DonorsChoose

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

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

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

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

About the DonorsChoose Data Set

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

Feature	Description
`project_id`	A unique identifier for the proposed project. **Example:** `p036502`

Feature	Description
`project_title`	Title of the project. **Examples:** - `Art Will Make You Happy!` - `First Grade Fun`
`project_grade_category`	Grade level of students for which the project is targeted. One of the following enumerated values: - `Grades PreK-2` - `Grades 3-5` - `Grades 6-8` - `Grades 9-12`
`project_subject_categories`	One or more (comma-separated) subject categories for the project from the following enumerated list of values: - `Applied Learning` - `Care & Hunger` - `Health & Sports` - `History & Civics` - `Literacy & Language` - `Math & Science` - `Music & The Arts` - `Special Needs` - `Warmth` **Examples:** - `Music & The Arts` - `Literacy & Language, Math & Science`

Feature	Description
`school_state`	State where school is located (Two-letter U.S. postal code). **Example:** `WY`
`project_subject_subcategories`	One or more (comma-separated) subject subcategories for the project. **Examples:** • `Literacy` • `Literature & Writing, Social Sciences`
`project_resource_summary`	An explanation of the resources needed for the project. **Example:** • `My students need hands on literacy materials to manage sensory needs!`
`project_essay_1`	First application essay*
`project_essay_2`	Second application essay*
`project_essay_3`	Third application essay*
`project_essay_4`	Fourth application essay*
`project_submitted_datetime`	Datetime when project application was submitted. **Example:** `2016-04-28 12:43:56.245`
`teacher_id`	A unique identifier for the teacher of the proposed project. **Example:** `bdf8baa8fedef6bfeec7ae4ff1c15c56`

Feature	Description
`teacher_prefix`	Teacher's title. One of the following enumerated values: • `nan` • `Dr.` • `Mr.` • `Mrs.` • `Ms.` • `Teacher.`
`teacher_number_of_previously_posted_projects`	Number of project applications previously submitted by the same teacher. **Example:** `2`

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

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

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

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

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

Label	Description

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
```

```python
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
```

1.1 Reading Data

In [2]:

```python
project_data = pd.read_csv('C:/Users/pramod reddy chandi/Desktop/pram/applied ai course/DonorsChoose_2018/train_data.csv')
```

```
resource_data = pd.read_csv('C:/Users/pramod reddy chandi/Desktop/pram/
applied ai course/DonorsChoose_2018/resources.csv')
```

In [3]:

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

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

In [4]:

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

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

Out[4]:

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

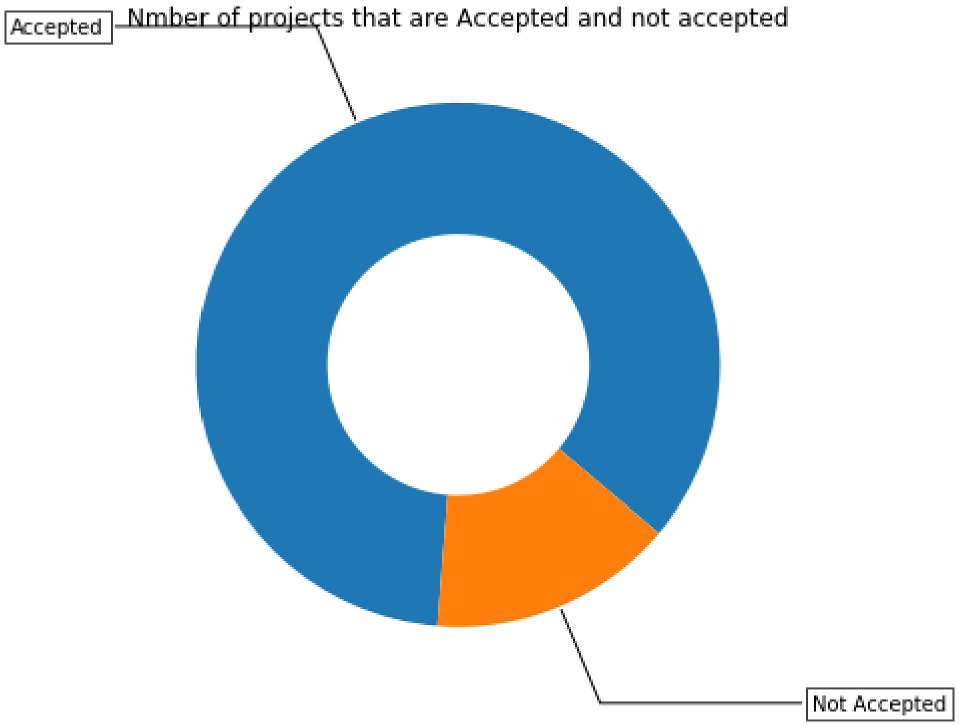
1.2 Data Analysis

In [5]:

```
# https://matplotlib.org/gallery/pie_and_polar_charts/pie_and_donut_lab
els.html#sphx-glr-gallery-pie-and-polar-charts-pie-and-donut-labels-py
```

```
y_value_counts = project_data['project_is_approved'].value_counts()
print("Number of projects thar are approved for funding ", y_value_coun
ts[1], ", (", (y_value_counts[1]/(y_value_counts[1]+y_value_counts[0]))
*100,"%)")
print("Number of projects thar are not approved for funding ", y_value_
counts[0], ", (", (y_value_counts[0]/(y_value_counts[1]+y_value_counts[
0]))*100,"%)")

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(arrowstyl
e="-"),
          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 , ( 84.85830404
22 %)
Number of projects thar are not approved for funding  16542 , ( 15.1416
959578 %)
```



The no of projects that are accepted accounts to 84.85% and 15.15% project proposols are rejected.

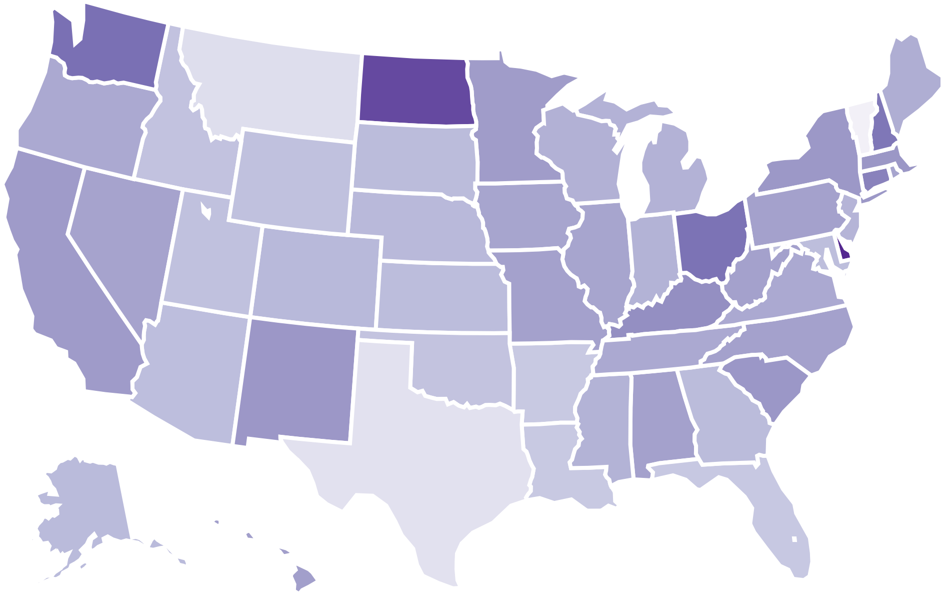
1.2.1 Univariate Analysis: School State

In [6]:

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

temp = pd.DataFrame(project_data.groupby("school_state")["project_is_approved"].apply(np.mean)).reset_index()
# if you have data which contain only 0 and 1, then the mean = percenta
```

```
ge (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(1
88,189,220)'],\
            [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')
```

Project Proposals % of Acceptance Rate by US State



In [7]:

```
# https://www.csi.cuny.edu/sites/default/files/pdf/administration/ops/2
letterstabbrev.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
```

In [8]:

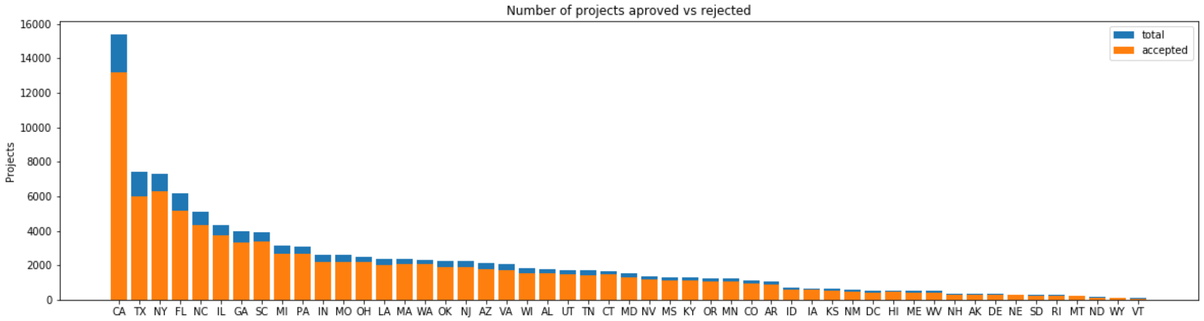
```
#stacked bar plots matplotlib: https://matplotlib.org/gallery/lines_bars_and_markers/bar_stacked.html
def stack_plot(data, xtick, col2='project_is_approved', col3='total'):
    ind = np.arange(data.shape[0])

    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 [9]:

```
def univariate_barplots(data, col1, col2='project_is_approved', top=False):
    # Count number of zeros in dataframe python: https://stackoverflow.com/a/51540521/4084039
    temp = pd.DataFrame(project_data.groupby(col1)[col2].agg(lambda x: x.eq(1).sum())).reset_index()

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

    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 [10]:

```
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
```

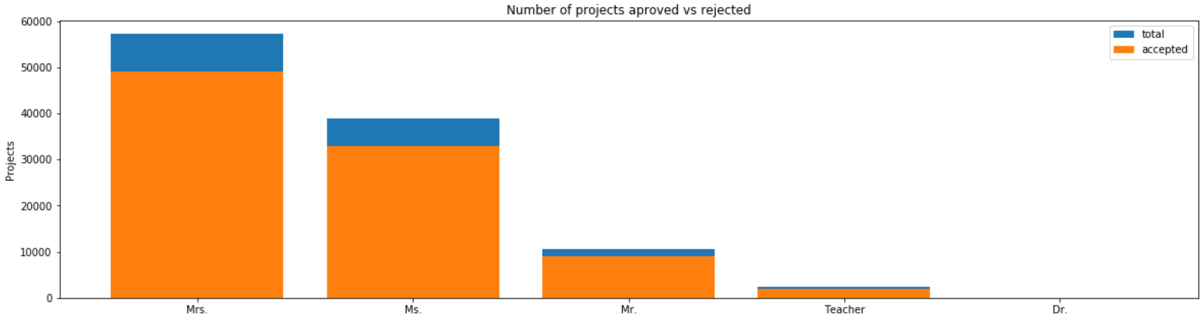
```
50          WY                   82     98  0.836735
46          VT                   64     80  0.800000
```

observation on Us state: Every state has greater than 80% success rate in approval

1.2.2 Univariate Analysis: teacher_prefix

In [11]:

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

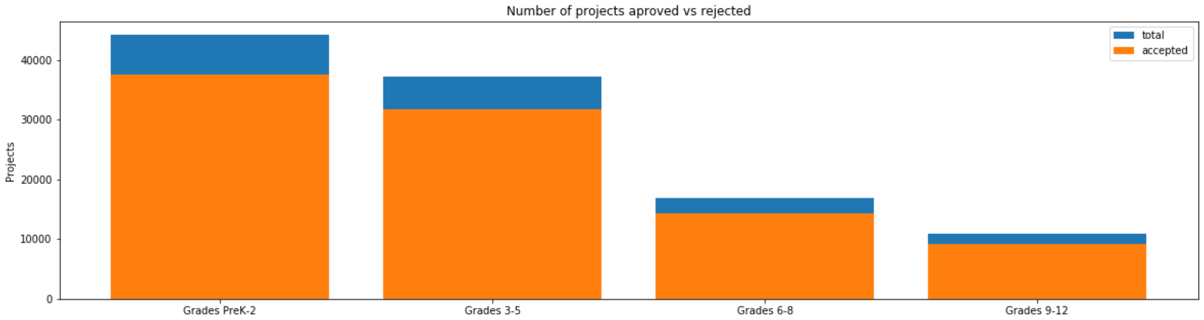
```
  teacher_prefix  project_is_approved  total       Avg
2           Mrs.                48997  57269  0.855559
3            Ms.                32860  38955  0.843537
1            Mr.                 8960  10648  0.841473
4        Teacher                 1877   2360  0.795339
0            Dr.     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

Summary on Surname:Teachers with surname

# of Mrs have max chance of project approval and with surname of Dr has less chance of approving the project.

1.2.3 Univariate Analysis: project_grade_category

In [12]:
```
univariate_barplots(project_data, 'project_grade_category', 'project_is_approved', top=False)
```



```
  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
```

Observation on project approval based on grade: All grade candiates have an project acceptance of above 80%

1.2.4 Univariate Analysis: project_subject_categories

In [13]:

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

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

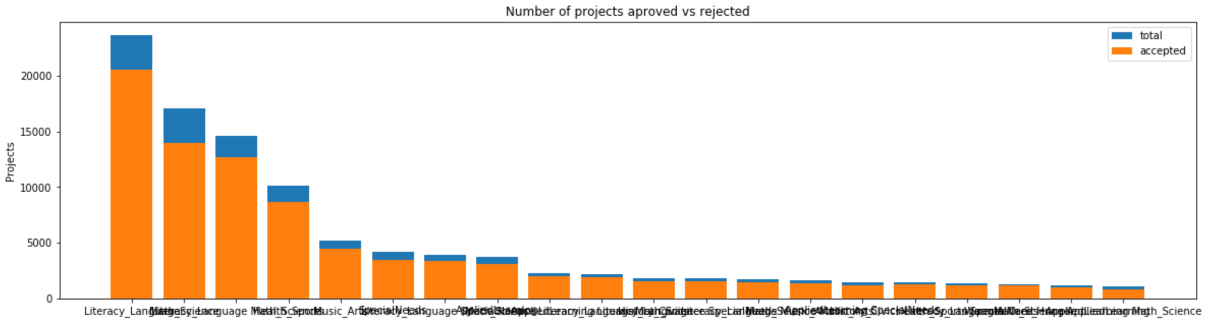
In [14]:

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

Out[14]:

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

In [15]:
```
univariate_barplots(project_data, 'clean_categories', 'project_is_appro
ved', top=20)
```



```
                  clean_categories  project_is_approved  total       Av
g
24               Literacy_Language                20520  23655  0.86747
0
32                    Math_Science                13991  17072  0.81952
9
28  Literacy_Language Math_Science                12725  14636  0.86943
2
8                    Health_Sports                 8640  10177  0.84897
3
```

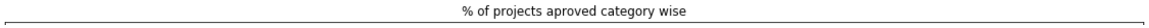
```
40                        Music_Arts                4429   5180  0.85501
9
==================================================
                    clean_categories  project_is_approved  total  
Avg
19  History_Civics Literacy_Language                 1271   1421  0.894
441
14        Health_Sports SpecialNeeds                 1215   1391  0.873
472
50                Warmth Care_Hunger                 1212   1309  0.925
898
33      Math_Science AppliedLearning                 1019   1220  0.835
246
4       AppliedLearning Math_Science                  855   1052  0.812
738
```

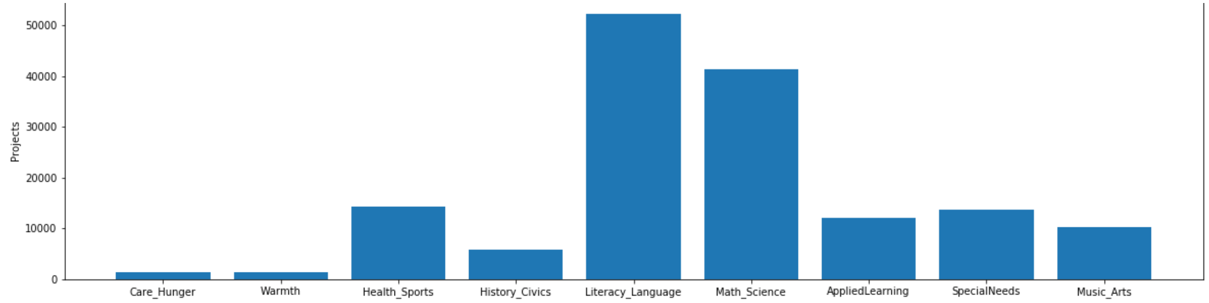
In [16]:

```python
# 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 [17]:

```python
# 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 [18]:

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

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

Observation on category:Literacy language bagged the max project approvals

1.2.5 Univariate Analysis: project_subject_subcategories

In [19]:

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

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

sub_cat_list = []
for i in sub_catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & H
unger"
    for j in i.split(','): # it will split it in three parts ["Math & S
cience", "Warmth", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory b
ased on space "Math & Science"=> "Math","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are g
oing to replace it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with
 ''(empty) ex:"Math & Science"=>"Math&Science"
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove
 the trailing spaces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())
```

In [20]:

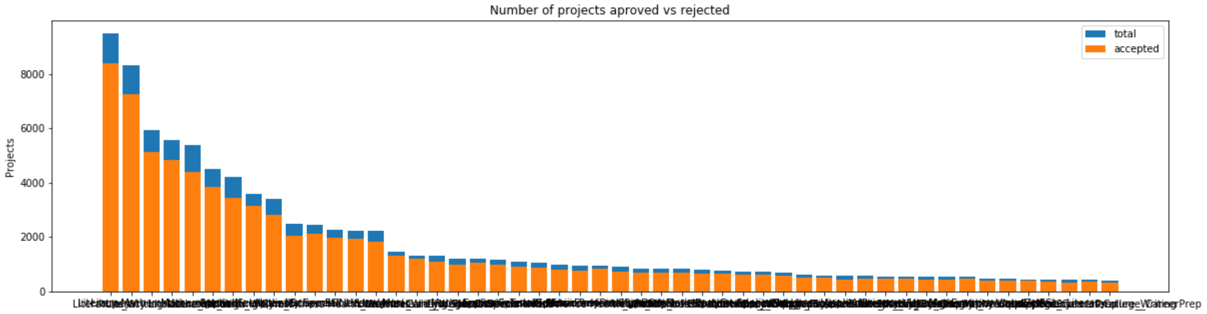
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=Tr
ue)
project_data.head(2)
```

Out[20]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL

In [21]:
```
univariate_barplots(project_data, 'clean_subcategories', 'project_is_ap
proved', top=50)
```



```
                clean_subcategories  project_is_approved  total       A
vg
317                        Literacy                 8371   9486  0.8824
58
319            Literacy Mathematics                 7260   8325  0.8720
72
331  Literature_Writing Mathematics                 5140   5923  0.8678
03
318     Literacy Literature_Writing                 4823   5571  0.8657
33
342                     Mathematics                 4385   5379  0.8152
07
==================================================
                    clean_subcategories  project_is_approved  total
   Avg
196       EnvironmentalScience Literacy                  389    444   0.
```

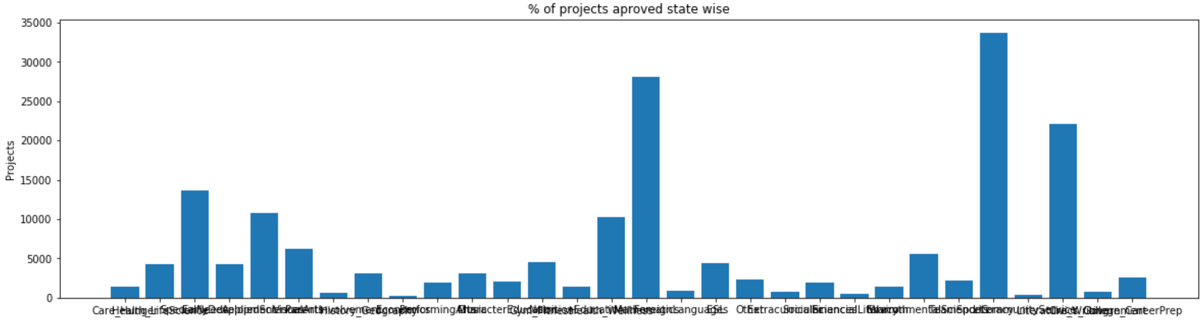
```
876126
127                                 ESL                  349    421  0.
828979
79                   College_CareerPrep                  343    421  0.
814727
17   AppliedSciences Literature_Writing                  361    420  0.
859524
3    AppliedSciences College_CareerPrep                  330    405  0.
814815
```

In [22]:

```
# 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 [23]:

```
# 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 [24]:

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

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

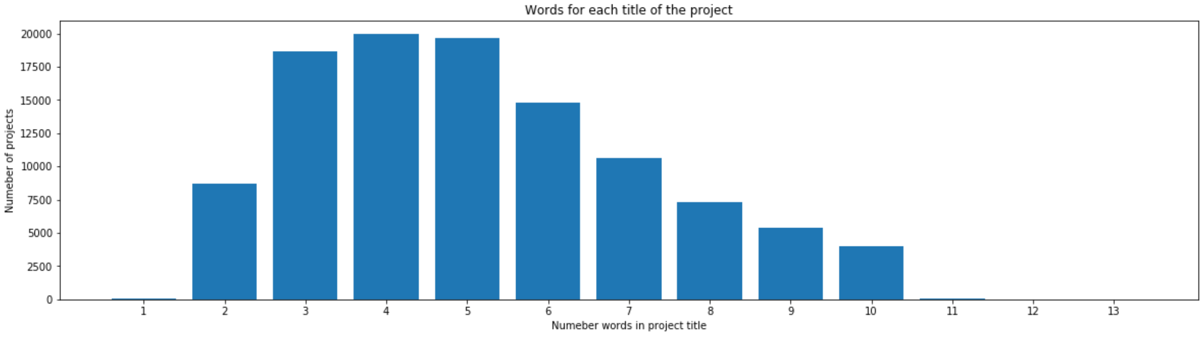
```
CommunityService      :       441
Literature_Writing    :     22179
Civics_Government     :       815
College_CareerPrep    :      2568
```

Observation : Literacy bagged the max number of project approvals

1.2.6 Univariate Analysis: Text features (Title)

In [25]:

```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/37483537/4084039
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()
```

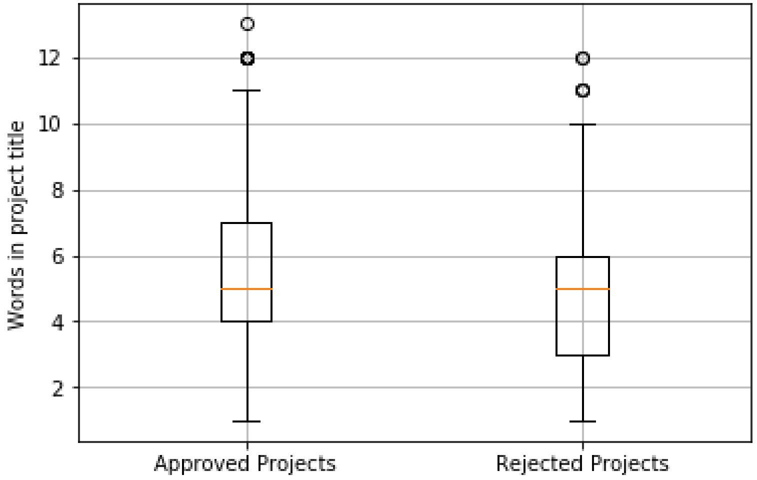


In [26]:

```
approved_title_word_count = project_data[project_data['project_is_approved']==1]['project_title'].str.split().apply(len)
approved_title_word_count = approved_title_word_count.values

rejected_title_word_count = project_data[project_data['project_is_approved']==0]['project_title'].str.split().apply(len)
rejected_title_word_count = rejected_title_word_count.values
```

In [27]:

```
# 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()
```

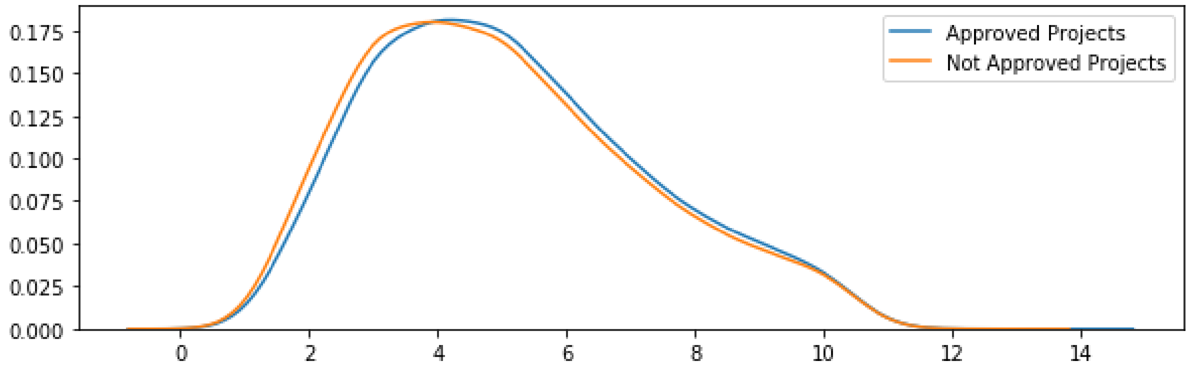


Observation: It can be inferred that the projectproposal with more number of words in project title has more chance of accptance.It can be inferred that the project proposal with less than four words are rejected.

In [28]:

```
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()
```



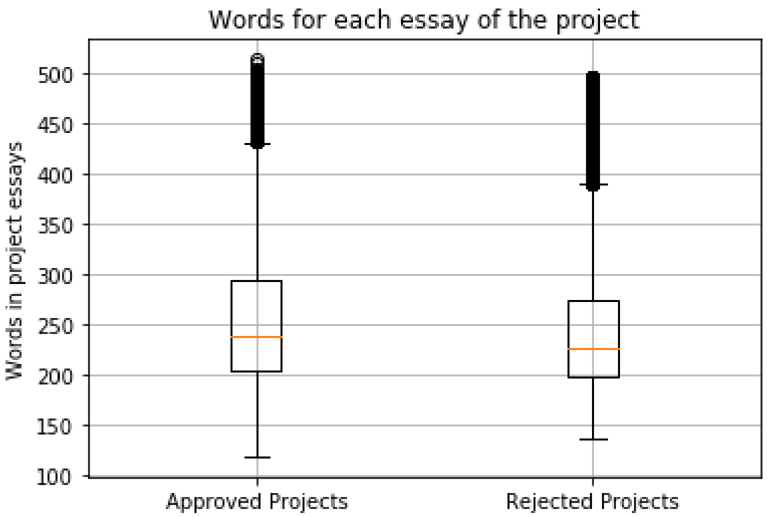
1.2.7 Univariate Analysis: Text features (Project Essay's)

In [29]:
```
# 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 [30]:
```
approved_word_count = project_data[project_data['project_is_approved']=
=1]['essay'].str.split().apply(len)
approved_word_count = approved_word_count.values

rejected_word_count = project_data[project_data['project_is_approved']=
=0]['essay'].str.split().apply(len)
rejected_word_count = rejected_word_count.values
```

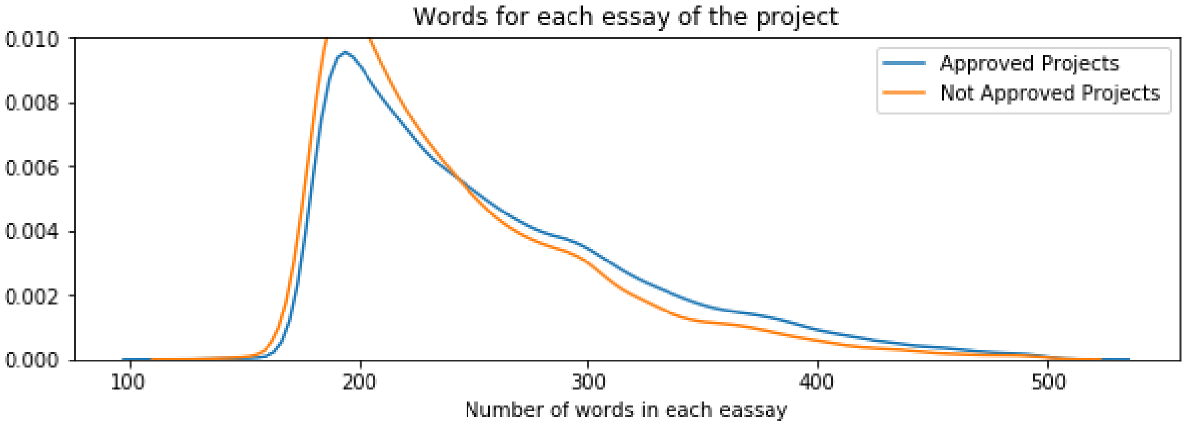
In [31]:
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.ht
```

```
ml
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()
```



In [32]:

```
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 Proje
cts")
plt.title('Words for each essay of the project')
plt.xlabel('Number of words in each eassay')
plt.legend()
plt.show()
```



1.2.8 Univariate Analysis: Cost per project

In [33]:

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

Out[33]:

	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 [34]:

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

Out[34]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

In [35]:

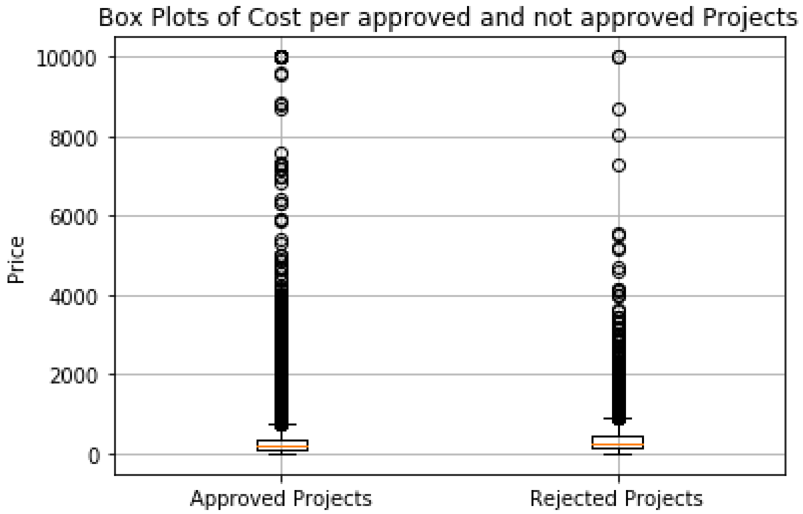
```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [36]:

```
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 [37]:

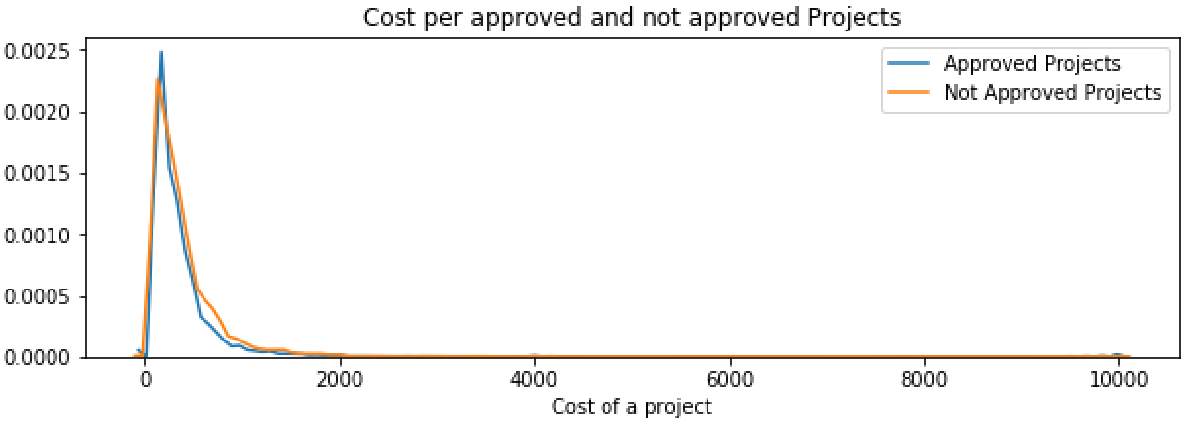
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.ht
ml
plt.boxplot([approved_price, rejected_price])
plt.title('Box Plots of Cost per approved and not approved Projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Price')
plt.grid()
plt.show()
```



In [38]:

```
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()
```



In [39]:

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

#If you get a ModuleNotFoundError error , install prettytable using: pi
p3 install prettytable

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

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

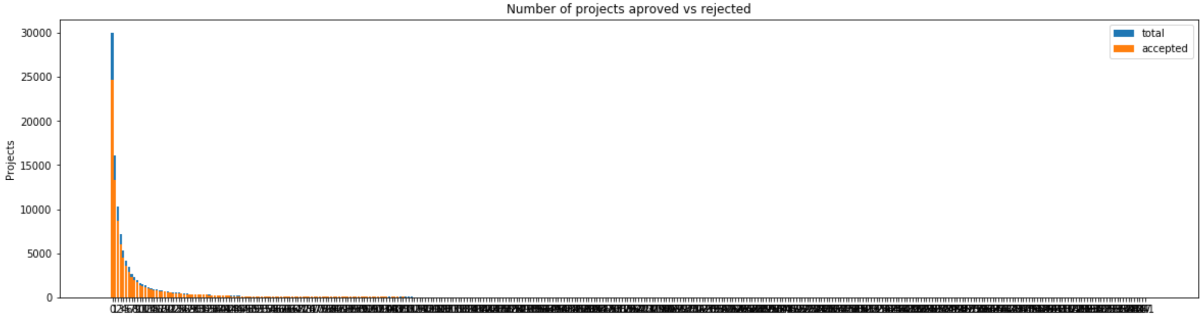
```
+------------+-------------------+-----------------------+
| Percentile | Approved Projects | Not Approved Projects |
+------------+-------------------+-----------------------+
|     0      |        0.66       |          1.97         |
|     5      |       13.59       |          41.9         |
|     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        |
+------------+-------------------+-----------------------+
```

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

Please do this on your own based on the data analysis that was done in the above cells

In [40]:

```
project_data.head(5)
univariate_barplots(project_data, 'teacher_number_of_previously_posted_
projects', 'project_is_approved', False)
```



```
   teacher_number_of_previously_posted_projects  project_is_approved  t
otal  \
0                                             0                24652  3
0014
1                                             1                13329  1
6058
2                                             2                 8705  1
0350
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  \
242                                           242                    1
     1
268                                           270                    1
     1
234                                           234                    1
     1
335                                           347                    1
     1
```

```
373                                                   451                        1
      1


      Avg
242   1.0
268   1.0
234   1.0
335   1.0
373   1.0
```

Observation: It can be inferred that the as the no of previous posted projects by teacher increases there is high chance of it to be accepted.

1.2.10 Univariate Analysis: project_resource_summary

Please do this on your own based on the data analysis that was done in the above cells

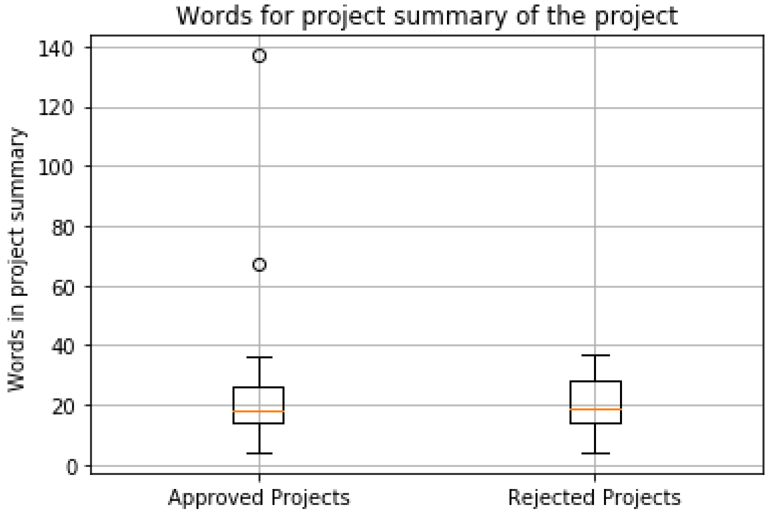
Check if the `presence of the numerical digits` in the `project_resource_summary` effects the acceptance of the project or not. If you observe that `presence of the numerical digits` is helpful in the classification, please include it for further process or you can ignore it.

In [41]:

```
project_data.head(3)
#project_resource_summary project_is_approved
approved_project_word_count = project_data[project_data['project_is_app
roved']==1]['project_resource_summary'].str.split().apply(len)
approved_project_word_count = approved_project_word_count.values

rejected_project_word_count = project_data[project_data['project_is_app
roved']==0]['project_resource_summary'].str.split().apply(len)
rejected_project_word_count = rejected_project_word_count.values
```

In [42]:

```
plt.boxplot([approved_project_word_count, rejected_project_word_count])
plt.title('Words for project summary of the project')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Words in project summary ')
plt.grid()
plt.show()
```



In [43]:

```
'''approved_project_number = project_data['project_resource_summary']
[int(s) for s in approved_project_number[0].split() if s.isdigit()]

text = [word for word in approved_project_number if (c.isdigit() for c
 in word)]

[int(s) for s in approved_project_number.split() if s.isdigit()]
print(text)'''
```

Out[43]:

```
"approved_project_number = project_data['project_resource_summary']\n[i
nt(s) for s in approved_project_number[0].split() if s.isdigit()]\n\nte
xt = [word for word in approved_project_number if (c.isdigit() for c in
word)]\n\n[int(s) for s in approved_project_number.split() if s.isdigit
()]\nprint(text)"
```

1.3 Text preprocessing

1.3.1 Essay Text

In [44]:

```
# 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 s
econd 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 have over 24 languages represented in our English Learner p
rogram with students at every level of mastery.  We also have over 40 c
ountries represented with the families within our school.  Each student
brings a wealth of knowledge and experiences to us that open our eyes t
o new cultures, beliefs, and respect.\"The limits of your language are
the limits of your world.\"-Ludwig Wittgenstein  Our English learner's
have a strong support system at home that begs for more resources.  Man
y times our parents are learning to read and speak English along side o
f their children.  Sometimes this creates barriers for parents to be ab
le to help their child learn phonetics, letter recognition, and other r
eading skills.\r\n\r\nBy providing these dvd's and players, students ar
e 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 proficiency status, will be a offered to be a part of this program.
These educational videos will be specially chosen by the English Learne
r Teacher and will be sent home regularly to watch.  The videos are to
help the child develop early reading skills.\r\n\r\nParents that do not
have access to a dvd player will have the opportunity to check out a dv
d player to use for the year.  The plan is to use these videos and educ
ational dvd's for the years to come for other EL students.\r\nnannan
==================================================
The 51 fifth grade students that will cycle through my classroom this y
ear all love learning, at least most of the time. At our school, 97.3%
of the students receive free or reduced price lunch. Of the 560 student
s, 97.3% are minority students. \r\nThe school has a vibrant community
that loves to get together and celebrate. Around Halloween there is a w
hole school parade to show off the beautiful costumes that students wea
r. On Cinco de Mayo we put on a big festival with crafts made by the st
udents, dances, and games. At the end of the year the school hosts a ca
rnival 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 fi
ve brightly colored Hokki stools in place of regular, stationary, 4-leg
ged chairs. As I will only have a total of ten in the classroom and not
enough for each student to have an individual one, they will 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 them
in place of chairs at my small group tables during math and reading tim
es. The rest of the day they will be used by the students who need the
highest amount of movement in their life in order to stay focused on sc
hool.\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. When the students are sitting in group with me on the
Hokki Stools, they are always moving, but at the same time doing their
work. Anytime the students get to pick where they can sit, the Hokki St
ools are the first to be taken. There are always students who head over
to the kidney table to get one of the stools who are disappointed as th
ere 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 stud
ents 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 school
s for a child who can't sit still.nannan
==================================================
How do you remember your days of school? Was it in a sterile environmen
t 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 eac
h day.\r\n\r\nMy class is made up of 28 wonderfully unique boys and gir
ls of mixed races in Arkansas.\r\nThey attend a Title I school, which m
```

```
eans 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, absor
bing all the information and experiences and keep on wanting more.With
these resources such as the comfy red throw pillows and the whimsical n
autical hanging decor and the blue fish nets, I will be able to help cr
eate the mood in our classroom setting to be one of a themed nautical e
nvironment. Creating a classroom environment is very important in the s
uccess in each and every child's education. The nautical photo props wi
ll 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 chil
d 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 ca
rds to their team groups.\r\n\r\nYour generous donations will help me t
o help make our classroom a fun, inviting, learning environment from da
y 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 t
o make our new school year a very successful one. Thank you!nannan
==================================================
My kindergarten students have varied disabilities ranging from speech a
nd language delays, cognitive delays, gross/fine motor delays, to autis
m. They are eager beavers and always strive to work their hardest worki
ng 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 disabiliti
es 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 an
d you needed to groove and move as you were in a meeting? This is how m
y 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 d
evelop their core, which enhances gross motor and in Turn fine motor sk
ills. \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 playi
ng. 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 tea
cher demonstrates. The great teacher inspires. -William A. Ward\r\n\r\n
My school has 803 students which is makeup is 97.6% African-American, m
aking up the largest segment of the student body. A typical school in D
allas is made up of 23.2% African-American students. Most of the studen
ts are on free or reduced lunch. We aren't receiving doctors, lawyers,
or engineers children from rich backgrounds or neighborhoods. As an edu
cator I am inspiring minds of young children and we focus not only on a
cademics but one smart, effective, efficient, and disciplined students
with good character.In our classroom we can utilize the Bluetooth for s
wift transitions during class. I use a speaker which doesn't amplify th
e sound enough to receive the message. Due to the volume of my speaker
my students can't hear videos or books clearly and it isn't making the
lessons as meaningful. But with the bluetooth speaker my students will
be able to hear and I can stop, pause and replay it at any time.\r\nThe
cart will allow me to have more room for storage of things that are nee
ded for the day and has an extra part to it I can use.  The table top c
hart has all of the letter, words and pictures for students to learn ab
out different letters and it is more accessible.nannan
==================================================
```

In [45]:

```python
# 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 [46]:
```
sent = decontracted(project_data['essay'].values[20000])
print(sent)
print("="*50)
```

```
My kindergarten students have varied disabilities ranging from speech a
nd language delays, cognitive delays, gross/fine motor delays, to autis
m. They are eager beavers and always strive to work their hardest worki
ng 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 disabiliti
es 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 an
d you needed to groove and move as you were in a meeting? This is how m
y 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 d
evelop their core, which enhances gross motor and in Turn fine motor sk
ills. \r\nThey also want to learn through games, my kids do not want to
sit and do worksheets. They want to learn to count by jumping and playi
ng. 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 [47]:
```
# \r \n \t remove from string python: http://texthandler.com/info/remov
e-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 a
nd language delays, cognitive delays, gross/fine motor delays, to autis
m. They are eager beavers and always strive to work their hardest worki
ng past their limitations.     The materials we have are the ones I see
k out for my students. I teach in a Title I school where most of the st
udents receive free or reduced price lunch.  Despite their disabilities
```

```
and limitations, my students love coming to school and come eager to le
arn 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 deve
lop their core, which enhances gross motor and in Turn fine motor skill
s.   They also want to learn through games, my kids do 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 colo
r 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 [48]:

```
#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 a
nd language delays cognitive delays gross fine motor delays to autism T
hey are eager beavers and always strive to work their hardest working p
ast their limitations 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 rece
ive free or reduced price lunch Despite their disabilities and limitati
ons my students love coming to school and come eager to learn and explo
re 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 t
he 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 w
hich 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 worksheets The
y 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 mak
e that happen My students will forget they are doing work and just have
the fun a 6 year old deserves nannan
```

In [49]:

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

In [50]:

```
# 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 [02:09<00:00, 845.10it/s]
```

In [51]:

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

Out[51]:

```
'my kindergarten students varied disabilities ranging speech language d
elays cognitive delays gross fine motor delays autism they eager beaver
s always strive work hardest working past limitations the materials one
s i seek students i teach title i school students receive free reduced
price lunch despite disabilities limitations students love coming schoo
l come eager learn explore have ever felt like ants pants needed groove
move meeting this kids feel time the want able move learn say wobble ch
airs answer i love develop core enhances gross motor turn fine motor sk
ills they also want learn games kids not want sit worksheets they want
learn count jumping playing physical engagement key success the number
toss color shape mats make happen my students forget work fun 6 year ol
d deserves nannan'
```

1.3.2 Project title Text

In [52]:

```
# similarly you can preprocess the titles also
project_data.columns
#sent1= decontracted(project_data['project_title'].values[20000])
preprocessed_title = []
# tqdm is for printing the status bar
for sentance in tqdm(project_data['project_title'].values):
    sent1 = decontracted(sentance)
    sent1 = sent1.replace('\\r', ' ')
    sent1 = sent1.replace('\\"', ' ')
    sent1 = sent1.replace('\\n', ' ')
    sent1 = re.sub('[^A-Za-z0-9]+', ' ', sent1)
    # https://gist.github.com/sebleier/554280
    sent1 = ' '.join(e for e in sent1.split() if e not in stopwords)
    preprocessed_title.append(sent1.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████
█████| 109248/109248 [00:06<00:00, 17606.91it/s]
```

1. 4 Preparing data for models

```
In [53]: project_data.columns
```

```
Out[53]: Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_stat
e',
       'project_submitted_datetime', 'project_grade_category', 'project
_title',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_appr
oved',
       'clean_categories', 'clean_subcategories', 'essay', 'price',
       'quantity'],
      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/

In [54]:

```
# we use count vectorizer to convert the values into one hot encoded features
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False, binary=True)
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)
```

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

In [55]:

```
# we use count vectorizer to convert the values of categorical data :clean_subcategories
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=False, binary=True)
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)
```

```
['Care_Hunger', 'Health_LifeScience', 'SpecialNeeds', 'EarlyDevelopmen
t', 'AppliedSciences', 'VisualArts', 'ParentInvolvement', 'History_Geog
raphy', 'Economics', 'PerformingArts', 'Music', 'CharacterEducation',
'Gym_Fitness', 'NutritionEducation', 'Health_Wellness', 'Mathematics',
'ForeignLanguages', 'ESL', 'Other', 'Extracurricular', 'SocialScience
s', 'FinancialLiteracy', 'Warmth', 'EnvironmentalScience', 'TeamSport
s', 'Literacy', 'CommunityService', 'Literature_Writing', 'Civics_Gover
nment', 'College_CareerPrep']
Shape of matrix after one hot encodig  (109248, 30)
```

In [56]:

```
# we use count vectorizer to convert the values of categorical data :sc
hool_state
vectorizer = CountVectorizer()
vectorizer.fit(project_data['school_state'])
print(vectorizer.get_feature_names())


school_state_one_hot = vectorizer.transform(project_data['school_state'
].values)
print("Shape of matrix after one hot encodig ",school_state_one_hot.sha
pe)
```

```
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'h
i', 'ia', 'id', 'il', 'in', 'ks', 'ky', 'la', 'ma', 'md', 'me', 'mi',
'mn', 'mo', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh', 'nj', 'nm', 'nv', 'ny',
'oh', 'ok', 'or', 'pa', 'ri', 'sc', 'sd', 'tn', 'tx', 'ut', 'va', 'vt',
'wa', 'wi', 'wv', 'wy']
Shape of matrix after one hot encodig  (109248, 51)
```

In [57]:

```
#we use count vectorizer to convert the values of categorical data :pro
ject_grade_category
vectorizer1 = CountVectorizer(stop_words=None)
k=project_data['project_grade_category']
k.replace(['Grades PreK-2', 'Grades 6-8', 'Grades 3-5','Grades 9-12'],
['A1', 'B2' ,'C3', 'D4'],inplace=True)


vectorizer1.fit(k)
```

```
project_grade_category_one_hot=vectorizer1.transform(project_data['proj
ect_grade_category'].values)
print("Shape of matrix after one hot encodig ",project_grade_category_o
ne_hot.shape)
```

```
Shape of matrix after one hot encodig  (109248, 4)
```

In [58]:
```
project_data['teacher_prefix'].unique()
```

Out[58]:
```
array(['Mrs.', 'Mr.', 'Ms.', 'Teacher', nan, 'Dr.'], dtype=object)
```

In [59]:
```
#we use count vectorizer to convert the values of categorical data : te
acher_prefix
# getting error as we have null balues replacing them with 0

vectorizer1 = CountVectorizer()
project_data['teacher_prefix'].unique()
project_data['teacher_prefix'].fillna("", inplace = True)


teacher_prefix_one_hot = vectorizer1.fit_transform(project_data['teache
r_prefix'].values)
print("Shape of matrix after one hot encodig ",teacher_prefix_one_hot.s
hape)
```

```
Shape of matrix after one hot encodig  (109248, 5)
```

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

In [60]:
```
# We are considering only the words which appeared in at least 10 docum
ents(rows or projects).
vectorizer = CountVectorizer(min_df=10)
text_bow = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after one hot encodig ",text_bow.shape)
```

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

1.4.2.2 Bag of Words on `project_title`

In [61]:
```
# 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_title)
print("Shape of matrix after one hot encodig title_bow",title_bow.shape
)
```

```
Shape of matrix after one hot encodig title_bow (109248, 132)
```

1.4.2.3 TFIDF vectorizer

In [62]:
```
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 [63]:
```
# 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_title)
print("Shape of matrix after one hot encodig ",title_tfidf.shape)
```

```
Shape of matrix after one hot encodig  (109248, 132)
```

1.4.2.5 Using Pretrained Models: Avg W2V

In [64]:

```
'''
# Reading glove vectors in python: https://stackoverflow.com/a/3823034
9/4084039
def loadGloveModel(gloveFile):
    print ("Loading Glove Model")
    f = open(gloveFile,'r', encoding="utf8")
    model = {}
    for line in tqdm(f):
        splitLine = line.split()
        word = splitLine[0]
        embedding = np.array([float(val) for val in splitLine[1:]])
        model[word] = embedding
    print ("Done.",len(model)," words loaded!")
    return model
model = loadGloveModel('glove.42B.300d.txt')


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

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

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

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


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

import pickle
with open('E:/applied ai course/DonorsChoose_2018/glove_vectors', 'wb')
 as f:
    pickle.dump(words_courpus, f)

'''
```

Out[64]:

```
'\n# Reading glove vectors in python: https://stackoverflow.com/a/38230
349/4084039\ndef loadGloveModel(gloveFile):\n    print ("Loading Glove
Model")\n    f = open(gloveFile,\'r\', encoding="utf8")\n    model = {}
\n    for line in tqdm(f):\n        splitLine = line.split()\n        w
ord = splitLine[0]\n        embedding = np.array([float(val) for val in
splitLine[1:]])\n        model[word] = embedding\n    print ("Done.",le
n(model)," words loaded!")\n    return model\nmodel = loadGloveModel
(\'glove.42B.300d.txt\')\n\n\nwords = []\nfor i in preproced_texts:\n
  words.extend(i.split(\' \'))\n\nfor i in preproced_titles:\n    word
s.extend(i.split(\' \'))\nprint("all the words in the coupus", len(word
s))\nwords = set(words)\nprint("the unique words in the coupus", len(wo
rds))\n\ninter_words = set(model.keys()).intersection(words)\nprint("Th
e number of words that are present in both glove vectors and our coupu
s",       len(inter_words),"(",np.round(len(inter_words)/len(words)*10
0,3),"%)")\n\nwords_courpus = {}\nwords_glove = set(model.keys())\nfor
i in words:\n    if i in words_glove:\n        words_courpus[i] = model
[i]\nprint("word 2 vec length", len(words_courpus))\n\n\n# stronging va
riables into pickle files python: http://www.jessicayung.com/how-to-use
-pickle-to-save-and-load-variables-in-python/\n\nimport pickle\nwith op
en(\'E:/applied ai course/DonorsChoose_2018/glove_vectors\', \'wb\') as
f:\n    pickle.dump(words_courpus, f)\n\n'
```

In [65]:

```
# stronging variables into pickle files python: http://www.jessicayung.
com/how-to-use-pickle-to-save-and-load-variables-in-python/
# make sure you have the glove_vectors file
```

```
with open('C:/Users/pramod reddy chandi/Desktop/pram/applied ai course/
DonorsChoose_2018/glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

In [66]:

```
# 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/re
view
    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 [00:38<00:00, 2829.74it/s]
```

```
109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on `project_title`

In [67]:

```
#vectorize the preprocessed title
avg_w2v_title = []; # the avg-w2v for each sentence/review is stored in
 this list
for sentence in tqdm(preprocessed_title): # 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/re
```

```
view
    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_title.append(vector)

print(len(avg_w2v_title))
print(len(avg_w2v_title[0]))
```

```
100%|██████████████████████████████████████████████████████████████████
██████| 109248/109248 [00:35<00:00, 3076.24it/s]
```

```
109248
300
```

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

In [68]:

```
# 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 v
alue
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model
.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [69]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is store
d 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 sentenc
```

```
e/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 t
he tf value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentenc
e.split())) # getting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors.append(vector)

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

```
100%|██████████████████████████████████████████████████████████████████
███████| 109248/109248 [07:28<00:00, 243.41it/s]
```

```
109248
300
```

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

In [70]:

```
# Similarly you can vectorize for title also
tfidf_model = TfidfVectorizer()
tfidf_model.fit(preprocessed_title)
# we are converting a dictionary with word as a key, and the idf as a v
alue
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model
.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [71]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_title = []; # the avg-w2v for each sentence/review is stored
 in this list
```

```
for sentence in tqdm(preprocessed_title): # 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 sentenc
e/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 t
he tf value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentenc
e.split())) # getting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_title.append(vector)

print(len(tfidf_w2v_title))
print(len(tfidf_w2v_title[0]))
```

```
100%|██████████████████████████████████████████████████████████████████
███████| 109248/109248 [07:39<00:00, 237.82it/s]
```

```
109248
300
```

1.4.3 Vectorizing Numerical features

In [72]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# taking numerical features like price(standard scaling),
# standardization sklearn: https://scikit-learn.org/stable/modules/gene
rated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler

# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 21
3.03 329.   ... 399.   287.73   5.5 ].
```

```
# 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 standard deviation of this data
print("Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(pr
ice_scalar.var_[0])}")

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

```
Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(price_sca
lar.var_[0])}
```

In [73]:

```
price_standardized
```

Out[73]:

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

In [74]:

```
previous_teacher_posted=project_data['teacher_number_of_previously_post
ed_projects']
```

1.4.4 Merging all the above features

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

categorical data :

```
school_state : school_state_one_hot
clean_categories : categories_one_hot
```

```
clean_subcategories : sub_categories_one_hot
teacher_prefix : teacher_prefix_one_hot
project_grade_category : project_grade_category_one_hot
```

project_title :

```
BOW:title_bow
TFIDF:title_tfidf
AVG W2V: avg_w2v_title
TFIDF W2V:tfidf_w2v_title
```

numerical: Price:price_standardized teacher_number_of_previously_posted_projects :previous_teacher_posted

y value: y=project_data['project_is_approved']

In [75]:

```
# 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((school_state_one_hot,categories_one_hot,sub_categories_one_hot))
X_cat=hstack((X,teacher_prefix_one_hot,project_grade_category_one_hot))


#dealing with numerical values
#converting previous techer posted to dataframe and Price standard array series to dataframe
Ptp = pd.DataFrame({'previous_teacher_post':previous_teacher_posted})
ps = pd.DataFrame({'price_standard':price_standardized[:,0]})

#joing both of numerical data attributes
X_num=Ptp.join(ps)

#combining both numerical and categorical data into X_cat_num
X_cat_num=hstack((X_cat,X_num))
```

```
#joining all the X attributes into respective title,tfidf,avg w2v title
 and tfidf w2v title

X_title = hstack((X_cat_num,title_bow))
X_title_tfidf = hstack((X_cat_num,title_tfidf))
X_avg_w2v_title = hstack((X_cat_num,avg_w2v_title))
X_tfidf_w2v_title = hstack((X_cat_num,tfidf_w2v_title))


y=project_data['project_is_approved']
```

Assignment 2: Apply TSNE

<font color=#F4274F>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.</font>

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)

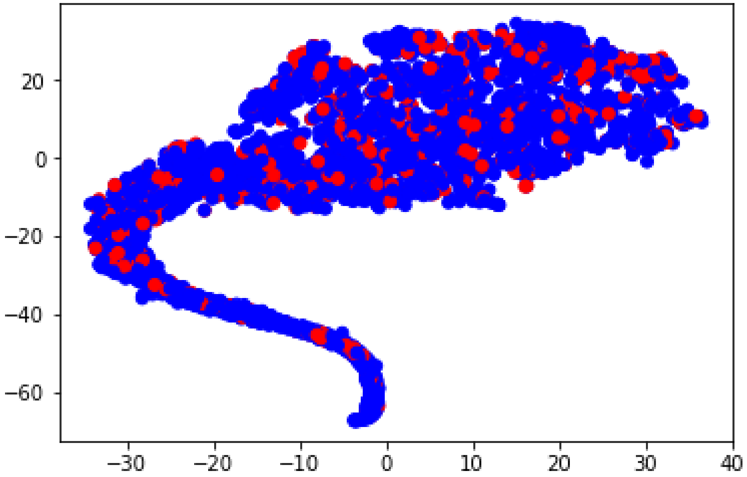
   B. categorical, numerical features + project_title(TFIDF)
   C. categorical, numerical features + project_title(AVG W2V)
   D. categorical, numerical features + project_title(TFIDF W2V)
5. Concatenate all the features and Apply TNSE on the final data matrix
6. Note 1: The TSNE accepts only dense matrices
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

2.1 TSNE with `BOW` encoding of `project_title` feature

In [76]:

```
import numpy as np
from sklearn.manifold import TSNE
from sklearn import datasets
import pandas as pd
import matplotlib.pyplot as plt

#considering only 4k data points

#Xlabel is bow on project title with 4k data points
bow=X_title.tocsr()
bow=bow[0:4000,:]

#ylabel is y_4k with 4k data points
y_4k=y.loc[:3999]

tsne = TSNE(n_components=2, perplexity=100, learning_rate=200)

X_embedding = tsne.fit_transform(bow.toarray())
# if x is a sparse matrix you need to pass it as X_embedding = tsne.fit_transform(x.toarray()) , .toarray() will convert the sparse matrix into dense matrix

for_tsne = np.hstack((X_embedding, y_4k.reshape(-1,1)))
for_tsne_df = pd.DataFrame(data=for_tsne, columns=['Dimension_x','Dimension_y','Score'])
```

```
colors = {0:'red', 1:'blue'}
plt.scatter(for_tsne_df['Dimension_x'], for_tsne_df['Dimension_y'], c=f
or_tsne_df['Score'].apply(lambda x: colors[x]))
plt.show()
```

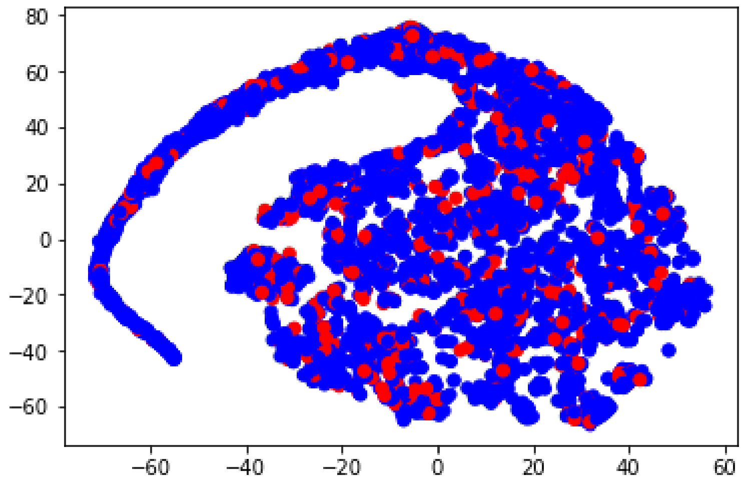


Observation: We could see few red clusters are present in between the blue clusters. we know that blue corresponding to accepting the project whereas red indicates the rejection of a project.From the diagram we can conclude that most data points belong to acceptance category.Please note that in this observation we have taken only 4k data points .we could see better deffernatiation if we increase perplexity .

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

In [77]:
```
import numpy as np
from sklearn.manifold import TSNE
from sklearn import datasets
import pandas as pd
import matplotlib.pyplot as plt

#considering only 4k data points
```

```
#X_title_tfidf = hstack((X_cat_num,title_tfidf))

#Xlabel is project title on title_tfidf with 4k data points
tfidf=X_title_tfidf.tocsr()
tfidf_4k=tfidf[0:4000,:]

#ylabel is y_4k with 4k data points
y_4k=y.loc[:3999]

tsne = TSNE(n_components=2, perplexity=30, learning_rate=200)

X_embedding = tsne.fit_transform(tfidf_4k.toarray())
# if x is a sparse matrix you need to pass it as X_embedding = tsne.fit
_transform(x.toarray()) , .toarray() will convert the sparse matrix int
o dense matrix

for_tsne = np.hstack((X_embedding, y_4k.reshape(-1,1)))
for_tsne_df = pd.DataFrame(data=for_tsne, columns=['Dimension_x','Dimen
sion_y','Score'])

# as we have two acceptance categories 1 for acceptance 0 for rejecting
 a proposal we are taking two colors
colors = {0:'red', 1:'blue'}
plt.scatter(for_tsne_df['Dimension_x'], for_tsne_df['Dimension_y'], c=f
or_tsne_df['Score'].apply(lambda x: colors[x]))
plt.show()
```

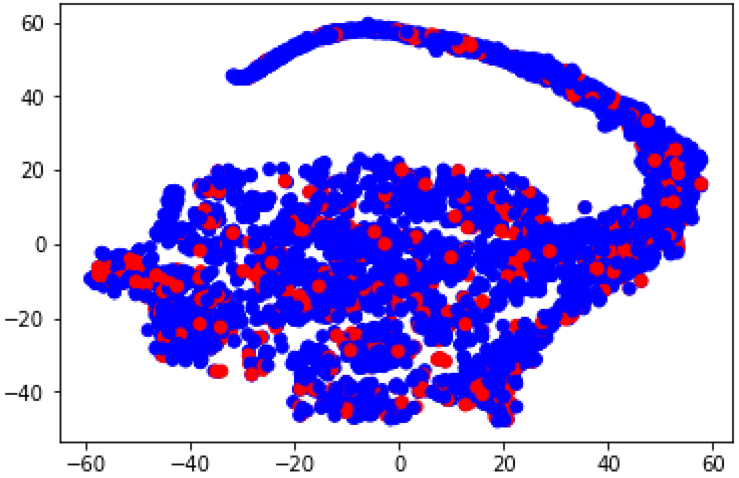


Observation: We could see that as perplexity decreased there is increase in sparse clusters,Blue clusters indicate that the project acceptance is sucessfull whereas red indicates project is rejected .From the figure we can draw that we could not differentiate much using TFIDF vectors of project title.

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

In [80]:
```
import numpy as np
from sklearn.manifold import TSNE
from sklearn import datasets
import pandas as pd
import matplotlib.pyplot as plt

#considering only 4k data points
#we know that the X_avg_w2v_title = hstack((X_cat_num,avg_w2v_title))

#Xlabel is project title avg_w2v_title with 4k data points
avg_w2v=X_avg_w2v_title.tocsr()
avg_w2v_4k=avg_w2v[0:4000,:]
```

```python
#ylabel is y_4k with 4k data points
y_4k=y.loc[:3999]

tsne = TSNE(n_components=2, perplexity=50, learning_rate=200)

X_embedding = tsne.fit_transform(avg_w2v_4k.toarray())
# if x is a sparse matrix you need to pass it as X_embedding = tsne.fit_transform(x.toarray()) , .toarray() will convert the sparse matrix into dense matrix

for_tsne = np.hstack((X_embedding, y_4k.reshape(-1,1)))
for_tsne_df = pd.DataFrame(data=for_tsne, columns=['Dimension_x','Dimension_y','Score'])

# as we have two acceptance categories 1 for acceptance 0 for rejecting a proposal we are taking two colors
colors = {0:'red', 1:'blue'}
plt.scatter(for_tsne_df['Dimension_x'], for_tsne_df['Dimension_y'], c=for_tsne_df['Score'].apply(lambda x: colors[x]))
plt.show()
```



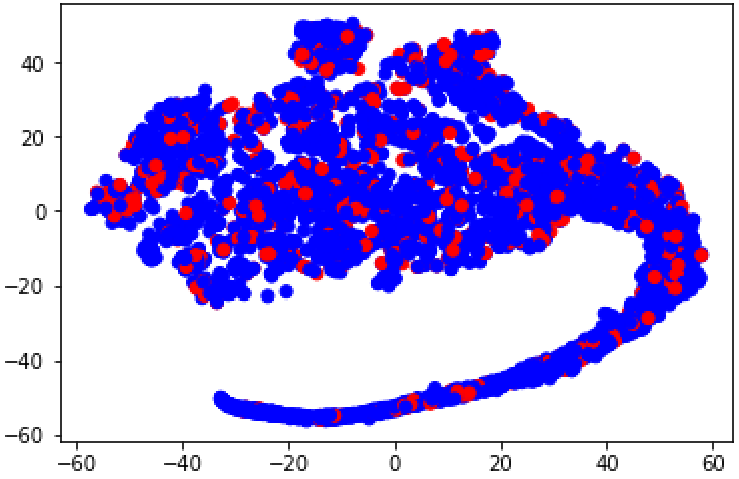
Observation:We could see few red clusters are present in between the blue clusters. we know that blue corresponding to accepting the project whereas red indicates the rejection of a project.From the diagram we can conclude that most data points belong to acceptance category.We could also draw that using avg_w2v of title feature the graph is sparse.Please note that in this observation we have taken only 4k data points

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

In [81]:

```
import numpy as np
from sklearn.manifold import TSNE
from sklearn import datasets
import pandas as pd
import matplotlib.pyplot as plt

#considering only 4k data points

#we know that X_tfidf_w2v_title = hstack((X_cat_num,tfidf_w2v_title))

#Xlabel is project title on tfidf_w2v_title with 4k data points
w2v_title=X_tfidf_w2v_title.tocsr()
w2v_title_4k=w2v_title[0:4000,:]

#ylabel is y_4k with 4k data points
y_4k=y.loc[:3999]

tsne = TSNE(n_components=2, perplexity=50, learning_rate=200)

X_embedding = tsne.fit_transform(w2v_title_4k.toarray())
# if x is a sparse matrix you need to pass it as X_embedding = tsne.fit
_transform(x.toarray()) , .toarray() will convert the sparse matrix int
o dense matrix

for_tsne = np.hstack((X_embedding, y_4k.reshape(-1,1)))
for_tsne_df = pd.DataFrame(data=for_tsne, columns=['Dimension_x','Dimen
sion_y','Score'])
```

```
# as we have two acceptance categories 1 for acceptance 0 for rejecting
 a proposal we are taking two colors
colors = {0:'red', 1:'blue'}
plt.scatter(for_tsne_df['Dimension_x'], for_tsne_df['Dimension_y'], c=f
or_tsne_df['Score'].apply(lambda x: colors[x]))
plt.show()
```



Observation:We could see few red clusters are present in between the blue clusters. we know that blue corresponding to accepting the project whereas red indicates the rejection of a project.From the diagram we can conclude that most data points belong to acceptance category.We could also draw that using tfidf_w2v of title feature the graph is sparse.Please note that in this observation we have taken only 4k data points

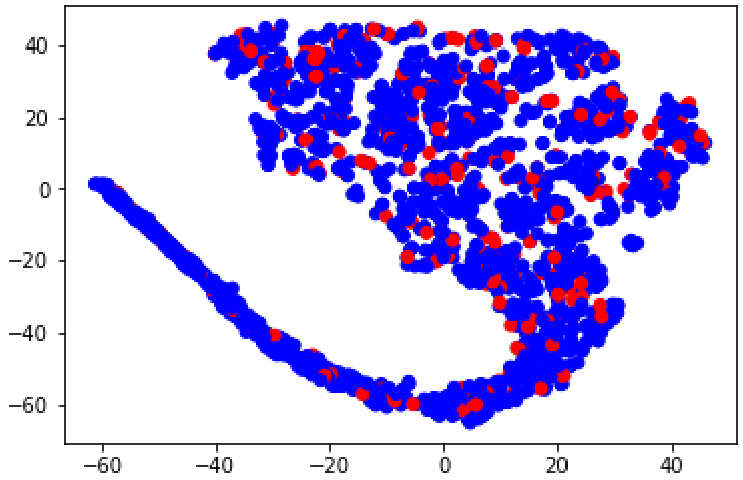
2.5 TNSE with all features combined

In [82]:

```
#combing all the numerical categorical and w2v title
```

```
#considering only 2k for memory issues
w2v_title_2k=w2v_title[0:2000,:]

#adding these features with 2k data points
#title_bow
#title_tfidf
#avg_w2v_title

tit=title_bow.tocsr()
tit_2k=tit[0:2000,:]


tit_tf_2k=title_tfidf.tocsr()
tit_tf_2k=tit_tf_2k[0:2000,:]

#kl=avg_w2v_title[0:2000, :]

#combing all these in hstack
#Xlabel is project title with 2k data points joining all attributes of
 X
#considering only 2k points as myy system ram is just 4GB

X_label1=hstack((w2v_title_2k,tit_2k,tit_tf_2k))


#ylabel is y_2k with 2k data points
y_2k=y.loc[:1999]

tsne = TSNE(n_components=2, perplexity=30, learning_rate=200)

X_embedding = tsne.fit_transform(X_label1.toarray())
# if x is a sparse matrix you need to pass it as X_embedding = tsne.fit
_transform(x.toarray()) , .toarray() will convert the sparse matrix int
o dense matrix

for_tsne = np.hstack((X_embedding, y_2k.reshape(-1,1)))
for_tsne_df = pd.DataFrame(data=for_tsne, columns=['Dimension_x','Dimen
sion_y','Score'])
```

```
# as we have two acceptance categories 1 for acceptance 0 for rejecting
 a proposal we are taking two colors
colors = {0:'red', 1:'blue'}
plt.scatter(for_tsne_df['Dimension_x'], for_tsne_df['Dimension_y'], c=f
or_tsne_df['Score'].apply(lambda x: colors[x]))
plt.show()
```



Observation:We could see few red clusters are present in between the blue clusters. we know that blue corresponding to accepting the project whereas red indicates the rejection of a project.From the diagram we can conclude that most data points belong to acceptance category.We could also draw that using all the features combined the graph is sparse.Please note that in this observation we have taken only 2k data points because of memory contraints.