DonorsChoose

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

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

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

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

About the DonorsChoose Data Set

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

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

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

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

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

Feature	Description
id	A `project_id` value from the `train.csv` file. **Example:** `p036502`
description	Desciption of the resource. **Example:** `Tenor Saxophone Reeds, Box of 25`

Feature	Description
`quantity`	Quantity of the resource required. **Example:** `3`
`price`	Price of the resource required. **Example:** `9.95`

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

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

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

Notes on the Essay Data

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

- **project_essay_1:** "Introduce us to your classroom"
- **project_essay_2:** "Tell us more about your students"
- **project_essay_3:** "Describe how your students will use the materials you're requesting"
- **project_essay_4:** "Close by sharing why your project will make a difference"

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

- **project_essay_1:** "Describe your students: What makes your students special? Specific details about their background, your neighborhood, and your school are all helpful."
- **project_essay_2:** "About your project: How will these materials make a difference in your students' learning and improve their school lives?"

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

In [1]:

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

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

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

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

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

from tqdm import tqdm
import os

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

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

1.1 Reading Data

In [2]:

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

In [3]:

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

```
Number of data points in train data (109248, 17)
--------------------------------------------------
The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix' 's
chool_state'
 'project_submitted_datetime' 'project_grade_category'
 'project_subject_categories' 'project_subject_subcategories'
 'project_title' 'project_essay_1' 'project_essay_2' 'project_essay_3'
 'project_essay_4' 'project_resource_summary'
 'teacher_number_of_previously_posted_projects' 'project_is_approved']
```

Out[3]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ	
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	
4	172407	p104768	be1f7507a41f8479dc06f047086a39ec	Mrs.	TX	

In [4]:

```
print("Number of data points in train data", resource_data.shape)
print(resource_data.columns.values)
resource_data.head(4)
```

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

Out[4]:

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

In [5]:

```
project_grade_category = []

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

In [6]:

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

In [7]:

```
project_data["project_grade_category"] = project_grade_category
```

In [8]:

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

Out[8]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ	
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	
4	172407	p104768	be1f7507a41f8479dc06f047086a39ec	Mrs.	TX	

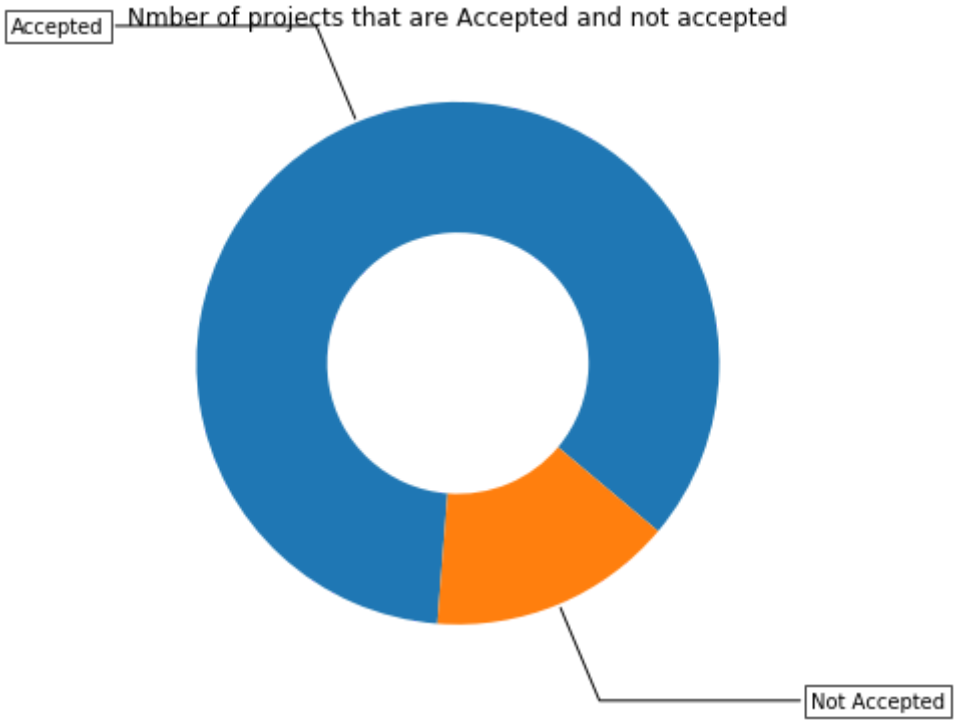
1.2 Data Analysis

We need to find the the perfect no of points that are approved for funding and the projects that are not approved for funding.

In [9]:

```
# https://matplotlib.org/gallery/pie_and_polar_charts/pie_and_donut_labels.html#sphx-glr-ga


y_value_counts = project_data['project_is_approved'].value_counts()

print("Number of projects thar are approved for funding ", y_value_counts[1], ", (", (y_val
print("Number of projects thar are not approved for funding ", y_value_counts[0], ", (", (y

fig, ax = plt.subplots(figsize=(6, 6), subplot_kw=dict(aspect="equal"))
recipe = ["Accepted", "Not Accepted"]

data = [y_value_counts[1], y_value_counts[0]]

wedges, texts = ax.pie(data, wedgeprops=dict(width=0.5), startangle=-40)

bbox_props = dict(boxstyle="square,pad=0.3", fc="w", ec="k", lw=0.72)
kw = dict(xycoords='data', textcoords='data', arrowprops=dict(arrowstyle="-"),
          bbox=bbox_props, zorder=0, va="center")

for i, p in enumerate(wedges):
    ang = (p.theta2 - p.theta1)/2. + p.theta1
    y = np.sin(np.deg2rad(ang))
    x = np.cos(np.deg2rad(ang))
    horizontalalignment = {-1: "right", 1: "left"}[int(np.sign(x))]
    connectionstyle = "angle,angleA=0,angleB={}".format(ang)
    kw["arrowprops"].update({"connectionstyle": connectionstyle})
    ax.annotate(recipe[i], xy=(x, y), xytext=(1.35*np.sign(x), 1.4*y),
                horizontalalignment=horizontalalignment, **kw)

ax.set_title("Nmber of projects that are Accepted and not accepted")

plt.show()
```

```
Number of projects thar are approved for funding  92706 , ( 84.8583040421792
7 %)
Number of projects thar are not approved for funding  16542 , ( 15.141695957
820739 %)
```



From the Donut Plot, we realise that only 84.85% of the total projects recieved gets approved for the funding,whereas 15.14% are not approved on various grounds.

1.2.1 Univariate Analysis: School State

In [10]:

```
# Pandas dataframe groupby count, mean: https://stackoverflow.com/a/19385591/4084039

temp = pd.DataFrame(project_data.groupby("school_state")["project_is_approved"].apply(np.me
# if you have data which contain only 0 and 1, then the mean = percentage (think about it)
temp.columns = ['state_code', 'num_proposals']

# How to plot US state heatmap: https://datascience.stackexchange.com/a/9620

scl = [[0.0, 'rgb(242,240,247)'],[0.2, 'rgb(218,218,235)'],[0.4, 'rgb(188,189,220)'],\
            [0.6, 'rgb(158,154,200)'],[0.8, 'rgb(117,107,177)'],[1.0, 'rgb(84,39,143)']]

data = [ dict(
        type='choropleth',
        colorscale = scl,
        autocolorscale = False,
        locations = temp['state_code'],
        z = temp['num_proposals'].astype(float),
        locationmode = 'USA-states',
        text = temp['state_code'],
        marker = dict(line = dict (color = 'rgb(255,255,255)',width = 2)),
        colorbar = dict(title = "% of pro")
    ) ]

layout = dict(
        title = 'Project Proposals % of Acceptance Rate by US States',
        geo = dict(
            scope='usa',
            projection=dict( type='albers usa' ),
            showlakes = True,
            lakecolor = 'rgb(255, 255, 255)',
        ),
    )

fig = go.Figure(data=data, layout=layout)
offline.iplot(fig, filename='us-map-heat-map')
```

In [11]:

```
# https://www.csi.cuny.edu/sites/default/files/pdf/administration/ops/2letterstabbrev.pdf
temp.sort_values(by=['num_proposals'], inplace=True)
print("States with lowest % approvals")
print(temp.head(5))
print('='*50)
print("States with highest % approvals")
print(temp.tail(5))
```

```
States with lowest % approvals
   state_code  num_proposals
46         VT       0.800000
7          DC       0.802326
43         TX       0.813142
26         MT       0.816327
18         LA       0.831245
==================================================
States with highest % approvals
   state_code  num_proposals
30         NH       0.873563
35         OH       0.875152
47         WA       0.876178
28         ND       0.888112
8          DE       0.897959
```

From the table above we can make out taht every state has a approval rate graeter than 80% and DE(delaware) is the highest among all with number of proposals i.e 89%

In [12]:

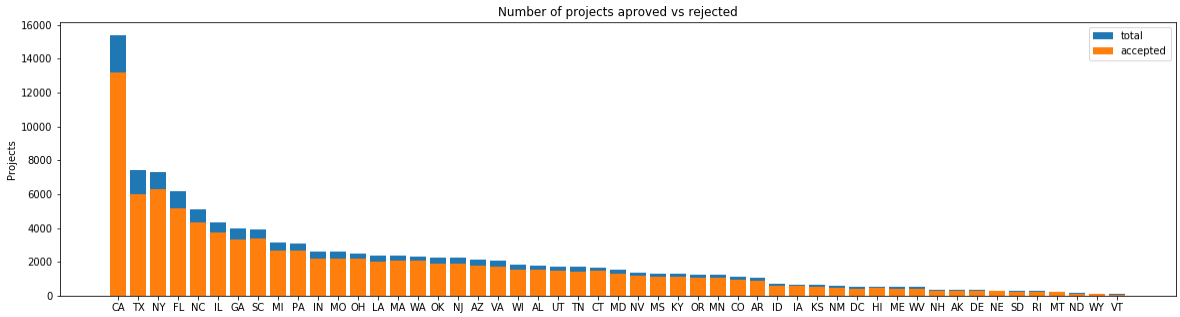
```
#stacked bar plots matplotlib: https://matplotlib.org/gallery/lines_bars_and_markers/bar_st
def stack_plot(data, xtick, col2='project_is_approved', col3='total'):
    ind = np.arange(data.shape[0])

    plt.figure(figsize=(20,5))
    p1 = plt.bar(ind, data[col3].values)
    p2 = plt.bar(ind, data[col2].values)

    plt.ylabel('Projects')
    plt.title('Number of projects aproved vs rejected')
    plt.xticks(ind, list(data[xtick].values))
    plt.legend((p1[0], p2[0]), ('total', 'accepted'))
    plt.show()
```

In [13]:

```
def univariate_barplots(data, col1, col2='project_is_approved', top=False):
    # Count number of zeros in dataframe python: https://stackoverflow.com/a/51540521/40840
    temp = pd.DataFrame(project_data.groupby(col1)[col2].agg(lambda x: x.eq(1).sum())).rese

    # Pandas dataframe grouby count: https://stackoverflow.com/a/19385591/4084039
    temp['total'] = pd.DataFrame(project_data.groupby(col1)[col2].agg({'total':'count'})).r
    temp['Avg'] = pd.DataFrame(project_data.groupby(col1)[col2].agg({'Avg':'mean'})).reset_

    temp.sort_values(by=['total'],inplace=True, ascending=False)

    if top:
        temp = temp[0:top]

    stack_plot(temp, xtick=col1, col2=col2, col3='total')
    print(temp.head(5))
    print("="*50)
    print(temp.tail(5))
```

In [14]:

```
univariate_barplots(project_data, 'school_state', 'project_is_approved', False)
```



	school_state	project_is_approved	total	Avg
4	CA	13205	15388	0.858136
43	TX	6014	7396	0.813142
34	NY	6291	7318	0.859661
9	FL	5144	6185	0.831690
27	NC	4353	5091	0.855038

==========

	school_state	project_is_approved	total	Avg
39	RI	243	285	0.852632
26	MT	200	245	0.816327
28	ND	127	143	0.888112
50	WY	82	98	0.836735
46	VT	64	80	0.800000

- **California(CA) has the highest number of project approvals of 13205 from 15388.Followed by Texas (TX) and New York (NY)**
- **Vermont(VT) has the least number of the projects approved (64 out of 80) yet we see that 80% of the project approvals from the state.**
- **This attribute alone can't help us find out the approval rate as we can see in the approval rates of Vermont(VT),Wyoming(WY) as every state has aproval rate higher than 80%**

1.2.2 Univariate Analysis: teacher_prefix

In [15]:

```
univariate_barplots(project_data, 'teacher_prefix', 'project_is_approved' , top=False)
```

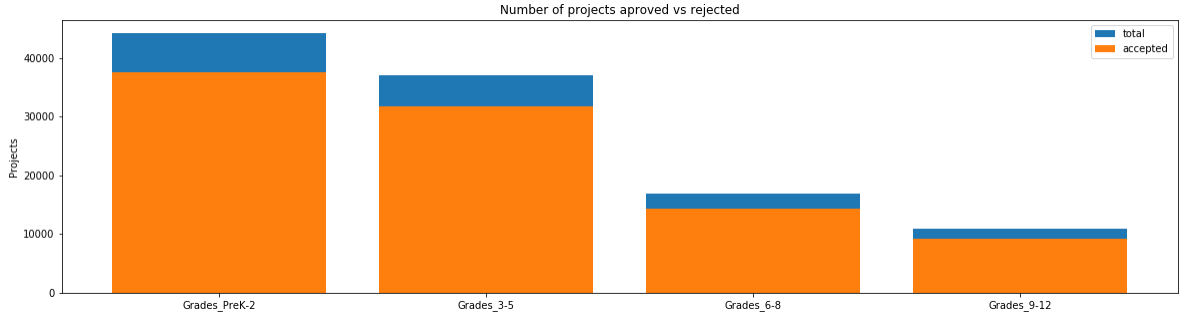

```
  teacher_prefix  project_is_approved  total       Avg
2           Mrs.                48997  57269  0.855559
3            Ms.                32860  38955  0.843537
1            Mr.                 8960  10648  0.841473
4        Teacher                 1877   2360  0.795339
0            Dr.                    9     13  0.692308
==================================================
  teacher_prefix  project_is_approved  total       Avg
2           Mrs.                48997  57269  0.855559
3            Ms.                32860  38955  0.843537
1            Mr.                 8960  10648  0.841473
4        Teacher                 1877   2360  0.795339
0            Dr.                    9     13  0.692308
```

- **The project approval by teacher prefix is the highest with Mrs. ie. 48997 out of 57269 , followed by Ms. and Mr.**
- **This tells that married females and not married females as teachers have approval rate higher than the others**
- **The Doctors (Dr) have just sent 13 projects out for approvals where in 9 were accepted.**

1.2.3 Univariate Analysis: project_grade_category

In [16]:

```
univariate_barplots(project_data, 'project_grade_category', 'project_is_approved', top=Fals
```




```
  project_grade_category  project_is_approved  total       Avg
3          Grades_PreK-2                37536  44225  0.848751
0             Grades_3-5                31729  37137  0.854377
1             Grades_6-8                14258  16923  0.842522
2            Grades_9-12                 9183  10963  0.837636
==================================================
  project_grade_category  project_is_approved  total       Avg
3          Grades_PreK-2                37536  44225  0.848751
0             Grades_3-5                31729  37137  0.854377
1             Grades_6-8                14258  16923  0.842522
2            Grades_9-12                 9183  10963  0.837636
```

- **The project submitted and approved the most were from the grades pre kindergarden to grade 5 with pre-kindergarden to Grade 2 being the highest with 84%**
- **The Grades 9-12 have low values of submissions and approvals of 83.7%**
- **The average accepatance rate in each categories is almost 84%**

1.2.4 Univariate Analysis: project_subject_categories

In [17]:

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

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

In [18]:

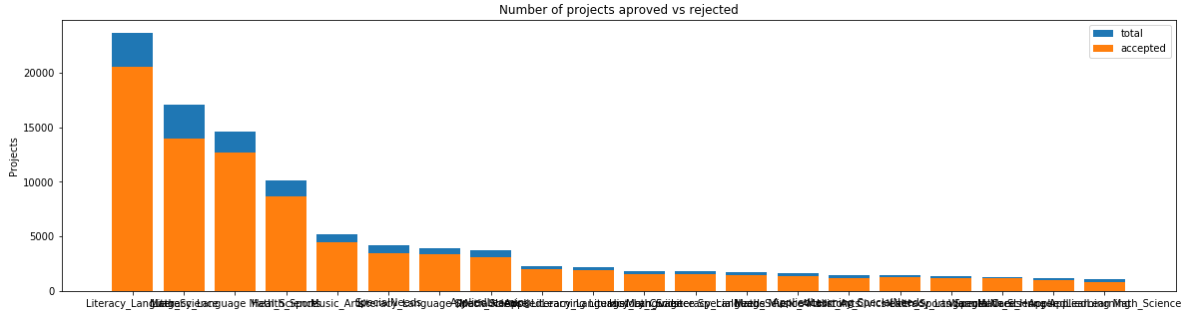
```
project_data['clean_categories'] = cat_list
project_data.drop(['project_subject_categories'], axis=1, inplace=True)
project_data.head(2)
```

Out[18]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	

In [19]:

```
univariate_barplots(project_data, 'clean_categories', 'project_is_approved', top=20)
```




```
                clean_categories  project_is_approved  total       Avg
24              Literacy_Language                20520  23655  0.867470
32                   Math_Science                13991  17072  0.819529
28  Literacy_Language Math_Science                12725  14636  0.869432
8                   Health_Sports                 8640  10177  0.848973
40                     Music_Arts                 4429   5180  0.855019
==================================================
                   clean_categories  project_is_approved  total       Avg
19  History_Civics Literacy_Language                 1271   1421  0.894441
14        Health_Sports SpecialNeeds                 1215   1391  0.873472
50                Warmth Care_Hunger                 1212   1309  0.925898
33      Math_Science AppliedLearning                 1019   1220  0.835246
4       AppliedLearning Math_Science                  855   1052  0.812738
```

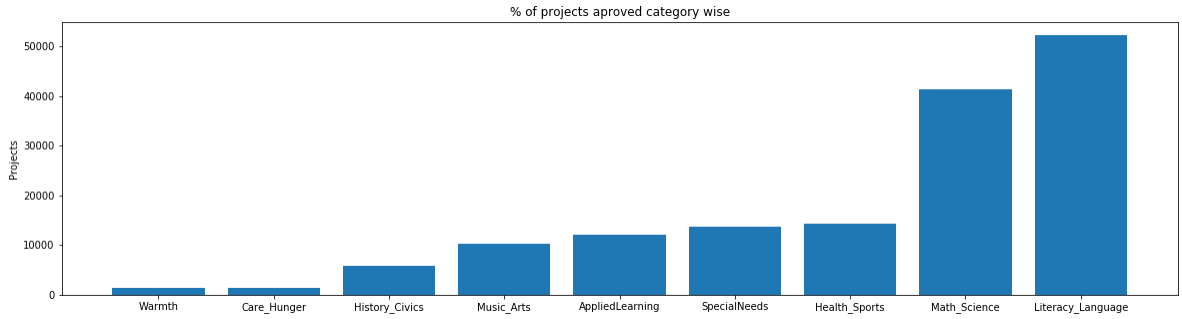
- **The literacy & language has the highest submitted and approved rates of approx. 87% followed by Math & Science.**
- **The Math & Science added with Literacy & language adds the approval rate from 82% to 87% .**
- **The Math & Science added with Applied learning results in the lowest submitted and approvals.**
- **the warmth,Care and Hunger have the highest approval rate of 92.5% from the submitted 1309 approvals.**

In [20]:

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

In [21]:

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


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

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



In [22]:

```
for i, j in sorted_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

```
Warmth               :      1388
Care_Hunger          :      1388
History_Civics       :      5914
Music_Arts           :     10293
AppliedLearning      :     12135
SpecialNeeds         :     13642
Health_Sports        :     14223
Math_Science         :     41421
Literacy_Language    :     52239
```

- **The Literacy & Language has the highest number of projects ie.52239 followed by Math & Science.**
- **the warmth,Care and Hunger have the same number of projects ie.1388**

1.2.5 Univariate Analysis: project_subject_subcategories

In [23]:

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

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

In [24]:

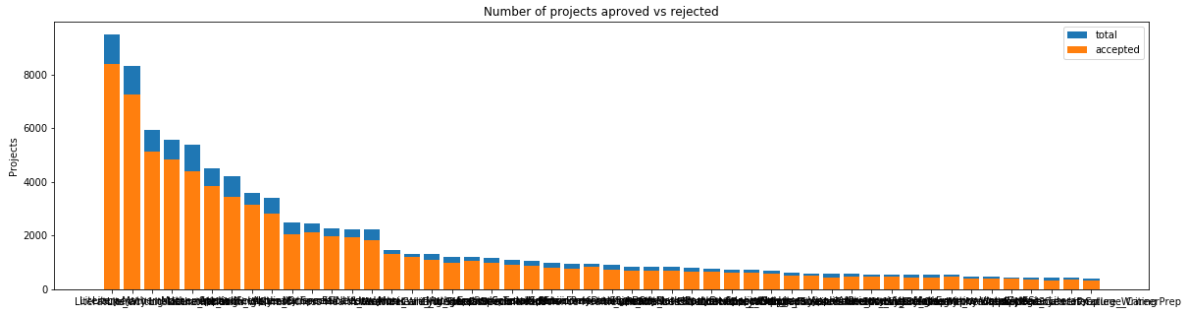
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=True)
project_data.head(2)
```

Out[24]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	

In [25]:

```
univariate_barplots(project_data, 'clean_subcategories', 'project_is_approved', top=50)
```




```
                clean_subcategories  project_is_approved  total       Avg
317                         Literacy                 8371   9486  0.882458
319             Literacy Mathematics                 7260   8325  0.872072
331  Literature_Writing Mathematics                 5140   5923  0.867803
318     Literacy Literature_Writing                 4823   5571  0.865733
342                     Mathematics                 4385   5379  0.815207
==================================================
                    clean_subcategories  project_is_approved  total       Av
g
196       EnvironmentalScience Literacy                  389    444  0.87612
6
127                                ESL                  349    421  0.82897
9
79                  College_CareerPrep                  343    421  0.81472
7
17   AppliedSciences Literature_Writing                  361    420  0.85952
4
3    AppliedSciences College_CareerPrep                  330    405  0.81481
5
```

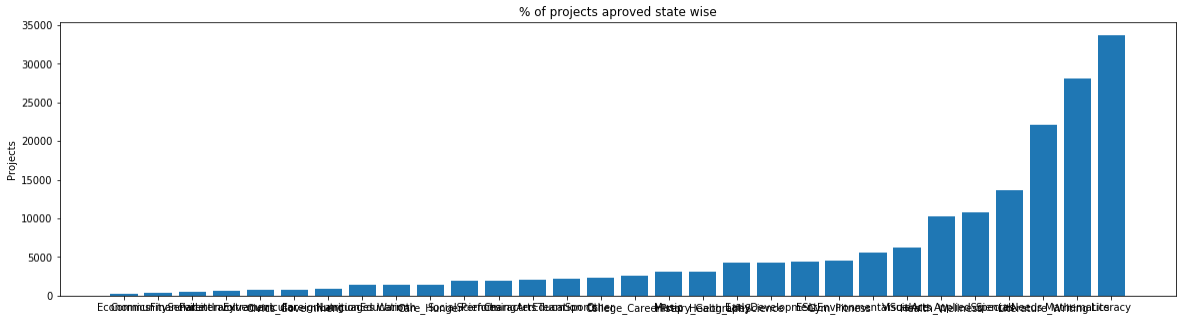
- **The Literacy has the highest number of projects ie.9486 followed by Literacy Mathematics in the sub category section.**
- **The AppliedSciences College_CareerPrep have the least number of projects approved and sunbmitted in the sub category section**

In [26]:

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

In [27]:

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


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

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



In [28]:

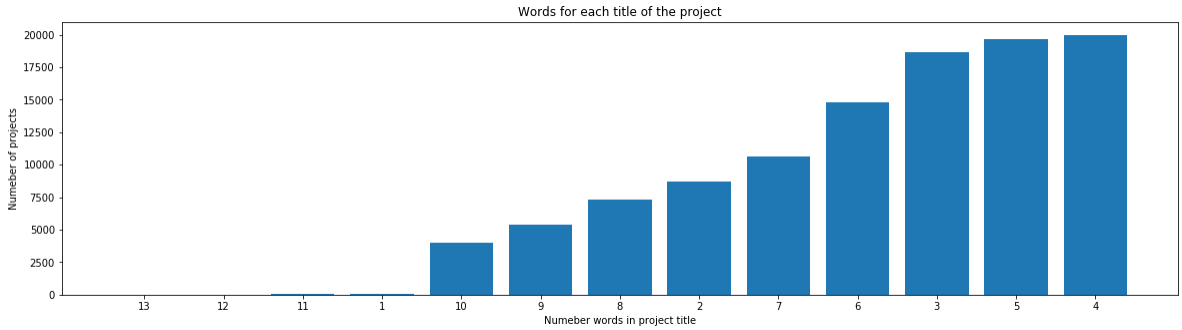
```
for i, j in sorted_sub_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

```
Economics            :       269
CommunityService     :       441
FinancialLiteracy    :       568
ParentInvolvement    :       677
Extracurricular      :       810
Civics_Government    :       815
ForeignLanguages     :       890
NutritionEducation   :      1355
Warmth               :      1388
Care_Hunger          :      1388
SocialSciences       :      1920
PerformingArts       :      1961
CharacterEducation   :      2065
TeamSports           :      2192
Other                :      2372
College_CareerPrep   :      2568
Music                :      3145
History_Geography    :      3171
Health_LifeScience   :      4235
EarlyDevelopment     :      4254
ESL                  :      4367
Gym_Fitness          :      4509
EnvironmentalScience :      5591
VisualArts           :      6278
Health_Wellness      :     10234
AppliedSciences      :     10816
SpecialNeeds         :     13642
Literature_Writing   :     22179
Mathematics          :     28074
Literacy             :     33700
```

1.2.6 Univariate Analysis: Text features (Title)

In [29]:

```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/374
word_count = project_data['project_title'].str.split().apply(len).value_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))


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

plt.ylabel('Numeber of projects')
plt.xlabel('Numeber words in project title')
plt.title('Words for each title of the project')
plt.xticks(ind, list(word_dict.keys()))
plt.show()
```



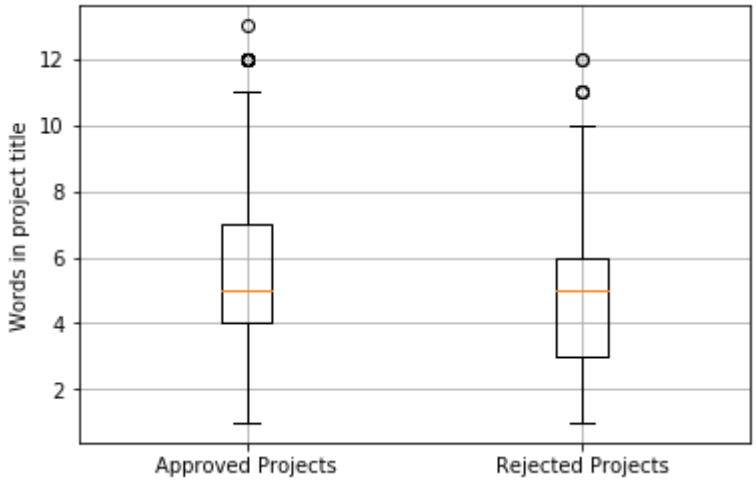
- **Most of the projects have titles with a word count of 4.We see word count greater than 10 are very few in comparision that are almost negligible.**

In [30]:

```
approved_title_word_count = project_data[project_data['project_is_approved']==1]['project_t
approved_title_word_count = approved_title_word_count.values

rejected_title_word_count = project_data[project_data['project_is_approved']==0]['project_t
rejected_title_word_count = rejected_title_word_count.values
```

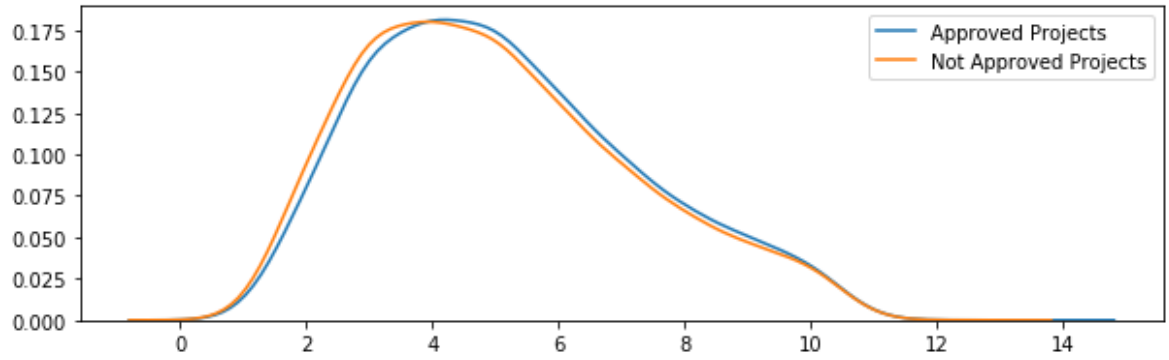
In [31]:

```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_title_word_count, rejected_title_word_count])
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Words in project title')
plt.grid()
plt.show()
```



In [32]:

```
plt.figure(figsize=(10,3))
sns.kdeplot(approved_title_word_count,label="Approved Projects", bw=0.6)
sns.kdeplot(rejected_title_word_count,label="Not Approved Projects", bw=0.6)
plt.legend()
plt.show()
```



The number of Projects approved have a slightly more number of words in the Title when compared to the Rejected Projects.We cannot differentiate much on the basis of word counts.

1.2.7 Univariate Analysis: Text features (Project Essay's)

In [33]:

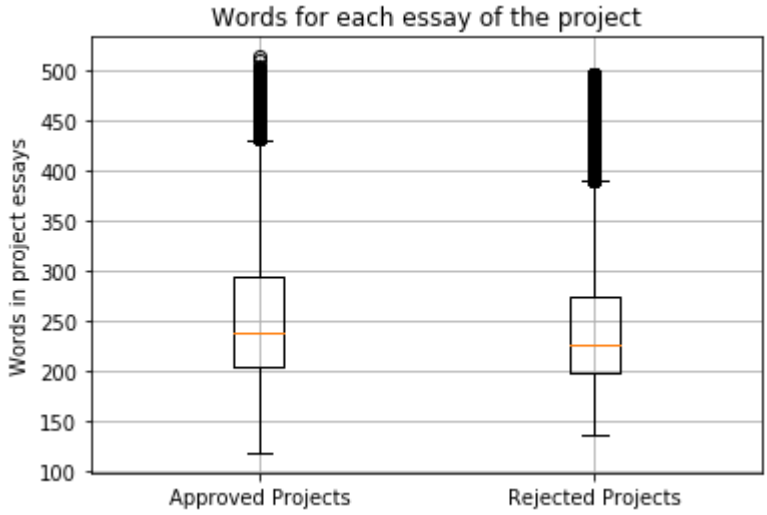
```
# merge two column text dataframe:
project_data["essay"] = project_data["project_essay_1"].map(str) +\
                        project_data["project_essay_2"].map(str) + \
                        project_data["project_essay_3"].map(str) + \
                        project_data["project_essay_4"].map(str)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

In [34]:

```
approved_word_count = project_data[project_data['project_is_approved']==1]['essay'].str.spl
approved_word_count = approved_word_count.values

rejected_word_count = project_data[project_data['project_is_approved']==0]['essay'].str.spl
rejected_word_count = rejected_word_count.values
```

In [35]:

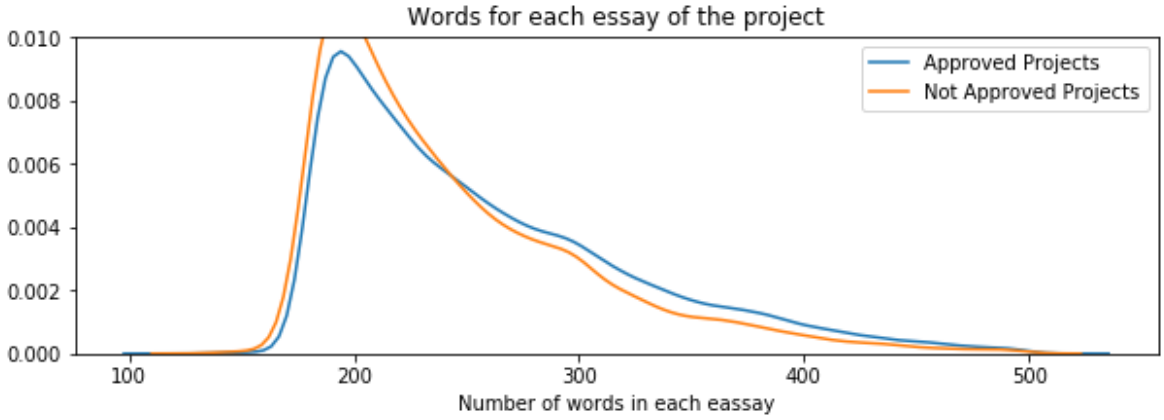
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_word_count, rejected_word_count])
plt.title('Words for each essay of the project')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Words in project essays')
plt.grid()
plt.show()
```



Approved projects have more number of words in the essays when compared to the projects that have not been approved.

In [36]:

```
plt.figure(figsize=(10,3))
sns.distplot(approved_word_count, hist=False, label="Approved Projects")
sns.distplot(rejected_word_count, hist=False, label="Not Approved Projects")
plt.title('Words for each essay of the project')
plt.xlabel('Number of words in each eassay')
plt.legend()
plt.show()
```



The number of words in the Essays of Approved Projects are slightly more than the number of words in the Essays of the Rejected Projects. This can be found by looking at the Blue Line (PDF) which is denser for words more than 240 to almost 480.

1.2.8 Univariate Analysis: Cost per project

In [37]:

```
# we get the cost of the project using resource.csv file
resource_data.head(2)
```

Out[37]:

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

In [38]:

```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframes-indexes-for-all-gr
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index
price_data.head(2)
```

Out[38]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

In [39]:

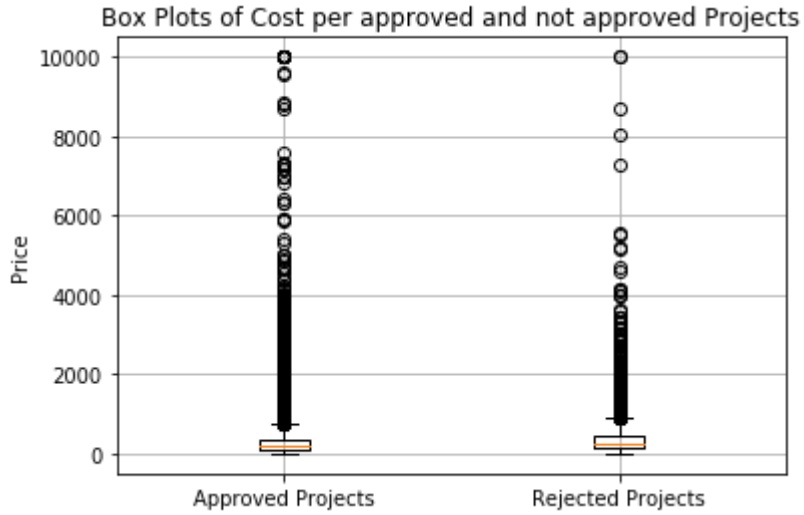
```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [40]:

```
approved_price = project_data[project_data['project_is_approved']==1]['price'].values

rejected_price = project_data[project_data['project_is_approved']==0]['price'].values
```

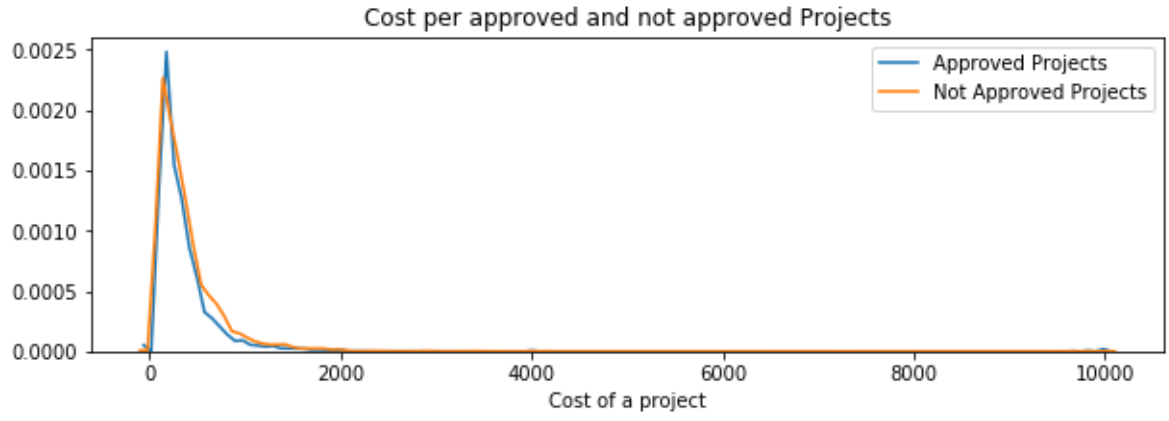
In [41]:

```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_price, rejected_price])
plt.title('Box Plots of Cost per approved and not approved Projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Price')
plt.grid()
plt.show()
```



In [42]:

```
plt.figure(figsize=(10,3))
sns.distplot(approved_price, hist=False, label="Approved Projects")
sns.distplot(rejected_price, hist=False, label="Not Approved Projects")
plt.title('Cost per approved and not approved Projects')
plt.xlabel('Cost of a project')
plt.legend()
plt.show()
```



The Approved and Not Aprroved Projects(PDF) almost overlap each other giving no idea.But Projects with high cost are not approved as per the graph.

In [43]:

```
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

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

x = PrettyTable()
x.field_names = ["Percentile", "Approved Projects", "Not Approved Projects"]

for i in range(0,101,5):
    x.add_row([i,np.round(np.percentile(approved_price,i), 3), np.round(np.percentile(rejec
print(x)
```

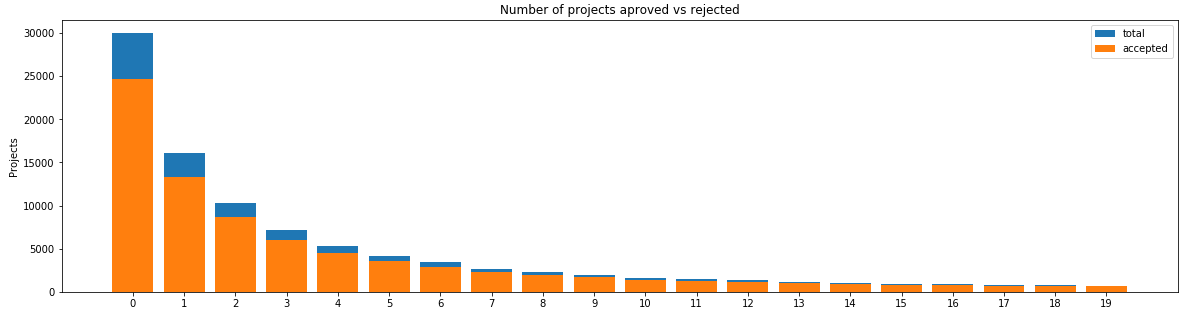
```
+------------+------------------+----------------------+
| Percentile | Approved Projects | Not Approved Projects |
+------------+------------------+----------------------+
|     0      |        0.66       |          1.97        |
|     5      |       13.59       |          41.9        |
|     10     |       33.88       |         73.67        |
|     15     |        58.0       |         99.109       |
|     20     |       77.38       |         118.56       |
|     25     |       99.95       |        140.892       |
|     30     |       116.68      |         162.23       |
|     35     |      137.232      |        184.014       |
|     40     |       157.0       |        208.632       |
|     45     |      178.265      |        235.106       |
|     50     |       198.99      |        263.145       |
|     55     |       223.99      |         292.61       |
|     60     |       255.63      |        325.144       |
|     65     |      285.412      |         362.39       |
|     70     |      321.225      |         399.99       |
|     75     |      366.075      |        449.945       |
|     80     |       411.67      |        519.282       |
|     85     |       479.0       |        618.276       |
|     90     |       593.11      |        739.356       |
|     95     |      801.598      |        992.486       |
|    100     |       9999.0      |         9999.0       |
+------------+------------------+----------------------+
```

- **Most of the Approved projects are quite less in price compared with non approved projects. The non appproved projects at 50th percentile is 263dollars whereas it is 198dollars for Approved Projects.**
- **Even at 25th percentile we can see 99dollars approved projects where for not Approved Projects it is 140 dollars.**

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

In [44]:

```
univariate_barplots(project_data, 'teacher_number_of_previously_posted_projects',
'project_is_approved', top=20)
```




```
   teacher_number_of_previously_posted_projects  project_is_approved  total
\
0                                             0                24652  30014
1                                             1                13329  16058
2                                             2                 8705  10350
3                                             3                 5997   7110
4                                             4                 4452   5266

        Avg
0  0.821350
1  0.830054
2  0.841063
3  0.843460
4  0.845423
==================================================
    teacher_number_of_previously_posted_projects  project_is_approved  total
\
15                                            15                 818    942
16                                            16                 769    894
17                                            17                 712    803
18                                            18                 666    772
19                                            19                 632    710

         Avg
15  0.868365
16  0.860179
17  0.886675
18  0.862694
19  0.890141
```

- **Around 82% are teachers who haven't posted any projects previously.Also they are the most submitted and selected for approvals.**
- **There are teachers who have posted more than once with each having approval rate of greater than 80%**

1.2.10 Univariate Analysis: project_resource_summary

In [45]:

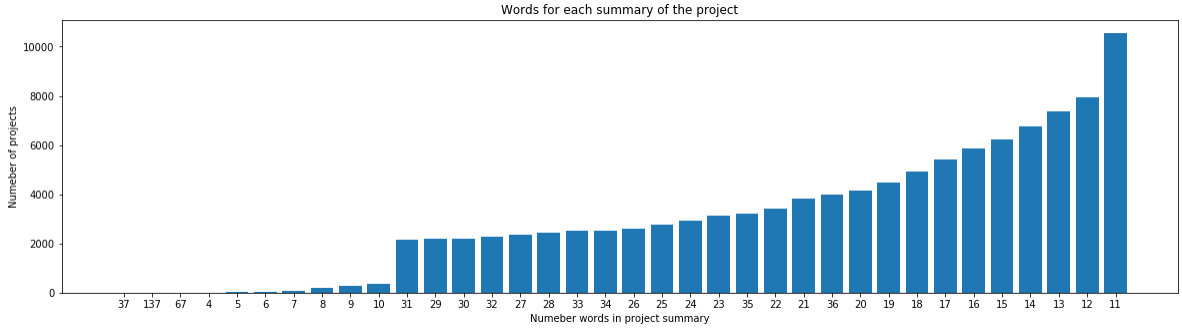
```
res_summary = []
for a in project_data["project_resource_summary"] :
    res_summary.append(a)

res_summary[0:10]
```

Out[45]:

```
['My students need opportunities to practice beginning reading skills in Eng
lish at home.',
 'My students need a projector to help with viewing educational programs',
 'My students need shine guards, athletic socks, Soccer Balls, goalie glove
s, and training materials for the upcoming Soccer season.',
 'My students need to engage in Reading and Math in a way that will inspire
them with these Mini iPads!',
 'My students need hands on practice in mathematics. Having fun and personal
ized journals and charts will help them be more involved in our daily Math r
outines.',
 'My students need movement to be successful. Being that I have a variety of
students that have all different types of needs, flexible seating would assi
st not only these students with special needs, but all students.',
 'My students need some dependable laptops for daily classroom use for readi
ng and math.',
 'My students need ipads to help them access a world of online resources tha
t will spark their interest in learning.',
 "My students need three devices and three management licenses for small gro
up's easy access to newly-implemented online programs--Go Noodle Plus, for i
ncreased in-class physical activity and Light Sail, an interactive reading p
rogram.",
 'My students need great books to use during Independent Reading, Read Aloud
s, Partner Reading and Author Studies.']
```

In [46]:

```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/374
word_count = project_data['project_resource_summary'].str.split().apply(len).value_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))


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

plt.ylabel('Numeber of projects')
plt.xlabel('Numeber words in project summary')
plt.title('Words for each summary of the project')
plt.xticks(ind, list(word_dict.keys()))
plt.show()
```



Summary

- **We see summaries with less words have the highest number of projects. this states that information reached is used far too less which can mislead in various ways resulting in non approval**
- **A situation wherein word count from 30 to 37 cannot be justified as they have high variablity in number of projects**
- **Even high as 137 words and low as one digit word count can be has number of projects under 2000 which can be confusing**

In [47]:

```
## Identifying the numbers from the project summaries and storing the values as a key value
## avoid missing the position of the value within the huge ocean of summary data.

numeric_summary_values = {}

for x in tqdm(range(len(res_summary))):
    for s in res_summary[x].split():
        if s.isdigit() :
            numeric_summary_values[x] = int(s)
```

```
100%|██████████████████████████████████████████████████████████████████████████████|
109248/109248 [00:00<00:00, 137612.49it/s]
```

In [48]:

```
## We only have the key value pairs for Summaries containing Numeric values, so in this ste

numeric_digits = {}

for c in range(len(res_summary)) :
    if c in numeric_summary_values.keys() :
        numeric_digits[c] = numeric_summary_values[c]
    else :
        numeric_digits[c] = 0
```

In [49]:

```
for i in range (20) :
    print(numeric_digits[i])
```

```
0
0
0
0
0
0
0
0
0
0
0
0
0
0
0
5
0
2
0
0
7
```

In [50]:

```
## Converting the key value pairs to 1 or 0 based on presence of Numeric Values.

digit_in_summary = []

for a in numeric_digits.values() :
    if a > 0 :
        digit_in_summary.append(1)
    else :
        digit_in_summary.append(0)
```

In [51]:

```
digit_in_summary[0:20]
```

Out[51]:

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 1]
```

In [52]:

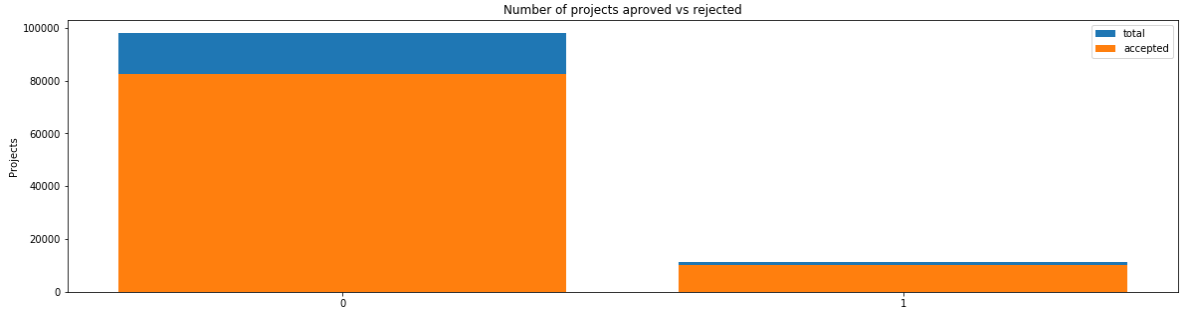
```
project_data['digit_in_summary'] = digit_in_summary

project_data.head(20)
```

Out[52]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ	2016-08-31

In [53]:

```
univariate_barplots(project_data, 'digit_in_summary', 'project_is_approved', top=2)
```




```
   digit_in_summary  project_is_approved  total       Avg
0                 0                82563  98012  0.842376
1                 1                10143  11236  0.902723
==================================================
   digit_in_summary  project_is_approved  total       Avg
0                 0                82563  98012  0.842376
1                 1                10143  11236  0.902723
```

- **The summaries with numeric values performed well as they show the insight to the project by valuation and neccesity**
- **90% of the approvals have been made with summaries having numeric values.**
- **The ones with digits in summary= 0 states its not neccesary to be stated in numeric values , valuation can also be made in words**

1.3 Text preprocessing

1.3.1 Essay Text

In [54]:

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

Out[54]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	

2 rows × 21 columns

In [55]:

```
# printing some random essays.
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)
```

```
My students are English learners that are working on English as their second
or third languages. We are a melting pot of refugees, immigrants, and native
-born Americans bringing the gift of language to our school. \r\n\r\n We hav
e over 24 languages represented in our English Learner program with students
at every level of mastery.  We also have over 40 countries represented with
the families within our school.  Each student brings a wealth of knowledge a
nd experiences to us that open our eyes to new cultures, beliefs, and respec
t.\"The limits of your language are the limits of your world.\"-Ludwig Wittg
enstein  Our English learner's have a strong support system at home that beg
s for more resources.  Many times our parents are learning to read and speak
English along side of their children.  Sometimes this creates barriers for p
arents to be able to help their child learn phonetics, letter recognition, a
nd other reading skills.\r\n\r\nBy providing these dvd's and players, studen
ts are able to continue their mastery of the English language even if no one
at home is able to assist.  All families with students within the Level 1 pr
oficiency status, will be a offered to be a part of this program.  These edu
cational videos will be specially chosen by the English Learner Teacher and
will be sent home regularly to watch.  The videos are to help the child deve
lop early reading skills.\r\n\r\nParents that do not have access to a dvd pl
ayer will have the opportunity to check out a dvd player to use for the yea
r.  The plan is to use these videos and educational dvd's for the years to c
ome for other EL students.\r\nnannan
==================================================
The 51 fifth grade students that will cycle through my classroom this year a
ll love learning, at least most of the time. At our school, 97.3% of the stu
dents receive free or reduced price lunch. Of the 560 students, 97.3% are mi
nority students. \r\nThe school has a vibrant community that loves to get to
gether and celebrate. Around Halloween there is a whole school parade to sho
w off the beautiful costumes that students wear. On Cinco de Mayo we put on
a big festival with crafts made by the students, dances, and games. At the e
nd of the year the school hosts a carnival to celebrate the hard work put in
during the school year, with a dunk tank being the most popular activity.My
students will use these five brightly colored Hokki stools in place of regul
ar, stationary, 4-legged chairs. As I will only have a total of ten in the c
lassroom and not enough for each student to have an individual one, they wil
l be used in a variety of ways. During independent reading time they will be
used as special chairs students will each use on occasion. I will utilize th
em in place of chairs at my small group tables during math and reading time
s. The rest of the day they will be used by the students who need the highes
t amount of movement in their life in order to stay focused on school.\r\n\r
\nWhenever asked what the classroom is missing, my students always say more
Hokki Stools. They can't get their fill of the 5 stools we already have. Whe
n the students are sitting in group with me on the Hokki Stools, they are al
ways moving, but at the same time doing their work. Anytime the students get
to pick where they can sit, the Hokki Stools are the first to be taken. Ther
e are always students who head over to the kidney table to get one of the st
```

ools who are disappointed as there are not enough of them. \r\n\r\nWe ask a lot of students to sit for 7 hours a day. The Hokki stools will be a compromise that allow my students to do desk work and move at the same time. These stools will help students to meet their 60 minutes a day of movement by allowing them to activate their core muscles for balance while they sit. For many of my students, these chairs will take away the barrier that exists in schools for a child who can't sit still.nannan

==========

How do you remember your days of school? Was it in a sterile environment with plain walls, rows of desks, and a teacher in front of the room? A typical day in our room is nothing like that. I work hard to create a warm inviting themed room for my students look forward to coming to each day.\r\n\r\nMy class is made up of 28 wonderfully unique boys and girls of mixed races in Arkansas.\r\nThey attend a Title I school, which means there is a high enough percentage of free and reduced-price lunch to qualify. Our school is an \"open classroom\" concept, which is very unique as there are no walls separating the classrooms. These 9 and 10 year-old students are very eager learners; they are like sponges, absorbing all the information and experiences and keep on wanting more.With these resources such as the comfy red throw pillows and the whimsical nautical hanging decor and the blue fish nets, I will be able to help create the mood in our classroom setting to be one of a themed nautical environment. Creating a classroom environment is very important in the success in each and every child's education. The nautical photo props will be used with each child as they step foot into our classroom for the first time on Meet the Teacher evening. I'll take pictures of each child with them, have them developed, and then hung in our classroom ready for their first day of 4th grade. This kind gesture will set the tone before even the first day of school! The nautical thank you cards will be used throughout the year by the students as they create thank you cards to their team groups.\r\n\r\nYour generous donations will help me to help make our classroom a fun, inviting, learning environment from day one.\r\n\r\nIt costs lost of money out of my own pocket on resources to get our classroom ready. Please consider helping with this project to make our new school year a very successful one. Thank you!nannan

==========

My kindergarten students have varied disabilities ranging from speech and language delays, cognitive delays, gross/fine motor delays, to autism. They are eager beavers and always strive to work their hardest working past their limitations. \r\n\r\nThe materials we have are the ones I seek out for my students. I teach in a Title I school where most of the students receive free or reduced price lunch. Despite their disabilities and limitations, my students love coming to school and come eager to learn and explore.Have you ever felt like you had ants in your pants and you needed to groove and move as you were in a meeting? This is how my kids feel all the time. The want to be able to move as they learn or so they say.Wobble chairs are the answer and I love then because they develop their core, which enhances gross motor and in Turn fine motor skills. \r\nThey also want to learn through games, my kids don't want to sit and do worksheets. They want to learn to count by jumping and playing. Physical engagement is the key to our success. The number toss and color and shape mats can make that happen. My students will forget they are doing work and just have the fun a 6 year old deserves.nannan

==========

The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires. -William A. Ward\r\n\r\nMy school has 803 students which is makeup is 97.6% African-American, making up the largest segment of the student body. A typical school in Dallas is made up of 23.2% African-American students. Most of the students are on free or reduced lunch. We aren't receiving doctors, lawyers, or engineers children from rich backgrounds or neighborhoods. As an educator I am inspiring minds of young children and we focus not only on academics but one smart, effective, efficient, and disciplined students with good character.In our classroom we can uti

```
lize the Bluetooth for swift transitions during class. I use a speaker which
doesn't amplify the sound enough to receive the message. Due to the volume o
f my speaker my students can't hear videos or books clearly and it isn't mak
ing the lessons as meaningful. But with the bluetooth speaker my students wi
ll be able to hear and I can stop, pause and replay it at any time.\r\nThe c
art will allow me to have more room for storage of things that are needed fo
r the day and has an extra part to it I can use.  The table top chart has al
l of the letter, words and pictures for students to learn about different le
tters and it is more accessible.nannan
==================================================
```

In [56]:

```
# 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 [57]:

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

```
My kindergarten students have varied disabilities ranging from speech and la
nguage delays, cognitive delays, gross/fine motor delays, to autism. They ar
e eager beavers and always strive to work their hardest working past their l
imitations. \r\n\r\nThe materials we have are the ones I seek out for my stu
dents. I teach in a Title I school where most of the students receive free o
r reduced price lunch.  Despite their disabilities and limitations, my stude
nts love coming to school and come eager to learn and explore.Have you ever
felt like you had ants in your pants and you needed to groove and move as yo
u were in a meeting? This is how my kids feel all the time. The want to be a
ble to move as they learn or so they say.Wobble chairs are the answer and I
love then because they develop their core, which enhances gross motor and in
Turn fine motor skills. \r\nThey also want to learn through games, my kids d
o not want to sit and do worksheets. They want to learn to count by jumping
and playing. Physical engagement is the key to our success. The number toss
and color and shape mats can make that happen. My students will forget they
are doing work and just have the fun a 6 year old deserves.nannan
==================================================
```

In [58]:

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

```
My kindergarten students have varied disabilities ranging from speech and la
nguage delays, cognitive delays, gross/fine motor delays, to autism. They ar
e eager beavers and always strive to work their hardest working past their l
imitations.     The materials we have are the ones I seek out for my student
s. I teach in a Title I school where most of the students receive free or re
duced price lunch.  Despite their disabilities and limitations, my students
love coming to school and come eager to learn and explore.Have you ever felt
like you had ants in your pants and you needed to groove and move as you wer
e in a meeting? This is how my kids feel all the time. The want to be able t
o move as they learn or so they say.Wobble chairs are the answer and I love
then because they develop their core, which enhances gross motor and in Turn
fine motor skills.   They also want to learn through games, my kids do not w
ant to sit and do worksheets. They want to learn to count by jumping and pla
ying. Physical engagement is the key to our success. The number toss and col
or and shape mats can make that happen. My students will forget they are doi
ng work and just have the fun a 6 year old deserves.nannan
```

In [59]:

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

```
My kindergarten students have varied disabilities ranging from speech and la
nguage delays cognitive delays gross fine motor delays to autism They are ea
ger beavers and always strive to work their hardest working past their limit
ations The materials we have are the ones I seek out for my students I teach
in a Title I school where most of the students receive free or reduced price
lunch Despite their disabilities and limitations my students love coming to
school and come eager to learn and explore Have you ever felt like you had a
nts in your pants and you needed to groove and move as you were in a meeting
This is how my kids feel all the time The want to be able to move as they le
arn or so they say Wobble chairs are the answer and I love then because they
develop their core which enhances gross motor and in Turn fine motor skills
They also want to learn through games my kids do not want to sit and do work
sheets They want to learn to count by jumping and playing Physical engagemen
t is the key to our success The number toss and color and shape mats can mak
e that happen My students will forget they are doing work and just have the
fun a 6 year old deserves nannan
```

In [60]:

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

In [61]:

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

```
100%|████████████████████████████████████████████████████████████
██| 109248/109248 [01:53<00:00, 959.54it/s]
```

In [62]:

```
# after preprocesing
preprocessed_essays[20000]
```

Out[62]:

```
'my kindergarten students varied disabilities ranging speech language delays
cognitive delays gross fine motor delays autism they eager beavers always st
rive work hardest working past limitations the materials ones i seek student
s i teach title i school students receive free reduced price lunch despite d
isabilities limitations students love coming school come eager learn explore
have ever felt like ants pants needed groove move meeting this kids feel tim
e the want able move learn say wobble chairs answer i love develop core enha
nces gross motor turn fine motor skills they also want learn games kids not
want sit worksheets they want learn count jumping playing physical engagemen
t key success the number toss color shape mats make happen my students forge
t work fun 6 year old deserves nannan'
```

1.3.2 Project title Text

In [63]:

```
# similarly you can preprocess the titles also
project_data.head(2)
```

Out[63]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	

2 rows × 21 columns

In [64]:

```
print(project_data['project_title'].values[0])
print("="*50)
print(project_data['project_title'].values[150])
print("="*50)
print(project_data['project_title'].values[1000])
print("="*50)
print(project_data['project_title'].values[20000])
print("="*50)
print(project_data['project_title'].values[99999])
print("="*50)
```

```
Educational Support for English Learners at Home
==================================================
More Movement with Hokki Stools
==================================================
Sailing Into a Super 4th Grade Year
==================================================
We Need To Move It While We Input It!
==================================================
Inspiring Minds by Enhancing the Educational Experience
==================================================
```

In [65]:

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

```
100%|██████████████████████████████████████████████████████████████████████████████
| 109248/109248 [00:05<00:00, 20792.94it/s]
```

In [66]:

```
preprocessed_titles[1000]
```

Out[66]:

```
'sailing into super 4th grade year'
```

1. 4 Preparing data for models

In [67]:

```
project_data.columns
```

Out[67]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_title', 'project_essay_1',
       'project_essay_2', 'project_essay_3', 'project_essay_4',
       'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approve
d',
       'project_grade_category', 'clean_categories', 'clean_subcategories',
       'essay', 'price', 'quantity', 'digit_in_summary'],
      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

       - quantity : numerical
       - teacher_number_of_previously_posted_projects : numerical
       - price : numerical
```

1.4.1 Vectorizing Categorical data

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

In [68]:

```
# we use count vectorizer to convert the values into one hot encoded features
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False, bina
vectorizer.fit(project_data['clean_categories'].values)
print(vectorizer.get_feature_names())


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

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning',
'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Literacy_Language']
Shape of matrix after one hot encodig  (109248, 9)
```

In [69]:

```
# we use count vectorizer to convert the values into one hot encoded features
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=False,
vectorizer.fit(project_data['clean_subcategories'].values)
print(vectorizer.get_feature_names())


sub_categories_one_hot = vectorizer.transform(project_data['clean_subcategories'].values)
print("Shape of matrix after one hot encodig ",sub_categories_one_hot.shape)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement',
'Extracurricular', 'Civics_Government', 'ForeignLanguages', 'NutritionEducat
ion', 'Warmth', 'Care_Hunger', 'SocialSciences', 'PerformingArts', 'Characte
rEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Music', 'History_
Geography', 'Health_LifeScience', 'EarlyDevelopment', 'ESL', 'Gym_Fitness',
'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'AppliedSciences',
'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy']
Shape of matrix after one hot encodig  (109248, 30)
```

In [70]:

```
# Please do the similar feature encoding with state, teacher_prefix and project_grade_categ
#one hot encode for state
my_counter = Counter()
for state in project_data['school_state'].values:
    my_counter.update(state.split())
```

In [71]:

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

In [72]:

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

vectorizer = CountVectorizer(vocabulary=list(sorted_school_state_cat_dict.keys()), lowercas
vectorizer.fit(project_data['school_state'].values)
print(vectorizer.get_feature_names())

school_state_categories_one_hot = vectorizer.transform(project_data['school_state'].values)
print("Shape of matrix after one hot encoding ",school_state_categories_one_hot.shape)
```

```
['VT', 'WY', 'ND', 'MT', 'RI', 'SD', 'NE', 'DE', 'AK', 'NH', 'WV', 'ME', 'H
I', 'DC', 'NM', 'KS', 'IA', 'ID', 'AR', 'CO', 'MN', 'OR', 'KY', 'MS', 'NV',
'MD', 'CT', 'TN', 'UT', 'AL', 'WI', 'VA', 'AZ', 'NJ', 'OK', 'WA', 'MA', 'L
A', 'OH', 'MO', 'IN', 'PA', 'MI', 'SC', 'GA', 'IL', 'NC', 'FL', 'NY', 'TX',
'CA']
Shape of matrix after one hot encoding  (109248, 51)
```

In [73]:

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

In [74]:

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

In [75]:

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

vectorizer = CountVectorizer(vocabulary=list(sorted_project_grade_cat_dict.keys()), lowerca
vectorizer.fit(project_data['project_grade_category'].values)
print(vectorizer.get_feature_names())

project_grade_cat_one_hot = vectorizer.transform(project_data['project_grade_category'].val
print("Shape of matrix after one hot encoding ",project_grade_cat_one_hot.shape)
```

```
['Grades_9-12', 'Grades_6-8', 'Grades_3-5', 'Grades_PreK-2']
Shape of matrix after one hot encoding  (109248, 4)
```

In [76]:

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

In [77]:

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

In [78]:

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

vectorizer = CountVectorizer(vocabulary=list(sorted_teacher_prefix_cat_dict.keys()), lowerc
vectorizer.fit(project_data['teacher_prefix'].values.astype("U"))
print(vectorizer.get_feature_names())

teacher_prefix_cat_dict_one_hot = vectorizer.transform(project_data['teacher_prefix'].value
print("Shape of matrix after one hot encoding ",teacher_prefix_cat_dict_one_hot.shape)
```

```
['nan', 'Dr.', 'Teacher', 'Mr.', 'Ms.', 'Mrs.']
Shape of matrix after one hot encoding  (109248, 6)
```

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

In [79]:

```
# We are considering only the words which appeared in at least 10 documents(rows or project
vectorizer = CountVectorizer(min_df=10)
text_bow = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after one hot encoding ",text_bow.shape)
```

```
Shape of matrix after one hot encoding  (109248, 16623)
```

There are 16623 unique text in 109248 number of Essays, considering only these words appered in 10 projects.

1.4.2.2 Bag of Words on `project_title`

In [80]:

```
# you can vectorize the title also
# before you vectorize the title make sure you preprocess it
vectorizer = CountVectorizer(min_df=10)
title_bow = vectorizer.fit_transform(preprocessed_titles)
print("Shape of matrix after one hot encoding ",title_bow.shape)
```

```
Shape of matrix after one hot encoding  (109248, 3329)
```

There are 3329 unique text among the 109248 number of titles,considering 10 projects have the same words.

1.4.2.3 TFIDF vectorizer

In [81]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
vectorizer = TfidfVectorizer(min_df=10)
text_tfidf = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after one hot encodig ",text_tfidf.shape)
```

```
Shape of matrix after one hot encodig  (109248, 16623)
```

1.4.2.4 TFIDF Vectorizer on project_title

In [82]:

```
# Similarly you can vectorize for title also
from sklearn.feature_extraction.text import TfidfVectorizer
vectorizer = TfidfVectorizer(min_df=10)
title_tfidf = vectorizer.fit_transform(preprocessed_titles)
print("Shape of matrix after one hot encodig ",title_tfidf.shape)
```

```
Shape of matrix after one hot encodig  (109248, 3329)
```

1.4.2.5 Using Pretrained Models: Avg W2V

In [83]:

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

In [84]:

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

```
Loading Glove Model

1333129it [07:18, 3038.84it/s]

Done. 1333129  words loaded!
```

In [86]:

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

for i in preprocessed_titles:
    words.extend(i.split(' '))
```

In [87]:

```
print("all the words in the coupus", len(words))
```

```
all the words in the coupus 17014413
```

In [88]:

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

```
the unique words in the coupus 58968
```

In [89]:

```
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),"%)")
```

```
The number of words that are present in both glove vectors and our coupus 50
544 ( 85.714 %)
```

In [90]:

```
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))
```

```
word 2 vec length 50544
```

In [91]:

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

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

In [92]:

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

In [93]:

```
# average Word2Vec
# compute average word2vec for each review.
avg_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_essays): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors.append(vector)

print(len(avg_w2v_vectors))
print(len(avg_w2v_vectors[0]))
```

```
100%|████████████████████████████████████████████████████████████████
██| 109248/109248 [03:46<00:00, 481.76it/s]

109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on `project_title`

In [94]:

```
# Similarly you can vectorize for title also

avg_w2v_titles_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_titles): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_titles_vectors.append(vector)

print(len(avg_w2v_titles_vectors))
print(len(avg_w2v_titles_vectors[0]))
```

```
100%|████████████████████████████████████████████████████████████████
█| 109248/109248 [00:22<00:00, 4838.25it/s]

109248
300
```

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

In [95]:

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

In [96]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_essays): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettir
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors.append(vector)

print(len(tfidf_w2v_vectors))
print(len(tfidf_w2v_vectors[0]))
```

```
100%|████████████████████████████████████████████████████████████████
██| 109248/109248 [07:32<00:00, 241.58it/s]

109248
300
```

1.4.2.9 Using Pretrained Models: TFIDF weighted W2V on `project_title`

In [97]:

```
# Similarly you can vectorize for title also

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

In [98]:

```
# average Word2Vec
# compute average word2vec for each Project Title
tfidf_w2v_title_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_titles): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentenc
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # gettin
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_title_vectors.append(vector)

print(len(tfidf_w2v_title_vectors))
print(len(tfidf_w2v_title_vectors[0]))
```

```
100%|██████████████████████████████████████████████████████████████
| 109248/109248 [00:16<00:00, 6593.33it/s]

109248
300
```

1.4.3 Vectorizing Numerical features : Price

In [99]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.prepro
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.
# Reshape your data either using array.reshape(-1, 1)

price_scalar = StandardScaler()
price_scalar.fit(project_data['price'].values.reshape(-1,1)) # finding the mean and standar
print(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_scalar.var_[0])

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

```
Mean : 298.1193425966608, Standard deviation : 367.49634838483496
```

In [100]:

```
price_standardized
```

Out[100]:

```
array([[-0.3905327 ],
       [ 0.00239637],
       [ 0.59519138],
       ...,
       [-0.15825829],
       [-0.61243967],
       [-0.51216657]])
```

1.4.3 Vectorizing Numerical features : Quantity

In [101]:

```
quantity_scalar = StandardScaler()
quantity_scalar.fit(project_data['quantity'].values.reshape(-1,1)) # finding the mean and s
print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation : {np.sqrt(quantity_scalar.va

# Now standardize the data with above maen and variance.
quantity_standardized = quantity_scalar.transform(project_data['quantity'].values.reshape(-
```

```
Mean : 16.965610354422964, Standard deviation : 26.182821919093175
```

In [102]:

```
quantity_standardized
```

Out[102]:

```
array([[ 0.23047132],
       [-0.60977424],
       [ 0.19227834],
       ...,
       [-0.4951953 ],
       [-0.03687954],
       [-0.45700232]])
```

1.4.3 Vectorizing Numerical features : Number of Teachers who Previously Posted Projects

In [103]:

```
prev_projects_scalar = StandardScaler()
prev_projects_scalar.fit(project_data['teacher_number_of_previously_posted_projects'].value
print(f"Mean : {prev_projects_scalar.mean_[0]}, Standard deviation : {np.sqrt(prev_projects

# Now standardize the data with above maen and variance.
prev_projects_standardized = prev_projects_scalar.transform(project_data['teacher_number_of
```

```
Mean : 11.153165275336848, Standard deviation : 27.77702641477403
```

In [104]:

```
prev_projects_standardized
```

Out[104]:

```
array([[-0.40152481],
       [-0.14951799],
       [-0.36552384],
       ...,
       [-0.29352189],
       [-0.40152481],
       [-0.40152481]])
```

1.4.4 Merging all the above features

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

In [105]:

```
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(text_bow.shape)
print(price_standardized.shape)
```

```
(109248, 9)
(109248, 30)
(109248, 16623)
(109248, 1)
```

In [106]:

```
# 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 :)
X = hstack((categories_one_hot, sub_categories_one_hot, text_bow, price_standardized))
X.shape
```

Out[106]:

```
(109248, 16663)
```

Assignment 2: Apply TSNE

If you are using any code snippet from the internet, you have to provide the reference/citations, as we did in the above cells. Otherwise, it will be treated as plagiarism without citations.

1. In the above cells we have plotted and analyzed many features. Please observe the plots and write the observations in markdown cells below every plot.
2. EDA: Please complete the analysis of the feature: teacher_number_of_previously_posted_projects
3. Build the data matrix using these features
   - school_state : categorical data (one hot encoding)
   - clean_categories : categorical data (one hot encoding)
   - clean_subcategories : categorical data (one hot encoding)
   - teacher_prefix : categorical data (one hot encoding)

- project_grade_category : categorical data (one hot encoding)
- project_title : text data (BOW, TFIDF, AVG W2V, TFIDF W2V)
- price : numerical
- teacher_number_of_previously_posted_projects : numerical

4. Now, plot FOUR t-SNE plots with each of these feature sets.
   A. categorical, numerical features + project_title(BOW)
   B. categorical, numerical features + project_title(TFIDF)
   C. categorical, numerical features + project_title(AVG W2V)
   D. categorical, numerical features + project_title(TFIDF W2V)
5. Concatenate all the features and Apply TNSE on the final data matrix
6. Note 1: The TSNE accepts only dense matrices
7. Note 2: Consider only 5k to 6k data points to avoid memory issues. If you run into memory error issues, reduce the number of data points but clearly state the number of datat-poins you are using

In [107]:

```
print("The Shape of Data matrices for Categorical Data are :")
print("\n")
print("The Shape of Data Matrix for different Categories of projects is : {}".format(categc
print("The Shape of Data Matrix for different Sub-categories of projects is : {}".format(su
print("The Shape of Data Matrix with respect to Projects from a particular State in the Uni
print("The Shape of the Data Matrix of the different projects with respect to the Grades of
print("The Shape of the Data Matrix with respect to title of the Teacher proposing the Teac
print("\n")
print("="*100)
print("\n")
print("The Shape of Data matrices for Numerical Data are :")
print("\n")
print("The Shape of the Data Matrix for price of the projects is : {}".format(price_standar
print("The Shape of the Data Matrix for Quantity of the items for the projects is : {}".for
print("The Shape of the Data Matrix for the Number of Projects Proposed Previously by the T
print("\n")
print("="*100)
print("\n")
print("TITLE BOW : {}".format(title_bow.shape))
print("\n")
print("TITLE TFIDF : {}".format(title_tfidf.shape))
print("\n")
print("TITLE AVG W2V : ({}, {})".format(len(avg_w2v_titles_vectors), len(avg_w2v_titles_vec
print("\n")
print("TITLE TFIDF W2V : ({}, {})".format(len(tfidf_w2v_title_vectors), len(tfidf_w2v_title
```

```
The Shape of Data matrices for Categorical Data are :


The Shape of Data Matrix for different Categories of projects is : (109248,
9)
The Shape of Data Matrix for different Sub-categories of projects is : (1092
48, 30)
The Shape of Data Matrix with respect to Projects from a particular State in
the United States is : (109248, 51)
The Shape of the Data Matrix of the different projects with respect to the G
rades of the students is : (109248, 4)
The Shape of the Data Matrix with respect to title of the Teacher proposing
the Teacher is : (109248, 6)


====================================================================================
========================


The Shape of Data matrices for Numerical Data are :


The Shape of the Data Matrix for price of the projects is : (109248, 1)
The Shape of the Data Matrix for Quantity of the items for the projects is :
(109248, 1)
The Shape of the Data Matrix for the Number of Projects Proposed Previously
by the Teacher is : (109248, 1)


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

```
TITLE BOW : (109248, 3329)


TITLE TFIDF : (109248, 3329)


TITLE AVG W2V : (109248, 300)


TITLE TFIDF W2V : (109248, 300)
```

In [108]:

```
X = hstack((categories_one_hot, sub_categories_one_hot, school_state_categories_one_hot, pr
X.shape
```

Out[108]:

```
(109248, 3432)
```

In [109]:

```
from sklearn.manifold import TSNE
X = X.tocsr()
X_new = X[0:5000,:]
```

In [110]:

```
X_new = X_new.toarray()
model = TSNE(n_components = 2, perplexity = 100.0, random_state = 0)
tsne_data_b = model.fit_transform(X_new)
```

In [111]:

```
labels = project_data["project_is_approved"]
labels_new = labels[0: 5000]
len(labels_new)
```

Out[111]:

```
5000
```

In [112]:

```
tsne_data_b = np.vstack((tsne_data_b.T, labels_new)).T
tsne_df_b = pd.DataFrame(tsne_data_b, columns = ("1st_Dim","2nd_Dim","Labels"))
```

In [113]:

```
tsne_df_b.shape
```

Out[113]:

```
(5000, 3)
```

2.1 TSNE with BOW encoding of project_title feature

In [114]:

```
# please write all of the code with proper documentation and proper titles for each subsect
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label

sns.FacetGrid(tsne_df_b, hue = "Labels", size = 10).map(plt.scatter, "1st_Dim", "2nd_Dim").
plt.show()
```

Summary:

- **The BOW is helping in proper scatter of poinys yet cannot didtinguish between approved and not approved form the project_title feature.**

2.2 TSNE with `TFIDF` encoding of `project_title` feature

In [115]:

```
# please write all the code with proper documentation, and proper titles for each subsectio
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label

X = hstack((categories_one_hot, sub_categories_one_hot, school_state_categories_one_hot, pr
X.shape
```

Out[115]:

```
(109248, 3432)
```

In [116]:

```
X = X.tocsr()
X_new = X[0:5000,:]
```

In [117]:

```
X_new = X_new.toarray()
model = TSNE(n_components = 2, perplexity = 100.0, random_state = 0)
tsne_data_tfidf = model.fit_transform(X_new)
```

In [118]:

```
tsne_data_tfidf = np.vstack((tsne_data_tfidf.T, labels_new)).T
tsne_df_tfidf = pd.DataFrame(tsne_data_tfidf, columns = ("1st_Dim","2nd_Dim","Labels"))
```

In [119]:

```
tsne_df_tfidf.shape
```

Out[119]:

```
(5000, 3)
```

In [120]:

```
sns.FacetGrid(tsne_df_tfidf, hue = "Labels", size = 10).map(plt.scatter, "1st_Dim", "2nd_Di
plt.show()
```

Summary:

- **The Blue and the Orange points do not form any clusters or accumulation of any type, Hence drawing conclusions seems to quite impossible with the current state of the T-SNE data using TF - IDF Encoding**

2.3 TSNE with `AVG W2V` encoding of `project_title` feature

In [121]:

```
# please write all the code with proper documentation, and proper titles for each subsectio
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
X = hstack((categories_one_hot, sub_categories_one_hot, school_state_categories_one_hot, pr
X.shape
```

Out[121]:

```
(109248, 403)
```

In [122]:

```
X = X.tocsr()
X_new = X[0:5000,:]
```

In [123]:

```
X_new = X_new.toarray()
model = TSNE(n_components = 2, perplexity = 100.0, random_state = 0)
tsne_data_avg_w2v = model.fit_transform(X_new)
```

In [124]:

```
tsne_data_avg_w2v = np.vstack((tsne_data_avg_w2v.T, labels_new)).T
tsne_df_avg_w2v = pd.DataFrame(tsne_data_avg_w2v, columns = ("1st_Dim","2nd_Dim","Labels"))
```

In [125]:

```
tsne_df_avg_w2v.shape
```

Out[125]:

```
(5000, 3)
```

In [126]:

```
sns.FacetGrid(tsne_df_avg_w2v, hue = "Labels", size = 10).map(plt.scatter, "1st_Dim", "2nd_
plt.show()
```

Summary:

- **Cannot justify from the two points approved and not approved as overlapping is too much**

2.4 TSNE with `TFIDF Weighted W2V` encoding of `project_title` feature

In [127]:

```
# please write all the code with proper documentation, and proper titles for each subsectio
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label


X = hstack((categories_one_hot, sub_categories_one_hot, school_state_categories_one_hot, pr
X.shape
```

Out[127]:

```
(109248, 403)
```

In [128]:

```
X = X.tocsr()
X_new = X[0:5000,:]
```

In [ ]:

```
X_new = X_new.toarray()
model = TSNE(n_components = 2, perplexity = 100.0, random_state = 0)
tsne_data_tfidf_w2v = model.fit_transform(X_new)
```

In [147]:

```
tsne_data_tfidf_w2v = np.vstack((tsne_data_tfidf_w2v.T, labels_new)).T
tsne_df_tfidf_w2v = pd.DataFrame(tsne_data_tfidf_w2v, columns = ("1st_Dim","2nd_Dim","Label
```

In [148]:

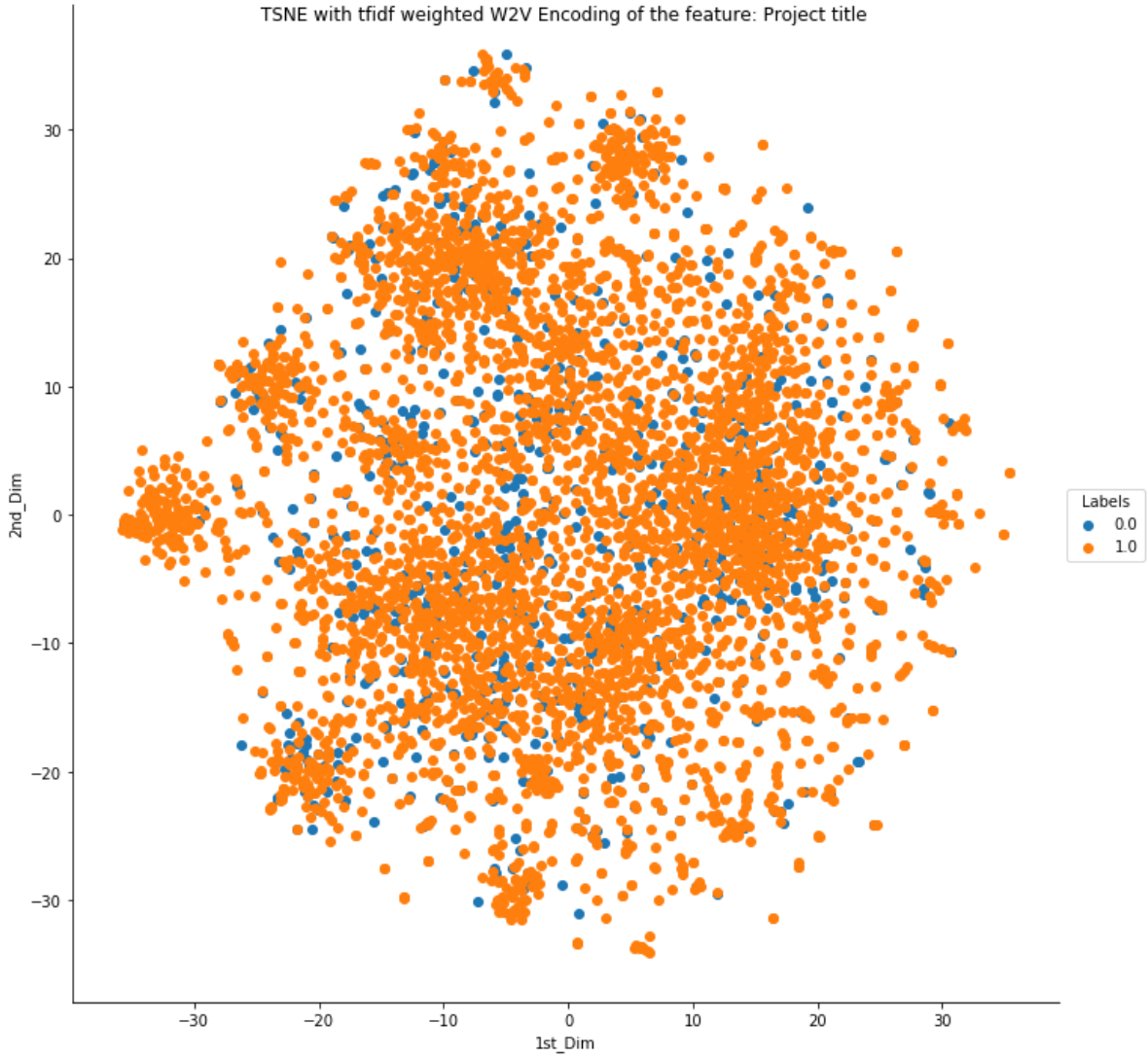
```
tsne_df_tfidf_w2v.shape
```

Out[148]:

```
(5000, 3)
```

In [150]:

```
sns.FacetGrid(tsne_df_tfidf_w2v, hue = "Labels", size = 10).map(plt.scatter, "1st_Dim", "2r
plt.show()
```



Summary:

- **THe clustering of the two points are overlapping which doesn't yield a perfect result as expected**

TSNE with BOW, TFIDF, AVG W2V, TFIDF Weighted W2V encoding of project_title feature (5000 Data Entries)

In [152]:

```
lized, quantity_standardized, prev_projects_standardized, title_bow, title_tfidf, avg_w2v_ti
```

Out[152]:

(109248, 7361)

In [153]:

```
X = X.tocsr()
X_new = X[0:5000,:]
```

In [154]:

```
X_new = X_new.toarray()
model = TSNE(n_components = 2, perplexity = 100.0, random_state = 0)
tsne_data_complete = model.fit_transform(X_new)
```

In [155]:

```
tsne_data_complete = np.vstack((tsne_data_complete.T, labels_new)).T
tsne_df_complete = pd.DataFrame(tsne_data_complete, columns = ("1st_Dim","2nd_Dim","Labels"
```

In [156]:

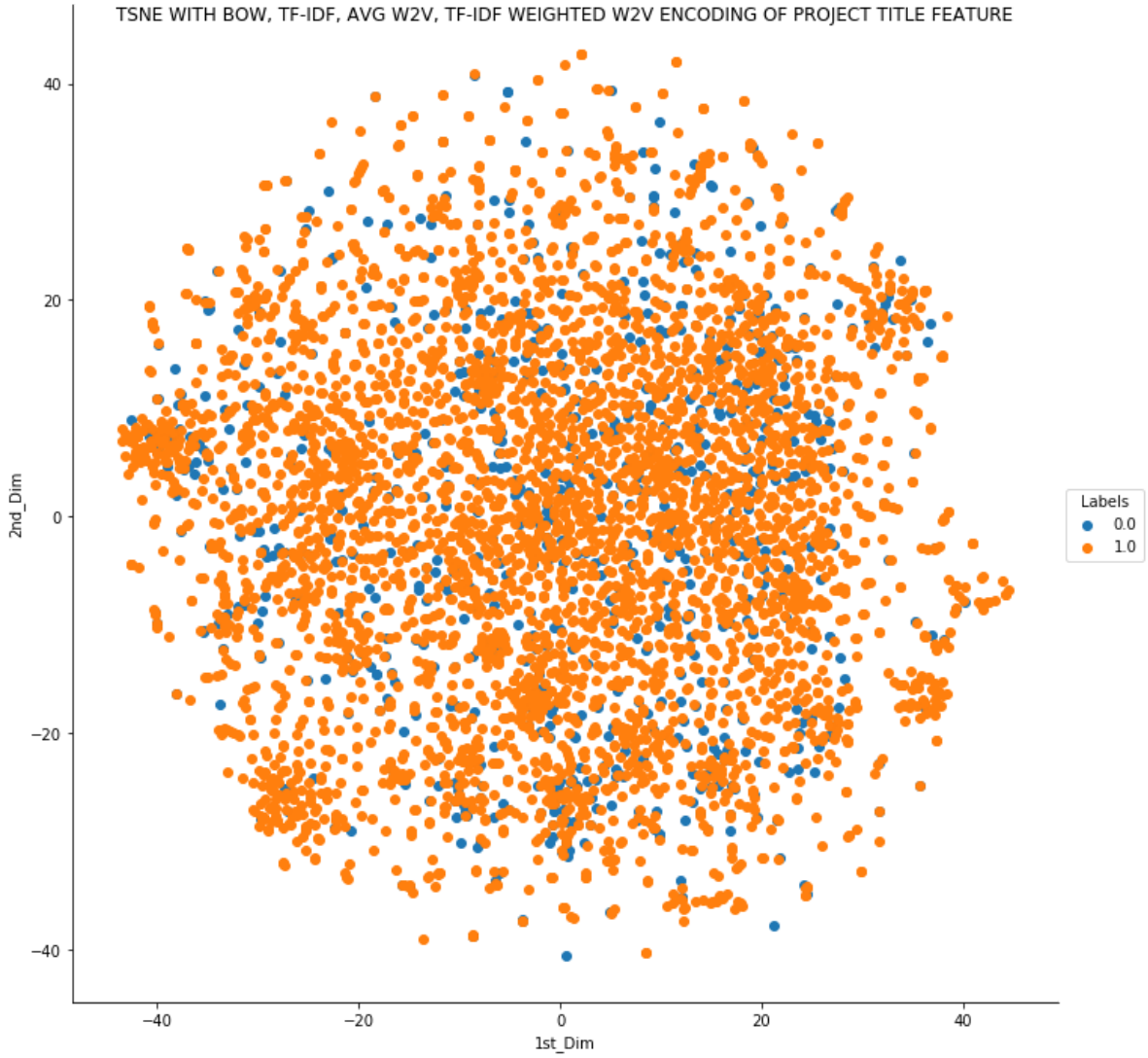
```
tsne_df_complete.shape
```

Out[156]:

(5000, 3)

In [157]:

```
sns.FacetGrid(tsne_df_complete, hue = "Labels", size = 10).map(plt.scatter, "1st_Dim", "2nd
plt.show()
```



2.5 Conclusion

Write few sentences about the results that you obtained and the observations you made.

- **From the table above we can make out taht every state has a approval rate graeter than 80% and DE(delaware) is the highest among all with number of proposals i.e 89%**
- **Vermont (VT) has the lowest Approval rate with exactly 80% followed by District of Columbia (DC) and Texas (TX) with nearly 80% and 81% respectively.**
- **The project approval by teacher prefix is the highest with Mrs. ie. 48997 out of 57269 , followed by Ms. and Mr. This tells that married females and not married females as teachers have approval rate higher than the others**
- **Alot of projects proposed for the students between Pre Kindergarden and 2nd Grade while for the rest it keeps decreasing as the Grades increase.**
- **The literacy & language has the highest submitted and approved rates of approx. 87% followed by Math & Science.**

- **Projects belonging to both Maths and Science have acceptance rate of nearly 82% while introducing the concept of Literacy and Language to this can increase its accpetance rate to nearly 87%**
- **Projects belonging to both Maths and Science when combined with Applied Learning has the least number of projects proposed as well approved.**
- **There is also Variability in Acceptance rate, projects under the category Warmth, Care and Hunger have an accpetance rate of 93.5%**
- **The highest number of projects are registered under Literacy and Langauage with 52,239 projects, followed by Maths and Science having 41,421 projects.**
- **The sub-Category Literacy has the highest number of projects approved with 8371 projects. Also the accpetance rate is 88%. The sub-Category Health and Wellness have the lowest number of projects proposed with 3,583 projects only.**
- **Roughly most of the projects have 3, 4 or 5 words in the title.There are hardly any project titles containing more than 10 words.**
- **The number of words in the Project Essays of Approved Projects are slightly more than the number of words in the Project Essays of the Rejected Projects.**
- **The Maximum price for any project should be less than 10,000 dollars.The approved projects tend to have lower cost when compared to the projects that have not been approved.**
- **We observe that it is not mandatory for a teacher to have proposed any project prior. Maximum number of teachers, nearly 82% of the approved projects have been submitted by teachers with no prior project proposals. New talent and efforts are well appreciated.**
- **We observe that on an average Each project costs nearly 298 Dollars. The Price paid is generally for the purchase of the Items. The projects on an average require atleast 17 Different of similar items.**
- **Visualisation of TSNE with Bag of Words, TF-IDF, Avg Word2Vec, TF-IDF Weighted Word2Vec does not seem to yield the expected result of clustering similar data points. Hence we would have to try any other method.**