

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
print('done')
```

done

Reading Data

In [2]:

```
dft = pd.read_csv('train_data.csv',nrows=50000)
dfr = pd.read_csv('resources.csv')
```

In [3]:

```
print("Number of data points in train data", dft.shape)
print('-'*50)
print("The attributes of data :", dft.columns.values)

print(dfr.shape)
print(dfr.columns.values)
```

Number of data points in train data (50000, 17)

The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix' 'school_state' 'project_submitted_datetime' 'project_grade_category' 'project_subject_categories' 'project_subject_subcategories' 'project_title' 'project_essay_1' 'project_essay_2' 'project_essay_3' 'project_essay_4' 'project_resource_summary' 'teacher_number_of_previously_posted_projects' 'project_is_approved']
(1541272, 4)
['id' 'description' 'quantity' 'price']

In [5]:

```
#sort the datapoints by date <-

# 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(dft.columns)]

#sort dataframe based on time pandas python: https://stackoverflow.com/a/49702492/4084039
dft['Date'] = pd.to_datetime(dft['project_submitted_datetime'])
dft.drop('project_submitted_datetime', axis=1, inplace=True)# we drop the col
dft.sort_values(by=['Date'], inplace=True)# sort the values y date

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

dft.head(2)
```

Out[5]:

| | Unnamed: 0 | id | teacher_id | teacher_prefix | school_state |
|-------|------------|---------|----------------------------------|----------------|--------------|
| 473 | 100660 | p234804 | cbc0e38f522143b86d372f8b43d4cff3 | Mrs. | GA |
| 41558 | 33679 | p137682 | 06f6e62e17de34fcf81020c77549e1d5 | Mrs. | WA |

Text preprocessing

In [6]:

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

In [7]:

```
dft.head(2)
```

Out[7]:

| | Unnamed: 0 | id | teacher_id | teacher_prefix | school_state |
|-------|------------|---------|----------------------------------|----------------|--------------|
| 473 | 100660 | p234804 | cbc0e38f522143b86d372f8b43d4cff3 | Mrs. | GA |
| 41558 | 33679 | p137682 | 06f6e62e17de34fcf81020c77549e1d5 | Mrs. | WA |

In [8]:

```
# 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 [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'r
e", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him',
'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 't
hey', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "th
at'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'ha
d', 'having', 'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as'
, 'until', 'while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through'
, 'during', 'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'ov
er', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'an
y', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too'
, 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'no
w', 'd', 'll', 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't",
'doesn', "doesn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'migh
tn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'w
asn', "wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

Preprocessing of project_subject_categories

In [10]:

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

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

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

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

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

Preprocessing of project_subject_subcategories

In [11]:

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

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

sub_cat_list = []
for i in sub_categories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(','): # it will split it in three parts ["Math & Science", "Warmth", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the category based on space "Math & Science" => "Math", "&", "Science"
            j = j.replace('The', '') # if we have the words "The" we are going to replace it with '' (i.e removing 'The')
            j = j.replace(' ', '') # we are replacing all the ' ' (space) with '' (empty) ex: "Math & Science" => "Math&Science"
            temp += j.strip() + " #"
    temp = temp.replace('&', '_')
    sub_cat_list.append(temp.strip())

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

Preprocessing of project_grade_category

In [12]:

```
print(dft['project_grade_category'][:20])# we have to remove the grades from every row
```

```
473      Grades PreK-2
41558      Grades 3-5
29891      Grades 3-5
23374      Grades PreK-2
49228      Grades PreK-2
7176      Grades PreK-2
35006      Grades 3-5
5145      Grades 3-5
48237      Grades 9-12
46375      Grades 3-5
36468      Grades PreK-2
36358      Grades PreK-2
39438      Grades PreK-2
2521      Grades PreK-2
40180      Grades PreK-2
25460      Grades 6-8
34399      Grades 3-5
5364      Grades 6-8
47478      Grades 9-12
45858      Grades 3-5
Name: project_grade_category, dtype: object
```

In [13]:

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

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

grade_cat_list = []
for i in d:
    # consider we have text like this:
    for j in i.split(' '): # # split by space
        j=j.replace('Grades','')# clean grades from the row
    grade_cat_list.append(j.strip())

dft['clean_grade'] = grade_cat_list
dft.drop(['project_grade_category'], axis=1, inplace=True)

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

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

Preparing data for the models

Test - Train Split

In [15]:

```
#Splitting Data into train and Test sklearn https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.train_test_split.html
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(dft,
                                                    dft['project_is_approved'],
                                                    stratify= dft['project_is_approve
d'],
                                                    test_size = 0.33
                                                    )
```

In [16]:

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

In [17]:

```
print(y_train.value_counts())
print(y_test.value_counts())
print(y_cv.value_counts())
# huge imbalance
```

```
1    18982
0     3463
Name: project_is_approved, dtype: int64
1    13954
0     2546
Name: project_is_approved, dtype: int64
1     9350
0     1705
Name: project_is_approved, dtype: int64
```


In [18]:

```
#dropping the y labels
#https://stackoverflow.com/questions/13411544/delete-column-from-pandas-dataframe-by-column-name
#x_train =
X_train.drop(["project_is_approved"], axis = 1, inplace = True)
#x_test =
X_test.drop(["project_is_approved"], axis = 1, inplace = True)
#x_cv =
X_cv.drop(["project_is_approved"], axis = 1, inplace = True)
print(X_train)
```

| | Unnamed: 0 | id | teacher_id | teacher_prefi |
|-------|------------|---------|-----------------------------------|---------------|
| x \ | | | | |
| 19617 | 115789 | p241258 | 1de26f587275b51c8113097c48d2191f | Mr |
| S. | | | | |
| 44542 | 155307 | p212523 | b8678a3f0938b1e1026fb0b7ce9e25bd | M |
| S. | | | | |
| 8792 | 66079 | p239681 | 62f7c40fbd176a2d9c3d93bb4b9c64ad | Mr |
| S. | | | | |
| 25974 | 172712 | p223608 | fd6df7d7e9374d98c5e32997f9af7ec6 | M |
| S. | | | | |
| 18120 | 59643 | p095656 | d23b27efc87b13832df0e2cd1107f768 | Mr |
| S. | | | | |
| 17351 | 72489 | p158391 | c01e73f550c7a0a39fc8e7b074322a33 | Mr |
| S. | | | | |
| 22925 | 77948 | p124386 | 2de7f0b5ad7387bfbaf3a08dfd9866eb | Mr |
| S. | | | | |
| 19317 | 61244 | p116830 | 1df3c8ea6a0f45314a5c922a2ce91d86 | M |
| S. | | | | |
| 10569 | 6582 | p244766 | c8b3f99581f468d0e8635cca0870a675 | Mr |
| S. | | | | |
| 42779 | 79687 | p258554 | 58d8ad4c9e0fa7129b8ff8d707aacde8 | Mr |
| S. | | | | |
| 40456 | 73497 | p220593 | ce21478a570b082b251d5a3425091fd4 | M |
| S. | | | | |
| 30426 | 40474 | p127767 | fb5c8d34582c1307185e9266a3b480bc | Mr |
| S. | | | | |
| 35093 | 67475 | p195646 | 1033f4a5a8fc318f17e08526eb94f1e9 | M |
| S. | | | | |
| 38144 | 120757 | p136385 | dc4b8bba53041d26a44a4c375b93e682 | Mr |
| S. | | | | |
| 47871 | 51251 | p164932 | 27eaaa612ac4b4711555e7e0b220f5a5 | M |
| r. | | | | |
| 39284 | 26685 | p109140 | ad3eae955a3cee708c82a0a11854d1b2 | M |
| S. | | | | |
| 11507 | 132632 | p135642 | c1dd0c3744029b837ef6e6f09099fd5d | M |
| S. | | | | |
| 35564 | 102961 | p059022 | 7213287aab328210611797e1c27bf48e | Mr |
| S. | | | | |
| 30320 | 159769 | p066097 | f9f8e9c3e599693bb3314ff645f4beec | M |
| S. | | | | |
| 18699 | 8286 | p053340 | ea94d0d360113e756195aeea80dd36f9 | M |
| S. | | | | |
| 36429 | 144611 | p102392 | 6c9dd23184c048df50a7388b5d61e8e4 | M |
| S. | | | | |
| 38984 | 124991 | p134222 | 507494cdcac17ac7974cc21ab7b349a3 | Mr |
| S. | | | | |
| 23309 | 120220 | p042134 | 862de24454ad34fd8937f9dcb18abdd3 | Mr |
| S. | | | | |
| 40353 | 155911 | p253123 | 5ea8a6daa87740fa916d9c98415e9114 | M |
| S. | | | | |
| 27925 | 163527 | p143021 | 42bc7030c016f625d8a0e28f69599752 | Mr |
| S. | | | | |
| 16118 | 139696 | p131898 | 6fefaf33c27c375ddb39a7fafc5e6df76 | Mr |
| S. | | | | |
| 216 | 50938 | p027540 | f356bc9063c1c1334cee2fcb6d0ddf57 | M |
| r. | | | | |
| 36537 | 88157 | p244428 | 85f308713e285c327047d95e50d1554f | M |
| S. | | | | |
| 8400 | 145981 | p169535 | a58e50a713edef56e6a136f421f4fa99 | M |
| S. | | | | |
| 39774 | 25240 | p238128 | 11c9673d9c660e711579d8e6ff07260e | M |

| | | | | |
|-------|--------|---------|------------------------------------|--------|
| S. | | | | |
| ... | | | | ... |
| ... | | | | |
| 12783 | 39244 | p176370 | 2d9af17605887d1048438175779c324e | Teache |
| r | | | | |
| 43739 | 3194 | p033209 | b852f9d7f183b4a6a41a6d2a695aa702 | M |
| S. | | | | |
| 3995 | 50128 | p209904 | 4e7e14041d3f3a64e99f6e698ba122ea | M |
| S. | | | | |
| 28114 | 54792 | p069249 | 9df44cd9b4f57a102ae8f463e53f15a0 | Mr |
| S. | | | | |
| 23615 | 56023 | p038396 | 3b950f9d307bcafc fed a4f833f99e8de | Mr |
| S. | | | | |
| 45830 | 137680 | p214261 | c25c2b33471663158b4a1398dcd fc4f7 | Mr |
| S. | | | | |
| 14894 | 103105 | p172065 | 04dc dcf90807262e5cbe3a7a1435ca8b | Mr |
| S. | | | | |
| 38994 | 179539 | p183680 | 4137d18d1b67c25b1ef331c039e7d643 | Mr |
| S. | | | | |
| 28377 | 143315 | p218796 | 6d13895525a0070ee4b1da65f32011bc | M |
| S. | | | | |
| 49705 | 36786 | p183090 | b25b1a97c0e1bd8f8f0e67405861db20 | M |
| S. | | | | |
| 43128 | 146380 | p214834 | 1a5b07c74d9ce2b245acc4e0af01f477 | Mr |
| S. | | | | |
| 14958 | 93536 | p151204 | dabeb82dcbf80009104fbf085819cc1f | M |
| S. | | | | |
| 22697 | 25398 | p178741 | cbe1077b38c3baed9b036e392f48817d | M |
| S. | | | | |
| 36777 | 81712 | p126609 | 555918822cf6000f32d8866f9ada2b30 | Mr |
| S. | | | | |
| 7348 | 1302 | p001014 | 49dbe5521b40c3f5e89ccfc29fb3fbb7 | Mr |
| S. | | | | |
| 8509 | 62127 | p137484 | b4af7caa752f754cfcb3a1f9f1e06fc0 | Mr |
| S. | | | | |
| 4665 | 143007 | p187559 | 493c3219121650b2fafcecc27d837dc2 | M |
| S. | | | | |
| 34668 | 60163 | p016176 | 881f55bb99d35f9b86bfc76f25baf3b1 | Mr |
| S. | | | | |
| 22540 | 61530 | p189297 | db7f3336654f2f84cc86c6b14f3903b6 | M |
| r. | | | | |
| 27347 | 162636 | p102923 | 28abf57a96070e068108255626395202 | M |
| r. | | | | |
| 32442 | 86102 | p165188 | 05005648111c30c372cbb3aaa84b6b59 | Mr |
| S. | | | | |
| 20527 | 14181 | p162053 | 7ec5df5e932c6a5fee2ee5c294182f95 | M |
| S. | | | | |
| 41095 | 116776 | p169026 | 5f3aded414868e29d90200eaa9251e25 | M |
| S. | | | | |
| 15558 | 175477 | p046203 | 51376478c08a9a60b3e558b4e28b503c | M |
| r. | | | | |
| 11860 | 81632 | p113712 | 464db35aa7cc3915c2b3a4cf8cc6c61d | Mr |
| S. | | | | |
| 14697 | 45976 | p143810 | 1837091274bd8a061b7ffd0cc6fb3338 | M |
| r. | | | | |
| 44715 | 132427 | p198999 | 12ddc3da8d9ac763918aca0bfba3d7c0 | M |
| S. | | | | |
| 33670 | 78339 | p179229 | 853c234b876d9bdfe586d7f10f5af870 | Mr |
| S. | | | | |
| 48247 | 110601 | p091962 | 5e9a1a690001f6d55919507bf4541399 | Mr |
| S. | | | | |

447 115547 p031282 ecd5f5ea74067b600dac8f5954771ab2
S.

Mr

| | school_state | Date \ |
|-------|--------------|---------------------|
| 19617 | LA | 2017-01-23 11:37:37 |
| 44542 | MI | 2016-08-18 20:25:18 |
| 8792 | NC | 2016-05-18 10:37:56 |
| 25974 | DC | 2016-12-22 23:37:30 |
| 18120 | CA | 2017-03-16 01:09:53 |
| 17351 | AR | 2016-11-29 08:21:15 |
| 22925 | CA | 2017-01-09 00:14:21 |
| 19317 | VA | 2016-12-31 12:33:55 |
| 10569 | MS | 2016-09-01 10:29:00 |
| 42779 | MA | 2016-11-22 13:25:56 |
| 40456 | LA | 2017-01-17 17:46:45 |
| 30426 | OK | 2016-08-19 19:14:37 |
| 35093 | MN | 2016-11-29 08:50:36 |
| 38144 | FL | 2016-10-02 16:41:25 |
| 47871 | ME | 2016-12-07 10:54:48 |
| 39284 | LA | 2016-09-01 03:53:57 |
| 11507 | NC | 2016-11-21 19:57:19 |
| 35564 | WY | 2016-10-07 14:10:29 |
| 30320 | AR | 2016-09-28 09:55:56 |
| 18699 | IN | 2017-03-09 15:27:29 |
| 36429 | MN | 2016-05-04 13:24:28 |
| 38984 | NY | 2016-06-02 23:19:28 |
| 23309 | TX | 2016-10-03 12:48:34 |
| 40353 | MD | 2017-02-08 11:27:27 |
| 27925 | MA | 2016-08-01 01:18:45 |
| 16118 | NC | 2016-08-20 19:39:56 |
| 216 | CA | 2016-07-31 21:46:25 |
| 36537 | CA | 2016-06-01 17:43:43 |
| 8400 | UT | 2016-09-02 20:28:00 |
| 39774 | IA | 2016-09-30 13:28:30 |
| ... | ... | ... |
| 12783 | PA | 2016-07-08 22:37:59 |
| 43739 | NY | 2017-03-19 22:48:14 |
| 3995 | MN | 2017-02-17 09:28:17 |
| 28114 | KY | 2017-01-17 14:41:35 |
| 23615 | UT | 2016-09-18 22:37:46 |
| 45830 | SC | 2016-11-16 12:11:43 |
| 14894 | GA | 2016-09-28 14:55:43 |
| 38994 | FL | 2016-07-19 19:25:29 |
| 28377 | MN | 2016-08-03 21:56:05 |
| 49705 | NC | 2017-03-30 12:53:16 |
| 43128 | SC | 2016-05-03 17:02:32 |
| 14958 | VA | 2016-08-15 18:58:09 |
| 22697 | NY | 2016-08-01 14:03:22 |
| 36777 | UT | 2016-09-01 17:23:21 |
| 7348 | NJ | 2017-03-28 18:40:54 |
| 8509 | VA | 2016-10-13 15:19:40 |
| 4665 | HI | 2016-08-31 17:07:55 |
| 34668 | MO | 2016-05-27 15:48:24 |
| 22540 | CA | 2017-01-14 17:37:48 |
| 27347 | TN | 2016-09-25 20:52:45 |
| 32442 | IL | 2016-08-08 08:18:01 |
| 20527 | NY | 2017-02-10 15:27:23 |
| 41095 | LA | 2016-10-05 23:53:14 |
| 15558 | TX | 2016-07-20 03:01:32 |
| 11860 | FL | 2016-08-18 19:12:15 |
| 14697 | FL | 2017-03-29 09:10:41 |

44715 CA 2016-05-10 21:54:37
 33670 NC 2016-08-17 22:59:34
 48247 CO 2016-08-16 13:48:53
 447 PA 2016-08-02 18:14:56

project_title \

19617 Building Young Minds: STEM BUNDLE In PRE-K
 44542 Books For 5th Graders
 8792 Beautiful, comfortable and educational rug!
 25974 It's Time for Graffiti Art with 3Doodler! Part 2
 18120 Flexible Seating For Flexible Minds
 17351 DASHing Into Coding
 22925 Can't Stop Moving!
 19317 Stick it to Math the Magnetic Way
 10569 Chrome for class
 42779 Music! Demystify the Magic Behind Sound
 40456 Chromebooks for Chrome-kids
 30426 HELP US SET OUR BRAIN TO WORK IN TWO LANGUAGES!!
 35093 Classroom Chromebooks!
 38144 iPads, Ebooks and Accelerated Reader
 47871 Keep Things Organized
 39284 Growing With Music Movement
 11507 Engaging Families at Home and School in Their ...
 35564 Building Our Future!
 30320 Something Wonderful Has Sprouted
 18699 Re-Imagining the Past...Classic Myths as Graph...
 36429 Teaching Young Minds in 2016
 38984 Our kids want to STAND and LEARN in the classr...
 23309 Taking the Lexile Hop To The Top!
 40353 The Interscholastic Athlete!
 27925 Increasing App-titudes is Fun!
 16118 Organization Leads to Successful First Graders!
 216 SAVVY STEM START-UP USING ROBUST ROBOTICS
 36537 Space and Place for STEM
 8400 Happy, Wiggly First Graders in Search of Rug a...
 39774 Chromebooks for Technology Class
 ...
 12783 Making Math Accessible: The Supplies that Seco...
 43739 The Heart and Soul of Our Classroom Needs an U...
 3995 Girl Runners! Girl Power!
 28114 A Nap a Day Keeps the Doctor Away!
 23615 Education in Motion
 45830 Technology in Kindergarten??? ... ABSOLUTELY!
 14894 My Students Are on Fire! Kindle Fire!
 38994 Back(pack) to School II.
 28377 Where does food come from?
 49705 Flexible Seating For My Energetic Class
 43128 Deskless Classroom and Flexible Seating
 14958 How Can We Play Volleyball Without A Net Or Sh...
 22697 Technology is KEY!
 36777 Sensory for Success!
 7348 Play doh in PreK: Help us Mold Our Future
 8509 Silly second graders wobble, but they don't fa...
 4665 Taffy Techies
 34668 Supporting a Classroom Community
 22540 Leveraging Learning with a Set of Laptops!
 27347 Gym Class Heroes
 32442 Flexible Seating for Kindergarten Wiggles
 20527 Book Club !
 41095 Today a Reader, Tomorrow a Leader!
 15558 Capturing Our Future, Changing The Past!

11860 Technology and Books for 1st Graders!
 14697 To Shot or Not to Shot
 44715 Spanish for Everyone
 33670 Starting The Year Off Right With Data Tracking...
 48247 Wiggles and Jiggles Help Us Learn
 447 We Need to Move It, Move It!

project_essay_1 \

19617 I am a preschool teacher at an elementary scho...
 44542 We are a school that is welcoming and invites ...
 8792 A typical day in our classroom consists of lot...
 25974 Save our art class! We need your help to conti...
 18120 As a teacher in a low-income/high poverty scho...
 17351 My sixth grade students work hard, knowing tha...
 22925 You may think that you know what goes on in ou...
 19317 I work at a school where the children are grow...
 10569 I have a typical seventh grade class. My stude...
 42779 All my students do is want to learn. That's i...
 40456 We are fantastic Scientists and Mathematicians...
 30426 My students have been enrolled in the Dual Lan...
 35093 My second grade class is filled with students ...
 38144 I teach at a Title 1 school. Many of them rece...
 47871 My students are energetic, eager, and enthusia...
 39284 My pre-kindergarten students would be best des...
 11507 As a teacher in a Title I school, many of my s...
 35564 I teach in a Title I School where the majority...
 30320 Our school's upper elementary is comprised of ...
 18699 As a teacher in a low-income school, I am alwa...
 36429 Talk. Talk. Talk.. this is how students are le...
 38984 We are a Title 1 school in the South Bronx. I ...
 23309 I teach at a Title I school where most of our ...
 40353 The students at Samuel Ogle Middle School are ...
 27925 Located in the heart of Chinatown, our school ...
 16118 Our classroom will soon be filled with a diver...
 216 After walking my students to their junior high...
 36537 My classroom community is made up of a diverse...
 8400 I teach at a Title One school in a small town ...
 39774 As the Technology and Project Lead the Way tea...
 ...
 12783 As an incoming first year teacher, I haven't b...
 43739 The school is located in an urban community, w...
 3995 Minneapolis 3rd, 4th, and 5th graders are gett...
 28114 Hunter Hills Elementary has the highest povert...
 23615 My students are a group of top notch students....
 45830 My classroom is filled with happy, diverse stu...
 14894 My students are brave, creative, and intellige...
 38994 Students at my school are awesome. There are a...
 28377 My students are five year olds! Most of my st...
 49705 My students come from a variety of backgrounds...
 43128 Where did you like to do your homework when yo...
 14958 The Lady Vikings Volleyball team has never bee...
 22697 I teach in a classroom where the students are ...
 36777 As a teacher of students with disabilities, my...
 7348 My students need the opportunity to fulfill th...
 8509 My students are eager learners from diverse ba...
 4665 My 5th graders can be quite a talkative class!...
 34668 My students have become my family. This is my ...
 22540 My students come from multicultural background...
 27347 As a traveling physical education teacher in a...
 32442 \"Tell me and I forgot. Teach me and I remembe...
 20527 Our students are full of wonder about what the...

41095 If you walk into my classroom, you would be gr...
 15558 I teach at a Junior High where 69.5% of the st...
 11860 There can be infinite uses of the computer and...
 14697 My students are Television Production vocation...
 44715 My students need to feel incredible about thei...
 33670 I teach at a low performing school where most ...
 48247 Our wonderful school is nestled in the downtow...
 447 My students are a great group of kids from a r...

project_essay_2 \

19617 The stem bundle will allow my little preschool...
 44542 The books that I am requesting for my classroo...
 8792 My student spend so much time learning while s...
 25974 My students love graffiti art, symbols, and em...
 18120 My students are in great need of flexible seat...
 17351 A Dash coding robot will make a difference in ...
 22925 My students are always on the go. A lot of th...
 19317 With your help, I'll be able to easily reach m...
 10569 Teachers and students will use these mobile de...
 42779 My students will be exploring and experimentin...
 40456 We all know that this generation of students t...
 30426 The Dual Language program has one unique objec...
 35093 My students will use these chromebooks during ...
 38144 Thank you for your interest in my project. Th...
 47871 Thesevarious storage materials will be used t...
 39284 Circle Time is an important and dynamic part o...
 11507 Partnering with my parents is very important t...
 35564 I teach in a Title I School where the majority...
 30320 The lighted plant stand that I am requesting w...
 18699 Every year, my students and I look forward to ...
 36429 I teach active third graders in a northern sub...
 38984 A lot of research supports giving students man...
 23309 My 1st grade students are like little sponges,...
 40353 When students participate in after-school acti...
 27925 My students were born in the 21st century. Th...
 16118 How do you feel about organization? Imagine yo...
 216 Presidential elections, no. World Series game...
 36537 When students are faced with a problem or task...
 8400 Currently, my classroom doesn't have a big eno...
 39774 Technology class is in great need of a few Chr...
 ...
 12783 I want my math classroom to build true mathema...
 43739 Our 4th grade classroom becomes a home away fr...
 3995 Girl Runners! Girl POWER!\r\n\r\nMy students n...
 28114 In preschool, students are between the ages of...
 23615 Students are children, and should be given the...
 45830 These tablets will be utilized each day within...
 14894 Students in my class aspire to great things, b...
 38994 Scores of students come to our school with sub...
 28377 Where does your food come from? \"Target!\" ...
 49705 My students tend to wander around the room whe...
 43128 My group of students are first graders who lov...
 14958 At our school we know in our hearts that SPORT...
 22697 Throughout teaching, a copy machine is require...
 36777 These products will enable my students to gain...
 7348 My students love to work with play doh. It has...
 8509 My students are eager to please and eager to l...
 4665 I strongly believe that having an iPad Air in ...
 34668 This project will help build on our classroom ...
 22540 All over the country, more and more classrooms...
 27347 In this first year of a physical education cla...

32442 We would love to be able to have more flexible...
 20527 My students need these different books to join...
 41095 As I mentioned, I am striving to provide a pos...
 15558 Technology is a powerful tool in motivating yo...
 11860 Currently we have 3 other Ipad Mini's in our c...
 14697 It is difficult for school systems to stay in ...
 44715 In my beautiful school, you will see students ...
 33670 I have been researching ways that I can motiva...
 48247 Students need the opportunity to move around w...
 447 My students need opportunities to move! A few ...

project_essay_3 \

| | |
|-------|---|
| 19617 | NaN |
| 44542 | NaN |
| 8792 | NaN |
| 25974 | NaN |
| 18120 | NaN |
| 17351 | NaN |
| 22925 | NaN |
| 19317 | NaN |
| 10569 | NaN |
| 42779 | NaN |
| 40456 | NaN |
| 30426 | NaN |
| 35093 | NaN |
| 38144 | NaN |
| 47871 | NaN |
| 39284 | NaN |
| 11507 | NaN |
| 35564 | NaN |
| 30320 | NaN |
| 18699 | NaN |
| 36429 | I am trying to design a 21st century classroom... |
| 38984 | NaN |
| 23309 | NaN |
| 40353 | NaN |
| 27925 | NaN |
| 16118 | NaN |
| 216 | NaN |
| 36537 | NaN |
| 8400 | NaN |
| 39774 | NaN |
| ... | ... |
| 12783 | NaN |
| 43739 | NaN |
| 3995 | NaN |
| 28114 | NaN |
| 23615 | NaN |
| 45830 | NaN |
| 14894 | NaN |
| 38994 | NaN |
| 28377 | NaN |
| 49705 | NaN |
| 43128 | I am on the journey to making our classroom co... |
| 14958 | NaN |
| 22697 | NaN |
| 36777 | NaN |
| 7348 | NaN |
| 8509 | NaN |
| 4665 | NaN |
| 34668 | NaN |

| | |
|-------|---|
| 22540 | NaN |
| 27347 | NaN |
| 32442 | NaN |
| 20527 | NaN |
| 41095 | NaN |
| 15558 | NaN |
| 11860 | NaN |
| 14697 | NaN |
| 44715 | Spanish is everywhere, whether your are at the... |
| 33670 | NaN |
| 48247 | NaN |
| 447 | NaN |

project_essay_4 \

| | |
|-------|---|
| 19617 | NaN |
| 44542 | NaN |
| 8792 | NaN |
| 25974 | NaN |
| 18120 | NaN |
| 17351 | NaN |
| 22925 | NaN |
| 19317 | NaN |
| 10569 | NaN |
| 42779 | NaN |
| 40456 | NaN |
| 30426 | NaN |
| 35093 | NaN |
| 38144 | NaN |
| 47871 | NaN |
| 39284 | NaN |
| 11507 | NaN |
| 35564 | NaN |
| 30320 | NaN |
| 18699 | NaN |
| 36429 | I believe that allowing children to move while... |
| 38984 | NaN |
| 23309 | NaN |
| 40353 | NaN |
| 27925 | NaN |
| 16118 | NaN |
| 216 | NaN |
| 36537 | NaN |
| 8400 | NaN |
| 39774 | NaN |
| ... | ... |
| 12783 | NaN |
| 43739 | NaN |
| 3995 | NaN |
| 28114 | NaN |
| 23615 | NaN |
| 45830 | NaN |
| 14894 | NaN |
| 38994 | NaN |
| 28377 | NaN |
| 49705 | NaN |
| 43128 | The deskless classroom will solve many issues ... |
| 14958 | NaN |
| 22697 | NaN |
| 36777 | NaN |
| 7348 | NaN |
| 8509 | NaN |

| | | |
|-------|---|-----|
| 4665 | | NaN |
| 34668 | | NaN |
| 22540 | | NaN |
| 27347 | | NaN |
| 32442 | | NaN |
| 20527 | | NaN |
| 41095 | | NaN |
| 15558 | | NaN |
| 11860 | | NaN |
| 14697 | | NaN |
| 44715 | My classroom will be a more pleasant place to ... | |
| 33670 | | NaN |
| 48247 | | NaN |
| 447 | | NaN |

project_resource_summary \

| | | |
|-------|---|--|
| 19617 | My students need the stem bundle to allow the ... | |
| 44542 | My students need lots of books to help them ha... | |
| 8792 | My students need a rug to sit on because we sp... | |
| 25974 | My students need 3Doodler create education kit... | |
| 18120 | My students need flexible seating to allow the... | |
| 17351 | My students need a DASH coding robot for our S... | |
| 22925 | My students need Bouncy Bands for Chairs to ke... | |
| 19317 | My students need the magnetic materials and ma... | |
| 10569 | My students need access to more technology. Th... | |
| 42779 | My students need books about music and sound t... | |
| 40456 | My students need Chromebooks to access technol... | |
| 30426 | My students need a great amount of Spanish res... | |
| 35093 | My students need chromebooks to provide them w... | |
| 38144 | My students need an ipad to have access to ebo... | |
| 47871 | My students need various types of storage cont... | |
| 39284 | My students need an iPod nano and classroom CD... | |
| 11507 | My students need books in their native languag... | |
| 35564 | My students need HANDS ON Building Supplies to... | |
| 30320 | My students need a lighted plant cart for grow... | |
| 18699 | My students need a set of graphic novels that ... | |
| 36429 | My students need an elementary classroom couch... | |
| 38984 | My students need to have an exciting alternati... | |
| 23309 | My students need a Leveled Books Classroom Lib... | |
| 40353 | My students need a fast pitch softball bat. T... | |
| 27925 | My students need iPads to allow us to use educ... | |
| 16118 | My students need individual seat sacks to hold... | |
| 216 | My students need a VEX IQ superkit to begin th... | |
| 36537 | My students need a STEM bundle appropriate for... | |
| 8400 | My students need a classroom rug to sit on, an... | |
| 39774 | My students need a set of 5 chromebooks that d... | |
| ... | ... | |
| 12783 | My students need effective, hands-on materials... | |
| 43739 | My students need 4 bookshelves to create a new... | |
| 3995 | My students need sf 20 yoga mats to prepare fo... | |
| 28114 | My students need 20 sheets and blankets for th... | |
| 23615 | My students need an option to move while learn... | |
| 45830 | My students need 2 iPad minis and 2 otterboxes... | |
| 14894 | My students need 3 Kindle Fire tablets so they... | |
| 38994 | My students need durable backpacks to begin th... | |
| 28377 | My students need the Miracle-Gro AeroGardens s... | |
| 49705 | My students need flexible seating so that they... | |
| 43128 | My students need the four stools to go at a sm... | |
| 14958 | My students need the necessary equipment to pl... | |
| 22697 | My students need these printing materials beca... | |
| 36777 | My students need sensory supplies in order to ... | |

7348 My students need play doh and foam dough to cr...
 8509 My students need stools that will allow them t...
 4665 My students need an iPad Air to use in the cla...
 34668 My students need a classroom where they can le...
 22540 My students need access to technology so that ...
 27347 My students need physical activity equipment t...
 32442 My students need to have more flexible seating...
 20527 My students need 5 copies of each book to star...
 41095 My students need clipboards, dry erase dots, w...
 15558 My students need a new Canon 70D DSLR camera t...
 11860 My students need an Ipad Mini 2 with Otterbox ...
 14697 My students need two DSLR cameras in order to ...
 44715 My students need Spanish books.\r\nMy students...
 33670 My students need one inch binders to track the...
 48247 My students need the opportunity to move their...
 447 My students need 8 Hokki stools to allow for c...

| | teacher_number_of_previously_posted_projects \ |
|-------|--|
| 19617 | 3 |
| 44542 | 0 |
| 8792 | 3 |
| 25974 | 128 |
| 18120 | 0 |
| 17351 | 3 |
| 22925 | 2 |
| 19317 | 1 |
| 10569 | 1 |
| 42779 | 18 |
| 40456 | 2 |
| 30426 | 0 |
| 35093 | 0 |
| 38144 | 1 |
| 47871 | 18 |
| 39284 | 3 |
| 11507 | 2 |
| 35564 | 0 |
| 30320 | 1 |
| 18699 | 2 |
| 36429 | 1 |
| 38984 | 0 |
| 23309 | 34 |
| 40353 | 3 |
| 27925 | 17 |
| 16118 | 0 |
| 216 | 7 |
| 36537 | 8 |
| 8400 | 1 |
| 39774 | 0 |
| ... | ... |
| 12783 | 0 |
| 43739 | 94 |
| 3995 | 1 |
| 28114 | 1 |
| 23615 | 1 |
| 45830 | 3 |
| 14894 | 14 |
| 38994 | 1 |
| 28377 | 8 |
| 49705 | 0 |
| 43128 | 0 |
| 14958 | 5 |

| | |
|-------|----|
| 22697 | 0 |
| 36777 | 4 |
| 7348 | 75 |
| 8509 | 18 |
| 4665 | 1 |
| 34668 | 1 |
| 22540 | 2 |
| 27347 | 0 |
| 32442 | 1 |
| 20527 | 1 |
| 41095 | 0 |
| 15558 | 0 |
| 11860 | 5 |
| 14697 | 1 |
| 44715 | 0 |
| 33670 | 0 |
| 48247 | 0 |
| 447 | 25 |

essay \

19617 I am a preschool teacher at an elementary scho...
 44542 We are a school that is welcoming and invites ...
 8792 A typical day in our classroom consists of lot...
 25974 Save our art class! We need your help to conti...
 18120 As a teacher in a low-income/high poverty scho...
 17351 My sixth grade students work hard, knowing tha...
 22925 You may think that you know what goes on in ou...
 19317 I work at a school where the children are grow...
 10569 I have a typical seventh grade class. My stude...
 42779 All my students do is want to learn. That's i...
 40456 We are fantastic Scientists and Mathematicians...
 30426 My students have been enrolled in the Dual Lan...
 35093 My second grade class is filled with students ...
 38144 I teach at a Title 1 school. Many of them rece...
 47871 My students are energetic, eager, and enthusia...
 39284 My pre-kindergarten students would be best des...
 11507 As a teacher in a Title I school, many of my s...
 35564 I teach in a Title I School where the majority...
 30320 Our school's upper elementary is comprised of ...
 18699 As a teacher in a low-income school, I am alwa...
 36429 Talk. Talk. Talk.. this is how students are le...
 38984 We are a Title 1 school in the South Bronx. I ...
 23309 I teach at a Title I school where most of our ...
 40353 The students at Samuel Ogle Middle School are ...
 27925 Located in the heart of Chinatown, our school ...
 16118 Our classroom will soon be filled with a diver...
 216 After walking my students to their junior high...
 36537 My classroom community is made up of a diverse...
 8400 I teach at a Title One school in a small town ...
 39774 As the Technology and Project Lead the Way tea...
 ...
 12783 As an incoming first year teacher, I haven't b...
 43739 The school is located in an urban community, w...
 3995 Minneapolis 3rd, 4th, and 5th graders are gett...
 28114 Hunter Hills Elementary has the highest povert...
 23615 My students are a group of top notch students....
 45830 My classroom is filled with happy, diverse stu...
 14894 My students are brave, creative, and intellige...
 38994 Students at my school are awesome. There are a...
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 36777 As a teacher of students with disabilities, my...
 7348 My students need the opportunity to fulfill th...
 8509 My students are eager learners from diverse ba...
 4665 My 5th graders can be quite a talkative class!...
 34668 My students have become my family. This is my ...
 22540 My students come from multicultural background...
 27347 As a traveling physical education teacher in a...
 32442 \"Tell me and I forgot. Teach me and I remembe...
 20527 Our students are full of wonder about what the...
 41095 If you walk into my classroom, you would be gr...
 15558 I teach at a Junior High where 69.5% of the st...
 11860 There can be infinite uses of the computer and...
 14697 My students are Television Production vocation...
 44715 My students need to feel incredible about thei...
 33670 I teach at a low performing school where most ...
 48247 Our wonderful school is nestled in the downtow...
 447 My students are a great group of kids from a r...

| | clean_categories | clean_subcategories |
|-------|-----------------------------------|--------------------------------|
| es \ | | |
| 19617 | Math_Science AppliedLearning | AppliedSciences EarlyDevelopme |
| nt | | |
| 44542 | Literacy_Language | Litera |
| cy | | |
| 8792 | Literacy_Language Math_Science | Literature_Writing Mathemati |
| cs | | |
| 25974 | Math_Science Music_Arts | AppliedSciences VisualAr |
| ts | | |
| 18120 | Health_Sports | Health_Wellne |
| ss | | |
| 17351 | Math_Science | AppliedScienc |
| es | | |
| 22925 | Health_Sports SpecialNeeds | Health_Wellness SpecialNee |
| ds | | |
| 19317 | Math_Science | Mathemati |
| cs | | |
| 10569 | Math_Science | Health_LifeScien |
| ce | | |
| 42779 | Math_Science Music_Arts | AppliedSciences Mus |
| ic | | |
| 40456 | Math_Science | EnvironmentalScience Mathemati |
| cs | | |
| 30426 | Literacy_Language | ForeignLanguages Litera |
| cy | | |
| 35093 | Literacy_Language Math_Science | Literature_Writing Mathemati |
| cs | | |
| 38144 | Literacy_Language Math_Science | Literacy Mathemati |
| cs | | |
| 47871 | Math_Science | AppliedScienc |
| es | | |
| 39284 | Literacy_Language Music_Arts | Literacy Mus |
| ic | | |
| 11507 | Literacy_Language AppliedLearning | Literacy ParentInvolveme |
| nt | | |
| 35564 | Math_Science | AppliedSciences Mathemati |
| cs | | |
| 30320 | Math_Science | EnvironmentalScien |
| ce | | |

| | | |
|-------|--|------------------------------|
| 18699 | Literacy_Language | Litera |
| cy | | |
| 36429 | Literacy_Language Math_Science | Literacy Mathemati |
| cs | | |
| 38984 | Math_Science SpecialNeeds | Mathematics SpecialNee |
| ds | | |
| 23309 | Literacy_Language | Litera |
| cy | | |
| 40353 | Health_Sports | TeamSpor |
| ts | | |
| 27925 | Literacy_Language Math_Science | Literacy Mathemati |
| cs | | |
| 16118 | Literacy_Language Math_Science | Literacy Mathemati |
| cs | | |
| 216 | Math_Science | AppliedScienc |
| es | | |
| 36537 | Math_Science | AppliedScienc |
| es | | |
| 8400 | Health_Sports Literacy_Language | Health_Wellness Litera |
| cy | | |
| 39774 | Math_Science | AppliedScienc |
| es | | |
| ... | ... | |
| ... | | |
| 12783 | Math_Science | Mathemati |
| cs | | |
| 43739 | Literacy_Language | Litera |
| cy | | |
| 3995 | Health_Sports | Health_Wellness TeamSpor |
| ts | | |
| 28114 | AppliedLearning | EarlyDevelopme |
| nt | | |
| 23615 | Health_Sports Literacy_Language | Health_Wellness Litera |
| cy | | |
| 45830 | Literacy_Language Math_Science | Literacy Mathemati |
| cs | | |
| 14894 | Literacy_Language | Literature_Writi |
| ng | | |
| 38994 | AppliedLearning | Oth |
| er | | |
| 28377 | Health_Sports Health_Wellness NutritionEducati | |
| on | | |
| 49705 | Math_Science | AppliedScienc |
| es | | |
| 43128 | AppliedLearning Literacy_Language | EarlyDevelopment Litera |
| cy | | |
| 14958 | Health_Sports | TeamSpor |
| ts | | |
| 22697 | Literacy_Language Math_Science | Literature_Writing Mathemati |
| cs | | |
| 36777 | AppliedLearning SpecialNeeds | Other SpecialNee |
| ds | | |
| 7348 | AppliedLearning Music_Arts | EarlyDevelopment VisualAr |
| ts | | |
| 8509 | Health_Sports SpecialNeeds | Health_Wellness SpecialNee |
| ds | | |
| 4665 | AppliedLearning | CharacterEducati |
| on | | |
| 34668 | AppliedLearning | CharacterEducati |
| on | | |
| 22540 | Literacy_Language AppliedLearning | Literacy Oth |

| | | | |
|-------|-------------------|--------------|------------------------------|
| er | | | |
| 27347 | Health_Sports | Gym_Fitness | Health_Wellne |
| ss | | | |
| 32442 | Health_Sports | | Health_Wellne |
| ss | | | |
| 20527 | Literacy_Language | | Litera |
| cy | | | |
| 41095 | Literacy_Language | | Litera |
| cy | | | |
| 15558 | AppliedLearning | Music_Arts | College_CareerPrep VisualAr |
| ts | | | |
| 11860 | Literacy_Language | | Litera |
| cy | | | |
| 14697 | Music_Arts | | VisualAr |
| ts | | | |
| 44715 | Literacy_Language | | ForeignLanguag |
| es | | | |
| 33670 | Literacy_Language | Math_Science | Literature_Writing Mathemati |
| cs | | | |
| 48247 | Literacy_Language | Math_Science | Literacy Mathemati |
| cs | | | |
| 447 | Health_Sports | | Health_Wellne |
| ss | | | |

clean_grade

| | |
|-------|--------|
| 19617 | PreK-2 |
| 44542 | 3-5 |
| 8792 | PreK-2 |
| 25974 | 3-5 |
| 18120 | 3-5 |
| 17351 | 6-8 |
| 22925 | PreK-2 |
| 19317 | 3-5 |
| 10569 | 6-8 |
| 42779 | PreK-2 |
| 40456 | 3-5 |
| 30426 | PreK-2 |
| 35093 | PreK-2 |
| 38144 | PreK-2 |
| 47871 | 6-8 |
| 39284 | PreK-2 |
| 11507 | PreK-2 |
| 35564 | PreK-2 |
| 30320 | 3-5 |
| 18699 | 3-5 |
| 36429 | 3-5 |
| 38984 | 3-5 |
| 23309 | PreK-2 |
| 40353 | 6-8 |
| 27925 | PreK-2 |
| 16118 | PreK-2 |
| 216 | 6-8 |
| 36537 | PreK-2 |
| 8400 | PreK-2 |
| 39774 | 6-8 |
| ... | ... |
| 12783 | PreK-2 |
| 43739 | 3-5 |
| 3995 | 3-5 |
| 28114 | PreK-2 |
| 23615 | 3-5 |

| | |
|-------|--------|
| 45830 | PreK-2 |
| 14894 | 6-8 |
| 38994 | 6-8 |
| 28377 | PreK-2 |
| 49705 | 9-12 |
| 43128 | PreK-2 |
| 14958 | 6-8 |
| 22697 | 3-5 |
| 36777 | 9-12 |
| 7348 | PreK-2 |
| 8509 | PreK-2 |
| 4665 | 3-5 |
| 34668 | 3-5 |
| 22540 | 3-5 |
| 27347 | PreK-2 |
| 32442 | PreK-2 |
| 20527 | PreK-2 |
| 41095 | PreK-2 |
| 15558 | 6-8 |
| 11860 | PreK-2 |
| 14697 | 9-12 |
| 44715 | 6-8 |
| 33670 | 3-5 |
| 48247 | 3-5 |
| 447 | 3-5 |

```
[22445 rows x 17 columns]
```

Text preprocessing

In [19]:

```
#Preprocessing for essay
# Combining all the above students
from tqdm import tqdm
preprocessed_essays_train = []
# tqdm is for printing the status bar
for sentence in tqdm(X_train['essay'].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_train.append(sent.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████████████|  
██████████| 22445/22445 [00:22<00:00, 1015.13it/s]
```



```
#Processing for essay
# Combining all the above students
from tqdm import tqdm
preprocessed_titles_train = []
# tqdm is for printing the status bar
for sentence in tqdm(X_train['project_title'].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_titles_train.append(sent.lower().strip())
```

In [24]:

```
#Preprocessing for essay
# Combining all the above students
from tqdm import tqdm
preprocessed_titles_test = []
# tqdm is for printing the status bar
for sentence in tqdm(X_test['project_title'].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_titles_test.append(sent.lower().strip())
```

Encoding numerical, Categorical features

vectorize categorical data

In [25]:

```
#projectsubjectcategories convert categorical to vectors
# convert train,cv and test data of clean_categories into vectors
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer1 = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False,
binary=True)
vectorizer1.fit(X_train['clean_categories'].values)

# firstly convert fit the train data into the vectoriaer then it Learn hte vocablery

# we use the fitted CountVectorizer to convert the text to vector
X_train_cat = vectorizer1.transform(X_train['clean_categories'].values)
X_cv_cat = vectorizer1.transform(X_cv['clean_categories'].values)
X_test_cat = vectorizer1.transform(X_test['clean_categories'].values)

print(vectorizer1.get_feature_names())
```

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

In [26]:

```
print("After vectorizations")
print(X_train_cat.shape, y_train.shape)
print(X_cv_cat.shape, y_cv.shape)
print(X_test_cat.shape, y_test.shape)
print("="*100)
```

After vectorizations

```
(22445, 9) (22445,)
```

```
(11055, 9) (11055,)
```

```
(16500, 9) (16500,)
```

```
=====
=====
```

2.project_subject_subcategories convert categorical to vectors*

In [27]:

```
#projectsubject subcategories convert categorical to vectors
# convert train,cv and test data of clean_categories into vectors
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer2 = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=False, binary=True)
vectorizer2.fit(X_train['clean_subcategories'].values)

# firstly convert fit the train data into the vectoriaer then it Learn hte vocablery

# we use the fitted CountVectorizer to convert the text to vector
X_train_subcat = vectorizer2.transform(X_train['clean_subcategories'].values)
X_cv_subcat = vectorizer2.transform(X_cv['clean_subcategories'].values)
X_test_subcat = vectorizer2.transform(X_test['clean_subcategories'].values)

print(vectorizer2.get_feature_names())
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Extracurricular', 'Civics_Government', 'ForeignLanguages', 'Nutrition Education', 'Warmth', 'Care_Hunger', 'SocialSciences', 'PerformingArts', 'CharacterEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Music', 'History_Geography', 'Health_LifeScience', 'EarlyDevelopment', 'ESL', 'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'AppliedSciences', 'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy']
```

In [28]:

```
print("After vectorizations")
print(X_train_subcat.shape, y_train.shape)
print(X_cv_subcat.shape, y_cv.shape)
print(X_test_subcat.shape, y_test.shape)
print("=="*100)
```

After vectorizations

(22445, 30) (22445,)

(11055, 30) (11055,)

(16500, 30) (16500,)

=====

*3 school_state convert categorical to vectors**

In [29]:

```
#school_state convert categorical to vectors
from collections import Counter
my_counter = Counter()
for word in dft['school_state'].values:
    my_counter.update(word.split())# count the words

school_state_dict = dict(my_counter)# store in dictionary
sorted_school_state_dict = dict(sorted(school_state_dict.items(), key=lambda kv: kv[1]))# sort it
print(sorted_school_state_dict)
```

```
{'VT': 32, 'WY': 51, 'ND': 63, 'MT': 106, 'RI': 126, 'NH': 141, 'SD': 142,
'NE': 144, 'AK': 153, 'DE': 155, 'WV': 218, 'ME': 222, 'NM': 236, 'HI': 239,
'DC': 247, 'KS': 285, 'ID': 302, 'IA': 306, 'AR': 446, 'CO': 538, 'MN': 556,
'OR': 577, 'MS': 598, 'KY': 614, 'NV': 665, 'MD': 668, 'TN': 774, 'CT': 774,
'AL': 790, 'UT': 792, 'WI': 833, 'VA': 916, 'AZ': 994, 'NJ': 1005,
'OK': 1074, 'MA': 1076, 'LA': 1094, 'WA': 1103, 'MO': 1166, 'IN': 1171,
'OH': 1180, 'PA': 1419, 'MI': 1468, 'GA': 1828, 'SC': 1830, 'IL': 1967, 'NC': 2340,
'FL': 2839, 'TX': 3320, 'NY': 3393, 'CA': 7024}
```

In [30]:

```
# convert train,cv and test data of clean_categories into vectors
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer3 = CountVectorizer(vocabulary=list(sorted_school_state_dict.keys()), lowercase=False, binary=True)
vectorizer3.fit(dft['school_state'].values)

# firstly convert fit the train data into the vectorizer then it learn the vocabulary

# we use the fitted CountVectorizer to convert the text to vector
X_train_school_state = vectorizer3.transform(X_train['school_state'].values)
X_cv_school_state = vectorizer3.transform(X_cv['school_state'].values)
X_test_school_state = vectorizer3.transform(X_test['school_state'].values)

print(vectorizer3.get_feature_names())
```

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

In [31]:

```
print("After vectorizations")
print(X_train_school_state.shape, y_train.shape)
print(X_cv_school_state.shape, y_cv.shape)
print(X_test_school_state.shape, y_test.shape)
print("="*100)
```

```
After vectorizations
(22445, 51) (22445,)
(11055, 51) (11055,)
(16500, 51) (16500,)
```

```
=====
=====
```

In [33]:

```
#project_grade_category categorical to vectors
#https://stackoverflow.com/questions/42224700/attributeerror-float-object-has-no-attribute-split
dft['clean_grade']=dft['clean_grade'].fillna("")# fill the nulll values with space

# convert train,cv and test data of clean_categories into vectors

# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer4 = CountVectorizer(vocabulary=list(sorted_project_grade_category_dict.keys()), lowercase=False, binary=True)
vectorizer4.fit(dft['clean_grade'].values)

# firstly convert fit the train data into the vectoriaer then it Learn hte vocablery

# we use the fitted CountVectorizer to convert the text to vector
X_train_project_grade_category = vectorizer4.transform(X_train['clean_grade'].values)
X_cv_project_grade_category = vectorizer4.transform(X_cv['clean_grade'].values)
X_test_project_grade_category = vectorizer4.transform(X_test['clean_grade'].values)

print(vectorizer4.get_feature_names())

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

In [34]:

```
print("After vectorizations")
print(X_train_project_grade_category .shape, y_train.shape)
print(X_cv_project_grade_category .shape, y_cv.shape)
print(X_test_project_grade_category .shape, y_test.shape)
print("="*100)
```

After vectorizations

(22445, 4) (22445,)

(11055, 4) (11055,)

(16500, 4) (16500,)

```
=====
=====
```

In [36]:

```
#teacher_prefix categorical to vectors
##https://stackoverflow.com/questions/42224700/attributeerror-float-object-has-no-attribute-split
dft['teacher_prefix']=dft['teacher_prefix'].fillna(" ")# fillll the null values with space
my_counter = Counter()
for word in dft['teacher_prefix'].values:
    my_counter.update(word.split())

# dict sort by value python: https://stackoverflow.com/a/613218/4084039
teacher_cat_dict = dict(my_counter)
sorted_teacher_prefix_dict = dict(sorted(teacher_cat_dict.items(), key=lambda kv: kv[1]))
```

In [37]:

```
# convert train,cv and test data of clean_categories into vectors
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer5 = CountVectorizer(vocabulary=list(sorted_teacher_prefix_dict.keys()), lower
case=False, binary=True)
vectorizer5.fit(dft['teacher_prefix'].values.astype('U'))

# firstly convert fit the train data into the vectoriaer then it Learn hte vocablery

# we use the fitted CountVectorizer to convert the text to vector
X_train_teacher_prefix = vectorizer5.transform(X_train['teacher_prefix'].values.astype(
'U'))
X_cv_teacher_prefix= vectorizer5.transform(X_cv['teacher_prefix'].values.astype('U'))
X_test_teacher_prefix = vectorizer5.transform(X_test['teacher_prefix'].values.astype(
'U'))

print(vectorizer5.get_feature_names())

# when i executeed this error comes
#np.nan is an invalid document, expected byte or unicode string.
# then i convert to unicode just write .astype('U') after the .values in fit and transfo
rm
#https://stackoverflow.com/questions/39303912/tfidfvectorizer-in-scikit-learn-valueerro
r-np-nan-is-an-invalid-document
```

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

In [38]:

```
print("After vectorizations")
print(X_train_teacher_prefix.shape, y_train.shape)
print(X_cv_teacher_prefix.shape, y_cv.shape)
print(X_test_teacher_prefix.shape, y_test.shape)
print("="*100)
```

After vectorizations

(22445, 5) (22445,)

(11055, 5) (11055,)

(16500, 5) (16500,)

=====

Encoding essay, and Project_title

In [39]:

```
#Bow featurezation essay
X_train_essay=preprocessed_essays_train
X_cv_essay=preprocessed_essays_cv
X_test_essay=preprocessed_essays_test

X_train_title=preprocessed_titles_train
X_cv_title=preprocessed_titles_cv
X_test_title=preprocessed_titles_test

# We are considering only the words which appeared in at least 10 documents(rows or projects).
vectorizer6 = CountVectorizer(min_df=10,max_features=5000,gram_range=(1, 2))# its a countvectors used for convert text to vectors
vectorizer6.fit(X_train_essay)# that is Learned from trained data

# we use the fitted CountVectorizer to convert the text to vector
X_train_bow = vectorizer6.transform(X_train_essay)
X_cv_bow = vectorizer6.transform(X_cv_essay)
X_test_bow = vectorizer6.transform(X_test_essay)

print("After vectorizations")
print(X_train_bow.shape, y_train.shape)
print(X_cv_bow.shape, y_cv.shape)
print(X_test_bow.shape, y_test.shape)
print("=*100)
# so the dimension of all are the same by using first fit and then transform
print(vectorizer6.get_feature_names())
```


After vectorizations

(22445, 5000) (22445,)

(11055, 5000) (11055,)

(16500, 5000) (16500,)

=====

=====

['000', '10', '100', '100 free', '100 percent', '100 students', '11', '12', '12th', '13', '14', '15', '16', '17', '18', '19', '1st', '1st grade', '20', '20 students', '200', '2016', '2017', '21', '21st', '21st century', '22', '23', '24', '25', '25 students', '26', '27', '28', '2nd', '2nd grade', '2nd graders', '30', '30 minutes', '30 students', '32', '35', '3d', '3d printer', '3rd', '3rd grade', '3rd graders', '40', '40 students', '400', '45', '4th', '4th 5th', '4th grade', '4th graders', '50', '50 students', '500', '500 students', '5th', '5th grade', '5th graders', '60', '60 minutes', '60 students', '600', '6th', '6th grade', '6th graders', '70', '70 students', '75', '75 students', '7th', '7th 8th', '7th grade', '80', '80 students', '85', '8th', '8th grade', '8th graders', '90', '90 students', '95', '98', '99', '9th', 'abilities', 'ability', 'ability learn', 'ability levels', 'able', 'able access', 'able choose', 'able complete', 'able control', 'able create', 'able explore', 'able focus', 'able get', 'able give', 'able help', 'able keep', 'able learn', 'able listen', 'able make', 'able move', 'able play', 'able practice', 'able print', 'able provide', 'able read', 'able see', 'able share', 'able sit', 'able take', 'able use', 'able work', 'absolutely', 'absolutely love', 'absorb', 'abstract', 'academic', 'academic achievement', 'academic areas', 'academic excellence', 'academic performance', 'academic skills', 'academic social', 'academic success', 'academically', 'academically socially', 'academics', 'academy', 'accelerate', 'acceptance', 'accepted', 'access', 'access books', 'access computer', 'access home', 'access internet', 'access many', 'access materials', 'access resources', 'access technology', 'accessible', 'accessible students', 'accessories', 'accommodate', 'accomplish', 'accomplished', 'accomplishment', 'accomplishments', 'according', 'achieve', 'achieve goals', 'achievement', 'achievement gap', 'achieving', 'acquire', 'acquisition', 'across', 'act', 'action', 'actions', 'active', 'active learners', 'active learning', 'active students', 'actively', 'actively engaged', 'activities', 'activities classroom', 'activities help', 'activities students', 'activity', 'actual', 'actually', 'add', 'add adhd', 'added', 'adding', 'addition', 'addition classroom', 'addition students', 'addition subtraction', 'additional', 'additionally', 'address', 'adequate', 'adhd', 'adult', 'adults', 'advance', 'advanced', 'advantage', 'adventure', 'adventures', 'adversity', 'affect', 'affects', 'affluent', 'afford', 'afraid', 'african', 'african american', 'afternoon', 'age', 'age appropriate', 'age students', 'ages', 'ago', 'ahead', 'ahead early', 'aid', 'aids', 'aim', 'air', 'algebra', 'alive', 'allow', 'allow children', 'allow student', 'allow students', 'allow us', 'allowed', 'allowing', 'allowing students', 'allows', 'allows students', 'almost', 'alone', 'along', 'alongside', 'aloud', 'alouds', 'alphabet', 'already', 'also', 'also able', 'also allow', 'also allows', 'also give', 'also help', 'also helps', 'also learn', 'also learning', 'also like', 'also love', 'also need', 'also provide', 'also requesting', 'also students', 'also teach', 'also use', 'also used', 'also want', 'alternate', 'alternative', 'alternative seating', 'although', 'although students', 'always', 'always eager', 'always excited', 'always looking', 'always ready', 'amaze', 'amazed', 'amazing', 'amazing group', 'amazing students', 'ambitious', 'america', 'american', 'americans', 'among', 'among students', 'amount', 'amount time', 'analysis', 'analyze', 'anchor', 'anchor charts', 'ancient', 'angeles', 'animal', 'animals', 'another', 'answer', 'answers', 'anxiety', 'anxious', 'anyone', 'anything', 'anywhere', 'ap', 'apart', 'app', 'apple', 'application', 'applications', 'apply', 'applying', 'appreciate', 'appreciated', 'appreciation', 'appreciative', 'approach', 'appropriate', 'appropriately', 'approximately', 'apps', 'area', 'area many', 'area students', 'areas', 'areas students', 'around', 'around classroom', 'around room']

m', 'around school', 'around students', 'around us', 'around world', 'arrangement', 'arrangements', 'array', 'arrive', 'arrive school', 'art', 'art class', 'art projects', 'art room', 'art students', 'art supplies', 'articles', 'artist', 'artistic', 'artists', 'arts', 'arts math', 'artwork', 'asian', 'ask', 'ask questions', 'asked', 'asking', 'asking help', 'aspect', 'aspects', 'assess', 'assessment', 'assessments', 'asset', 'assigned', 'assignment', 'assignments', 'assist', 'assist students', 'assistance', 'athletes', 'athletic', 'atmosphere', 'attend', 'attend school', 'attend title', 'attendance', 'attended', 'attending', 'attention', 'attitude', 'attitudes', 'audio', 'audio books', 'auditory', 'august', 'authentic', 'author', 'authors', 'autism', 'autism spectrum', 'autistic', 'available', 'available classroom', 'available students', 'average', 'avid', 'award', 'aware', 'awareness', 'away', 'awesome', 'back', 'background', 'background knowledge', 'backgrounds', 'backgrounds cultures', 'backgrounds many', 'backgrounds school', 'backgrounds students', 'backpack', 'backpacks', 'bad', 'bag', 'bag chairs', 'bags', 'balance', 'balance ball', 'balance balls', 'balanced', 'ball', 'ball chairs', 'balls', 'band', 'bands', 'barely', 'barrier', 'barriers', 'base', 'baseball', 'based', 'based learning', 'based socioeconomic', 'basic', 'basic needs', 'basic school', 'basic skills', 'basic supplies', 'basics', 'basis', 'basis students', 'basketball', 'basketball s', 'bean', 'bean bag', 'bean bags', 'beat', 'beautiful', 'became', 'become', 'become better', 'become engaged', 'become independent', 'become life', 'become lifelong', 'become successful', 'becomes', 'becoming', 'began', 'begin', 'beginning', 'beginning year', 'begins', 'behavior', 'behavioral', 'behaviors', 'behind', 'belief', 'believe', 'believe students', 'beneficial', 'beneficial students', 'benefit', 'benefit greatly', 'benefit students', 'benefits', 'besides', 'best', 'best education', 'best every', 'best learning', 'best part', 'best possible', 'best students', 'best want', 'best way', 'best work', 'better', 'better able', 'better place', 'better readers', 'better students', 'better understand', 'better understanding', 'better way', 'beyond', 'big', 'bigger', 'biggest', 'bilingual', 'bin', 'binders', 'bins', 'biology', 'bit', 'black', 'blended', 'blessed', 'block', 'blocks', 'blood', 'blue', 'board', 'boards', 'bodies', 'body', 'boogie', 'book', 'book bins', 'book read', 'book students', 'books', 'books allow', 'books also', 'books books', 'books classroom', 'books help', 'books home', 'books level', 'books nannan', 'books not', 'books read', 'books reading', 'books students', 'books used', 'books would', 'boost', 'bored', 'boring', 'born', 'borrow', 'bottles', 'bounce', 'bouncy', 'bouncy bands', 'bound', 'box', 'boxes', 'boys', 'boys girls', 'brain', 'brain breaks', 'brains', 'brand', 'brand new', 'break', 'breakfast', 'breakfast lunch', 'break out', 'breaks', 'bridge', 'bright', 'brilliant', 'bring', 'bringing', 'brings', 'broaden', 'broken', 'bronx', 'brooklyn', 'brought', 'budget', 'budget cuts', 'build', 'build confidence', 'building', 'builds', 'built', 'bunch', 'bundle', 'burn', 'bus', 'business', 'busy', 'buy', 'calculators', 'california', 'call', 'called', 'calm', 'calming', 'calories', 'came', 'camera', 'cameras', 'campus', 'cannot', 'cannot afford', 'cannot wait', 'capabilities', 'capable', 'capacity', 'capture', 'card', 'cards', 'care', 'care d', 'career', 'career ready', 'careers', 'caring', 'carolina', 'carpet', 'carry', 'cart', 'carts', 'case', 'cases', 'catch', 'caucasian', 'cause', 'causes', 'cd', 'celebrate', 'cell', 'center', 'center students', 'center time', 'centered', 'centers', 'centers students', 'central', 'century', 'century learners', 'century learning', 'century skills', 'certain', 'certainly', 'certainly control', 'chair', 'chairs', 'chairs allow', 'chairs help', 'chairs students', 'chairs would', 'challenge', 'challenge students', 'challenged', 'challenges', 'challenges classroom', 'challenges face', 'challenges students', 'challenging', 'chance', 'chances', 'change', 'change students', 'change world', 'changed', 'changes', 'changing', 'chapter', 'chapter books', 'character', 'characters', 'charge', 'charging', 'chart', 'chart paper', 'charter', 'charter school', 'charts', 'check', 'chemistry', 'chicago', 'child', 'childhood', 'children', 'children able', 'children come', 'children learn', 'children love', 'children need', 'children no

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 n', 'remaining', 'remember', 'remind', 'replace', 'report', 'reports', 're

present', 'represented', 'request', 'requested', 'requesting', 'require', 'required', 'requires', 'research', 'research projects', 'research shown', 'research shows', 'researched', 'researching', 'resilient', 'resource', 'resources', 'resources available', 'resources help', 'resources home', 'resources need', 'resources needed', 'resources students', 'respect', 'respectful', 'respond', 'response', 'responses', 'responsibility', 'responsible', 'rest', 'result', 'results', 'retain', 'return', 'review', 'reward', 'rewarding', 'rewards', 'rhythm', 'rich', 'ride', 'right', 'right tools', 'rigor', 'rigorous', 'rise', 'risk', 'risks', 'road', 'robot', 'robotics', 'robots', 'rock', 'rocking', 'role', 'roles', 'roll', 'room', 'room students', 'ropes', 'rotate', 'rotation', 'rotations', 'rough', 'round', 'rounded', 'routine', 'routines', 'rug', 'rules', 'run', 'running', 'runs', 'rural', 'rural area', 'rural community', 'rural school', 'sadly', 'safe', 'safe comfortable', 'safe environment', 'safe learning', 'safe place', 'safely', 'safety', 'said', 'san', 'sand', 'save', 'savvy', 'saw', 'say', 'saying', 'says', 'schedule', 'scholars', 'scholastic', 'scholastic news', 'school', 'school 100', 'school 90', 'school also', 'school building', 'school children', 'school classroom', 'school college', 'school come', 'school community', 'school considered', 'school day', 'school district', 'school diverse', 'school eager', 'school environment', 'school every', 'school everyday', 'school excited', 'school experience', 'school first', 'school full', 'school great', 'school help', 'school high', 'school home', 'school large', 'school learn', 'school learning', 'school library', 'school life', 'school limited', 'school located', 'school love', 'school low', 'school majority', 'school many', 'school means', 'school nannan', 'school need', 'school new', 'school not', 'school often', 'school one', 'school place', 'school population', 'school program', 'school provides', 'school ready', 'school receive', 'school rural', 'school safe', 'school school', 'school serves', 'school setting', 'school small', 'school student', 'school students', 'school supplies', 'school system', 'school teach', 'school title', 'school urban', 'school want', 'school well', 'school wide', 'school without', 'school work', 'school would', 'school year', 'schooling', 'schools', 'science', 'science class', 'science classroom', 'science concepts', 'science experiments', 'science math', 'science social', 'science standards', 'science students', 'science technology', 'scientific', 'scientist', 'scientists', 'scissors', 'scores', 'screen', 'search', 'searching', 'season', 'seat', 'seated', 'seating', 'seating allows', 'seating choices', 'seating classroom', 'seating option', 'seating options', 'seating students', 'seats', 'second', 'second grade', 'second graders', 'second language', 'second year', 'secondary', 'section', 'secure', 'see', 'see students', 'see typical', 'seeds', 'seeing', 'seek', 'seeking', 'seem', 'seems', 'seen', 'select', 'selected', 'selection', 'self', 'self confidence', 'self contained', 'self esteem', 'semester', 'send', 'seniors', 'sense', 'sense community', 'senses', 'sensory', 'sensory input', 'sensory needs', 'sentence', 'sentences', 'separate', 'series', 'serious', 'serve', 'serve students', 'served', 'serves', 'serves students', 'service', 'services', 'serving', 'sessions', 'set', 'set students', 'sets', 'setting', 'setting students', 'settings', 'seuss', 'seven', 'seventh', 'several', 'several challenges', 'several students', 'several years', 'severe', 'shape', 'shapes', 'share', 'share ideas', 'shared', 'sharing', 'sharpener', 'sheets', 'shelf', 'shelters', 'shelves', 'shine', 'shoes', 'shop', 'short', 'show', 'show students', 'showcase', 'showing', 'shown', 'shows', 'siblings', 'side', 'sight', 'sight word', 'sight words', 'sign', 'significant', 'significantly', 'silly', 'similar', 'simple', 'simple provide', 'simply', 'simply not', 'simultaneously', 'since', 'since students', 'sing', 'singing', 'single', 'single day', 'single parent', 'sit', 'sit floor', 'sit still', 'site', 'sites', 'sitting', 'sitting desk', 'sitting still', 'situation', 'situations', 'six', 'six year', 'sixth', 'sixth grade', 'sixth graders', 'size', 'sizes', 'skill', 'skills', 'skills also', 'skills help', 'skills learn', 'skills learning', 'skills nannan', 'skills necessary', 'skills need', 'skills needed', 'skills not', 'skills reading', 'skills students', 'skills taught', 'skill

s use', 'skills using', 'skills well', 'slow', 'small', 'small community', 'small group', 'small groups', 'small rural', 'small school', 'small town', 'smaller', 'smart', 'smart board', 'smile', 'smile face', 'smiles', 'smiles faces', 'smiling', 'snack', 'snacks', 'soak', 'soar', 'soccer', 'social', 'social economic', 'social emotional', 'social skills', 'social studies', 'socially', 'society', 'socio', 'socio economic', 'socioeconomic', 'socioeconomic background', 'socioeconomic backgrounds', 'socioeconomic status', 'socioeconomically', 'soft', 'software', 'soil', 'solar', 'solid', 'solution', 'solutions', 'solve', 'solve problems', 'solvers', 'solving', 'solving skills', 'someone', 'something', 'something new', 'sometimes', 'song', 'songs', 'soon', 'sort', 'sound', 'sounds', 'source', 'sources', 'south', 'southern', 'space', 'space students', 'spaces', 'span', 'spanish', 'spanish speaking', 'spark', 'speak', 'speak english', 'speaker', 'speakers', 'speaking', 'special', 'special education', 'special needs', 'specialized', 'specific', 'specific learning', 'specifically', 'spectrum', 'speech', 'speech language', 'speed', 'spelling', 'spend', 'spend time', 'spending', 'spent', 'spirit', 'spite', 'spoken', 'sponges', 'sport', 'sports', 'spot', 'spots', 'spread', 'spring', 'squares', 'stability', 'stability balls', 'stable', 'staff', 'stage', 'stamina', 'stand', 'standard', 'standardized', 'standards', 'standards students', 'standing', 'standing desks', 'stands', 'stars', 'start', 'start day', 'start school', 'started', 'starting', 'starts', 'state', 'state standards', 'states', 'station', 'stations', 'status', 'stay', 'stay active', 'stay engaged', 'stay focused', 'stay organized', 'stay task', 'staying', 'steam', 'stem', 'stem activities', 'step', 'steps', 'sticks', 'still', 'still learning', 'still need', 'stimulate', 'stimulating', 'stimulation', 'stock', 'stool', 'stools', 'stools allow', 'stools help', 'stop', 'storage', 'store', 'store day', 'stories', 'stories read', 'story', 'strategies', 'strategy', 'strength', 'strengthen', 'strengthening', 'strengths', 'stress', 'stretch', 'stricken', 'strive', 'strive best', 'strive make', 'strive provide', 'strives', 'striving', 'strong', 'stronger', 'structure', 'structured', 'structures', 'struggle', 'struggle reading', 'struggles', 'struggling', 'struggling readers', 'struggling students', 'student', 'student able', 'student achievement', 'student athletes', 'student body', 'student centered', 'student class', 'student classroom', 'student engagement', 'student learning', 'student led', 'student needs', 'student not', 'student population', 'student school', 'student success', 'student use', 'student work', 'students', 'students ability', 'students able', 'students absolutely', 'students academic', 'students access', 'students achieve', 'students active', 'students actively', 'student s adhd', 'students already', 'students also', 'students always', 'students amazing', 'students around', 'students art', 'students asked', 'students asking', 'students attend', 'students attention', 'students autism', 'students awesome', 'students become', 'students begin', 'students believe', 'students benefit', 'students best', 'students better', 'students books', 'students bright', 'students bring', 'students build', 'students building', 'students cannot', 'students chance', 'students choice', 'students choose', 'students class', 'students classes', 'students classroom', 'students collaborate', 'students come', 'students comfortable', 'students coming', 'students community', 'students complete', 'students constantly', 'students continue', 'students could', 'students create', 'students creative', 'students curious', 'students currently', 'students daily', 'students day', 'students deserve', 'students desire', 'students develop', 'students different', 'students disabilities', 'students diverse', 'students eager', 'students easily', 'students economically', 'students encouraged', 'students energetic', 'students engage', 'students engaged', 'students english', 'students enjoy', 'students enter', 'students enthusiastic', 'students especially', 'students even', 'students ever', 'students every', 'students excited', 'students expected', 'students experience', 'students explore', 'students exposed', 'students extremely', 'students face', 'students faced', 'students families', 'students feel', 'students find', 'students first', 'students focus', 'students free', 'students full', 'students fun', 'students

future', 'students gain', 'students get', 'students give', 'students give n', 'students go', 'students grade', 'students grades', 'students great', 'students group', 'students grow', 'students growing', 'students hands', 'students hard', 'students help', 'students high', 'students highly', 'students improve', 'students increase', 'students individual', 'students inquisitive', 'students interact', 'students interested', 'students involved', 'students keep', 'students kindergarten', 'students know', 'students lack', 'students learn', 'students learning', 'students life', 'students like', 'students limited', 'students listen', 'students little', 'students live', 'students lives', 'students living', 'students look', 'students love', 'students low', 'students make', 'students many', 'students materials', 'students math', 'students may', 'students meet', 'students motivated', 'students move', 'students moving', 'students much', 'students multiple', 'students must', 'students nannan', 'students need', 'students needs', 'students never', 'students new', 'students no', 'students not', 'students often', 'students one', 'students opportunities', 'students opportunity', 'students parents', 'students part', 'students participate', 'students place', 'students play', 'students practice', 'students pre', 'students project', 'students qualify', 'students range', 'students reach', 'students read', 'students reading', 'students ready', 'students really', 'students receive', 'students receiving', 'students require', 'students required', 'students research', 'students room', 'students safe', 'students school', 'students second', 'students see', 'students serve', 'students share', 'students show', 'students sit', 'students small', 'students speak', 'students special', 'students spend', 'students start', 'students stay', 'students still', 'students strive', 'students struggle', 'students struggling', 'students students', 'students succeed', 'students success', 'students successful', 'students take', 'students teach', 'students teachers', 'students technology', 'students think', 'students thrive', 'students time', 'students title', 'students tools', 'students truly', 'students try', 'students unable', 'students understand', 'students understanding', 'students unique', 'students use', 'students using', 'students utilize', 'students variety', 'students various', 'students varying', 'students visual', 'students walk', 'students want', 'students way', 'students well', 'students wide', 'students wonderful', 'students work', 'students working', 'students world', 'students would', 'students write', 'students year', 'students years', 'students young', 'students studies', 'students science', 'students shown', 'study', 'studying', 'sturdy', 'style', 'styles', 'subject', 'subject areas', 'subjects', 'subscription', 'subtraction', 'suburban', 'succeed', 'succeed school', 'succeed students', 'success', 'success nannan', 'success school', 'success students', 'successes', 'successful', 'successful classroom', 'successful school', 'successful students', 'successfully', 'suggested', 'summer', 'super', 'supplement', 'supplies', 'supplies help', 'supplies need', 'supplies needed', 'supplies students', 'supply', 'support', 'support learning', 'support nannan', 'support students', 'supported', 'supporting', 'supportive', 'supports', 'sure', 'sure students', 'surface', 'surprise', 'surrounded', 'surrounding', 'sweet', 'system', 'systems', 'table', 'tables', 'tablet', 'tablets', 'tackle', 'tactile', 'take', 'take advantage', 'take care', 'take granted', 'take home', 'take learning', 'take ownership', 'take place', 'take pride', 'take risks', 'take turns', 'taken', 'takes', 'taking', 'taking time', 'talented', 'talents', 'tales', 'talk', 'talking', 'tangible', 'tape', 'target', 'task', 'task hand', 'tasks', 'taught', 'teach', 'teach kindergarten', 'teach low', 'teach school', 'teach students', 'teach title', 'teacher', 'teacher low', 'teacher students', 'teacher title', 'teacher want', 'teachers', 'teachers school', 'teachers students', 'teaches', 'teaching', 'teaching learning', 'teaching students', 'team', 'team building', 'teams', 'teamwork', 'tech', 'technical', 'techniques', 'technological', 'technologically', 'technologies', 'technology', 'technology available', 'technology based', 'technology classroom', 'technology daily', 'technology engineering', 'technology help', 'technology home', 'technology learning', 'technology nannan', 'technology not', 'technology school', 'te

chnology skills', 'technology students', 'technology use', 'technology would', 'tell', 'telling', 'ten', 'tend', 'term', 'terms', 'test', 'test scores', 'testing', 'tests', 'texas', 'text', 'textbook', 'textbooks', 'texts', 'thank', 'thank advance', 'thank considering', 'thank much', 'thank nanan', 'thankful', 'thanks', 'theater', 'theme', 'themes', 'therapy', 'therefore', 'thing', 'thing common', 'things', 'things like', 'things may', 'things simple', 'things students', 'think', 'think critically', 'think outside', 'thinkers', 'thinking', 'thinking problem', 'thinking skills', 'third', 'third grade', 'third graders', 'thirst', 'thirst knowledge', 'thirty', 'though', 'though students', 'thought', 'thoughtful', 'thoughts', 'three', 'three years', 'thrilled', 'thrive', 'throughout', 'throughout day', 'throughout school', 'throughout year', 'thus', 'tight', 'tight knit', 'tiles', 'time', 'time also', 'time classroom', 'time day', 'time kids', 'time learning', 'time nanan', 'time not', 'time read', 'time school', 'time sitting', 'time spent', 'time students', 'times', 'times students', 'tiny', 'tired', 'title', 'title one', 'title school', 'titles', 'today', 'today students', 'today world', 'together', 'together create', 'together make', 'together students', 'told', 'tomorrow', 'tone', 'took', 'tool', 'tools', 'tools help', 'tools need', 'tools students', 'top', 'topic', 'topics', 'total', 'touch', 'tough', 'toward', 'towards', 'town', 'toys', 'track', 'traditional', 'traditional classroom', 'train', 'training', 'traits', 'transfer', 'transform', 'transient', 'transition', 'transitional', 'transportation', 'trauma', 'travel', 'treat', 'tremendous', 'tremendously', 'tried', 'trip', 'trips', 'trouble', 'true', 'truly', 'truly believe', 'trust', 'try', 'try best', 'try make', 'try new', 'try provide', 'trying', 'tubs', 'turn', 'turns', 'tv', 'twenty', 'twice', 'two', 'two students', 'two years', 'type', 'types', 'typical', 'typical day', 'typically', 'typing', 'ultimate', 'ultimate goal', 'ultimately', 'unable', 'uncomfortable', 'understand', 'understanding', 'unfortunately', 'unfortunately many', 'unfortunately not', 'unique', 'unique learning', 'unit', 'united', 'united states', 'units', 'university', 'upcoming', 'updated', 'upon', 'upper', 'urban', 'urban area', 'urban school', 'us', 'us get', 'us see', 'use', 'use books', 'use chromebooks', 'use classroom', 'use computer', 'use computers', 'use daily', 'use google', 'use hands', 'use help', 'use ipad', 'use ipads', 'use materials', 'use math', 'use new', 'use students', 'use tablets', 'use technology', 'used', 'used classroom', 'used daily', 'used help', 'used small', 'used students', 'useful', 'uses', 'using', 'using hands', 'using ipads', 'using materials', 'using technology', 'usually', 'utilize', 'utilized', 'utilizing', 'valley', 'valuable', 'value', 'valued', 'values', 'varied', 'variety', 'variety backgrounds', 'variety books', 'variety different', 'variety learning', 'variety seating', 'variety ways', 'various', 'various backgrounds', 'various learning', 'vary', 'varying', 'vast', 'vegetables', 'verbal', 'via', 'vibrant', 'video', 'videos', 'view', 'violence', 'virtual', 'vision', 'visit', 'visual', 'visual learners', 'visualize', 'visually', 'visuals', 'vital', 'vocabulary', 'voice', 'voices', 'volleyball', 'volume', 'wait', 'wait see', 'waiting', 'walk', 'walk classroom', 'walk door', 'walking', 'walks', 'walks life', 'wall', 'walls', 'want', 'want able', 'want best', 'want classroom', 'want continue', 'want create', 'want give', 'want help', 'want know', 'want learn', 'want make', 'want provide', 'want read', 'want school', 'want see', 'want students', 'want use', 'wanted', 'wanting', 'wants', 'war', 'warm', 'washington', 'waste', 'watch', 'watching', 'water', 'way', 'way get', 'way help', 'way hopeful', 'way learn', 'way learning', 'way nanan', 'way students', 'way teach', 'ways', 'ways help', 'ways learn', 'ways students', 'wear', 'weather', 'web', 'website', 'websites', 'week', 'week students', 'weekend', 'weekends', 'weekly', 'weeks', 'weight', 'welcome', 'welcoming', 'well', 'well nanan', 'well rounded', 'well school', 'well students', 'wellness', 'went', 'west', 'whatever', 'whenever', 'whether', 'white', 'white board', 'white boards', 'whiteboard', 'whiteboards', 'whole', 'whole child', 'whole class', 'whole group', 'whole new', 'whose', 'wide', 'wide range', 'wide variety', 'wiggle', 'wiggles', 'wiggling', 'wiggly', 'willing', 'willing learn

n', 'willingness', 'win', 'winning', 'winter', 'wipes', 'wireless', 'wish', 'within', 'within classroom', 'within school', 'without', 'wobble', 'wobble chairs', 'wobble stools', 'women', 'wonder', 'wonderful', 'wonderful group', 'wonderful students', 'wonderfully', 'word', 'word work', 'words', 'work', 'work best', 'work collaboratively', 'work every', 'work groups', 'work hard', 'work independently', 'work many', 'work nannan', 'work not', 'work school', 'work small', 'work students', 'work team', 'work time', 'work title', 'work together', 'work well', 'worked', 'workers', 'work force', 'working', 'working hard', 'working small', 'working students', 'working together', 'works', 'works best', 'worksheets', 'workshop', 'world', 'world around', 'world live', 'world nannan', 'world outside', 'world problems', 'world students', 'world technology', 'worlds', 'worn', 'worry', 'worth', 'would', 'would able', 'would allow', 'would also', 'would benefit', 'would give', 'would great', 'would greatly', 'would help', 'would like', 'would love', 'would make', 'would not', 'would provide', 'would really', 'would use', 'would used', 'write', 'writer', 'writers', 'writing', 'writing math', 'writing skills', 'writing students', 'written', 'year', 'year class', 'year classroom', 'year long', 'year many', 'year nannan', 'year not', 'year old', 'year olds', 'year school', 'year students', 'year teacher', 'year teaching', 'year want', 'year would', 'year year', 'years', 'years ago', 'years come', 'years old', 'years students', 'yes', 'yet', 'yoga', 'yoga balls', 'yoga mats', 'york', 'york city', 'young', 'young adults', 'young age', 'young children', 'young learners', 'young men', 'young minds', 'young people', 'young students', 'younger', 'youth']

In [40]:

```
#bow featurization title
vectorizer7 = CountVectorizer(min_df=10,max_features=5000,ngram_range=(1, 2))
vectorizer7.fit(X_train_title)# that is learned from trained data

# we use the fitted CountVectorizer to convert the text to vector
X_train_bow_title = vectorizer7.transform(X_train_title)
X_cv_bow_title= vectorizer7.transform(X_cv_title)
X_test_bow_title = vectorizer7.transform(X_test_title)

print("After vectorizations")
print(X_train_bow_title.shape, y_train.shape)
print(X_cv_bow_title.shape, y_cv.shape)
print(X_test_bow_title.shape, y_test.shape)
print("=*100)
# so the dimension of all are the same by using first fit and then transform
```

After vectorizations

```
(22445, 1576) (22445,)
(11055, 1576) (11055,)
(16500, 1576) (16500,)
```

```
=====
=====
```

Tfidf featurization

In [41]:

```
#for titles
from sklearn.feature_extraction.text import TfidfVectorizer
# We are considering only the words which appeared in at least 10 documents(rows or projects).
vectorizer8 = TfidfVectorizer(min_df=10,max_features=5000,ngram_range=(1, 2))# its a countvectors used for convert text to vectors
vectorizer8.fit(X_train_title)# that is learned from trained data

# we use the fitted CountVectorizer to convert the text to vector
X_train_tf_title = vectorizer8.transform(X_train_title)
X_cv_tf_title= vectorizer8.transform(X_cv_title)
X_test_tf_title = vectorizer8.transform(X_test_title)

print("After vectorizations")
print(X_train_tf_title.shape, y_train.shape)
print(X_cv_tf_title.shape, y_cv.shape)
print(X_test_tf_title.shape, y_test.shape)
print("="*100)
# so the dimension of all are the same by using first fit and then transform
```

After vectorizations

```
(22445, 1576) (22445,)
(11055, 1576) (11055,)
(16500, 1576) (16500,)
```

```
=====
=====
```

In [42]:

```

#for essay
from sklearn.feature_extraction.text import TfidfVectorizer
# We are considering only the words which appeared in at least 10 documents(rows or projects).
vectorizer9 = TfidfVectorizer(min_df=10,max_features=5000,ngram_range=(1, 2))# its a countvectors used for convert text to vectors
vectorizer9.fit(X_train_essay)# that is learned from trained data

# we use the fitted CountVectorizer to convert the text to vector
X_train_tf_essay = vectorizer9.transform(X_train_essay)
X_cv_tf_essay= vectorizer9.transform(X_cv_essay)
X_test_tf_essay = vectorizer9.transform(X_test_essay)

print("After vectorizations")
print(X_train_tf_essay.shape, y_train.shape)
print(X_cv_tf_essay.shape, y_cv.shape)
print(X_test_tf_essay.shape, y_test.shape)
print("=="*100)
# so the dimension of all are the same by using first fit and then transform

```

After vectorizations

(22445, 5000) (22445,)

(11055, 5000) (11055,)

(16500, 5000) (16500,)

```

=====
=====

```

Using Pretrained Models: Avg W2V

In [43]:

```

# 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

```

In [44]:

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

Loading Glove Model

1917495it [09:04, 3519.90it/s]

Done. 1917495 words loaded!

In [45]:

```
glove_words = set(model.keys())
```

In [46]:

```
#for essay
# average Word2Vec
# compute average word2vec for each review.
def func(wordlist):

    train_avg_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this list
    for sentence in tqdm(wordlist): # for each review/sentence
        vector = np.zeros(300) # as word vectors are of zero length # we are taking the 300 dimensions very large
        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
        train_avg_w2v_vectors.append(vector)

    print(len(train_avg_w2v_vectors))
    print(len(train_avg_w2v_vectors[0]))
    return train_avg_w2v_vectors
```


In [49]:

```
# average Word2Vec
# compute average word2vec for each review.
def tf_idf_done(word_list):

    train_title_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored
    in this list
    for sentence in tqdm(word_list): # 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((sen
                tence.count(word)/len(sentence.split())))
                tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
                tting the tfidf value for each word
                vector += (vec * tf_idf) # calculating tfidf weighted w2v
                tf_idf_weight += tf_idf
        if tf_idf_weight != 0:
            vector /= tf_idf_weight
        train_title_tfidf_w2v_vectors.append(vector)

    print(len(train_title_tfidf_w2v_vectors))
    print(len(train_title_tfidf_w2v_vectors[0]))
    return train_title_tfidf_w2v_vectors
```

```
train_tfidf_w2v_vectors=tf_idf_done(preprocessed_essays_train)
test_tfidf_w2v_vectors=tf_idf_done(preprocessed_essays_test)
cv_tfidf_w2v_vectors=tf_idf_done(preprocessed_essays_cv)

train_title_tfidf_w2v_vectors=tf_idf_done(preprocessed_titles_train)
test_title_tfidf_w2v_vectors=tf_idf_done(preprocessed_titles_test)
cv_title_tfidf_w2v_vectors=tf_idf_done(preprocessed_titles_cv)
```

22445
300

16500
300

11055
300

22445
300

16500
300

11055
300

Vectorizing Numerical features

In [52]:

```
price_data = dfr.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
dft = pd.merge(dft, price_data, on='id', how='left')
print(price_data.head(2))
```

```
# we also have to do this in train, test and cv
# so also merge the resource data with the train, cv and test
```

```
X_train = pd.merge(X_train, price_data, on = "id", how = "left")
#print(x_train.columns)
X_test = pd.merge(X_test, price_data, on = "id", how = "left")
X_cv = pd.merge(X_cv, price_data, on = "id", how = "left")
```

| | id | price | quantity |
|---|---------|--------|----------|
| 0 | p000001 | 459.56 | 7 |
| 1 | p000002 | 515.89 | 21 |

In [53]:

```
#standardization
# check this one: https://www.youtube.com/watch?v=0H0qOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler
from sklearn.preprocessing import MinMaxScaler
from sklearn import preprocessing
```

```
price_scalar = StandardScaler()
```

```
price_scalar.fit(X_train['price'].values.reshape(-1,1)) # finding the mean and standard deviation of this data
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])}")
```

```
# Now standardize the data with above mean and variance.
train_price_standar = price_scalar.transform(X_train['price'].values.reshape(-1, 1))
```

```
# Now standardize the data with above mean and variance.
test_price_standar = price_scalar.transform(X_test['price'].values.reshape(-1, 1))
```

```
# Now standardize the data with above mean and variance.
cv_price_standar = price_scalar.transform(X_cv['price'].values.reshape(-1, 1))
```


In [54]:

```
# previous_year_projects
price_scalar.fit(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1)) # finding the mean and standard deviation of this data
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
train_prev_proj_standar = price_scalar.transform(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
# Now standardize the data with above maen and variance.
test_prev_proj_standar = price_scalar.transform(X_test['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
# Now standardize the data with above maen and variance.
cv_prev_proj_standar = price_scalar.transform(X_cv['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

In [55]:

```
price_scalar.fit(X_train['quantity'].values.reshape(-1,1)) # finding the mean and standard deviation of this data
#print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
train_qnty_standar = price_scalar.transform(X_train['quantity'].values.reshape(-1, 1))

# Now standardize the data with above maen and variance.
cv_qnty_standar = price_scalar.transform(X_cv['quantity'].values.reshape(-1, 1))

# Now standardize the data with above maen and variance.
test_qnty_standar = price_scalar.transform(X_test['quantity'].values.reshape(-1, 1))
```

MERGING

In [56]:

```
from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix :)
X_set1_train = hstack((X_train_bow_title,X_train_bow,# all bows
                        X_train_teacher_prefix,X_train_cat,X_train_subcat ,X_train_project_grade_category,X_train_school_state,#all categorials
                        train_qnty_standar,train_price_standar,train_prev_proj_standar))#
all numericals

print(X_set1_train.shape, y_train.shape)
```

(22445, 6678) (22445,)

In [57]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set1_cv = hstack((X_cv_bow_title,X_cv_bow,
                    X_cv_teacher_prefix,X_cv_cat,X_cv_subcat,
                    X_cv_project_grade_category,X_cv_school_state, cv_qnty_standar,cv
                    _price_standar,cv_prev_proj_standar))

print(X_set1_cv.shape, y_cv.shape)

```

(11055, 6678) (11055,)

In [58]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set1_test = hstack((X_test_bow_title,X_test_bow,
                     X_test_teacher_prefix,X_test_cat,X_test_subcat,
                     X_test_project_grade_category,X_test_school_state,
                     test_qnty_standar,test_price_standar,test_prev_proj_standar))

print(X_set1_test.shape, y_test.shape)

```

(16500, 6678) (16500,)

In [59]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set2_train = hstack((X_train_tf_essay,X_train_tf_title,
                      X_train_teacher_prefix,X_train_cat,X_train_subcat,
                      X_train_project_grade_category,X_train_school_state,
                      train_qnty_standar,train_price_standar,train_prev_proj_standar))

print(X_set2_train.shape, y_train.shape)

```

(22445, 6678) (22445,)

In [60]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set2_cv = hstack((X_cv_tf_essay,X_cv_tf_title,
                   X_cv_teacher_prefix,X_cv_cat,X_cv_subcat,
                   X_cv_project_grade_category,X_cv_school_state,
                   cv_qnty_standar,cv_price_standar,cv_prev_proj_standar))

print(X_set2_cv.shape, y_cv.shape)

```

(11055, 6678) (11055,)

In [61]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set2_test = hstack((X_test_tf_essay,X_test_tf_title,
                      X_test_teacher_prefix,X_test_cat,X_test_subcat,
                      X_test_project_grade_category,X_test_school_state,
                      test_qnty_standar,test_price_standar,test_prev_proj_standar))

print(X_set2_test.shape, y_test.shape)

(16500, 6678) (16500,)

```

In [62]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set3_train = hstack((train_avg_w2v_vectors,train_avg_w2v_vectors_title,train_prev_proj_
standar,train_price_standar,train_qnty_standar,
                      X_train_teacher_prefix,X_train_cat,X_train_subcat,
                      X_train_project_grade_category,X_train_school_state))

print(X_set3_train.shape, y_train.shape)

(22445, 702) (22445,)

```

In [63]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set3_cv = hstack((cv_avg_w2v_vectors,cv_avg_w2v_vectors_title,cv_prev_proj_standar,cv_
_price_standar,cv_qnty_standar,
                   X_cv_teacher_prefix,X_cv_cat,X_cv_subcat,
                   X_cv_project_grade_category,X_cv_school_state))

print(X_set3_cv.shape, y_cv.shape)

(11055, 702) (11055,)

```

In [64]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set3_test = hstack((test_avg_w2v_vectors,test_avg_w2v_vectors_title,test_prev_proj_st
andar,test_price_standar,test_qnty_standar,
                     X_test_teacher_prefix,X_test_cat,X_test_subcat,
                     X_test_project_grade_category,X_test_school_state))

print(X_set3_test.shape, y_test.shape)

(16500, 702) (16500,)

```

In [65]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set4_train = hstack((train_tfidf_w2v_vectors, train_title_tfidf_w2v_vectors, train_prev_
proj_standar, train_price_standar, train_qnty_standar,
                      X_train_teacher_prefix, X_train_cat, X_train_subcat,
                      X_train_project_grade_category, X_train_school_state))

print(X_set4_train.shape, y_train.shape)

```

(22445, 702) (22445,)

In [66]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set4_cv = hstack((cv_tfidf_w2v_vectors, cv_title_tfidf_w2v_vectors, cv_prev_proj_standa
r, cv_price_standar, cv_qnty_standar,
                  X_cv_teacher_prefix, X_cv_cat, X_cv_subcat,
                  X_cv_project_grade_category, X_cv_school_state))

print(X_set4_cv.shape, y_cv.shape)

```

(11055, 702) (11055,)

In [67]:

```

from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set4_test = hstack((test_title_tfidf_w2v_vectors, test_tfidf_w2v_vectors, test_prev_pro
j_standar, test_price_standar, test_qnty_standar,
                    X_test_teacher_prefix, X_test_cat, X_test_subcat,
                    X_test_project_grade_category, X_test_school_state))

print(X_set4_test.shape, y_test.shape)

```

(16500, 702) (16500,)

Logistic Regression on BOW

In [70]:

```
import warnings
warnings.filterwarnings('ignore')
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
#from sklearn.grid_search import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV

"""
y_true : array, shape = [n_samples] or [n_samples, n_classes]
True binary labels or binary label indicators.

y_score : array, shape = [n_samples] or [n_samples, n_classes]
Target scores, can either be probability estimates of the positive class, confidence va
lues, or non-thresholded measure of
decisions (as returned by "decision_function" on some classifiers).
For binary y_true, y_score is supposed to be the score of the class with greater label.

"""

clf = LogisticRegression(class_weight='balanced');
parameters = {'C':[10**-4, 10**-3, 10**-2, 1, 10, 100, 1000, 500, 1000, 10000]}
sd=GridSearchCV(clf, parameters, cv=5, scoring='roc_auc', return_train_score=True)
sd.fit(X_set1_train, y_train);

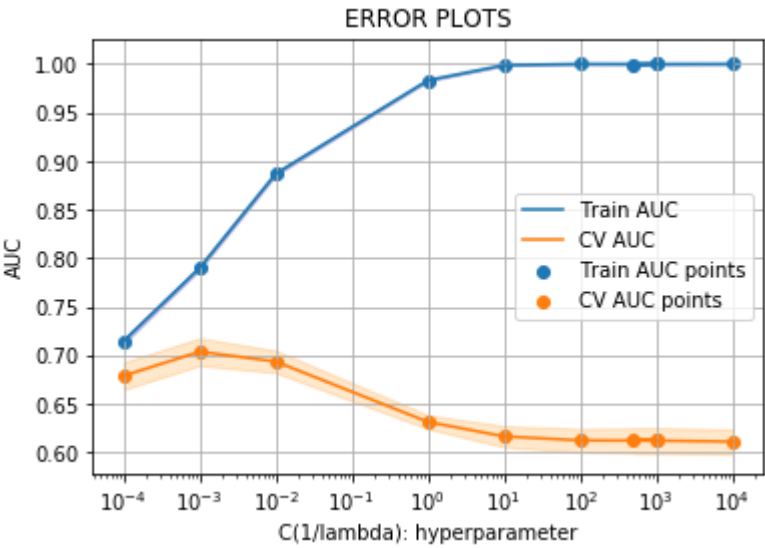
train_auc= sd.cv_results_['mean_train_score']
train_auc_std= sd.cv_results_['std_train_score']
cv_auc = sd.cv_results_['mean_test_score']
cv_auc_std= sd.cv_results_['std_test_score']

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, alpha=0.2, color='darkblue')

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=0.2, color='darkorange')

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("C(1/lambda): hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()
```



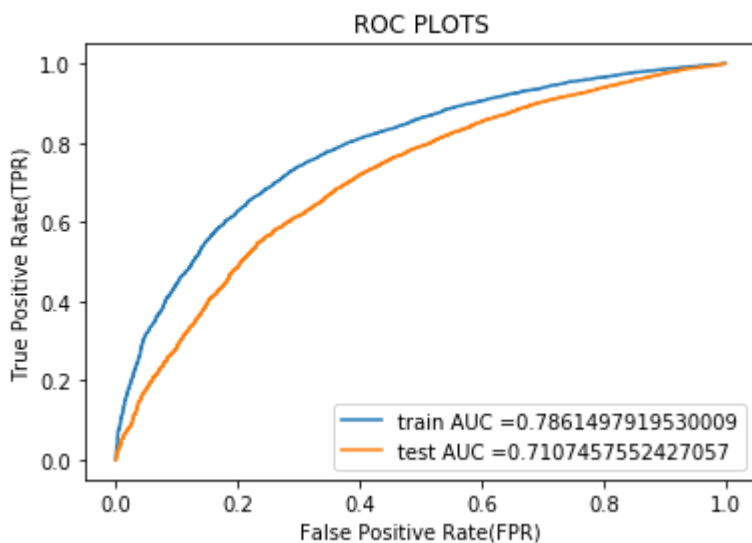
In [99]:

```
##Fitting Model to Hyper-Parameter Curve
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

neigh = LogisticRegression(C=10**-3,class_weight='balanced');
neigh.fit(X_set1_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set1_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set1_test)[:,1])

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



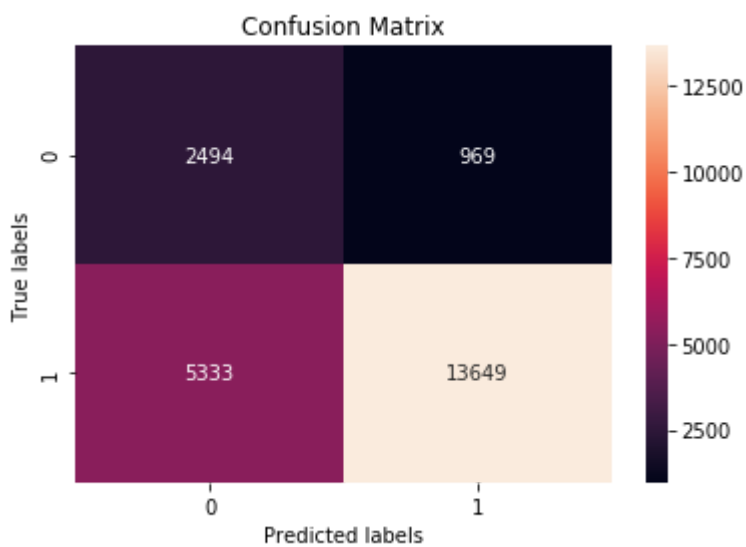
OBSERVATIONS: As we seen form the roc plot ,Model works well 71 auc score also good

In [72]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set1_train )), annot=True, ax = ax,
fmt='g'); #annot=True to annotate cells

# Labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'business']);
```



In [73]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
```

```
import seaborn as sns
import matplotlib.pyplot as plt
```

```
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set1_test )), annot=True, ax = ax,
fmt='g'); #annot=True to annotate cells
```

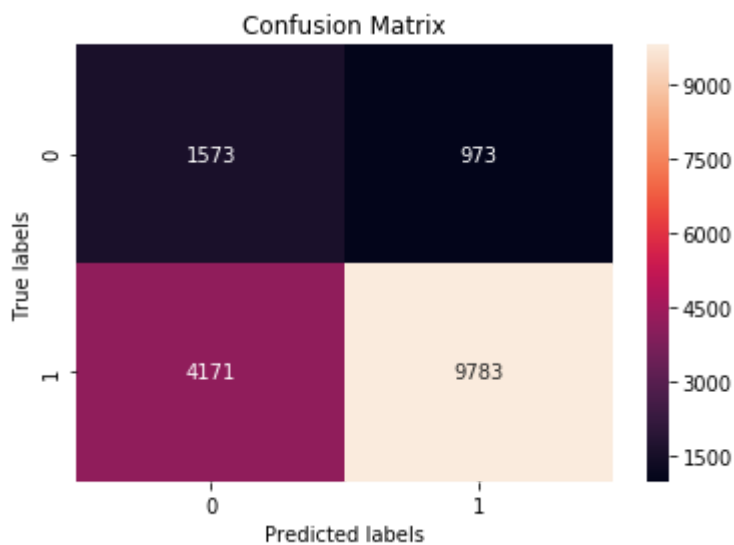
```
# Labels, title and ticks
```

```
ax.set_xlabel('Predicted labels');
```

```
ax.set_ylabel('True labels');
```

```
ax.set_title('Confusion Matrix');
```

```
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'business']);
```



logistic regression on TFIDF

In [75]:

```

from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
#from sklearn.grid_search import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV

"""
y_true : array, shape = [n_samples] or [n_samples, n_classes]
True binary labels or binary label indicators.

y_score : array, shape = [n_samples] or [n_samples, n_classes]
Target scores, can either be probability estimates of the positive class, confidence va
lues, or non-thresholded measure of
decisions (as returned by "decision_function" on some classifiers).
For binary y_true, y_score is supposed to be the score of the class with greater label.
"""

clf = LogisticRegression(class_weight='balanced');
parameters = {'C':[10**-4, 10**-3, 10**-2, 1, 10, 100, 1000, 500, 1000, 10000]}
sd = GridSearchCV(clf, parameters, cv=3, scoring='roc_auc', return_train_score=True)
sd.fit(X_set2_train, y_train);

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

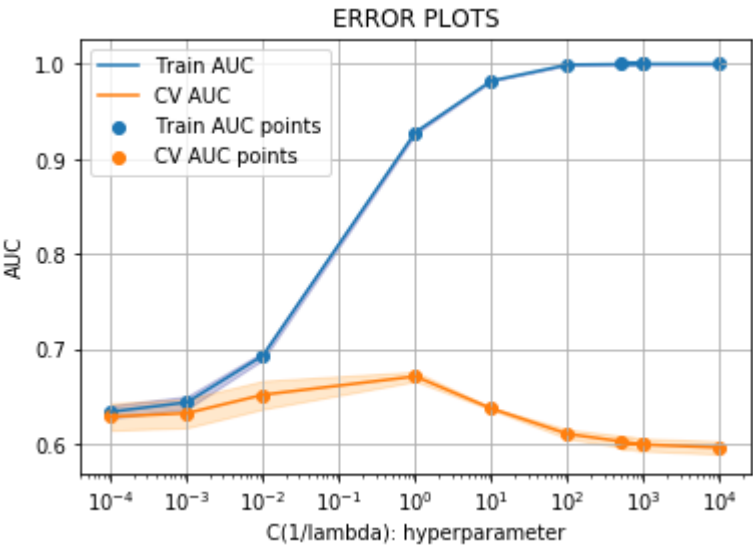
plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'], train_auc - train_auc_std, train_auc + train_auc_
std, alpha=0.2, color='darkblue')

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.
2, color='darkorange')

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("C(1/lambda): hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()

```



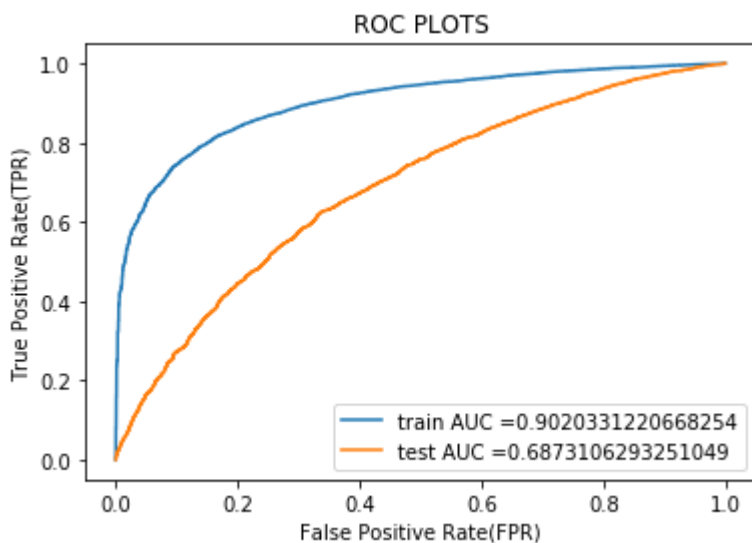
In [100]:

```
#Fitting Model to Hyper-Parameter Curve
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

neigh = LogisticRegression(C=1,class_weight='balanced');
neigh.fit(X_set2_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set2_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set2_test)[:,1])

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



OBSERVATIONS: So in training data roc curve is good, but training data curve is very much higher than the test data, so this is overfitting in this case.

Confusion matrix

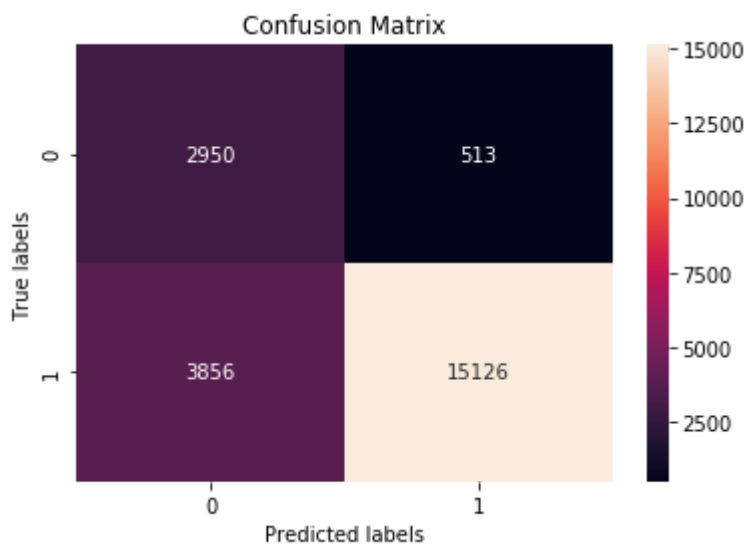
In [77]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
```

```
import seaborn as sns
import matplotlib.pyplot as plt
```

```
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set2_train )), annot=True, ax = ax,
            fmt='g'); #annot=True to annotate cells
```

```
# Labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'business']);
```



In [78]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
```

```
import seaborn as sns
```

```
import matplotlib.pyplot as plt
```

```
ax= plt.subplot()
```

```
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set2_test )), annot=True, ax = ax,  
fmt='g'); #annot=True to annotate cells
```

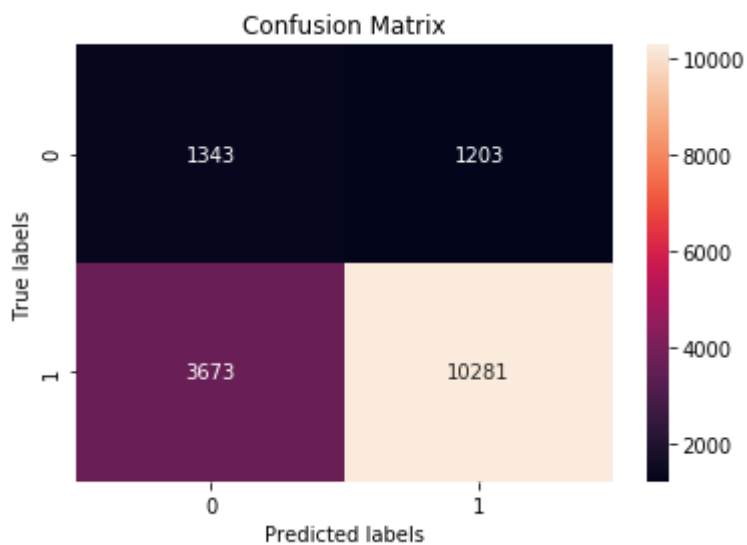
```
# Labels, title and ticks
```

```
ax.set_xlabel('Predicted labels');
```

```
ax.set_ylabel('True labels');
```

```
ax.set_title('Confusion Matrix');
```

```
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'b  
usiness']);
```



logistic regression on AVG W2V

In [79]:

```

from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
#from sklearn.grid_search import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV

"""
y_true : array, shape = [n_samples] or [n_samples, n_classes]
True binary labels or binary label indicators.

y_score : array, shape = [n_samples] or [n_samples, n_classes]
Target scores, can either be probability estimates of the positive class, confidence va
lues, or non-thresholded measure of
decisions (as returned by "decision_function" on some classifiers).
For binary y_true, y_score is supposed to be the score of the class with greater label.
"""

clf = LogisticRegression(class_weight='balanced');
parameters = {'C':[10**-4, 10**-3, 10**-2, 1, 10, 100, 1000, 500, 1000, 10000]}
cl = GridSearchCV(clf, parameters, cv=3, scoring='roc_auc', return_train_score=True)
cl.fit(X_set3_train, y_train);

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

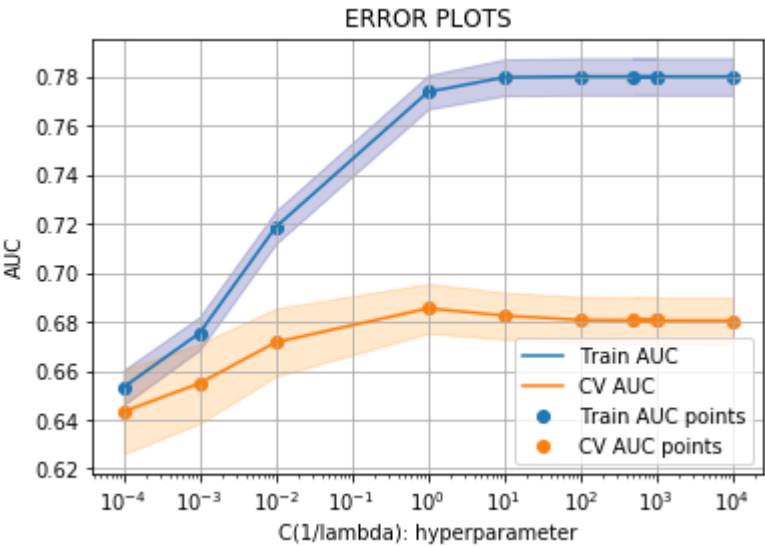
plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'], train_auc - train_auc_std, train_auc + train_auc_
std, alpha=0.2, color='darkblue')

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.
2, color='darkorange')

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("C(1/lambda): hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()

```



Fitting Model to Hyper-Parameter Curve:

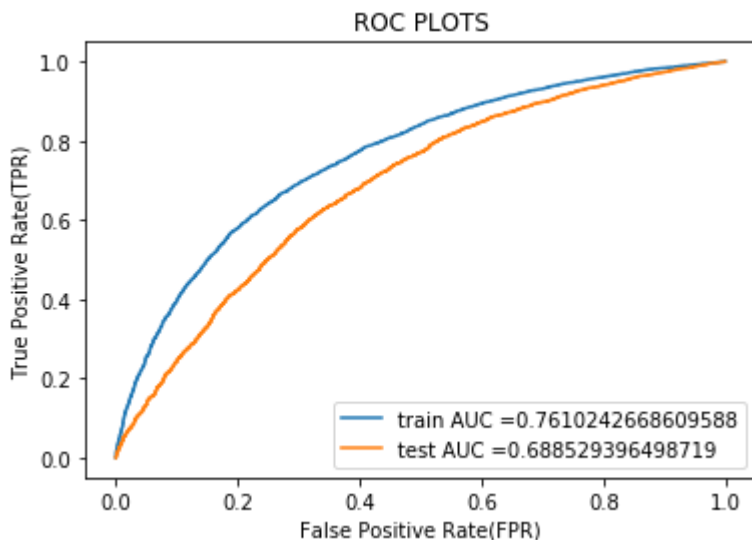
In [101]:

```
#Fitting Model to Hyper-Parameter Curve:
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

neigh = LogisticRegression(C=1,class_weight='balanced');
neigh.fit(X_set3_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set3_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set3_test)[:,1])

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.ylabel("True Positive Rate(TPR)")
plt.xlabel("False Positive Rate(FPR)")
plt.title("ROC PLOTS")
plt.show()
print(" "*100)
```



```
=====
=====
```

Observations: So logistic regressoin with word2vec works prettywell , train and test roc curve very close to each other, so LR with word2vec is better than LR with tf_idf of essay and titles

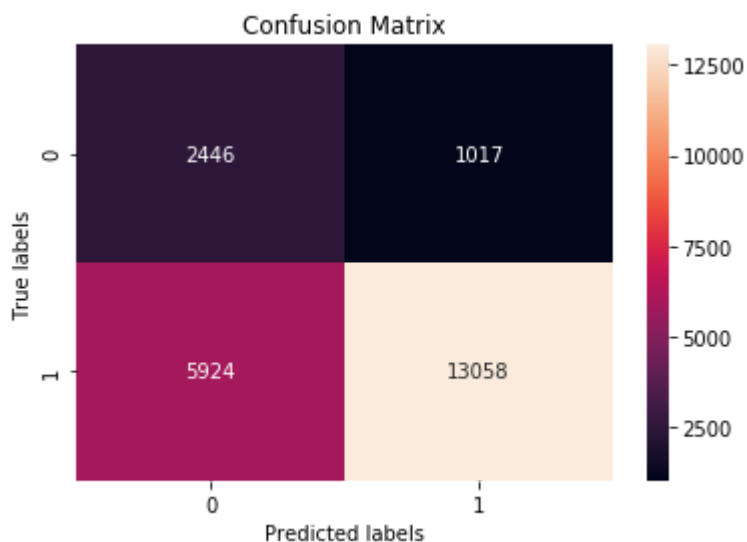
confusion matrix of train and test data

In [81]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set3_train )), annot=True, ax = ax,
fmt='g'); #annot=True to annotate cells

# Labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'business']);
```

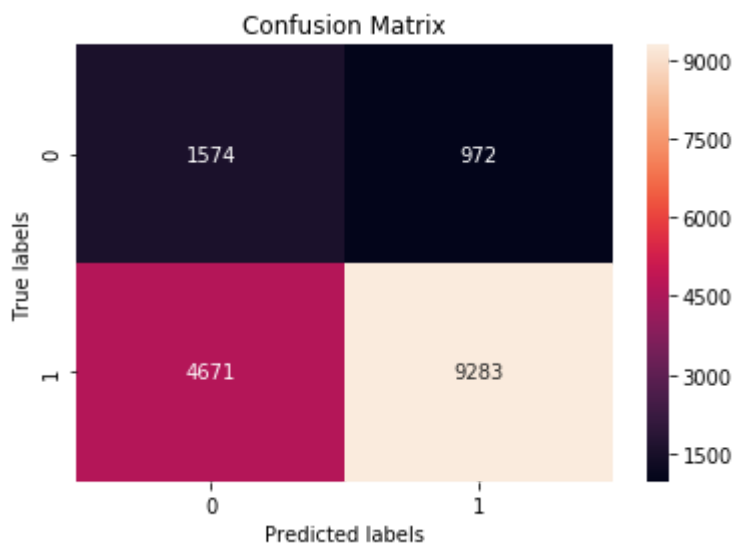


In [82]:

```
#for test data
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set3_test )), annot=True, ax = ax,
fmt='g'); #annot=True to annotate cells

# Labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'b
usiness']);
```



logistic regresion on td_idf W2V

In [83]:

```

from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
#from sklearn.grid_search import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV

"""
y_true : array, shape = [n_samples] or [n_samples, n_classes]
True binary labels or binary label indicators.

y_score : array, shape = [n_samples] or [n_samples, n_classes]
Target scores, can either be probability estimates of the positive class, confidence va
lues, or non-thresholded measure of
decisions (as returned by "decision_function" on some classifiers).
For binary y_true, y_score is supposed to be the score of the class with greater label.
"""

clf = LogisticRegression(class_weight='balanced');
parameters = {'C':[10**-4, 10**-3, 10**-2, 1, 10, 100, 1000, 500, 1000, 10000]}
cl = GridSearchCV(clf, parameters, cv=3, scoring='roc_auc', return_train_score=True)
cl.fit(X_set4_train, y_train);

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

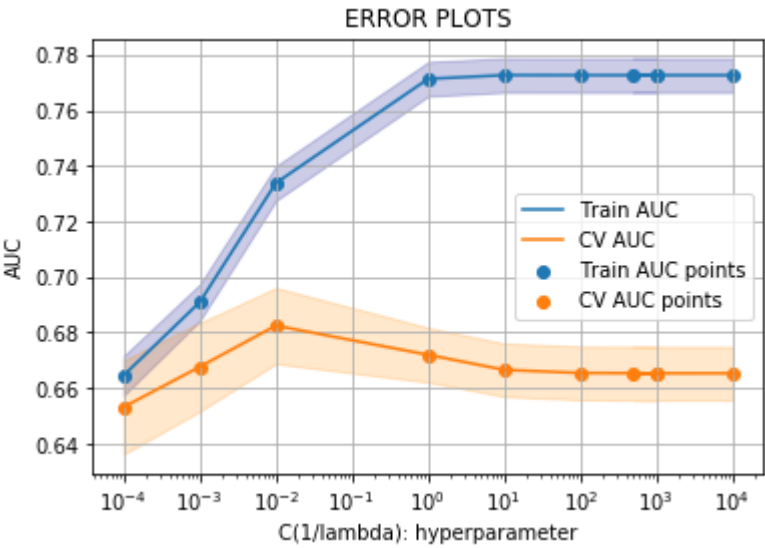
plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'], train_auc - train_auc_std, train_auc + train_auc_
std, alpha=0.2, color='darkblue')

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.
2, color='darkorange')

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("C(1/lambda): hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()

```



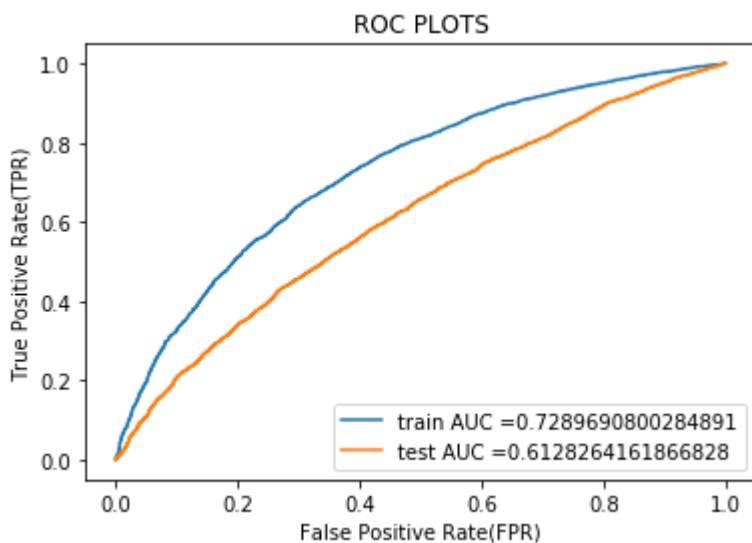
In [102]:

```
#Fitting Model to Hyper-Parameter Curve:
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

neigh = LogisticRegression(C=10**-2,class_weight='balanced');
neigh.fit(X_set4_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set4_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set4_test)[:,1])

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



Observation: This is overfitting, in train data roc is good but in test data roc curve is only 61,so much less.

Confusion matrix

In [85]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
```

```
import seaborn as sns
import matplotlib.pyplot as plt
```

```
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set4_train )), annot=True, ax = ax,
            fmt='g'); #annot=True to annotate cells
```

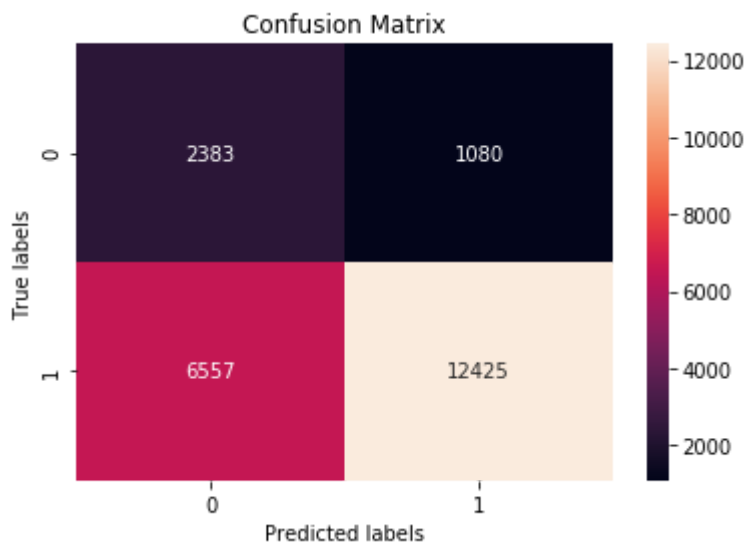
```
# Labels, title and ticks
```

```
ax.set_xlabel('Predicted labels');
```

```
ax.set_ylabel('True labels');
```

```
ax.set_title('Confusion Matrix');
```

```
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'business']);
```



In [86]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
```

```
import seaborn as sns
import matplotlib.pyplot as plt
```

```
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set4_test )), annot=True, ax = ax,
fmt='g'); #annot=True to annotate cells
```

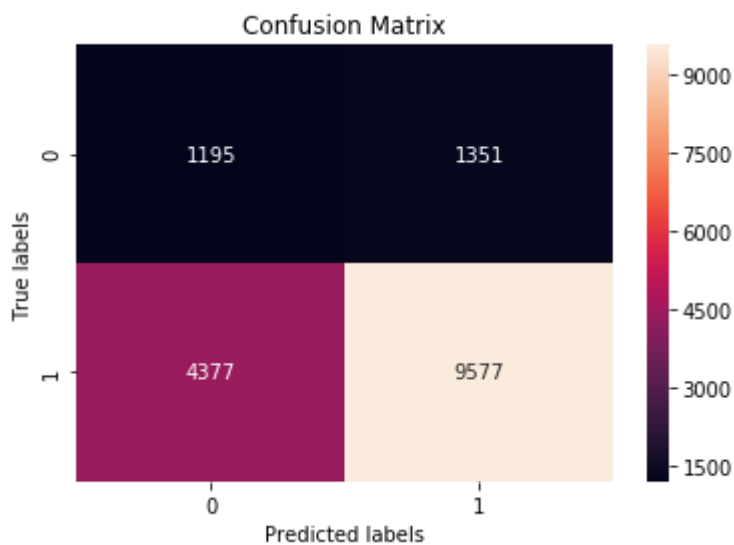
```
# Labels, title and ticks
```

```
ax.set_xlabel('Predicted labels');
```

```
ax.set_ylabel('True labels');
```

```
ax.set_title('Confusion Matrix');
```

```
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'business']);
```



New feature(No. of words in title)

In [87]:

```
# For train data
title_length_train=[]
for i in range(0,22445):
    title_length_train.append(len(X_train["project_title"][i].split()))

title_length_train=np.array(title_length_train)

#for test data titles
title_length_test=[]
for i in range(0,16500):
    title_length_test.append(len(X_test["project_title"][i].split()))

title_length_test=np.array(title_length_test)

#for cv data titles

title_length_cv=[]
for i in range(0,11055):
    title_length_cv.append(len(X_cv["project_title"][i].split()))

title_length_cv=np.array(title_length_cv)
```

New feature(No. of words in combined essays)

In [88]:

```
#for test data essay
essay_length_test=[]
for i in range(0,16500):
    essay_length_test.append(len(X_test["essay"][i].split()))

essay_length_test=np.array(essay_length_test)

#for cv data essay

essay_length_cv=[]
for i in range(0,11055):
    essay_length_cv.append(len(X_cv["essay"][i].split()))

essay_length_cv=np.array(essay_length_cv)

#for train data essay

essay_length_train=[]
for i in range(0,22445):
    essay_length_train.append(len(X_train["essay"][i].split()))

essay_length_train=np.array(essay_length_train)
```

New feature(Sentiment scores of each combined essay's)

In [89]:

```
import nltk
from nltk.sentiment.vader import SentimentIntensityAnalyzer
nltk.download('vader_lexicon')

#https://www.programcreek.com/python/example/100005/nltk.sentiment.vader.SentimentIntensityAnalyzer
def analyze_sentiment(df):
    sentiments = []
    sid = SentimentIntensityAnalyzer()
    for i in range(df.shape[0]):
        line = df['essay'][i] # take one essay
        sentiment = sid.polarity_scores(line) # calculate the sentiment
        sentiments.append([sentiment['neg'], sentiment['pos'],
                           sentiment['neu'], sentiment['compound']]) # list of lists
    df[['neg', 'pos', 'neu', 'compound']] = pd.DataFrame(sentiments)
    df['Negative'] = df['compound'] < -0.1
    df['Positive'] = df['compound'] > 0.1
    return df
```

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

In [90]:

```
X_train=analyze_sentiment(X_train)
X_test=analyze_sentiment(X_test)
X_cv=analyze_sentiment(X_cv)
```

In [91]:

```
#for train

pos=list(X_train['pos'])
pos=np.array(pos)
neg=list(X_train['neg'])
neg=np.array(neg)
com=list(X_train['compound'])
com=np.array(com)

# combine all
from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set5_train = hstack((
    X_train_teacher_prefix,X_train_cat,X_train_subcat ,X_train_project_grade_category,X_train_school_state,#all categorials
    train_qnty_standar,train_price_standar,train_prev_proj_standar,
    essay_length_train.reshape(-1,1),title_length_train.reshape(-1,1),
    pos.reshape(-1,1),neg.reshape(-1,1),com.reshape(-1,1),
    ))# all numericals

print(X_set5_train.shape, y_train.shape)
```

(22445, 107) (22445,)

In [92]:

```
#For cv

pos=list(X_cv['pos'])
pos=np.array(pos)

neg=list(X_cv['neg'])
neg=np.array(neg)

com=list(X_cv['compound'])
com=np.array(com)

# combine all
from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set5_cv = hstack((
    X_cv_teacher_prefix,X_cv_cat,X_cv_subcat ,X_cv_project_grade_category,X_cv_school_state,#all categorials
    cv_qnty_standar,cv_price_standar,cv_prev_proj_standar,
    essay_length_cv.reshape(-1,1),title_length_cv.reshape(-1,1),
    pos.reshape(-1,1),neg.reshape(-1,1),com.reshape(-1,1),
    ))# all numericals

print(X_set5_cv.shape, y_cv.shape)
```

(11055, 107) (11055,)

In [93]:

```
#for test
pos=list(X_test['pos'])
pos=np.array(pos)

neg=list(X_test['neg'])
neg=np.array(neg)

com=list(X_test['compound'])
com=np.array(com)

# combine all
from scipy.sparse import hstack
# with the same hstack function we are concatenating a sparse matrix and a dense matrix
:)
X_set5_test = hstack((
    X_test_teacher_prefix,X_test_cat,X_test_subcat ,X_test_project_grade_category,X_test_school_state,#all categoricals
    test_qnty_standar,test_price_standar,test_prev_proj_standar,
    essay_length_test.reshape(-1,1),title_length_test.reshape(-1,1),
    pos.reshape(-1,1),neg.reshape(-1,1),com.reshape(-1,1),
    ))# all numericals

print(X_set5_test.shape, y_test.shape)

(16500, 107) (16500,)
```

logistic regression on SET 5

In [95]:

```

from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
#from sklearn.grid_search import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV

"""
y_true : array, shape = [n_samples] or [n_samples, n_classes]
True binary labels or binary label indicators.

y_score : array, shape = [n_samples] or [n_samples, n_classes]
Target scores, can either be probability estimates of the positive class, confidence va
lues, or non-thresholded measure of
decisions (as returned by "decision_function" on some classifiers).
For binary y_true, y_score is supposed to be the score of the class with greater label.
"""

clf = LogisticRegression(class_weight='balanced');
parameters = {'C':[10**-4, 10**-3, 10**-2, 1, 10, 100, 1000, 500, 1000, 10000]}
cl = GridSearchCV(clf, parameters, cv=3, scoring='roc_auc', return_train_score=True)
cl.fit(X_set5_train, y_train);

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

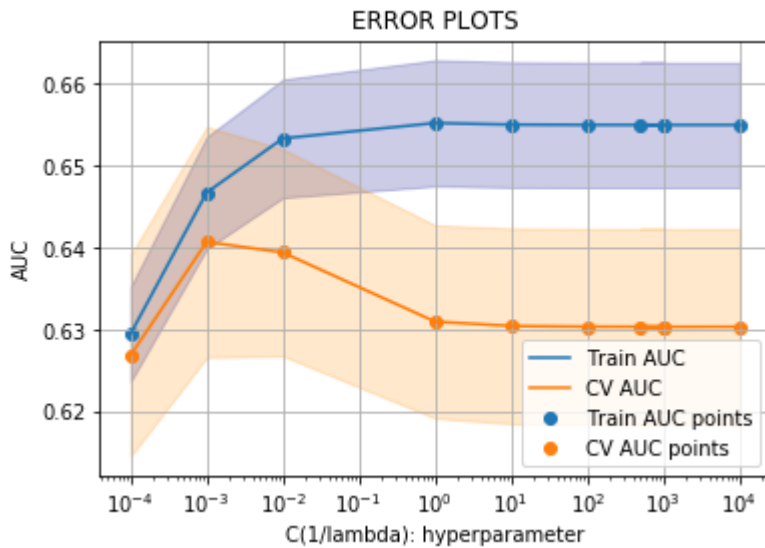
plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'], train_auc - train_auc_std, train_auc + train_auc_
std, alpha=0.2, color='darkblue')

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.
2, color='darkorange')

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("C(1/lambda): hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()

```



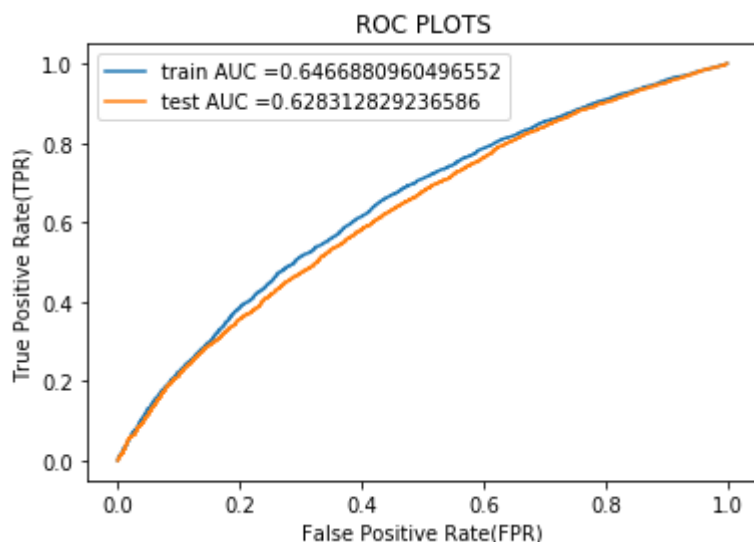
In [103]:

```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

neigh = LogisticRegression(C=10**-3, class_weight='balanced');
neigh.fit(X_set5_train, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set5_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set5_test)[:,1])

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



Observation:

In this plot there is no overfitting so this roc curve is better than roc curves in which we used bow or tf_idf, but if we talk about confusion matrix, without featurization our confusion matrix is so bad, predicting negative class wrong, also (model with featurization) confusion matrix did the same.

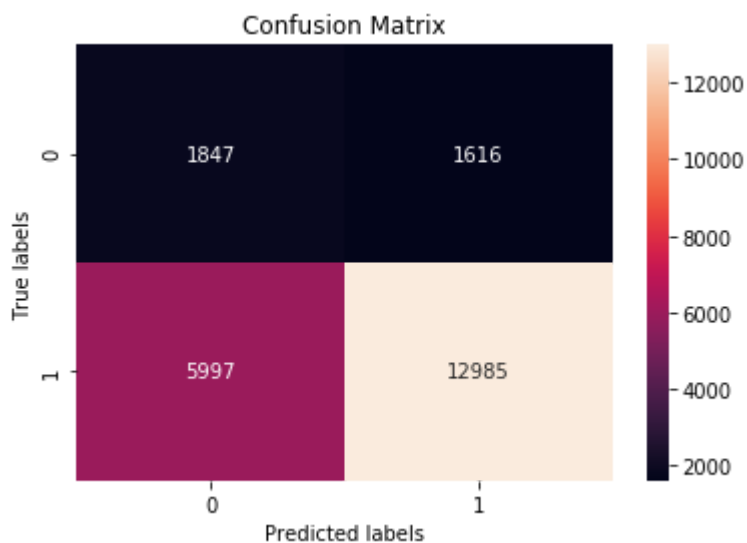
Confusion matrix

In [97]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set5_train)), annot=True, ax = ax,
            fmt='g'); #annot=True to annotate cells

# Labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'business']);
```

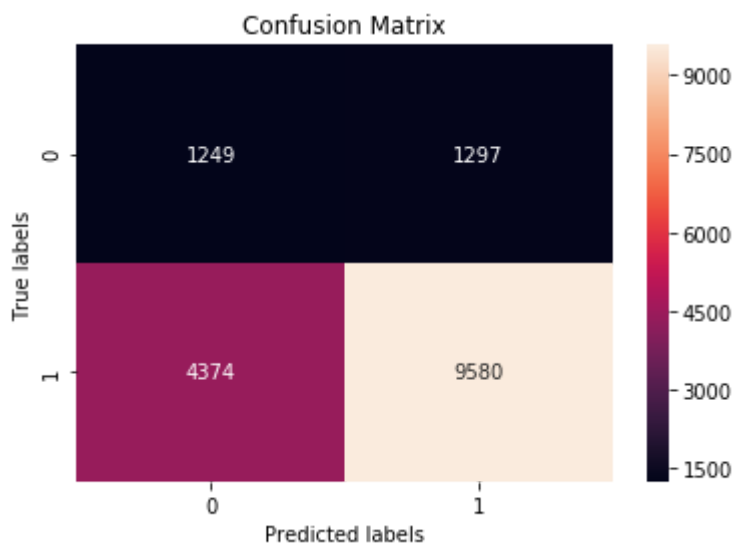


In [98]:

```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set5_test )), annot=True, ax = ax,
fmt='g'); #annot=True to annotate cells

# Labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
#ax.xaxis.set_ticklabels(['business', 'health']); ax.yaxis.set_ticklabels(['health', 'b
usiness']);
```



Observations:

1. If we compare the roc curves between model with featurizations and model without featurization, the model with featurization is better.
2. Confusion matrix is bad in both but in (with featurization model) the confusion matrix is little bit good from the (model with featurization).

3. Conclusions

In [105]:

```
# Please compare all your models using Prettytable library
# Please compare all your models using Prettytable library
#how to use pretty table http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

tb = PrettyTable()
tb.field_names= ("Vectorizer", "Model", "HyperParameter", "AUC")
tb.add_row(["BOW", "Auto", 10**-3, 71])
tb.add_row(["Tf-Idf", "Auto", 1, 68])
tb.add_row(["AVGW2V", "Auto", 1, 68])
tb.add_row(["Tf-Idf w2v", "Auto", 10**-2, 61])
tb.add_row(["Set 5", "Auto", 10**-3, 62])
print(tb.get_string(titles = "Logistic Reg> - Observations"))
```

| Vectorizer | Model | HyperParameter | AUC |
|------------|-------|----------------|-----|
| BOW | Auto | 0.001 | 71 |
| Tf-Idf | Auto | 1 | 68 |
| AVGW2V | Auto | 1 | 68 |
| Tf-Idf w2v | Auto | 0.01 | 61 |
| Set 5 | Auto | 0.001 | 62 |