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 p **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 follow enumerated values: • `Grades PreK-2` • `Grades 3-5` • `Grades 6-8` • `Grades 9-12`
project_subject_categories	One or more (comma-separated) su categories for the project from the fo 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, Ma & Science`

Feature	Description
school_state	State where school is located (Two-l U.S. postal code). **Example:** WY
project_subject_subcategories	One or more (comma-separated) su subcategories for the project. **Exam** • Literacy • Literature & Writing, Social Sciences
project_resource_summary	An explanation of the resources nee the project. **Example:** • My students need hands 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 w submitted. **Example:** 2016-04-28 12:43:56.245
teacher_id	A unique identifier for the teacher of proposed project. **Example:** bdf8baa8fedef6bfeec7ae4ff1c

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 previ submitted by the same teacher. **Exa** 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
`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 [230]:
```
%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 [231]:
```
project_data = pd.read_csv('train_data.csv')
resource_data = pd.read_csv('resources.csv')
```

In [232]:
```
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 [233]:
```
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[233]:

	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

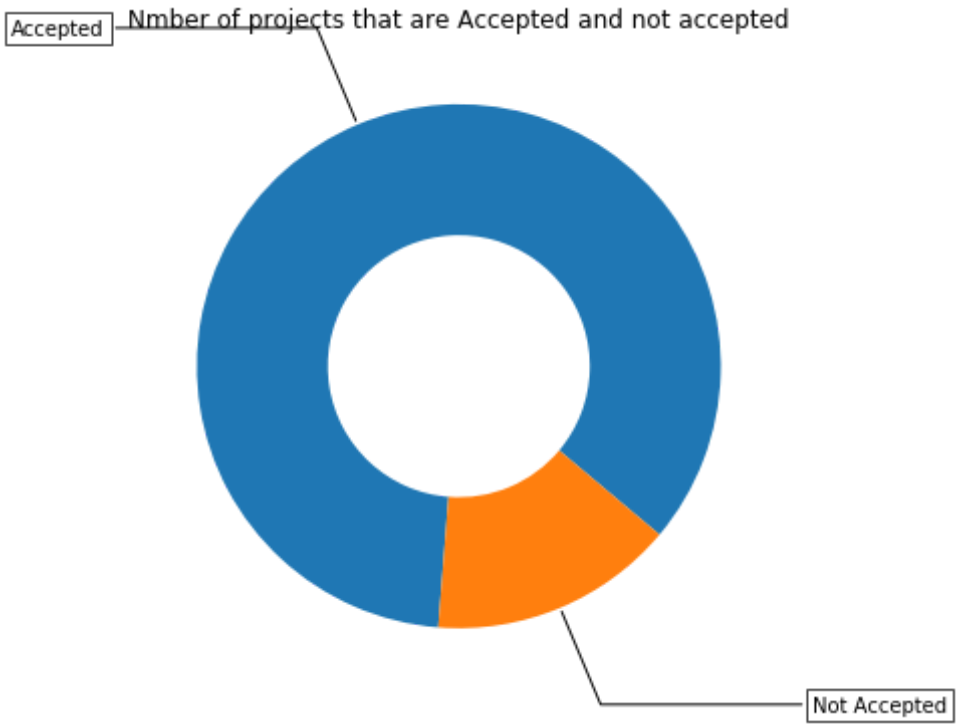
1.2 Data Analysis

In [234]:
```
# PROVIDE CITATIONS TO YOUR CODE IF YOU TAKE IT FROM ANOTHER WEBSITE.
```

```
# 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 %)
```



Observation: Around 85% of projects are approved i.e. 92706 projects are approved from 109248 submitted projects.

1.2.1 Univariate Analysis: School State

In [235]:
```
# Pandas dataframe groupby count, mean: https://stackoverflow.com/a/193
85591/4084039

temp = pd.DataFrame(project_data.groupby("school_state")["project_is_ap
proved"].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(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')'''
```

Out[235]:
```
'# How to plot US state heatmap: https://datascience.stackexchange.com/a/9620\n\nscl = [[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)\']]\n\ndata = [
dict(\n        type=\'choropleth\',\n        colorscale = scl,\n
autocolorscale = False,\n        locations = temp[\'state_code\'],\n
     z = temp[\'num_proposals\'].astype(float),\n        locationmode =
\'USA-states\',\n        text = temp[\'state_code\'],\n        marker =
dict(line = dict (color = \'rgb(255,255,255)\',width = 2)),\n        co
lorbar = dict(title = "% of pro")\n    ) ]\n\nlayout = dict(\n        t
itle = \'Project Proposals % of Acceptance Rate by US States\',\n
  geo = dict(\n            scope=\'usa\',\n            projection=dict(
type=\'albers usa\' ),\n            showlakes = True,\n            lake
color = \'rgb(255, 255, 255)\',\n        ),\n    )\n\nfig = go.Figure(d
ata=data, layout=layout)\noffline.iplot(fig, filename=\'us-map-heat-map
\')'
```

In [236]:

```
# 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
```

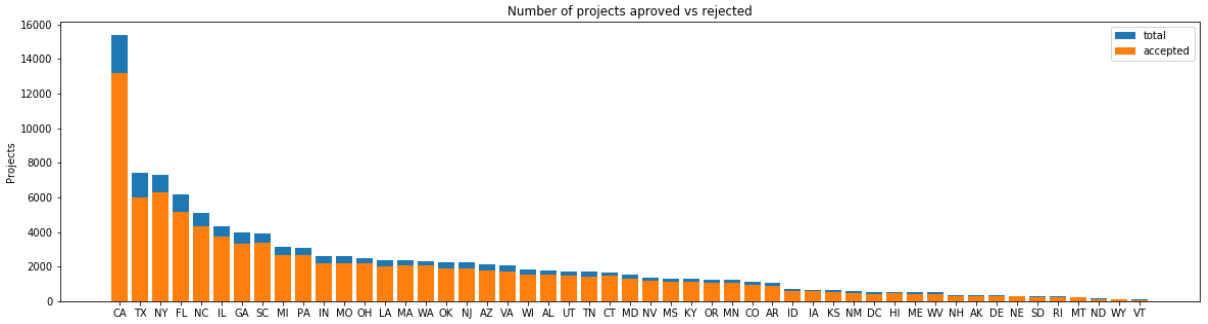
Observation: State code DE has highest number of approved projects and VT has lowest

In [237]:
```
#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 [238]:
```
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({'Avg':'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 [239]:
```
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

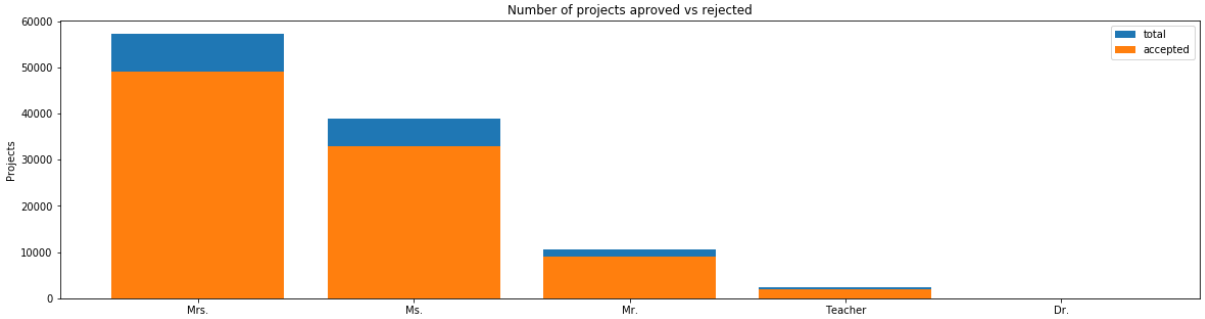
==========

	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

SUMMARY: Every state has greater than 80% success rate in approval

1.2.2 Univariate Analysis: teacher_prefix

In [240]:
```
univariate_barplots(project_data, 'teacher_prefix', 'project_is_approve
d' , 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

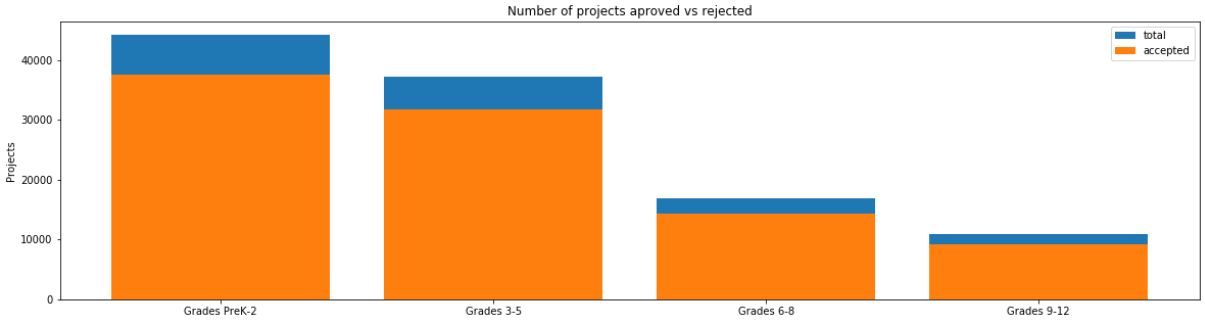
==========

	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

Observation: Among submitted project, project submitted by Mrs. teacher prefix has highest approvals more than 85% and Dr has lowest

1.2.3 Univariate Analysis: project_grade_category

In [241]:
```
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: Project grade category Grades Prek-2 has highest approved project around 85% while Grades 9-12 has lowest.

1.2.4 Univariate Analysis: project_subject_categories

In [242]:
```
catogories = list(project_data['project_subject_categories'].values)
# remove special characters from list of strings python: https://stacko
verflow.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 & 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('&','_') # we are replacing the & value int
o
    cat_list.append(temp.strip())
```

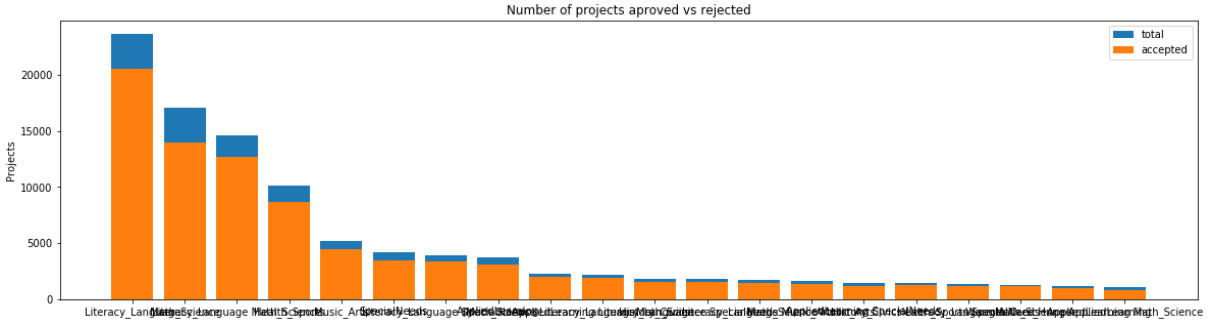
In [243]:

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

Out[243]:

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

In [244]:
```
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

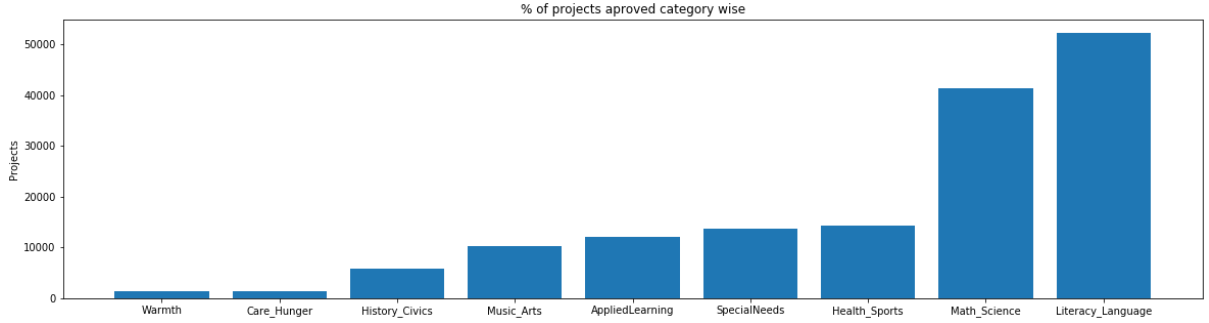
==========

	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

Observation: Maximum approved projects are on Literacy Language more than 86% and AppliedLearning Math_Science has least.

In [245]:
```
# 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 [246]:
```
# 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 [247]:
```
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
```

Observation: Category Literacy language has maximum submitted project and Warmth and Core_Hunger has least.

1.2.5 Univariate Analysis: project_subject_subcategories

In [248]:
```
sub_catogories = list(project_data['project_subject_subcategories'].val
ues)
# remove special characters from list of strings python: https://stacko
verflow.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
```

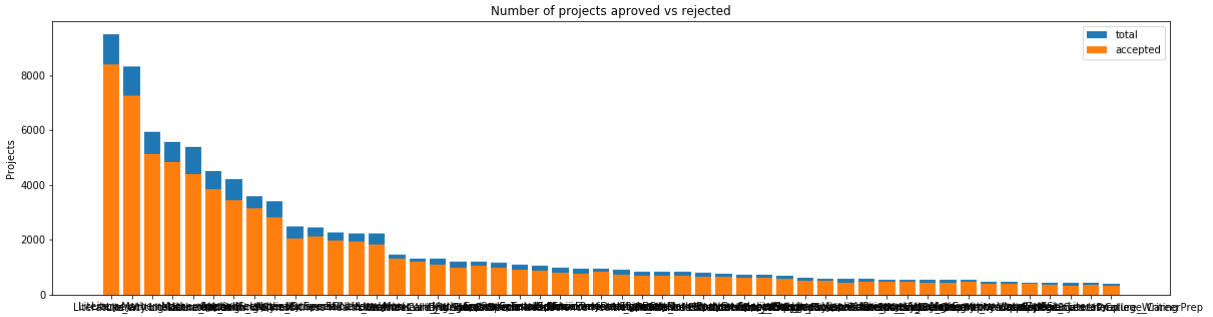
```
        ''(empty) ex:"Math & Science"=>"Math&Science"
            temp +=j.strip()+" "#" abc ".strip() will return "abc", remove
        the trailing spaces
            temp = temp.replace('&','_')
        sub_cat_list.append(temp.strip())
```

In [249]:
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=True)
project_data.head(2)
```

Out[249]:

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

In [250]:
```
univariate_barplots(project_data, 'clean_subcategories', 'project_is_approved', top=50)
```

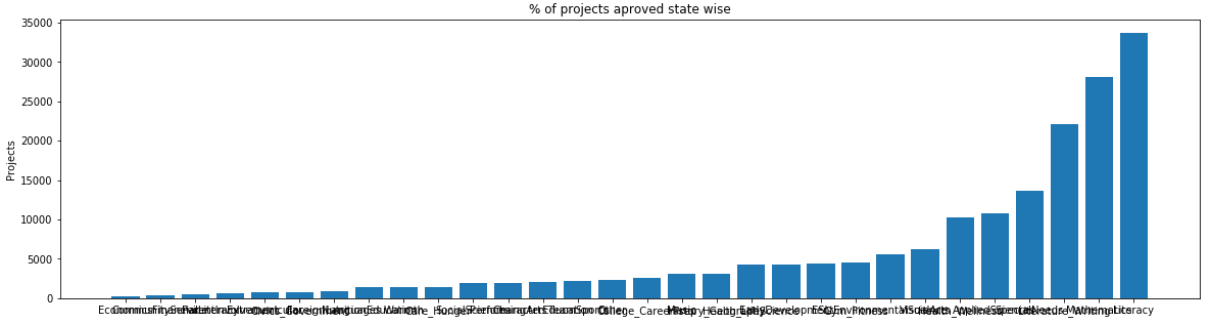



```
                clean_subcategories  project_is_approved  total       A
vg
317                        Literacy                 8371   9486  0.8824
58
319             Literacy Mathematics                 7260   8325  0.8720
72
331  Literature_Writing Mathematics                 5140   5923  0.8678
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
```

Observation: Literacy subcategory has highest approved projects while AppliedSciences College_CareerPrep has least.

In [251]:
```
# 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 [252]:
```
# 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 [253]:
```
for i, j in sorted_sub_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

```
Economics            :       269
CommunityService     :       441
FinancialLiteracy    :       568
```

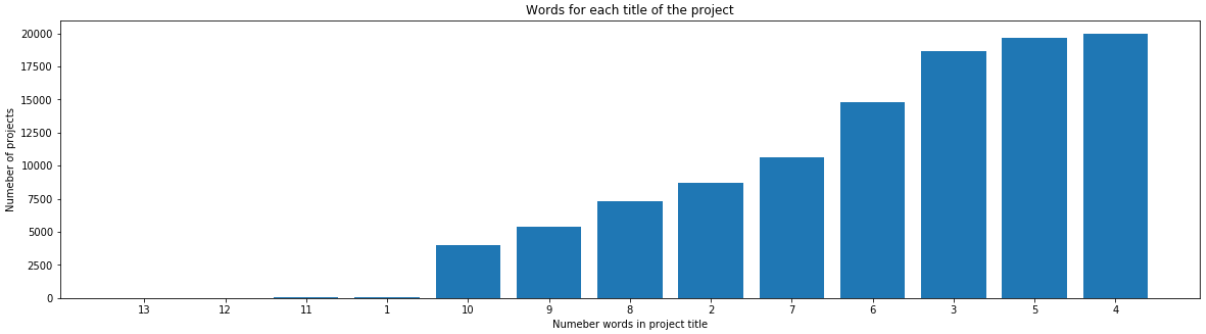
```
ParentInvolvement    :       677
Extracurricular      :       810
Civics_Government    :       815
ForeignLanguages     :       890
NutritionEducation   :      1355
Warmth               :      1388
Care_Hunger          :      1388
SocialSciences       :      1920
PerformingArts       :      1961
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
```

Observation: Subcategory Economics has least number of submitted project while Literacy has max.

1.2.6 Univariate Analysis: Text features (Title)

In [254]:
```
#How to calculate number of words in a string in DataFrame: https://sta
ckoverflow.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()
```

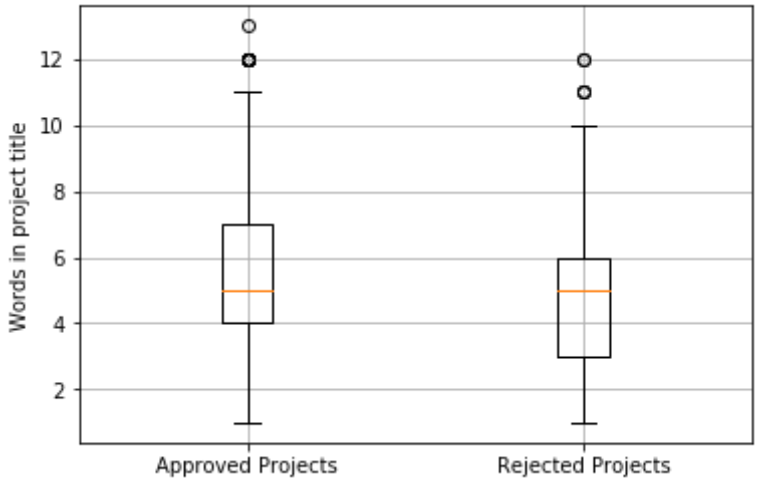


Observation: Project Title contains 4 and 5 words mostly and very less title has more than 10 words

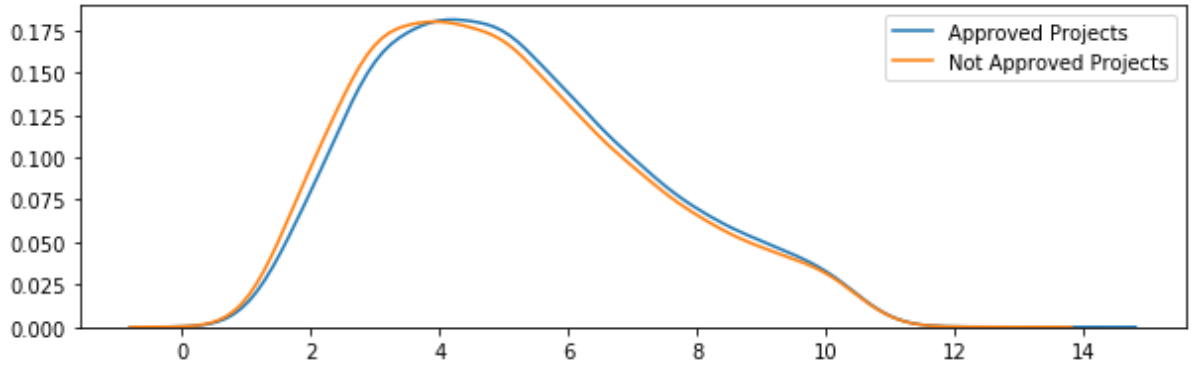
In [255]:
```
approved_title_word_count = project_data[project_data['project_is_approved']==1]['project_title'].str.split().apply(len)
approved_title_word_count = approved_title_word_count.values

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 [256]:
```
# 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 [257]:
```
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()
```



Observation: Box plot shows that approved projects tile has more words as compared to non approved projects title. PDF shows that both approved and non approved creates slightly right skewed graph.

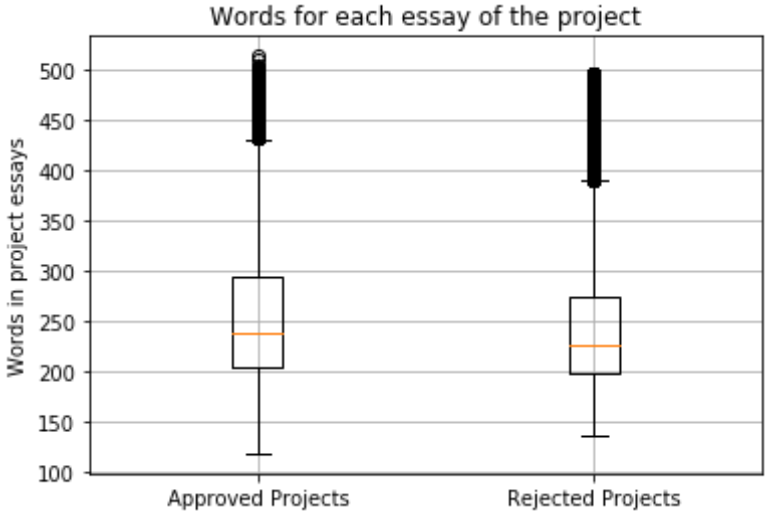
1.2.7 Univariate Analysis: Text features (Project Essay's)

In [258]:
```
# 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)
```

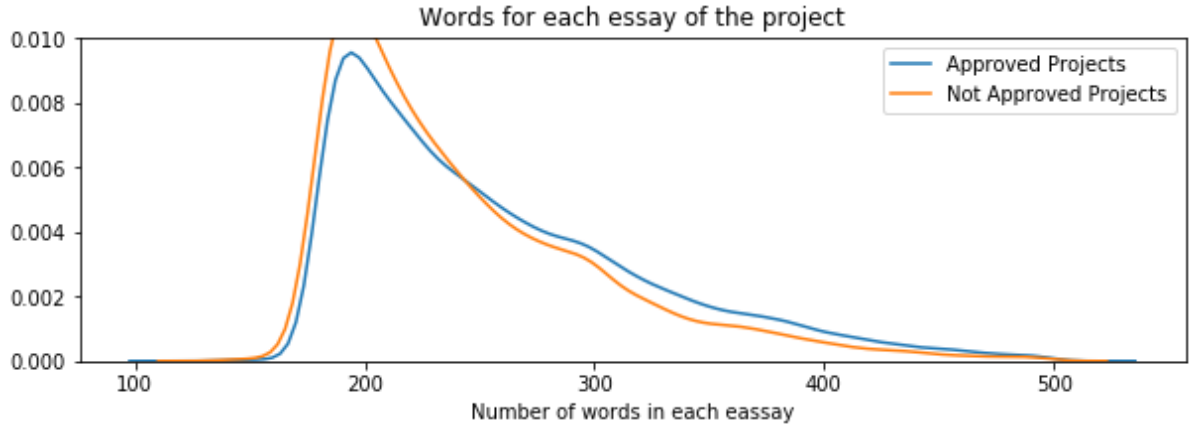
In [259]:
```
approved_word_count = project_data[project_data['project_is_approved']==1]['essay'].str.split().apply(len)
approved_word_count = approved_word_count.values

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

In [260]:
```
# 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()
```



In [261]:
```
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()
```



Observation: Box plot shows that Approved project has more words in essay as compared to non approved projects. PDF shows that non- approved project essayhas very high density of words around 200. It creates right skewed graph.

1.2.8 Univariate Analysis: Cost per project

In [262]:
```
# we get the cost of the project using resource.csv file
resource_data.head(2)
```

Out[262]:

	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 [263]:
```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframes-indexes-for-all-groups-in-one-step
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
price_data.head(2)
```

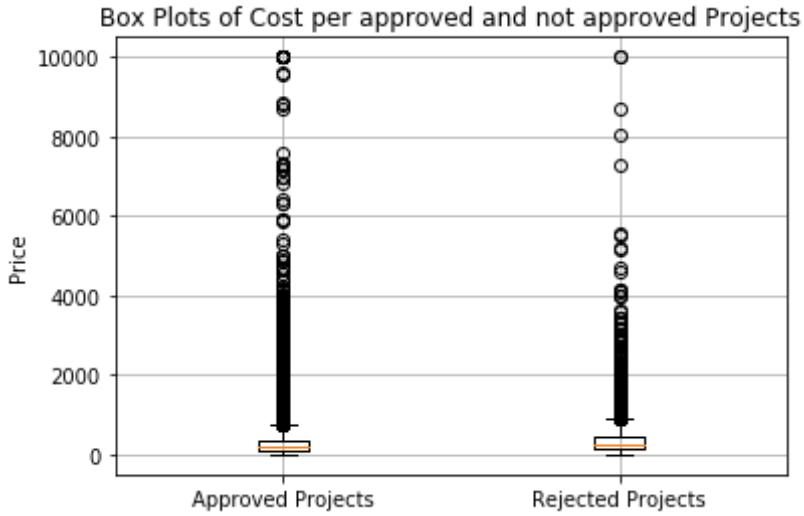
Out[263]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

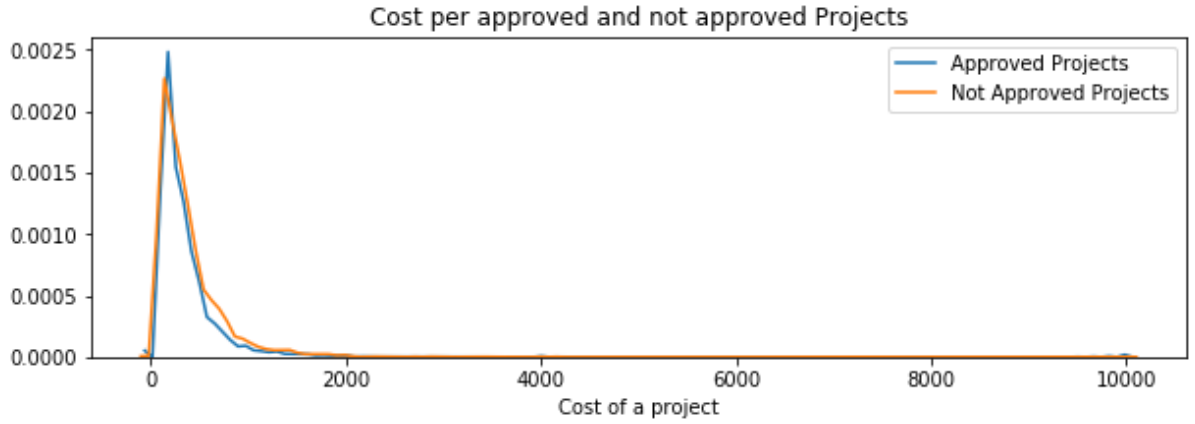
In [264]:
```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [265]:
```
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 [266]:
```
# 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 [267]:
```
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()
```



Observation: Box plot does not elaborate much diffrence in cost for approved and non approved project. PDF shows approved and rejected projects have very high density cost near 1000.

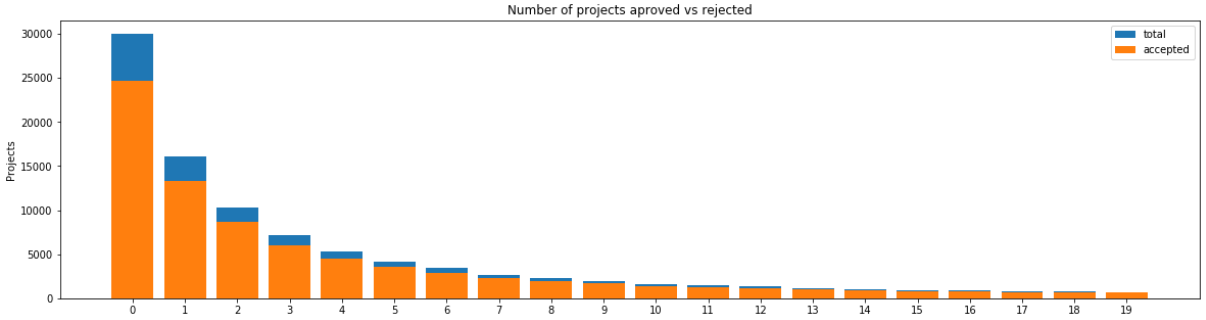
In [268]:
```
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

#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

In [269]:
```
univariate_barplots(project_data, 'teacher_number_of_previously_posted_
projects', 'project_is_approved' , top=20)
```




```
   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  \
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
```

Observation: There are 202 projects which are submitted for the first time out of which 168 are approved. Around 83% of new projects are approved.

In [270]:
```
teacher_prefix_project_data = project_data.groupby('teacher_prefix').ag
g({'teacher_number_of_previously_posted_projects':'sum'}).reset_index()
print(teacher_prefix_project_data)

school_state_project_data = project_data.groupby('school_state').agg({
'teacher_number_of_previously_posted_projects':'sum'}).reset_index()
print(school_state_project_data.sort_values(by=['teacher_number_of_prev
iously_posted_projects']))

project_grade_category_project_data = project_data.groupby('project_gra
de_category').agg({'teacher_number_of_previously_posted_projects':'sum'
}).reset_index()
```

```
print(project_grade_category_project_data.sort_values(by=['teacher_numb
er_of_previously_posted_projects']))
```

```
  teacher_prefix  teacher_number_of_previously_posted_projects
0            Dr.                                           53
1            Mr.                                       129559
2           Mrs.                                       639594
3            Ms.                                       441583
4        Teacher                                         7671
   school_state  teacher_number_of_previously_posted_projects
50           WY                                          474
46           VT                                          554
28           ND                                         1088
41           SD                                         1347
26           MT                                         1665
30           NH                                         2141
29           NE                                         2225
39           RI                                         2307
21           ME                                         2949
12           IA                                         3053
16           KS                                         3263
49           WV                                         3811
11           HI                                         4625
32           NM                                         4899
7            DC                                         5515
8            DE                                         5984
0            AK                                         7162
13           ID                                         7790
5            CO                                         7936
44           UT                                         8781
25           MS                                         9835
23           MN                                        10303
20           MD                                        10502
2            AR                                        10997
37           OR                                        11265
18           LA                                        12207
1            AL                                        13341
45           VA                                        14191
3            AZ                                        15177
42           TN                                        15852
```

```
36           OK                                                16042
33           NV                                                18015
48           WI                                                18791
19           MA                                                18810
17           KY                                                18859
31           NJ                                                21562
35           OH                                                21664
6            CT                                                22107
24           MO                                                22261
47           WA                                                23179
15           IN                                                29416
10           GA                                                29825
22           MI                                                29884
40           SC                                                34401
43           TX                                                46933
14           IL                                                47271
9            FL                                                50089
38           PA                                                55980
27           NC                                                80616
34           NY                                               160338
4            CA                                               251179
  project_grade_category  teacher_number_of_previously_posted_projects
2            Grades 9-12                                          103697
1             Grades 6-8                                          178380
0             Grades 3-5                                          386718
3          Grades PreK-2                                          549666
```

Observation:

i. Teacher with Prefix Mrs. submitted maximum number of previously posted projects and prefix with Teacher submitted least.

ii. State Code CA has maximum number of previously posted projects and DC and NM has least.

iii. Grades PreK-2 has maximum number of previously posted projects and Grades 6-8 has least.

In [271]:
```
clean_categories_project_data = project_data.groupby('clean_categories'
).agg({'teacher_number_of_previously_posted_projects':'sum'}).reset_ind
```

```
ex()
print(clean_categories_project_data.sort_values(by=['teacher_number_of_
previously_posted_projects']).head(2))
print(clean_categories_project_data.sort_values(by=['teacher_number_of_
previously_posted_projects']).tail(2))

clean_subcategories_project_data = project_data.groupby('clean_subcateg
ories').agg({'teacher_number_of_previously_posted_projects':'sum'}).res
et_index()
print(clean_subcategories_project_data.sort_values(by=['teacher_number_
of_previously_posted_projects']).head(5))
print(clean_subcategories_project_data.sort_values(by=['teacher_number_
of_previously_posted_projects']).tail(2))
```

```
                    clean_categories  \
23  History_Civics Warmth Care_Hunger
45      Music_Arts Warmth Care_Hunger

    teacher_number_of_previously_posted_projects
23                                             2
45                                            74
     clean_categories  teacher_number_of_previously_posted_projects
32       Math_Science                                        184941
24  Literacy_Language                                        208628
                  clean_subcategories  \
102      College_CareerPrep TeamSports
184                   Economics Other
112       CommunityService Gym_Fitness
129                     ESL Economics
67   Civics_Government Health_Wellness

     teacher_number_of_previously_posted_projects
102                                             0
184                                             0
112                                             0
129                                             0
67                                              1
      clean_subcategories  teacher_number_of_previously_posted_projects


319  Literacy_Mathematics                                         61471
```

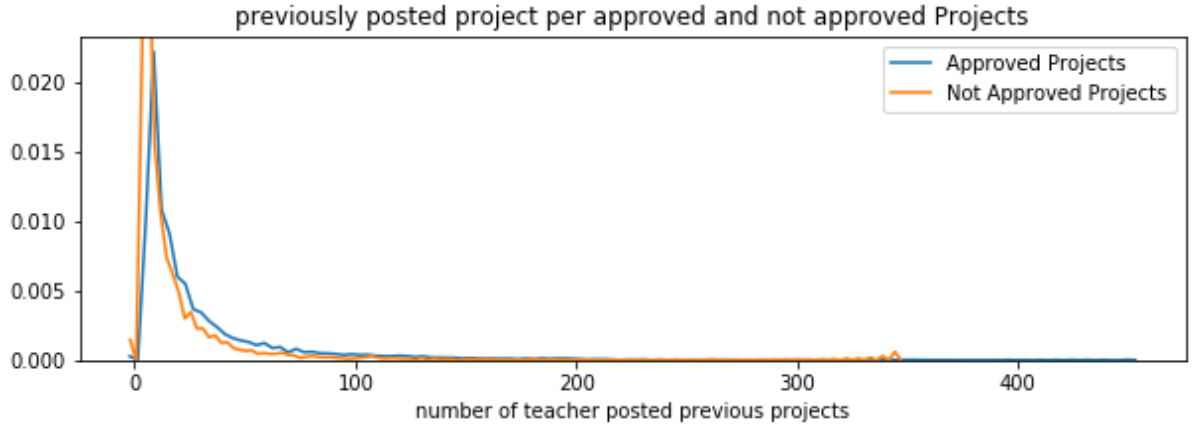
```
317              Literacy                                    81750
```

Observation:

Project category History_Civics Math_Science has no previously posted project while Health_Sports has maximum.

Project Subcategory arlyDevelopment SpecialNeeds, CommunityService , EnvironmentalScience History_Geography, History_Geography Mathematics, Health_Wellness Other has no previously posted project while Warmth Care_Hunger has maximum.

In [272]:
```
approved_project = project_data[project_data['project_is_approved']==1]
['teacher_number_of_previously_posted_projects'].values
rejected_project = project_data[project_data['project_is_approved']==0]
['teacher_number_of_previously_posted_projects'].values
plt.figure(figsize=(10,3))
sns.distplot(approved_project, hist=False, label="Approved Projects")
sns.distplot(rejected_project, hist=False, label="Not Approved Project
s")
plt.title('previously posted project per approved and not approved Proj
ects')
plt.xlabel('number of teacher posted previous projects')
plt.legend()
plt.show()
```



Observation:

Distribution plot of approved and not approved project with teacher_number_of_previously_posted_projects shows high density between 0 and 30.

1.2.10 Univariate Analysis: project_resource_summary

In [273]:
```
# To check whether a string has digit.https://stackoverflow.com/questio
ns/19859282/check-if-a-string-contains-a-number
def hasNumbers(inputString):
     return bool(re.search(r'\d', inputString))


resource_summary = list(project_data['project_resource_summary'].values
)

res_sum_list = []
for i in resource_summary:
    temp_data = ""

    for j in i.split(' '): # Splitting based on spaces

        if 'My' in j: # Removing repetition word 'My'
            j = ''

        if 'students' in j: # Removing repition word 'students'
            j = ''

        if 'need' in j: # Replacing need with Required.
            j = j.replace('need', 'Required')

        if (hasNumbers(j) == True): # if string has digit remove string
 as it is not helpful in classification
            j = ''

        temp_data += j.strip()+" " # Removing trailer/trimming string
```

```
        temp_data = temp_data.replace('&',' ') # Replacing & with space
    res_sum_list.append(temp_data.strip()) # Appending list
```

In [274]:
```
project_data['clean_resource_summary'] = res_sum_list
project_data.drop(['project_resource_summary'], axis=1, inplace=True)
project_data.head(20)
```

Out[274]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_sta
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY

	Unnamed: 0	id	teacher_id	teacher_prefix	school_sta
4	172407	p104768	be1f7507a41f8479dc06f047086a39ec	Mrs.	TX
5	141660	p154343	a50a390e8327a95b77b9e495b58b9a6e	Mrs.	FL
6	21147	p099819	9b40170bfa65e399981717ee8731efc3	Mrs.	CT
7	94142	p092424	5bfd3d12fae3d2fe88684bbac570c9d2	Ms.	GA

	Unnamed: 0	id	teacher_id	teacher_prefix	school_sta
8	112489	p045029	487448f5226005d08d36bdd75f095b31	Mrs.	SC
9	158561	p001713	140eeac1885c820ad5592a409a3a8994	Ms.	NC
10	43184	p040307	363788b51d40d978fe276bcb1f8a2b35	Mrs.	CA
11	127083	p251806	4ba7c721133ef651ca54a03551746708	Ms.	CA
12	19090	p051126	5e52c92b7e3c472aad247a239d345543	Mrs.	NY

	Unnamed: 0	id	teacher_id	teacher_prefix	school_sta
13	15126	p003874	178f6ae765cd4e0fb143a77c47fd65e2	Mrs.	OK
14	62232	p233127	424819801de22a60bba7d0f4354d0258	Ms.	MA
15	67303	p132832	bb6d6d054824fa01576ab38dfa2be160	Ms.	TX
16	127215	p174627	4ad7e280fddff889e1355cc9f29c3b89	Mrs.	FL
17	157771	p152491	e39abda057354c979c5b075cffbe5f88	Ms.	NV

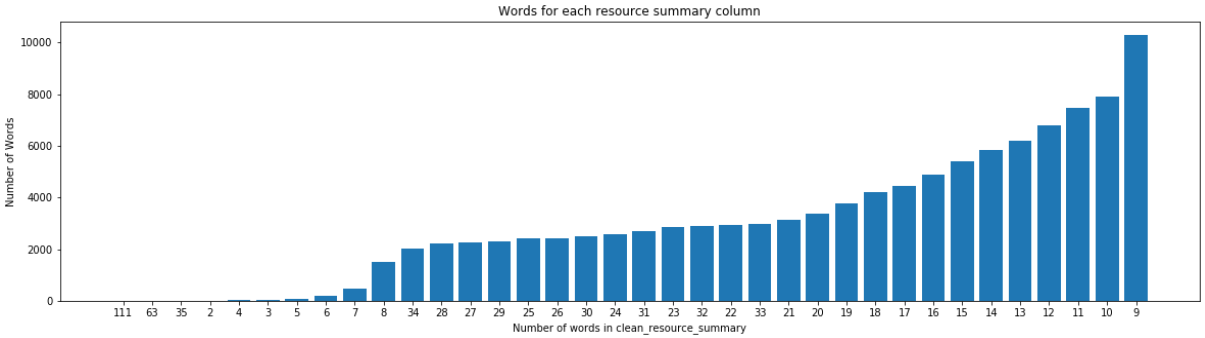
	Unnamed: 0	id	teacher_id	teacher_prefix	school_sta
18	122186	p196421	fcd9b003fc1891383f340a89da02a1a6	Mrs.	GA
19	146331	p058343	8e07a98deb1bc74c75b97521e05b1691	Ms.	OH

Observation: In above data, project_resource_summary is dropped and clean_resource_summary created with alterations

In [275]:
```
rs_word_count = project_data['clean_resource_summary'].str.split().appl
y(len).value_counts()
rs_word_dict = dict(rs_word_count)
rs_word_dict = dict(sorted(rs_word_dict.items(), key=lambda kv: kv[1]))
print(rs_word_dict)
rs_ind = np.arange(len(rs_word_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(rs_ind, list(rs_word_dict.values()))

plt.ylabel('Number of Words')
plt.xlabel('Number of words in clean_resource_summary')
plt.title('Words for each resource summary column')
plt.xticks(rs_ind, list(rs_word_dict.keys()))
plt.show()
```

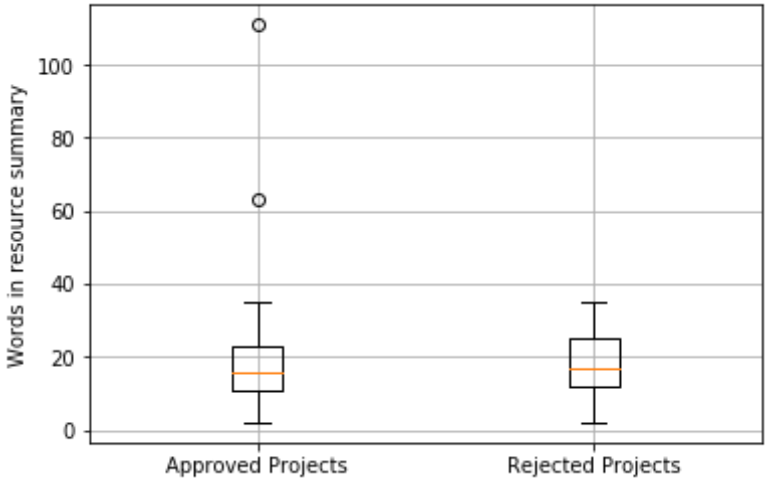
```
{111: 1, 63: 1, 35: 2, 2: 9, 4: 42, 3: 45, 5: 80, 6: 206, 7: 453, 8: 15
04, 34: 2020, 28: 2234, 27: 2277, 29: 2314, 25: 2416, 26: 2429, 30: 251
4, 24: 2578, 31: 2702, 23: 2877, 32: 2913, 22: 2946, 33: 2973, 21: 315
```

```
3, 20: 3364, 19: 3779, 18: 4221, 17: 4464, 16: 4883, 15: 5385, 14: 582
9, 13: 6187, 12: 6791, 11: 7458, 10: 7907, 9: 10291}
```

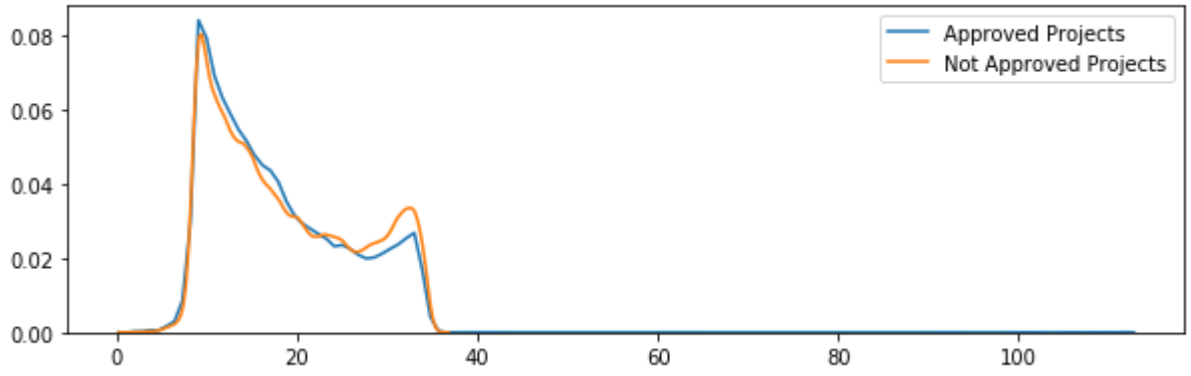


Observation: Resource summary column has a single word maximum of around 70 times and minimum 1 time

In [276]:
```
approved_rs_word_count = project_data[project_data['project_is_approve
d']==1]['clean_resource_summary'].str.split().apply(len)
approved_rs_word_count = approved_rs_word_count.values

rejected_rs_word_count = project_data[project_data['project_is_approve
d']==0]['clean_resource_summary'].str.split().apply(len)
rejected_rs_word_count = rejected_rs_word_count.values

plt.boxplot([approved_rs_word_count, rejected_rs_word_count])
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Words in resource summary')
plt.grid()
plt.show()
```



In [277]:
```
plt.figure(figsize=(10,3))
sns.kdeplot(approved_rs_word_count,label="Approved Projects", bw=0.6)
sns.kdeplot(rejected_rs_word_count,label="Not Approved Projects", bw=0.
6)
plt.legend()
plt.show()
```



Observation: Rejected project has more words in resource summary as copared to approved projects and word density is high between 5 to 10.

1.3 Text preprocessing

1.3.1 Essay Text

In [278]:
```
project_data.head(2)
```

Out[278]:

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

In [279]:
```
# 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[300])
print("="*50)
print(project_data['essay'].values[500])
```

```
print("="*50)
print(project_data['essay'].values[700])
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

==========

My AP Biology students are some of the best Artesia High School has to offer. These students are college bound and career oriented. They choos e to take this very challenging college level course, that covers 2 sem esters of introductory biology classes, because they are motivated and willing to push themselves to achieve to their max potential. \r\n\r\nT his course allows them to explore a variety of topics, think criticall y, develop an understanding for the world around them, collaborate with their peers and more!My AP students will greatly benefit from these not ebooks as they will be able to use them to create their interactive lea rning logs with them. This will be where all of their coursework throug hout the semester goes. Much research has been done about the various m ethods students learn best by and the use of the interactive notebook i s one way to incorporate many learning styles. Interactive notebooks al low me as the teacher to incorporate a variety of learning activities a ll organized in to one convenient place for the students to reference. \r\n\r\nInteractive notebooks have been shown to help increase student achievement! AP students naturally tend be high level students, but the y are still high school students who need guidance in developing tools

and techniques to be successful in their academic careers. This noteboo
k allows me to help them grow as students and as learners.nannan
==========
My students are high school seniors who are simultaneously excited for
and terrified by the prospect of college. In order to help them prepare
for the academic demands of college, I have placed a heavy writing requ
irement in our ELA class spanning essays, poetry, memoirs, etc.\r\n\r\n
My students are the definition of survivors. They have grown up in some
of the toughest neighborhoods in New York. They fight the norm that sur
rounds them every single day by making the decision to stay in school a
nd better themselves - both academically and emotionally. This group of
students has made it to their senior year of high school - a milestone
that too many of their friends, family, and former classmates have not
yet been able to achieve. They have big plans for college and want to g
o on to become doctors, lawyers, teachers, and investment bankers. They
have only a short year until they will have to navigate the world outsi
de of the school that many of them have known since sixth grade. I want
to ensure that they are given all the resources necessary for them to t
ransition from high school to college and beyond.Without computers at
home, many of my students hand write multi paragraph essays, or type th
em out line-by-line on their cell phones. Adding 5 Chromebooks to our c
lassroom will allow my students to practice the essential skills of the
writing process on a computer. These skills – such as the basic mechani
cs of typing, or the revision of a rough draft – will be necessary for
their colleges and careers. With 5 Chromebooks, my ELA students would b
e able to type up their personal essays for their college applications,
persuasive essays, poetry, and research papers. In addition, they will
start building a writing portfolio through Google Drive that will serve
and support them for the rest of their academic and professional career
s. The writings and subsequent teacher and peer feedback that they rece
ive will no longer be lost after they have turned in their assignments,
but will remain with them as long as they have access to the Interne
t.\r\n\r\nEvery week, new technologies emerge that could engage student
s and transform their academic understanding into real world action. B
ut without student computers, our learning remains stagnant. Through th
e addition of these classroom computers, my students will be able to en
gage in a world outside of the four walls of our classroom. They have t
he ability, motivation, and passion to change the world, but can only d
o this if they have access to the resources they so badly need and dese

```
rve.nannan
==================================================
We strive to create a loving and nurturing classroom, where students ca
n feel safe and supported, so that they can be fully engaged throughout
their day in order to learn to become their best selves.\r\n\r\n\r\nOur
goal is to help foster their growth, both personally and academically,
despite their severely complex medical needs. We do not want them to se
e their disabilities as limitations, but rather as an opportunity to fi
nd successful ways to navigate their environment.  We want to set them
up for success so that they can access their environment just like thei
r typical peers. We want to give them each the individual tool they nee
d to succeed. \r\n\r\nOur goal is to always give our students opportuni
ties in which they can feel successful and included in. These materials
will help with their physical therapy, gross motor development, and sel
f-esteem. Through adapted sports, our students will also learn about wh
at it means to be part of a team and also the chance to form friendship
s. Giving students with disabilities this opportunity is an investment
in their future and will directly have an impact on their growth and de
velopment. \r\n\r\nThis project will enrich the lives of our students b
y making adaptive physical education and swimming accessible and exciti
ng for all students to participate in, despite their disabilities. \r\n
nannan
==================================================
```

In [280]:

```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 [281]:
```
sent = decontracted(project_data['essay'].values[500])
print(sent)
print("="*50)
```

```
My students are high school seniors who are simultaneously excited for
and terrified by the prospect of college. In order to help them prepare
for the academic demands of college, I have placed a heavy writing requ
irement in our ELA class spanning essays, poetry, memoirs, etc.\r\n\r\n
My students are the definition of survivors. They have grown up in some
of the toughest neighborhoods in New York. They fight the norm that sur
rounds them every single day by making the decision to stay in school a
nd better themselves - both academically and emotionally. This group of
students has made it to their senior year of high school - a milestone
that too many of their friends, family, and former classmates have not
yet been able to achieve. They have big plans for college and want to g
o on to become doctors, lawyers, teachers, and investment bankers. They
have only a short year until they will have to navigate the world outsi
de of the school that many of them have known since sixth grade. I want
to ensure that they are given all the resources necessary for them to t
ransition from high school  to college and beyond.Without computers at
home, many of my students hand write multi paragraph essays, or type th
em out line-by-line on their cell phones. Adding 5 Chromebooks to our c
lassroom will allow my students to practice the essential skills of the
writing process on a computer. These skills – such as the basic mechani
cs of typing, or the revision of a rough draft – will be necessary for
their colleges and careers. With 5 Chromebooks, my ELA students would b
e able to type up their personal essays for their college applications,
persuasive essays, poetry, and research papers. In addition, they will
start building a writing portfolio through Google Drive that will serve
and support them for the rest of their academic and professional career
s. The writings and subsequent teacher and peer feedback that they rece
ive will no longer be lost after they have turned in their assignments,
but will remain with them as long as they have access to the Interne
t.\r\n\r\nEvery week, new technologies emerge that could engage student
s and transform their academic understanding into real world action.  B
```

```
ut without student computers, our learning remains stagnant. Through th
e addition of these classroom computers, my students will be able to en
gage in a world outside of the four walls of our classroom. They have t
he ability, motivation, and passion to change the world, but can only d
o this if they have access to the resources they so badly need and dese
rve.nannan
==================================================
```

In [282]:
```
# \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 students are high school seniors who are simultaneously excited for
and terrified by the prospect of college. In order to help them prepare
for the academic demands of college, I have placed a heavy writing requ
irement in our ELA class spanning essays, poetry, memoirs, etc.    My s
tudents are the definition of survivors. They have grown up in some of
the toughest neighborhoods in New York. They fight the norm that surrou
nds them every single day by making the decision to stay in school and
better themselves - both academically and emotionally. This group of st
udents has made it to their senior year of high school - a milestone th
at too many of their friends, family, and former classmates have not ye
t been able to achieve. They have big plans for college and want to go
on to become doctors, lawyers, teachers, and investment bankers. They h
ave only a short year until they will have to navigate the world outsid
e of the school that many of them have known since sixth grade. I want
to ensure that they are given all the resources necessary for them to t
ransition from high school  to college and beyond.Without computers at
home, many of my students hand write multi paragraph essays, or type th
em out line-by-line on their cell phones. Adding 5 Chromebooks to our c
lassroom will allow my students to practice the essential skills of the
writing process on a computer. These skills – such as the basic mechani
cs of typing, or the revision of a rough draft – will be necessary for
their colleges and careers. With 5 Chromebooks, my ELA students would b
e able to type up their personal essays for their college applications,
persuasive essays, poetry, and research papers. In addition, they will
```

```
start building a writing portfolio through Google Drive that will serve
and support them for the rest of their academic and professional career
s. The writings and subsequent teacher and peer feedback that they rece
ive will no longer be lost after they have turned in their assignments,
but will remain with them as long as they have access to the Internet.
   Every week, new technologies emerge that could engage students and t
ransform their academic understanding into real world action.  But with
out student computers, our learning remains stagnant. Through the addit
ion of these classroom computers, my students will be able to engage in
a world outside of the four walls of our classroom. They have the abili
ty, motivation, and passion to change the world, but can only do this i
f they have access to the resources they so badly need and deserve.nann
an
```

In [283]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
My students are high school seniors who are simultaneously excited for
and terrified by the prospect of college In order to help them prepare
for the academic demands of college I have placed a heavy writing requi
rement in our ELA class spanning essays poetry memoirs etc My students
are the definition of survivors They have grown up in some of the tough
est neighborhoods in New York They fight the norm that surrounds them e
very single day by making the decision to stay in school and better the
mselves both academically and emotionally This group of students has ma
de it to their senior year of high school a milestone that too many of
their friends family and former classmates have not yet been able to ac
hieve They have big plans for college and want to go on to become docto
rs lawyers teachers and investment bankers They have only a short year
until they will have to navigate the world outside of the school that m
any of them have known since sixth grade I want to ensure that they are
given all the resources necessary for them to transition from high scho
ol to college and beyond Without computers at home many of my students
hand write multi paragraph essays or type them out line by line on thei
r cell phones Adding 5 Chromebooks to our classroom will allow my stude
nts to practice the essential skills of the writing process on a comput
er These skills such as the basic mechanics of typing or the revision o
f a rough draft will be necessary for their colleges and careers With 5
```

```
Chromebooks my ELA students would be able to type up their personal ess
ays for their college applications persuasive essays poetry and researc
h papers In addition they will start building a writing portfolio throu
gh Google Drive that will serve and support them for the rest of their
academic and professional careers The writings and subsequent teacher a
nd peer feedback that they receive will no longer be lost after they ha
ve turned in their assignments but will remain with them as long as the
y have access to the Internet Every week new technologies emerge that c
ould engage students and transform their academic understanding into re
al world action But without student computers our learning remains stag
nant Through the addition of these classroom computers my students will
be able to engage in a world outside of the four walls of our classroom
They have the ability motivation and passion to change the world but ca
n only do this if they have access to the resources they so badly need
and deserve nannan
```

In [284]:

```
# 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 [285]:
```
# 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 [00:55<00:00, 1973.24it/s]
```

In [286]:
```
# after preprocesing
preprocessed_essays[500]
```

Out[286]:
```
'my students high school seniors simultaneously excited terrified prosp
ect college in order help prepare academic demands college i placed hea
vy writing requirement ela class spanning essays poetry memoirs etc my
students definition survivors they grown toughest neighborhoods new yor
k they fight norm surrounds every single day making decision stay schoo
l better academically emotionally this group students made senior year
high school milestone many friends family former classmates not yet abl
e achieve they big plans college want go become doctors lawyers teacher
s investment bankers they short year navigate world outside school many
```

```
known since sixth grade i want ensure given resources necessary transit
ion high school college beyond without computers home many students han
d write multi paragraph essays type line line cell phones adding 5 chro
mebooks classroom allow students practice essential skills writing proc
ess computer these skills basic mechanics typing revision rough draft n
ecessary colleges careers with 5 chromebooks ela students would able ty
pe personal essays college applications persuasive essays poetry resear
ch papers in addition start building writing portfolio google drive ser
ve support rest academic professional careers the writings subsequent t
eacher peer feedback receive no longer lost turned assignments remain l
ong access internet every week new technologies emerge could engage stu
dents transform academic understanding real world action but without st
udent computers learning remains stagnant through addition classroom co
mputers students able engage world outside four walls classroom they ab
ility motivation passion change world access resources badly need deser
ve nannan'
```

1.3.2 Project title Text

In [287]:
```
# printing some project titles.
for i in range (0,21):

    print(project_data['project_title'].values[i])
    print("="*50)
```

```
Educational Support for English Learners at Home
==================================================
Wanted: Projector for Hungry Learners
==================================================
Soccer Equipment for AWESOME Middle School Students
==================================================
Techie Kindergarteners
==================================================
Interactive Math Tools
==================================================
Flexible Seating for Mrs. Jarvis' Terrific Third Graders!!
==================================================
```

```
Chromebooks for Special Education Reading Program
==================================================
It's the 21st Century
==================================================
Targeting More Success in Class
==================================================
Just For the Love of Reading--\r\nPure Pleasure
==================================================
Reading Changes Lives
==================================================
Elevating Academics and Parent Rapports Through Technology
==================================================
Building Life Science Experiences
==================================================
Everyone deserves to be heard!
==================================================
TABLETS CAN SHOW US THE WORLD
==================================================
Making Recess Active
==================================================
Making Great LEAP's With Leapfrog!
==================================================
Technology Teaches Tomorrow's Talents Today
==================================================
Test Time
==================================================
Wiggling Our Way to Success
==================================================
Magic Carpet Ride in Our Library
==================================================
```

Printed first 20 data of project title from the train.csv. Data has many stopwords and special characters. Even it has /r/n also. Some titles have numbers also like(21st). Some titles have 'it's'.

In [288]:
```
preprocessed_titles = []

for dataset in tqdm(project_data['project_title'].values):
```

```
    data = decontracted(dataset)  # Replacing some specific and general
 short form into proper word/stopword.
    data = re.sub(r"it's", "it is", data) # Replacing it's with it is a
s it is not part of function decontracted
    data = data.replace('\\r', ' ') # Replacing \r with space
    data = data.replace('\\"', ' ') # Replacing \ with space
    data = data.replace('\\n', ' ') # Replacing \n with space
    data = re.sub('[^A-Za-z0-9]+', ' ', data) # Replacing special chara
cters with space
    data = re.sub("\S*\d\S*", "", data).strip() # Trimming numbers cont
aining digits

    data = ' '.join(e for e in data.split() if e not in stopwords) # Re
moving stopwords
    preprocessed_titles.append(data.lower().strip()) # Creating array i
n all the lower cases.
```

```
100%|██████████████████████████████████████████████████████████████
██████| 109248/109248 [00:03<00:00, 34677.92it/s]
```

In [289]:

```
for i in range (0,21):
    print(preprocessed_titles[i])
    print("="*50)
```

```
educational support english learners home
==================================================
wanted projector hungry learners
==================================================
soccer equipment awesome middle school students
==================================================
techie kindergarteners
==================================================
interactive math tools
==================================================
flexible seating mrs jarvis terrific third graders
==================================================
chromebooks special education reading program
==================================================
it century
==================================================
```

```
targeting more success class
==================================================
just for love reading pure pleasure
==================================================
reading changes lives
==================================================
elevating academics parent rapports through technology
==================================================
building life science experiences
==================================================
everyone deserves heard
==================================================
tablets can show us the world
==================================================
making recess active
==================================================
making great leap with leapfrog
==================================================
technology teaches tomorrow talents today
==================================================
test time
==================================================
wiggling our way success
==================================================
magic carpet ride our library
==================================================
```

Observation: As we can see after preprocessing data do not have any special characters, symbols, stopwords and all the words are in lowercase

1. 4 Preparing data for models

In [290]:
```
project_data.columns
```

Out[290]:
```
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', 'teacher_number_of_previously_posted_project
s',
       'project_is_approved', 'clean_categories', 'clean_subcategorie
s',
       'essay', 'price', 'quantity', 'clean_resource_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/

In [291]:
```
# we use count vectorizer to convert the values into one hot encoded fe
atures
from sklearn.feature_extraction.text import CountVectorizer
```

```
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), l
owercase=False, binary=True)
vectorizer.fit(project_data['clean_categories'].values)
print(vectorizer.get_feature_names())


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

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearn
ing', 'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Literacy_Langua
ge']
Shape of matrix after one hot encodig  (109248, 9)
```

In [292]:
```
# we use count vectorizer to convert the values into one hot encoded fe
atures
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_subca
tegories'].values)
print("Shape of matrix after one hot encodig ",sub_categories_one_hot.s
hape)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolveme
nt', 'Extracurricular', 'Civics_Government', 'ForeignLanguages', 'Nutri
tionEducation', 'Warmth', 'Care_Hunger', 'SocialSciences', 'PerformingA
rts', 'CharacterEducation', 'TeamSports', 'Other', 'College_CareerPre
p', 'Music', 'History_Geography', 'Health_LifeScience', 'EarlyDevelopme
nt', 'ESL', 'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Healt
h_Wellness', 'AppliedSciences', 'SpecialNeeds', 'Literature_Writing',
'Mathematics', 'Literacy']
Shape of matrix after one hot encodig  (109248, 30)
```

In [293]:
```
school_state_vectorizer = CountVectorizer(lowercase=False, binary=True)
school_state_vectorizer.fit(project_data['school_state'].values)
print(school_state_vectorizer.get_feature_names())

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

```
['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)
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
```

In [294]:
```
# https://www.geeksforgeeks.org/python-pandas-dataframe-fillna-to-repla
ce-null-values-in-dataframe/
project_data["teacher_prefix"].fillna("No_Prefix", inplace = True)

teacher_prefix_vectorizer = CountVectorizer(lowercase=False, binary=Tru
e)
teacher_prefix_vectorizer.fit(project_data['teacher_prefix'].values)
print(teacher_prefix_vectorizer.get_feature_names())

teacher_prefix_one_hot = teacher_prefix_vectorizer.transform(project_da
ta['teacher_prefix'].values)
print("Shape of matrix after one hot encodig ",teacher_prefix_one_hot.s
hape)
```

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

In [372]:
```
my_grade_counter = Counter()

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

```
project_grade_cat_dict = dict(my_grade_counter)
sorted_project_grade_cat_dict = dict(sorted(project_grade_cat_dict.item
s(), key=lambda kv: kv[1]))

grade_cat_vectorizer = CountVectorizer(vocabulary=list(sorted_project_g
rade_cat_dict.keys()), lowercase=False, binary=True)
grade_cat_vectorizer.fit(project_data['project_grade_category'].values)
print(grade_cat_vectorizer.get_feature_names())

grade_cat_one_hot = grade_cat_vectorizer.transform(project_data['projec
t_grade_category'].values)
print("Shape of matrix after one hot encodig ",grade_cat_one_hot.shape)
```

```
['9-12', '6-8', '3-5', 'PreK-2', 'Grades']
Shape of matrix after one hot encodig  (109248, 5)
```

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

In [296]:
```
# 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 [332]:
```
titles_vectorizer = CountVectorizer(min_df=10)
titles_bow = titles_vectorizer.fit_transform(preprocessed_titles)
print("some sample features(unique words in the corpus)",titles_vectori
zer.get_feature_names()[0:10])
```

```
print("Shape of matrix after one hot encodig ",titles_bow.shape)
print("the type of count vectorizer ",type(titles_bow))
print("the number of unique words ", titles_bow.get_shape()[1])
```

```
some sample features(unique words in the corpus) ['abc', 'abcs', 'abili
ties', 'ability', 'able', 'aboard', 'about', 'above', 'abstract', 'acad
emic']
Shape of matrix after one hot encodig  (109248, 3290)
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the number of unique words  3290
```

1.4.2.3 TFIDF vectorizer

In [333]:
```
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 [334]:
```
titles_tfidf_vectorizer = TfidfVectorizer(min_df=10)
titles_tfidf = titles_tfidf_vectorizer.fit_transform(preprocessed_title
s)
print("some sample features(unique words in the corpus)",titles_tfidf_v
ectorizer.get_feature_names()[10:21])
print("Shape of matrix after one hot encodig ",titles_tfidf.shape)
```

```
some sample features(unique words in the corpus) ['academics', 'academ
y', 'acceptance', 'access', 'accessibility', 'accessible', 'accessing',
'accessories', 'ace', 'achieve', 'achievement']
Shape of matrix after one hot encodig  (109248, 3290)
```

1.4.2.5 Using Pretrained Models: Avg W2V

In [335]:
```
'''
# 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')

# ============================
Output:

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

# ============================

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

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

inter_words = set(model.keys()).intersection(words)
print("The number of words that are present in both glove vectors and 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('glove_vectors', 'wb') as f:
    pickle.dump(words_courpus, f)


'''
```

Out[335]:

```
'\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# ============================\nOutput:\n
  \nLoading Glove Model\n1917495it [06:32, 4879.69it/s]\nDone. 1917495
words loaded!\n\n# ============================\n\nwords = []\nfor i in
preproced_texts:\n    words.extend(i.split(\' \'))\n\nfor i in preproce
d_titles:\n    words.extend(i.split(\' \'))\nprint("all the words in th
e coupus", len(words))\nwords = set(words)\nprint("the unique words in
the coupus", len(words))\n\ninter_words = set(model.keys()).intersectio
n(words)\nprint("The number of words that are present in both glove vec
tors and our coupus",       len(inter_words),"(",np.round(len(inter_wor
ds)/len(words)*100,3),"%)")\n\nwords_courpus = {}\nwords_glove = set(mo
del.keys())\nfor i in words:\n    if i in words_glove:\n        words_c
ourpus[i] = model[i]\nprint("word 2 vec length", len(words_courpus))\n
\n\n# stronging variables into pickle files python: http://www.jessicay
```

```
ung.com/how-to-use-pickle-to-save-and-load-variables-in-python/\n\nimpo
rt pickle\nwith open(\'glove_vectors\', \'wb\') as f:\n    pickle.dump
(words_courpus, f)\n\n\n'
```

In [336]:
```
# 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('glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

In [337]:
```
# 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 [01:05<00:00, 1667.24it/s]

109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on `project_title`

In [338]:
```
avg_w2v_titles_vectors = [];

for sentence in tqdm(preprocessed_titles):

    vector_titles = np.zeros(300)
    cnt_words_titles = 0;

    for word in sentence.split():

        if word in glove_words:

            vector += model[word]
            cnt_words_titles += 1

    if cnt_words_titles != 0:

        vector_titles /= cnt_words_titles

    avg_w2v_titles_vectors.append(vector_titles)

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

```
100%|██████████| 109248/109248 [00:03<00:00, 32636.30it/s]

109248
300
```

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

In [339]:
```
# 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 [340]:
```
# 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 [08:30<00:00, 213.82it/s]
```

```
109248
300
```

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

In [341]:
```
titles_tfidf_model = TfidfVectorizer()
titles_tfidf_model.fit(preprocessed_titles)
titles_dictionary = dict(zip(titles_tfidf_model.get_feature_names(), li
```

```
st(titles_tfidf_model.idf_)))
titles_tfidf_words = set(titles_tfidf_model.get_feature_names())
```

In [342]:
```
titles_tfidf_w2v_vectors = [];

for titles_sentence in tqdm(preprocessed_titles):

    titles_vector = np.zeros(300)
    titles_tfidf_weight = 0;

    for word in titles_sentence.split():

        if (word in glove_words) and (word in titles_tfidf_words):

            titles_vec = model[word]

            titles_tf_idf = titles_dictionary[word]*(titles_sentence.co
unt(word)/len(titles_sentence.split()))
            titles_vector += (titles_vec * titles_tf_idf)
            titles_tfidf_weight += titles_tf_idf

    if titles_tfidf_weight != 0:

        titles_vector /= titles_tfidf_weight

    titles_tfidf_w2v_vectors.append(titles_vector)

print(len(titles_tfidf_w2v_vectors))
print(len(titles_tfidf_w2v_vectors[0]))
```

```
100%|██████████| 109248/109248 [00:06<00:00, 16447.89it/s]
```

```
109248
300
```

1.4.3 Vectorizing Numerical features

In [343]:
```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# 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(f"Mean : {price_scalar.mean_[0]}, Standard deviation : {np.sqrt(p
rice_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 : 298.1193425966608, Standard deviation : 367.49634838483496
```

In [344]:
```
price_standardized
```

Out[344]:
```
array([[-0.3905327 ],
       [ 0.00239637],
       [ 0.59519138],
       ...,
       [-0.15825829],
       [-0.61243967],
       [-0.51216657]])
```

1.4.4 Merging all the above features

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

In [345]:
```
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 [346]:
```
# 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[346]: (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.

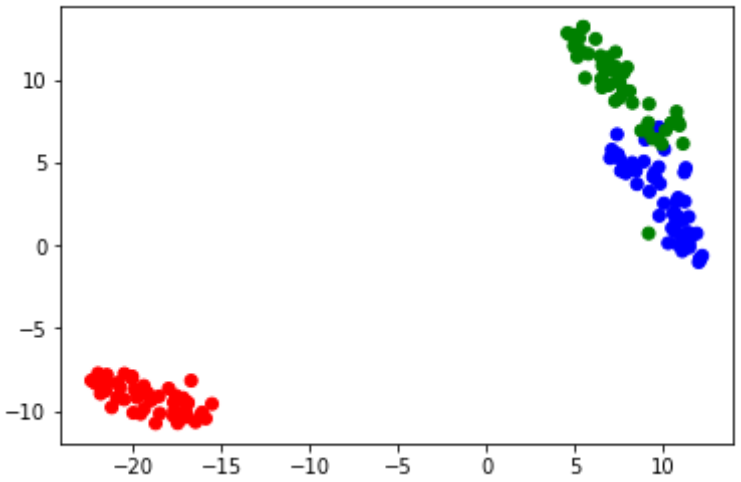
1. In the above cells we have plotted and analyzed many features. Please observe the plots and write the observations in markdown cells below every plot.
2. EDA: Please complete the analysis of the feature: teacher_number_of_previously_posted_projects
3. Build the data matrix using these features
   - 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 [347]:
```
# this is the example code for TSNE
import numpy as np
from sklearn.manifold import TSNE
from sklearn import datasets
import pandas as pd
import matplotlib.pyplot as plt

iris = datasets.load_iris()
x = iris['data']
y = iris['target']

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

X_embedding = tsne.fit_transform(x)
# 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.reshape(-1,1)))
for_tsne_df = pd.DataFrame(data=for_tsne, columns=['Dimension_x','Dimen
sion_y','Score'])
```

```
colors = {0:'red', 1:'blue', 2:'green'}
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()
```



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

In [373]:
```
# printing shape of all the categorical and numerical data
print(titles_bow.shape)
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(school_state_one_hot.shape)
print(teacher_prefix_one_hot.shape)
print(grade_cat_one_hot.shape)
print(price_standardized.shape)
```

```
(109248, 3290)
(109248, 9)
(109248, 30)
(109248, 51)
(109248, 6)
```

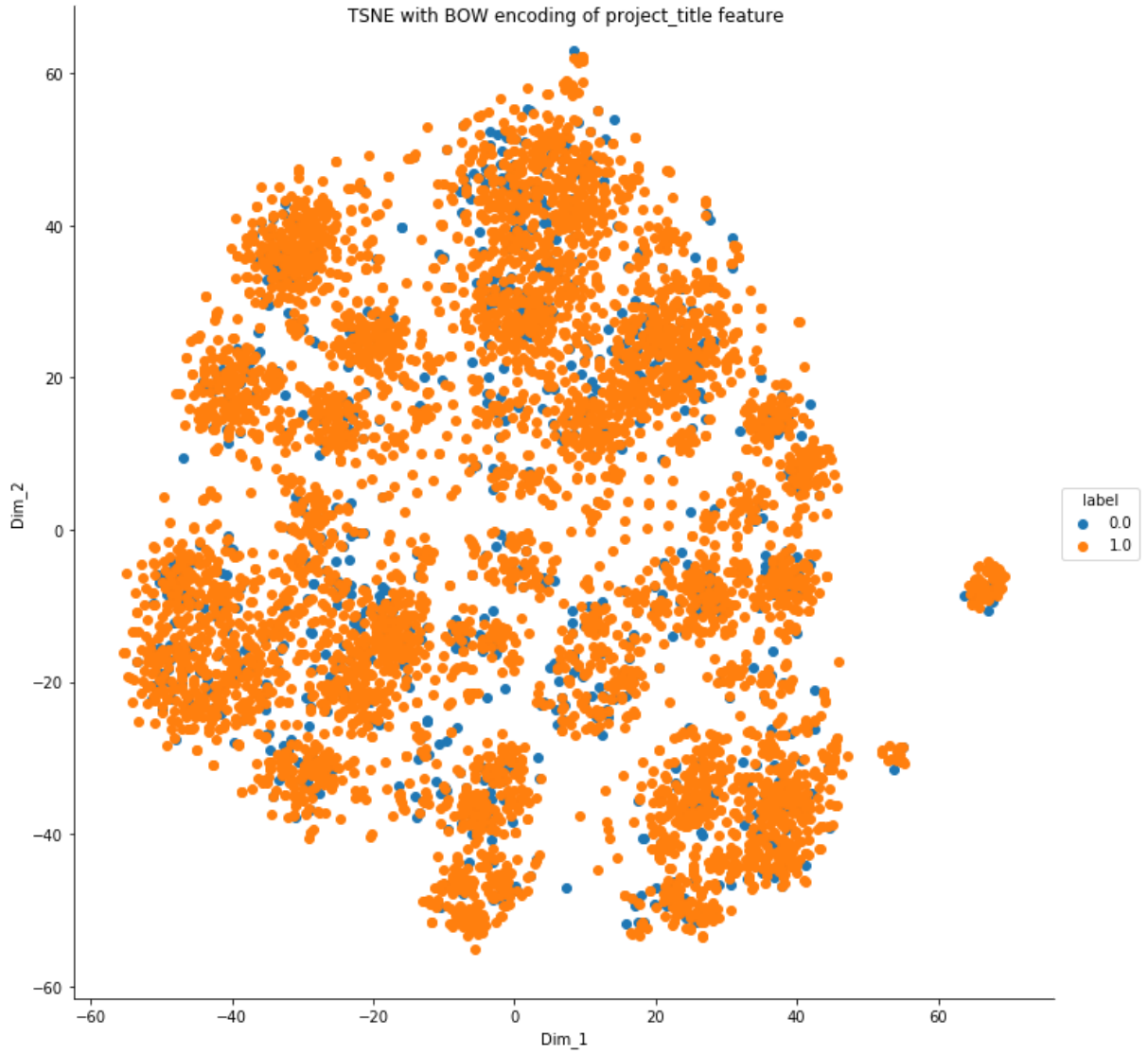
```
(109248, 5)
(109248, 1)
```

In [356]:
```
# Creating merged numerical an dcategorical data with title BOW.
data = hstack((titles_bow, categories_one_hot, sub_categories_one_hot,
school_state_one_hot, teacher_prefix_one_hot,
                grade_cat_one_hot, price_standardized))

# https://stackoverflow.com/questions/30163830/accessing-elements-in-coo-matrix
data = data.tocsr()

# Applying t-SNE on first 6000 datapoint.
data_6000 = data[0:6000,:]

labels = project_data['project_is_approved']
labels_6000 = labels[0:6000]

#Configuring parameters with default values.
model = TSNE(n_components=2, random_state=0)
data_6000_embedding = data_6000.toarray()
bow_tsne_data = model.fit_transform(data_6000_embedding)


# creating a new data frame which help us in ploting the result data
bow_tsne_data = np.vstack((bow_tsne_data.T, labels_6000)).T
bow_tsne_df = pd.DataFrame(data = bow_tsne_data, columns = ("Dim_1", "Dim_2", "label"))

print(bow_tsne_df.shape)
```

```
(6000, 3)
```

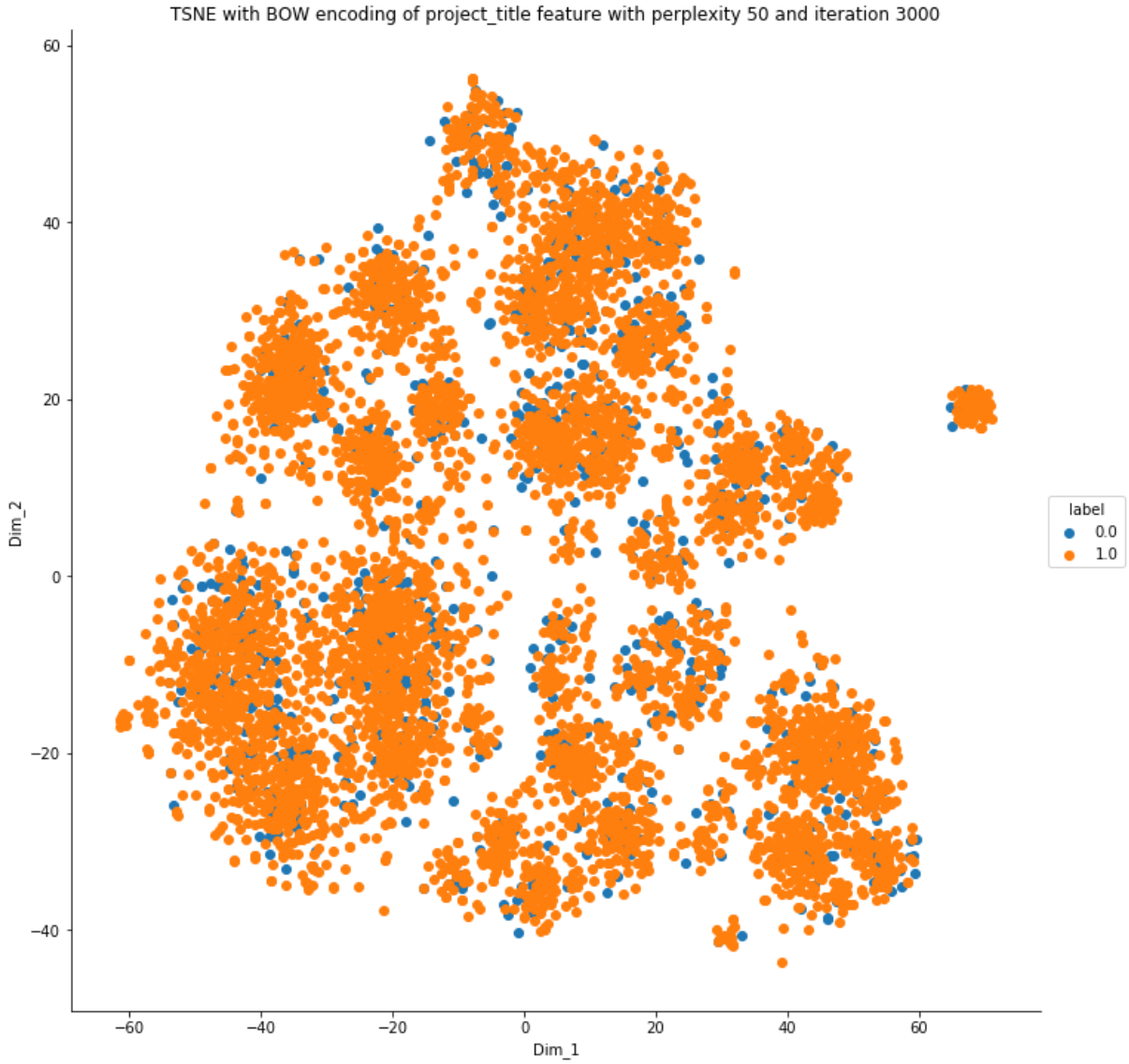
In [362]:
```
#Plotting TSNE with BOW encoding of project_title feature with perplexity 30 and iteration 1000
sns.FacetGrid(bow_tsne_df, hue = "label", size = 10).map(plt.scatter, "Dim_1", "Dim_2").add_legend()
plt.title('TSNE with BOW encoding of project_title feature with perplex
```

```
ity 30 and iteration 1000')
plt.show()
```



Observation: Data is high overlapped and very difficult to figure out ant conlcusion.

In [365]:
```
data = hstack((titles_bow, categories_one_hot, sub_categories_one_hot,
school_state_one_hot, teacher_prefix_one_hot,
                grade_cat_one_hot, price_standardized))

data = data.tocsr() # https://stackoverflow.com/questions/30163830/acce
ssing-elements-in-coo-matrix
data_6000 = data[0:6000,:]

labels = project_data['project_is_approved']
labels_6000 = labels[0:6000]

#Changing the perplexity to 50 and iteration 3000
model = TSNE(n_components=2, random_state=0, perplexity = 50, n_iter =
3000)

data_6000_embedding = data_6000.toarray()
bow_tsne_data = model.fit_transform(data_6000_embedding)


# creating a new data frame which help us in ploting the result data
bow_tsne_data = np.vstack((bow_tsne_data.T, labels_6000)).T
bow_tsne_df = pd.DataFrame(data = bow_tsne_data, columns = ("Dim_1", "D
im_2", "label"))

sns.FacetGrid(bow_tsne_df, hue = "label", size = 10).map(plt.scatter,
"Dim_1", "Dim_2").add_legend()
plt.title('TSNE with BOW encoding of project_title feature with perplex
ity 50 and iteration 3000')
plt.show()
```



Observation: Data is high overlapped and very difficult to figure out ant conlcusion.

In [366]:
```
data = hstack((titles_bow, categories_one_hot, sub_categories_one_hot,
school_state_one_hot, teacher_prefix_one_hot,
```

```
                grade_cat_one_hot, price_standardized))

data = data.tocsr() # https://stackoverflow.com/questions/30163830/accessing-elements-in-coo-matrix
data_6000 = data[0:6000,:]

labels = project_data['project_is_approved']
labels_6000 = labels[0:6000]

# Changing perplexity to 100 and iteration 5000
model = TSNE(n_components=2, random_state=0, perplexity = 100, n_iter =
 5000)

data_6000_embedding = data_6000.toarray()
bow_tsne_data = model.fit_transform(data_6000_embedding)


# creating a new data frame which help us in ploting the result data
bow_tsne_data = np.vstack((bow_tsne_data.T, labels_6000)).T
bow_tsne_df = pd.DataFrame(data = bow_tsne_data, columns = ("Dim_1", "Dim_2", "label"))

sns.FacetGrid(bow_tsne_df, hue = "label", size = 10).map(plt.scatter, "Dim_1", "Dim_2").add_legend()
plt.title('TSNE with BOW encoding of project_title feature with perplexity 100 and iteration 5000')
plt.show()
```

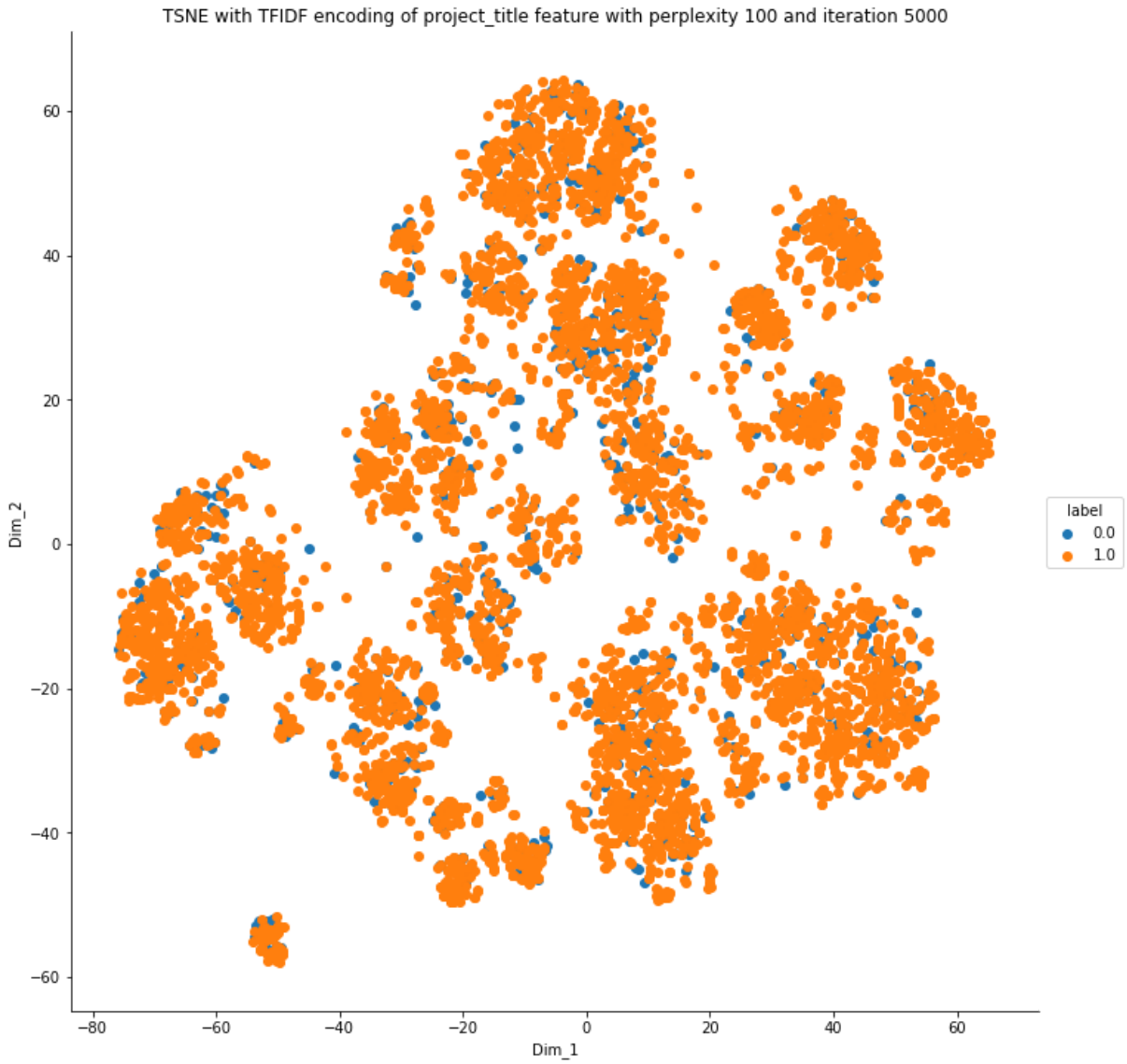
TSNE with BOW encoding of project_title feature with perplexity 100 and iteration 5000

Observation: Data is high overlapped and very difficult to figure out ant conlcusion.

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

In [367]:

```
data = hstack((titles_tfidf, categories_one_hot, sub_categories_one_hot
, school_state_one_hot, teacher_prefix_one_hot,
                grade_cat_one_hot, price_standardized))

data = data.tocsr() # https://stackoverflow.com/questions/30163830/acce
ssing-elements-in-coo-matrix
data_6000 = data[0:6000,:]

labels = project_data['project_is_approved']
labels_6000 = labels[0:6000]

model = TSNE(n_components=2, random_state=0, perplexity = 100, n_iter =
 5000)
# configuring the parameteres
# the number of components = 2
# default perplexity = 30
# default learning rate = 200
# default Maximum number of iterations for the optimization = 1000
data_6000_embedding = data_6000.toarray()
bow_tsne_data = model.fit_transform(data_6000_embedding)


# creating a new data frame which help us in ploting the result data
bow_tsne_data = np.vstack((bow_tsne_data.T, labels_6000)).T
bow_tsne_df = pd.DataFrame(data = bow_tsne_data, columns = ("Dim_1", "D
im_2", "label"))

sns.FacetGrid(bow_tsne_df, hue = "label", size = 10).map(plt.scatter,
"Dim_1", "Dim_2").add_legend()
plt.title('TSNE with TFIDF encoding of project_title feature with perpl
exity 100 and iteration 5000')
plt.show()
```



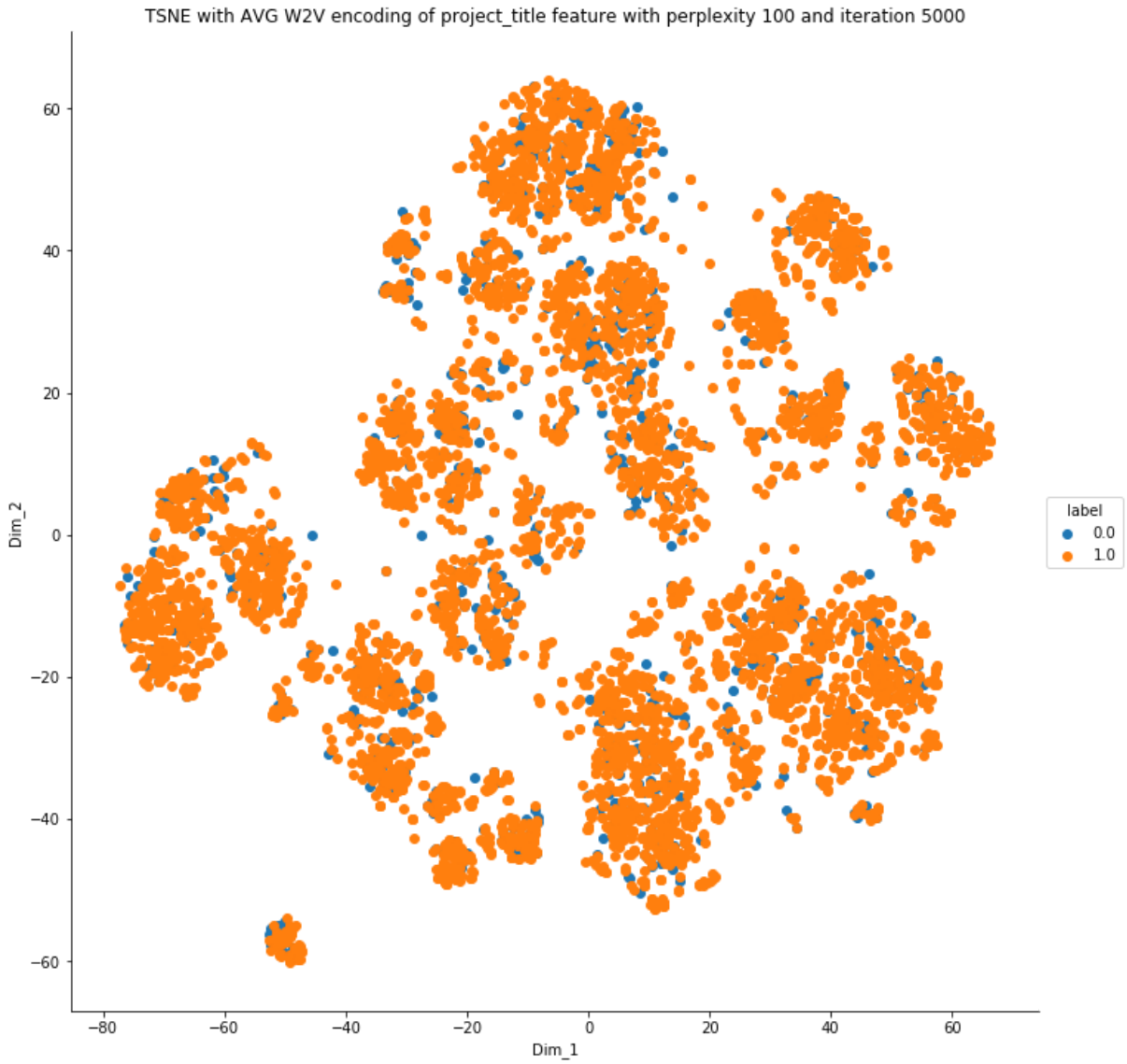
Observation: Data is high overlapped and very difficult to figure out ant conlcusion.

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

feature

In [368]:

```
data = hstack((avg_w2v_titles_vectors, categories_one_hot, sub_categori
es_one_hot, school_state_one_hot, teacher_prefix_one_hot,
               grade_cat_one_hot, price_standardized))

data = data.tocsr() # https://stackoverflow.com/questions/30163830/acce
ssing-elements-in-coo-matrix
data_6000 = data[0:6000,:]

labels = project_data['project_is_approved']
labels_6000 = labels[0:6000]

model = TSNE(n_components=2, random_state=0, perplexity = 100, n_iter =
 5000)
# configuring the parameteres
# the number of components = 2
# default perplexity = 30
# default learning rate = 200
# default Maximum number of iterations for the optimization = 1000
data_6000_embedding = data_6000.toarray()
bow_tsne_data = model.fit_transform(data_6000_embedding)


# creating a new data frame which help us in ploting the result data
bow_tsne_data = np.vstack((bow_tsne_data.T, labels_6000)).T
bow_tsne_df = pd.DataFrame(data = bow_tsne_data, columns = ("Dim_1", "D
im_2", "label"))

sns.FacetGrid(bow_tsne_df, hue = "label", size = 10).map(plt.scatter,
"Dim_1", "Dim_2").add_legend()
plt.title('TSNE with AVG W2V encoding of project_title feature with per
plexity 100 and iteration 5000')
plt.show()
```



Observation: Data is high overlapped and very difficult to figure out ant conlcusion.

2.4 TSNE with `TFIDF Weighted W2V` encoding of

`project_title` feature

In [369]:
```
data = hstack((titles_tfidf_w2v_vectors, categories_one_hot, sub_categories_one_hot, school_state_one_hot, teacher_prefix_one_hot,
               grade_cat_one_hot, price_standardized))

data = data.tocsr() # https://stackoverflow.com/questions/30163830/accessing-elements-in-coo-matrix
data_6000 = data[0:6000,:]

labels = project_data['project_is_approved']
labels_6000 = labels[0:6000]

model = TSNE(n_components=2, random_state=0, perplexity = 100, n_iter = 5000)
# configuring the parameteres
# the number of components = 2
# default perplexity = 30
# default learning rate = 200
# default Maximum number of iterations for the optimization = 1000
data_6000_embedding = data_6000.toarray()
bow_tsne_data = model.fit_transform(data_6000_embedding)


# creating a new data frame which help us in ploting the result data
bow_tsne_data = np.vstack((bow_tsne_data.T, labels_6000)).T
bow_tsne_df = pd.DataFrame(data = bow_tsne_data, columns = ("Dim_1", "Dim_2", "label"))

sns.FacetGrid(bow_tsne_df, hue = "label", size = 10).map(plt.scatter, "Dim_1", "Dim_2").add_legend()
plt.title('TSNE with TFIDF Weighted W2V encoding of project_title feature with perplexity 100 and iteration 5000')
plt.show()
```

Observation: Data is high overlapped and very difficult to figure out ant conlcusion.

In [371]:
```
# Merging all the data and creating final data matrix.
data = hstack((titles_tfidf_w2v_vectors, avg_w2v_titles_vectors, titles
```

```
_tfidf, titles_bow, categories_one_hot, sub_categories_one_hot, school_
state_one_hot, teacher_prefix_one_hot,
                grade_cat_one_hot, price_standardized))

data = data.tocsr() # https://stackoverflow.com/questions/30163830/acce
ssing-elements-in-coo-matrix
data_6000 = data[0:6000,:]

labels = project_data['project_is_approved']
labels_6000 = labels[0:6000]

model = TSNE(n_components=2, random_state=0, perplexity = 100, n_iter =
 5000)
# configuring the parameteres
# the number of components = 2
# default perplexity = 30
# default learning rate = 200
# default Maximum number of iterations for the optimization = 1000
data_6000_embedding = data_6000.toarray()
bow_tsne_data = model.fit_transform(data_6000_embedding)


# creating a new data frame which help us in ploting the result data
bow_tsne_data = np.vstack((bow_tsne_data.T, labels_6000)).T
bow_tsne_df = pd.DataFrame(data = bow_tsne_data, columns = ("Dim_1", "D
im_2", "label"))

sns.FacetGrid(bow_tsne_df, hue = "label", size = 10).map(plt.scatter,
"Dim_1", "Dim_2").add_legend()
plt.title('TSNE on final data matrix with perplexity 100 and iteration
 5000')
plt.show()
```

Observation: Data is high overlapped and very difficult to figure out ant conlcusion.

2.5 Summary

Observation Visualisation of TSNE with numerical and categorical data with project title Bag of Words, TF-IDF, Avg Word2Vec, TF-IDF Weighted Word2Vec and even merging all to get final data matrix does not conclude anything. All the data are highly overlapped even if we try it with different perplexity and iterations. We need to use another data visulaization method to verify if any conclusion can be made.