caring community successful l
earners seen collaborative student project based learning classroom kinderga
rteners class love work hands materials many different opportunities practic
e skill mastered having social skills work cooperatively friends crucial asp
ect kindergarten curriculum montana perfect place learn agriculture nutritio
n my students love role play pretend kitchen early childhood classroom i sev
eral kids ask can try cooking real food i take idea create common core cooki
ng lessons learn important math writing concepts cooking delicious healthy f
ood snack time my students grounded appreciation work went making food knowl
edge ingredients came well healthy bodies this project would expand learning
nutrition agricultural cooking recipes us peel apples make homemade applesau
ce make bread mix healthy plants classroom garden spring we also create cook
books printed shared families students gain math literature skills well life
long enjoyment healthy cooking nannan
```

In [32]:

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

```
a person person no matter small dr seuss i teach smallest students biggest e
nthusiasm learning my students learn many different ways using senses multip
le intelligences i use wide range techniques help students succeed students 
class come variety different backgrounds makes wonderful sharing experiences
cultures including native americans our school caring community successful l
earners seen collaborative student project based learning classroom kinderga
rteners class love work hands materials many different opportunities practic
e skill mastered having social skills work cooperatively friends crucial asp
ect kindergarten curriculum montana perfect place learn agriculture nutritio
n my students love role play pretend kitchen early childhood classroom i sev
eral kids ask can try cooking real food i take idea create common core cooki
ng lessons learn important math writing concepts cooking delicious healthy f
ood snack time my students grounded appreciation work went making food knowl
edge ingredients came well healthy bodies this project would expand learning
nutrition agricultural cooking recipes us peel apples make homemade applesau
ce make bread mix healthy plants classroom garden spring we also create cook
books printed shared families students gain math literature skills well life
long enjoyment healthy cooking nannan
```

In [33]:

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

Preprocessed Train data (Essay)

In [34]:

```
# Combining all the above stundents
from tqdm import tqdm
preprocessed_essays_train = []
# tqdm is for printing the status bar
for sentance in tqdm(X_train['clean_essays'].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 [00:37<00:00, 1309.34it/s]
```

In [35]:

```
# after preprocesing
preprocessed_essays_train[20000]
```

Out[35]:

```
'students awesome not intelligent also determination succeed times seems imp
ossible push many kids age would choose give students suffered witnessed eve
nts tragedies many adults never experienced makes going work day worth knowi
ng providing safe place students grow learn explore world live giving studen
ts access quality fiction non fiction texts give ability travel explore plac
es staying comfort safety classroom many students come without love reading
hope begin make difference help materials want kids excited moment open book
believe obtaining materials begin journey books take places allow live dream
s words page want show kids nannan'
```

Preprocessed Test data (Essay)

In [36]:

```
preprocessed_essays_test = []
# tqdm is for printing the status bar
for sentence in tqdm(X_test['clean_essays'].values):
    sent = decontracted(sentence)
    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 [00:27<00:00, 1321.07it/s]
```

In [37]:

```
preprocessed_essays_test[0]
```

Out[37]:

```
'science classroom always buzzing excitement students get hands discoveries
use creativity imagination every time come class way science supposed fun sc
hool 60 free reduced lunch half english language learners see every class en
tire school week 40 minute hands science lesson class approximately 30 kids
children naturally curious everything students extremely enthusiastic love l
earning things science run ask science today class many questions variety su
bjects time clean go always hear collective oh no already excitement energy
contagious really want know everything world works students coding last 2 ye
ars year begin using coding skills program robots starting lego wedo robots
would like progress advanced vex iq robots not strengthen students knowledge
technology coding also problem solving collaboration creativity skills skill
s essential future workforce innovative scientists engineers well beneficial
career students choose follow beauty coding robotics activities touch upon p
arts curriculum includes stem science technology engineering math plus liter
acy communication skills must learned utilized however best part robotics co
ding fun students love kids fun learning exactly way science supposed done m
any children united states not get proper exposure quality stem curriculum c
urrently shortage engineers country objective get students excited engineeri
ng stem careers important essential part brighter future entire world nanna
n'
```

Preprocessed Cross Validation data (essay)

In [38]:

```
preprocessed_essays_cv = []
# tqdm is for printing the status bar
for sentence in tqdm(X_cv['clean_essays'].values):
    sent = decontracted(sentence)
    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 [00:18<00:00, 1326.09it/s]
```

In [39]:

```
preprocessed_essays_cv[0]
```

Out[39]:

```
'students face challenges boggle mind living high poverty zone affects every
aspect learning school 100 free breakfast lunch students return home daily e
mpty home lock parents arrive sometimes late night arrive school gates early
6 00 stay school program 5 6 pm others homeless silently arriving school dai
ly silently keeping never knowing sleeping hoping no one notices clothes som
etimes dirty sometimes torn sometimes not warm enough others fortunate paren
ts working higher end jobs allow basic necessities life yet access level sup
port need every child wants learn wants succeed majority 5th grade students
start school year reading 3rd grade level majority leave reading grade level
students treasure ability expand potential school 150 5th grade students str
uggling meet physical education standards california school supplies student
s education materials often difficult obtain materials need five classrooms
trying use equipment time often forces students one ball class 33 providing
baseballs soccer balls allows students access materials need practice skills
materials allow students effectively use instructional time practicing less
time observing due limited resources nannan'
```

1.4 Preprocessing of `project_title`

Preprocessing of Project Title for Train data

In [40]:

```
# similarly you can preprocess the titles also
preprocessed_titles_train = []

for titles in tqdm(X_train["clean_titles"]):
    title = decontracted(titles)
    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_titles_train.append(title.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████████
██| 49041/49041 [00:02<00:00, 21092.17it/s]
```

In [41]:

```
preprocessed_titles_train[0]
```

Out[41]:

```
'eggspert game learning gain'
```

Preprocessing of Project Title for Test data

In [42]:

```
preprocessed_titles_test = []

for titles in tqdm(X_test["clean_titles"]):
    title = decontracted(titles)
    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_titles_test.append(title.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████████
██| 36052/36052 [00:01<00:00, 22850.08it/s]
```

In [43]:

```
preprocessed_titles_test[0]
```

Out[43]:

```
'hvc robot invasion'
```

Preprocessing of Project Title for CV data

In [44]:

```
preprocessed_titles_cv = []

for titles in tqdm(X_cv["clean_titles"]):
    title = decontracted(titles)
    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_titles_cv.append(title.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████
██| 24155/24155 [00:01<00:00, 20353.25it/s]
```

In [45]:

```
preprocessed_titles_cv[0]
```

Out[45]:

```
'take ball game'
```

1.5 Preparing data for models

In [46]:

```
project_data.columns
```

Out[46]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'Date', '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',
       'project_grade_category', 'clean_categories', 'clean_subcategories',
       'clean_titles', 'title_word_count', 'clean_essays', 'essay_word_coun
t',
       'pos', 'neg', 'neu', 'compound'],
      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

1.5.1 Vectorizing Categorical data

- https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/handling-categorical-and-numerical-features/ (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/handling-categorical-and-numerical-features/)

In [47]:

```
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer

vectorizer_proj = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False,
vectorizer_proj.fit(X_train['clean_categories'].values)

categories_one_hot_train = vectorizer_proj.transform(X_train['clean_categories'].values)
categories_one_hot_test = vectorizer_proj.transform(X_test['clean_categories'].values)
categories_one_hot_cv = vectorizer_proj.transform(X_cv['clean_categories'].values)

print(vectorizer_proj.get_feature_names())

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

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning',
'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Literacy_Language']
Shape of matrix of Train data after one hot encoding  (49041, 9)
Shape of matrix of Test data after one hot encoding  (36052, 9)
Shape of matrix of CV data after one hot encoding  (24155, 9)
```

In [48]:

```
# we use count vectorizer to convert the values into one
vectorizer_sub_proj = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercas
vectorizer_sub_proj.fit(X_train['clean_subcategories'].values)

sub_categories_one_hot_train = vectorizer_sub_proj.transform(X_train['clean_subcategories']
sub_categories_one_hot_test = vectorizer_sub_proj.transform(X_test['clean_subcategories'].v
sub_categories_one_hot_cv = vectorizer_sub_proj.transform(X_cv['clean_subcategories'].value


print(vectorizer_sub_proj.get_feature_names())

print("Shape of matrix of Train data after one hot encoding ",sub_categories_one_hot_train.
print("Shape of matrix of Test data after one hot encoding ",sub_categories_one_hot_test.sh
print("Shape of matrix of Cross Validation data after one hot encoding ",sub_categories_one
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement',
'Extracurricular', 'Civics_Government', 'ForeignLanguages', 'NutritionEducat
ion', 'Warmth', 'Care_Hunger', 'SocialSciences', 'PerformingArts', 'Characte
rEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Music', 'History_
Geography', 'Health_LifeScience', 'EarlyDevelopment', 'ESL', 'Gym_Fitness',
'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'AppliedSciences',
'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy']
Shape of matrix of Train data after one hot encoding  (49041, 30)
Shape of matrix of Test data after one hot encoding  (36052, 30)
Shape of matrix of Cross Validation data after one hot encoding  (24155, 30)
```

In [49]:

```
# you can do the similar thing with state, teacher_prefix and project_grade_category also
my_counter = Counter()
for state in project_data['school_state'].values:
    my_counter.update(state.split())
```

In [50]:

```
school_state_cat_dict = dict(my_counter)
sorted_school_state_cat_dict = dict(sorted(school_state_cat_dict.items(), key=lambda kv: kv
```

In [51]:

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

vectorizer_states = CountVectorizer(vocabulary=list(sorted_school_state_cat_dict.keys()), l
vectorizer_states.fit(X_train['school_state'].values)

school_state_categories_one_hot_train = vectorizer_states.transform(X_train['school_state']
school_state_categories_one_hot_test = vectorizer_states.transform(X_test['school_state'].v
school_state_categories_one_hot_cv = vectorizer_states.transform(X_cv['school_state'].value

print(vectorizer_states.get_feature_names())

print("Shape of matrix of Train data after one hot encoding ",school_state_categories_one_h
print("Shape of matrix of Test data after one hot encoding ",school_state_categories_one_ho
print("Shape of matrix of Cross Validation data after one hot encoding ",school_state_categ
```

```
['VT', 'WY', 'ND', 'MT', 'RI', 'SD', 'NE', 'DE', 'AK', 'NH', 'WV', 'ME', 'H
I', 'DC', 'NM', 'KS', 'IA', 'ID', 'AR', 'CO', 'MN', 'OR', 'KY', 'MS', 'NV',
'MD', 'CT', 'TN', 'UT', 'AL', 'WI', 'VA', 'AZ', 'NJ', 'OK', 'WA', 'MA', 'L
A', 'OH', 'MO', 'IN', 'PA', 'MI', 'SC', 'GA', 'IL', 'NC', 'FL', 'NY', 'TX',
'CA']
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, 51)
```

In [52]:

```
my_counter = Counter()
for project_grade in project_data['project_grade_category'].values:
    my_counter.update(project_grade.split())
```

In [53]:

```
project_grade_cat_dict = dict(my_counter)
sorted_project_grade_cat_dict = dict(sorted(project_grade_cat_dict.items(), key=lambda kv:
```

In [54]:

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

vectorizer_grade = CountVectorizer(vocabulary=list(sorted_project_grade_cat_dict.keys()), l
vectorizer_grade.fit(X_train['project_grade_category'].values)

project_grade_categories_one_hot_train = vectorizer_grade.transform(X_train['project_grade_
project_grade_categories_one_hot_test = vectorizer_grade.transform(X_test['project_grade_ca
project_grade_categories_one_hot_cv = vectorizer_grade.transform(X_cv['project_grade_catego

print(vectorizer_grade.get_feature_names())

print("Shape of matrix of Train data after one hot encoding ",project_grade_categories_one_
print("Shape of matrix of Test data after one hot encoding ",project_grade_categories_one_h
print("Shape of matrix of Cross Validation data after one hot encoding ",project_grade_cate
```

```
['Grades_9-12', 'Grades_6-8', 'Grades_3-5', 'Grades_PreK-2']
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)
```

In [55]:

```
my_counter = Counter()
for teacher_prefix in project_data['teacher_prefix'].values:
    teacher_prefix = str(teacher_prefix)
    my_counter.update(teacher_prefix.split())
```

In [56]:

```
teacher_prefix_cat_dict = dict(my_counter)
sorted_teacher_prefix_cat_dict = dict(sorted(teacher_prefix_cat_dict.items(), key=lambda kv
```

In [57]:

```
## we use count vectorizer to convert the values into one hot encoded features
## Unlike the previous Categories this category returns a
## ValueError: np.nan is an invalid document, expected byte or unicode string.
## The link below explains h0w to tackle such discrepancies.
## https://stackoverflow.com/questions/39303912/tfidfvectorizer-in-scikit-learn-valueerror-

vectorizer_teacher = CountVectorizer(vocabulary=list(sorted_teacher_prefix_cat_dict.keys())
vectorizer_teacher.fit(X_train['teacher_prefix'].values.astype("U"))

teacher_prefix_categories_one_hot_train = vectorizer_teacher.transform(X_train['teacher_pre
teacher_prefix_categories_one_hot_test = vectorizer_teacher.transform(X_test['teacher_prefi
teacher_prefix_categories_one_hot_cv = vectorizer_teacher.transform(X_cv['teacher_prefix'].

print(vectorizer_teacher.get_feature_names())

print("Shape of matrix after one hot encoding ",teacher_prefix_categories_one_hot_train.sha
print("Shape of matrix after one hot encoding ",teacher_prefix_categories_one_hot_test.shap
print("Shape of matrix after one hot encoding ",teacher_prefix_categories_one_hot_cv.shape)
```

```
['nan', 'Dr.', 'Teacher', 'Mr.', 'Ms.', 'Mrs.']
Shape of matrix after one hot encoding  (49041, 6)
Shape of matrix after one hot encoding  (36052, 6)
Shape of matrix after one hot encoding  (24155, 6)
```

1.5.2 Vectorizing Text data

a) Bag of words Train Data (Essays)

In [58]:

```
# We are considering only the words which appeared in at least 10 documents(rows or project
vectorizer_bow_essay = CountVectorizer(ngram_range=(2,2), min_df=10, max_features = 5000)

vectorizer_bow_essay.fit(preprocessed_essays_train)

text_bow_train = vectorizer_bow_essay.transform(preprocessed_essays_train)

print("Shape of matrix after one hot encoding ",text_bow_train.shape)
```

```
Shape of matrix after one hot encoding  (49041, 5000)
```

b) Bag of words Test Data (Essays)

In [59]:

```
text_bow_test = vectorizer_bow_essay.transform(preprocessed_essays_test)
print("Shape of matrix after one hot encoding ",text_bow_test.shape)
```

```
Shape of matrix after one hot encoding  (36052, 5000)
```

c) Bag of words CV Data (Essays)

In [60]:

```
text_bow_cv = vectorizer_bow_essay.transform(preprocessed_essays_cv)
print("Shape of matrix after one hot encoding ",text_bow_cv.shape)
```

```
Shape of matrix after one hot encoding  (24155, 5000)
```

d) Bag of words train Data (Titles)

In [61]:

```
# you can vectorize the title also
# before you vectorize the title make sure you preprocess it
vectorizer_bow_title = CountVectorizer(ngram_range=(2,2), min_df=10, max_features = 5000)

vectorizer_bow_title.fit(preprocessed_titles_train)

title_bow_train = vectorizer_bow_title.transform(preprocessed_titles_train)
print("Shape of matrix after one hot encoding ",title_bow_train.shape)
```

```
Shape of matrix after one hot encoding  (49041, 1250)
```

e) Bag of words Test Data (Titles)

In [62]:

```
title_bow_test = vectorizer_bow_title.transform(preprocessed_titles_test)
print("Shape of matrix after one hot encoding ",title_bow_test.shape)
```

```
Shape of matrix after one hot encoding  (36052, 1250)
```

f) Bag of words Data (Titles)

In [63]:

```
title_bow_cv = vectorizer_bow_title.transform(preprocessed_titles_cv)
print("Shape of matrix after one hot encoding ",title_bow_cv.shape)
```

```
Shape of matrix after one hot encoding  (24155, 1250)
```

1.5.2.2 TFIDF vectorizer

a) TFIDF vectorizer Train Data (Essays)

In [64]:

```
from sklearn.feature_extraction.text import TfidfVectorizer

vectorizer_tfidf_essay = TfidfVectorizer(ngram_range=(2,2), min_df=10, max_features = 5000)
vectorizer_tfidf_essay.fit(preprocessed_essays_train)

text_tfidf_train = vectorizer_tfidf_essay.transform(preprocessed_essays_train)
print("Shape of matrix after one hot encoding ",text_tfidf_train.shape)
```

```
Shape of matrix after one hot encoding  (49041, 5000)
```

b) TFIDF vectorizer Test Data (Essays)

In [65]:

```
text_tfidf_test = vectorizer_tfidf_essay.transform(preprocessed_essays_test)
print("Shape of matrix after one hot encoding ",text_tfidf_test.shape)
```

```
Shape of matrix after one hot encoding  (36052, 5000)
```

c) TFIDF vectorizer CV Data (Essays)

In [66]:

```
text_tfidf_cv = vectorizer_tfidf_essay.transform(preprocessed_essays_cv)
print("Shape of matrix after one hot encoding ",text_tfidf_cv.shape)
```

```
Shape of matrix after one hot encoding  (24155, 5000)
```

c) TFIDF vectorizer Train Data (Titles)

In [67]:

```
vectorizer_tfidf_titles = TfidfVectorizer(ngram_range=(2,2), min_df=10, max_features = 5000

vectorizer_tfidf_titles.fit(preprocessed_titles_train)
title_tfidf_train = vectorizer_tfidf_titles.transform(preprocessed_titles_train)
print("Shape of matrix after one hot encoding ",title_tfidf_train.shape)
```

```
Shape of matrix after one hot encoding  (49041, 1250)
```

d) TFIDF vectorizer Test Data (Titles)

In [68]:

```
title_tfidf_test = vectorizer_tfidf_titles.transform(preprocessed_titles_test)
print("Shape of matrix after one hot encoding ",title_tfidf_test.shape)
```

```
Shape of matrix after one hot encoding  (36052, 1250)
```

e) TFIDF vectorizer CV Data (Titles)

In [69]:

```
title_tfidf_cv = vectorizer_tfidf_titles.transform(preprocessed_titles_cv)
print("Shape of matrix after one hot encoding ",title_tfidf_cv.shape)
```

```
Shape of matrix after one hot encoding  (24155, 1250)
```

C) Using Pretrained Models : AVG W2V

In [72]:

```
# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039
def loadGloveModel(gloveFile):
    print ("Loading Glove Model")
    f = open(gloveFile,'r', encoding="utf8")
    model = {}
    for line in tqdm(f):
        splitLine = line.split()
        word = splitLine[0]
        embedding = np.array([float(val) for val in splitLine[1:]])
        model[word] = embedding
    print ("Done.",len(model)," words loaded!")
    return model

model = loadGloveModel('glove.42B.300d.txt')


words = []
for i in preprocessed_essays_train :
    words.extend(i.split(' '))

print("all the words in the coupus", len(words))
words = set(words)
print("the unique words in the coupus", len(words))

inter_words = set(model.keys()).intersection(words)
print("The number of words that are present in both glove vectors and our coupus", \
      len(inter_words),"(",np.round(len(inter_words)/len(words)*100,3),"%)")

words_courpus = {}
words_glove = set(model.keys())
for i in words:
    if i in words_glove:
        words_courpus[i] = model[i]
print("word 2 vec length", len(words_courpus))


# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-pickl

import pickle
with open('glove_vectors', 'wb') as f:
    pickle.dump(words_courpus, f)
```

```
Loading Glove Model

1333129it [06:31, 3404.12it/s]

Done. 1333129  words loaded!
all the words in the coupus 6767354
the unique words in the coupus 41263
The number of words that are present in both glove vectors and our coupus 37
422 ( 90.691 %)
word 2 vec length 37422
```

In [70]:

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

Train Essay

In [71]:

```
# average Word2Vec
# compute average word2vec for each review.

avg_w2v_vectors_train = [];

for sentence in tqdm(X_train["clean_essays"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            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 [00:25<00:00, 1940.11it/s]

49041
300
```

Test Essay

In [72]:

```
# average Word2Vec
# compute average word2vec for each review.

avg_w2v_vectors_test = [];

for sentence in tqdm(X_test["clean_essays"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            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 [00:18<00:00, 1962.67it/s]

36052
300
```

Cross validation Essay

In [73]:

```
avg_w2v_vectors_cv = [];

for sentence in tqdm(X_cv["clean_essays"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            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 [00:12<00:00, 1943.79it/s]

24155
300
```

train Titles

In [74]:

```
avg_w2v_vectors_titles_train = []; # the avg-w2v for each sentence/review is stored in this
for sentence in tqdm(X_train["clean_titles"]): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_titles_train.append(vector)

print(len(avg_w2v_vectors_titles_train))
print(len(avg_w2v_vectors_titles_train[0]))
```

```
100%|████████████████████████████████████████████████████████████████████
██| 49041/49041 [00:01<00:00, 34684.26it/s]

49041
300
```

Test Titles

In [75]:

```
avg_w2v_vectors_titles_test = []; # the avg-w2v for each sentence/review is stored in this
for sentence in tqdm(X_test["clean_titles"]): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_titles_test.append(vector)

print(len(avg_w2v_vectors_titles_test))
print(len(avg_w2v_vectors_titles_test[0]))
```

```
100%|████████████████████████████████████████████████████████████████████
██| 36052/36052 [00:01<00:00, 34595.13it/s]

36052
300
```

CV Titles

In [76]:

```
avg_w2v_vectors_titles_cv = []; # the avg-w2v for each sentence/review is stored in this li
for sentence in tqdm(X_cv["clean_titles"]): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_titles_cv.append(vector)

print(len(avg_w2v_vectors_titles_cv))
print(len(avg_w2v_vectors_titles_cv[0]))
```

```
100%|████████████████████████████████████████████████████████████████████████
██| 24155/24155 [00:00<00:00, 30960.18it/s]

24155
300
```

D) Using Pretrained Models: TFIDF weighted W2V

Train - Essays

In [77]:

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

In [78]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_train = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(X_train["clean_essays"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettin
            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_train.append(vector)

print(len(tfidf_w2v_vectors_train))
print(len(tfidf_w2v_vectors_train[0]))
```

```
100%|████████████████████████████████████████████████████████████████████
████| 49041/49041 [03:04<00:00, 262.50it/s]

49041
300
```

Test essays

In [79]:

```
# compute average word2vec for each review.

tfidf_w2v_vectors_test = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(X_test["clean_essays"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettin
            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_test.append(vector)

print(len(tfidf_w2v_vectors_test))
print(len(tfidf_w2v_vectors_test[0]))
```

```
100%|████████████████████████████████████████████████████████████████████
████| 36052/36052 [02:16<00:00, 264.23it/s]

36052
300
```

CV essays

In [80]:

```
# compute average word2vec for each review.

tfidf_w2v_vectors_cv = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(X_cv["clean_essays"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettin
            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_cv.append(vector)

print(len(tfidf_w2v_vectors_cv))
print(len(tfidf_w2v_vectors_cv[0]))
```

```
100%|████████████████████████████████████████████████████████████████
████| 24155/24155 [01:31<00:00, 263.54it/s]

24155
300
```

Train Titles

In [81]:

```
tfidf_model = TfidfVectorizer()
tfidf_model.fit(X_train["clean_titles"])
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [82]:

```
# compute average word2vec for each review.

tfidf_w2v_vectors_titles_train = [];

for sentence in tqdm(X_train["clean_titles"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettin
            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_titles_train.append(vector)

print(len(tfidf_w2v_vectors_titles_train))
print(len(tfidf_w2v_vectors_titles_train[0]))
```

```
100%|████████████████████████████████████████████████████████████████
██| 49041/49041 [00:02<00:00, 16882.27it/s]

49041
300
```

Test Titles

In [83]:

```
# compute average word2vec for each review.

tfidf_w2v_vectors_titles_test = [];

for sentence in tqdm(X_test["clean_titles"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettin
            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_titles_test.append(vector)

print(len(tfidf_w2v_vectors_titles_test))
print(len(tfidf_w2v_vectors_titles_test[0]))
```

```
100%|████████████████████████████████████████████████████████████████
██| 36052/36052 [00:01<00:00, 18843.50it/s]

36052
300
```

CV Titles

In [84]:

```
# compute average word2vec for each review.

tfidf_w2v_vectors_titles_cv = [];

for sentence in tqdm(X_cv["clean_titles"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettir
            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_titles_cv.append(vector)

print(len(tfidf_w2v_vectors_titles_cv))
print(len(tfidf_w2v_vectors_titles_cv[0]))
```

```
100%|████████████████████████████████████████████████████████████████
██| 24155/24155 [00:01<00:00, 17929.94it/s]

24155
300
```

1.5.3 Vectorizing Numerical features

a) Price

In [85]:

```
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [86]:

```
# join two dataframes in python:
X_train = pd.merge(X_train, price_data, on='id', how='left')
X_test = pd.merge(X_test, price_data, on='id', how='left')
X_cv = pd.merge(X_cv, price_data, on='id', how='left')
```

In [87]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikitlearn.org/stable/modules/generated/sklearn.preproc
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn.preprocessing import Normalizer
from sklearn import preprocessing
price_scalar = MinMaxScaler()
price_scalar.fit(X_train['price'].values.reshape(-1,1)) # finding the mean and standarddevi
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
price_train = price_scalar.transform(X_train['price'].values.reshape(-1, 1))
price_train
# Now standardize the data with above maen and variance.
price_test = price_scalar.transform(X_test['price'].values.reshape(-1, 1))
price_test
# Now standardize the data with above maen and variance.
price_cv = price_scalar.transform(X_cv['price'].values.reshape(-1, 1))
price_cv
```

Out[87]:

```
array([[0.00128021],
       [0.02371794],
       [0.01451441],
       ...,
       [0.01670777],
       [0.01216202],
       [0.04573859]])
```

In [88]:

```
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,)
```

b) Quantity

In [89]:

```
price_scalar.fit(X_train['quantity'].values.reshape(-1,1)) # finding the mean and standard
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
quantity_train = price_scalar.transform(X_train['quantity'].values.reshape(-1, 1))
quantity_train
# Now standardize the data with above maen and variance.
quantity_cv = price_scalar.transform(X_cv['quantity'].values.reshape(-1, 1))
quantity_cv
# Now standardize the data with above maen and variance.
quantity_test = price_scalar.transform(X_test['quantity'].values.reshape(-1, 1))
quantity_test
```

Out[89]:

```
array([[0.        ],
       [0.02892102],
       [0.02113459],
       ...,
       [0.07007786],
       [0.01223582],
       [0.00889878]])
```

In [90]:

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

```
After vectorizations
<built-in method reshape of numpy.ndarray object at 0x00000213B03B0E90> (490
41,)
(24155, 1) (24155,)
(36052, 1) (36052,)
```

c) Number of Projects previously proposed by Teacher

In [91]:

```
price_scalar.fit(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
prev_projects_train = price_scalar.transform(X_train['teacher_number_of_previously_posted_p
prev_projects_train
# Now standardize the data with above maen and variance.
prev_projects_cv = price_scalar.transform(X_cv['teacher_number_of_previously_posted_project
prev_projects_cv
# Now standardize the data with above maen and variance.
prev_projects_test = price_scalar.transform(X_test['teacher_number_of_previously_posted_pro
prev_projects_test
```

Out[91]:

```
array([[0.01144165],
       [0.00686499],
       [0.00228833],
       ...,
       [0.00915332],
       [0.00457666],
       [0.00228833]])
```

In [92]:

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

d) Count of Words in the Title

In [93]:

```
price_scalar.fit(X_train['title_word_count'].values.reshape(-1,1)) # finding the mean and s
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
title_word_count_train = price_scalar.transform(X_train['title_word_count'].values.reshape(
title_word_count_train
# Now standardize the data with above maen and variance.
title_word_count_cv = price_scalar.transform(X_cv['title_word_count'].values.reshape(-1, 1)
title_word_count_cv
# Now standardize the data with above maen and variance.
title_word_count_test = price_scalar.transform(X_test['title_word_count'].values.reshape(-1
title_word_count_test
```

Out[93]:

```
array([[0.14285714],
       [0.28571429],
       [0.28571429],
       ...,
       [0.28571429],
       [0.5       ],
       [0.42857143]])
```

In [94]:

```
print("After vectorizations")
print(title_word_count_train.shape, y_train.shape)
print(title_word_count_cv.shape, y_cv.shape)
print(title_word_count_test.shape, y_test.shape)
```

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

e) Count of Words in the Essay

In [95]:

```
price_scalar.fit(X_train['essay_word_count'].values.reshape(-1,1)) # finding the mean and s
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
essay_word_count_train = price_scalar.transform(X_train['essay_word_count'].values.reshape(
essay_word_count_train
# Now standardize the data with above maen and variance.
essay_word_count_cv = price_scalar.transform(X_cv['essay_word_count'].values.reshape(-1, 1)
essay_word_count_cv
# Now standardize the data with above maen and variance.
essay_word_count_test = price_scalar.transform(X_test['essay_word_count'].values.reshape(-1
essay_word_count_test


print("After vectorizations")
print(essay_word_count_train.shape, y_train.shape)
print(essay_word_count_cv.shape, y_cv.shape)
print(essay_word_count_test.shape, y_test.shape)
```

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

In [96]:

```
essay_word_count_train
```

Out[96]:

```
array([[0.53231939],
       [0.15209125],
       [0.11787072],
       ...,
       [0.15209125],
       [0.54372624],
       [0.11406844]])
```

Essay Sentiments - Pos

In [97]:

```
price_scalar.fit(X_train['pos'].values.reshape(-1,1)) # finding the mean and standard devia
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
essay_sent_pos_train = price_scalar.transform(X_train['pos'].values.reshape(-1, 1))
essay_sent_pos_train
# Now standardize the data with above maen and variance.
essay_sent_pos_cv = price_scalar.transform(X_cv['pos'].values.reshape(-1, 1))
essay_sent_pos_cv
# Now standardize the data with above maen and variance.
essay_sent_pos_test = price_scalar.transform(X_test['pos'].values.reshape(-1, 1))
essay_sent_pos_test
```

Out[97]:

```
array([[0.48825503],
       [0.3238255 ],
       [0.44630872],
       ...,
       [0.31208054],
       [0.55033557],
       [0.31375839]])
```

In [98]:

```
print("After vectorizations")
print(essay_sent_pos_train.shape, y_train.shape)
print(essay_sent_pos_cv.shape, y_cv.shape)
print(essay_sent_pos_test.shape, y_test.shape)
```

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

Essay Sentiments - Neg

In [99]:

```
price_scalar.fit(X_train['neg'].values.reshape(-1,1)) # finding the mean and standard devia
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
essay_sent_neg_train = price_scalar.transform(X_train['neg'].values.reshape(-1, 1))
essay_sent_neg_train
# Now standardize the data with above maen and variance.
essay_sent_neg_cv = price_scalar.transform(X_cv['neg'].values.reshape(-1, 1))
essay_sent_neg_cv
# Now standardize the data with above maen and variance.
essay_sent_neg_test = price_scalar.transform(X_test['neg'].values.reshape(-1, 1))
essay_sent_neg_test
```

Out[99]:

```
array([[0.11730205],
       [0.19941349],
       [0.21994135],
       ...,
       [0.13196481],
       [0.1143695 ],
       [0.04692082]])
```

In [100]:

```
print("After vectorizations")
print(essay_sent_neg_train.shape, y_train.shape)
print(essay_sent_neg_cv.shape, y_cv.shape)
print(essay_sent_neg_test.shape, y_test.shape)
```

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

Essay Sentiments - Neu

In [101]:

```
price_scalar.fit(X_train['neu'].values.reshape(-1,1)) # finding the mean and standard devia
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
essay_sent_neu_train = price_scalar.transform(X_train['neu'].values.reshape(-1, 1))
essay_sent_neu_train
# Now standardize the data with above maen and variance.
essay_sent_neu_cv = price_scalar.transform(X_cv['neu'].values.reshape(-1, 1))
essay_sent_neu_cv
# Now standardize the data with above maen and variance.
essay_sent_neu_test = price_scalar.transform(X_test['neu'].values.reshape(-1, 1))
essay_sent_neu_test
```

Out[101]:

```
array([[0.46537842],
       [0.58132045],
       [0.44927536],
       ...,
       [0.62640902],
       [0.40901771],
       [0.6747182 ]])
```

In [102]:

```
print("After vectorizations")
print(essay_sent_neu_train.shape, y_train.shape)
print(essay_sent_neu_cv.shape, y_cv.shape)
print(essay_sent_neu_test.shape, y_test.shape)
```

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

Essay Sentiments - Compound

In [103]:

```
price_scalar.fit(X_train['compound'].values.reshape(-1,1)) # finding the mean and standard
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0]
# Now standardize the data with above maen and variance.
essay_sent_comp_train = price_scalar.transform(X_train['compound'].values.reshape(-1, 1))
essay_sent_comp_train
# Now standardize the data with above maen and variance.
essay_sent_comp_cv = price_scalar.transform(X_cv['compound'].values.reshape(-1, 1))
essay_sent_comp_cv
# Now standardize the data with above maen and variance.
essay_sent_comp_test = price_scalar.transform(X_test['compound'].values.reshape(-1, 1))
essay_sent_comp_test
```

Out[103]:

```
array([[0.9985444 ],
       [0.98991116],
       [0.99322391],
       ...,
       [0.98840536],
       [0.99844401],
       [0.99573357]])
```

In [104]:

```
print("After vectorizations")
print(essay_sent_comp_train.shape, y_train.shape)
print(essay_sent_comp_cv.shape, y_cv.shape)
print(essay_sent_comp_test.shape, y_test.shape)
```

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

Assignment 5: Logistic Regression

1. **[Task-1] Logistic Regression(either SGDClassifier with log loss, or LogisticRegression) on these feature sets**
    - Set 1: categorical, numerical features + project_title(BOW) + preprocessed_eassay (`BOW with bi-grams` with `min_df=10` and `max_features=5000`)
    - Set 2: categorical, numerical features + project_title(TFIDF)+ preprocessed_eassay (`TFIDF with bi-grams` with `min_df=10` and `max_features=5000`)
    - Set 3: categorical, numerical features + project_title(AVG W2V)+ preprocessed_eassay (AVG W2V)
    - Set 4: categorical, numerical features + project_title(TFIDF W2V)+ preprocessed_essay (TFIDF W2V)
2. **Hyper paramter tuning (find best hyper parameters corresponding the algorithm that you choose)**
    - Find the best hyper parameter which will give the maximum AUC (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/receiver-operating-characteristic-curve-roc-curve-and-auc-1/) value
    - Find the best hyper paramter using k-fold cross validation or simple cross validation data

- Use gridsearch cv or randomsearch cv or you can also write your own for loops to do this task of hyperparameter tuning

3. **Representation of results**

- You need to plot the performance of model both on train data and cross validation data for each hyper parameter, like shown in the figure.

- Once after you found the best hyper parameter, you need to train your model with it, and find the AUC on test data and plot the ROC curve on both train and test.

- Along with plotting ROC curve, you need to print the confusion matrix (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/confusion-matrix-tpr-fpr-fnr-tnr-1/) with predicted and original labels of test data points. Please visualize your confusion matrices using seaborn heatmaps.

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

4. **[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.**
5. 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

And apply the Logistic regression on these features by finding the best hyper paramter as suggested in step 2 and step 3

6. **Conclusion**

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

Note: Data Leakage

1. There will be an issue of data-leakage if you vectorize the entire data and then split it into train/cv/test.
2. To avoid the issue of data-leakage, make sure to split your data first and then vectorize it.
3. While vectorizing your data, apply the method fit_transform() on you train data, and apply the method transform() on cv/test data.
4. For more details please go through this link. (https://soundcloud.com/applied-ai-course/leakage-bow-and-tfidf)

2. Logistic Regression

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

In [113]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack

X_tr = hstack((categories_one_hot_train, sub_categories_one_hot_train, school_state_categor
X_te = hstack((categories_one_hot_test, sub_categories_one_hot_test, school_state_categorie
X_cr = hstack((categories_one_hot_cv, sub_categories_one_hot_cv, school_state_categories_or
```

In [114]:

```
print("Final Data matrix")
print(X_tr.shape, y_train.shape)
print(X_cr.shape, y_cv.shape)
print(X_te.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(49041, 6349) (49041,)
(24155, 6349) (24155,)
(36052, 6349) (36052,)
====================================================================================
========================
```

In [113]:

```
def batch_predict(clf, data):
    # roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of t
    # not the predicted outputs

    y_data_pred = []
    tr_loop = data.shape[0] - data.shape[0]%1000
    # consider you X_tr shape is 49041, then your cr_loop will be 49041 - 49041%1000 = 4900
    # in this for loop we will iterate unti the last 1000 multiplier
    for i in range(0, tr_loop, 1000):
        y_data_pred.extend(clf.predict_proba(data[i:i+1000])[:,1])
    # we will be predicting for the last data points
    y_data_pred.extend(clf.predict_proba(data[tr_loop:])[:,1])

    return y_data_pred
```

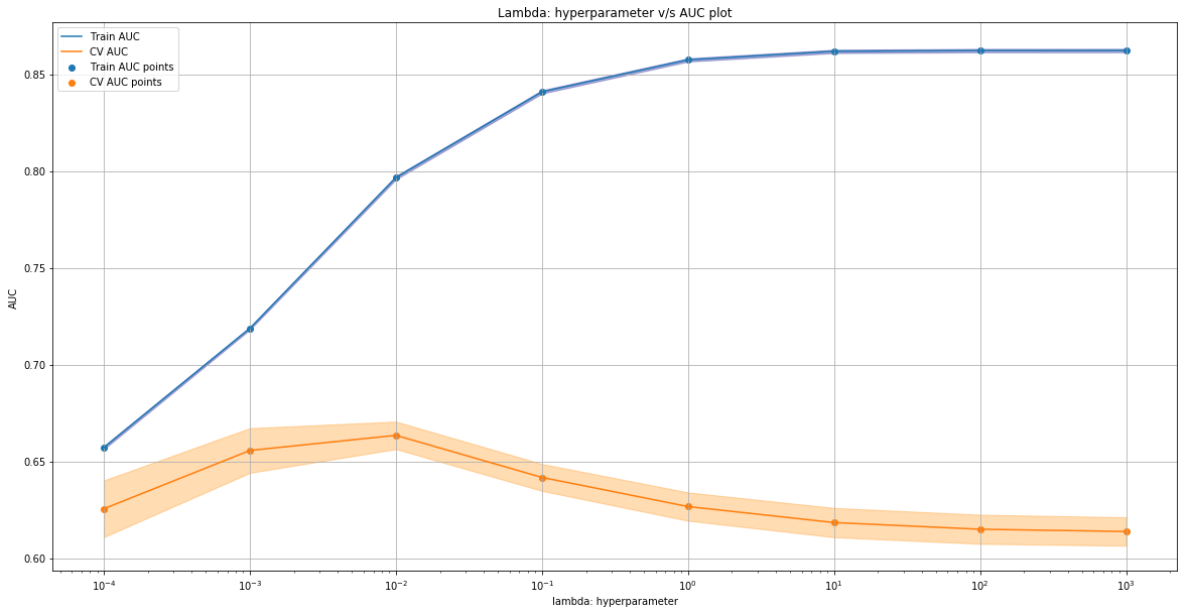
A) Gridsearch-cv

In [108]:

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

In [121]:

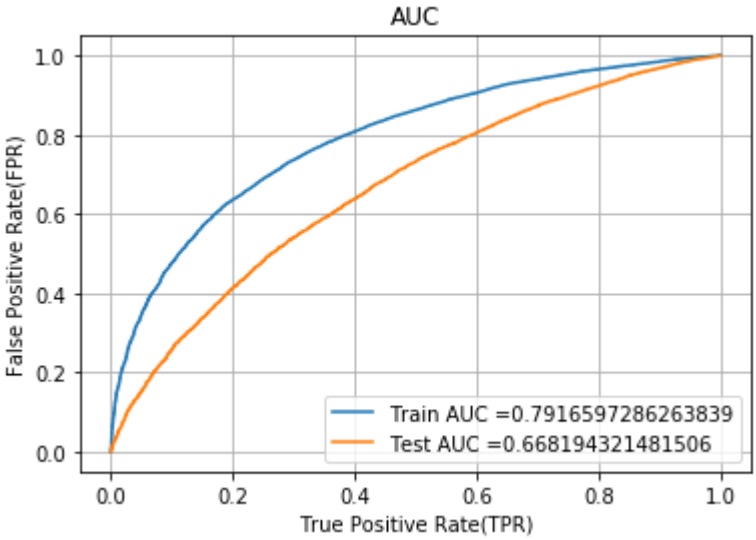
```
lr = LogisticRegression(class_weight = 'balanced')

C_vals = [10**x for x in range(-4,4)]

parameters = {'C':C_vals}

clf = GridSearchCV(lr, parameters, cv= 10, scoring='roc_auc')

clf.fit(X_tr, y_train)

train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

plt.figure(figsize=(20,10))

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.3,cc

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')
plt.xscale('log')

plt.legend()
plt.xlabel("lambda: hyperparameter")
plt.ylabel("AUC")
plt.title("Lambda: hyperparameter v/s AUC plot")
plt.grid()
plt.show()
```



B) Train model using the best hyper-parameter value

In [122]:

```
model = LogisticRegression(C = 0.01,class_weight = 'balanced')

model.fit(X_tr, y_train)

# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the p
# not the predicted outputs

y_train_pred = batch_predict(model, X_tr)
y_test_pred = batch_predict(model, X_te)

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)

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.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC")
plt.grid()
plt.show()
```



D) Confusion Matrix

In [112]:

```
def predict(proba, threshould, fpr, tpr):

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

    # (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.round(t
    predictions = []
    for i in proba:
        if i>=t:
            predictions.append(1)
        else:
            predictions.append(0)
    return predictions
```

Train Data

In [124]:

```
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))
```

```
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.413
[[ 3713  3713]
 [ 5718 35897]]
```

In [125]:

```
conf_matr_df_train_1 = pd.DataFrame(confusion_matrix(y_train, predict(y_train_pred, tr_thre
```

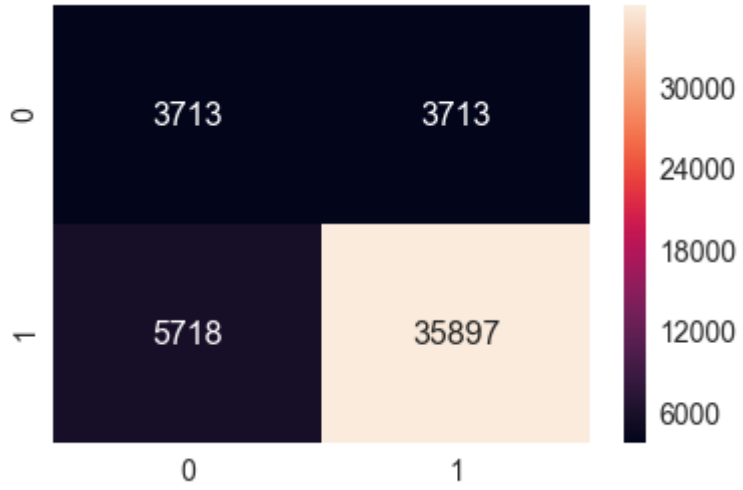
```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.413
```

In [126]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_train_1, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[126]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1ce62ed0f98>
```



Test Data

In [127]:

```
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr)))
```

```
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.457
[[ 2606  2853]
 [ 7585 23008]]
```

In [128]:

```
conf_matr_df_test_2 = pd.DataFrame(confusion_matrix(y_test, predict(y_test_pred, tr_thresho
```

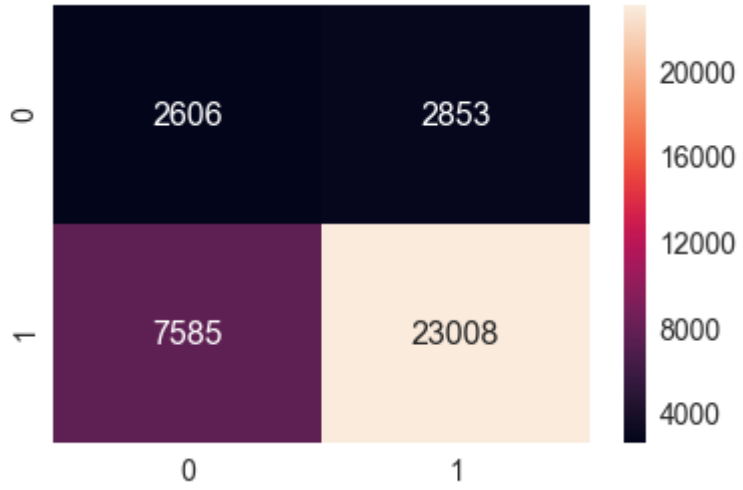
```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.457
```

In [129]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_test_2, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[129]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1ce09fbeda0>
```



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

In [130]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack

X_tr = hstack((categories_one_hot_train, sub_categories_one_hot_train, school_state_categor
X_te = hstack((categories_one_hot_test, sub_categories_one_hot_test, school_state_categorie
X_cr = hstack((categories_one_hot_cv, sub_categories_one_hot_cv, school_state_categories_or
```

In [131]:

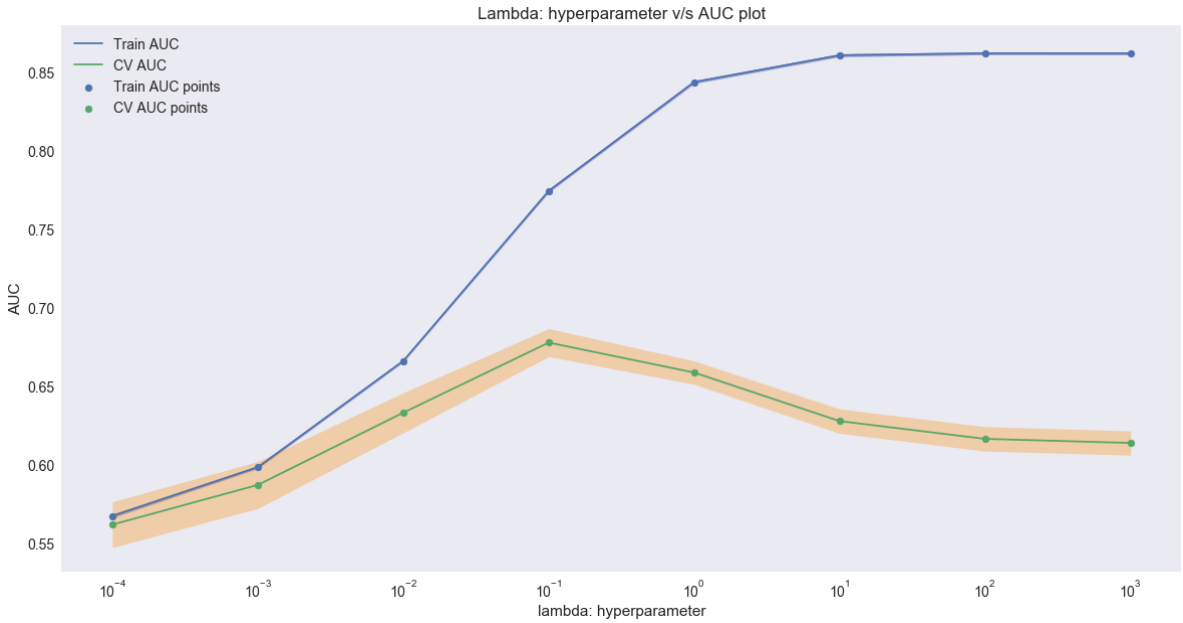
```
print("Final Data matrix")
print(X_tr.shape, y_train.shape)
print(X_cr.shape, y_cv.shape)
print(X_te.shape, y_test.shape)
```

```
Final Data matrix
(49041, 6349) (49041,)
(24155, 6349) (24155,)
(36052, 6349) (36052,)
```

GridSearch CV

In [132]:

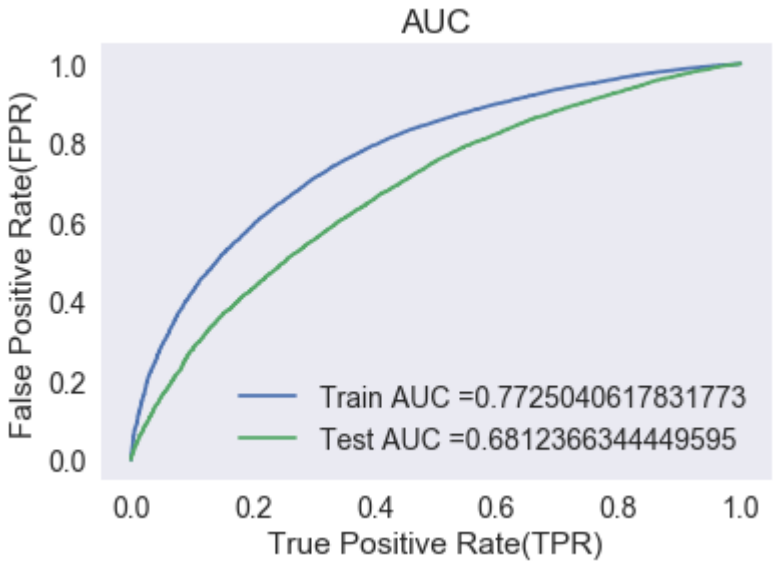
```
lr = LogisticRegression(class_weight = 'balanced')

C_vals = [10**x for x in range(-4,4)]

parameters = {'C':C_vals}

clf = GridSearchCV(lr, parameters, cv= 10, scoring='roc_auc')

clf.fit(X_tr, y_train)

train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

plt.figure(figsize=(20,10))

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.3,cc

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')

plt.xscale('log')
plt.legend()
plt.xlabel("lambda: hyperparameter")
plt.ylabel("AUC")
plt.title("Lambda: hyperparameter v/s AUC plot")
plt.grid()
plt.show()
```



Train model using the best hyper-parameter value

In [133]:

```
model = LogisticRegression(C = 0.1,class_weight = 'balanced')

model.fit(X_tr, y_train)

# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the p
# not the predicted outputs

y_train_pred = batch_predict(model, X_tr)
y_test_pred = batch_predict(model, X_te)

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)

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.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC")
plt.grid()
plt.show()
```



Confusion Matrix -Train data

In [134]:

```
print("Train confusion matrix")
print(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_fpr))
```

```
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.2499999818661462 for threshold 0.429
[[ 3714  3712]
 [ 6084 35531]]
```

In [135]:

```
conf_matr_df_train_3 = pd.DataFrame(confusion_matrix(y_train, predict(y_train_pred, tr_thre
```

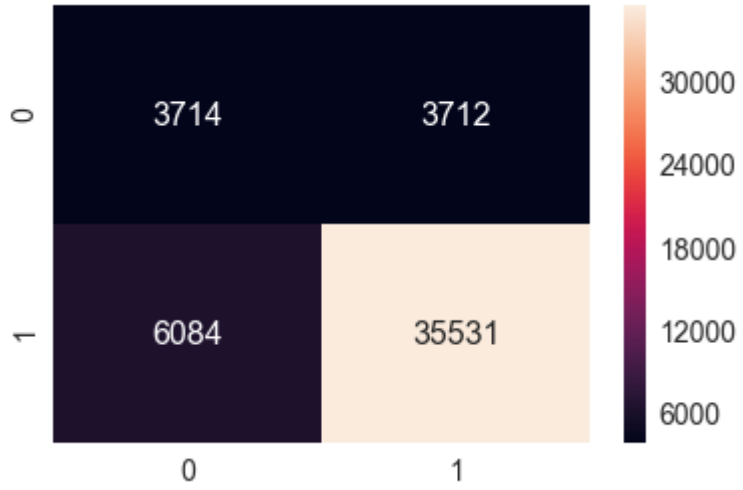
```
the maximum value of tpr*(1-fpr) 0.2499999818661462 for threshold 0.429
```

In [136]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_train_3, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[136]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1ce68f38e80>
```



Test Data

In [137]:

```
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr)))
```

```
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.471
[[ 2823  2636]
 [ 8046 22547]]
```

In [138]:

```
conf_matr_df_test_4 = pd.DataFrame(confusion_matrix(y_test, predict(y_test_pred, tr_threshc
```

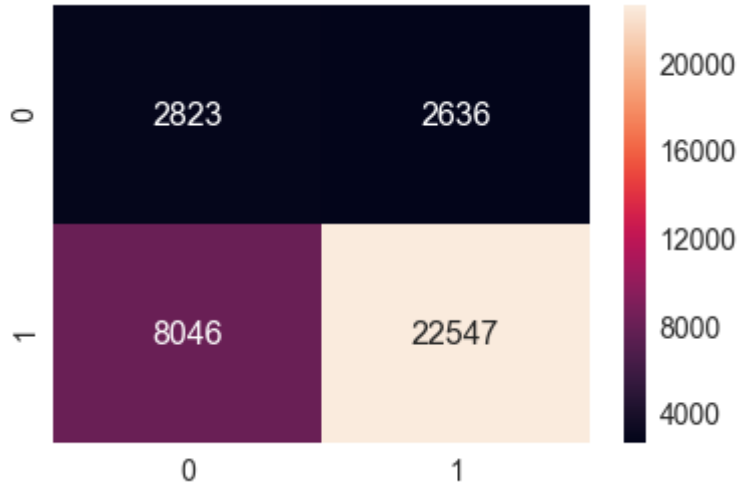
```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.471
```

In [139]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_test_4, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[139]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1ce66a601d0>
```



Set 3 : Categorical, Numerical features + Project_title(AVG W2V) + Preprocessed_essay (AVG W2V)

In [140]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack

X_tr = hstack((categories_one_hot_train, sub_categories_one_hot_train, school_state_categor
X_te = hstack((categories_one_hot_test, sub_categories_one_hot_test, school_state_categorie
X_cr = hstack((categories_one_hot_cv, sub_categories_one_hot_cv, school_state_categories_or
```

In [141]:

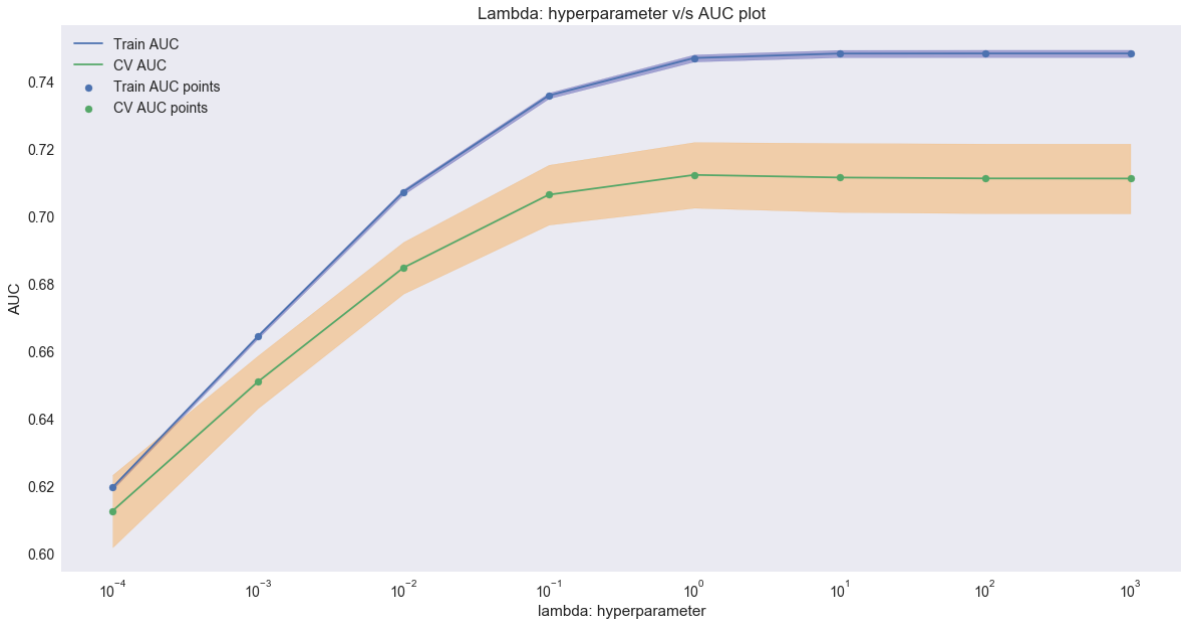
```
print("Final Data matrix")
print(X_tr.shape, y_train.shape)
print(X_cr.shape, y_cv.shape)
print(X_te.shape, y_test.shape)
```

```
Final Data matrix
(49041, 705) (49041,)
(24155, 705) (24155,)
(36052, 705) (36052,)
```

Gridsearch CV

In [142]:

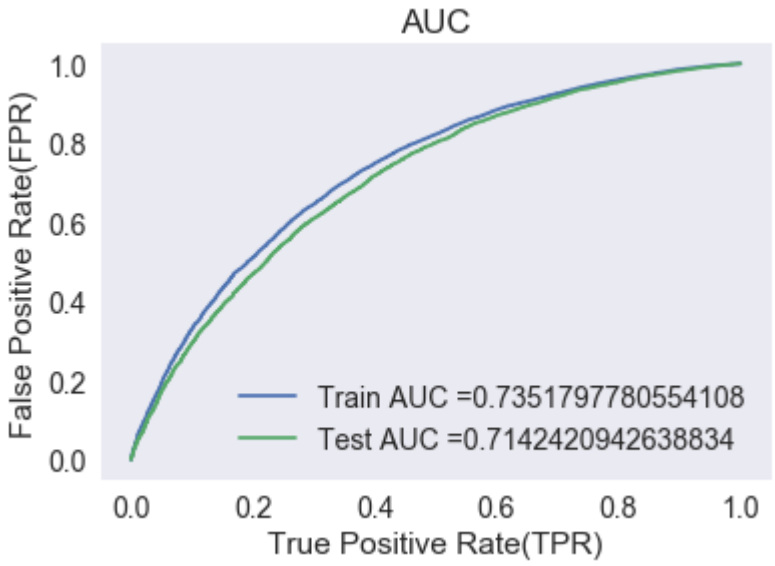
```
lr = LogisticRegression(class_weight = 'balanced')

C_vals = [10**x for x in range(-4,4)]

parameters = {'C':C_vals}

clf = GridSearchCV(lr, parameters, cv= 10, scoring='roc_auc')

clf.fit(X_tr, y_train)

train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

plt.figure(figsize=(20,10))

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.3,cc

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')

plt.xscale('log')
plt.legend()
plt.xlabel("lambda: hyperparameter")
plt.ylabel("AUC")
plt.title("Lambda: hyperparameter v/s AUC plot")
plt.grid()
plt.show()
```



B) Train the model using the best hyper parameter value

In [143]:

```
model = LogisticRegression(C = 0.1,class_weight = 'balanced')

model.fit(X_tr, y_train)

# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the p
# not the predicted outputs

y_train_pred = batch_predict(model, X_tr)
y_test_pred = batch_predict(model, X_te)

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)

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.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC")
plt.grid()
plt.show()
```



C) Confusion Matrix

Train data

In [144]:

```
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))
```

```
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.412
[[ 3713  3713]
 [ 7437 34178]]
```

In [145]:

```
conf_matr_df_train_5 = pd.DataFrame(confusion_matrix(y_train, predict(y_train_pred, tr_thre
```

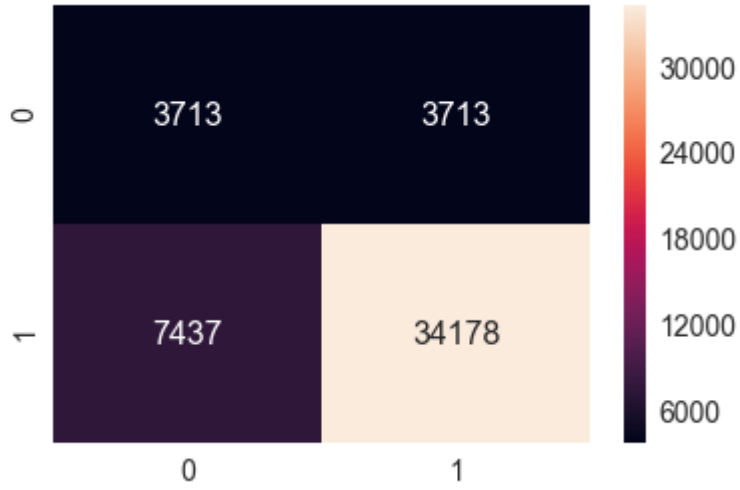
```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.412
```

In [146]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_train_5, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[146]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1ce407f4f28>
```



Test data

In [147]:

```
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr)))
```

```
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.477
[[ 3348  2111]
 [ 9157 21436]]
```

In [148]:

```
conf_matr_df_test_6 = pd.DataFrame(confusion_matrix(y_test, predict(y_test_pred, tr_thresho
```

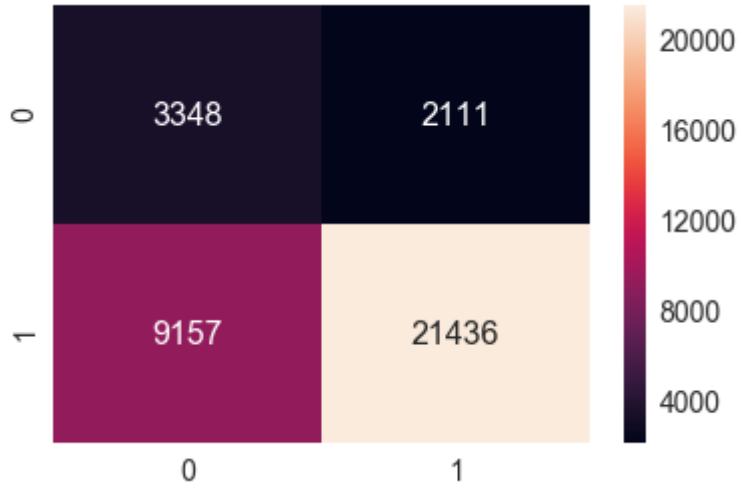
```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.477
```

In [ ]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_test_6, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[156]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1ce70b4a128>
```



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

In [105]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack

X_tr = hstack((categories_one_hot_train, sub_categories_one_hot_train, school_state_categor
X_te = hstack((categories_one_hot_test, sub_categories_one_hot_test, school_state_categorie
X_cr = hstack((categories_one_hot_cv, sub_categories_one_hot_cv, school_state_categories_or
```

In [106]:

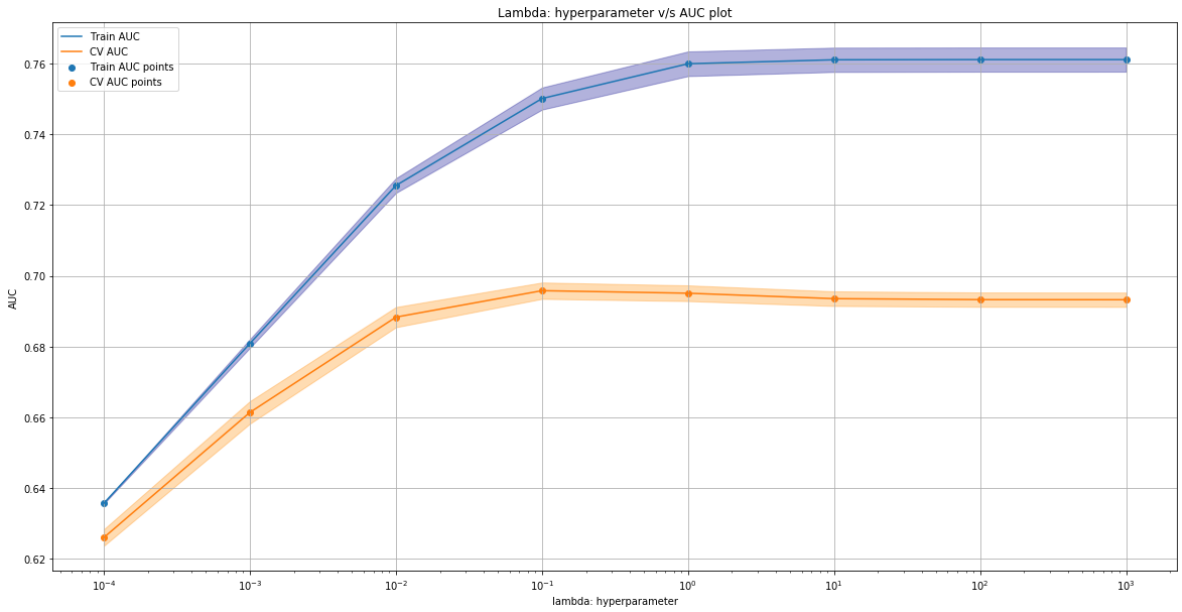
```
print("Final Data matrix")
print(X_tr.shape, y_train.shape)
print(X_cr.shape, y_cv.shape)
print(X_te.shape, y_test.shape)
```

```
Final Data matrix
(49041, 705) (49041,)
(24155, 705) (24155,)
(36052, 705) (36052,)
```

GridSearchCV

In [110]:

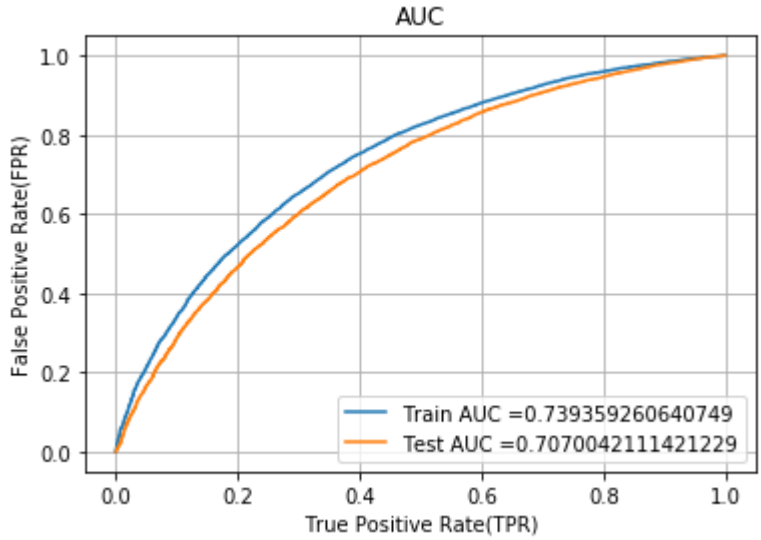
```
lr = LogisticRegression(class_weight = 'balanced')

C_vals = [10**x for x in range(-4,4)]

parameters = {'C':C_vals}

clf = GridSearchCV(lr, parameters, cv= 2, scoring='roc_auc',n_jobs=-1)

clf.fit(X_tr, y_train)

train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

plt.figure(figsize=(20,10))

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.3,cc

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')

plt.xscale('log')
plt.legend()
plt.xlabel("lambda: hyperparameter")
plt.ylabel("AUC")
plt.title("Lambda: hyperparameter v/s AUC plot")
plt.grid()
plt.show()
```



Train the model using the best hyper parameter value

In [114]:

```
model = LogisticRegression(C = 0.1,class_weight = 'balanced')

model.fit(X_tr, y_train)

# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the p
# not the predicted outputs

y_train_pred = batch_predict(model, X_tr)
y_test_pred = batch_predict(model, X_te)

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)

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.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC")
plt.grid()
plt.show()
```



Confusion Matrix

In [115]:

```
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))
```

```
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.2499999818661462 for threshold 0.401
[[ 3712  3714]
 [ 7267 34348]]
```

In [116]:

```
conf_matr_df_train_7 = pd.DataFrame(confusion_matrix(y_train, predict(y_train_pred, tr_thre
```

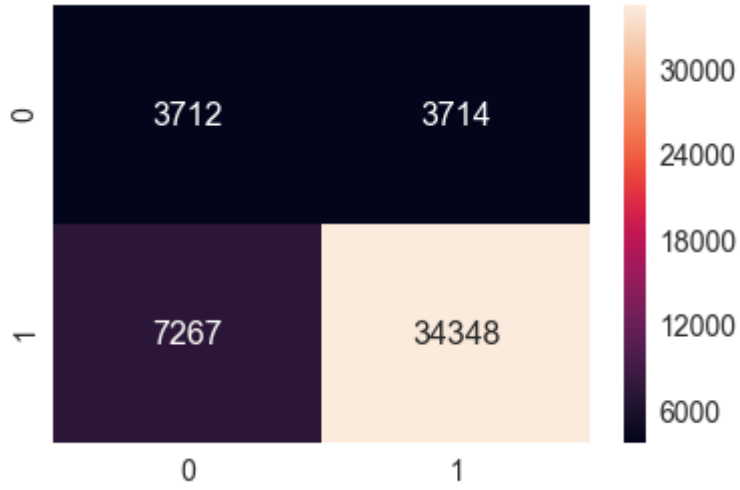
```
the maximum value of tpr*(1-fpr) 0.2499999818661462 for threshold 0.401
```

In [117]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_train_7, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[117]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x213e716b9e8>
```



In [118]:

```
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr)))
```

```
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092995 for threshold 0.468
[[ 3284  2175]
 [ 9037 21556]]
```

In [119]:

```
conf_matr_df_test_8 = pd.DataFrame(confusion_matrix(y_test, predict(y_test_pred, tr_thresho
```

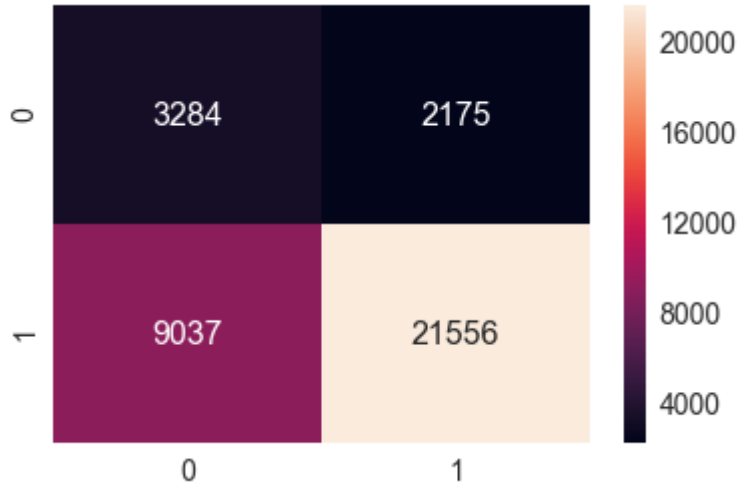
```
the maximum value of tpr*(1-fpr) 0.24999999161092995 for threshold 0.468
```

In [120]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_test_8, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[120]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x213bfded780>
```



Set 5 : Categorical features, Numerical features & Essay Sentiments

In [121]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack

X_tr = hstack((categories_one_hot_train, sub_categories_one_hot_train, school_state_categor
X_te = hstack((categories_one_hot_test, sub_categories_one_hot_test, school_state_categorie
X_cr = hstack((categories_one_hot_cv, sub_categories_one_hot_cv, school_state_categories_or
```

In [122]:

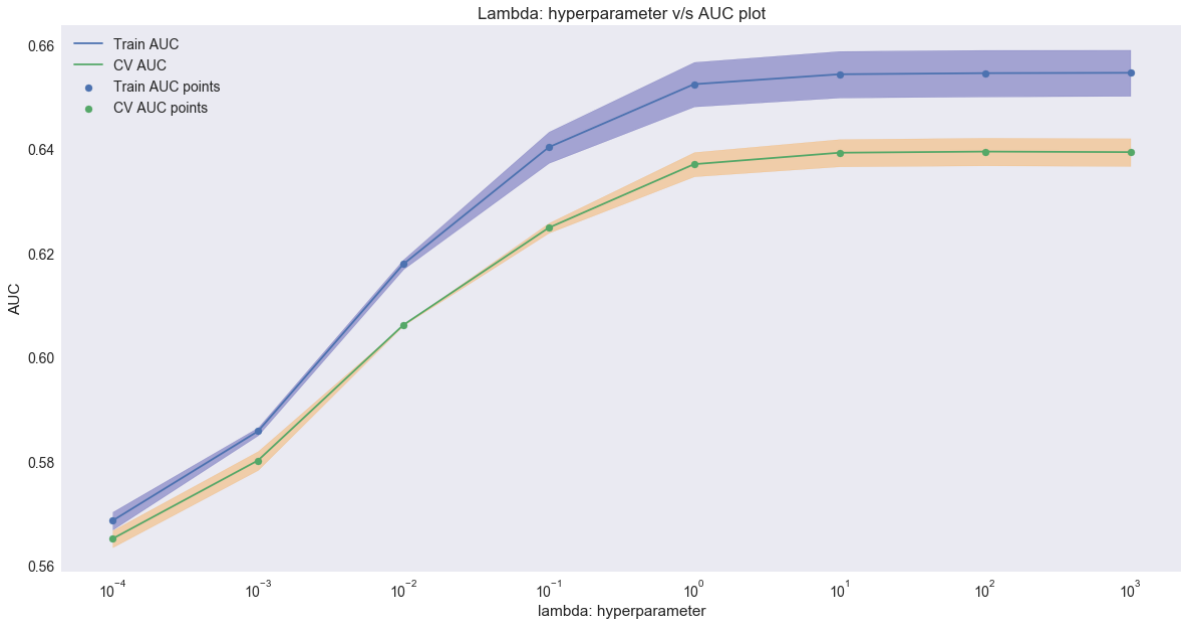
```
print("Final Data matrix")
print(X_tr.shape, y_train.shape)
print(X_cr.shape, y_cv.shape)
print(X_te.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(49041, 109) (49041,)
(24155, 109) (24155,)
(36052, 109) (36052,)
====================================================================================
========================
```

GridSearch CV

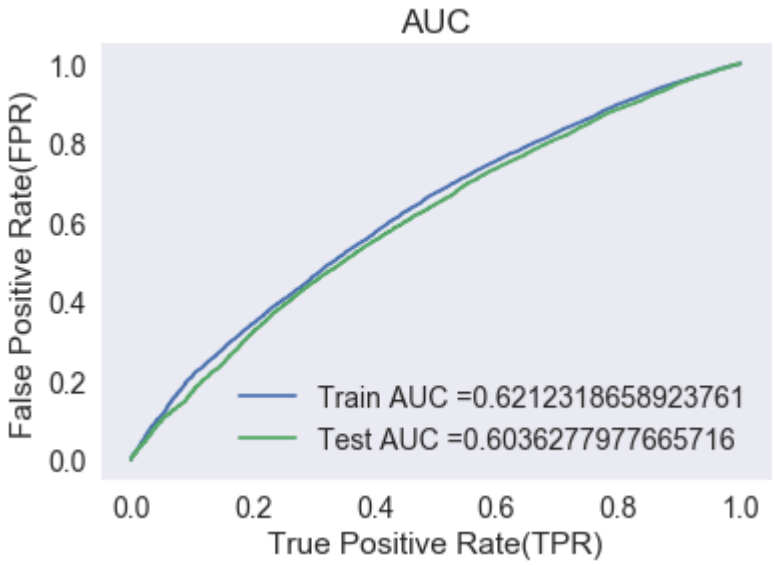
In [123]:

```
lr = LogisticRegression(class_weight = 'balanced')

C_vals = [10**x for x in range(-4,4)]

parameters = {'C':C_vals}

clf = GridSearchCV(lr, parameters, cv= 2, scoring='roc_auc',n_jobs=-1)

clf.fit(X_tr, y_train)

train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

plt.figure(figsize=(20,10))

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.3,cc

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')

plt.xscale('log')
plt.legend()
plt.xlabel("lambda: hyperparameter")
plt.ylabel("AUC")
plt.title("Lambda: hyperparameter v/s AUC plot")
plt.grid()
plt.show()
```



In [124]:

```
model = LogisticRegression(C = 0.01,class_weight = 'balanced')

model.fit(X_tr, y_train)

# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the p
# not the predicted outputs

y_train_pred = batch_predict(model, X_tr)
y_test_pred = batch_predict(model, X_te)

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)

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.xlabel("True Positive Rate(TPR)")
plt.ylabel("False Positive Rate(FPR)")
plt.title("AUC")
plt.grid()
plt.show()
```



Confusion Matrix

In [125]:

```
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))
```

```
Train confusion matrix
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.481
[[ 3713  3713]
 [13545 28070]]
```

In [126]:

```
conf_matr_df_train_9 = pd.DataFrame(confusion_matrix(y_train, predict(y_train_pred, tr_thre
```

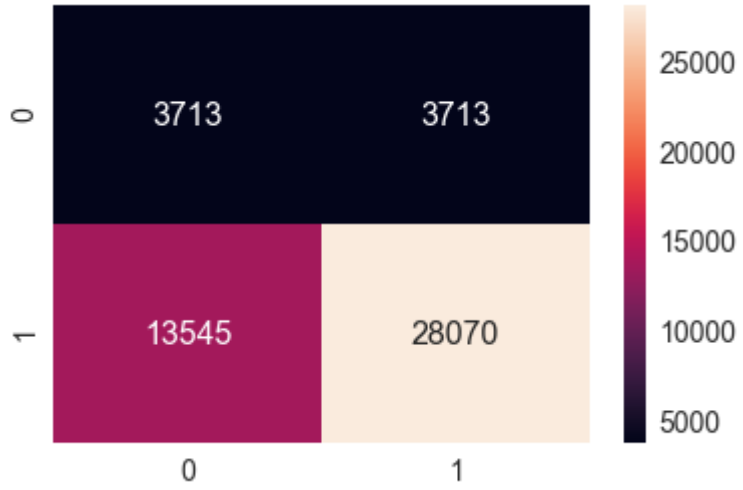
```
the maximum value of tpr*(1-fpr) 0.25 for threshold 0.481
```

In [127]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_train_9, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[127]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x213e76ba780>
```



In [128]:

```
print("Test confusion matrix")
print(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_fpr)))
```

```
Test confusion matrix
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.509
[[ 3351  2108]
 [14051 16542]]
```

In [129]:

```
conf_matr_df_test_10 = pd.DataFrame(confusion_matrix(y_test, predict(y_test_pred, tr_thresh
```

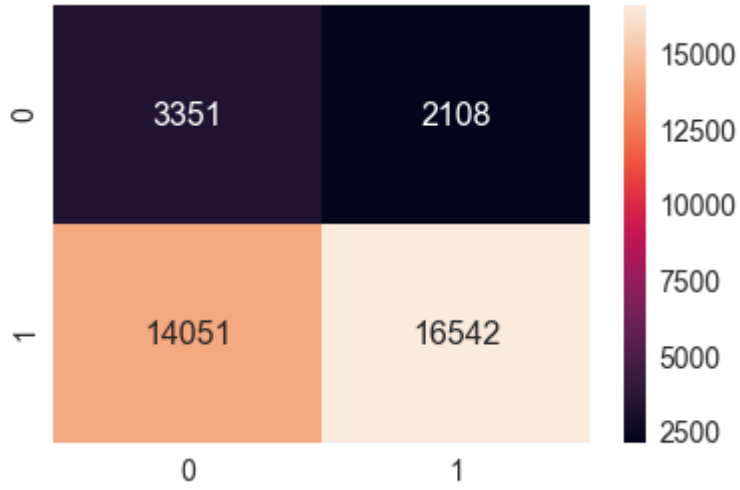
```
the maximum value of tpr*(1-fpr) 0.24999999161092998 for threshold 0.509
```

In [130]:

```
sns.set(font_scale=1.4)#for label size
sns.heatmap(conf_matr_df_test_10, annot=True,annot_kws={"size": 16}, fmt='g')
```

Out[130]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x213bf409a20>
```



In [132]:

```
from prettytable import PrettyTable

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

x = PrettyTable()
x.field_names = ["Vectorizer", "Model", "Alpha:Hyper Parameter", "AUC"]

x.add_row(["BOW", "Logistic Regression", 0.01, 0.67])
x.add_row(["TFIDF", "Logistic Regression", 0.1, 0.68])
x.add_row(["AVG W2V", "Logistic Regression", 0.1, 0.71])
x.add_row(["TFIDF W2V", "Logistic Regression", 0.1, 0.70])
x.add_row(["WITHOUT TEXT", "Logistic Regression", 0.01, 0.6])


print(x)
```

```
+--------------+---------------------+-----------------------+------+
|  Vectorizer  |        Model        | Alpha:Hyper Parameter | AUC  |
+--------------+---------------------+-----------------------+------+
|     BOW      | Logistic Regression |          0.01         | 0.67 |
|    TFIDF     | Logistic Regression |          0.1          | 0.68 |
|   AVG W2V    | Logistic Regression |          0.1          | 0.71 |
|  TFIDF W2V   | Logistic Regression |          0.1          | 0.7  |
| WITHOUT TEXT | Logistic Regression |          0.01         | 0.6  |
+--------------+---------------------+-----------------------+------+
```