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**
`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 targete enumerated values: • `Grades PreK-2` • `Grades 3-5` • `Grades 6-8` • `Grades 9-12`
`project_subject_categories`	One or more (comma-separated) subject categories f 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 (https://en.wikipedia.org/wiki/List_of_U.S._state_abbr **Example:** `WY`
`project_subject_subcategories`	One or more (comma-separated) subject subcategori **Examples:** • `Literacy` • `Literature & Writing, Social Sciences`
`project_resource_summary`	An explanation of the resources needed for the projec • `My students need hands on literacy mate sensory needs!`

Feature	Description
`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. **Exa** `12:43:56.245`
`teacher_id`	A unique identifier for the teacher of the proposed pro `bdf8baa8fedef6bfeec7ae4ff1c15c56`
`teacher_prefix`	Teacher's title. One of the following enumerated value • `nan` • `Dr.` • `Mr.` • `Mrs.` • `Ms.` • `Teacher.`
`teacher_number_of_previously_posted_projects`	Number of project applications previously submitted b **Example:** `2`

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

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

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

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

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

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

Notes on the Essay Data

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

- __project_essay_1:__ "Introduce us to your classroom"
- __project_essay_2:__ "Tell us more about your students"
- __project_essay_3:__ "Describe how your students will use the materials you're requesting"
- __project_essay_4:__ "Close by sharing why your project will make a difference"

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

- __project_essay_1:__ "Describe your students: What makes your students special? Specific details about their background, your neighborhood, and your school are all helpful."
- __project_essay_2:__ "About your project: How will these materials make a difference in your students' learning and improve their school lives?"

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

In [1]:

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

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

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

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

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

from tqdm import tqdm
import os

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

In [86]:

```
#os.getcwd()
```

1.1 Reading Data

Only 4000 data is used in this assignment while ploting TSNE due to memory constrain.Hence conclusion are based on that data.

In [4]:

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

In [5]:

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

```
Number of data points in train data (109248, 17)
==================================================
Number of data points in resource data (1541272, 4)
==================================================
The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix'
'school_state'
 'project_submitted_datetime' 'project_grade_category'
 'project_subject_categories' 'project_subject_subcategories'
 'project_title' 'project_essay_1' 'project_essay_2' 'project_essay_3'
 'project_essay_4' 'project_resource_summary'
 'teacher_number_of_previously_posted_projects' 'project_is_approved']
==================================================
<class 'pandas.core.frame.DataFrame'>
```

In [6]:

```
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[6]:

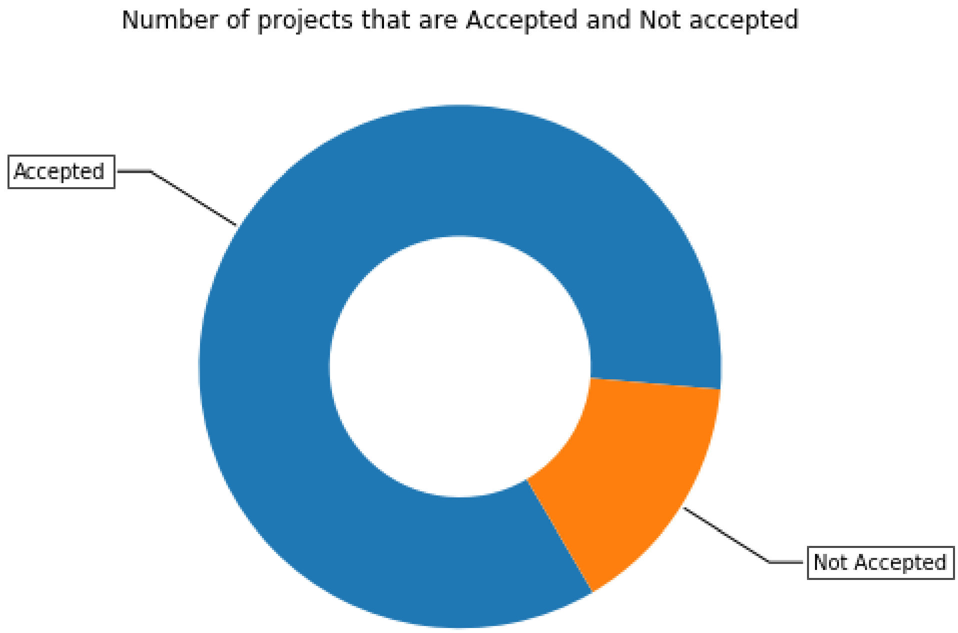
	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.00
1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95

1.2 Data Analysis

In [7]:

```
# PROVIDE CITATIONS TO YOUR CODE IF YOU TAKE IT FROM ANOTHER WEBSITE.
# https://matplotlib.org/gallery/pie_and_polar_charts/pie_and_donut_labels.html#sphx-gl
r-gallery-pie-and-polar-charts-pie-and-donut-labels-py



y_value_counts = project_data['project_is_approved'].value_counts()
print("Number of projects that are approved for funding ", y_value_counts[1], ", (", (y
_value_counts[1]/(y_value_counts[1]+y_value_counts[0]))*100,"%)")
print("Number of projects that 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=-5)

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

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

ax.set_title("Number of projects that are Accepted and Not accepted")

plt.show()
```

```
Number of projects that are approved for funding  92706 , ( 84.85830404217
927 %)
Number of projects that are not approved for funding  16542 , ( 15.1416959
57820739 %)
```



SUMMARY: Overall Project accept rate for funding is high.

1.2.1 Univariate Analysis: School State

In [8]:

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

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

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

scl = [[0.0, 'rgb(242,240,247)'],[0.2, 'rgb(218,218,235)'],[0.4, 'rgb(188,189,220)'],\
            [0.6, 'rgb(158,154,200)'],[0.8, 'rgb(117,107,177)'],[1.0, 'rgb(84,39,14
3)']]

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[8]:

```
'# How to plot US state heatmap: https://datascience.stackexchange.com/a/9
620\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, \'r
gb(117,107,177)\'],[1.0, \'rgb(84,39,143)\']]\n\ndata = [ dict(\n        t
ype=\'choropleth\',\n        colorscale = scl,\n        autocolorscale = F
alse,\n        locations = temp[\'state_code\'],\n        z = temp[\'num_p
roposals\'].astype(float),\n        locationmode = \'USA-states\',\n
text = temp[\'state_code\'],\n        marker = dict(line = dict (color =
\'rgb(255,255,255)\',width = 2)),\n        colorbar = dict(title = "% of p
ro")\n    ) ]\n\nlayout = dict(\n        title = \'Project Proposals % of
Acceptance Rate by US States\',\n        geo = dict(\n            scope=
\'usa\',\n            projection=dict( type=\'albers usa\' ),\n
showlakes = True,\n            lakecolor = \'rgb(255, 255, 255)\',\n
),\n    )\n\nfig = go.Figure(data=data, layout=layout)\noffline.iplot(fig,
filename=\'us-map-heat-map\')\n'
```

In [9]:

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

SUMMARY: States such as ND,DE,WA are having 100% approval rate where as VT,DC states have very low approval rate when compare to other states.

In [10]:

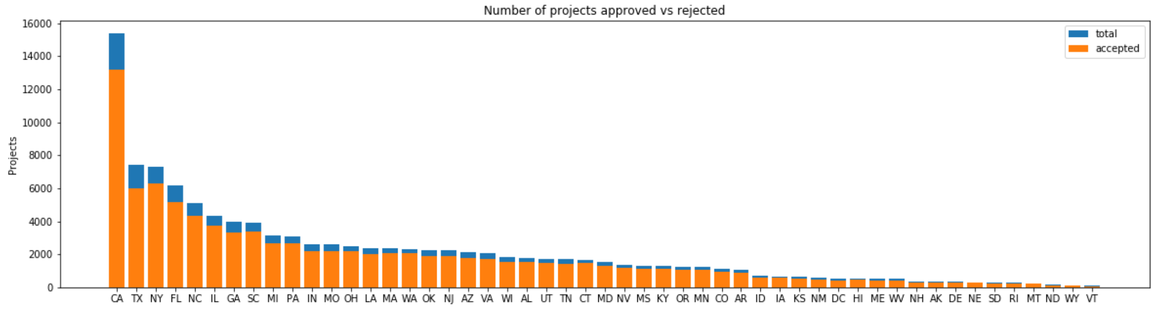
```
# stacked bar plots matplotlib: https://matplotlib.org/gallery/lines_bars_and_markers/b
ar_stacked.html
def stack_plot(data, xtick, col2='project_is_approved', col3='total'):
    ind = np.arange(data.shape[0])

    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 approved vs rejected')
    plt.xticks(ind, list(data[xtick].values))
    plt.legend((p1[0], p2[0]), ('total', 'accepted'))
    plt.show()
```

In [11]:

```
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 [12]:

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



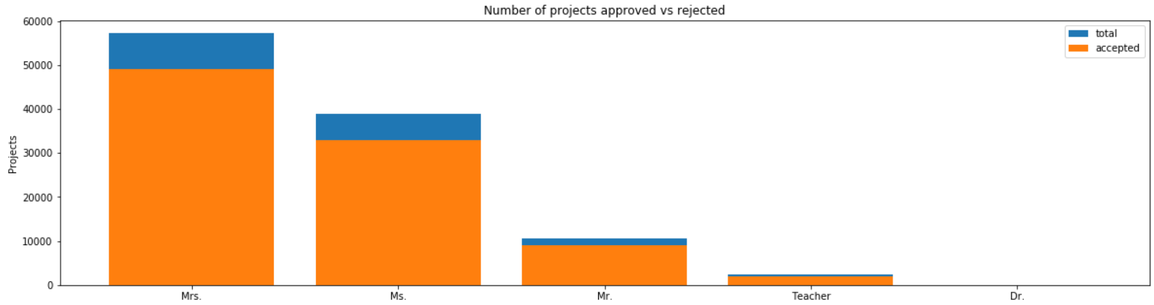
```
   school_state  project_is_approved  total       Avg
4            CA                13205  15388  0.858136
43           TX                 6014   7396  0.813142
34           NY                 6291   7318  0.859661
9            FL                 5144   6185  0.831690
27           NC                 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: From the above plot we can see total no of project submitted by the school vs project approval rate.Seems CA,TX and NY have submitted more project compare to others school state.Out of that CA having 85% approval rate. School state VT,WY,ND have submitted the less no of project out of that ND having 88% approval rate.

1.2.2 Univariate Analysis: teacher_prefix

In [13]:

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



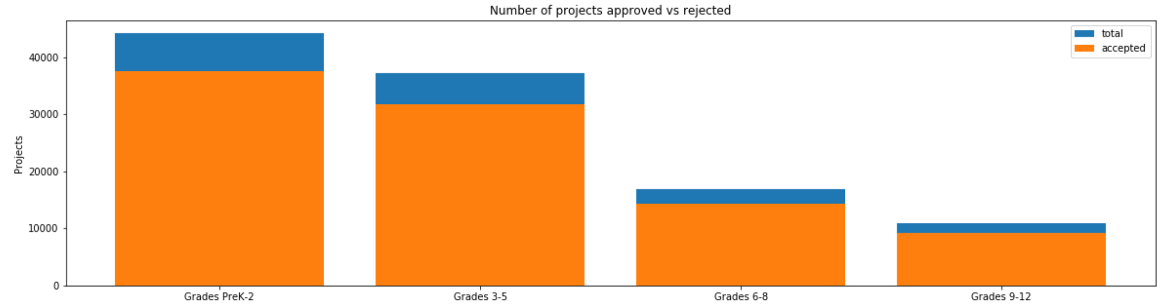
```
  teacher_prefix  project_is_approved  total       Avg
2           Mrs.                48997  57269  0.855559
3            Ms.                32860  38955  0.843537
1            Mr.                 8960  10648  0.841473
4        Teacher                 1877   2360  0.795339
0            Dr.     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

SUMMARY: More number of projects were submitted by the Teacher prefix (Mrs) and project approval rate also 85%. Very low number of projects were submitted by Teacher prefix (Dr).

1.2.3 Univariate Analysis: project_grade_category

In [14]:

```
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: 1.Project Approval rate for Grade 3-5 is high when compare to the other Grades. 2.More projects approval request are coming for Grades PreK-2.

1.2.4 Univariate Analysis: project_subject_categories

In [15]:

```
catogories = list(project_data['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039

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

In [16]:

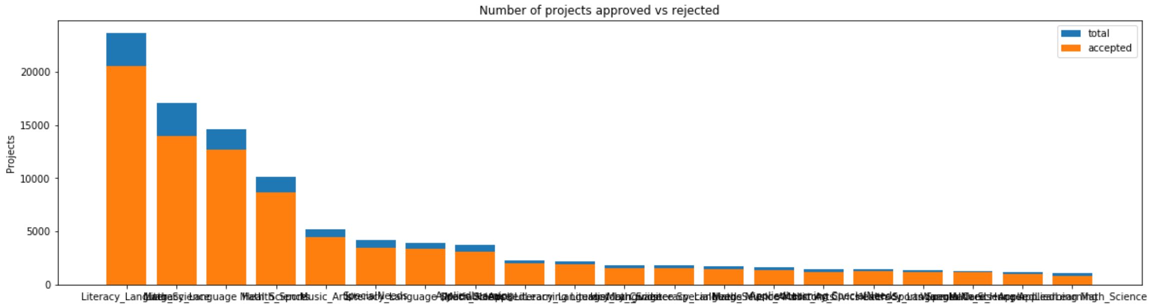
```
project_data['clean_categories'] = cat_list
project_data.drop(['project_subject_categories'], axis=1, inplace=True)
project_data.head(2)
```

Out[16]:

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

In [17]:

```
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
```

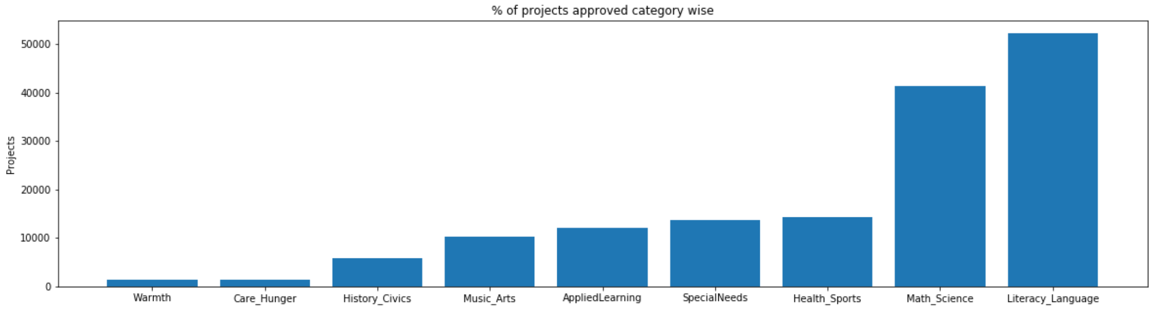
SUMMARY: High projects were submitted under categories "Literacy_Language Math_Science","Literacy_Language","Music_Arts" out of that 86% of projects were approved under categorie "Literacy_Language Math_Science". Whereas low no of projects were submitted under categories "AppliedLearning Math_Science","Math_Science AppliedLearning","Warmth Care_Hunger" out of that 92% of projects were approved under the categorie under "Warmth Care_Hunger".

In [18]:

```
# 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 [19]:

```
# 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 approved category wise')
plt.xticks(ind, list(sorted_cat_dict.keys()))
plt.show()
```



SUMMARY: 1.Project approved category under Warmth and Care_Hunger are low. 2.Project approved category under Math_Science and Literacy_Language are high.

In [20]:

```
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
```

1.2.5 Univariate Analysis: project_subject_subcategories

In [21]:

```
sub_catogories = list(project_data['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47
301924/4084039

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

sub_cat_list = []
for i in sub_catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(','): # it will split it in three parts ["Math & Science", "Warmt
h", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "M
ath & Science"=> "Math","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace
 it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"M
ath & Science"=>"Math&Science"
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spa
ces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())
```

In [22]:

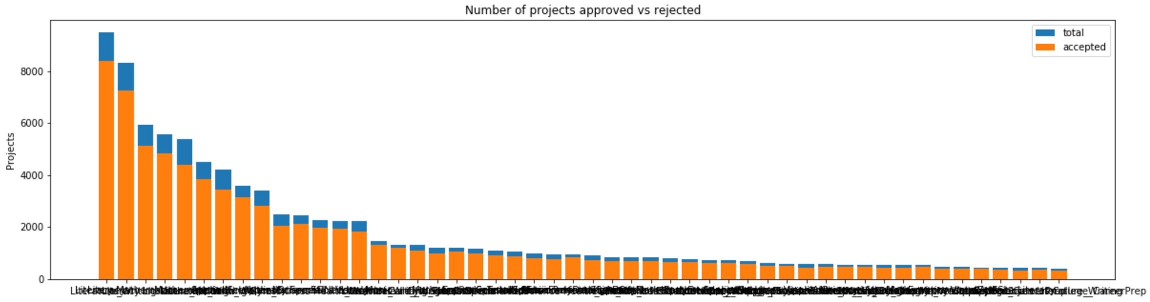
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=True)
project_data.head(2)
```

Out[22]:

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

In [23]:

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



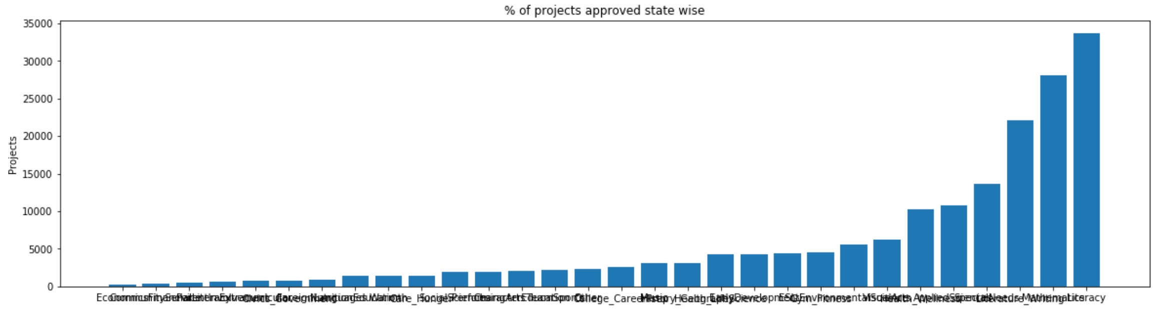
```
                 clean_subcategories  project_is_approved  total       Avg
317                         Literacy                 8371   9486  0.882458
319             Literacy Mathematics                 7260   8325  0.872072
331  Literature_Writing Mathematics                 5140   5923  0.867803
318      Literacy Literature_Writing                 4823   5571  0.865733
342                      Mathematics                 4385   5379  0.815207
==================================================
                     clean_subcategories  project_is_approved  total  
Avg
196        EnvironmentalScience Literacy                  389    444  0.876
126
127                                  ESL                  349    421  0.828
979
79                    College_CareerPrep                  343    421  0.814
727
17   AppliedSciences Literature_Writing                  361    420  0.859
524
3    AppliedSciences College_CareerPrep                  330    405  0.814
815
```

In [24]:

```
# 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 [25]:

```
# 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 approved state wise')
plt.xticks(ind, list(sorted_sub_cat_dict.keys()))
plt.show()
```



In [26]:

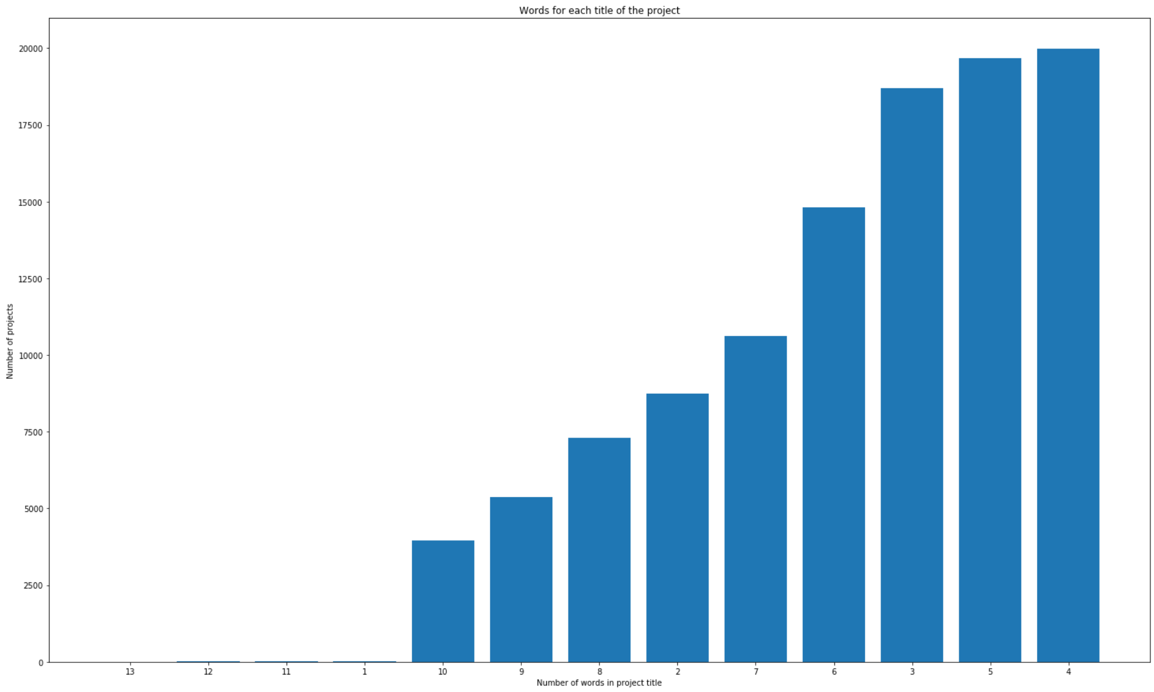
```
for i, j in sorted_sub_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

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

1.2.6 Univariate Analysis: Text features (Title)

In [27]:

```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/
a/37483537/4084039
#https://stackoverflow.com/questions/4804005/matplotlib-figure-facecolor-background-col
or
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]))


wrd = np.arange(len(word_dict))
plt.figure(figsize=(25,15),edgecolor='black')
p1 = plt.bar(wrd, list(word_dict.values()))

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



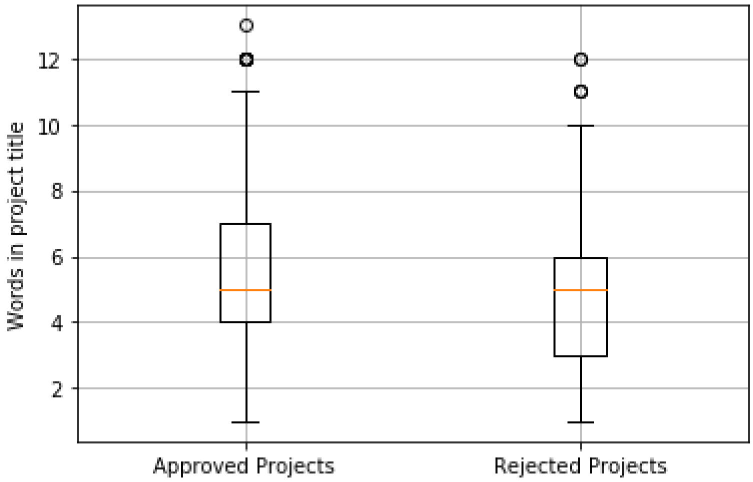
SUMMARY: More than 2000 projects title is having the 4-5 words.It shows most project titles are short and chrisp, also they are more specfic.

In [28]:

```
approved_title_word_count = project_data[project_data['project_is_approved']==1]['proje
ct_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]['proje
ct_title'].str.split().apply(len)
rejected_title_word_count = rejected_title_word_count.values
```

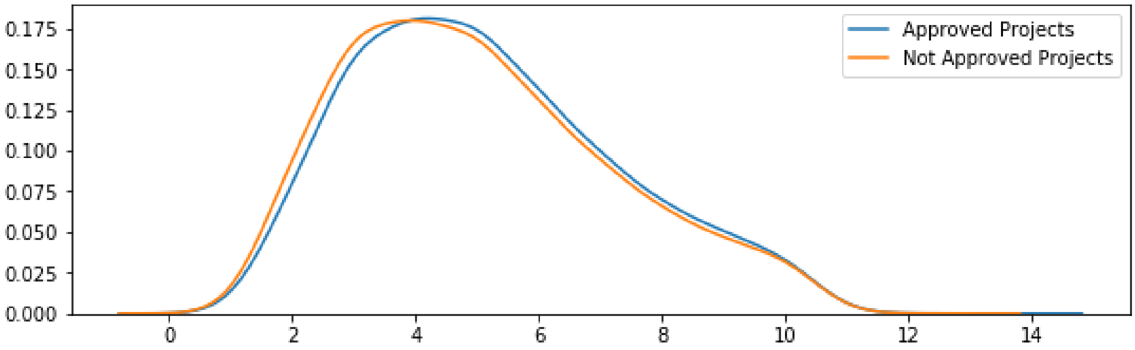
In [29]:

```
#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 [30]:

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



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

In [31]:

```
# 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)
print(type(project_data["essay"]))
```

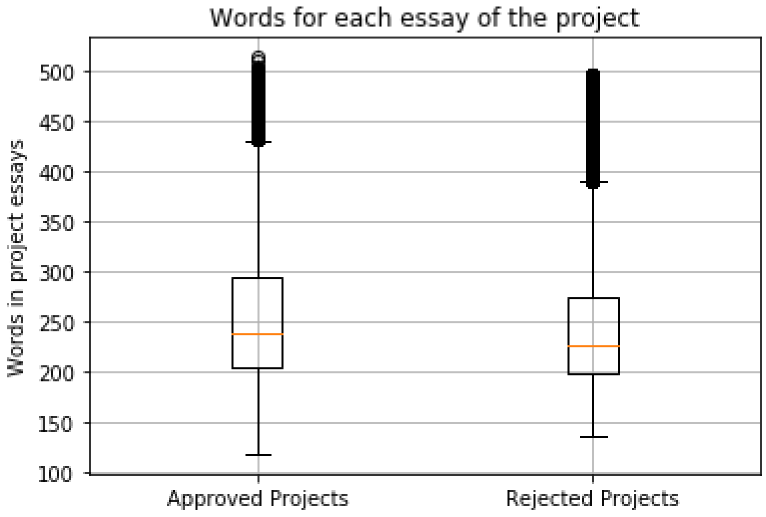
```
<class 'pandas.core.series.Series'>
```

In [32]:

```
approved_word_count = project_data[project_data['project_is_approved']==1]['essay'].str
.split().apply(len)
# print(approved_word_count)
approved_word_count = approved_word_count.values
# print(approved_word_count)
rejected_word_count = project_data[project_data['project_is_approved']==0]['essay'].str
.split().apply(len)
rejected_word_count = rejected_word_count.values
```

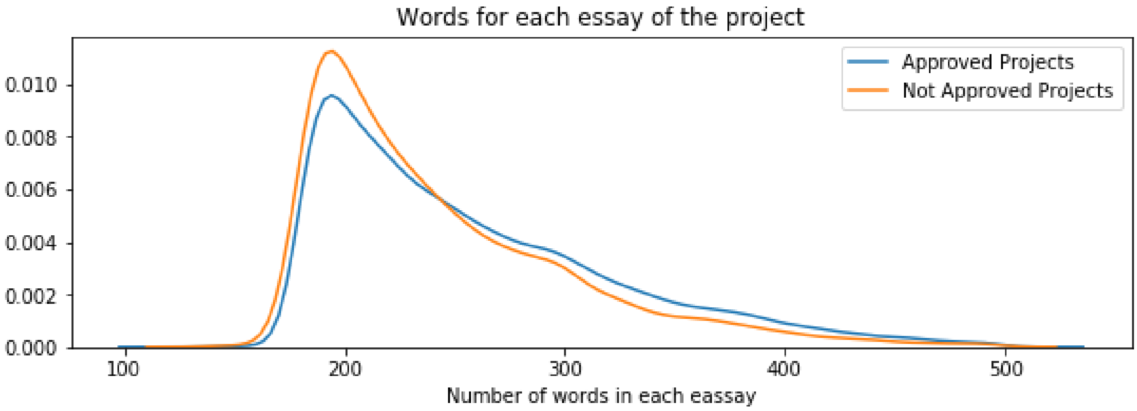
In [33]:

```
# 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 [34]:

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



1.2.8 Univariate Analysis: Cost per project

In [35]:

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

Out[35]:

	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 [36]:

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

Out[36]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

In [37]:

```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
project_data.head(2)
```

Out[37]:

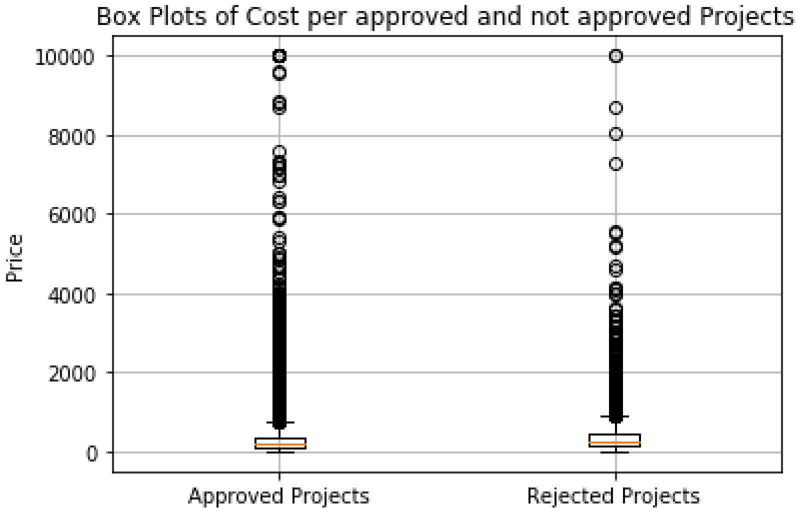
	Unnamed: 0	id	teacher_id	teacher_prefix	school_s
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL

In [38]:

```
approved_price = project_data[project_data['project_is_approved']==1]['price'].values
rejected_price = project_data[project_data['project_is_approved']==0]['price'].values
```

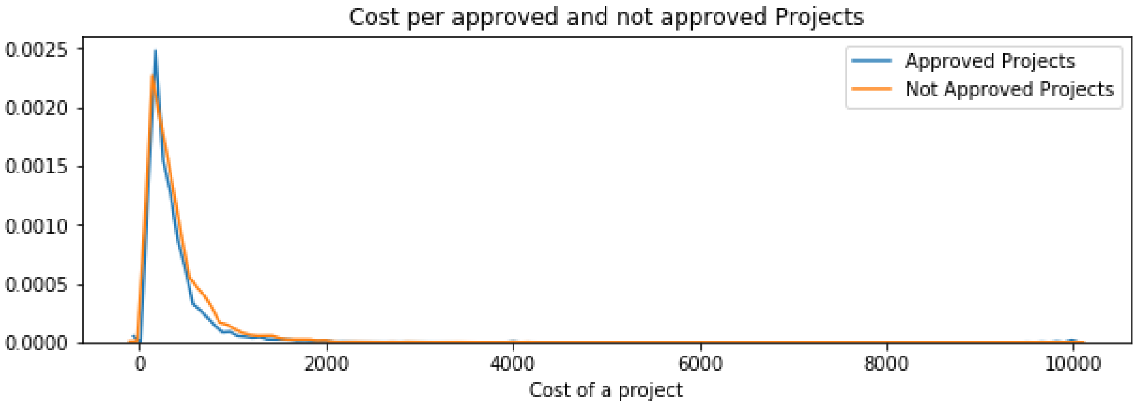
In [39]:

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



In [40]:

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



In [41]:

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

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

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

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

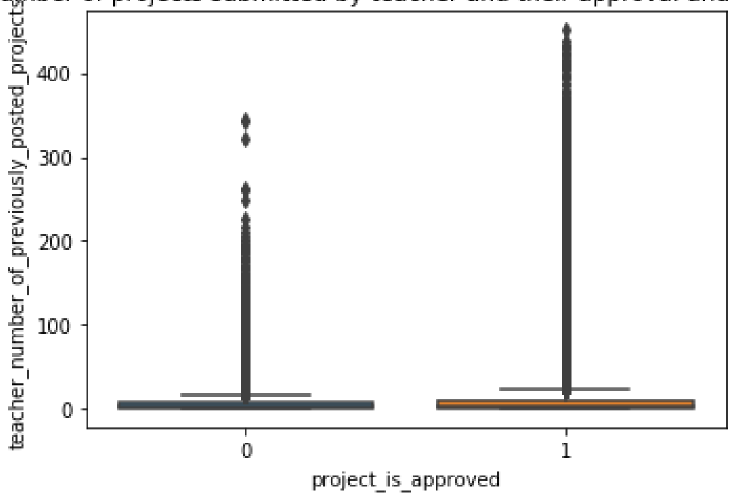
```
+------------+-------------------+-----------------------+
| Percentile | Approved Projects | Not Approved Projects |
+------------+-------------------+-----------------------+
|     0      |        0.66       |          1.97         |
|     5      |       13.59       |          41.9         |
|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

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

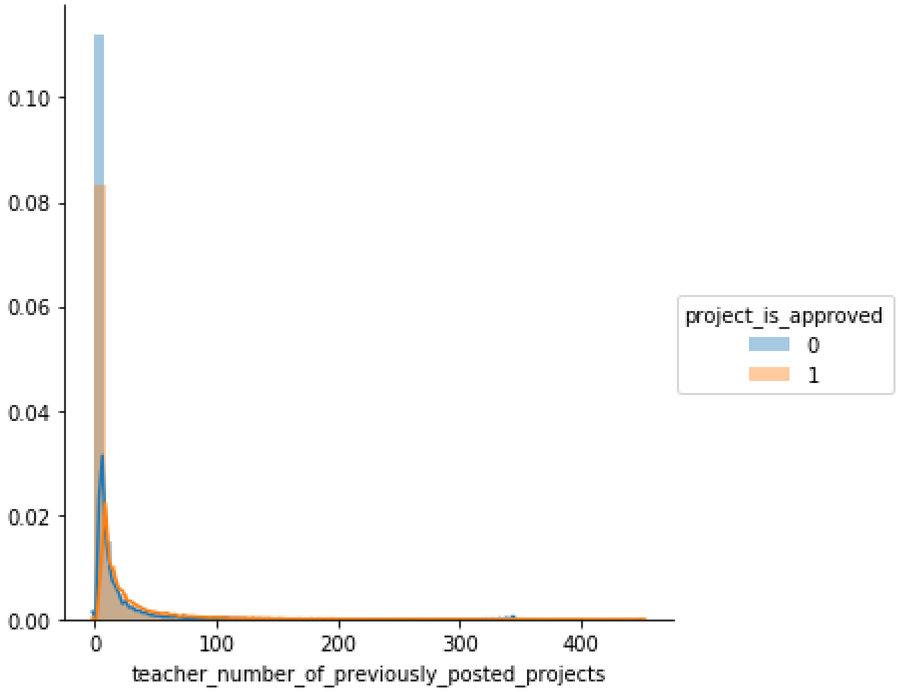
Please do this on your own based on the data analysis that was done in the above cells

In [42]:

```
# we get the teacher's previously posted project data using train_data.csv file
warnings.filterwarnings("ignore")
new = project_data[['teacher_number_of_previously_posted_projects','project_is_approve
d']]
pp = new['teacher_number_of_previously_posted_projects']
pa = new['project_is_approved']
pp=pp.values
pa=pa.values

#print(pp)
#print(pa)

# https://seaborn.pydata.org/generated/seaborn.boxplot.html
sns.boxplot(x='project_is_approved',y='teacher_number_of_previously_posted_projects', d
ata=new)
plt.title('Box Plots of number of projects submitted by teacher and their approval and
 non-approval status')
plt.show()

# https://seaborn.pydata.org/generated/seaborn.FacetGrid.html
# https://www.tutorialspoint.com/seaborn/seaborn_facet_grid.htm
sns.FacetGrid(new, hue="project_is_approved", size=5).map(sns.distplot, "teacher_number
_of_previously_posted_projects").add_legend();
plt.show();

x = PrettyTable()
x.field_names = ["Number of projects submitted by teacher", "Approved Projects", "Not A
pproved Projects"]
for i in range(0,101,5):
    x.add_row([i,np.round(np.percentile(pp,i), 3), np.round(np.percentile(pa,i), 3)])
print(x)
```



Box Plots of number of projects submitted by teacher and their approval and non-approval status



```
+-----------------------------------------+-------------------+-----------
------------+
| Number of projects submitted by teacher | Approved Projects | Not Approv
ed Projects |
+-----------------------------------------+-------------------+-----------
------------+
|                    0                    |        0.0        |
0.0          |
|                    5                    |        0.0        |
0.0          |
|                    10                   |        0.0        |
0.0          |
|                    15                   |        0.0        |
0.0          |
|                    20                   |        0.0        |
1.0          |
|                    25                   |        0.0        |
1.0          |
|                    30                   |        1.0        |
1.0          |
|                    35                   |        1.0        |
1.0          |
|                    40                   |        1.0        |
1.0          |
|                    45                   |        2.0        |
1.0          |
|                    50                   |        2.0        |
1.0          |
|                    55                   |        3.0        |
1.0          |
|                    60                   |        4.0        |
1.0          |
|                    65                   |        5.0        |
1.0          |
|                    70                   |        7.0        |
1.0          |
|                    75                   |        9.0        |
1.0          |
|                    80                   |        12.0       |
1.0          |
|                    85                   |        18.0       |
1.0          |
|                    90                   |        28.0       |
1.0          |
|                    95                   |        53.0       |
1.0          |
|                   100                   |       451.0       |
1.0          |
+-----------------------------------------+-------------------+-----------
------------+
```

Observation: According to the above analysis the box plot and the PDF doesnot give much information but from the pretty table(percentile values) we can gather that as the number of Teacher's previously posted projects increase their approval rate is also getting increased, the rate of not getting approved is lower.

1.2.10 Univariate Analysis: project_resource_summary

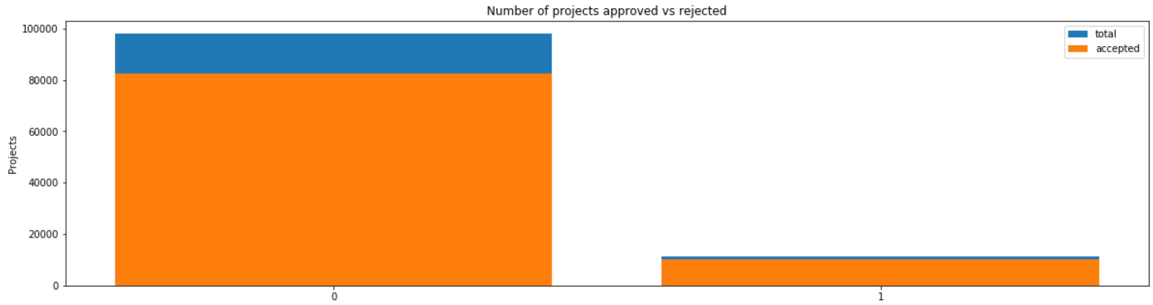
Please do this on your own based on the data analysis that was done in the above cells

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 [43]:

```
# https://stackoverflow.com/questions/29517072/add-column-to-dataframe-with-default-value
import pdb
s1 = {}
s2 = {}
l1 = []
v = range(len(pp))
def Numbers(pp):
    for j in tqdm(v):
        for k in pp[j].split():
            # pdb.set_trace()
            if k.isdigit():
                s1[j] = int(k)
def form_list():
    for x in v:
        if x in s1.keys():
            s2[x] = s1[x]
        else:
            s2[x] = 0
def number_conversion():
    for r in s2.values():
        if r == 0:
            l1.append(0)
        else:
            l1.append(1)

pp = []
for i in project_data['project_resource_summary']:
    pp.append(i)

Numbers(pp)
form_list()
number_conversion()

# len(s2)
project_data['number_in_summary'] = l1
univariate_barplots(project_data, 'number_in_summary', 'project_is_approved', top=2)
```

```
100%|██████████████████████████████████████████████████
█| 109248/109248 [00:00<00:00, 151743.98it/s]
```



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

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

OBSERVATION: Project Resource Summary column of DonorsChose[Train] data seems to be affecting the both acceptance and rejection of project. From the above plot we can seen 90% of the total project with numerical presents are got approved. Hence this shows that we might have a chance of project to get approved, if we have numerical. Hence we can say Project resource summary column data is useful to classifing whether a give project will be approved or not.

1.3 Text preprocessing

1.3.1 Essay Text

In [44]:

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

Out[44]:

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

2 rows × 21 columns

In [45]:

```
# 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[999])
#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 seco
nd or third languages. We are a melting pot of refugees, immigrants, and n
ative-born Americans bringing the gift of language to our school. \r\n\r\n
We have over 24 languages represented in our English Learner program with 
students at every level of mastery.  We also have over 40 countries repres
ented with the families within our school.  Each student brings a wealth o
f knowledge and experiences to us that open our eyes to new cultures, beli
efs, and respect.\"The limits of your language are the limits of your worl
d.\"-Ludwig Wittgenstein  Our English learner's have a strong support syst
em at home that begs for more resources.  Many times our parents are learn
ing to read and speak English along side of their children.  Sometimes thi
s creates barriers for parents to be able to help their child learn phonet
ics, letter recognition, and other reading skills.\r\n\r\nBy providing the
se dvd's and players, students are able to continue their mastery of the E
nglish language even if no one at home is able to assist.  All families wi
th 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 Learner Teacher and will be sent home regularly to watch.  
The videos are to help the child develop early reading skills.\r\n\r\nPare
nts that do not have access to a dvd player will have the opportunity to c
heck out a dvd player to use for the year.  The plan is to use these video
s and educational dvd's for the years to come for other EL students.\r\nna
nnan
==================================================
The 51 fifth grade students that will cycle through my classroom this year
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 students, 97.3% a
re minority students. \r\nThe school has a vibrant community that loves to
get together and celebrate. Around Halloween there is a whole school parad
e to show off the beautiful costumes that students wear. On Cinco de Mayo 
we put on a big festival with crafts made by the students, dances, and gam
es. At the end of the year the school hosts a carnival to celebrate the ha
rd work put in during the school year, with a dunk tank being the most pop
ular activity.My students will use these five brightly colored Hokki stool
s in place of regular, stationary, 4-legged chairs. As I will only have a 
total of ten in the classroom and not enough for each student to have an i
ndividual 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 times. The rest of the day they will be used by th
e students who need the highest amount of movement in their life in order 
to stay focused on school.\r\n\r\nWhenever asked what the classroom is mis
sing, 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 wi
th me on the Hokki Stools, they are always moving, but at the same time do
ing their work. Anytime the students get to pick where they can sit, the H
okki Stools 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 
there are not enough of them. \r\n\r\nWe ask a lot of students to sit for 
7 hours a day. The Hokki stools will be a compromise that allow my student
s to do desk work and move at the same time. These stools will help studen
ts 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, th
ese chairs will take away the barrier that exists in schools for a child w
ho can't sit still.nannan
==================================================
Welcome to our spectacular 1st and 2nd grade ELL classroom.  I have the mo
st amazing class of motivated second language learners.  These youngsters 
come from homes with hardworking families that support education.  The stu
dents along with their parents want to succeed and place value on doing we
ll school.  However, life challenges seem to make this difficult for many 
```

```
of the families at my school.\r\nEach day, my students come to class eager
to start the day and learn.  My classroom brings much stability and ongoin
g support which they don't always get at home.  Our typical day includes h
ands-on experiences, cooperative learning, and plenty of opportunities for
success.  I want each student to feel like the classroom is a safe, happy
place.  It is my hope that each student develops a lifelong love for learn
ing.  Our Title 1 school community works hard toward our goals of student
success and growth.Student engagement is the key to success in learning.
My first and second graders often struggle with the ability to focus and p
ay attention. They need an opportunity for extra movement which will allow
their brains to be more alert and attentive. I would like to provide them
with a few \"tools\" to help relieve stress, reduce anxiety, and relax.\r
\n\r\n    Having \"tools\" like balance balls, wobble cushions, and squish
y-fidget balls will provide much needed sensory input for my students.\r\n
\r\nThese items will enable them to channel their physical energy in a pos
itive way, allowing them to focus on their work and reach their full poten
tial as learners.nannan
```

In [46]:

```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 [47]:

```
sent = decontracted(project_data['essay'].values[49])
print(sent)
print("="*50)
```

```
Located in the Bay Area, our city is a melting pot of diversity and cultur
e and our school is home to amazing students who enjoy and embrace each ot
her. With a variety of excited and motivated learners, our class is dedica
ted to implementing more science and technology into the classroom. \r\n\r
\nStudents are eager to learn new science curriculum as well as develop sk
ills and strategies to make them better readers. In the classroom, student
s are full of energy, positivity, and confidence. They enjoy learning new 
things, especially topics related to science. They are inquisitive and det
ermined, and as an educator, I intend to continue nurturing this drive. As
an enthusiastic and energetic educator, I am looking forward to helping my
students reach for the stars, theoretically and literally!My students enjo
y being active outside as well as inside the classroom, and Rainy Day Rece
ss will not stop them from being active! They have requested to participat
e in regular activities that get them up and moving throughout the day. In
addition to Rainy Day Recess activities, they will benefit from regular 
\"body breaks\" as well as \"brain breaks\" every day. This allows for the
m to get up and move and get their wiggles out. They will need a bright an
d colorful carpet with a design which allows for them to have individual s
pace. \r\nThe requested carpet provides them with ample room to participat
e in fun and invigorating indoor activities, like hot potato, \"Farmer and
the Pig\", speed ball, and many others, all while respecting the space eac
h child needs to participate. Additionally, the carpet provides them with 
space for daily yoga, dancing, and indoor PE. They will also benefit from 
books on nutrition, and maintaining a healthy and active lifestyle. On rai
ny days, they will benefit from an indoor playground, which can be created
with the use of balancing pods. The use of fitness dice will allow student
s to take ownership of their activity, as each child will have a turn in r
olling the dice to determine how many of each activity we should do as a g
roup. \r\nThese supplies will help encourage students to be active and to 
have fun while doing so. Even on rainy days when students are stuck insid
e, they will be able to stimulate their minds and bodies by balancing on t
he indoor obstacle course, practicing stretching on the carpet, rolling th
e fitness dice to stay active, or construct a game of \"Farmer and the Pig
\". Health, fitness, and nutrition are important to me and my students!!na
nnan
==================================================
```

In [48]:

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

```
Located in the Bay Area, our city is a melting pot of diversity and cultur
e and our school is home to amazing students who enjoy and embrace each ot
her. With a variety of excited and motivated learners, our class is dedica
ted to implementing more science and technology into the classroom.     St
udents are eager to learn new science curriculum as well as develop skills
and strategies to make them better readers. In the classroom, students are
full of energy, positivity, and confidence. They enjoy learning new thing
s, especially topics related to science. They are inquisitive and determin
ed, and as an educator, I intend to continue nurturing this drive. As an e
nthusiastic and energetic educator, I am looking forward to helping my stu
dents reach for the stars, theoretically and literally!My students enjoy b
eing active outside as well as inside the classroom, and Rainy Day Recess 
will not stop them from being active! They have requested to participate i
n regular activities that get them up and moving throughout the day. In ad
dition to Rainy Day Recess activities, they will benefit from regular  bod
y breaks  as well as  brain breaks  every day. This allows for them to get
up and move and get their wiggles out. They will need a bright and colorfu
l carpet with a design which allows for them to have individual space.   T
he requested carpet provides them with ample room to participate in fun an
d invigorating indoor activities, like hot potato,  Farmer and the Pig , s
peed ball, and many others, all while respecting the space each child need
s to participate. Additionally, the carpet provides them with space for da
ily yoga, dancing, and indoor PE. They will also benefit from books on nut
rition, and maintaining a healthy and active lifestyle. On rainy days, the
y will benefit from an indoor playground, which can be created with the us
e of balancing pods. The use of fitness dice will allow students to take o
wnership of their activity, as each child will have a turn in rolling the 
dice to determine how many of each activity we should do as a group.   The
se supplies will help encourage students to be active and to have fun whil
e doing so. Even on rainy days when students are stuck inside, they will b
e able to stimulate their minds and bodies by balancing on the indoor obst
acle course, practicing stretching on the carpet, rolling the fitness dice
to stay active, or construct a game of  Farmer and the Pig . Health, fitne
ss, and nutrition are important to me and my students!!nannan
```

In [49]:

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

```
Located in the Bay Area our city is a melting pot of diversity and culture
and our school is home to amazing students who enjoy and embrace each othe
r With a variety of excited and motivated learners our class is dedicated
to implementing more science and technology into the classroom Students ar
e eager to learn new science curriculum as well as develop skills and stra
tegies to make them better readers In the classroom students are full of e
nergy positivity and confidence They enjoy learning new things especially
topics related to science They are inquisitive and determined and as an ed
ucator I intend to continue nurturing this drive As an enthusiastic and en
ergetic educator I am looking forward to helping my students reach for the
stars theoretically and literally My students enjoy being active outside a
s well as inside the classroom and Rainy Day Recess will not stop them fro
m being active They have requested to participate in regular activities th
at get them up and moving throughout the day In addition to Rainy Day Rece
ss activities they will benefit from regular body breaks as well as brain
breaks every day This allows for them to get up and move and get their wig
gles out They will need a bright and colorful carpet with a design which a
llows for them to have individual space The requested carpet provides them
with ample room to participate in fun and invigorating indoor activities l
ike hot potato Farmer and the Pig speed ball and many others all while res
pecting the space each child needs to participate Additionally the carpet
provides them with space for daily yoga dancing and indoor PE They will al
so benefit from books on nutrition and maintaining a healthy and active li
festyle On rainy days they will benefit from an indoor playground which ca
n be created with the use of balancing pods The use of fitness dice will a
llow students to take ownership of their activity as each child will have
a turn in rolling the dice to determine how many of each activity we shoul
d do as a group These supplies will help encourage students to be active a
nd to have fun while doing so Even on rainy days when students are stuck i
nside they will be able to stimulate their minds and bodies by balancing o
n the indoor obstacle course practicing stretching on the carpet rolling t
he fitness dice to stay active or construct a game of Farmer and the Pig H
ealth fitness and nutrition are important to me and my students nannan
```

In [50]:

```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you'r
e", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him',
'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 't
hey', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "th
at'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'ha
d', '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', 'ov
er', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'an
y', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too'
, 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'no
w', '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', "isn't", 'ma', 'migh
tn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'w
asn', "wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

In [51]:

```
# 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 [01:31<00:00, 1194.19it/s]
```

In [52]:

```
# after preprocesing
preprocessed_essays[999]
```

Out[52]:

```
'welcome spectacular 1st 2nd grade ell classroom i amazing class motivated
second language learners these youngsters come homes hardworking families
support education the students along parents want succeed place value well
school however life challenges seem make difficult many families school ea
ch day students come class eager start day learn my classroom brings much
stability ongoing support not always get home our typical day includes han
ds experiences cooperative learning plenty opportunities success i want st
udent feel like classroom safe happy place it hope student develops lifelo
ng love learning our title 1 school community works hard toward goals stud
ent success growth student engagement key success learning my first second
graders often struggle ability focus pay attention they need opportunity e
xtra movement allow brains alert attentive i would like provide tools help
relieve stress reduce anxiety relax having tools like balance balls wobble
cushions squishy fidget balls provide much needed sensory input students t
hese items enable channel physical energy positive way allowing focus work
reach full potential learners nannan'
```

1.3.2 Project title Text

In [53]:

```
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())

preprocessed_titles[998]
```

```
100%|██████████████████████████████████████████████████████████████████████
██| 109248/109248 [00:04<00:00, 25319.93it/s]
```

Out[53]:

```
'super students need super supplies success second grade'
```

OBSERVATION: Project tile column of the train.csv data has been preprocessed in the same method as we done for Project Essay.

1. 4 Preparing data for models

In [54]:

```
project_data.columns
```

Out[54]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_grade_category', 'project_ti
tle',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approve
d',
       'clean_categories', 'clean_subcategories', 'essay', 'price', 'quant
ity',
       'number_in_summary'],
      dtype='object')
```

we are going to consider

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

- project_title : text data
- text : text data
- project_resource_summary: text data

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

1.4.1 Vectorizing Categorical data

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

In [55]:

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


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

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

In [56]:

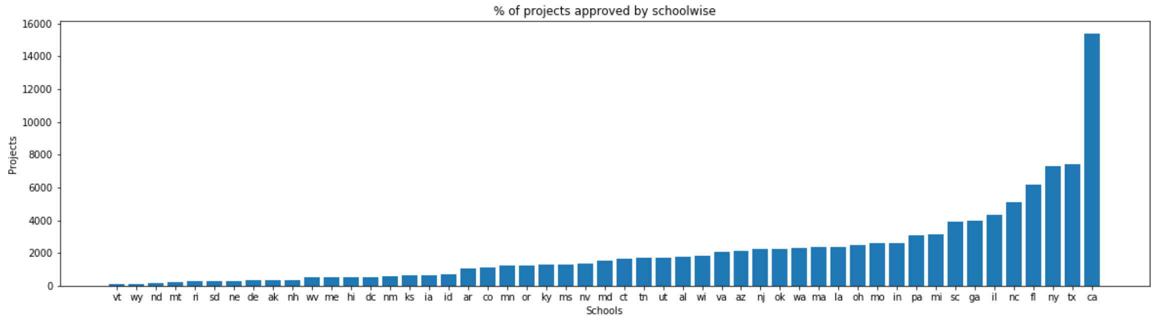
```
# we use count vectorizer to convert the values into one hot encoded features
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=False, binary=True)
vectorizer.fit(project_data['clean_subcategories'].values)
print(vectorizer.get_feature_names())


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

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvemen
t', 'Extracurricular', 'Civics_Government', 'ForeignLanguages', 'Nutrition
Education', 'Warmth', 'Care_Hunger', 'SocialSciences', 'PerformingArts',
'CharacterEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Musi
c', 'History_Geography', 'Health_LifeScience', 'EarlyDevelopment', 'ESL',
'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'A
ppliedSciences', 'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Lit
eracy']
Shape of matrix after one hot encodig  (109248, 30)
```

In [57]:

```
project_data = pd.read_csv('train_data.csv')
sch1_catogories = list(project_data['school_state'].values)
school_list = []
for sent in sch1_catogories:
    school_list.append(sent.lower().strip())
project_data['school_categories'] = school_list
project_data.drop(['school_state'], axis=1, inplace=True)
print(project_data.head(2))

# Count of words in corpus python:
#https://stackoverflow.com/questions/8139239/how-to-count-words-in-a-corpus-document
my_counter_sch = Counter()
for word in project_data['school_categories'].values:
    my_counter_sch.update(word.split())

# dict sort by value:
#https://stackoverflow.com/questions/20944483/python-3-sort-a-dict-by-its-values
sch_dict = dict(my_counter_sch)
sorted_sch_dict = dict(sorted(sch_dict.items(), key=lambda kv: kv[1]))


ind1 = np.arange(len(sorted_sch_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind1, list(sorted_sch_dict.values()))
plt.xlabel('Schools')
plt.ylabel('Projects')
plt.title('% of projects approved by schoolwise')
plt.xticks(ind1, list(sorted_sch_dict.keys()))
plt.show()

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

vectorizer = CountVectorizer(vocabulary=list(sorted_sch_dict.keys()), lowercase=False,
binary=True)
vectorizer.fit(project_data['school_categories'].values)
print(vectorizer.get_feature_names())

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

```
   Unnamed: 0       id                        teacher_id teacher_prefix  \
0      160221  p253737  c90749f5d961ff158d4b4d1e7dc665fc           Mrs.   
1      140945  p258326  897464ce9ddc600bced1151f324dd63a            Mr.   

  project_submitted_datetime project_grade_category  \
0        2016-12-05 13:43:57          Grades PreK-2   
1        2016-10-25 09:22:10             Grades 6-8   

          project_subject_categories     project_subject_subcategories  \
0                Literacy & Language                     ESL, Literacy   
1  History & Civics, Health & Sports  Civics & Government, Team Sports   

                                   project_title  \
0  Educational Support for English Learners at Home   
1             Wanted: Projector for Hungry Learners   

                                     project_essay_1  \
0  My students are English learners that are work...   
1  Our students arrive to our school eager to lea...   

                                     project_essay_2 project_essay_3  \
0  \"The limits of your language are the limits o...             NaN   
1  The projector we need for our school is very c...             NaN   

  project_essay_4                           project_resource_summary  \
0             NaN  My students need opportunities to practice beg...   
1             NaN  My students need a projector to help with view...   

   teacher_number_of_previously_posted_projects  project_is_approved  \
0                                            0                    0   
1                                            7                    1   

  school_categories  
0               in  
1               fl  
```



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

OBSERVATION: The "school_state" column has been preprocessed to get the words in lowercase under new column name "school_categories".

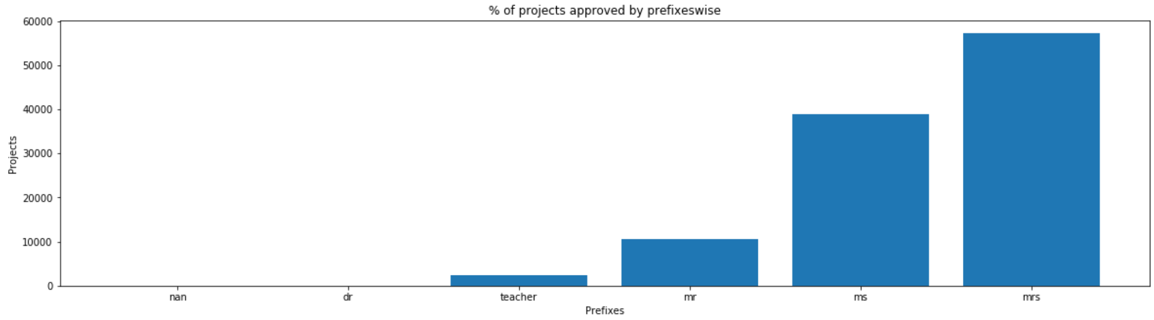
In [58]:

```
project_data = pd.read_csv('train_data.csv')
# Remove special characters from list of strings python:
#https://stackoverflow.com/a/47301924/4084039
# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-stri
ng
prefix_catogories = list(project_data['teacher_prefix'].values)
prefix_list = []
for sent in prefix_catogories:
    sent = re.sub('[^A-Za-z0-9]+', ' ', str(sent))
    sent = ' '.join(e for e in sent.split())
    prefix_list.append(sent.lower().strip())
project_data['prefix_catogories'] = prefix_list
```

In [59]:

```
project_data.drop(['teacher_prefix'], axis=1, inplace=True)
print(project_data.head(2))

# Count of words in corpus python:
#https://stackoverflow.com/questions/8139239/how-to-count-words-in-a-corpus-document

my_counter_prefix = Counter()
for word in project_data['prefix_catogories'].values:
    my_counter_prefix.update(word.split())

# dict sort by value:
#https://stackoverflow.com/questions/20944483/python-3-sort-a-dict-by-its-values

prefix_dict = dict(my_counter_prefix)
sorted_prefix_dict = dict(sorted(prefix_dict.items(), key=lambda kv: kv[1]))


ind2 = np.arange(len(sorted_prefix_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind2, list(sorted_prefix_dict.values()))
plt.xlabel('Prefixes')
plt.ylabel('Projects')
plt.title('% of projects approved by prefixeswise')
plt.xticks(ind2, list(sorted_prefix_dict.keys()))
plt.show()

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

vectorizer = CountVectorizer(vocabulary=list(sorted_prefix_dict.keys()), lowercase=False, binary=True)
vectorizer.fit(project_data['prefix_catogories'].values)
print(vectorizer.get_feature_names())

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

```
   Unnamed: 0       id                        teacher_id school_state  \
0      160221  p253737  c90749f5d961ff158d4b4d1e7dc665fc           IN
1      140945  p258326  897464ce9ddc600bced1151f324dd63a           FL

  project_submitted_datetime project_grade_category  \
0        2016-12-05 13:43:57          Grades PreK-2
1        2016-10-25 09:22:10             Grades 6-8

          project_subject_categories     project_subject_subcategories  \
0                Literacy & Language                     ESL, Literacy
1  History & Civics, Health & Sports  Civics & Government, Team Sports

                                      project_title  \
0  Educational Support for English Learners at Home
1             Wanted: Projector for Hungry Learners

                                     project_essay_1  \
0  My students are English learners that are work...
1  Our students arrive to our school eager to lea...

                                     project_essay_2 project_essay_3  \
0  \"The limits of your language are the limits o...             NaN
1  The projector we need for our school is very c...             NaN

  project_essay_4                           project_resource_summary  \
0             NaN  My students need opportunities to practice beg...
1             NaN  My students need a projector to help with view...

   teacher_number_of_previously_posted_projects  project_is_approved  \
0                                             0                    0
1                                             7                    1

  prefix_catogories
0               mrs
1                mr
```



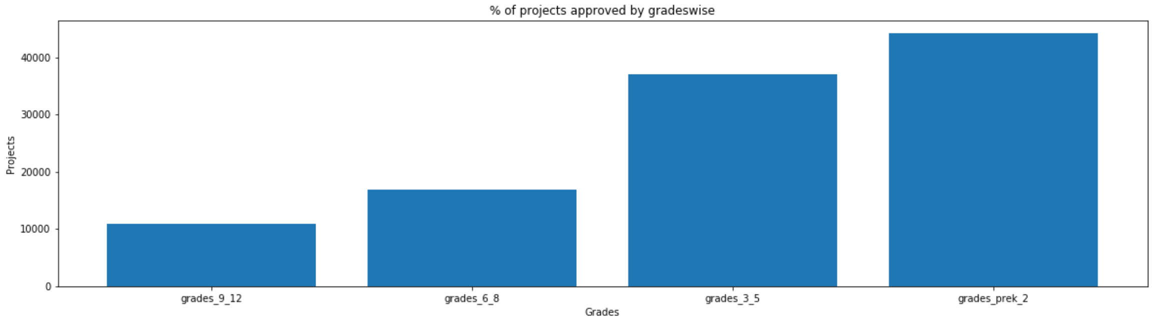
```
nan                  :         3
dr                   :        13
teacher              :      2360
mr                   :     10648
ms                   :     38955
mrs                  :     57269
['nan', 'dr', 'teacher', 'mr', 'ms', 'mrs']
Shape of the matrix after one hot encodig  (109248, 6)
```

OBSERVATION: The "teacher_prefix" column has been preprocessed to get the words in lowercase under new column name "prefix_catogories".

In [60]:

```
project_data = pd.read_csv('train_data.csv')
grade_catogories = list(project_data['project_grade_category'].values)
# Remove special characters from list of strings python:
#https://stackoverflow.com/a/47301924/4084039
# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-stri
ng
grade_list = []
for sent in grade_catogories:
    sent = sent.replace('-','_')
    sent = sent.replace(' ','_')
    sent = ' '.join(e for e in sent.split())
    grade_list.append(sent.lower().strip())

project_data['new_grade_category'] = grade_list

project_data.drop(['project_grade_category'], axis=1, inplace=True)
print(project_data.head(2))

# Count of words in corpus python:
#https://stackoverflow.com/questions/8139239/how-to-count-words-in-a-corpus-document

my_counter_grade = Counter()
for word in project_data['new_grade_category'].values:
    my_counter_grade.update(word.split())

# dict sort by value:
#https://stackoverflow.com/questions/20944483/python-3-sort-a-dict-by-its-values

grade_dict = dict(my_counter_grade)
sorted_grade_dict = dict(sorted(grade_dict.items(), key=lambda kv: kv[1]))


ind3 = np.arange(len(sorted_grade_dict))
plt.figure(figsize=(20,5))
p1 = plt.bar(ind3, list(sorted_grade_dict.values()))
plt.xlabel('Grades')
plt.ylabel('Projects')
plt.title('% of projects approved by gradeswise')
plt.xticks(ind3, list(sorted_grade_dict.keys()))
plt.show()

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

vectorizer = CountVectorizer(vocabulary=list(sorted_grade_dict.keys()), lowercase=False
, binary=True)
vectorizer.fit(project_data['new_grade_category'].values)
print(vectorizer.get_feature_names())

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

```
   Unnamed: 0       id                        teacher_id teacher_prefix  \
0      160221  p253737  c90749f5d961ff158d4b4d1e7dc665fc           Mrs.
1      140945  p258326  897464ce9ddc600bced1151f324dd63a            Mr.

  school_state project_submitted_datetime         project_subject_categori
es  \
0           IN        2016-12-05 13:43:57              Literacy & Langua
ge
1           FL        2016-10-25 09:22:10  History & Civics, Health & Spor
ts

      project_subject_subcategories  \
0                    ESL, Literacy
1  Civics & Government, Team Sports

                                   project_title  \
0  Educational Support for English Learners at Home
1             Wanted: Projector for Hungry Learners

                                  project_essay_1  \
0  My students are English learners that are work...
1  Our students arrive to our school eager to lea...

                                  project_essay_2 project_essay_3  \
0  \"The limits of your language are the limits o...             NaN
1  The projector we need for our school is very c...             NaN

  project_essay_4                          project_resource_summary  \
0             NaN  My students need opportunities to practice beg...
1             NaN  My students need a projector to help with view...

   teacher_number_of_previously_posted_projects  project_is_approved  \
0                                             0                    0
1                                             7                    1

  new_grade_category
0      grades_prek_2
1         grades_6_8
```



```
grades_9_12          :      10963
grades_6_8           :      16923
grades_3_5           :      37137
grades_prek_2        :      44225
['grades_9_12', 'grades_6_8', 'grades_3_5', 'grades_prek_2']
Shape of the matrix after one hot encodig  (109248, 4)
```

OBSERVATION: Replacing the '' and '-' with '_' to convert the grades into the single whole word. The "project_grade_category" column has been preprocessed to get the words in lowercase under new column name "new_grade_category".

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

In [61]:

```
# 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 encoding ",text_bow.shape)
```

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

1.4.2.2 Bag of Words on `project_title`

In [62]:

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

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

1.4.2.3 TFIDF vectorizer

In [63]:

```
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 encoding ",text_tfidf.shape)
```

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

1.4.2.4 TFIDF Vectorizer on `project_title`

In [64]:

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

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

1.4.2.5 Using Pretrained Models: Avg W2V

In [65]:

```
# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039
from tqdm import tqdm

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 preprocessed_essays:
    words.extend(i.split(' '))

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

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

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


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

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

```
Loading Glove Model

1427032it [06:08, 3875.52it/s]

Done. 1427032  words loaded!
all the words in the corpus 17014413
the unique words in the corpus 58968
The number of words that are present in both glove vectors and our corpus
50725 ( 86.021 %)
word 2 vec length 50725
```

In [66]:

```
# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-p
ickle-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 [67]:

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

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

```
100%|█████████████████████████████████████████████████████████████████████
████| 109248/109248 [02:03<00:00, 884.98it/s]

109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on `project_title`

In [68]:

```
# Similarly you can vectorize for title also
# compute average word2vec for each title.
avg_w2v_vectors_title = []; # the avg-w2v for each sentence/review is stored in this li
st
for sentence in tqdm(preprocessed_titles): # for each review/sentence
    vector_title = np.zeros(300) # as word vectors are of zero length
    cnt_title_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector_title += model[word]
            cnt_title_words += 1
    if cnt_words != 0:
        vector_title /= cnt_title_words
    avg_w2v_vectors_title.append(vector_title)

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

```
100%|██████████████████████████████████████████████████████████████████████
███| 109248/109248 [00:50<00:00, 2182.14it/s]

109248
300
```

OBSERVATION: PreProcessed_titles data column has been vectorized using GloveWords,Average word to vector models.

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

In [69]:

```
# 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 [70]:

```
# 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((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors.append(vector)

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

```
100%|█████████████████████████████████████████████████████████████████████
████| 109248/109248 [07:39<00:00, 237.99it/s]

109248
300
```

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

In [71]:

```
# Similarly you can vectorize for title also
tfidf_model_title = TfidfVectorizer()
tfidf_model_title.fit(preprocessed_titles)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model_title.get_feature_names(), list(tfidf_model_title.idf
_)))
tfidf_words_title = set(tfidf_model_title.get_feature_names())

# compute tfidf word2vec for each title.
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_title = 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((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            vector_title += (vector_title * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector_title /= tf_idf_weight
    tfidf_w2v_vectors_title.append(vector_title)

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

```
100%|█████████████████████████████████████████████████████████████████████
███| 109248/109248 [00:59<00:00, 1826.44it/s]

109248
300
```

OBSERVATION: PreProcessed_titles data column has been vectorized using GloveWords,TFIDF weighted word to vector models.

1.4.3 Vectorizing Numerical features

In [72]:

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


#price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.   ...
 399.   287.73   5.5 ].
# Reshape your data either using array.reshape(-1, 1)
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_i
ndex()
#print(price_data)
project_data = pd.merge(project_data, price_data, on='id', how='left')
#print(project_data)
approved_price = project_data[project_data['project_is_approved']==1]['price'].values
rejected_price = project_data[project_data['project_is_approved']==0]['price'].values

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

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

In [73]:

```
price_standardized
```

Out[73]:

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

In [74]:

```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.pr
eprocessing.StandardScaler.html
previously_posted_projects_scalar = StandardScaler()
previously_posted_projects_scalar.fit(project_data['teacher_number_of_previously_posted
_projects'].values.reshape(-1,1)) # finding the mean and standard deviation of this dat
a
print(f"Mean : {previously_posted_projects_scalar.mean_[0]}, Standard deviation : {np.s
qrt(previously_posted_projects_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
previously_posted_projects_standardized = previously_posted_projects_scalar.transform(p
roject_data['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

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

In [75]:

```
previously_posted_projects_standardized
```

Out[75]:

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

OBSERVATION: The "teacher_number_of_previously_posted_projects" data is numerical feature and that has been vectorized using the StandardScalar and scaling it to unit variance.

1.4.4 Merging all the above features

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

In [76]:

```
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 [77]:

```
print(title_bow.shape)
print(grade_one_hot.shape)
print(prefix_one_hot.shape)
print(sch_one_hot.shape)
print(previously_posted_projects_standardized.shape)
```

```
(109248, 3329)
(109248, 4)
(109248, 6)
(109248, 51)
(109248, 1)
```

In [78]:

```
# 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[78]:

```
(109248, 16663)
```

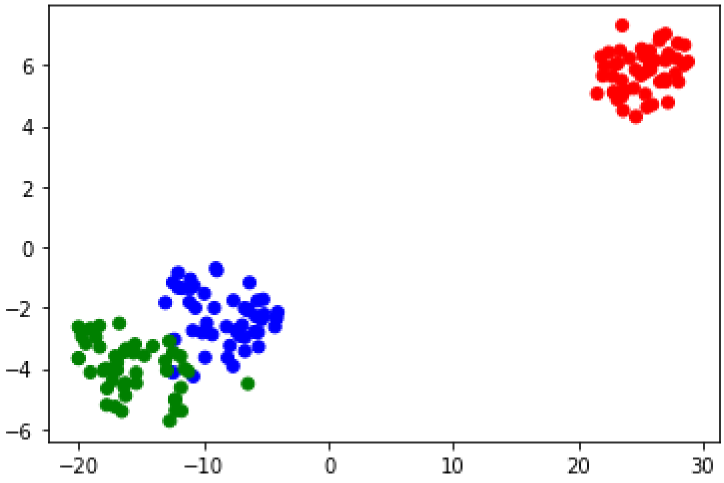
Assignment 2: Apply TSNE

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 [83]:

```
# 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 into dense matrix

for_tsne = np.hstack((X_embedding, y.reshape(-1,1)))
for_tsne_df = pd.DataFrame(data=for_tsne, columns=['Dimension_x','Dimension_y','Score'])
colors = {0:'red', 1:'blue', 2:'green'}
plt.scatter(for_tsne_df['Dimension_x'], for_tsne_df['Dimension_y'], c=for_tsne_df['Score'].apply(lambda x: colors[x]))
plt.show()
```



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

In [79]:

```
### please write all of 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 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
:)
Y1 = hstack((categories_one_hot, sub_categories_one_hot, price_standardized,title_bow,
grade_one_hot, prefix_one_hot, sch_one_hot, previously_posted_projects_standardized))
Y1.shape
type(Y1)
```

Out[79]:

```
scipy.sparse.coo.coo_matrix
```

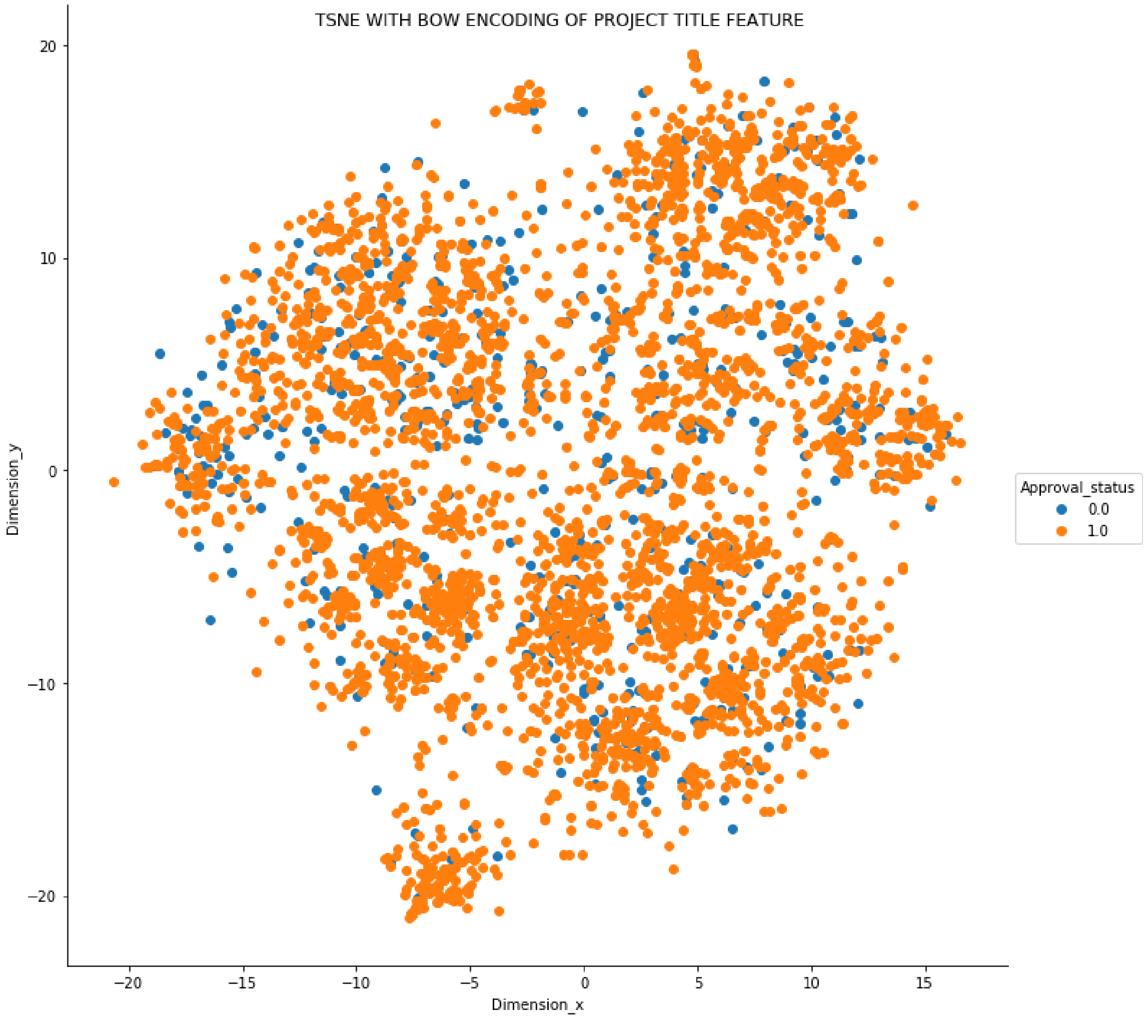
Only 4000 data is used in this assignment while ploting TSNE due to memory constrain.Hence conclusion are based on that data.

In [80]:

```
from sklearn.manifold import TSNE
Y1 = Y1.tocsr()
N1 = Y1[0:4000,:]
#type(N1)
#N1.shape
```

In [81]:

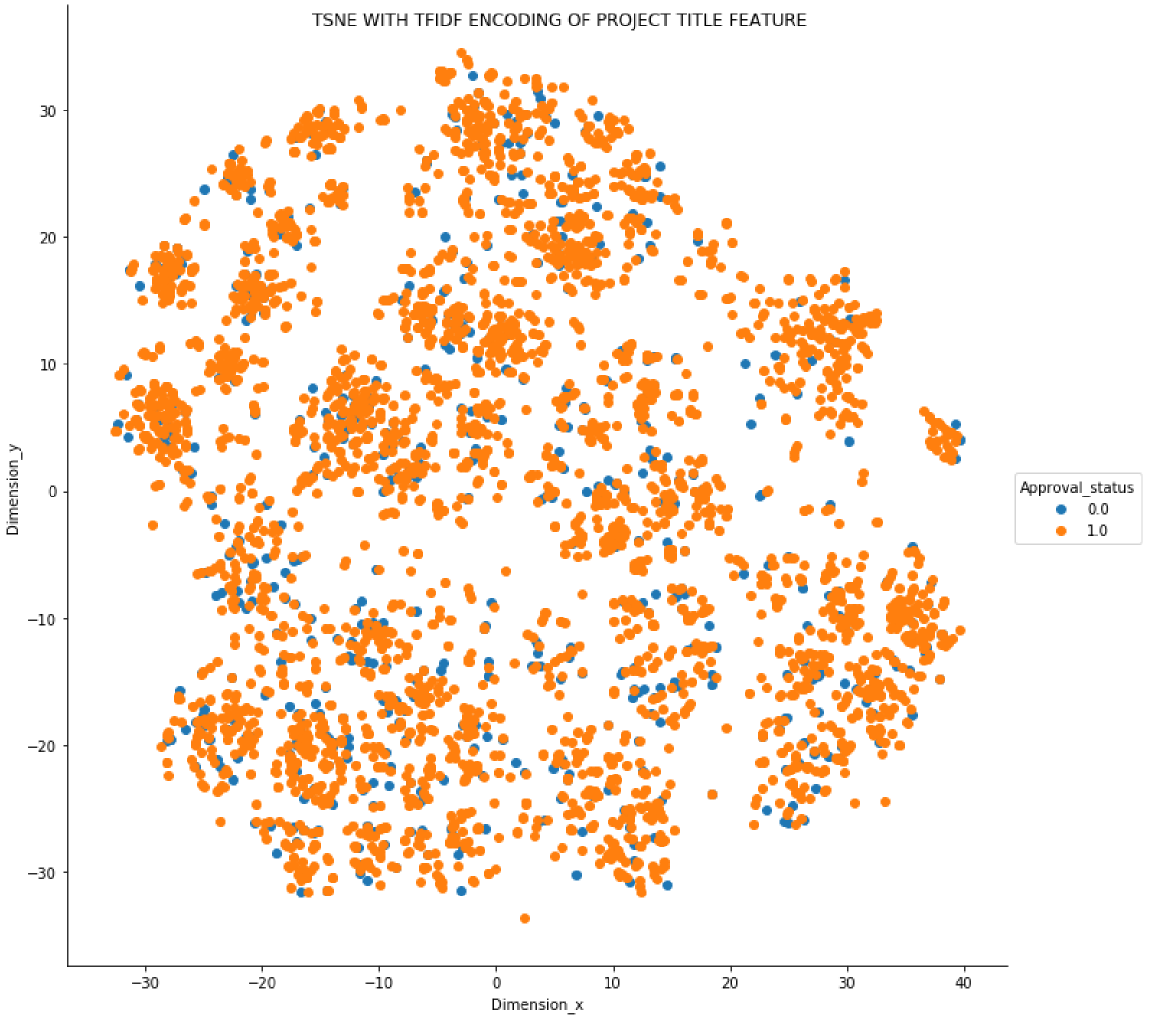
```
# https://scikit-learn.org/stable/modules/impute.html
#https://docs.scipy.org/doc/scipy/reference/sparse.html
#https://sparse.pydata.org/en/latest/generated/sparse.COO.tocsr.html

import scipy.sparse as sp
from sklearn.impute import SimpleImputer
# X = sp.csc_matrix([[1, 2], [0, -1], [8, 4]])
#imp = SimpleImputer(missing_values=np.nan, strategy='median')
#imp.fit(Y1)
#SimpleImputer(copy=True, fill_value=None, missing_values=np.nan, strategy='median', ve
rbose=0)
#N1 = imp.transform(Y1)
N1 = N1.toarray()
# print(type(N1))
# print(N1)

tsne = TSNE(n_components=2, perplexity=180, learning_rate=200, random_state = 0)
N1_embedding = tsne.fit_transform(N1)

# print(Y_embedding)

# if x is a sparse matrix you need to pass it as X_embedding = tsne.fit_transform(x.toa
rray()) , .toarray() will convert the sparse matrix into dense matrix
t = project_data['project_is_approved']
t1=t[0:4000]
# print(type(t1))


for_tsne1 = np.vstack((N1_embedding.T, t1)).T
for_tsne1_df = pd.DataFrame(data=for_tsne1, columns=['Dimension_x','Dimension_y','Appro
val_status'])
sns.FacetGrid(for_tsne1_df, hue = "Approval_status", size = 10).map(plt.scatter, "Dimen
sion_x", "Dimension_y").add_legend().fig.suptitle("TSNE WITH BOW ENCODING OF PROJECT TI
TLE FEATURE ")
plt.show()
```



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

In [82]:

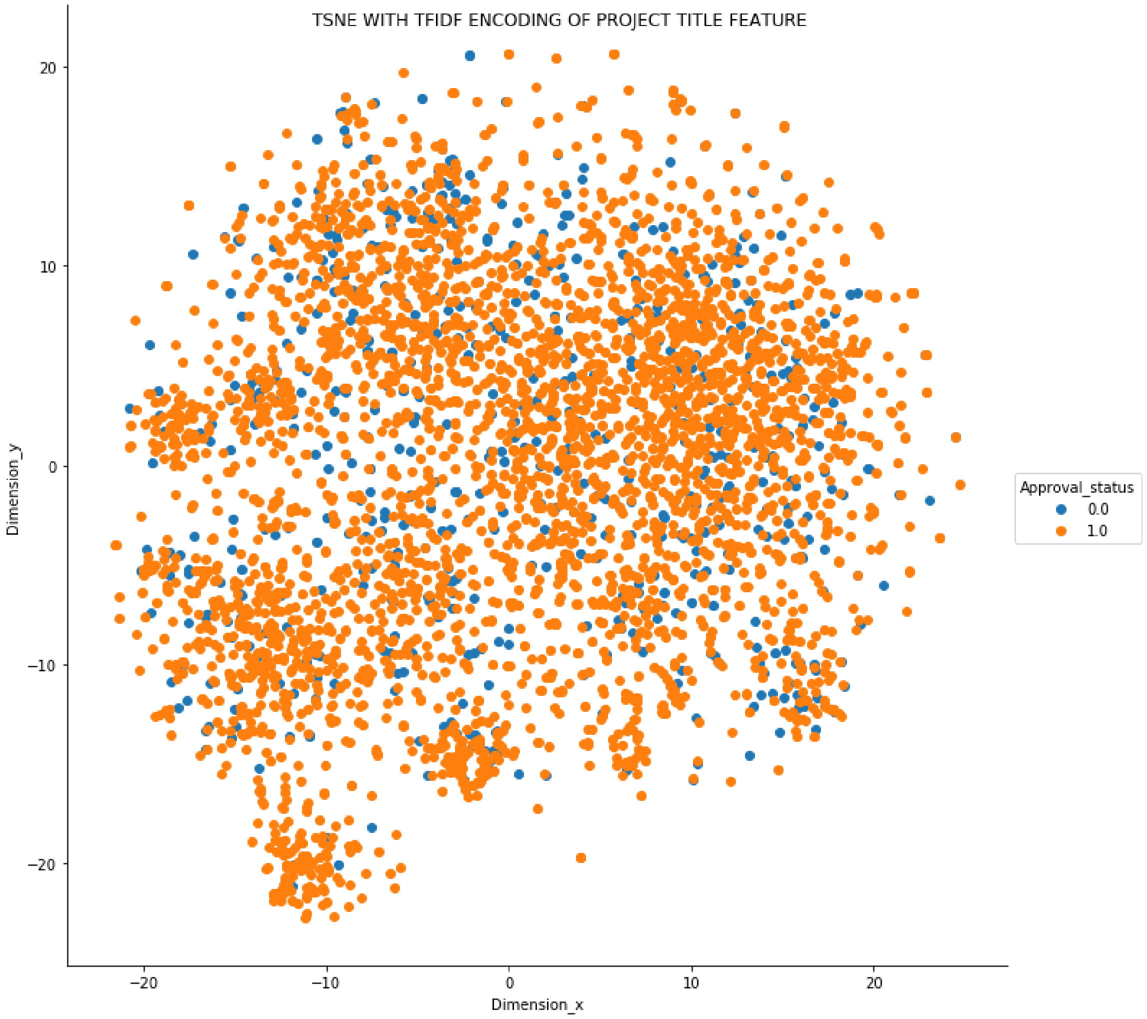
```
# https://scikit-learn.org/stable/modules/impute.html
#https://docs.scipy.org/doc/scipy/reference/sparse.html
#https://sparse.pydata.org/en/latest/generated/sparse.COO.tocsr.html

import scipy.sparse as sp
from sklearn.impute import SimpleImputer
# X = sp.csc_matrix([[1, 2], [0, -1], [8, 4]])

Y_tf = hstack((categories_one_hot, sub_categories_one_hot, price_standardized,title_tfi
df, grade_one_hot, prefix_one_hot, sch_one_hot, previously_posted_projects_standardized
))

from sklearn.manifold import TSNE
Y_tf = Y_tf.tocsr()
N2 = Y_tf[0:4000,:]
N2 = N2.toarray()

tsne = TSNE(n_components=2, perplexity=120, learning_rate=200, random_state = 0)
Y_embedding = tsne.fit_transform(N2)

t = project_data['project_is_approved']
t1=t[0:4000]
# print(type(t1))


for_tsne1 = np.vstack((Y_embedding.T, t1)).T
for_tsne1_df = pd.DataFrame(data=for_tsne1, columns=['Dimension_x','Dimension_y','Appro
val_status'])
sns.FacetGrid(for_tsne1_df, hue = "Approval_status", size = 10).map(plt.scatter, "Dimen
sion_x", "Dimension_y").add_legend().fig.suptitle("TSNE WITH TFIDF ENCODING OF PROJECT
 TITLE FEATURE ")
plt.show()
```



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

In [83]:

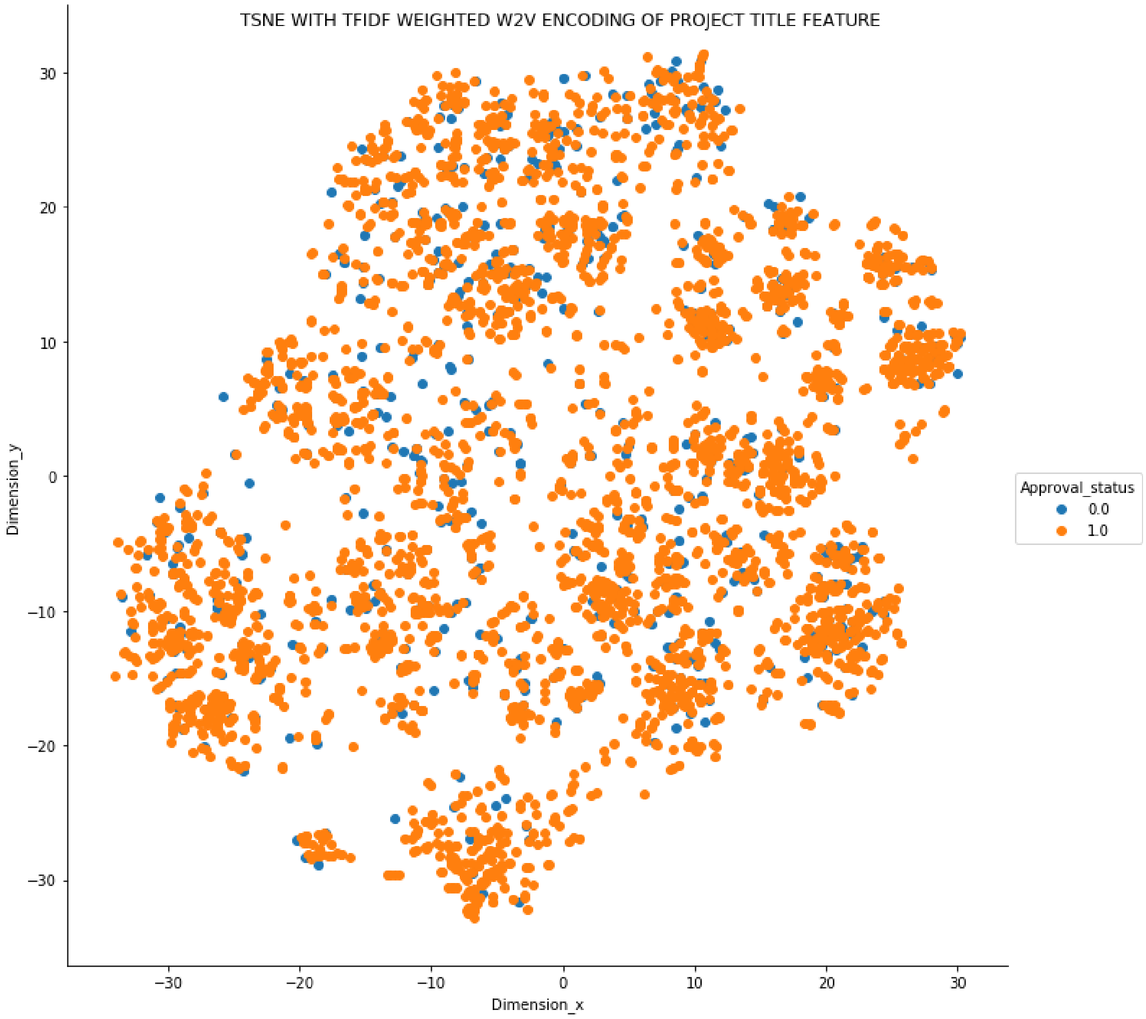
```
# https://scikit-learn.org/stable/modules/impute.html
#https://docs.scipy.org/doc/scipy/reference/sparse.html
#https://sparse.pydata.org/en/latest/generated/sparse.COO.tocsr.html

import scipy.sparse as sp
from sklearn.impute import SimpleImputer

Y_avg_w2v = hstack((categories_one_hot, sub_categories_one_hot, price_standardized,avg_
w2v_vectors_title, grade_one_hot, prefix_one_hot, sch_one_hot, previously_posted_projec
ts_standardized))

from sklearn.manifold import TSNE

Y_avg_w2v = Y_avg_w2v.tocsr()
N3 = Y_avg_w2v[0:4000,:]
N3 = N3.toarray()

tsne = TSNE(n_components=2, perplexity=120, learning_rate=200, random_state = 0)
Y_embedding = tsne.fit_transform(N3)

t = project_data['project_is_approved']
t1=t[0:4000]
# print(type(t1))


for_tsne1 = np.vstack((Y_embedding.T, t1)).T
for_tsne1_df = pd.DataFrame(data=for_tsne1, columns=['Dimension_x','Dimension_y','Appro
val_status'])
sns.FacetGrid(for_tsne1_df, hue = "Approval_status", size = 10).map(plt.scatter, "Dimen
sion_x", "Dimension_y").add_legend().fig.suptitle("TSNE WITH TFIDF ENCODING OF PROJECT
 TITLE FEATURE ")
plt.show()
```



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

In [84]:

```
# https://scikit-learn.org/stable/modules/impute.html
#https://docs.scipy.org/doc/scipy/reference/sparse.html
#https://sparse.pydata.org/en/latest/generated/sparse.COO.tocsr.html

import scipy.sparse as sp
from sklearn.impute import SimpleImputer

Y_tfidf_w2v = hstack((categories_one_hot, sub_categories_one_hot, price_standardized,tf
idf_w2v_vectors_title, grade_one_hot, prefix_one_hot, sch_one_hot, previously_posted_pr
ojects_standardized))
from sklearn.manifold import TSNE

Y_tfidf_w2v = Y_tfidf_w2v.tocsr()
N4 = Y_tfidf_w2v[0:4000,:]
N4 = N4.toarray()

tsne = TSNE(n_components=2, perplexity=150, learning_rate=200, random_state = 0)
Y_embedding = tsne.fit_transform(N4)

t = project_data['project_is_approved']
t1=t[0:4000]
# print(type(t1))


for_tsne1 = np.vstack((Y_embedding.T, t1)).T
for_tsne1_df = pd.DataFrame(data=for_tsne1, columns=['Dimension_x','Dimension_y','Appro
val_status'])
sns.FacetGrid(for_tsne1_df, hue = "Approval_status", size = 10).map(plt.scatter, "Dimen
sion_x", "Dimension_y").add_legend().fig.suptitle("TSNE WITH TFIDF WEIGHTED W2V ENCODIN
G OF PROJECT TITLE FEATURE ")
plt.show()
```

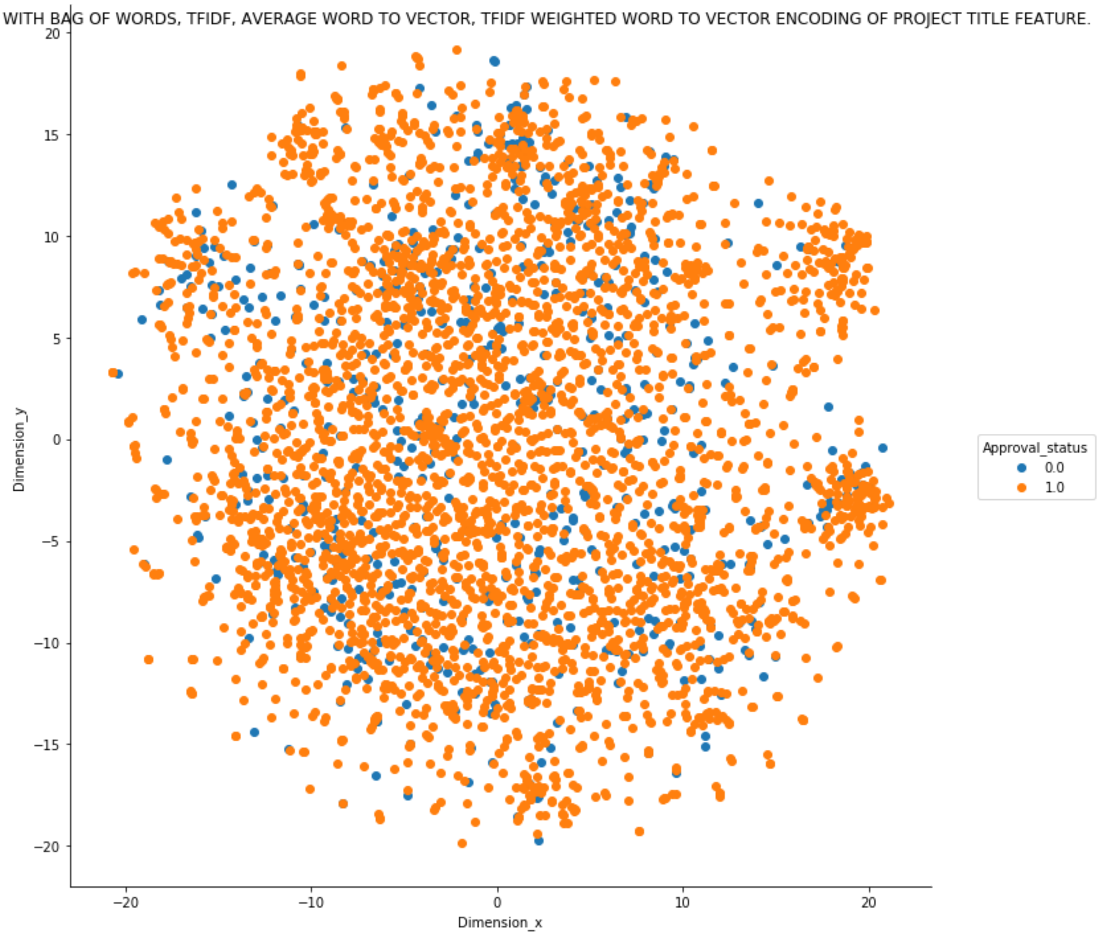


TSNE WITH BAG OF WORDS, TFIDF, AVERAGE WORD TO VECTOR, TFIDF WEIGHTED WORD TO VECTOR ENCODING OF PROJECT TITLE FEATURE.

In [85]:

```
# https://scikit-learn.org/stable/modules/impute.html
#https://docs.scipy.org/doc/scipy/reference/sparse.html
#https://sparse.pydata.org/en/latest/generated/sparse.COO.tocsr.html

import scipy.sparse as sp
from sklearn.impute import SimpleImputer


Y_all = hstack((categories_one_hot, sub_categories_one_hot, price_standardized, title_bow, title_tfidf, avg_w2v_vectors_title, tfidf_w2v_vectors_title, grade_one_hot, prefix_one_hot, sch_one_hot, previously_posted_projects_standardized))

from sklearn.manifold import TSNE

Y_all = Y_all.tocsr()
N5 = Y_all[0:4000,:]
N5 = N5.toarray()

tsne = TSNE(n_components=2, perplexity=170, learning_rate=200, random_state = 0)
Y_embedding = tsne.fit_transform(N5)

t = project_data['project_is_approved']
t1=t[0:4000]
# print(type(t1))


for_tsne1 = np.vstack((Y_embedding.T, t1)).T
for_tsne1_df = pd.DataFrame(data=for_tsne1, columns=['Dimension_x','Dimension_y','Approval_status'])
sns.FacetGrid(for_tsne1_df, hue = "Approval_status", size = 10).map(plt.scatter, "Dimension_x", "Dimension_y").add_legend().fig.suptitle("TSNE WITH BAG OF WORDS, TFIDF, AVERAGE WORD TO VECTOR, TFIDF WEIGHTED WORD TO VECTOR ENCODING OF PROJECT TITLE FEATURE.")
plt.show()
```

TSNE WITH BAG OF WORDS, TFIDF, AVERAGE WORD TO VECTOR, TFIDF WEIGHTED WORD TO VECTOR ENCODING OF PROJECT TITLE FEATURE.



2.5 Summary

SUMMARY: After ploting the TSNE with Bag of Words, TF-IDF, Avg Word2Vec, TF-IDF Weighted Word2Vec it does not seem to get the expected result. Most of the points are overlapping.And we dont see any unique pattern for project acception and rejection status. Hence it make difficult to find the acceptance and rejection pattern.