DonorsChoose

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

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

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

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

About the DonorsChoose Data Set

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

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

Feature	Description
`project_title`	Title of the project. **Examples:** - `Art Will Make You Happy!` - `First Grade Fun`
`project_grade_category`	Grade level of students for which the project is targeted. One of the following enumerated values: - `Grades PreK-2` - `Grades 3-5` - `Grades 6-8` - `Grades 9-12`
`project_subject_categories`	One or more (comma-separated) subject categories for the project from the following enumerated list of values: - `Applied Learning` - `Care & Hunger` - `Health & Sports` - `History & Civics` - `Literacy & Language` - `Math & Science` - `Music & The Arts` - `Special Needs` - `Warmth` **Examples:** - `Music & The Arts` - `Literacy & Language, Math & Science`
`school_state`	State where school is located (Two-letter U.S. postal code). **Example:** `WY`
`project_subject_subcategories`	One or more (comma-separated) subject subcategories for the project. **Examples:** - `Literacy` - `Literature & Writing, Social Sciences`

Feature	Description
`project_resource_summary`	An explanation of the resources needed for the project. **Example:** - `My students need hands on literacy materials to manage sensory needs!`
`project_essay_1`	First application essay*
`project_essay_2`	Second application essay*
`project_essay_3`	Third application essay*
`project_essay_4`	Fourth application essay*
`project_submitted_datetime`	Datetime when project application was submitted. **Example:** `2016-04-28 12:43:56.245`
`teacher_id`	A unique identifier for the teacher of the proposed project. **Example:** `bdf8baa8fedef6bfeec7ae4ff1c15c56`
`teacher_prefix`	Teacher's title. One of the following enumerated values: - `nan` - `Dr.` - `Mr.` - `Mrs.` - `Ms.` - `Teacher.`
`teacher_number_of_previously_posted_projects`	Number of project applications previously submitted by the same teacher. **Example:** `2`

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

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

Feature	Description

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 [57]:

```
%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
```

1.1 Reading Data

In [58]:

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

In [59]:

```
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 [60]:

```
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[60]:

	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

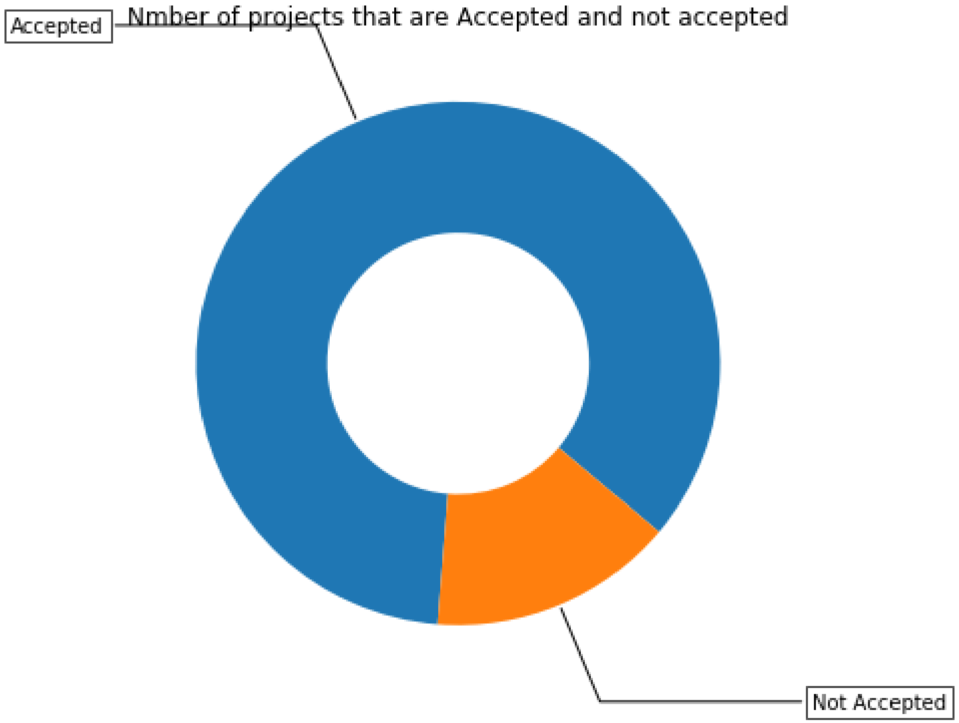
1.2 Data Analysis

In [61]:

```
# 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
217927 %)
Number of projects thar are not approved for funding  16542 , ( 15.1416
95957820739 %)
```



Summary of above donut pie chart

1. Approx 85% project got approved from volunteers that would be shown on https://www.donorschoose.org/
2. Approx 15% project got rejected from volunteers.

1.2.1 Univariate Analysis: School State

In [62]:

```
# 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.co
m/a/9620

scl = [[0.0, 'rgb(242,240,247)'],[0.2, 'rgb(218,218,235)'],[0.4, 'rgb(1
88,189,220)'],\
            [0.6, 'rgb(158,154,200)'],[0.8, 'rgb(117,107,177)'],[1.0,
 'rgb(84,39,143)']]

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

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

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

Out[62]:

```
'# 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 [63]:

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

```
States with lowest % approvals
   state_code  num_proposals
46         VT       0.800000
7          DC       0.802326
43         TX       0.813142
26         MT       0.816327
18         LA       0.831245
```

```
==================================================
States with highest % approvals
   state_code  num_proposals
30         NH       0.873563
35         OH       0.875152
47         WA       0.876178
28         ND       0.888112
8          DE       0.897959
```

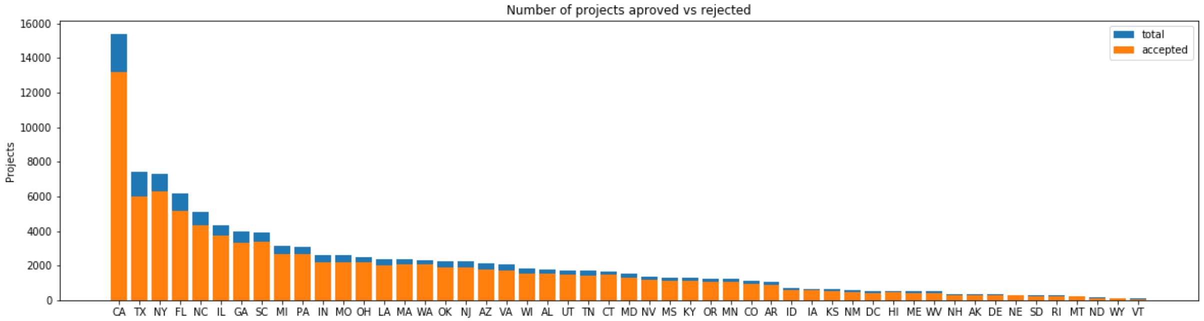
In [64]:

```python
#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 [65]:

```python
def univariate_barplots(project_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 [66]:
```
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
```

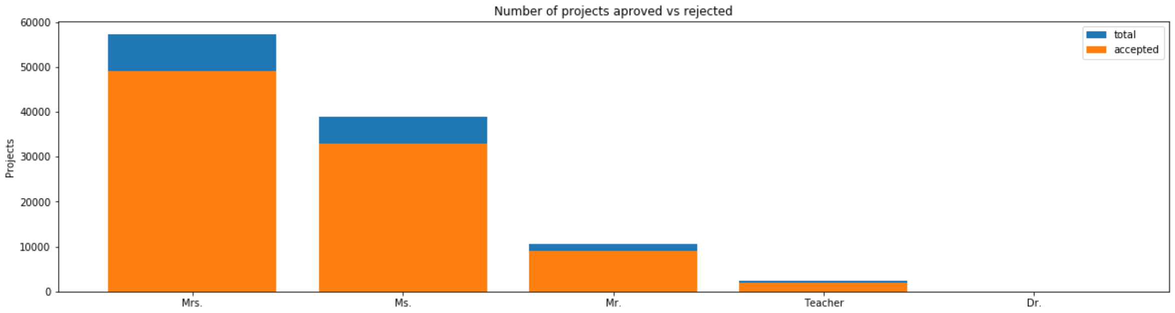
SUMMARY: Every state has greater than 80% success rate in approval

Summary of above bar plot

1. Every state has more than equal to 80% approval rate.
2. California has maximum approved project and new york has maximum approval percentage as per stats.
3. Vermont has minimum approved project and minimum approval percentage as per stats.

1.2.2 Univariate Analysis: teacher_prefix

In [67]:
```
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
```

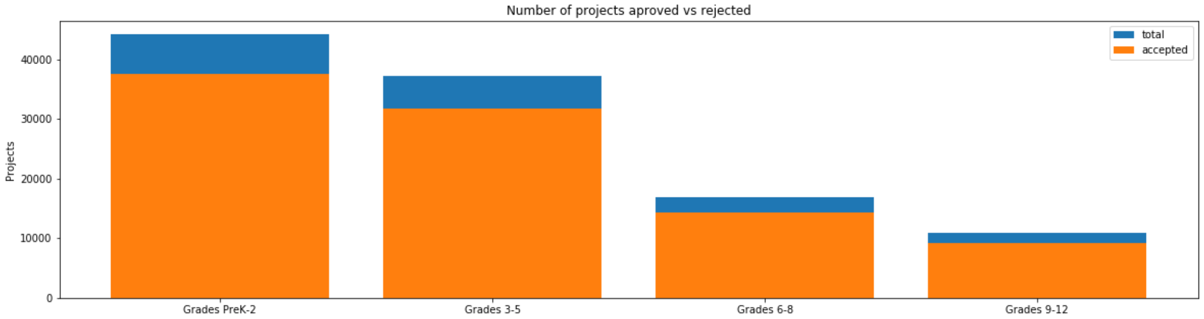
Summary of above bar plot

1. Mrs. teacher prefix has maximum approved projects.
2. Dr. teacher prefix has minimum approved projects.
3. There are 3 entries that doesn't contains teacher's prefix.

1.2.3 Univariate Analysis: project_grade_category

In [68]:

```
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
```

Summary of above bar plot

1. Grades PreK-2 has maximum approved projects.
2. Grades 9-12 has minimum approved projects.
3. There are variation in data for projects as per grades.

1.2.4 Univariate Analysis: project_subject_categories

In [69]:

```
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 [70]:

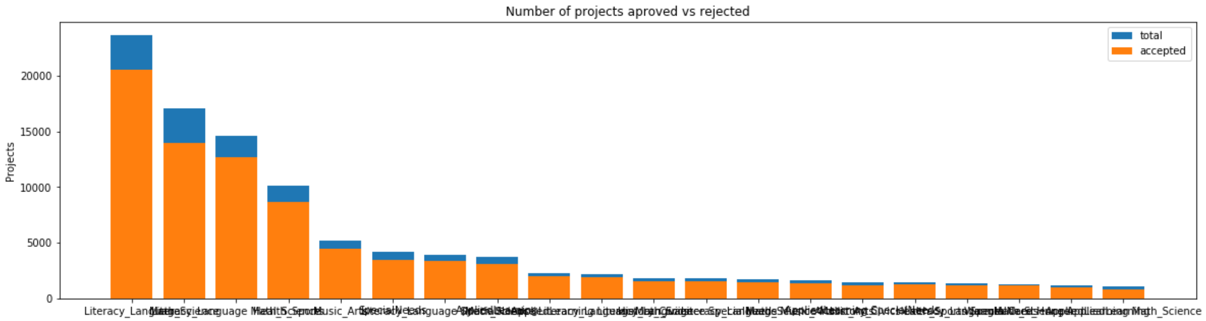
```
project_data['clean_categories'] = cat_list
project_data.drop(['project_subject_categories'], axis=1, inplace=True)
project_data.head(2)
```

Out[70]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2

In [71]:

```
univariate_barplots(project_data, 'clean_categories', 'project_is_appro
ved', top=20)
```



```
                 clean_categories  project_is_approved  total       Av
g
24              Literacy_Language                20520  23655  0.86747
0
32                   Math_Science                13991  17072  0.81952
9
```

```
9
28  Literacy_Language Math_Science                12725   14636   0.86943
2
8                     Health_Sports                8640   10177   0.84897
3
40                       Music_Arts                4429    5180   0.85501
9
==================================================
                    clean_categories  project_is_approved  total
Avg
19  History_Civics Literacy_Language                 1271    1421   0.894
441
14        Health_Sports SpecialNeeds                 1215    1391   0.873
472
50                Warmth Care_Hunger                 1212    1309   0.925
898
33      Math_Science AppliedLearning                 1019    1220   0.835
246
4       AppliedLearning Math_Science                  855    1052   0.812
738
```

Summary of above bar plot

1. Literacy & Language has maximum project submission and approval rate.
2. AppliedLearning has minimum project approval rate.

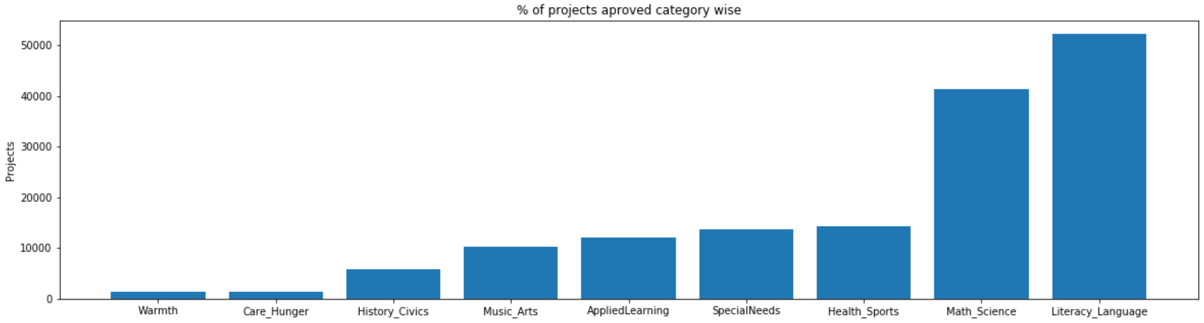
In [72]:

```
# 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 [73]:

```
# 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 [74]:
```
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
```

Summary of above bar plot

1. Literacy & Language has maximum project submission and approval rate.

2. AppliedLearning has minimum project approval rate.

1.2.5 Univariate Analysis: project_subject_subcategories

In [75]:

```
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 [76]:

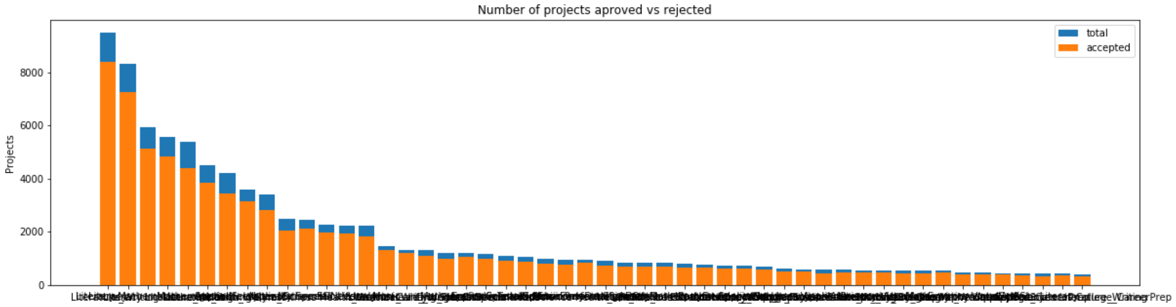
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=Tr
ue)
project_data.head(2)
```

Out[76]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2

In [77]:

```
univariate_barplots(project_data, 'clean_subcategories', 'project_is_ap
proved', top=50)
```



```
                    clean_subcategories  project_is_approved  total
Avg
317                            Literacy                 8371   9486  0.88
2458
319                Literacy Mathematics                 7260   8325  0.87
2072
331    Literature_Writing Mathematics                   5140   5923  0.86
7803
318       Literacy Literature_Writing                   4823   5571  0.86
5733
```

```
342                       Mathematics                 4385   5379  0.81
5207
==================================================
                    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
```

Summary of above bar plot

1. Literacy has maximum project submission and approval rate.
2. ESL has minimum project approval rate.

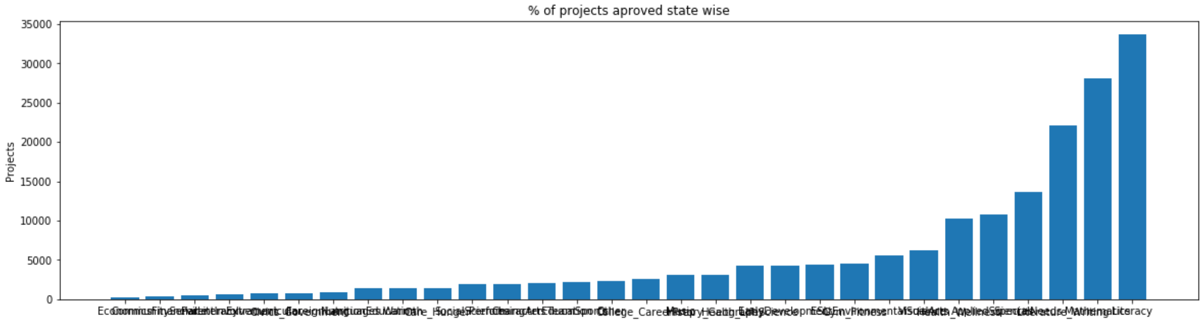
In [78]:

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

In [79]:

```python
# 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 [80]:

```
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
```

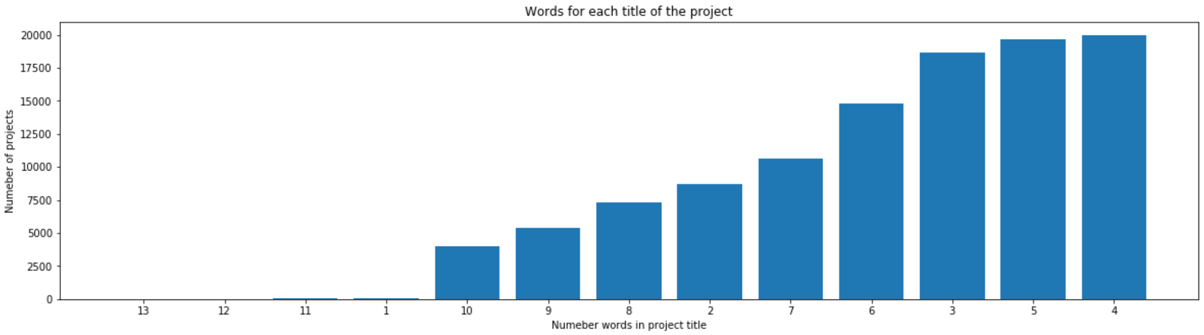
Summary of above bar plot

1. Literacy has maximum project submission & approval rate.
2. Economics has minimum project submission & approval rate.

1.2.6 Univariate Analysis: Text features (Title)

In [81]:

```python
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/37483537/4084039
word_count = project_data['project_title'].str.split().apply(len).value_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))


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

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



Summary of above bar plot

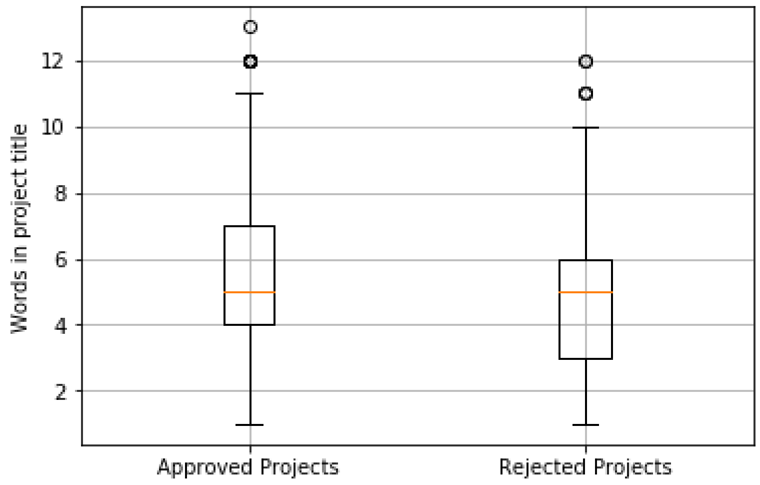
1. Project title with word count 4,5 and 3 has maximum approval rate.

In [82]:

```
approved_title_word_count = project_data[project_data['project_is_appro
ved']==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_appro
ved']==0]['project_title'].str.split().apply(len)
rejected_title_word_count = rejected_title_word_count.values
```

In [83]:

```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.ht
ml
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()
```

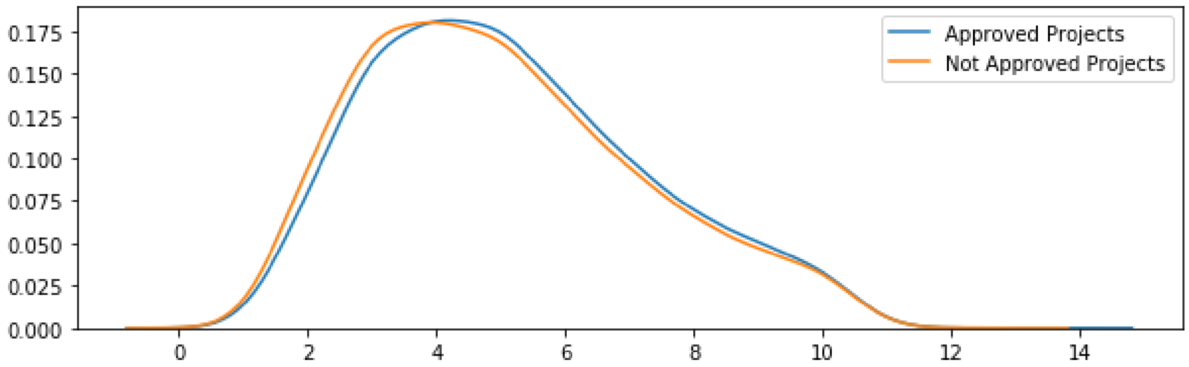


Summary of above box plot

1. Word count in project title is slightly higher for approved projects

In [84]:

```
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()
```



Summary of above PDF plot

1. Word count in title is slightly high in approved projects.

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

In [85]:

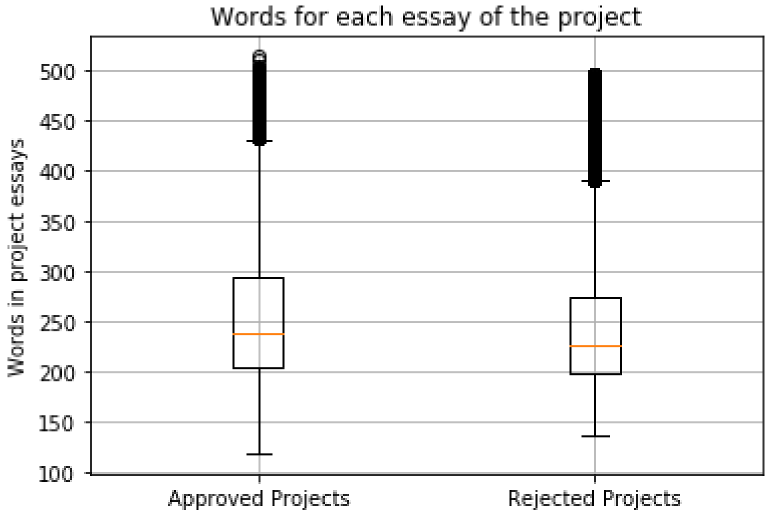
```
# merge two column text dataframe:
project_data["essay"] = project_data["project_essay_1"].map(str) +\
                        project_data["project_essay_2"].map(str) + \
                        project_data["project_essay_3"].map(str) + \
                        project_data["project_essay_4"].map(str)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

In [86]:

```
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 [87]:

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

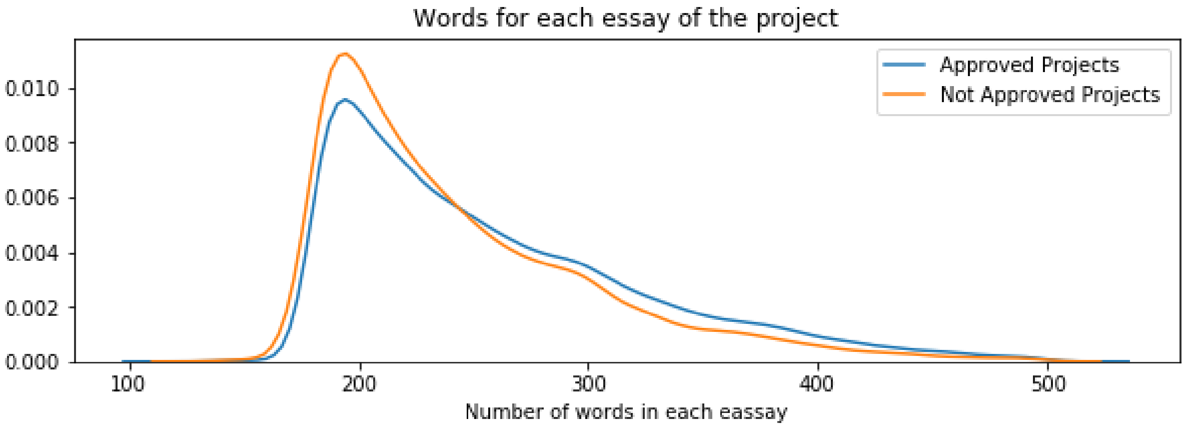


Summary of above box plot

1. Word count in essay is higher in approved project.

In [88]:

```
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()
```



Summary of above PDF plot

1. Word count in essay is slightly higher in the approved project.

1.2.8 Univariate Analysis: Cost per project

In [89]:
```
# we get the cost of the project using resource.csv file
resource_data.head(2)
```

Out[89]:

	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 [90]:
```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframe
s-indexes-for-all-groups-in-one-step
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity'
:'sum'}).reset_index()
price_data.head(2)
```

Out[90]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

In [91]:

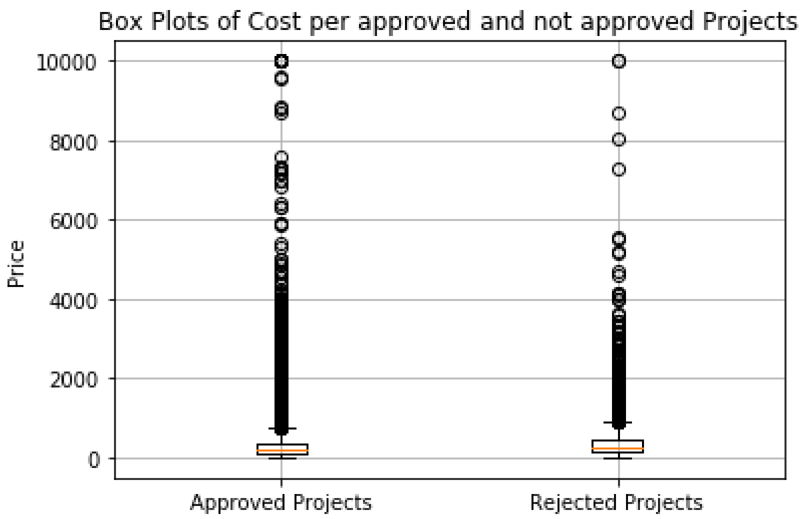
```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [92]:

```
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 [93]:

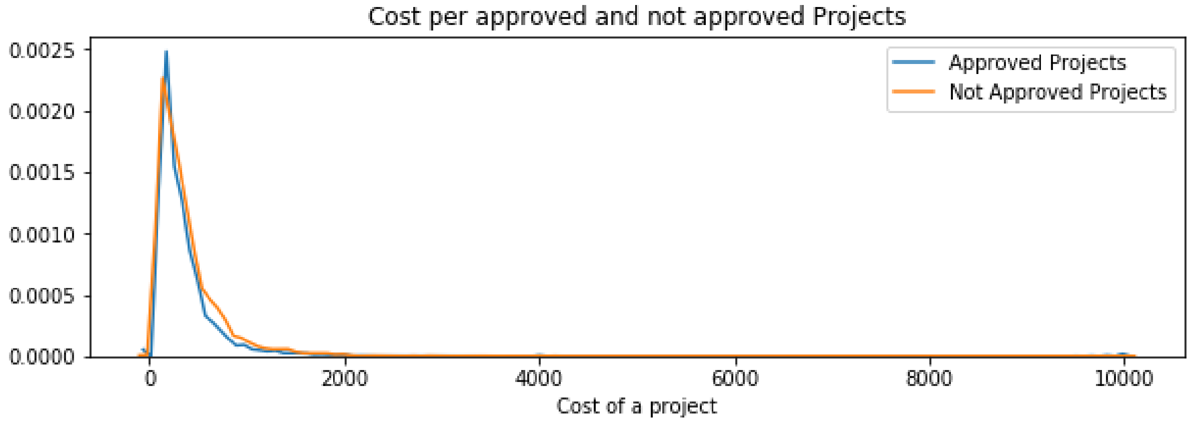
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.ht
ml
plt.boxplot([approved_price, rejected_price])
plt.title('Box Plots of Cost per approved and not approved Projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Price')
plt.grid()
plt.show()
```



Summary of above box plot

1. Cost of project is not clear

In [94]:
```
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()
```



Summary of above PDF plot

1. Cost of unapproved project is slightly higher than approved projects.

In [95]:
```
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)
```

Summary of above PDF plot

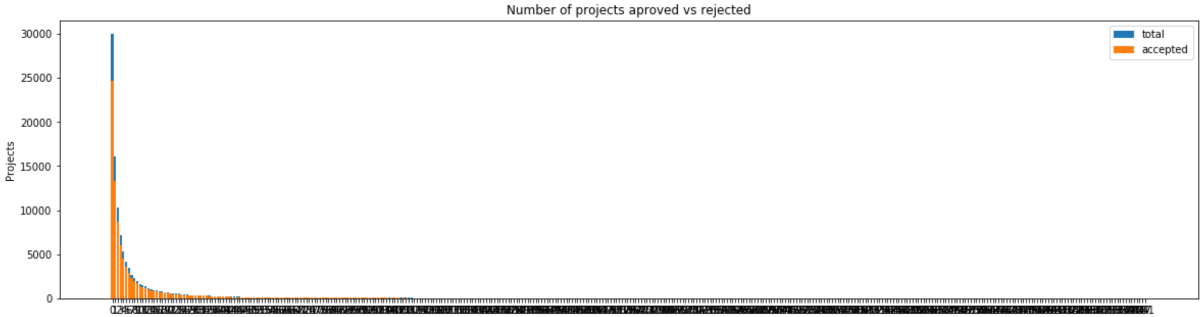
1. Cost of unapproved project is slightly higher than approved projects.

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

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

In [96]:

```
univariate_barplots(project_data, 'teacher_number_of_previously_posted_
projects', 'project_is_approved' , top=False)
```



```
   teacher_number_of_previously_posted_projects  project_is_approved  t
otal  \
0                                             0                24652  3
0014
1                                             1                13329  1
6058
2                                             2                 8705  1
0350
3                                             3                 5997
7110
4                                             4                 4452
5266

        Avg
0  0.821350
1  0.830054
2  0.841063
3  0.843460
```

```
4  0.845423
==================================================
     teacher_number_of_previously_posted_projects  project_is_approved
total  \
242                                           242                    1
     1
268                                           270                    1
     1
234                                           234                    1
     1
335                                           347                    1
     1
373                                           451                    1
     1

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

Summary of above bar plot

1. Maximum no. of teachers submit project first time.
2. Maximum project posted by a teacher is 451.

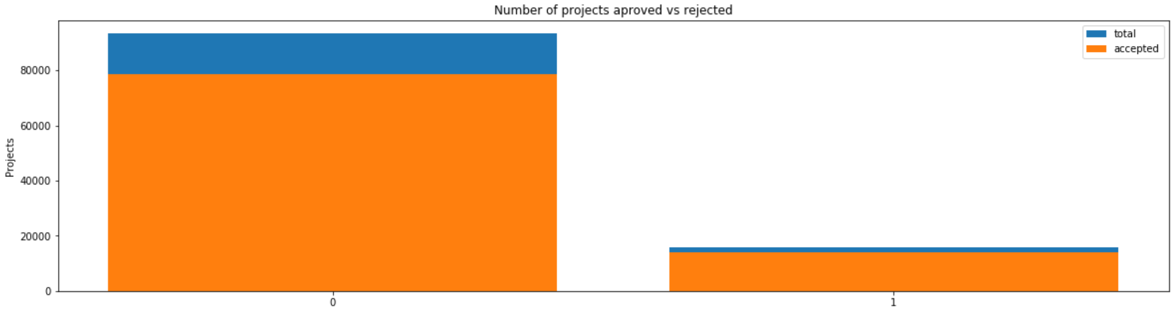
1.2.10 Univariate Analysis: project_resource_summary

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

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

In [97]:

```
# Collect and iterate project resource summary for number
project_resource_summary = list(project_data['project_resource_summary'
])

# python check number in string https://stackoverflow.com/questions/198
59282/check-if-a-string-contains-a-number
def hasNumbers(inputString):
    return bool(re.search(r'\d', inputString))

# Check number is found in project resource summary
number_found = []
for summary in project_resource_summary:
    if (hasNumbers(summary)):
        number_found.append(1)
    else:
        number_found.append(0)

# number_found[0:100]
project_data['is_number_found'] = number_found
univariate_barplots(project_data, 'is_number_found', 'project_is_approv
ed' , top=False)
```



```
   is_number_found  project_is_approved  total       Avg
0                0                78616  93492  0.840885
1                1                14090  15756  0.894263
==================================================
   is_number_found  project_is_approved  total       Avg
0                0                78616  93492  0.840885
1                1                14090  15756  0.894263
```

Summary of above bar plot

1. Project resource summary with quantities has more approval rate.

1.3 Text preprocessing

1.3.1 Essay Text

In [98]:
```
project_data.head(2)
```

Out[98]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2

2 rows × 21 columns

In [99]:
```
# printing some random essays.
print(project_data['essay'].values[0])
print("="*50)
print(project_data['essay'].values[150])
print("="*50)
print(project_data['essay'].values[1000])
print("="*50)
print(project_data['essay'].values[20000])
print("="*50)
print(project_data['essay'].values[99999])
print("="*50)
```

```
My students are English learners that are working on English as their s
econd or third languages. We are a melting pot of refugees, immigrants,
and native-born Americans bringing the gift of language to our school.
\r\n\r\n We have over 24 languages represented in our English Learner p
rogram with students at every level of mastery.  We also have over 40 c
ountries represented with the families within our school.  Each student
brings a wealth of knowledge and experiences to us that open our eyes t
o new cultures, beliefs, and respect.\"The limits of your language are
the limits of your world.\"-Ludwig Wittgenstein  Our English learner's
have a strong support system at home that begs for more resources.  Man
y times our parents are learning to read and speak English along side o
f their children.  Sometimes this creates barriers for parents to be ab
le to help their child learn phonetics, letter recognition, and other r
eading skills.\r\n\r\nBy providing these dvd's and players, students ar
e able to continue their mastery of the English language even if no one
at home is able to assist.  All families with students within the Level
1 proficiency status, will be a offered to be a part of this program.
These educational videos will be specially chosen by the English Learne
r Teacher and will be sent home regularly to watch.  The videos are to
help the child develop early reading skills.\r\n\r\nParents that do not
have access to a dvd player will have the opportunity to check out a dv
d player to use for the year.  The plan is to use these videos and educ
ational dvd's for the years to come for other EL students.\r\nnannan
==================================================
The 51 fifth grade students that will cycle through my classroom this y
ear all love learning, at least most of the time. At our school, 97.3%
of the students receive free or reduced price lunch. Of the 560 student
```

```
s, 97.3% are minority students. \r\nThe school has a vibrant community
that loves to get together and celebrate. Around Halloween there is a w
hole school parade to show off the beautiful costumes that students wea
r. On Cinco de Mayo we put on a big festival with crafts made by the st
udents, dances, and games. At the end of the year the school hosts a ca
rnival to celebrate the hard work put in during the school year, with a
dunk tank being the most popular activity.My students will use these fi
ve brightly colored Hokki stools in place of regular, stationary, 4-leg
ged chairs. As I will only have a total of ten in the classroom and not
enough for each student to have an individual one, they will be used in
a variety of ways. During independent reading time they will be used as
special chairs students will each use on occasion. I will utilize them
in place of chairs at my small group tables during math and reading tim
es. The rest of the day they will be used by the students who need the
highest amount of movement in their life in order to stay focused on sc
hool.\r\n\r\nWhenever asked what the classroom is missing, my students
always say more Hokki Stools. They can't get their fill of the 5 stools
we already have. When the students are sitting in group with me on the
Hokki Stools, they are always moving, but at the same time doing their
work. Anytime the students get to pick where they can sit, the Hokki St
ools are the first to be taken. There are always students who head over
to the kidney table to get one of the stools who are disappointed as th
ere are not enough of them. \r\n\r\nWe ask a lot of students to sit for
7 hours a day. The Hokki stools will be a compromise that allow my stud
ents to do desk work and move at the same time. These stools will help
students to meet their 60 minutes a day of movement by allowing them to
activate their core muscles for balance while they sit. For many of my
students, these chairs will take away the barrier that exists in school
s for a child who can't sit still.nannan
==================================================
How do you remember your days of school? Was it in a sterile environmen
t with plain walls, rows of desks, and a teacher in front of the room?
A typical day in our room is nothing like that. I work hard to create a
warm inviting themed room for my students look forward to coming to eac
h day.\r\n\r\nMy class is made up of 28 wonderfully unique boys and gir
ls of mixed races in Arkansas.\r\nThey attend a Title I school, which m
eans there is a high enough percentage of free and reduced-price lunch
to qualify. Our school is an \"open classroom\" concept, which is very
unique as there are no walls separating the classrooms. These 9 and 10
```

```
year-old students are very eager learners; they are like sponges, absor
bing all the information and experiences and keep on wanting more.With 
these resources such as the comfy red throw pillows and the whimsical n
autical hanging decor and the blue fish nets, I will be able to help cr
eate the mood in our classroom setting to be one of a themed nautical e
nvironment. Creating a classroom environment is very important in the s
uccess in each and every child's education. The nautical photo props wi
ll be used with each child as they step foot into our classroom for the
first time on Meet the Teacher evening. I'll take pictures of each chil
d with them, have them developed, and then hung in our classroom ready 
for their first day of 4th grade.  This kind gesture will set the tone 
before even the first day of school! The nautical thank you cards will 
be used throughout the year by the students as they create thank you ca
rds to their team groups.\r\n\r\nYour generous donations will help me t
o help make our classroom a fun, inviting, learning environment from da
y one.\r\n\r\nIt costs lost of money out of my own pocket on resources 
to get our classroom ready. Please consider helping with this project t
o make our new school year a very successful one. Thank you!nannan
==================================================
My kindergarten students have varied disabilities ranging from speech a
nd language delays, cognitive delays, gross/fine motor delays, to autis
m. They are eager beavers and always strive to work their hardest worki
ng past their limitations. \r\n\r\nThe materials we have are the ones I
seek out for my students. I teach in a Title I school where most of the
students receive free or reduced price lunch.  Despite their disabiliti
es and limitations, my students love coming to school and come eager to
learn and explore.Have you ever felt like you had ants in your pants an
d you needed to groove and move as you were in a meeting? This is how m
y kids feel all the time. The want to be able to move as they learn or 
so they say.Wobble chairs are the answer and I love then because they d
evelop their core, which enhances gross motor and in Turn fine motor sk
ills. \r\nThey also want to learn through games, my kids don't want to 
sit and do worksheets. They want to learn to count by jumping and playi
ng. Physical engagement is the key to our success. The number toss and 
color and shape mats can make that happen. My students will forget they
are doing work and just have the fun a 6 year old deserves.nannan
==================================================
The mediocre teacher tells. The good teacher explains. The superior tea
cher demonstrates. The great teacher inspires. -William A. Ward\r\n\r\n
```

```
My school has 803 students which is makeup is 97.6% African-American, m
aking up the largest segment of the student body. A typical school in D
allas is made up of 23.2% African-American students. Most of the studen
ts are on free or reduced lunch. We aren't receiving doctors, lawyers,
or engineers children from rich backgrounds or neighborhoods. As an edu
cator I am inspiring minds of young children and we focus not only on a
cademics but one smart, effective, efficient, and disciplined students
with good character.In our classroom we can utilize the Bluetooth for s
wift transitions during class. I use a speaker which doesn't amplify th
e sound enough to receive the message. Due to the volume of my speaker
my students can't hear videos or books clearly and it isn't making the
lessons as meaningful. But with the bluetooth speaker my students will
be able to hear and I can stop, pause and replay it at any time.\r\nThe
cart will allow me to have more room for storage of things that are nee
ded for the day and has an extra part to it I can use.  The table top c
hart has all of the letter, words and pictures for students to learn ab
out different letters and it is more accessible.nannan
==================================================
```

In [100]:

```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 [101]:

```python
sent = decontracted(project_data['essay'].values[20000])
```

```
print(sent)
print("="*50)
```

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

In [102]:

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

```
My kindergarten students have varied disabilities ranging from speech a
nd language delays, cognitive delays, gross/fine motor delays, to autis
m. They are eager beavers and always strive to work their hardest worki
ng past their limitations.     The materials we have are the ones I see
k out for my students. I teach in a Title I school where most of the st
udents receive free or reduced price lunch.  Despite their disabilities
and limitations, my students love coming to school and come eager to le
arn and explore.Have you ever felt like you had ants in your pants and
you needed to groove and move as you were in a meeting? This is how my
kids feel all the time. The want to be able to move as they learn or so
```

```
they say.Wobble chairs are the answer and I love then because they deve
lop their core, which enhances gross motor and in Turn fine motor skill
s.   They also want to learn through games, my kids do not want to sit
and do worksheets. They want to learn to count by jumping and playing.
Physical engagement is the key to our success. The number toss and colo
r and shape mats can make that happen. My students will forget they are
doing work and just have the fun a 6 year old deserves.nannan
```

In [103]:

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

```
My kindergarten students have varied disabilities ranging from speech a
nd language delays cognitive delays gross fine motor delays to autism T
hey are eager beavers and always strive to work their hardest working p
ast their limitations The materials we have are the ones I seek out for
my students I teach in a Title I school where most of the students rece
ive free or reduced price lunch Despite their disabilities and limitati
ons my students love coming to school and come eager to learn and explo
re Have you ever felt like you had ants in your pants and you needed to
groove and move as you were in a meeting This is how my kids feel all t
he time The want to be able to move as they learn or so they say Wobble
chairs are the answer and I love then because they develop their core w
hich enhances gross motor and in Turn fine motor skills They also want
to learn through games my kids do not want to sit and do worksheets The
y want to learn to count by jumping and playing Physical engagement is
the key to our success The number toss and color and shape mats can mak
e that happen My students will forget they are doing work and just have
the fun a 6 year old deserves nannan
```

In [104]:

```
# 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 [105]:

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

```
100%|██████████| 109248/109248 [01:55<00:00, 948.46it/s]
```

In [106]:
```
# after preprocesing
preprocessed_essays[20000]
```

Out[106]:
```
'my kindergarten students varied disabilities ranging speech language d
elays cognitive delays gross fine motor delays autism they eager beaver
s always strive work hardest working past limitations the materials one
s i seek students i teach title i school students receive free reduced
price lunch despite disabilities limitations students love coming schoo
l come eager learn explore have ever felt like ants pants needed groove
move meeting this kids feel time the want able move learn say wobble ch
airs answer i love develop core enhances gross motor turn fine motor sk
ills they also want learn games kids not want sit worksheets they want
learn count jumping playing physical engagement key success the number
toss color shape mats make happen my students forget work fun 6 year ol
d deserves nannan'
```

1.3.2 Project title Text

In [107]:
```
# similarly you can preprocess the titles also
# Combining all the above statemennts
from tqdm import tqdm
preprocessed_titles = []
# tqdm is for printing the status bar
for sentance in tqdm(project_data['project_title'].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_titles.append(sent.lower().strip())
```

```
100%|██████████| 109248/109248 [00:03<00:00, 28045.80it/s]
```

In [108]:
```
# after preprocesing
preprocessed_titles[20000]
```

```
Out[108]: 'we need to move it while we input it'
```

1. 4 Preparing data for models

```
In [109]: project_data.columns
```

```
Out[109]: Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_stat
e',
       'project_submitted_datetime', 'project_grade_category', 'project
_title',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_appr
oved',
       'clean_categories', 'clean_subcategories', 'essay', 'price', 'qu
antity',
       'is_number_found'],
      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 [110]:
```
# 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 [118]:
```
# 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 [126]:

```
# Preprocess teacher_prefix
from tqdm import tqdm
preprocessed_teacher_prefix = []
# tqdm is for printing the status bar
for teacher_prefix in tqdm(project_data['teacher_prefix'].values):
    teacher_prefix = str(teacher_prefix)
    clean_teacher_prefix = decontracted(teacher_prefix)
    clean_teacher_prefix = clean_teacher_prefix.replace('\\r', ' ')
    clean_teacher_prefix = clean_teacher_prefix.replace('\\"', ' ')
    clean_teacher_prefix = clean_teacher_prefix.replace('\\n', ' ')
    clean_teacher_prefix = re.sub('[^A-Za-z0-9]+', ' ', clean_teacher_p
refix)
    if clean_teacher_prefix in stopwords:
        continue
    preprocessed_teacher_prefix.append(clean_teacher_prefix.lower().str
ip())
```

```
100%|██████████| 109248/109248 [00:01<00:00, 73609.81it/s]
```

In [129]:

```
preprocessed_teacher_prefix[0:10]
```

Out[129]:

```
['mrs', 'mr', 'ms', 'mrs', 'mrs', 'mrs', 'mrs', 'ms', 'mrs', 'ms']
```

In [133]:

```
# Preprocess project_grade_category
from tqdm import tqdm
```

```
preprocessed_project_grade_category = []
# tqdm is for printing the status bar
for project_grade_category in tqdm(project_data['project_grade_categor
y'].values):
    project_grade_category = str(project_grade_category)
    clean_project_grade_category = decontracted(project_grade_category)
    clean_project_grade_category = clean_project_grade_category.replace
('\\r', ' ')
    clean_project_grade_category = clean_project_grade_category.replace
('\\"', ' ')
    clean_project_grade_category = clean_project_grade_category.replace
('\\n', ' ')
    clean_project_grade_category = re.sub('[^A-Za-z0-9]+', ' ', clean_p
roject_grade_category)
    if clean_project_grade_category in stopwords:
        continue
    preprocessed_project_grade_category.append(clean_project_grade_cate
gory.lower().strip())
```

```
100%|██████████| 109248/109248 [00:01<00:00, 58803.26it/s]
```

In [134]:

```
preprocessed_project_grade_category[0:10]
```

Out[134]:

```
['grades prek 2',
 'grades 6 8',
 'grades 6 8',
 'grades prek 2',
 'grades prek 2',
 'grades 3 5',
 'grades 6 8',
 'grades 3 5',
 'grades prek 2',
 'grades prek 2']
```

In [143]:

```
# Please do the similar feature encoding with state, teacher_prefix and
 project_grade_category also

# Get distinct school state
project_school_state = project_data['school_state'].value_counts()
```

```python
# Convert data frame into dictionary
project_school_state_dict = dict(project_school_state)
# Sort values in ascending order
sorted_project_school_state_dict = dict(sorted(project_school_state_dict.items(), key=lambda kv: kv[1]))

print(sorted_project_school_state_dict)
print("="*100)

# Convert one hot encoding for school state
vectorizer = CountVectorizer(vocabulary=list(sorted_project_school_state_dict.items()), lowercase=False, binary=True)
vectorizer.fit(project_data['school_state'].values)
print(vectorizer.get_feature_names())

school_state_one_hot = vectorizer.transform(project_data['school_state'].values)
print("Shape of matrix after one hot encodig ",school_state_one_hot.shape)
print("="*100)


# Convert one hot encoding for teacher prefix
vectorizer = CountVectorizer(vocabulary=set(preprocessed_teacher_prefix), lowercase=False, binary=True)
vectorizer.fit(preprocessed_teacher_prefix)
print(vectorizer.get_feature_names())

teacher_prefix_one_hot = vectorizer.transform(preprocessed_teacher_prefix)
print("Shape of matrix after one hot encodig ",teacher_prefix_one_hot.shape)
print("="*100)

# Convert one hot encoding for project grade category
vectorizer = CountVectorizer(vocabulary=set(preprocessed_project_grade_category), lowercase=False, binary=True)
vectorizer.fit(preprocessed_project_grade_category)
print(vectorizer.get_feature_names())
```

```
project_grade_category_one_hot = vectorizer.transform(preprocessed_proj
ect_grade_category)
print("Shape of matrix after one hot encodig ",project_grade_category_o
ne_hot.shape)
print("="*100)
```

```
{'VT': 80, 'WY': 98, 'ND': 143, 'MT': 245, 'RI': 285, 'SD': 300, 'NE':
309, 'DE': 343, 'AK': 345, 'NH': 348, 'WV': 503, 'ME': 505, 'HI': 507,
'DC': 516, 'NM': 557, 'KS': 634, 'IA': 666, 'ID': 693, 'AR': 1049, 'C
O': 1111, 'MN': 1208, 'OR': 1242, 'KY': 1304, 'MS': 1323, 'NV': 1367,
'MD': 1514, 'CT': 1663, 'TN': 1688, 'UT': 1731, 'AL': 1762, 'WI': 1827,
'VA': 2045, 'AZ': 2147, 'NJ': 2237, 'OK': 2276, 'WA': 2334, 'MA': 2389,
'LA': 2394, 'OH': 2467, 'MO': 2576, 'IN': 2620, 'PA': 3109, 'MI': 3161,
'SC': 3936, 'GA': 3963, 'IL': 4350, 'NC': 5091, 'FL': 6185, 'NY': 7318,
'TX': 7396, 'CA': 15388}
=======================================================================
=============================
[('VT', 80), ('WY', 98), ('ND', 143), ('MT', 245), ('RI', 285), ('SD',
300), ('NE', 309), ('DE', 343), ('AK', 345), ('NH', 348), ('WV', 503),
('ME', 505), ('HI', 507), ('DC', 516), ('NM', 557), ('KS', 634), ('IA',
666), ('ID', 693), ('AR', 1049), ('CO', 1111), ('MN', 1208), ('OR', 124
2), ('KY', 1304), ('MS', 1323), ('NV', 1367), ('MD', 1514), ('CT', 166
3), ('TN', 1688), ('UT', 1731), ('AL', 1762), ('WI', 1827), ('VA', 204
5), ('AZ', 2147), ('NJ', 2237), ('OK', 2276), ('WA', 2334), ('MA', 238
9), ('LA', 2394), ('OH', 2467), ('MO', 2576), ('IN', 2620), ('PA', 310
9), ('MI', 3161), ('SC', 3936), ('GA', 3963), ('IL', 4350), ('NC', 509
1), ('FL', 6185), ('NY', 7318), ('TX', 7396), ('CA', 15388)]
Shape of matrix after one hot encodig  (109248, 51)
=======================================================================
=============================
['dr', 'mr', 'mrs', 'ms', 'nan', 'teacher']
Shape of matrix after one hot encodig  (109248, 6)
=======================================================================
=============================
['grades 3 5', 'grades 6 8', 'grades 9 12', 'grades prek 2']
Shape of matrix after one hot encodig  (109248, 4)
=======================================================================
=============================
```

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

In [144]:

```
# We are considering only the words which appeared in at least 10 documents(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 [145]:

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

In [146]:

```
# Similarly you can vectorize for title also
vectorizer = CountVectorizer(min_df=10)
project_title_bow = vectorizer.fit_transform(preprocessed_titles)
print("Shape of matrix after one hot encodig ",project_title_bow.shape)
```

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

1.4.2.3 TFIDF vectorizer

In [147]:

```
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 [148]:

```
# Similarly you can vectorize for title also
vectorizer = TfidfVectorizer(min_df=10)
project_title_tfidf = vectorizer.fit_transform(preprocessed_titles)
print("Shape of matrix after one hot encodig ",project_title_tfidf.shap
e)
```

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

1.4.2.5 Using Pretrained Models: Avg W2V

In [149]:

```
'''
# 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[149]:

```
'\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 [150]:

```
# 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 [151]:

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

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

```
100%|██████████| 109248/109248 [00:52<00:00, 2097.05it/s]
```

```
109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on `project_title`

In [152]:

```
# Similarly you can vectorize for title also
# average Word2Vec
# compute average word2vec for each review.
avg_w2v_vectors_title = []; # the avg-w2v for each sentence/review is s
tored in this list
for sentence in tqdm(preprocessed_titles): # 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_title.append(vector)

print(len(avg_w2v_vectors_title))
print(len(avg_w2v_vectors_title[0]))
```

```
100%|██████████| 109248/109248 [00:02<00:00, 44719.69it/s]
```

```
109248
300
```

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

In [153]:

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

In [154]:

```
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sentence in tqdm(preprocessed_essays): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.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 [06:28<00:00, 280.94it/s]
```

```
109248

300
```

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

In [155]:

```
# Similarly you can vectorize for title also
# average Word2Vec
# compute average word2vec for each review.
tfidf_w2v_vectors_title = []; # the avg-w2v for each sentence/review is
 stored in this list
for sentence in tqdm(preprocessed_titles): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the 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_title.append(vector)

print(len(tfidf_w2v_vectors_title))
print(len(tfidf_w2v_vectors_title[0]))
```

```
100%|██████████| 109248/109248 [00:03<00:00, 34367.65it/s]
```

```
109248
300
```

1.4.3 Vectorizing Numerical features

In [156]:

```
# 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 [157]:

```
price_standardized
```

Out[157]:

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

In [158]:

```
# 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)

teacher_number_of_previously_posted_projects_scalar = StandardScaler()
teacher_number_of_previously_posted_projects_scalar.fit(project_data['t
eacher_number_of_previously_posted_projects'].values.reshape(-1,1)) # f
inding the mean and standard deviation of this data
print(f"Mean : {teacher_number_of_previously_posted_projects_scalar.mea
n_[0]}, Standard deviation : {np.sqrt(teacher_number_of_previously_post
ed_projects_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
teacher_number_of_previously_posted_projects_standardized = teacher_num
ber_of_previously_posted_projects_scalar.transform(project_data['teache
r_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

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

In [159]:
```
teacher_number_of_previously_posted_projects_standardized
```

Out[159]:
```
array([[-0.40152481],
       [-0.14951799],
       [-0.36552384],
       ...,
       [-0.29352189],
       [-0.40152481],
       [-0.40152481]])
```

1.4.4 Merging all the above features

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

In [160]:

```
print(school_state_one_hot.shape)
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(teacher_prefix_one_hot.shape)
print(project_grade_category_one_hot.shape)
print(project_title_bow.shape)
print(project_title_tfidf.shape)
print(len(avg_w2v_vectors_title), ',', len(avg_w2v_vectors_title[0]))
print(len(tfidf_w2v_vectors_title), ',', len(tfidf_w2v_vectors_title[0
]))
print(price_standardized.shape)
print(teacher_number_of_previously_posted_projects_standardized.shape)

# Don't consider essay text for processing
# print(text_bow.shape)
```

```
(109248, 51)
(109248, 9)
(109248, 30)
(109248, 6)
(109248, 4)
(109248, 3329)
(109248, 3329)
109248 , 300
109248 , 300
(109248, 1)
(109248, 1)
```

In [161]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/40840
39
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix an
d a dense matirx :)
X = hstack((school_state_one_hot, categories_one_hot, sub_categories_on
e_hot, teacher_prefix_one_hot, project_grade_category_one_hot, project_
title_bow, project_title_tfidf, avg_w2v_vectors_title, tfidf_w2v_vector
s_title, price_standardized, teacher_number_of_previously_posted_projec
ts_standardized))#, text_bow
X.shape
```

```
Out[161]: (109248, 7360)
```

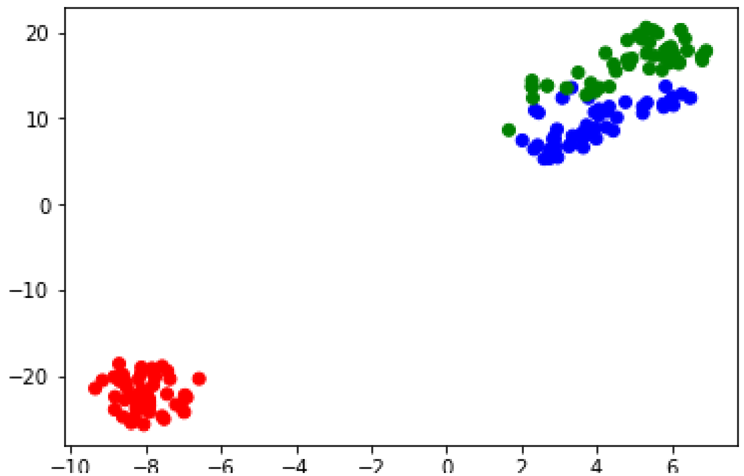
Assignment 2: Apply TSNE

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 [162]:

```
# 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()
```



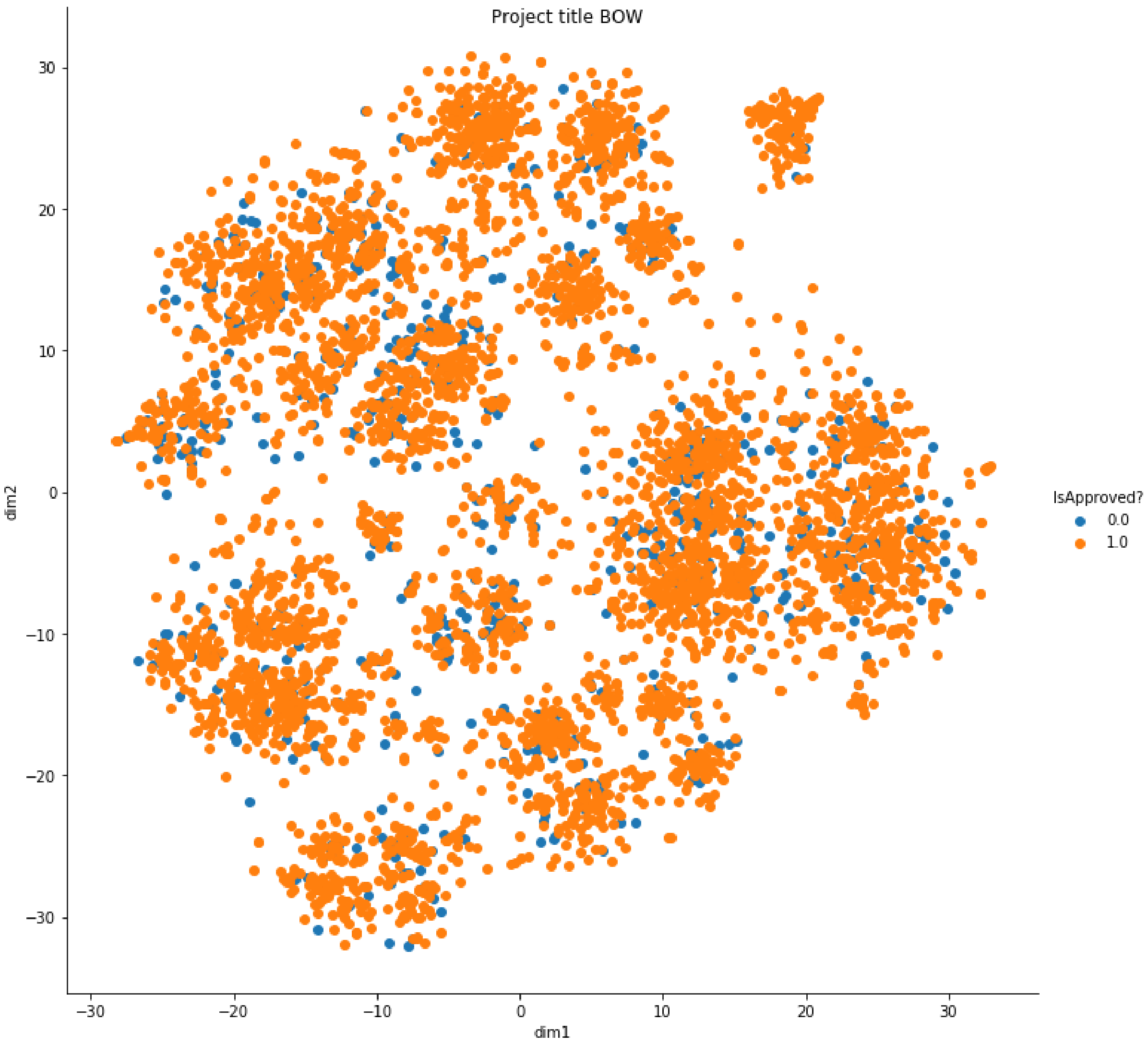
2.1 TSNE with `BOW` encoding of `project_title` feature "with 5000 data points"

In [163]:

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

# Merge all feature matrices i.e. categorical feature, numerical featur
e and project_title BOW encoding
X = hstack((school_state_one_hot, categories_one_hot, sub_categories_on
e_hot, teacher_prefix_one_hot, project_grade_category_one_hot, price_st
andardized, teacher_number_of_previously_posted_projects_standardized,
project_title_bow))
print(X.shape)

# Collect 5K data points
X = X.tocsr()
X = X[0:5000,:]

# Collect 5K class labels
class_labels = project_data['project_is_approved'][0:5000]

# Perform TSNE
model = TSNE(n_components=2, random_state=0, perplexity=100)
tsne_data = model.fit_transform(X.toarray())

tsne_data = np.vstack((tsne_data.T, class_labels)).T
tsne_data_df = pd.DataFrame(data=tsne_data, columns=('dim1', 'dim2', 'I
sApproved?'))
print(tsne_data_df.shape)
```

```
sns.FacetGrid(tsne_data_df, hue='IsApproved?', height=10).map(plt.scatt
er, 'dim1', 'dim2').add_legend().fig.suptitle("Project title BOW")
plt.show()
```

```
(109248, 3431)
(5000, 3)
```

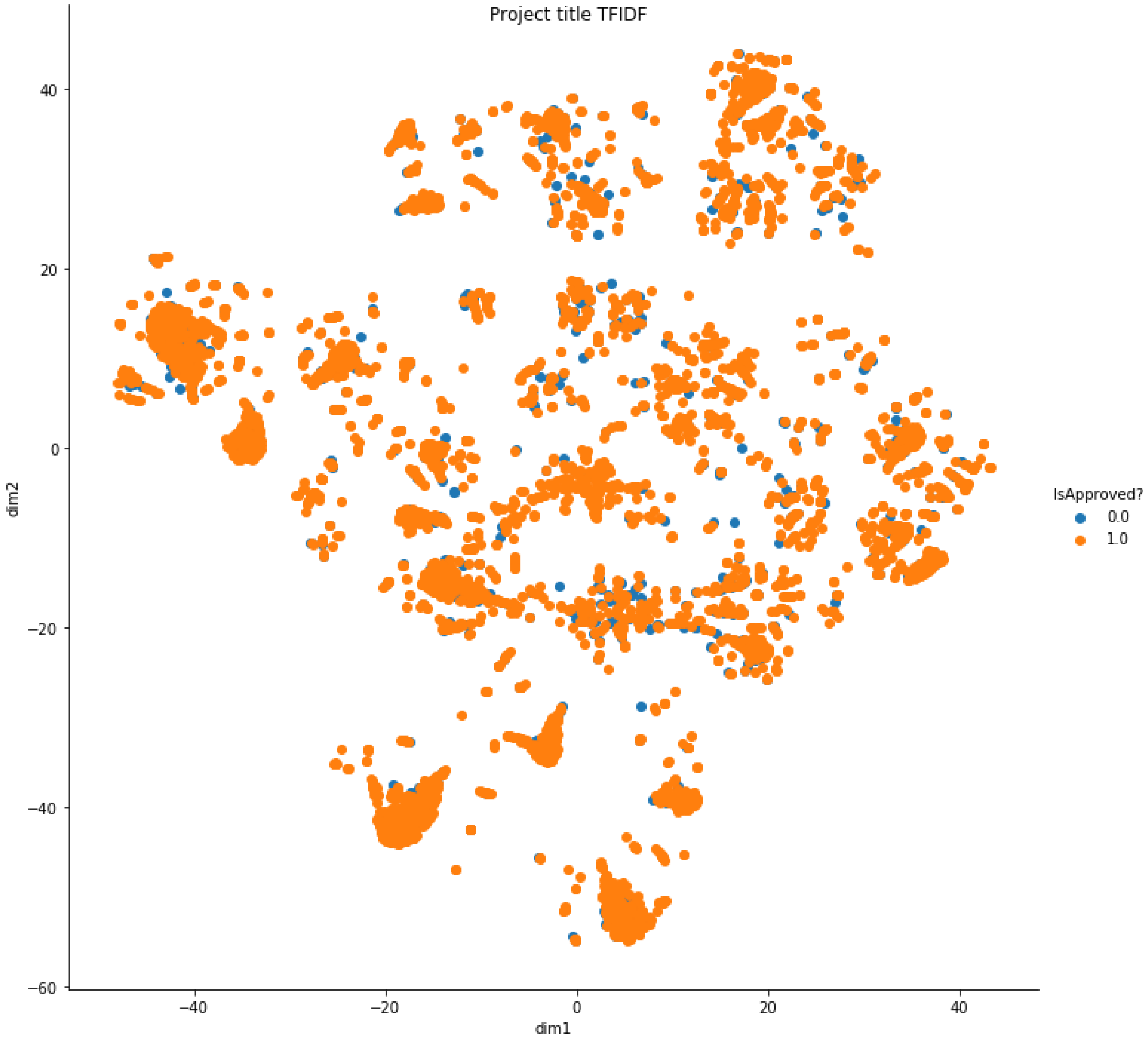


2.2 TSNE with `TFIDF` encoding of `project_title` feature "With 5000 data points"

In [164]:

```
# please write all the code with proper documentation, and proper titles for each subsection
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
# Merge all feature matrices i.e. categorical feature, numerical feature and project_title TFIDF encoding
X = hstack((school_state_one_hot, categories_one_hot, sub_categories_one_hot, teacher_prefix_one_hot, project_grade_category_one_hot, price_standardized, teacher_number_of_previously_posted_projects_standardized, project_title_tfidf))
print(X.shape)

# Collect 5K data points
X = X.tocsr()
X = X[0:5000,:]

# Collect 5K class labels
class_labels = project_data['project_is_approved'][0:5000]

# Perform TSNE
model = TSNE(n_components=2, random_state=0, perplexity=100)
tsne_data = model.fit_transform(X.toarray())

tsne_data = np.vstack((tsne_data.T, class_labels)).T
tsne_data_df = pd.DataFrame(data=tsne_data, columns=('dim1', 'dim2', 'IsApproved?'))
print(tsne_data_df.shape)

sns.FacetGrid(tsne_data_df, hue='IsApproved?', height=10).map(plt.scatt
er, 'dim1', 'dim2').add_legend().fig.suptitle("Project title TFIDF")
plt.show()
```

```
(109248, 3431)
(5000, 3)
```

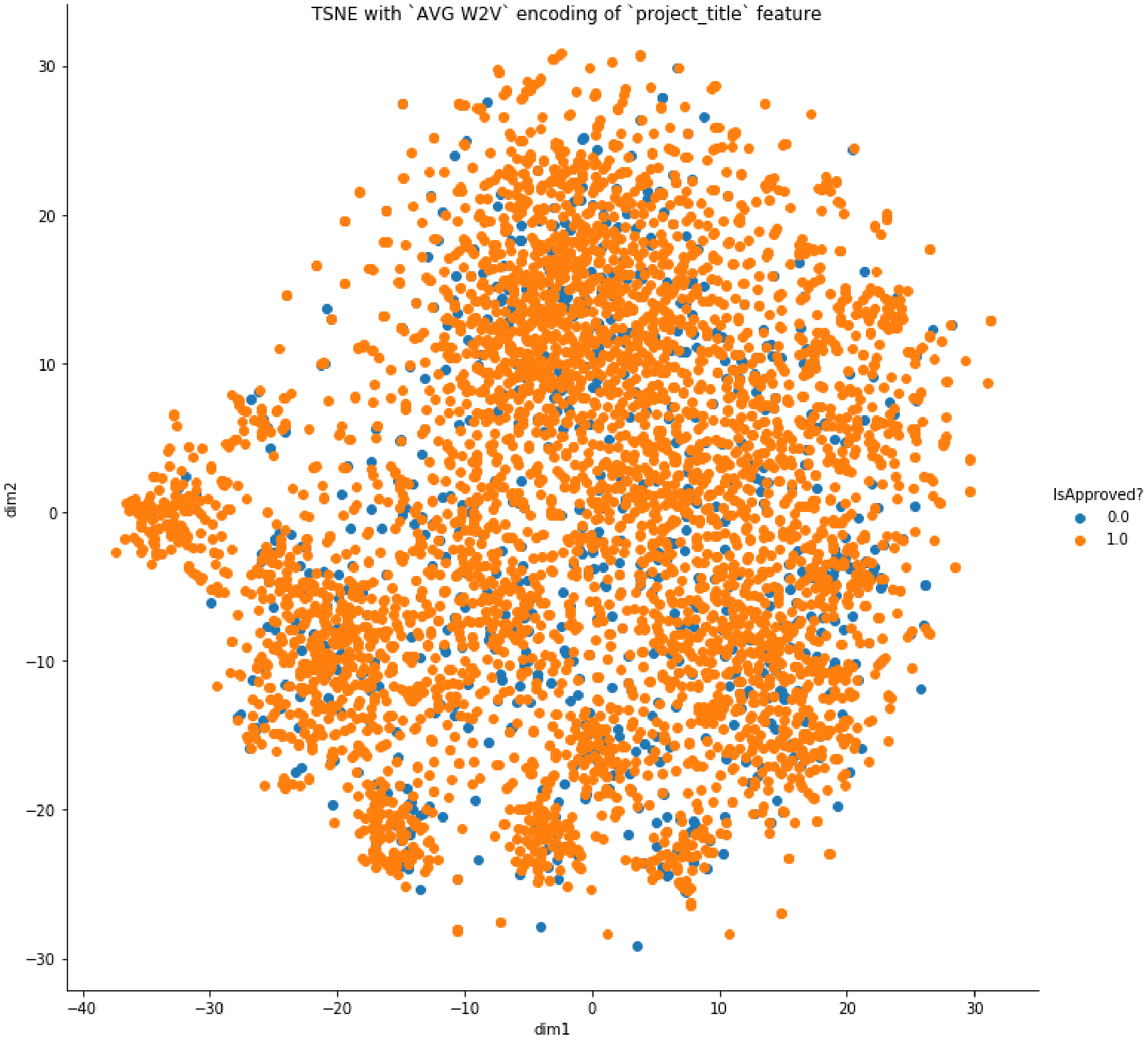


2.3 TSNE with `AVG W2V` encoding of `project_title` feature "With 5000 data points"

In [165]:

```
# please write all the code with proper documentation, and proper title
s for each subsection
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to
 the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
# Merge all feature matrices i.e. categorical feature, numerical featur
e and project_title AvgW2V encoding
X = hstack((school_state_one_hot, categories_one_hot, sub_categories_on
e_hot, teacher_prefix_one_hot, project_grade_category_one_hot, price_st
andardized, teacher_number_of_previously_posted_projects_standardized,
avg_w2v_vectors_title))
print(X.shape)

# Collect 5K data points
X = X.tocsr()
X = X[0:5000,:]

# Collect 5K class labels
class_labels = project_data['project_is_approved'][0:5000]

# Perform TSNE
model = TSNE(n_components=2, random_state=0, perplexity=100)
tsne_data = model.fit_transform(X.toarray())

tsne_data = np.vstack((tsne_data.T, class_labels)).T
tsne_data_df = pd.DataFrame(data=tsne_data, columns=('dim1', 'dim2', 'I
sApproved?'))
print(tsne_data_df.shape)

sns.FacetGrid(tsne_data_df, hue='IsApproved?', height=10).map(plt.scatt
er, 'dim1', 'dim2').add_legend().fig.suptitle("TSNE with `AVG W2V` enco
ding of `project_title` feature")
plt.show()
```

```
(109248, 402)
(5000, 3)
```

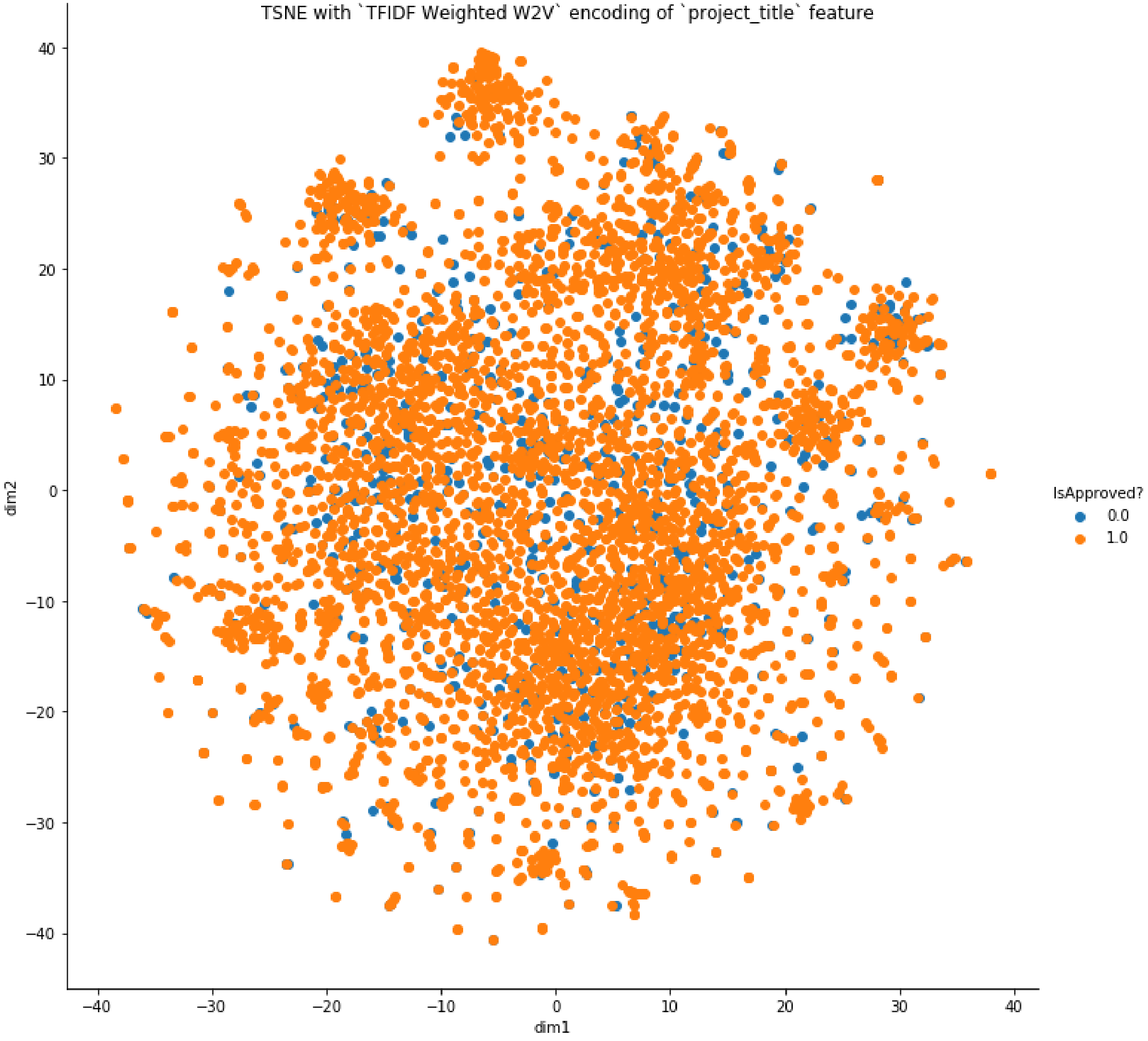


2.4 TSNE with `TFIDF Weighted W2V` encoding of `project_title` feature "With 5000 data points"

In [166]:

```
# please write all the code with proper documentation, and proper title
s for each subsection
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to
 the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
# Merge all feature matrices i.e. categorical feature, numerical featur
e and project_title TFIDF W2V encoding
X = hstack((school_state_one_hot, categories_one_hot, sub_categories_on
e_hot, teacher_prefix_one_hot, project_grade_category_one_hot, price_st
andardized, teacher_number_of_previously_posted_projects_standardized,
tfidf_w2v_vectors_title))
print(X.shape)

# Collect 5K data points
X = X.tocsr()
X = X[0:5000,:]

# Collect 5K class labels
class_labels = project_data['project_is_approved'][0:5000]

# Perform TSNE
model = TSNE(n_components=2, random_state=0, perplexity=100)
tsne_data = model.fit_transform(X.toarray())

tsne_data = np.vstack((tsne_data.T, class_labels)).T
tsne_data_df = pd.DataFrame(data=tsne_data, columns=('dim1', 'dim2', 'I
sApproved?'))
print(tsne_data_df.shape)

sns.FacetGrid(tsne_data_df, hue='IsApproved?', height=10).map(plt.scatt
er, 'dim1', 'dim2').add_legend().fig.suptitle("TSNE with `TFIDF Weighte
d W2V` encoding of `project_title` feature")
plt.show()
```

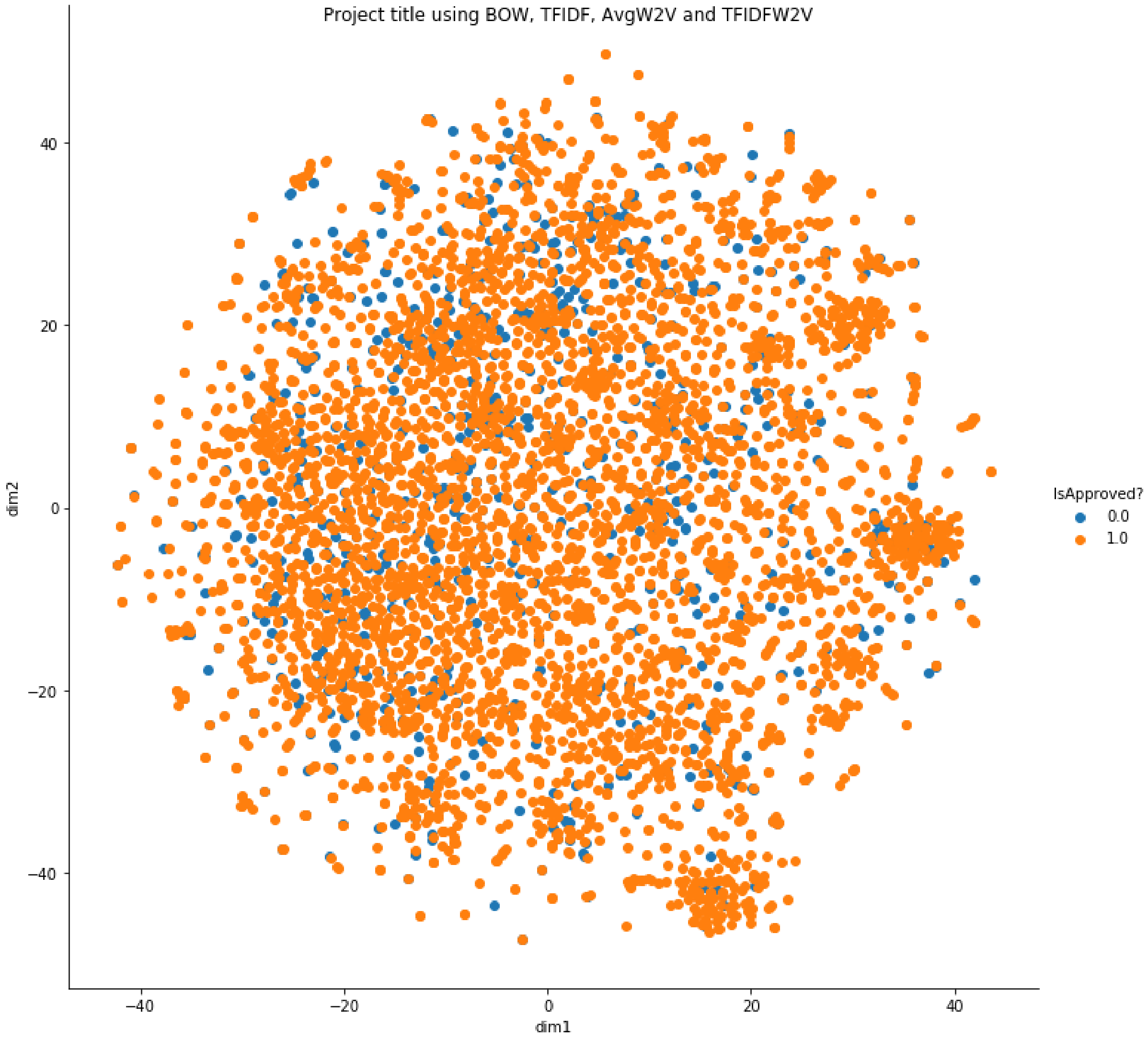
```
(109248, 402)
(5000, 3)
```



In [167]:

```
# Combining all features

# Merge all feature matrices i.e. categorical feature, numerical feature and project_title BOW, TFIDF, AvgW2V, TFIDF W2V encoding
X = hstack((school_state_one_hot, categories_one_hot, sub_categories_one_hot, teacher_prefix_one_hot, project_grade_category_one_hot, price_standardized, teacher_number_of_previously_posted_projects_standardized, project_title_bow, project_title_tfidf, avg_w2v_vectors_title, tfidf_w2v_vectors_title))
print(X.shape)

# Collect 5K data points
X = X.tocsr()
X = X[0:5000,:]

# Collect 5K class labels
class_labels = project_data['project_is_approved'][0:5000]

# Perform TSNE
model = TSNE(n_components=2, random_state=0, perplexity=100)
tsne_data = model.fit_transform(X.toarray())

tsne_data = np.vstack((tsne_data.T, class_labels)).T
tsne_data_df = pd.DataFrame(data=tsne_data, columns=('dim1', 'dim2', 'IsApproved?'))
print(tsne_data_df.shape)

sns.FacetGrid(tsne_data_df, hue='IsApproved?', height=10).map(plt.scatter, 'dim1', 'dim2').add_legend().fig.suptitle("Project title using BOW, TFIDF, AvgW2V and TFIDFW2V")
plt.show()
```

```
(109248, 7360)
(5000, 3)
```


Project title using BOW, TFIDF, AvgW2V and TFIDFW2V
40
20
0
−20
−40
dim2
−40
−20
0
20
40
dim1
IsApproved?
● 0.0
● 1.0

2.5 Summary

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

1. Approx 85% project got approved from volunteers that would be shown on https://www.donorschoose.org/
2. Delaware has maximum approval rate (89%) while Vermont has minimum approval rate 80%.
3. California submitted maximum no. of projects (15388) while Vermont minimum (80).
4. Female participant have maximum no. of approval.
5. Grades PreK-2 has maximum approved projects while Grades 9-12 has minimum approved projects.
6. Literacy & Language has maximum project submission and approval rate while Applied learning has minimum approval rate.
7. Project title with word count 4,5 and 3 has maximum approval rate.
8. Cost of unapproved project is slightly higher than approved projects.
9. Maximum no. of teachers submit project first time.
10. Project resource summary with quantities has more approval rate.
11. We can’t categorise our data using TSNE BOW, TFIDF, AVGW2V and TFIDFW2V, we will explore another algorithm that will categorise our data better.

In [ ]: