

DonorsChoose

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

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

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

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

About the DonorsChoose Data Set

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

Feature	Description
<code>project_id</code>	A unique identifier for the proposed project. Example: p036502
<code>project_title</code>	Title of the project. Examples: <ul style="list-style-type: none">• Art Will Make You Happy!• First Grade Fun
<code>project_grade_category</code>	Grade level of students for which the project is targeted. One of the following enumerated values: <ul style="list-style-type: none">• Grades PreK-2• Grades 3-5• Grades 6-8• Grades 9-12
<code>project_subject_categories</code>	One or more (comma-separated) subject categories for the project from the following enumerated list of values: <ul style="list-style-type: none">• Applied Learning• Care & Hunger• Health & Sports• History & Civics• Literacy & Language• Math & Science• Music & The Arts• Special Needs• Warmth Examples: <ul style="list-style-type: none">• Music & The Arts• Literacy & Language, Math & Science
<code>school_state</code>	State where school is located (Two-letter U.S. postal code). Example: WY
<code>project_subject_subcategories</code>	One or more (comma-separated) subject subcategories for the project. Examples: <ul style="list-style-type: none">• Literacy

Feature	Description
<code>project_resource_summary</code>	An explanation of the resources needed for the project. Example: <ul style="list-style-type: none"> My students need hands on literacy materials to manage sensory needs!
<code>project_essay_1</code>	First application essay*
<code>project_essay_2</code>	Second application essay*
<code>project_essay_3</code>	Third application essay*
<code>project_essay_4</code>	Fourth application essay*
<code>project_submitted_datetime</code>	Datetime when project application was submitted. Example: 2016-04-28 12:43:56.245
<code>teacher_id</code>	A unique identifier for the teacher of the proposed project. Example: bdf8baa8fedef6bfeec7ae4ff1c15c56
<code>teacher_prefix</code>	Teacher's title. One of the following enumerated values: <ul style="list-style-type: none"> nan Dr. Mr. Mrs. Ms. Teacher.
<code>teacher_number_of_previously_posted_projects</code>	Number of project applications previously submitted by the same teacher. Example: 2

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

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

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

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

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

Label	Description
<code>project_is_approved</code>	A binary flag indicating whether DonorsChoose approved the project. A value of 0 indicates the project was not approved, and a value of 1 indicates the project was approved.

Notes on the Essay Data

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

- `__project_essay_1__` "Introduce us to your classroom"
- `__project_essay_2__` "Tell us more about your students"
- `__project_essay_3__` "Describe how your students will use the materials you're requesting"
- `__project_essay_3__` "Close by sharing why your project will make a difference"

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

- `__project_essay_1__` "Describe your students: What makes your students special? Specific details about their background, your neighborhood, and your school are all helpful."

your neighborhood, and your school are all helpful.

- `__project_essay_2__` "About your project: How will these materials make a difference in your students' learning and improve their school lives?"

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

In [1]:

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

import sqlite3
import pandas as pd
import numpy as np
import nltk
import string
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import roc_curve, auc
from nltk.stem.porter import PorterStemmer

import re
# Tutorial about Python regular expressions: https://pymotw.com/2/re/
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle

from tqdm import tqdm
import os

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

1.1 Reading Data

In [2]:

```
project_data = pd.read_csv('train_data.csv')
resource_data = pd.read_csv('resources.csv')
```

In [3]:

```
project_data
```

Out[3]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57

1	Unnamed: 0			teacher_id	Teacher_prefix	School_state	Project_submitted_datetime
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ	2016-08-31 12:03:56	
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	2016-10-06 21:16:17	
4	172407	p104768	be1f7507a41f8479dc06f047086a39ec	Mrs.	TX	2016-07-11 01:10:09	
5	141660	p154343	a50a390e8327a95b77b9e495b58b9a6e	Mrs.	FL	2017-04-08 22:40:43	
6	21147	p099819	9b40170bfa65e399981717ee8731efc3	Mrs.	CT	2017-02-17 19:58:56	
7	94142	p092424	5bfd3d12fae3d2fe88684bbac570c9d2	Ms.	GA	2016-09-01 00:02:15	
8	112489	p045029	487448f5226005d08d36bdd75f095b31	Mrs.	SC	2016-09-25 17:00:26	
9	158561	p001713	140eeac1885c820ad5592a409a3a8994	Ms.	NC	2016-11-17 18:18:56	
10	43184	p040307	363788b51d40d978fe276bcb1f8a2b35	Mrs.	CA	2017-01-04 16:40:30	
11	127083	p251806	4ba7c721133ef651ca54a03551746708	Ms.	CA	2016-11-14 22:57:28	
12	19090	p051126	5e52c92b7e3c472aad247a239d345543	Mrs.	NY	2016-05-23 15:46:02	
13	15126	p003874	178f6ae765cd4e0fb143a77c47fd65e2	Mrs.	OK	2016-10-17 09:49:27	
14	62232	p233127	424819801de22a60bba7d0f4354d0258	Ms.	MA	2017-02-14 16:29:10	
15	67303	p132832	bb6d6d054824fa01576ab38dfa2be160	Ms.	TX	2016-10-05 21:05:38	
16	127215	p174627	4ad7e280fddff889e1355cc9f29c3b89	Mrs.	FL	2017-01-18 10:59:05	
17	157771	p152491	e39abda057354c979c5b075cffbe5f88	Ms.	NV	2016-11-23 17:14:17	

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime
18	122186	p196421	fcd9b003fc1891383f340a89da02a1a6	Mrs.	GA	2016-08-28 15:04:42
19	146331	p058343	8e07a98deb1bc74c75b97521e05b1691	Ms.	OH	2016-08-06 13:05:20
20	75560	p052326	e0c1aad1f71badeff703fadc15f57680	Mrs.	PA	2016-10-07 18:27:02
21	132078	p187097	2d4a4d2d774e5c2fdd25b2ba0e7341f8	Mrs.	NC	2016-05-17 19:45:13
22	84810	p165540	30f08fbe02eba5453c4ce2e857e88eb4	Ms.	CA	2016-09-01 10:09:15
23	8636	p219330	258ef2e6ab5ce007ac6764ce15d261ba	Mr.	AL	2017-01-10 11:41:06
24	21478	p126524	74f8690562c44fc88f65f845b9fe61d0	Mrs.	FL	2017-03-31 12:34:44
25	20142	p009037	b8bf3507cee960d5fedcb27719df2d59	Mrs.	AL	2017-03-09 15:36:20
26	33903	p040091	7a0a5de5ed94e7036946b1ac3eaa99d0	Ms.	TX	2016-09-18 22:10:40
27	1156	p161033	efdc3cf14d136473c9f62becc00d4cec	Teacher	LA	2016-11-06 16:02:31
28	35430	p085706	22c8184c4660f1c589bea061d14b7f35	Mrs.	GA	2017-01-27 12:34:59
29	22088	p032018	45f16a103f1e00b7439861d4e0728a59	Mrs.	VA	2016-07-15 12:58:40
...
109218	127181	p077978	91f5c69bf72c82edb9bc1f55596d8d95	Mrs.	IL	2017-01-10 14:08:28
109219	65838	p042022	9a6784108c76576565f46446594f99c4	Teacher	FL	2016-07-26 22:43:52
109220	21062	p064087	19c622a38a0cd76c2e9dbcc40541fabd	Mrs.	WI	2016-09-18 13:15:13
109221	81490	p117254	031e299278ac511616b2950fc1312a55	Teacher	NY	2016-07-03 23:09:29

	Unnamed:	id	teacher_id	teacher_prefix	school_state	project_submitted_date
	0					
109222	69138	p152194	6f6e951e435aa9dc966091945414bcc4	Ms.	NC	2016-12-01 20:29:04
109223	5110	p041136	6db62616b4ef6efc2310088f7ea0ae14	Ms.	GA	2017-02-15 14:07:07
109224	109630	p257774	651866d8215616f65934aafcbee21bf5	Ms.	NY	2016-05-23 20:36:51
109225	177841	p079425	c628dff071aa8028b08a5d4972bef2a1	Mrs.	NC	2016-11-14 21:04:43
109226	65359	p085810	1d286ff10ee3982b2b47813f1e415ef2	Ms.	CA	2016-08-12 09:19:22
109227	55643	p146149	e15cd063caa1ce11a45f2179535105f2	Mrs.	NY	2016-10-19 10:10:04
109228	103666	p191845	d0603199630760d8d0eb003108208998	Mrs.	LA	2016-10-14 18:05:17
109229	121219	p055363	523f95270c6aec82bee90e3931ceeeca	Mrs.	CO	2016-09-06 23:19:17
109230	117282	p235512	ee59900af64d9244487e7ed87d0bc423	Ms.	NY	2016-08-09 21:06:33
109231	170085	p248898	9d7a4dae637d1a170778e2db1515e574	Mrs.	AZ	2016-09-17 09:58:59
109232	36083	p204774	c116af7435274872bea9ff123a69cf6a	Mrs.	MD	2017-03-14 19:59:52
109233	155847	p120664	b90258ab009b84e0dc11a7186d597141	Ms.	AZ	2016-12-21 16:36:26
109234	52918	p057638	dd68d9fbae85933c0173c13f66291cbe	Ms.	NY	2017-03-29 20:06:10
109235	69971	p105083	9636fcacbf65eb393133a94c83c4a0d4	Mrs.	TX	2017-01-07 14:50:08
109236	120581	p254202	2950019dd34581dbccddcae683e74207a	Mrs.	OH	2016-08-14 08:27:24

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime
109237	115336	p056813	07fd2c09f8dfcc74dbb161e1ec3df1fe	Mrs.	IN	2016-05-05 13:03:58
109238	32628	p143363	5b42211690ca8418c7c839436d0b7e49	Mrs.	WI	2016-08-01 21:17:33
109239	156548	p103958	8b9a9dc5bd4aa0301b0ff416e2ed29f6	Mrs.	MN	2016-08-15 17:01:00
109240	93971	p257729	58c112dcb2f1634a4d4236bf0dcdcb31	Mrs.	MD	2016-08-25 13:09:19
109241	36517	p180358	3e5c98480f4f39d465837b2955df6ae0	Mrs.	MD	2016-06-24 11:48:12
109242	34811	p080323	fe10e79b7aeb570dfac87eeea7e9a8f1	Mrs.	SC	2017-03-09 20:00:33
109243	38267	p048540	fadf72d6cd83ce6074f9be78a6fcd374	Mr.	MO	2016-06-17 12:02:31
109244	169142	p166281	1984d915cc8b91aa16b4d1e6e39296c6	Ms.	NJ	2017-01-11 12:49:39
109245	143653	p155633	cdbfd04aa041dc6739e9e576b1fb1478	Mrs.	NJ	2016-08-25 17:11:32
109246	164599	p206114	6d5675dbfafa1371f0e2f6f1b716fe2d	Mrs.	NY	2016-07-29 17:53:15
109247	128381	p191189	ca25d5573f2bd2660f7850a886395927	Ms.	VA	2016-06-29 09:17:01

109248 rows × 7 columns



In [4]:

```
resource_data
```

Out[4]:

	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.00
1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95
2	p069063	Cory Stories: A Kid's Book About Living With Adhd	1	8.45
3	p069063	Dixon Ticonderoga Wood-Cased #2 HB Pencils, Bo...	2	13.59
4	p069063	EDUCATIONAL INSIGHTS FLUORESCENT LIGHT FILTERS...	3	24.95
5	p069063	Last to Finish: A Story About the Smartest Boy...	1	16.99

6	p069063	Mrs. Gorski, I Think I Have the Wiggle Fidgets...	description	1	9.95
7	p069063	See-N-Read 1503905CQ Reading Tool - Book Size,...		2	10.11
8	p096795	Brewster WPD90218 Wall Pops Flirt Dot, Set of ...		2	9.95
9	p096795	Brewster Wall Pops WPE99065 Peel & Stick Calyp...		2	9.02
10	p096795	TIME For Kids - 3-4 PRINT Bundle - 24 issues /...		40	5.01
11	p149007	Ahora, Spanish, Grades 6 - 12, Level 2 (min. 1...		60	7.99
12	p149007	Scholastic News, Grades 5/6 (min. 10 subscript...		96	5.25
13	p149007	Science Spin Grades 3-6 - 8 Issues / Min. 10 S...		96	0.99
14	p236235	PP440X - Fairy Tales Problem Solving STEM Kits		2	149.00
15	p052460	DD165AT - Calming Colors® Easy-Clean Room...		1	129.00
16	p052460	DD165SB - Calming Colors® Easy-Clean Room...		1	129.00
17	p052460	DD165SE - Calming Colors® Easy-Clean Room...		1	129.00
18	p052460	DD165SG - Calming Colors® Easy-Clean Room...		1	129.00
19	p233680	AA758BU - Connect & Store Book Bin - Blue		4	4.99
20	p233680	AA758GR - Connect & Store Book Bin - Green		4	4.99
21	p233680	AA758RD - Connect & Store Book Bin - Red		4	4.99
22	p233680	AA758RG - Connect & Store Book Bin - Orange		4	4.99
23	p233680	AA758VT - Connect & Store Book Bin		5	4.99
24	p233680	AA758YE - Connect & Store Book Bin - Yellow		5	4.99
25	p233680	JJ302 - Books On Wheels Mobile Library - 6 Bins		1	149.00
26	p233680	LX468BU - Extra Storage Bin - Blue		2	8.99
27	p233680	LX468GR - Extra Storage Bin - Green		2	8.99
28	p233680	LX468RD - Extra Storage Bin - Red		2	8.99
29	p233680	LX468YE - Extra Storage Bin - Yellow		2	8.99
...
1541242	p187432	Samsung Chromebook, 11.6" Screen, 2 GB RAM, 16...		3	202.99
1541243	p187432	Sentry Folding Headphones, Black		10	7.99
1541244	p187432	Sentry Folding Headphones, White		4	7.99
1541245	p149426	Piper Computer Kit Educational Computer that...		1	299.00
1541246	p238803	CARPET MY FAVORITE COLORS-7FT6INX12FT		1	314.97
1541247	p087783	BALL STAY N PLACE SAND FILL		2	34.07
1541248	p087783	BR302BU - Comfy Floor Seat - Blue		1	49.99
1541249	p087783	BR302RD - Comfy Floor Seat - Red		1	49.99
1541250	p087783	CARDINAL (PP) - CLASSROOM SELECT		3	0.00
1541251	p087783	CF521GR - Giant Comfy Pillow - Green		1	69.99
1541252	p087783	OPTION CLASS - CS NEOCLASS/NEOMOVE SHELL COLOR...		3	0.00
1541253	p087783	STOOL - CS NEOROK - STOOL HEIGHT 12 - RUBBER B...		3	59.47
1541254	p086116	Apple iPad 2 2nd generation Tablet, 1 GHz proc...		1	124.99
1541255	p086116	Apple iPad with Retina Display MD513LL/A (16GB...		11	367.95
1541256	p086116	ProCase iPad Case 9.7" 2017 - Vintage Folio St...		3	11.99
1541257	p086116	iPad 2 Case, iPad 3 Case, iPad 4 Case, AiSMei ...		7	10.99
1541258	p086116	iPad 9.7 2017 Case (New 2017 Model), EasyAcc U...		2	9.90
1541259	p086116	iPad Mini Case, Apple iPad Mini 2 Case, iPad M...		1	14.99
1541260	p228679	AA162 - First 100 Sight-Words Talking Boards		1	59.99
1541261	p228679	EE809 - Magnetic Fishing Poles - Set of 2		2	12.99

1541262	p228679	FF468 - Magnetic Sight-Word Sentence Board	description	1	quantity	29.99	price
1541263	p228679	TT507 - Fishing for Sight-Words - Level 1		1		21.99	
1541264	p183340	42 PC GRADESTUFF MID SCHOOL - PACK OF 42		1		219.10	
1541265	p183340	Rubbermaid Commercial FG9S3100GRAY Brute Tote ...		1		27.49	
1541266	p031981	5pcs DC3V/0.1A 1.5V/0.05A 10x2.7mm Coin Mobile...		2		6.46	
1541267	p031981	AmazonBasics 9 Volt Everyday Alkaline Batterie...		1		9.99	
1541268	p031981	AmazonBasics AAA Performance Alkaline Batterie...		1		6.99	
1541269	p031981	Black Electrical Tape (GIANT 3 PACK) Each Roll...		6		8.99	
1541270	p031981	Flormoon DC Motor Mini Electric Motor 0.5-3V 1...		2		8.14	
1541271	p031981	WAYLLSHINE 6PCS 2 x 1.5V AAA Battery Spring Cl...		2		7.39	

1541272 rows × 4 columns

In [5]:

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

Number of data points in train data (109248, 17)

The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix' 'school_state' 'project_submitted_datetime' 'project_grade_category' 'project_subject_categories' 'project_subject_subcategories' 'project_title' 'project_essay_1' 'project_essay_2' 'project_essay_3' 'project_essay_4' 'project_resource_summary' 'teacher_number_of_previously_posted_projects' 'project_is_approved']

In [6]:

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

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

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

project_data.head(2)
```

Out [6]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	Date	project_grade_cate
55660	8393	p205479	2bf07ba08945e5d8b2a3f269b2b3cfe5	Mrs.	CA	2016-04-27 00:27:36	Grades PreK-2
76127	37728	p043609	3f60494c61921b3b43ab61bdde2904df	Ms.	UT	2016-04-27 00:31:25	Grades 3-5

In [7]:

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

```
print(resource_data.columns.values)
resource_data.head(2)
```

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

Out[7]:

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

1.2 preprocessing of project_subject_categories

In [8]:

```
categories = list(project_data['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())

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

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

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

1.3 preprocessing of project_subject_subcategories

In [9]:

```
sub_categories = list(project_data['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() + " " # " abc ".strip() will return "abc", remove the trailing spaces
            temp = temp.replace('&', '_') # we are replacing the & value into
    sub_cat_list.append(temp.strip())

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

```

if 'The' in j.split(): # this will split each of the category based on space "Math & Science"
e"> "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 placing all the ' '(space) with '' (empty) ex:"Math & Science"=>"Math&Science"
temp +=j.strip()+" #" abc ".strip() will return "abc", remove the trailing spaces
temp = temp.replace('&','_')
sub_cat_list.append(temp.strip())

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

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

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

```

In []:

1.3 Text preprocessing

In [10]:

```

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

```

In [11]:

```

X = project_data
y = project_data['project_is_approved'].values
X_train, X_test, y_train, y_test=train_test_split(project_data, y, test_size=0.33, stratify=y)
#X_train, X_cv, y_train, y_cv=train_test_split(X_train, y_train, test_size=0.33, stratify=y_train)

```

In [12]:

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

Out[12]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	Date	project_grade_ca
75603	97960	p248439	898bc1cbc9f4cb5b16b774aa7feb4838	Mrs.	NC	2016-10-04 10:48:11	Grades PreK-2
107572	150597	p158982	2c956c5a7079e908408f908ee8d70218	Mr.	CA	2016-08-22 22:26:06	Grades 9-12

In [13]:

```
#### 1.4.2.3 Using Pretrained Models: TFIDF weighted W2V
```

In [14]:

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

I have been fortunate enough to use the Fairy Tale STEM kits in my classroom as well as the STEM journals, which my students really enjoyed. I would love to implement more of the Lakeshore STEM kits in my classroom for the next school year as they provide excellent and engaging STEM lessons. My students come from a variety of backgrounds, including language and socioeconomic status. Many of them don't have a lot of experience in science and engineering and these kits give me the materials to provide these exciting opportunities for my students. Each month I try to do several science or STEM/STEAM projects. I would use the kits and robot to help guide my science instruction in engaging and meaningful ways. I can adapt the kits to my current language arts pacing guide where we already teach some of the material in the kits like tall tales (Paul Bunyan) or Johnny Appleseed. The following units will be taught in the next school year where I will implement these kits: magnets, motion, sink vs. float, robots. I often get to these units and don't know if I am teaching the right way or using the right materials. The kits will give me additional ideas, strategies, and lessons to prepare my students in science. It is challenging to develop high quality science activities. These kits give me the materials I need to provide my students with science activities that will go along with the curriculum in my classroom. Although I have some things (like magnets) in my classroom, I don't know how to use them effectively. The kits will provide me with the right amount of materials and show me how to use them in an appropriate way.

I teach high school English to students with learning and behavioral disabilities. My students all vary in their ability level. However, the ultimate goal is to increase all students literacy levels. This includes their reading, writing, and communication levels. I teach a really dynamic group of students. However, my students face a lot of challenges. My students all live in poverty and in a dangerous neighborhood. Despite these challenges, I have students who have the desire to defeat these challenges. My students all have learning disabilities and currently all are performing below grade level. My students are visual learners and will benefit from a classroom that fulfills their preferred learning style. The materials I am requesting will allow my students to be prepared for the classroom with the necessary supplies. Too often I am challenged with students who come to school unprepared for class due to economic challenges. I want my students to be able to focus on learning and not how they will be able to get school supplies. The supplies will last all year. Students will be able to complete written assignments and maintain a classroom journal. The chart paper will be used to make learning more visual in class and to create posters to aid students in their learning. The students have access to a classroom printer. The toner will be used to print student work that is completed on the classroom Chromebooks. I want to try and remove all barriers for the students learning and create opportunities for learning. One of the biggest barriers is the students not having the resources to get pens, paper, and folders. My students will be able to increase their literacy skills because of this project.

"Life moves pretty fast. If you don't stop and look around once in awhile, you could miss it." from the movie, Ferris Bueller's Day Off. Think back...what do you remember about your grandparents? How amazing would it be to be able to flip through a book to see a day in their lives? My second graders are voracious readers! They love to read both fiction and nonfiction books. Their favorite characters include Pete the Cat, Fly Guy, Piggie and Elephant, and Mercy Watson. They also love to read about insects, space and plants. My students are hungry bookworms! My students are eager to learn and read about the world around them. My kids love to be at school and are like little sponges absorbing everything around them. Their parents work long hours and usually do not see their children. My students are usually cared for by their grandparents or a family friend. Most of my students do not have someone who speaks English at home. Thus it is difficult for my students to acquire language. Now think forward... wouldn't it mean a lot to your kids, nieces or nephews or grandchildren, to be able to see a day in your life today 30 years from now? Memories are so precious to us and being able to share these memories with future generations will be a rewarding experience. As part of our social studies curriculum, students will be learning about changes over time. Students will be studying photos to learn about how their community has changed over time. In particular, we will look at photos to study how the land, buildings, clothing, and schools have changed over time. As a culminating activity, my students will capture a slice of their history and preserve it through scrap booking. Key important events in their young lives will be documented with the date, location, and names. Students will be using photos from home and from school to create their second grade memories. Their scrap books will preserve

from home and from school to create their second grade memories. Their scrap books will preserve their unique stories for future generations to enjoy. Your donation to this project will provide my second graders with an opportunity to learn about social studies in a fun and creative manner. Through their scrapbooks, children will share their story with others and have a historical document for the rest of their lives.

=====

"A person's a person, no matter how small." (Dr. Seuss) I teach the smallest students with the biggest enthusiasm for learning. My students learn in many different ways using all of our senses and multiple intelligences. I use a wide range of techniques to help all my students succeed. \r\nStudents in my class come from a variety of different backgrounds which makes for wonderful sharing of experiences and cultures, including Native Americans. \r\nOur school is a caring community of successful learners which can be seen through collaborative student project based learning in and out of the classroom. Kindergarteners in my class love to work with hands-on materials and have many different opportunities to practice a skill before it is mastered. Having the social skills to work cooperatively with friends is a crucial aspect of the kindergarten curriculum. Montana is the perfect place to learn about agriculture and nutrition. My students love to role play in our pretend kitchen in the early childhood classroom. I have had several kids ask me, "\"Can we try cooking with REAL food?\"" I will take their idea and create "\"Common Core Cooking Lessons\"" where we learn important math and writing concepts while cooking delicious healthy food for snack time. My students will have a grounded appreciation for the work that went into making the food and knowledge of where the ingredients came from as well as how it's healthy for their bodies. This project would expand our learning of nutrition and agricultural cooking recipes by having us peel our own apples to make homemade applesauce, make our own bread, and mix up healthy plants from our classroom garden in the spring. We will also create our own cookbooks to be printed and shared with families. \r\nStudents will gain math and literature skills as well as a life long enjoyment for healthy cooking. nannan

=====

My classroom consists of twenty-two amazing sixth graders from different cultures and backgrounds. They are a social bunch who enjoy working in partners and working with groups. They are hard-working and eager to head to middle school next year. My job is to get them ready to make this transition and make it as smooth as possible. In order to do this, my students need to come to school every day and feel safe and ready to learn. Because they are getting ready to head to middle school, I give them lots of choice- choice on where to sit and work, the order to complete assignments, choice of projects, etc. Part of the students feeling safe is the ability for them to come into a welcoming, encouraging environment. My room is colorful and the atmosphere is casual. I want them to take ownership of the classroom because we ALL share it together. Because my time with them is limited, I want to ensure they get the most of this time and enjoy it to the best of their abilities. Currently, we have twenty-two desks of differing sizes, yet the desks are similar to the ones the students will use in middle school. We also have a kidney table with crates for seating. I allow my students to choose their own spots while they are working independently or in groups. More often than not, most of them move out of their desks and onto the crates. Believe it or not, this has proven to be more successful than making them stay at their desks! It is because of this that I am looking toward the "Flexible Seating" option for my classroom. \r\nThe students look forward to their work time so they can move around the room. I would like to get rid of the constricting desks and move toward more "fun" seating options. I am requesting various seating so my students have more options to sit. Currently, I have a stool and a papasan chair I inherited from the previous sixth-grade teacher as well as five milk crate seats I made, but I would like to give them more options and reduce the competition for the "good seats". I am also requesting two rugs as not only more seating options but to make the classroom more welcoming and appealing. In order for my students to be able to write and complete work without desks, I am requesting a class set of clipboards. Finally, due to curriculum that requires groups to work together, I am requesting tables that we can fold up when we are not using them to leave more room for our flexible seating options. \r\nI know that with more seating options, they will be that much more excited about coming to school! Thank you for your support in making my classroom one students will remember forever! nannan

=====

In [15]:

```
# 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 [16]:

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

```
\nA person is a person, no matter how small.\" (Dr.Seuss) I teach the smallest students with the b
iggest enthusiasm for learning. My students learn in many different ways using all of our senses a
nd multiple intelligences. I use a wide range of techniques to help all my students succeed. \r\nS
tudents in my class come from a variety of different backgrounds which makes for wonderful sharing
of experiences and cultures, including Native Americans.\r\nOur school is a caring community of su
ccessful learners which can be seen through collaborative student project based learning in and ou
t of the classroom. Kindergarteners in my class love to work with hands-on materials and have many
different opportunities to practice a skill before it is mastered. Having the social skills to wor
k cooperatively with friends is a crucial aspect of the kindergarten curriculum.Montana is the
perfect place to learn about agriculture and nutrition. My students love to role play in our
pretend kitchen in the early childhood classroom. I have had several kids ask me, \"Can we try coo
king with REAL food?\" I will take their idea and create \"Common Core Cooking Lessons\" where we
learn important math and writing concepts while cooking delicious healthy food for snack time. My
students will have a grounded appreciation for the work that went into making the food and knowled
ge of where the ingredients came from as well as how it is healthy for their bodies. This project
would expand our learning of nutrition and agricultural cooking recipes by having us peel our own
apples to make homemade applesauce, make our own bread, and mix up healthy plants from our classro
om garden in the spring. We will also create our own cookbooks to be printed and shared with famil
ies. \r\nStudents will gain math and literature skills as well as a life long enjoyment for health
y cooking.nannan
=====
```

In [17]:

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

```
A person is a person, no matter how small. (Dr.Seuss) I teach the smallest students with the big
gest enthusiasm for learning. My students learn in many different ways using all of our senses and
multiple intelligences. I use a wide range of techniques to help all my students succeed.
Students in my class come from a variety of different backgrounds which makes for wonderful
sharing of experiences and cultures, including Native Americans. Our school is a caring community
of successful learners which can be seen through collaborative student project based learning in a
nd out of the classroom. Kindergarteners in my class love to work with hands-on materials and have
many different opportunities to practice a skill before it is mastered. Having the social skills t
o work cooperatively with friends is a crucial aspect of the kindergarten curriculum.Montana is
the perfect place to learn about agriculture and nutrition. My students love to role play in our p
retend kitchen in the early childhood classroom. I have had several kids ask me, Can we try cooki
ng with REAL food? I will take their idea and create Common Core Cooking Lessons where we learn
important math and writing concepts while cooking delicious healthy food for snack time. My
students will have a grounded appreciation for the work that went into making the food and knowled
ge of where the ingredients came from as well as how it is healthy for their bodies. This project
would expand our learning of nutrition and agricultural cooking recipes by having us peel our own
apples to make homemade applesauce, make our own bread, and mix up healthy plants from our classro
om garden in the spring. We will also create our own cookbooks to be printed and shared with famil
ies. Students will gain math and literature skills as well as a life long enjoyment for healthy
cooking.nannan
```

In [18]:

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

```
A person is a person no matter how small Dr Seuss I teach the smallest students with the biggest
enthusiasm for learning My students learn in many different ways using all of our senses and multi
ple intelligences I use a wide range of techniques to help all my students succeed Students in my
class come from a variety of different backgrounds which makes for wonderful sharing of
experiences and cultures including Native Americans Our school is a caring community of successful
learners which can be seen through collaborative student project based learning in and out of the
classroom Kindergarteners in my class love to work with hands on materials and have many different
opportunities to practice a skill before it is mastered Having the social skills to work
```

cooperatively with friends is a crucial aspect of the kindergarten curriculum Montana is the perfect place to learn about agriculture and nutrition My students love to role play in our pretend kitchen in the early childhood classroom I have had several kids ask me Can we try cooking with REAL food I will take their idea and create Common Core Cooking Lessons where we learn important math and writing concepts while cooking delicious healthy food for snack time My students will have a grounded appreciation for the work that went into making the food and knowledge of where the ingredients came from as well as how it is healthy for their bodies This project would expand our learning of nutrition and agricultural cooking recipes by having us peel our own apples to make homemade applesauce make our own bread and mix up healthy plants from our classroom garden in the spring We will also create our own cookbooks to be printed and shared with families Students will gain math and literature skills as well as a life long enjoyment for healthy cooking

In [19]:

```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you're", "you've",
\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his',
'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they', 'them',
'their', \
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll",
'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', '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', 'over', 'under'
, 'again', 'further', \
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'e
ach', 'few', 'more', \
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'very', \
's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 'd', 'll'
, 'm', 'o', \
            're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'doesn', "d
esn't", 'hadn', \
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn',
'mightn't', 'mustn', \
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn',
'wasn't', 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

In [20]:

```
# Combining all the above students
from tqdm import tqdm
preprocessed_essays_tr = []
# 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('\\n', ' ')
    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_tr.append(sent.lower().strip())
```

```
100% | ████████████████████████████████████████████████████████████ | 73196/73196 [03:  
12<00:00, 381.15it/s]
```

In [21]:

```
# after preprocessing
#preprocessed_essays[20000]
X_train.columns.values
```

Out[21]:

```
array(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
      'Date', 'project_grade_category', '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', 'clean_categories', 'clean_subcategories',
      'essay'], dtype=object)
```

In [22]:

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

1.4 Preprocessing of `project_title`

In [23]:

```
# similarly you can preprocess the titles also
from tqdm import tqdm
preprocessed_project_title_tr = []
# tqdm is for printing the status bar
for sentence in 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 not in stopwords)
    preprocessed_project_title_tr.append(sent.lower().strip())
```

In [24]:

```
from tqdm import tqdm
preprocessed_project_title_te = []
# tqdm is for printing the status bar
for sentence in 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 not in stopwords)
    preprocessed_project_title_te.append(sent.lower().strip())
```

1.5 Preparing data for models

In [25]:

```
project_data.columns
```

Out [25]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
      'Date', 'project_grade_category', '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',
```



```
'clean_categories', 'clean_subcategories', 'essay'],
dtype='object')
```

we are going to consider

- school_state : categorical data
- clean_categories : categorical data
- clean_subcategories : categorical data
- project_grade_category : categorical data
- teacher_prefix : categorical data

- project_title : text data
- text : text data
- project_resource_summary: text data (optinal)

- quantity : numerical (optinal)
- teacher_number_of_previously_posted_projects : numerical
- price : numerical

1.5.1 Vectorizing Categorical data

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

In [26]:

```
my_counter = Counter()
for word in X_train['clean_subcategories'].values:
    my_counter.update(word.split())

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

In [27]:

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

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

In [28]:

```
# we use count vectorizer to convert the values into one
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict_tr.keys()), lowercase=False, binary=True)
categories_one_hot = vectorizer.fit((X_train['clean_categories'].values))
categories_one_hot_tr=categories_one_hot.transform((X_train['clean_categories'].values))
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",categories_one_hot_tr.shape)
```

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning', 'SpecialNeeds',
'Health_Sports', 'Math_Science', 'Literacy_Language']
Shape of matrix after one hot encodig (73196, 9)
```

In [29]:

```
categories_one_hot_te = categories_one_hot.transform((X_test['clean_categories'].values))
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encodig ",categories_one_hot_te.shape)
```

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning', 'SpecialNeeds',
'Health_Sports', 'Math_Science', 'Literacy_Language']
Shape of matrix after one hot encodig (36052, 9)
```

In [30]:

```
# we use count vectorizer to convert the values into one
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict_tr.keys()), lowercase=False, binary=True)
sub_categories_one_hot = vectorizer.fit((X_train['clean_subcategories'].values))
sub_categories_one_hot_tr=sub_categories_one_hot.transform((X_train['clean_subcategories'].values))
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encoding ",sub_categories_one_hot_tr.shape)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Civics_Government', '
Extracurricular', 'ForeignLanguages', 'NutritionEducation', 'Warmth', 'Care_Hunger',
'SocialSciences', 'PerformingArts', 'CharacterEducation', 'TeamSports', 'Other',
'College_CareerPrep', 'History_Geography', 'Music', 'EarlyDevelopment', 'Health_LifeScience', 'ESL',
'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'AppliedSciences',
'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy']
Shape of matrix after one hot encoding (73196, 30)
```

In [31]:

```
sub_categories_one_hot_te = sub_categories_one_hot.transform((X_test['clean_subcategories'].values))
print(vectorizer.get_feature_names())
print("Shape of matrix after one hot encoding ",sub_categories_one_hot_te.shape)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Civics_Government', '
Extracurricular', 'ForeignLanguages', 'NutritionEducation', 'Warmth', 'Care_Hunger',
'SocialSciences', 'PerformingArts', 'CharacterEducation', 'TeamSports', 'Other',
'College_CareerPrep', 'History_Geography', 'Music', 'EarlyDevelopment', 'Health_LifeScience', 'ESL',
'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'AppliedSciences',
'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy']
Shape of matrix after one hot encoding (36052, 30)
```

In [32]:

```
# you can do the similar thing with state, teacher_prefix and project_grade_category also
#teacher_prefix
#how to remove nan from string:https://stackoverflow.com/questions/26837998/pandas-replace-nan-with-blank-empty-string
#cleanedList_teacher_prefix = [x for x in project_data['teacher_prefix'].values if x != np.nan]
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
#from math import isnan
import numpy as np
X_train = X_train.replace(np.nan, 'NA', regex=True)
#X_cv = X_cv.replace(np.nan, 'NA', regex=True)
X_test = X_test.replace(np.nan, 'NA', regex=True)

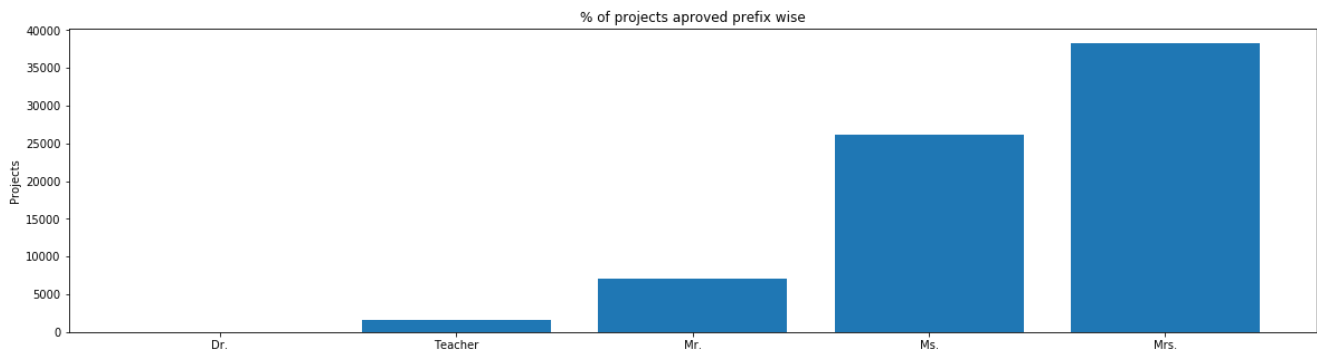
my_counter = Counter()
for word in X_train['teacher_prefix'].values:
    if word == "NA":
        continue
    my_counter[word] += 1

# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict_teacher_prefix = dict(my_counter)
'''cat_dict_teacher_prefix = {k:cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not isnan(k)}
cat_dict_teacher_prefix = {k: cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not isnan(my_dict[k])}'''
sorted_cat_dict_teacher_prefix = dict(sorted(cat_dict_teacher_prefix.items(), key=lambda kv: kv[1]))

ind = np.arange(len(sorted_cat_dict_teacher_prefix))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_cat_dict_teacher_prefix.values()))

plt.ylabel('Projects')
plt.title('% of projects aproved prefix wise')
```

```
plt.xticks(ind, list(sorted_cat_dict_teacher_prefix.keys()))
plt.show()
```



In [33]:

```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict_teacher_prefix.keys()), lowercase=False, binary=True)
vectorizer.fit(X_train['teacher_prefix'].values.astype('U'))
print(vectorizer.get_feature_names())
```

```
teacher_prefix_one_hot_tr = vectorizer.transform(X_train['teacher_prefix'].values)
print("Shape of matrix after one hot encodig ", teacher_prefix_one_hot_tr.shape)
```

```
['Dr.', 'Teacher', 'Mr.', 'Ms.', 'Mrs.']
Shape of matrix after one hot encodig (73196, 5)
```

In [34]:

```
teacher_prefix_one_hot_te = vectorizer.transform(X_test['teacher_prefix'].values)
print("Shape of matrix after one hot encodig ", teacher_prefix_one_hot_te.shape)
```

```
Shape of matrix after one hot encodig (36052, 5)
```

In [35]:

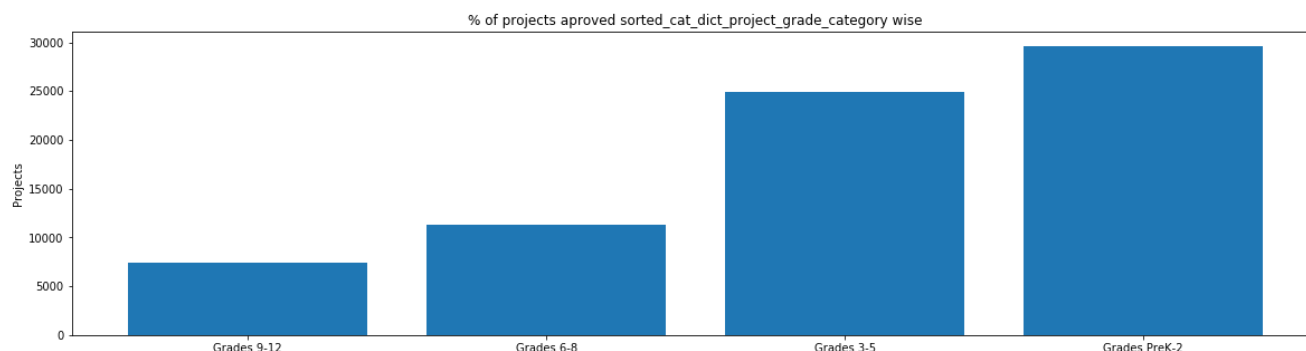
```
#project_grade_category
#how to remove nan from string:https://stackoverflow.com/questions/26837998/pandas-replace-nan-with-blank-empty-string
#cleanedList_teacher_prefix = [x for x in project_data['teacher_prefix'].values if x != np.nan]
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
#from math import isnan
import numpy as np
my_counter = Counter()
for word in X_train['project_grade_category'].values:
    my_counter[word] += 1

# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict_project_grade_category= dict(my_counter)
'''cat_dict_teacher_prefix = {k:cat_dict_teacher_prefix [k] for k in cat_dict_teacher_prefix if not isnan(k)}
cat_dict_teacher_prefix = {k: cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not isnan(my_dict[k])}
'''
sorted_cat_dict_project_grade_category = dict(sorted(cat_dict_project_grade_category.items(), key=lambda kv: kv[1]))

ind = np.arange(len(sorted_cat_dict_project_grade_category))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_cat_dict_project_grade_category.values()))

plt.ylabel('Projects')
plt.title('% of projects aproved sorted_cat_dict_project_grade_category wise')
plt.xticks(ind, list(sorted_cat_dict_project_grade_category.keys()))
plt.show()
```

```
#type(project_data['teacher_prefix'].values[0])
```



In [36]:

```
print(sorted_cat_dict_project_grade_category.keys())
print(sorted_cat_dict_project_grade_category.values())
```

```
dict_keys(['Grades 9-12', 'Grades 6-8', 'Grades 3-5', 'Grades PreK-2'])
dict_values([7368, 11317, 24897, 29614])
```

project_grade_category : categorical data

In [37]:

```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict_project_grade_category.keys()), lower
case=False, binary=True)
vectorizer.fit(X_train['project_grade_category'].values.astype('U'))
print(vectorizer.get_feature_names())
```

```
project_grade_category_one_hot_tr = vectorizer.transform(X_train['project_grade_category'].values)
print("Shape of matrix after one hot encodig ",project_grade_category_one_hot_tr.shape)
```

```
['Grades 9-12', 'Grades 6-8', 'Grades 3-5', 'Grades PreK-2']
Shape of matrix after one hot encodig (73196, 4)
```

In [38]:

```
project_grade_category_one_hot_te = vectorizer.transform(X_test['project_grade_category'].values)
print("Shape of matrix after one hot encodig ",project_grade_category_one_hot_te.shape)
```

```
Shape of matrix after one hot encodig (36052, 4)
```

school_state : categorical data

In [112]:

```
#project_grade_category
#how to remove nan from string:https://stackoverflow.com/questions/26837998/pandas-replace-nan-with-blank-empty-string
#cleanedList_teacher_prefix = [x for x in project_data['teacher_prefix'].values if x != np.nan]
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
#from math import isnan
import numpy as np
my_counter = Counter()
for word in X_train['school_state'].values:
    my_counter[word] += 1

# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict_school_state_category= dict(my_counter)
```

```

'''cat_dict_teacher_prefix = {k:cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not
isnan(k)}
cat_dict_teacher_prefix = {k: cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not i
snan(my_dict[k])}
'''

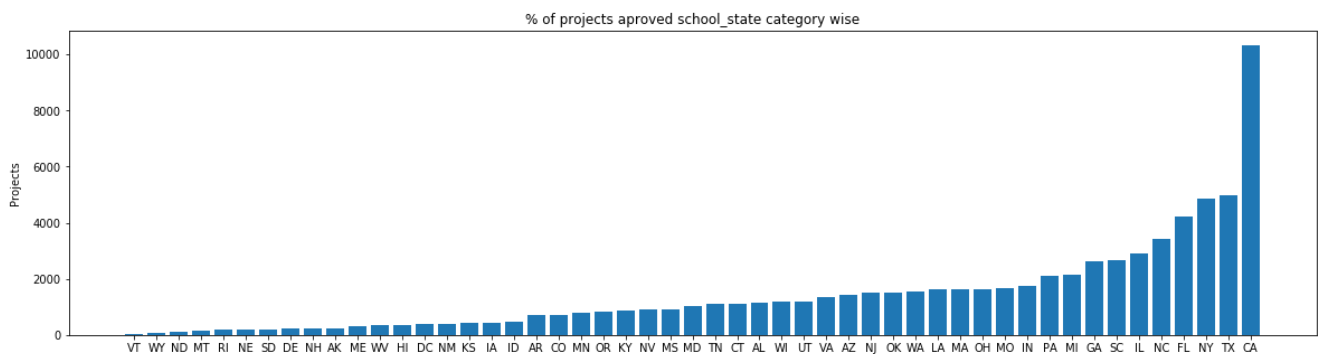
sorted_cat_dict_school_state_category = dict(sorted(cat_dict_school_state_category.items(),
key=lambda kv: kv[1]))

ind = np.arange(len(sorted_cat_dict_school_state_category))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_cat_dict_school_state_category.values()))

plt.ylabel('Projects')
plt.title('% of projects aproved school_state category wise')
plt.xticks(ind, list(sorted_cat_dict_school_state_category.keys()))
plt.show()

#type(project_data['teacher_prefix'].values[0])

```



In [113]:

```

from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict_school_state_category.keys()),
lowercase=False, binary=True)
vectorizer.fit(X_train['school_state'].values.astype('U'))
print(vectorizer.get_feature_names())

```

```

school_state_category_one_hot_tr = vectorizer.transform(X_train['school_state'].values)
print("Shape of matrix after one hot encodig ",school_state_category_one_hot_tr.shape)

```

```

['VT', 'WY', 'ND', 'MT', 'RI', 'NE', 'SD', 'DE', 'NH', 'AK', 'ME', 'WV', 'HI', 'DC', 'NM', 'KS', 'I
A', 'ID', 'AR', 'CO', 'MN', 'OR', 'KY', 'NV', 'MS', 'MD', 'TN', 'CT', 'AL', 'WI', 'UT', 'VA', 'AZ',
'NJ', 'OK', 'WA', 'LA', 'MA', 'OH', 'MO', 'IN', 'PA', 'MI', 'GA', 'SC', 'IL', 'NC', 'FL', 'NY', 'TX
', 'CA']
Shape of matrix after one hot encodig (73196, 51)

```

In [114]:

```

school_state_category_one_hot_te = vectorizer.transform(X_test['school_state'].values)
print("Shape of matrix after one hot encodig ",school_state_category_one_hot_te.shape)

```

Shape of matrix after one hot encodig (36052, 51)

clean_subcategories : categorical data

In [115]:

```

#project_grade_category
#how to remove nan from string:https://stackoverflow.com/questions/26837998/pandas-replace-nan-with-blank-empty-string
#cleanedList_teacher_prefix = [x for x in project_data['teacher_prefix'].values if x != np.nan]
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
#from math import isnan
import numpy as np

```

```

my_counter = Counter()
for word in X_train['clean_categories'].values:
    my_counter[word] += 1

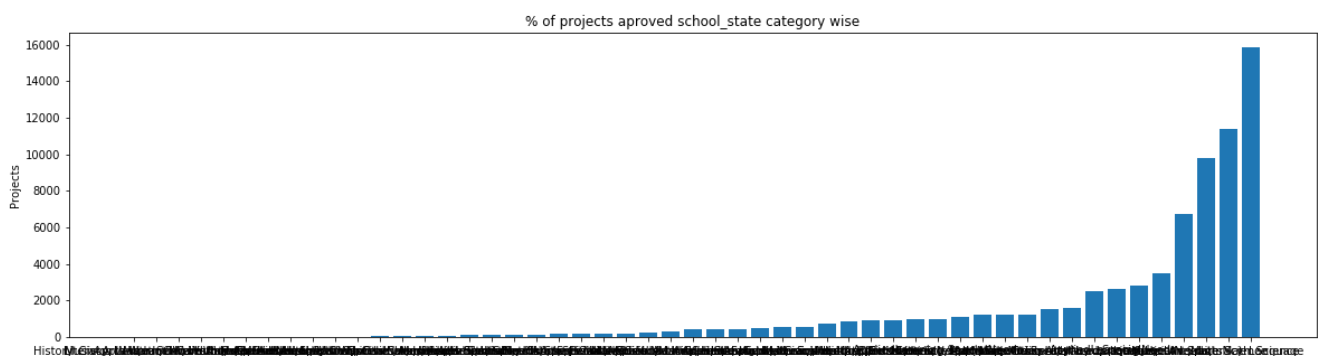
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict_clean_categories_category= dict(my_counter)
'''cat_dict_teacher_prefix = {k:cat_dict_teacher_prefix [k] for k in cat_dict_teacher_prefix if n
ot isnan(k)}
cat_dict_teacher_prefix = {k: cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not i
snan(my_dict[k])}
'''
sorted_cat_dict_clean_categories_category = dict(sorted(cat_dict_clean_categories_category.items()
, key=lambda kv: kv[1]))

ind = np.arange(len(sorted_cat_dict_clean_categories_category))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_cat_dict_clean_categories_category.values()))

plt.ylabel('Projects')
plt.title('% of projects aproved school_state category wise')
plt.xticks(ind, list(sorted_cat_dict_clean_categories_category.keys()))
plt.show()

#type(project_data['teacher_prefix'].values[0])

```



In [116]:

```

from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict_clean_categories_category.keys()), lo
wercase=False, binary=True)
vectorizer.fit(X_train['clean_categories'].values.astype('U'))
print(vectorizer.get_feature_names())

clean_categories_category_one_hot_tr = vectorizer.transform(X_train['clean_categories'].values)
print("Shape of matrix after one hot encodig ",clean_categories_category_one_hot_tr.shape)

```

```

['History_Civics Warmth Care_Hunger', 'Music_Arts Warmth Care_Hunger', 'Literacy_Language Warmth C
are_Hunger', 'AppliedLearning Warmth Care_Hunger', 'Math_Science Warmth Care_Hunger', 'Music_Arts
AppliedLearning', 'History_Civics Health_Sports', 'Music_Arts History_Civics', 'Music_Arts
Health_Sports', 'SpecialNeeds Warmth Care_Hunger', 'Health_Sports Warmth Care_Hunger',
'Health_Sports History_Civics', 'History_Civics AppliedLearning', 'SpecialNeeds Health_Sports',
'Literacy_Language Health_Sports', 'Music_Arts SpecialNeeds', 'Health_Sports Music_Arts',
'AppliedLearning History_Civics', 'Health_Sports AppliedLearning', 'History_Civics SpecialNeeds',
'Health_Sports Math_Science', 'History_Civics Music_Arts', 'SpecialNeeds Music_Arts',
'History_Civics Math_Science', 'Math_Science Health_Sports', 'AppliedLearning Health_Sports',
'Literacy_Language AppliedLearning', 'Math_Science History_Civics', 'AppliedLearning Music_Arts',
'Health_Sports Literacy_Language', 'Literacy_Language History_Civics', 'AppliedLearning
Math_Science', 'Math_Science AppliedLearning', 'Warmth Care_Hunger', 'Health_Sports SpecialNeeds',
'History_Civics Literacy_Language', 'AppliedLearning SpecialNeeds', 'Math_Science Music_Arts', 'Li
teracy_Language Music_Arts', 'History_Civics', 'Math_Science SpecialNeeds', 'AppliedLearning
Literacy_Language', 'Math_Science Literacy_Language', 'AppliedLearning', 'Literacy_Language
SpecialNeeds', 'SpecialNeeds', 'Music_Arts', 'Health_Sports', 'Literacy_Language Math_Science',
'Math_Science', 'Literacy_Language']
Shape of matrix after one hot encodig  (73196, 51)

```

In [117]:

```

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

```

```
clean_subcategories_category_one_hot_te = vectorizer.transform(X_test[clean_subcategories].values)
print("Shape of matrix after one hot encoding ", clean_subcategories_category_one_hot_te.shape)
```

Shape of matrix after one hot encoding (36052, 51)

clean_subcategories : categorical data

In [118]:

```
#project_grade_category
#how to remove nan from string:https://stackoverflow.com/questions/26837998/pandas-replace-nan-with-blank-empty-string
#cleanedList_teacher_prefix = [x for x in project_data['teacher_prefix'].values if x != np.nan]
# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
from collections import Counter
#from math import isnan
import numpy as np
my_counter = Counter()
for word in X_train['clean_subcategories'].values:
    my_counter[word] += 1

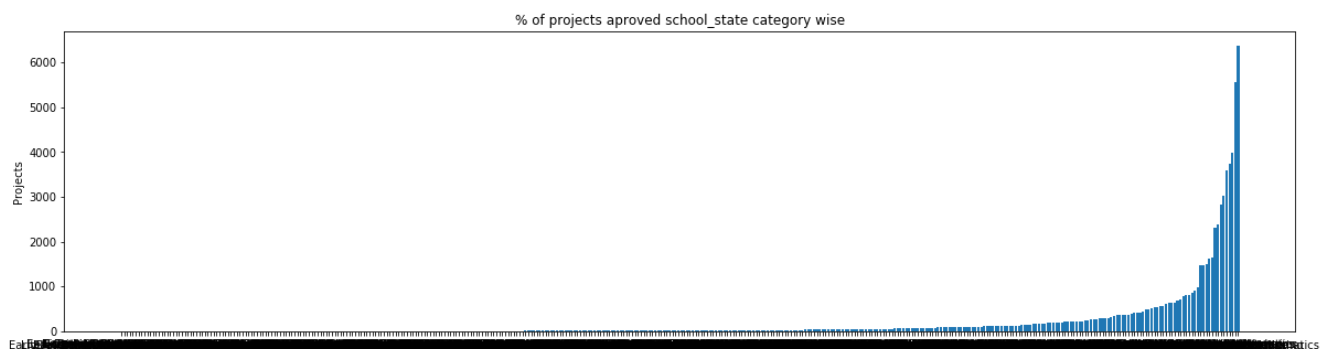
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict_clean_subcategories_category = dict(my_counter)
'''cat_dict_teacher_prefix = {k:cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not isnan(k)}
cat_dict_teacher_prefix = {k: cat_dict_teacher_prefix[k] for k in cat_dict_teacher_prefix if not isnan(my_dict[k])}
'''

sorted_cat_dict_clean_subcategories_category = dict(sorted(cat_dict_clean_subcategories_category.items(), key=lambda kv: kv[1]))

ind = np.arange(len(sorted_cat_dict_clean_subcategories_category))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind, list(sorted_cat_dict_clean_subcategories_category.values()))

plt.ylabel('Projects')
plt.title('% of projects approved school_state category wise')
plt.xticks(ind, list(sorted_cat_dict_clean_subcategories_category.keys()))
plt.show()

#type(project_data['teacher_prefix'].values[0])
```



In [119]:

```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict_clean_subcategories_category.keys()),
lowercase=False, binary=True)
vectorizer.fit(X_train['clean_subcategories'].values.astype('U'))
print(vectorizer.get_feature_names())

clean_subcategories_category_one_hot_tr =
vectorizer.transform(X_train['clean_subcategories'].values)
print("Shape of matrix after one hot encoding ", clean_subcategories_category_one_hot_tr.shape)
```

['EarlyDevelopment Warmth Care_Hunger', 'Literature_Writing NutritionEducation', 'Economics NutritionEducation', 'EarlyDevelopment ForeignLanguages', 'FinancialLiteracy PerformingArts',

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


```
'Economics', 'Gym_Fitness Mathematics', 'Extracurricular Literacy', 'College_CareerPrep
ParentInvolvement', 'Health_Wellness VisualArts', 'EarlyDevelopment Gym_Fitness',
'College_CareerPrep Extracurricular', 'CommunityService EnvironmentalScience', 'FinancialLiteracy
SpecialNeeds', 'Music VisualArts', 'SpecialNeeds TeamSports', 'College_CareerPrep
Health_LifeScience', 'ForeignLanguages Mathematics', 'ParentInvolvement', 'EnvironmentalScience Nu
tritionEducation', 'EnvironmentalScience Health_Wellness', 'Literature_Writing Music',
'CharacterEducation Extracurricular', 'Other VisualArts', 'Health_LifeScience NutritionEducation',
'EarlyDevelopment EnvironmentalScience', 'Literature_Writing ParentInvolvement', 'AppliedSciences
CharacterEducation', 'SocialSciences VisualArts', 'CommunityService', 'ESL ForeignLanguages',
'AppliedSciences SocialSciences', 'Extracurricular Mathematics', 'ESL EarlyDevelopment',
'Gym_Fitness NutritionEducation', 'Mathematics Music', 'SocialSciences SpecialNeeds',
'Health_LifeScience History_Geography', 'CharacterEducation CommunityService', 'AppliedSciences Mu
sic', 'Mathematics SocialSciences', 'EnvironmentalScience SocialSciences', 'CharacterEducation Vis
ualArts', 'AppliedSciences ESL', 'AppliedSciences ParentInvolvement', 'ForeignLanguages
Literature_Writing', 'Mathematics ParentInvolvement', 'Civics_Government SocialSciences',
'Health_LifeScience SocialSciences', 'College_CareerPrep Other', 'Health_LifeScience VisualArts',
'Civics_Government Literature_Writing', 'Civics_Government', 'Economics FinancialLiteracy',
'Extracurricular VisualArts', 'PerformingArts VisualArts', 'AppliedSciences History_Geography', 'C
haracterEducation Mathematics', 'CharacterEducation Health_Wellness', 'CharacterEducation Other',
'Mathematics Other', 'History_Geography SpecialNeeds', 'History_Geography Mathematics',
'College_CareerPrep VisualArts', 'College_CareerPrep SpecialNeeds', 'CharacterEducation
College_CareerPrep', 'Music SpecialNeeds', 'Literature_Writing PerformingArts', 'Literacy
PerformingArts', 'FinancialLiteracy Mathematics', 'Literature_Writing Other', 'Extracurricular',
'AppliedSciences Other', 'Health_LifeScience SpecialNeeds', 'EnvironmentalScience SpecialNeeds', '
EarlyDevelopment Other', 'Civics_Government Literacy', 'AppliedSciences Extracurricular',
'EnvironmentalScience History_Geography', 'Literacy Music', 'EarlyDevelopment VisualArts',
'FinancialLiteracy', 'AppliedSciences EarlyDevelopment', 'Literacy ParentInvolvement',
'History_Geography VisualArts', 'Gym_Fitness SpecialNeeds', 'CharacterEducation EarlyDevelopment',
'Health_Wellness Other', 'Literacy Other', 'CharacterEducation Literature_Writing',
'Health_LifeScience Health_Wellness', 'ESL SpecialNeeds', 'Health_LifeScience Literature_Writing',
'CharacterEducation SpecialNeeds', 'SocialSciences', 'EnvironmentalScience VisualArts',
'ForeignLanguages Literacy', 'Health_Wellness Mathematics', 'Civics_Government History_Geography',
'EarlyDevelopment Literature_Writing', 'College_CareerPrep Literacy', 'ESL Mathematics',
'NutritionEducation', 'EarlyDevelopment Health_Wellness', 'Other SpecialNeeds', 'Health_Wellness L
iterature_Writing', 'EnvironmentalScience Literature_Writing', 'College_CareerPrep Mathematics', '
SpecialNeeds VisualArts', 'CharacterEducation', 'EarlyDevelopment Mathematics', 'History_Geography
SocialSciences', 'College_CareerPrep Literature_Writing', 'CharacterEducation Literacy',
'Health_Wellness TeamSports', 'ForeignLanguages', 'Health_LifeScience Literacy',
'Literature_Writing SocialSciences', 'AppliedSciences SpecialNeeds', 'Literacy SocialSciences', 'A
ppliedSciences College_CareerPrep', 'PerformingArts', 'College_CareerPrep', 'AppliedSciences
Literature_Writing', 'ESL', 'EnvironmentalScience Literacy', 'Health_Wellness Literacy',
'Mathematics VisualArts', 'History_Geography Literacy', 'History_Geography', 'AppliedSciences
Literacy', 'Health_LifeScience Mathematics', 'Literacy VisualArts', 'AppliedSciences
Health_LifeScience', 'Gym_Fitness TeamSports', 'History_Geography Literature_Writing',
'AppliedSciences VisualArts', 'Literature_Writing VisualArts', 'ESL Literature_Writing',
'EarlyDevelopment Literacy', 'EarlyDevelopment SpecialNeeds', 'Health_Wellness
NutritionEducation', 'Other', 'Health_LifeScience', 'EnvironmentalScience Mathematics',
'EarlyDevelopment', 'Music PerformingArts', 'EnvironmentalScience Health_LifeScience',
'AppliedSciences EnvironmentalScience', 'TeamSports', 'EnvironmentalScience', 'Health_Wellness
SpecialNeeds', 'Mathematics SpecialNeeds', 'Gym_Fitness', 'Literature_Writing SpecialNeeds',
'Warmth Care_Hunger', 'Music', 'ESL Literacy', 'Gym_Fitness Health_Wellness', 'VisualArts',
'AppliedSciences', 'Literacy SpecialNeeds', 'AppliedSciences Mathematics', 'Health_Wellness',
'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy Literature_Writing',
'Literature_Writing Mathematics', 'Literacy Mathematics', 'Literacy']
Shape of matrix after one hot encodig (73196, 388)
```

In [120]:

```
clean_subcategories_category_one_hot_te = vectorizer.transform(X_test['clean_categories'].values)
print("Shape of matrix after one hot encodig ", clean_subcategories_category_one_hot_te.shape)
```

Shape of matrix after one hot encodig (36052, 388)

1.5.2 Vectorizing Text data

1.5.2.1 Bag of words

In [39]:

```
# We are considering only the words which appeared in at least 10 documents(rows or projects).
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(min_df=10,ngram_range=(1,2),max_features=5000)
```

```
vectorizer.fit(preprocessed_essays_tr)
```

Out[39]:

```
CountVectorizer(analyzer='word', binary=False, decode_error='strict',
dtype=<class 'numpy.int64'>, encoding='utf-8', input='content',
lowercase=True, max_df=1.0, max_features=5000, min_df=10,
ngram_range=(1, 2), preprocessor=None, stop_words=None,
strip_accents=None, token_pattern='(?u)\\b\\w\\w+\\b',
tokenizer=None, vocabulary=None)
```

In [40]:

```
X_train_essay_bow = vectorizer.transform(preprocessed_essays_tr)
#X_cv_essay_bow = vectorizer.transform(preprocessed_essays_cv)
X_test_essay_bow = vectorizer.transform(preprocessed_essays_te)
```

In [41]:

```
# you can vectorize the title also
# before you vectorize the title make sure you preprocess it

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

Out[41]:

```
CountVectorizer(analyzer='word', binary=False, decode_error='strict',
dtype=<class 'numpy.int64'>, encoding='utf-8', input='content',
lowercase=True, max_df=1.0, max_features=5000, min_df=10,
ngram_range=(1, 2), preprocessor=None, stop_words=None,
strip_accents=None, token_pattern='(?u)\\b\\w\\w+\\b',
tokenizer=None, vocabulary=None)
```

In [42]:

```
X_train_title_bow = vectorizer.transform(preprocessed_project_title_tr)
#X_cv_title_bow = vectorizer.transform(preprocessed_project_title_cv)
X_test_title_bow = vectorizer.transform(preprocessed_project_title_te)
```

1.5.2.2 TFIDF vectorizer

In [43]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
vectorizer = TfidfVectorizer(min_df=10,ngram_range=(1,2),max_features=5000)
vectorizer.fit(preprocessed_essays_tr)
```

Out[43]:

```
TfidfVectorizer(analyzer='word', binary=False, decode_error='strict',
dtype=<class 'numpy.float64'>, encoding='utf-8', input='content',
lowercase=True, max_df=1.0, max_features=5000, min_df=10,
ngram_range=(1, 2), norm='l2', preprocessor=None, smooth_idf=True,
stop_words=None, strip_accents=None, sublinear_tf=False,
token_pattern='(?u)\\b\\w\\w+\\b', tokenizer=None, use_idf=True,
vocabulary=None)
```

In [44]:

```
X_train_essay_tfidf = vectorizer.transform(preprocessed_essays_tr)
#X_cv_essay_tfidf = vectorizer.transform(preprocessed_essays_cv)
X_test_essay_tfidf = vectorizer.transform(preprocessed_essays_te)
```

In [45]:

```
vectorizer.fit(preprocessed_project_title_tr)
```

Out[45]:

```
TfidfVectorizer(analyzer='word', binary=False, decode_error='strict',
                dtype=<class 'numpy.float64'>, encoding='utf-8', input='content',
                lowercase=True, max_df=1.0, max_features=5000, min_df=10,
                ngram_range=(1, 2), norm='l2', preprocessor=None, smooth_idf=True,
                stop_words=None, strip_accents=None, sublinear_tf=False,
                token_pattern='(?u)\\b\\w\\w+\\b', tokenizer=None, use_idf=True,
                vocabulary=None)
```

In [46]:

```
X_train_title_tfidf = vectorizer.transform(preprocessed_project_title_tr)
#X_cv_title_tfidf = vectorizer.transform(preprocessed_project_title_cv)
X_test_title_tfidf = vectorizer.transform(preprocessed_project_title_te)
```

1.5.2.3 Using Pretrained Models: Avg W2V

In [47]:

```
'''
# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039
def loadGloveModel(gloveFile):
    print ("Loading Glove Model")
    f = open(gloveFile,'r', encoding="utf8")
    model = {}
    for line in tqdm(f):
        splitLine = line.split()
        word = splitLine[0]
        embedding = np.array([float(val) for val in splitLine[1:]])
        model[word] = embedding
    print ("Done.",len(model)," words loaded!")
    return model
model = loadGloveModel('glove.42B.300d.txt')

# =====
Output:

Loading Glove Model
1917495it [06:32, 4879.69it/s]
Done. 1917495 words loaded!

# =====

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

for i in preproced_titles:
    words.extend(i.split(' '))
print("all the words in the coupus", len(words))
words = set(words)
print("the unique words in the coupus", len(words))

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

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

# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-pickle-to-sa
ve-and-load-variables-in-python/

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

'''
```

Out [47]:

```
'\n# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039\ndef
loadGloveModel(gloveFile):\n    print ("Loading Glove Model")\n    f = open(gloveFile,\nencoding="utf8")\n    model = {}\n    for line in tqdm(f):\n        splitLine = line.split()\nword = splitLine[0]\n        embedding = np.array([float(val) for val in splitLine[1:]])\n        model[word] = embedding\n    print ("Done.",len(model)," words loaded!")\n    return model\nmodel =
loadGloveModel('glove.42B.300d.txt')\n\n# =====\nOutput:\n\nLoading G
love Model\n1917495it [06:32, 4879.69it/s]\nDone. 1917495 words loaded!\n\n#
=====
\n\nwords = []\nfor i in preproced_texts:\n    words.extend(i.split('\n\n#
\n\nfor i in preproced_titles:\n    words.extend(i.split('\n\n#
\n\nprint("all the words in the
coupus", len(words))\nwords = set(words)\nprint("the unique words in the coupus",
len(words))\n\ninter_words = set(model.keys()).intersection(words)\nprint("The number of words tha
t are present in both glove vectors and our coupus", len(inter_words),
(",np.round(len(inter_words)/len(words)*100,3),"%")\n\nwords_courpus = {}\nwords_glove =
set(model.keys())\nfor i in words:\n    if i in words_glove:\n        words_courpus[i] = model[i]\nr
print("word 2 vec length", len(words_courpus))\n\n\n# stronging variables into pickle files python
: http://www.jessicayung.com/how-to-use-pickle-to-save-and-load-variables-in-python/\n\nimport pic
kle\n\nwith open('glove_vectors', 'wb') as f:\n    pickle.dump(words_courpus, f)\n\n\n'
```

In [48]:

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

In [49]:

```
# average Word2Vec
# compute average word2vec for each review.
avg_w2v_vectors_tr = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in preprocessed_essays_tr: # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words = 0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_tr.append(vector)

print(len(avg_w2v_vectors_tr))
print(len(avg_w2v_vectors_tr[0]))
```

73196
300

In [50]:

```
# average Word2Vec
# compute average word2vec for each review.
avg_w2v_vectors_te = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in preprocessed_essays_te: # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words = 0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_te.append(vector)

print(len(avg_w2v_vectors_te))
print(len(avg_w2v_vectors_te[0]))
```

36052
300

In [51]:

```
avg_w2v_vectors_preprocessed_project_title_tr = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in preprocessed_project_title_tr: # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words = 0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_preprocessed_project_title_tr.append(vector)

print(len(avg_w2v_vectors_preprocessed_project_title_tr))
print(len(avg_w2v_vectors_preprocessed_project_title_tr[0]))
```

73196
300

In [52]:

```
avg_w2v_vectors_preprocessed_project_title_te = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_project_title_te): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words = 0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors_preprocessed_project_title_te.append(vector)

print(len(avg_w2v_vectors_preprocessed_project_title_te))
print(len(avg_w2v_vectors_preprocessed_project_title_te[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████████████| 36052/36052  
[00:03<00:00, 10094.08it/s]
```

36052
300

1.5.2.3 Using Pretrained Models: TFIDF weighted W2V

In [53]:

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

In [54]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_tr = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in preprocessed_essays_tr: # 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((sentence.count(word)/len(sentence.split()))))
```

```

        tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf
idf value for each word
        vector += (vec * tf_idf) # calculating tfidf weighted w2v
        tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_tr.append(vector)

print(len(tfidf_w2v_vectors_tr))
print(len(tfidf_w2v_vectors_tr[0]))

```

73196

300

In [55]:

```

tfidf_w2v_vectors_te = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in preprocessed_essays_te: # 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((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf
idf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_te.append(vector)

print(len(tfidf_w2v_vectors_te))
print(len(tfidf_w2v_vectors_te[0]))

```

36052

300

In [56]:

```

# Similarly you can vectorize for title also
# Similarly you can vectorize for title also
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
tfidf_model = TfidfVectorizer()
tfidf_model.fit(preprocessed_project_title_tr)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())

```

In [57]:

```

# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_preprocessed_project_title_tr = []; # the avg-w2v for each sentence/review is st
ored in this list
for sentence in tqdm(preprocessed_project_title_tr): # 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((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf
idf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_preprocessed_project_title_tr.append(vector)

print(len(tfidf_w2v_vectors_preprocessed_project_title_tr))

```

```
print(len(tfidf_w2v_vectors_preprocessed_project_title_tr[0]))
```

```
100%|████████████████████████████████████████████████████████████████████████████████| 73196/73196  
[00:16<00:00, 4545.63it/s]
```

```
73196  
300
```

In [58]:

```
# average Word2Vec  
# compute average word2vec for each review.  
tfidf_w2v_vectors_preprocessed_project_title_te = []; # the avg-w2v for each sentence/review is stored in this list  
for sentence in preprocessed_project_title_te: # 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((sentence.count(word)/len(sentence.split())))  
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tf  
            idf value for each word  
            vector += (vec * tf_idf) # calculating tfidf weighted w2v  
            tf_idf_weight += tf_idf  
    if tf_idf_weight != 0:  
        vector /= tf_idf_weight  
    tfidf_w2v_vectors_preprocessed_project_title_te.append(vector)  
  
print(len(tfidf_w2v_vectors_preprocessed_project_title_te))  
print(len(tfidf_w2v_vectors_preprocessed_project_title_te[0]))
```

```
36052  
300
```

1.5.3 Vectorizing Numerical features

In [59]:

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

In [60]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s  
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html  
from sklearn.preprocessing import StandardScaler  
  
# price_standardized = standardScaler.fit(project_data['price'].values)  
# this will rise the error  
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287.  
73 5.5 ].  
# Reshape your data either using array.reshape(-1, 1)  
  
price_scaler = StandardScaler()  
price_scaler.fit(X_train['price'].values.reshape(-1,1)) # finding the mean and standard deviation of this data  
print(f"Mean : {price_scaler.mean_[0]}, Standard deviation : {np.sqrt(price_scaler.var_[0])}")  
  
# Now standardize the data with above mean and variance.  
price_standardized_tr = price_scaler.transform(X_train['price'].values.reshape(-1, 1))
```

```
Mean : 296.88872493032403, Standard deviation : 360.06016530154136
```

In [61]:

```
price_standardized_tr.shape
```

```
Out[61]:  
(73196, 1)
```

```
In [62]:
```

```
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()  
X_test = pd.merge(X_test, price_data, on='id', how='left')  
price_standardized_test = price_scalar.transform(X_test['price'].values.reshape(-1, 1))
```

```
In [63]:
```

```
price_standardized_test.shape
```

```
Out[63]:  
(36052, 1)
```

quantity : numerical data

```
In [121]:
```

```
# 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  
  
# price_standardized = standardScalar.fit(project_data['price'].values)  
# this will rise the error  
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.    ... 399.    287.  
73    5.5 ].  
# Reshape your data either using array.reshape(-1, 1)
```

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

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

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

```
Mean : 16.993114377834853, Standard deviation : 26.431008481016157
```

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

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

```
In [122]:
```

```
quantity_standardized_test = quantity_scalar.transform(X_test['quantity'].values.reshape(-1, 1))
```

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

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

```
In [123]:
```



```
quantity_standardized_test.shape
```

```
Out[123]:  
(36052, 1)
```

teacher_number_of_previously_posted_projects : numerical data

```
In [124]:
```

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s  
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html  
from sklearn.preprocessing import StandardScaler  
  
# price_standardized = standardScaler.fit(project_data['price'].values)  
# this will rise the error  
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287.  
73 5.5 ].  
# Reshape your data either using array.reshape(-1, 1)  
  
teacher_number_of_previously_posted_projects_scalar = StandardScaler()  
teacher_number_of_previously_posted_projects_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 : {quantity_scalar.mean_[0]}, Standard deviation :  
{np.sqrt(quantity_scalar.var_[0])}")  
  
# Now standardize the data with above mean and variance.  
teacher_number_of_previously_posted_projects_standardized_tr = quantity_scalar.transform(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

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

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

```
Mean : 16.993114377834853, Standard deviation : 26.431008481016157
```

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

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

```
In [125]:
```

```
teacher_number_of_previously_posted_projects_standardized_test = quantity_scalar.transform(X_test['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

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

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

```
In [126]:
```

```
teacher_number_of_previously_posted_projects_standardized_test.shape
```

```
Out[126]:  
(36052, 1)
```

sentiment score's of each of the essay : numerical data

In [128]:

```
from textblob import TextBlob
```

In [182]:

```
essay1_pol=[]
for i in range(0,X_train.shape[0]):
    essay1 = TextBlob(X_train['project_essay_1'].values[i])
    essay1_pol.append(essay1.sentiment.polarity)
```

In [183]:

```
import numpy as np
myarray = np.asarray(essay1_pol)
```

In [184]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler

# price_standardized = standardScaler.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287. 73 5.5 ].
# Reshape your data either using array.reshape(-1, 1)

essay1_pol_scalar = StandardScaler()
essay1_pol_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation : {np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above mean and variance.
essay1_pol_standardized_tr = quantity_scalar.transform(myarray.reshape(-1, 1))
```

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

In [185]:

```
essay1_pol=[]
for i in range(0,X_test.shape[0]):
    essay1 = TextBlob(X_train['project_essay_1'].values[i])
    essay1_pol.append(essay1.sentiment.polarity)
```

In [186]:

```
myarray = np.asarray(essay1_pol)
```

In [187]:

```
essay1_pol_standardized__test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

In [188]:

```
essay1_pol_standardized__test.shape
```

Out[188]:

```
(36052, 1)
```

In [260]:

```
essay2_pol=[]
for i in range(0,X_train.shape[0]):
```

```
essay2 = TextBlob(X_train['project_essay_2'].values[i])
essay2_pol.append(essay2.sentiment.polarity)
```

In [261]:

```
myarray = np.asarray(essay2_pol)
```

In [262]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler

# price_standardized = standardScaler.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287.
73 5.5 ].
# Reshape your data either using array.reshape(-1, 1)

essay2_pol_scalar = StandardScaler()
essay2_pol_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation :
{np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above mean and variance.
essay2_pol_standardized_tr = quantity_scalar.transform(myarray.reshape(-1, 1))
```

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

In [192]:

```
essay2_pol=[]
for i in range(0,X_test.shape[0]):
    essay2 = TextBlob(X_train['project_essay_2'].values[i])
    essay2_pol.append(essay2.sentiment.polarity)
```

In [193]:

```
myarray = np.asarray(essay2_pol)
```

In [194]:

```
essay2_pol_standardized__test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

In [195]:

```
essay2_pol_standardized__test.shape
```

Out[195]:

```
(36052, 1)
```

In [216]:

```
essay3_pol=[]
for i in range(0,X_train.shape[0]):
    essay3 = TextBlob(X_train['project_essay_3'].values[i])
    essay3_pol.append(essay3.sentiment.polarity)
```

In [217]:

```
myarray = np.asarray(essay3_pol)
```

In [218]:

```
# 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

# price_standardized = standardScaler.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287. 73 5.5 ].
# Reshape your data either using array.reshape(-1, 1)

essay3_pol_scalar = StandardScaler()
essay3_pol_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation : {np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above mean and variance.
essay3_pol_standardized_tr = quantity_scalar.transform(myarray.reshape(-1, 1))
```

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

In [219]:

```
essay3_pol=[]
for i in range(0,X_test.shape[0]):
    essay3 = TextBlob(X_train['project_essay_3'].values[i])
    essay3_pol.append(essay3.sentiment.polarity)
```

In [220]:

```
myarray = np.asarray(essay3_pol)
```

In [221]:

```
essay3_pol_standardized__test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

In [222]:

```
essay3_pol_standardized__test.shape
```

Out[222]:

```
(36052, 1)
```

In [223]:

```
essay4_pol=[]
for i in range(0,X_train.shape[0]):
    essay4 = TextBlob(X_train['project_essay_4'].values[i])
    essay4_pol.append(essay4.sentiment.polarity)
```

In [224]:

```
myarray = np.asarray(essay4_pol)
```

In [225]:

```
# 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

# price_standardized = standardScaler.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287. 73 5.5 ].
# Reshape your data either using array.reshape(-1, 1)

essay4_pol_scalar = StandardScaler()
```

```
essay4_pol_scalar = StandardScaler()
essay4_pol_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation :
{np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above mean and variance.
essay4_pol_standardized_tr = quantity_scalar.transform(myarray.reshape(-1, 1))
```

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

In [226]:

```
essay4_pol=[]
for i in range(0,X_test.shape[0]):
    essay4 = TextBlob(X_train['project_essay_4'].values[i])
    essay4_pol.append(essay3.sentiment.polarity)
```

In [227]:

```
myarray = np.asarray(essay4_pol)
```

In [228]:

```
essay4_pol_standardized__test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

In [229]:

```
essay4_pol_standardized__test.shape
```

Out[229]:

(36052, 1)

number of words in the title : numerical data

In [230]:

```
count_project_title = []
for i in range(0,X_train.shape[0]):
    count = 0
    for word in X_train['project_title'].values[i].split(' '):
        count += 1
    count_project_title.append(count)
```

In [231]:

```
myarray = np.asarray(count_project_title)
```

In [232]:

```
# 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

# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287.73 5.5 ].
# Reshape your data either using array.reshape(-1, 1)

count_project_title_scalar = StandardScaler()
count_project_title_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation :
{np.sqrt(quantity_scalar.var_[0])}")
```

```
# Now standardize the data with above mean and variance.
count_project_title_tr = count_project_title_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [233]:

```
count_project_title = []
for i in range(0,X_test.shape[0]):
    count = 0
    for word in X_test['project_title'].values[i].split(' '):
        count += 1
    count_project_title.append(count)
```

In [234]:

```
myarray = np.asarray(count_project_title)
```

In [235]:

```
count_project_title_test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

number of words in the combine essays : numerical data

In [236]:

```
count_project_essay_1 = []
for i in range(0,X_train.shape[0]):
    count = 0
    for word in X_train['project_essay_1'].values[i].split(' '):
        count += 1
    count_project_essay_1.append(count)
```

In [237]:

```
myarray = np.asarray(count_project_essay_1)
```

In [238]:

```
# 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

# price_standardized = standardScaler.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.    ... 399.    287.
73    5.5 ].
# Reshape your data either using array.reshape(-1, 1)
```

```
count_project_essay_1_scalar = StandardScaler()
count_project_essay_1_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation
of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation :
{np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above mean and variance.
count_project_essay_1_tr = count_project_essay_1_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [239]:

```
count_project_essay_1 = []
for i in range(0,X_test.shape[0]):
    count = 0
    for word in X_test['project_essay_1'].values[i].split(' '):
        count += 1
    count_project_essay_1.append(count)
```

In [240]:

```
myarray = np.asarray(count_project_essay_1)
```

In [241]:

```
count_project_essay_1_test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [242]:

```
count_project_essay_2 = []
for i in range(0,X_train.shape[0]):
    count = 0
    for word in X_train['project_essay_2'].values[i].split(' '):
        count += 1
    count_project_essay_2.append(count)
```

In [243]:

```
myarray = np.asarray(count_project_essay_2)
```

In [244]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler

# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
```

```
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287.
73 5.5 ].
# Reshape your data either using array.reshape(-1, 1)

count_project_essay_2_scalar = StandardScaler()
count_project_essay_2_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation
of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation :
{np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above mean and variance.
count_project_essay_2_tr = count_project_essay_1_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [245]:

```
count_project_essay_2 = []
for i in range(0,X_test.shape[0]):
    count = 0
    for word in X_test['project_essay_2'].values[i].split(' '):
        count += 1
    count_project_essay_2.append(count)
```

In [246]:

```
myarray = np.asarray(count_project_essay_2)
```

In [247]:

```
count_project_essay_2_test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [248]:

```
count_project_essay_3 = []
for i in range(0,X_train.shape[0]):
    count = 0
    for word in X_train['project_essay_3'].values[i].split(' '):
        count += 1
    count_project_essay_3.append(count)
```

In [249]:

```
myarray = np.asarray(count_project_essay_3)
```

In [250]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-
learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler
```



```

from sklearn.preprocessing import StandardScaler

# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.    ... 399.    287.
73    5.5 ].
# Reshape your data either using array.reshape(-1, 1)

count_project_essay_3_scalar = StandardScaler()
count_project_essay_3_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation
of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation :
{np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
count_project_essay_3_tr = count_project_essay_1_scalar.transform(myarray.reshape(-1, 1))

```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [251]:

```

count_project_essay_3 = []
for i in range(0,X_test.shape[0]):
    count = 0
    for word in X_test['project_essay_3'].values[i].split(' '):
        count += 1
    count_project_essay_3.append(count)

```

In [252]:

```
myarray = np.asarray(count_project_essay_3)
```

In [253]:

```
count_project_essay_3_test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [254]:

```

count_project_essay_4 = []
for i in range(0,X_train.shape[0]):
    count = 0
    for word in X_train['project_essay_4'].values[i].split(' '):
        count += 1
    count_project_essay_4.append(count)

```

In [255]:

```
myarray = np.asarray(count_project_essay_4)
```

In [256]:

```
# check this new link: https://www.youtube.com/watch?v=Q1QwQw1w384&list=PL28...
```

```
# check this one: https://www.youtube.com/watch?v=0HUQOC1n3Z4&t=530S
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler

# price_standardized = standardScaler.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329. ... 399. 287. 73 5.5 ].
# Reshape your data either using array.reshape(-1, 1)

count_project_essay_4_scalar = StandardScaler()
count_project_essay_4_scalar.fit(myarray.reshape(-1,1)) # finding the mean and standard deviation of this data
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation : {np.sqrt(quantity_scalar.var_[0])}")

# Now standardize the data with above mean and variance.
count_project_essay_4_tr = count_project_essay_1_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

Mean : 16.993114377834853, Standard deviation : 26.431008481016157

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [257]:

```
count_project_essay_4 = []
for i in range(0,X_test.shape[0]):
    count = 0
    for word in X_test['project_essay_4'].values[i].split(' '):
        count += 1
    count_project_essay_4.append(count)
```

In [258]:

```
myarray = np.asarray(count_project_essay_4)
```

In [259]:

```
count_project_essay_4_test = quantity_scalar.transform(myarray.reshape(-1, 1))
```

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

Data with input dtype int32 was converted to float64 by StandardScaler.

In [127]:

```
X_train.columns
```

Out[127]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
      'Date', 'project_grade_category', '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',
      'clean_categories', 'clean_subcategories', 'essay', 'price',
      'quantity'],
      dtype='object')
```

1.5.4 Merging all the above features

- we need to merge all the numerical vectors i.e catogorical, text, numerical vectors

In [64]:

```
print(categories_one_hot_tr.shape)
print(sub_categories_one_hot_tr.shape)

print(price_standardized_tr.shape)
```

```
(73196, 9)
(73196, 30)
(73196, 1)
```

In [65]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix and a dense matirx :)
X1_tr = hstack((categories_one_hot_tr, sub_categories_one_hot_tr,
price_standardized_tr,project_grade_category_one_hot_tr,teacher_prefix_one_hot_tr))
X1_tr.shape
```

Out[65]:

```
(73196, 49)
```

In [66]:

```
X1_te = hstack((categories_one_hot_te, sub_categories_one_hot_te,
price_standardized_test,project_grade_category_one_hot_te,teacher_prefix_one_hot_te))
X1_te.shape
```

Out[66]:

```
(36052, 49)
```

Assignment 5: Logistic Regression

1. [Task-1] Logistic Regression(either SGDClassifier with log loss, or LogisticRegression) on these feature sets

- **Set 1:** categorical, numerical features + project_title(BOW) + preprocessed_eassay ('BOW with bi-grams' with 'min_df=10' and 'max_features=5000')
- **Set 2:** categorical, numerical features + project_title(TFIDF)+ preprocessed_eassay ('TFIDF with bi-grams' with 'min_df=10' and 'max_features=5000')
- **Set 3:** categorical, numerical features + project_title(AVG W2V)+ preprocessed_eassay (AVG W2V)
- **Set 4:** categorical, numerical features + project_title(TFIDF W2V)+ preprocessed_essay (TFIDF W2V)

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

- Find the best hyper parameter which will give the maximum [AUC](#) value
- Find the best hyper paramter using k-fold cross validation or simple cross validation data
- Use gridsearch cv or randomsearch cv or you can also write your own for loops to do this task of hyperparameter tuning

3. Representation of results

- You need to plot the performance of model both on train data and cross validation data for each hyper parameter, like shown in the figure.
- Once after you found the best hyper parameter, you need to train your model with it, and find the AUC on test data and plot the ROC curve on both train and test.
- Along with plotting ROC curve, you need to print the [confusion matrix](#) with predicted and original labels of test data points. Please visualize your confusion matrices using [seaborn heatmap](#).

points. Please visualize your confusion matrices using [seaborn neatmaps](#).

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

- [school_state](#) : categorical data
- [clean_categories](#) : categorical data
- [clean_subcategories](#) : categorical data
- [project_grade_category](#) : categorical data
- [teacher_prefix](#) : categorical data
- [quantity](#) : numerical data
- [teacher_number_of_previously_posted_projects](#) : numerical data
- [price](#) : numerical data
- [sentiment_score's of each of the essay](#) : numerical data
- [number of words in the title](#) : numerical data
- [number of words in the combine essays](#) : numerical data

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

6. Conclusion

- [You need to summarize the results at the end of the notebook, summarize it in the table format. To print out a table please refer to this prettytable library link](#)

Note: Data Leakage

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

2. Logistic Regression

2.4.1 Applying Naive Bayes on BOW, SET 1

In [97]:

```
from scipy.sparse import hstack
X_tr = hstack((X_train_essay_bow,X_train_title_bow ,X1_tr)).tocsr()
#X_cr = hstack((X_cv_essay_bow,X_cv_title_bow ,X1_cv)).tocsr()
X_te = hstack((X_test_essay_bow,X_test_title_bow ,X1_te)).tocsr()
```

In [98]:

```
'''X_tr = X_tr[0:30000,:]
y_train = y_train[0:30000]
X_te = X_te[0:20000,:]
y_test = y_test[0:20000]'''
```

Out[98]:

```
'X_tr = X_tr[0:30000,:]\ny_train = y_train[0:30000]\nX_te = X_te[0:20000,:]\ny_test = y_test[0:20000]'
```

In [99]:

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

```
Final Data matrix
(73196, 10049) (73196,)
```

(36052, 10049) (36052,)

In [100]:

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

from sklearn.linear_model import LogisticRegression

parameters = [{'C': [10**-4, 10**-2, 10**0, 10**2, 10**4]}]
model = LogisticRegression()
clf = GridSearchCV(model, parameters, cv=3, scoring='roc_auc', n_jobs=-1)
clf.fit(X_tr, y_train)

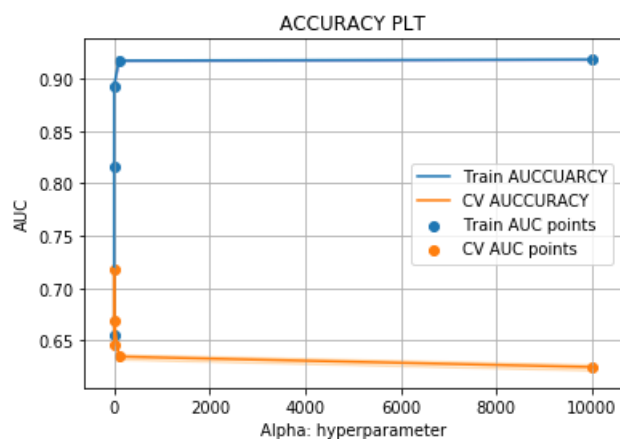
train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUCCUARC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc - train_auc_std, train_auc +
train_auc_std, alpha=0.2, color='darkblue')

plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUCCURACY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc - cv_auc_std, cv_auc + cv_auc_std,
alpha=0.2, color='darkorange')

plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUC points')
plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUC points')

plt.legend()
plt.xlabel("Alpha: hyperparameter")
plt.ylabel("AUC")
plt.title("ACCURACY PLT")
plt.grid()
plt.show()
print(clf.best_estimator_)
print(clf.score(X_tr, y_train))
print(clf.best_params_)
```



```
LogisticRegression(C=0.01, class_weight=None, dual=False, fit_intercept=True,
intercept_scaling=1, max_iter=100, multi_class='warn',
n_jobs=None, penalty='l2', random_state=None, solver='warn',
tol=0.0001, verbose=0, warm_start=False)
0.8024736124487593
{'C': 0.01}
```

From above AUC plot best value of hyper parameter = 0.01.

In [71]:

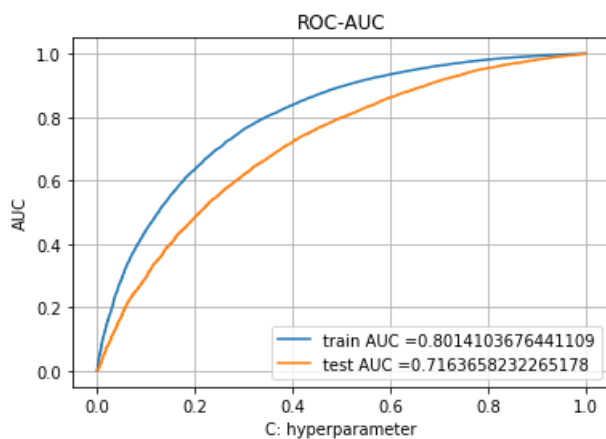
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

neigh = LogisticRegression(C = 0.01)
neigh.fit(X_tr, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

y_train_pred = neigh.predict_log_proba(X_tr)[:,1]
y_test_pred = neigh.predict_log_proba(X_te)[:,1]

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

plt.plot(train_fpr, train_tpr, label="train AUC =" + str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC =" + str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("C: hyperparameter")
plt.ylabel("AUC")
plt.title("ROC-AUC")
plt.grid()
plt.show()
```



1. From above plot its clear that train AUC = .801 which is very high.
2. And test AUC = .716 which is much better than .5 i.e. a random model.

In [72]:

```
import seaborn as sns
def predict(proba, threshold, fpr, tpr):

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

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

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

In [73]:

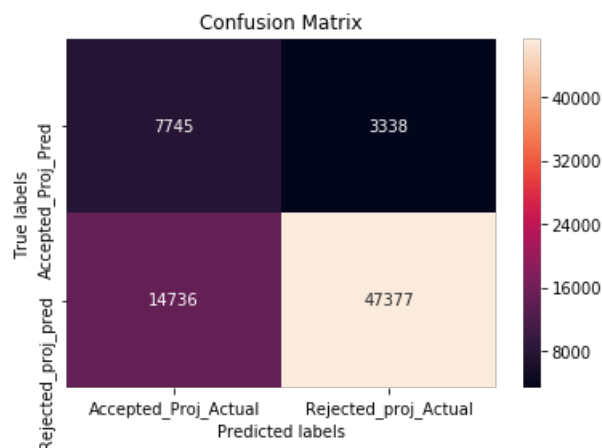
```
#ax = sns.heatmap(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_tpr)), annot=True, fmt="d")
```

In [74]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_tpr)),
annot=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels
(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr \cdot (1 - fpr)$ 0.5330269160903994 6170 for threshold -0.1971570625827575 -0.197

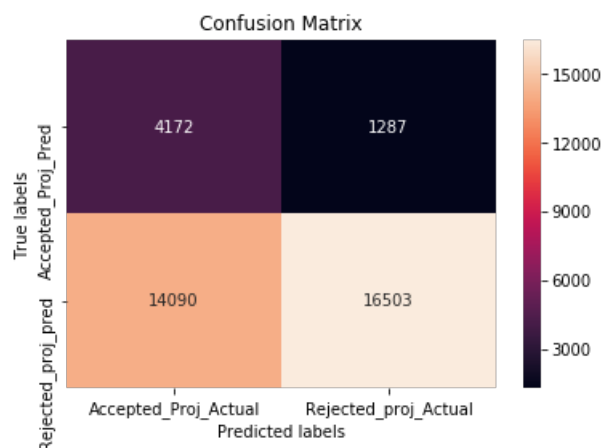


In [75]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_tpr)), anno
t=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels
(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr \cdot (1 - fpr)$ 0.437715563702058 3303 for threshold -0.12308281907696916 -0.123



In [76]:

```
#ax = sns.heatmap(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr,
test_tpr)), annot=True, fmt="d")
```

TN = 3571 < FN = 11047, majority of the negative points are classified as +ve points.

FP = 1888 < Tp = 19546 +ve points are classified more accurately.

2.4.2 Applying Naive Bayes on TFIDF, SET 2

In [101]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
X_tr = hstack((X_train_essay_tfidf,X_train_title_tfidf ,X1_tr)).tocsr()

X_te = hstack((X_test_essay_tfidf ,X_test_title_tfidf ,X1_te)).tocsr()

print("Final Data matrix")
print(X_tr.shape, y_train.shape)

print(X_te.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(73196, 10049) (73196,)
(36052, 10049) (36052,)
```

In [102]:

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

from sklearn.linear_model import LogisticRegression

parameters = [{'C': [10**-4, 10**-2, 10**0, 10**2, 10**4]}]
model = LogisticRegression()
clf = GridSearchCV(model, parameters, cv=3, scoring='roc_auc',n_jobs=-1)
clf.fit(X_tr, y_train)

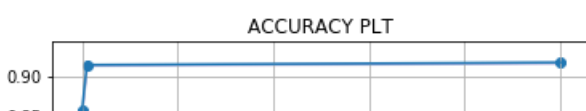
train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

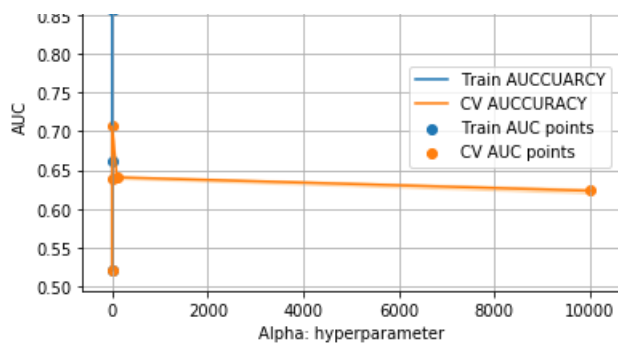
plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUCCUARCY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4],train_auc - train_auc_std,train_auc +
train_auc_std,alpha=0.2,color='darkblue')

plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUCCUARCY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4],cv_auc - cv_auc_std,cv_auc + cv_auc_std,
alpha=0.2,color='darkorange')

plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUC points')
plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUC points')

plt.legend()
plt.xlabel("Alpha: hyperparameter")
plt.ylabel("AUC")
plt.title("ACCURACY PLT")
plt.grid()
plt.show()
print(clf.best_estimator_)
print(clf.score(X_tr, y_train))
print(clf.best_params_)
```





```
LogisticRegression(C=1, class_weight=None, dual=False, fit_intercept=True,
    intercept_scaling=1, max_iter=100, multi_class='warn',
    n_jobs=None, penalty='l2', random_state=None, solver='warn',
    tol=0.0001, verbose=0, warm_start=False)
0.835945279005371
{'C': 1}
```

From the above plot the best value of C = 1.

In [88]:

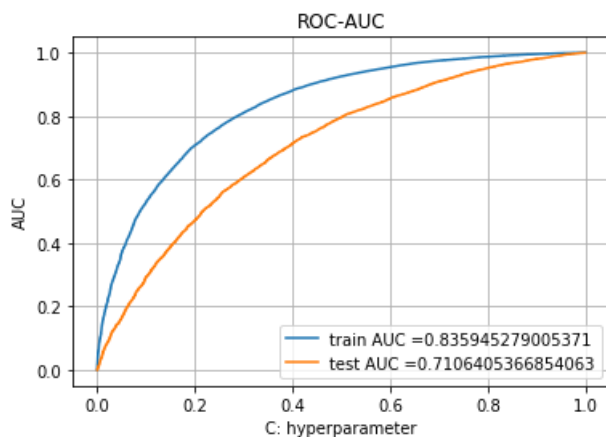
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

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

y_train_pred = neigh.predict_log_proba(X_tr)[:,1]
y_test_pred = neigh.predict_log_proba(X_te)[:,1]

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

plt.plot(train_fpr, train_tpr, label="train AUC =" + str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC =" + str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("C: hyperparameter")
plt.ylabel("AUC")
plt.title("ROC-AUC")
plt.grid()
plt.show()
```



1. From above plot its clear that train AUC = .835 which is very high.
2. And test AUC = .71 which is much better than .5 i.e. a random model.

In []:

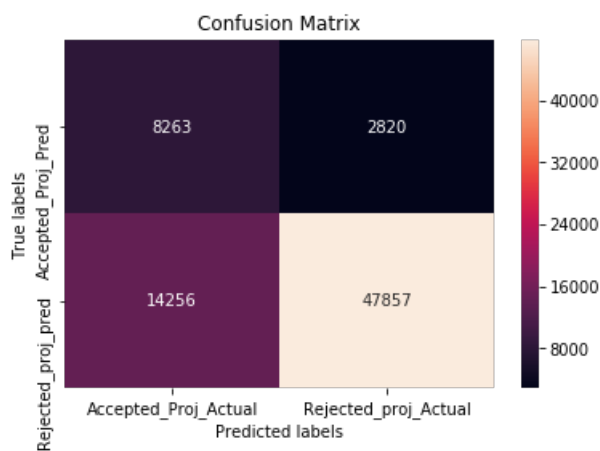
```
#ax = sns.heatmap(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_tpr)), annot=True, fmt="d")
```

In [89]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_tpr)),
annot=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr \cdot (1 - fpr)$ 0.5744382948350899 5284 for threshold -0.187821014669342 -0.188



In []:

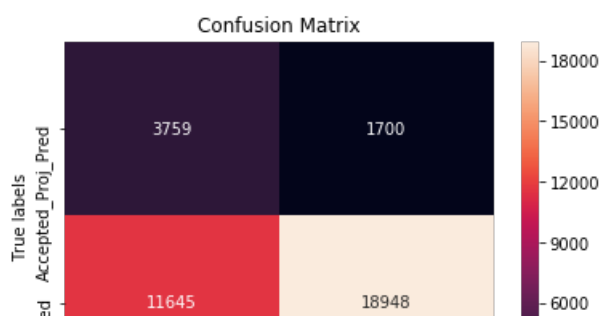
```
#ax = sns.heatmap(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_tpr)), annot=True, fmt="d")
```

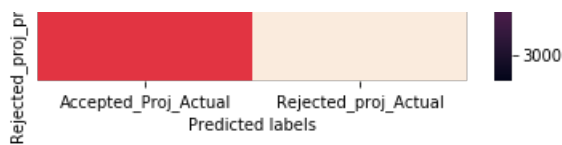
In [90]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_tpr)), anno
t=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr \cdot (1 - fpr)$ 0.4315374164107081 3484 for threshold -0.13848334197025594 -0.138





TN = 2146 < FN = 5520, majority of the negative points are classified as +ve points.

FP = 3313 < Tp = 25073, +ve points are classified more accurately.

SET 3

In [103]:

```
from scipy.sparse import hstack
X_tr = hstack((avg_w2v_vectors_tr, avg_w2v_vectors_preprocessed_project_title_tr, X1_tr)).tocsr()
#X_cr = hstack((X_cv_essay_bow, X_cv_title_bow, X1_cv)).tocsr()
X_te = hstack((avg_w2v_vectors_te, avg_w2v_vectors_preprocessed_project_title_te, X1_te)).tocsr()
```

In [104]:

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

```
Final Data matrix
(73196, 649) (73196,)
(36052, 649) (36052,)
```

In [105]:

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

from sklearn.linear_model import LogisticRegression

parameters = [{'C': [10**-4, 10**-2, 10**0, 10**2, 10**4]}]
model = LogisticRegression()
clf = GridSearchCV(model, parameters, cv=3, scoring='roc_auc', n_jobs=-1)
clf.fit(X_tr, y_train)

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

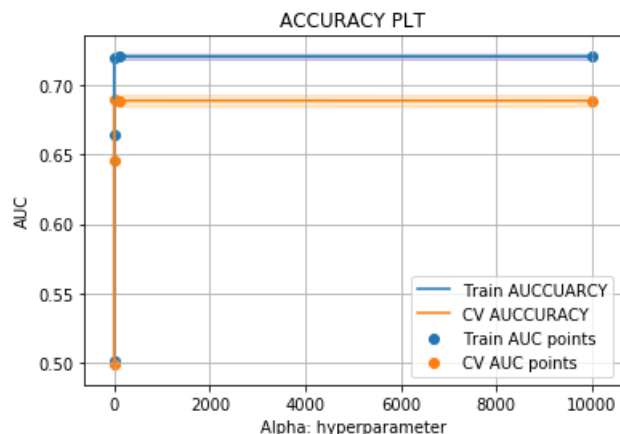
plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUCCUARCY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc - train_auc_std, train_auc + train_auc_std, alpha=0.2, color='darkblue')

plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUCCUARCY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc - cv_auc_std, cv_auc + cv_auc_std, alpha=0.2, color='darkorange')

plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUC points')
plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUC points')

plt.legend()
plt.xlabel("Alpha: hyperparameter")
plt.ylabel("AUC")
plt.title("ACCURACY PLT")
plt.grid()
plt.show()
```

```
plt.show()
print(clf.best_estimator_)
print(clf.score(X_tr, y_train))
print(clf.best_params_)
```



```
LogisticRegression(C=1, class_weight=None, dual=False, fit_intercept=True,
                    intercept_scaling=1, max_iter=100, multi_class='warn',
                    n_jobs=None, penalty='l2', random_state=None, solver='warn',
                    tol=0.0001, verbose=0, warm_start=False)
0.5123716800617277
{'C': 1}
```

From above AUC plot best value of hyper parameter = 1.

In [95]:

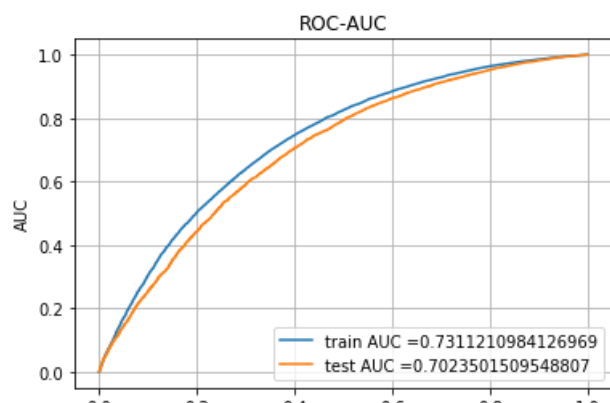
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

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

y_train_pred = neigh.predict_log_proba(X_tr)[:,1]
y_test_pred = neigh.predict_log_proba(X_te)[:,1]

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

plt.plot(train_fpr, train_tpr, label="train AUC =" + str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC =" + str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("C: hyperparameter")
plt.ylabel("AUC")
plt.title("ROC-AUC")
plt.grid()
plt.show()
```



0.0 0.2 0.4 0.6 0.8 1.0
C: hyperparameter

1. From above plot its clear that train AUC = .731 which is very high.
2. And test AUC = .693 which is much better than .702 i.e. a random model.

Task 4

In [279]:

```
from scipy.sparse import hstack
X_tr = hstack((tfidf_w2v_vectors_tr,tfidf_w2v_vectors_preprocessed_project_title_tr ,X1_tr)).tocsr()
()
#X_cr = hstack((X_cv_essay_bow,X_cv_title_bow ,X1_cv)).tocsr()
X_te = hstack((tfidf_w2v_vectors_te,tfidf_w2v_vectors_preprocessed_project_title_te ,X1_te)).tocsr()
()
```

In [280]:

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

Final Data matrix
(73196, 649) (73196,)
(36052, 649) (36052,)



In [281]:

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

from sklearn.linear_model import LogisticRegression

parameters = [{'C': [10**-4, 10**-2, 10**0, 10**2, 10**4]}]
model = LogisticRegression()
clf = GridSearchCV(model, parameters, cv=3, scoring='roc_auc',n_jobs=-1)
clf.fit(X_tr, y_train)

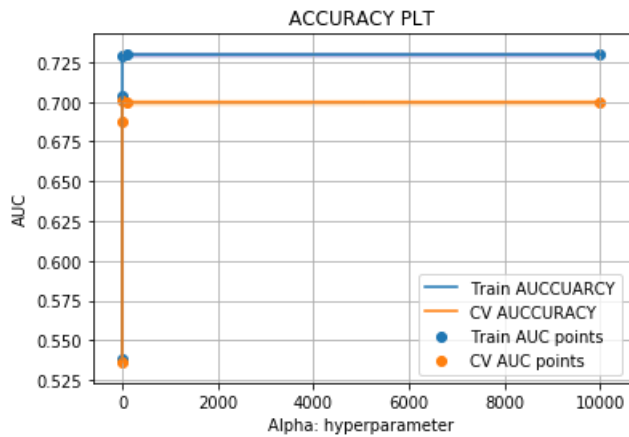
train_auc= clf.cv_results_['mean_train_score']
train_auc_std= clf.cv_results_['std_train_score']
cv_auc = clf.cv_results_['mean_test_score']
cv_auc_std= clf.cv_results_['std_test_score']

plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUCCUARCY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4],train_auc - train_auc_std,train_auc +
train_auc_std,alpha=0.2,color='darkblue')

plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUCCURACY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4],cv_auc - cv_auc_std,cv_auc + cv_auc_std,
alpha=0.2,color='darkorange')

plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUC points')
plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUC points')

plt.legend()
plt.xlabel("Alpha: hyperparameter")
plt.ylabel("AUC")
plt.title("ACCURACY PLT")
plt.grid()
plt.show()
print(clf.best_estimator_)
print(clf.score(X_tr, y_train))
print(clf.best_params_)
```



```
LogisticRegression(C=1, class_weight=None, dual=False, fit_intercept=True,
                    intercept_scaling=1, max_iter=100, multi_class='warn',
                    n_jobs=None, penalty='l2', random_state=None, solver='warn',
                    tol=0.0001, verbose=0, warm_start=False)
0.724780296148838
{'C': 1}
```

From above AUC plot best value of hyper parameter = 1.

In [282]:

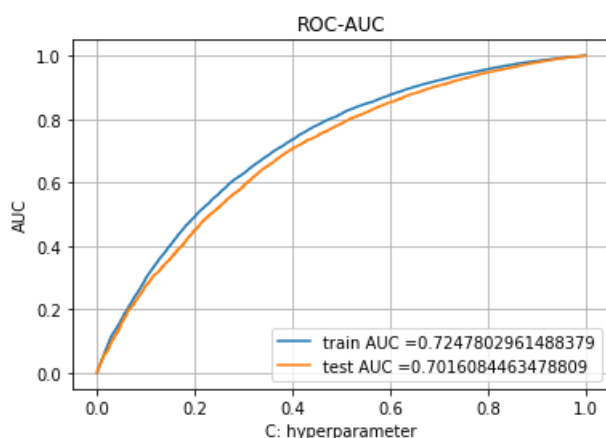
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

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

y_train_pred = neigh.predict_log_proba(X_tr)[:,1]
y_test_pred = neigh.predict_log_proba(X_te)[:,1]

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

plt.plot(train_fpr, train_tpr, label="train AUC =" + str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC =" + str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("C: hyperparameter")
plt.ylabel("AUC")
plt.title("ROC-AUC")
plt.grid()
plt.show()
```



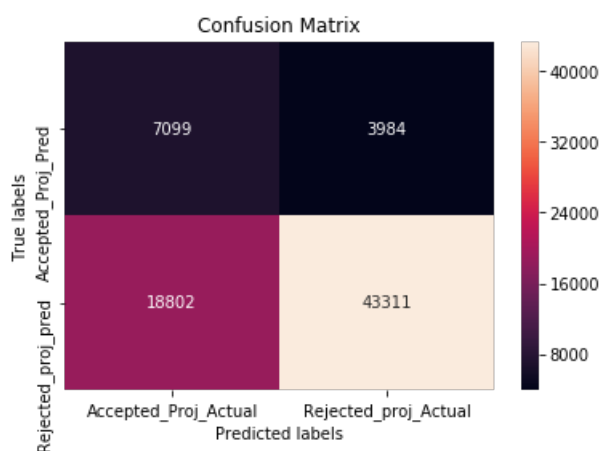
1. From above plot its clear that train AUC = .724 which is very high.
2. And test AUC = .701 which is much better than .5 i.e. a random model.

In [283]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_tpr)),
            annot=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels
(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr \cdot (1 - fpr)$ 0.44663787478209627 7283 for threshold -0.18404523791064115 -0.184

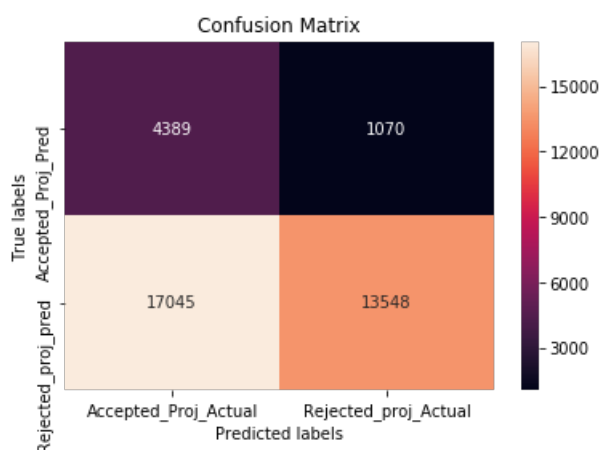


In [284]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_tpr)),
            annot=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels
(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr \cdot (1 - fpr)$ 0.426701277233057 3706 for threshold -0.11412461977168152 -0.114



TN = 4389 < FN = 17045, majority of the negative points are classified as +ve points.

FP = 1070 < Tp = 13548, +ve points are classified more accurately.

2.5 Logistic Regression with added Features `Set 5`

In [264]:

```
from scipy.sparse import hstack
X_tr =
hstack((teacher_prefix_one_hot_tr,project_grade_category_one_hot_tr,school_state_category_one_hot_t
,clean_categories_category_one_hot_tr,clean_subcategories_category_one_hot_tr,price_standardized_tr
,quantity_standardized_tr,teacher_number_of_previously_posted_projects_standardized_tr,essay1_pol_s
tandardized_tr,essay2_pol_standardized_tr,essay3_pol_standardized_tr,essay4_pol_standardized_tr,co
unt_project_title_tr,count_project_essay_1_tr,count_project_essay_2_tr,count_project_essay_3_tr,co
unt_project_essay_4_tr))
#X_cr = hstack((X_cv_essay_bow,X_cv_title_bow ,X1_cv)).tocsr()
X_te =
hstack((teacher_prefix_one_hot_te,project_grade_category_one_hot_te,school_state_category_one_hot_t
,clean_categories_category_one_hot_te,clean_subcategories_category_one_hot_te,price_standardized_t
st,quantity_standardized_test,teacher_number_of_previously_posted_projects_standardized_test,essay
1_pol_standardized_test,essay2_pol_standardized_test,essay3_pol_standardized_test,essay4_pol_sta
ndardized_test,count_project_title_test,count_project_essay_1_test,count_project_essay_2_test,co
unt_project_essay_3_test,count_project_essay_4_test))
```

In [265]:

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

```
Final Data matrix
(73196, 511) (73196,)
(36052, 511) (36052,)
```

In [269]:

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

from sklearn.linear_model import LogisticRegression

parameters = [{'C': [10**-4, 10**-2, 10**0, 10**2, 10**4]}]
model = LogisticRegression()
clf = GridSearchCV(model, parameters, cv=3, scoring='roc_auc',n_jobs=-1)
clf.fit(X_tr, y_train)

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

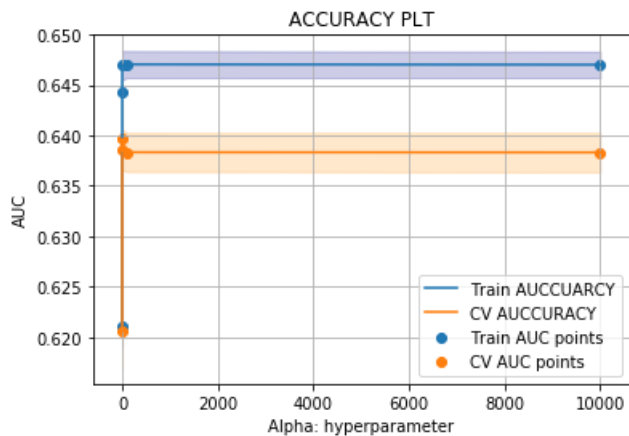
plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUCCUARC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4],train_auc - train_auc_std,train_auc +
train_auc_std,alpha=0.2,color='darkblue')

plt.plot([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUCCURACY')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between([10**-4, 10**-2, 10**0, 10**2, 10**4],cv_auc - cv_auc_std,cv_auc + cv_auc_st
d,alpha=0.2,color='darkorange')

plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], train_auc, label='Train AUC points')
plt.scatter([10**-4, 10**-2, 10**0, 10**2, 10**4], cv_auc, label='CV AUC points')
```



```
plt.legend()
plt.xlabel("Alpha: hyperparameter")
plt.ylabel("AUC")
plt.title("ACCURACY PLT")
plt.grid()
plt.show()
print(clf.best_estimator_)
print(clf.score(X_tr, y_train))
print(clf.best_params_)
```



```
LogisticRegression(C=0.01, class_weight=None, dual=False, fit_intercept=True,
                    intercept_scaling=1, max_iter=100, multi_class='warn',
                    n_jobs=None, penalty='l2', random_state=None, solver='warn',
                    tol=0.0001, verbose=0, warm_start=False)
0.6443936222574981
{'C': 0.01}
```

From above AUC plot best value of hyper parameter = 0.01.

In [270]:

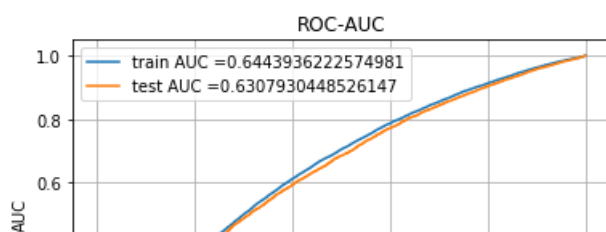
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

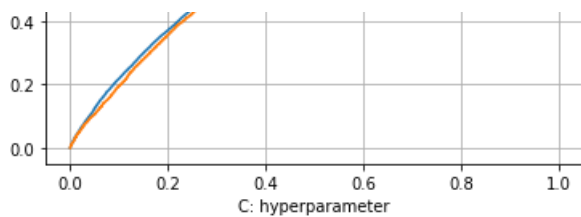
neigh = LogisticRegression(C = 0.01)
neigh.fit(X_tr, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

y_train_pred = neigh.predict_log_proba(X_tr)[:,1]
y_test_pred = neigh.predict_log_proba(X_te)[:,1]

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

plt.plot(train_fpr, train_tpr, label="train AUC =" + str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC =" + str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("C: hyperparameter")
plt.ylabel("AUC")
plt.title("ROC-AUC")
plt.grid()
plt.show()
```





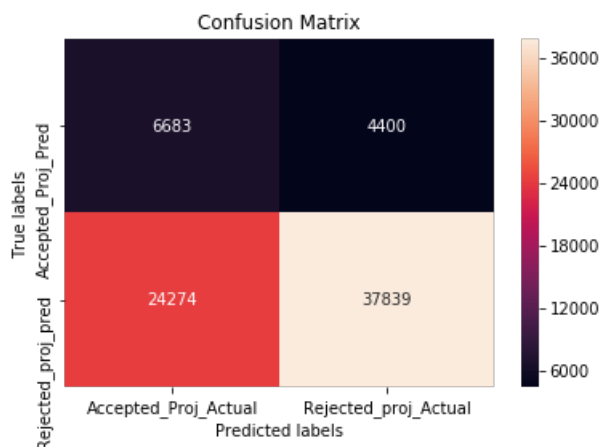
1. From above plot its clear that train AUC = .644 which is very high.
2. And test AUC = .6307 which is much better than .5 i.e. a random model.

In [271]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, predict(y_train_pred, tr_thresholds, train_fpr, train_tpr)),
annot=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels
(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr*(1-fpr)$ 0.36734258056700037 7872 for threshold -0.17232840762518845 -0.172



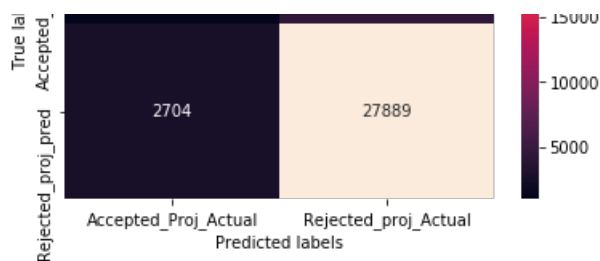
In [272]:

```
#https://stackoverflow.com/questions/19233771/sklearn-plot-confusion-matrix-with-labels/19252430
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, predict(y_test_pred, tr_thresholds, test_fpr, test_tpr)), anno
t=True, fmt="d", ax = ax)
# labels, title and ticks
ax.set_xlabel('Predicted labels');ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix');
ax.xaxis.set_ticklabels(['Accepted_Proj_Actual', 'Rejected_proj_Actual']); ax.yaxis.set_ticklabels
(['Accepted_Proj_Pred', 'Rejected_proj_pred']);
```

the maximum value of $tpr*(1-fpr)$ 0.356368238212407 3904 for threshold -0.13666338524524962 -0.137





TN = 1016 < FN = 2704, majority of the negative points are classified as +ve points.

FP = 4443 < Tp = 27889, +ve points are classified more accurately.

3. Conclusions

In [287]:

```
from prettytable import PrettyTable

x = PrettyTable()

x.field_names = ["vectorizer", "Model", "Hyper parameter ", "AUC"]

x.add_row(["BOW", "Multinomial Naive Bayes", 0.01, 0.7])
x.add_row(["TFIDF", "Multinomial Naive Bayes", 1, 0.7])
x.add_row(["AVG W2V", "Multinomial Naive Bayes", 1, 0.7])
x.add_row(["TFIDF W2V", "Multinomial Naive Bayes", 1, 0.7])
x.add_row(["One hot encoding", "Multinomial Naive Bayes", 0.01, 0.6])

print(x)
```

vectorizer	Model	Hyper parameter	AUC
BOW	Multinomial Naive Bayes	0.01	0.7
TFIDF	Multinomial Naive Bayes	1	0.7
AVG W2V	Multinomial Naive Bayes	1	0.7
TFIDF W2V	Multinomial Naive Bayes	1	0.7
One hot encoding	Multinomial Naive Bayes	0.01	0.6