From: Snapshot-Content-Location: https://docs-secure-cdn.fresco.me/system/attachments/files/009/743/128/original/879380efdb029bdd864fc1ac78fc4129851fd169/akshaykachroo2050%40gmail.com_2.html?Expires=1568726431&Signature=Ao6Lvz2hZH3Rc5av0cXLbM8KZ6Pv77rz0XX1v3ON9p0yOWAMMCw7rJZUtQDS6795BFRq4TwWBhQbyu-I03TPXAb0f9t0vBJ6SUE3qEb-D-3nOmfF9cm1dSxWh1kHxqiTirxdnh56X0d8BAjcq1VzfVJ5uG0upcqivnDBsfBnYo8DIEkNvvErqrs3vdJAjTkG7AmNlI7pEHLj9SEogntMo4u9REvHb7JFkN4mws6ci15JP3BBraLjMNJzx4Uw0bo4Jo-IKQdJdZjPs8te9Xr1kAOyfZrFAsui5xLVhoMvfwA9mfgysdAHv0WEHsG8WWaqPfHKnLuxK2dqBUbsNSHFJw__&Key-Pair-Id=APKAJUTRVJCFRZY3Z43A Subject: akshaykachroo2050_gmail_com_2 Date: Tue, 17 Sep 2019 13:20:27 -0000 MIME-Version: 1.0 Content-Type: multipart/related; type="text/html"; boundary="----MultipartBoundary--pgtdNnZD0a3sxxh6XND2zbg8Rl8LvqBZoLwfvMyj4z----" ------MultipartBoundary--pgtdNnZD0a3sxxh6XND2zbg8Rl8LvqBZoLwfvMyj4z---- Content-Type: text/html Content-ID: Content-Transfer-Encoding: binary Content-Location: https://docs-secure-cdn.fresco.me/system/attachments/files/009/743/128/original/879380efdb029bdd864fc1ac78fc4129851fd169/akshaykachroo2050%40gmail.com_2.html?Expires=1568726431&Signature=Ao6Lvz2hZH3Rc5av0cXLbM8KZ6Pv77rz0XX1v3ON9p0yOWAMMCw7rJZUtQDS6795BFRq4TwWBhQbyu-I03TPXAb0f9t0vBJ6SUE3qEb-D-3nOmfF9cm1dSxWh1kHxqiTirxdnh56X0d8BAjcq1VzfVJ5uG0upcqivnDBsfBnYo8DIEkNvvErqrs3vdJAjTkG7AmNlI7pEHLj9SEogntMo4u9REvHb7JFkN4mws6ci15JP3BBraLjMNJzx4Uw0bo4Jo-IKQdJdZjPs8te9Xr1kAOyfZrFAsui5xLVhoMvfwA9mfgysdAHv0WEHsG8WWaqPfHKnLuxK2dqBUbsNSHFJw__&Key-Pair-Id=APKAJUTRVJCFRZY3Z43A

DonorsChoose

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

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

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

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

About the DonorsChoose Data Set

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

Feature	Description
`project_id`	A unique identifier for the proposed project. **Example:** `p036502`
`project_title`	Title of the project. **Examples:** • `Art Will Make You Happy!` • `First Grade Fun`
`project_grade_category`	Grade level of students for which the project is targeted. One of the following enumerated values: • `Grades PreK-2` • `Grades 3-5` • `Grades 6-8` • `Grades 9-12`
`project_subject_categories`	One or more (comma-separated) subject categories for the project from the following enumerated list of values: • `Applied Learning` • `Care & Hunger` • `Health & Sports` • `History & Civics` • `Literacy & Language` • `Math & Science` • `Music & The Arts` • `Special Needs` • `Warmth` **Examples:** • `Music & The Arts` • `Literacy & Language, Math & Science`
`school_state`	State where school is located (Two-letter U.S. postal code). **Example:** `WY`

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

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

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

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

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

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

Label	Description
`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 [0]:
```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")

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

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

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

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

from tqdm import tqdm
import os

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

In [0]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?
client_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleuser
content.com&redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%3Aoob&scope=emai
l%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdocs.test%20https%3A%2F%2
Fwww.googleapis.com%2Fauth%2Fdrive%20https%3A%2F%2Fwww.googleapis.com%2
Fauth%2Fdrive.photos.readonly%20https%3A%2F%2Fwww.googleapis.com%2Faut
h%2Fpeopleapi.readonly&response_type=code

Enter your authorization code:
Â·Â·Â·Â·Â·Â·Â·Â·Â·Â·Â·Â·
Mounted at /content/drive
```

1.1 Reading Data

In [0]:
```
resource_data = pd.read_csv("/content/drive/My Drive/resources.csv",eng
ine='python')
project_data = pd.read_csv("/content/drive/My Drive/train_data.csv",eng
ine='python')
```

In [0]:
```
print("Number of data points in train data", project_data.shape)
print('-'*50)
print("The attributes of data :", project_data.columns.values)
```

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

In [0]:
```
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[0]:

	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

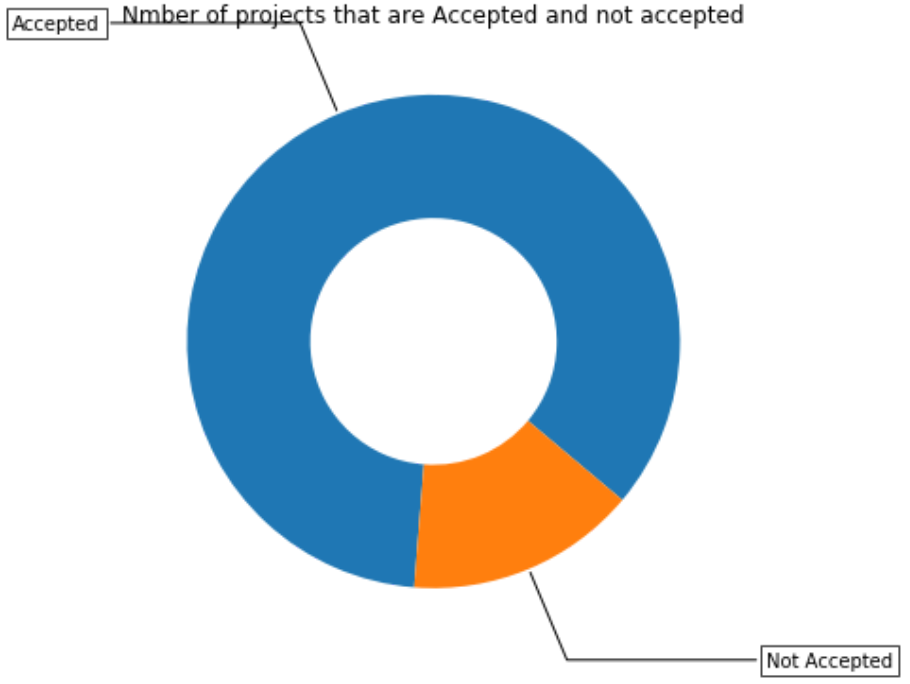
1.2 Data Analysis

In [0]:

```
# 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-glr-gallery-pie-and-polar-charts-pie-and-donut-labels-py


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

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

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

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

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

for i, p in enumerate(wedges):
```

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

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

plt.show()
```

```
Number of projects thar are approved for funding  92706 , ( 84.85830404
217927 %)
Number of projects thar are not approved for funding  16542 , ( 15.1416
95957820739 %)
```



1.2.1 Univariate Analysis: School State

In [0]:
```
# Pandas dataframe groupby count, mean: https://stackoverflow.com/a/19385591/4084039

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

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

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

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

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

```
            lakecolor = 'rgb(255, 255, 255)',
        ),
    )

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

Out[0]:
```
'# How to plot US state heatmap: https://datascience.stackexchange.com/
a/9620\n\nscl = [[0.0, \'rgb(242,240,247)\'],[0.2, \'rgb(218,218,235)
\'],[0.4, \'rgb(188,189,220)\'],            [0.6, \'rgb(158,154,200)
\'],[0.8, \'rgb(117,107,177)\'],[1.0, \'rgb(84,39,143)\']]\n\ndata = [
dict(\n        type=\'choropleth\',\n        colorscale = scl,\n
autocolorscale = False,\n        locations = temp[\'state_code\'],\n
     z = temp[\'num_proposals\'].astype(float),\n        locationmode =
\'USA-states\',\n        text = temp[\'state_code\'],\n        marker =
dict(line = dict (color = \'rgb(255,255,255)\',width = 2)),\n        co
lorbar = dict(title = "% of pro")\n    ) ]\n\nlayout = dict(\n        t
itle = \'Project Proposals % of Acceptance Rate by US States\',\n
  geo = dict(\n            scope=\'usa\',\n            projection=dict(
type=\'albers usa\' ),\n            showlakes = True,\n            lake
color = \'rgb(255, 255, 255)\',\n        ),\n    )\n\nfig = go.Figure(d
ata=data, layout=layout)\noffline.iplot(fig, filename=\'us-map-heat-map
\')\n'
```

In [0]:
```
# https://www.csi.cuny.edu/sites/default/files/pdf/administration/ops/2
letterstabbrev.pdf
temp.sort_values(by=['num_proposals'], inplace=True)
print("States with lowest % approvals")
print(temp.head(5))
print('='*50)
print("States with highest % approvals")
print(temp.tail(5))
```

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

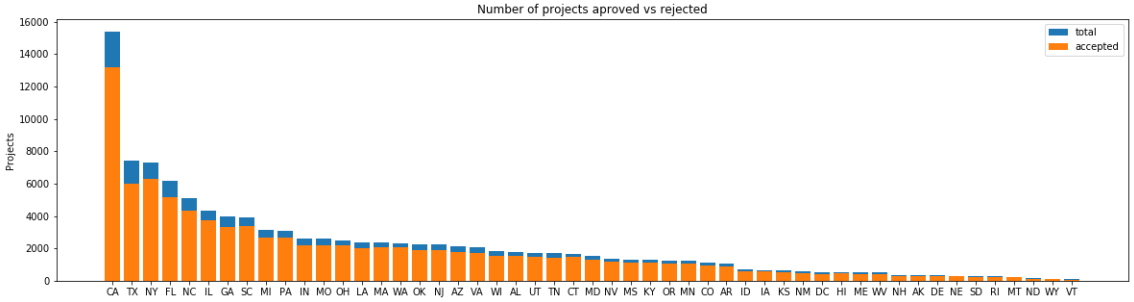
```
States with highest % approvals
   state_code  num_proposals
30         NH       0.873563
35         OH       0.875152
47         WA       0.876178
28         ND       0.888112
8          DE       0.897959
```

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

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

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

In [0]:
```
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 [0]:
```
univariate_barplots(project_data, 'school_state', 'project_is_approved'
, False)
```



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

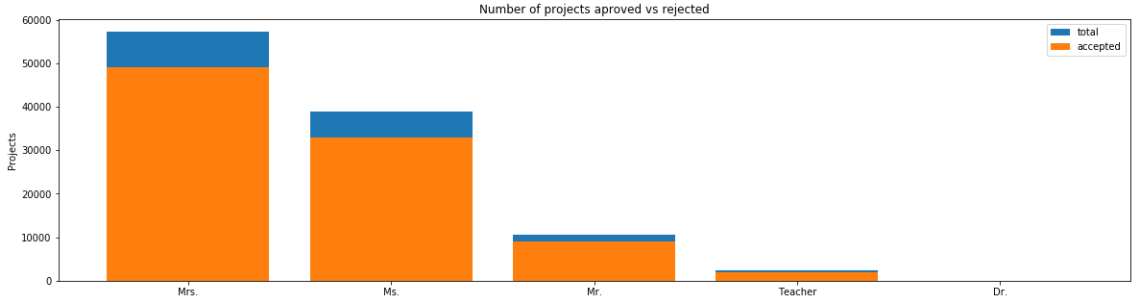
==========

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

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

1.2.2 Univariate Analysis: teacher_prefix

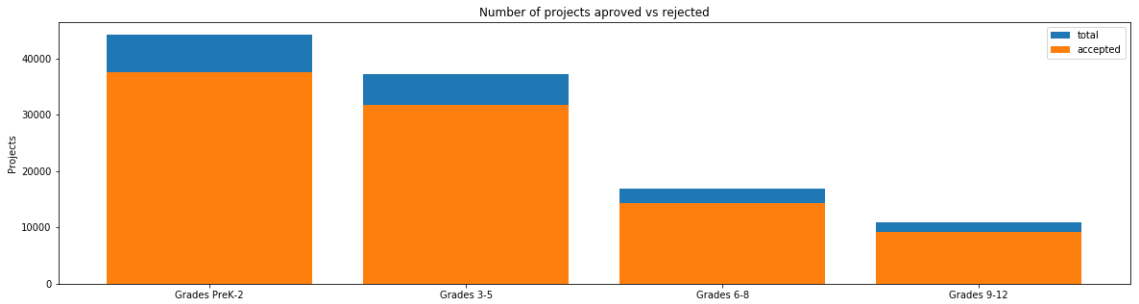
In [0]:
```
univariate_barplots(project_data, 'teacher_prefix', 'project_is_approved' , top=False)
```




```
  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
```

1.2.3 Univariate Analysis: project_grade_category

In [0]:
```
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
```

1.2.4 Univariate Analysis: project_subject_categories

In [0]:
```
catogories = list(project_data['project_subject_categories'].values)
# remove special characters from list of strings python: https://stacko
verflow.com/a/47301924/4084039

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

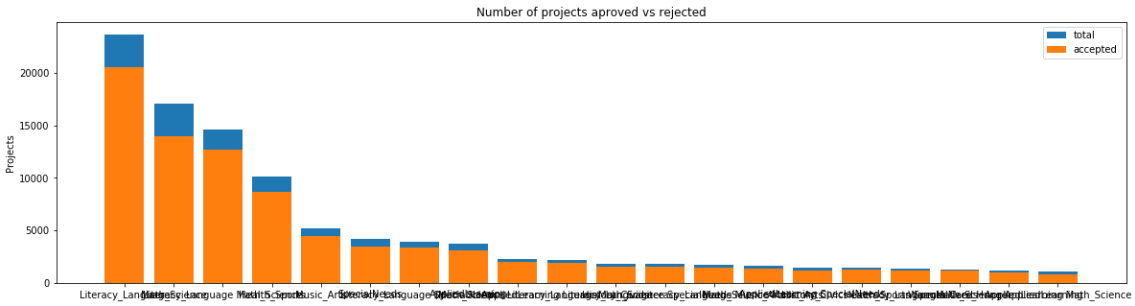
```
cat_list = []
for i in catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & H
unger"
    for j in i.split(','): # it will split it in three parts ["Math & S
cience", "Warmth", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the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

In [0]:
```
project_data['clean_categories'] = cat_list
project_data.drop(['project_subject_categories'], axis=1, inplace=True)
project_data.head(2)
```

Out[0]:

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

In [0]:
```
univariate_barplots(project_data, 'clean_categories', 'project_is_appro
ved', top=20)
```



	clean_categories	project_is_approved	total	Avg
24	Literacy_Language	20520	23655	0.86747
0				
32	Math_Science	13991	17072	0.81952
9				
28	Literacy_Language Math_Science	12725	14636	0.86943
2				
8	Health_Sports	8640	10177	0.84897
3				
40	Music_Arts	4429	5180	0.85501
9				

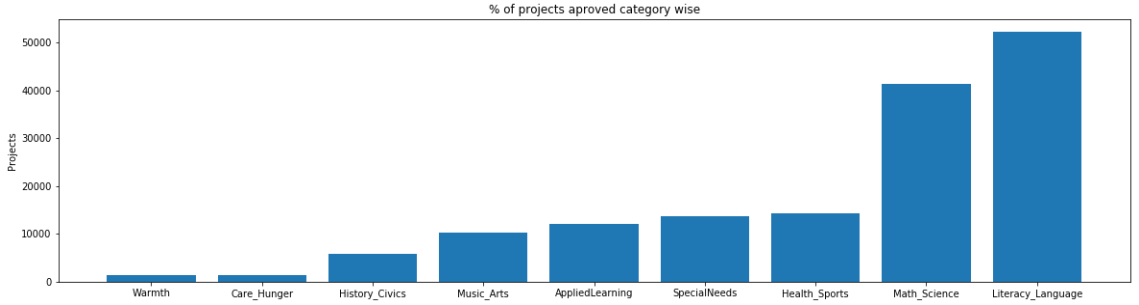
==========

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

In [0]:
```
# 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 [0]:
```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
cat_dict = dict(my_counter)
sorted_cat_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))


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

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



In [0]:
```
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

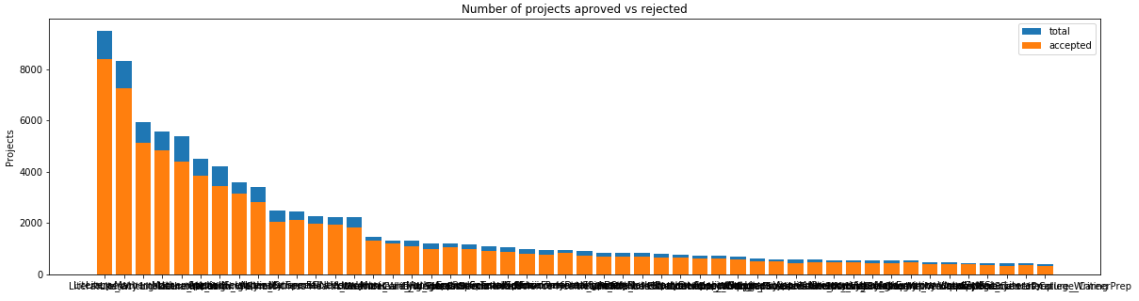
In [0]:
```
sub_catogories = list(project_data['project_subject_subcategories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039

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

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

In [0]:
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=True)
project_data.head(2)
```

Out[0]:

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

In [0]:
```
univariate_barplots(project_data, 'clean_subcategories', 'project_is_approved', top=50)
```

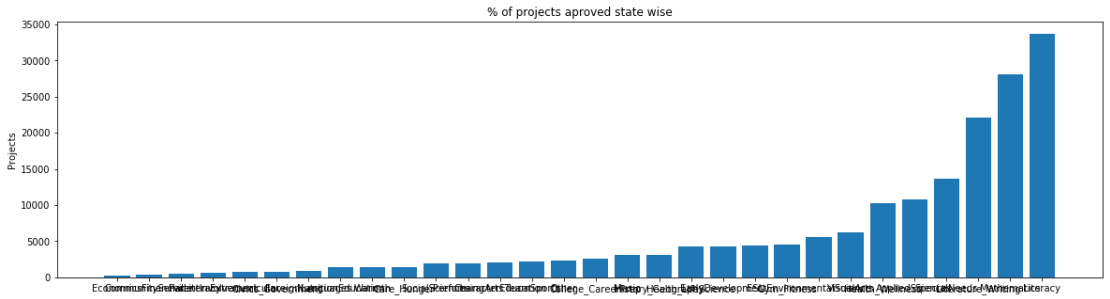



```
                clean_subcategories  project_is_approved  total
Avg
317                         Literacy                 8371   9486  0.88
2458
319             Literacy Mathematics                 7260   8325  0.87
2072
331  Literature_Writing Mathematics                 5140   5923  0.86
7803
```

```
318     Literacy Literature_Writing                 4823   5571  0.86
5733
342                      Mathematics                4385   5379  0.81
5207
==================================================
                    clean_subcategories  project_is_approved  total
     Avg
196       EnvironmentalScience Literacy                  389    444
0.876126
127                                  ESL                349    421
0.828979
79                    College_CareerPrep                343    421
0.814727
17   AppliedSciences Literature_Writing                 361    420
0.859524
3    AppliedSciences College_CareerPrep                 330    405
0.814815
```

In [0]:
```
# 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 [0]:
```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
sub_cat_dict = dict(my_counter)
sorted_sub_cat_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv:
kv[1]))


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

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



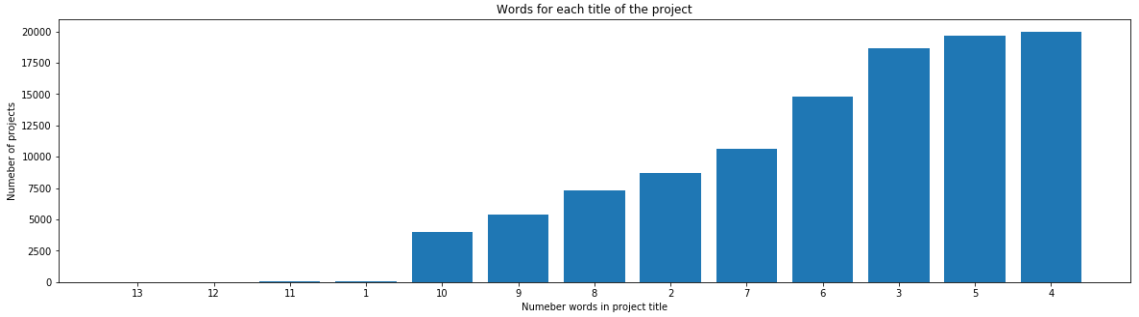
In [0]:
```
for i, j in sorted_sub_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

```
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)

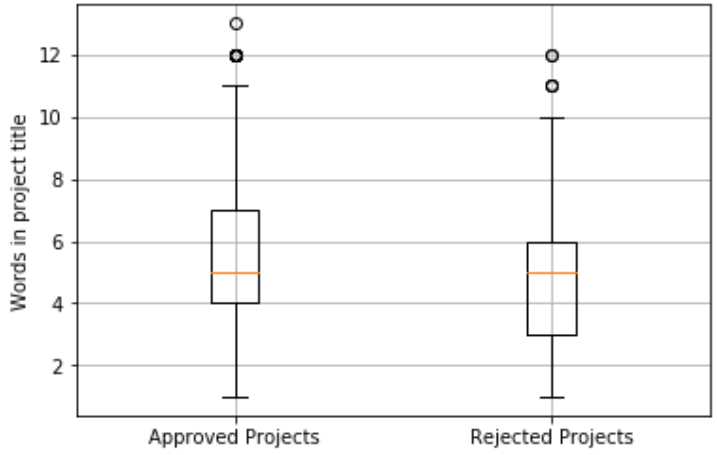
In [0]:
```
#How to calculate number of words in a string in DataFrame: https://sta
ckoverflow.com/a/37483537/4084039
word_count = project_data['project_title'].str.split().apply(len).value
_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))


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

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



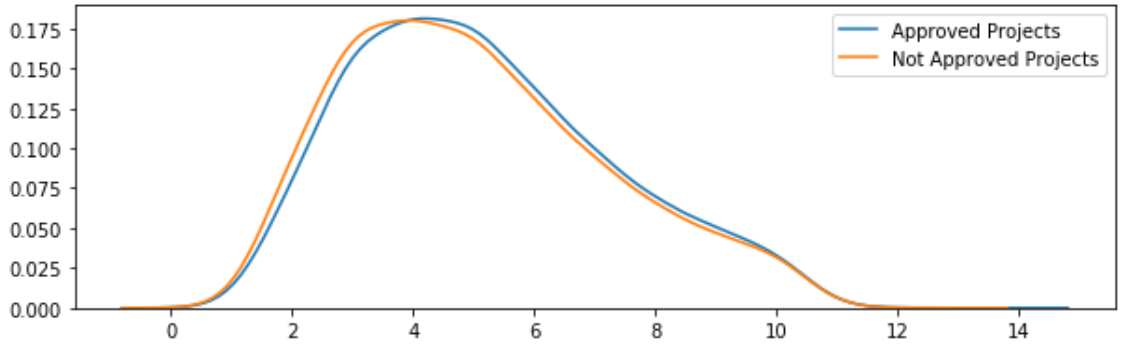
In [0]:
```
approved_title_word_count = project_data[project_data['project_is_appro
ved']==1]['project_title'].str.split().apply(len)
```

```
approved_title_word_count = approved_title_word_count.values

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

In [0]:
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.ht
ml
plt.boxplot([approved_title_word_count, rejected_title_word_count])
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Words in project title')
plt.grid()
plt.show()
```



In [0]:
```
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()
```



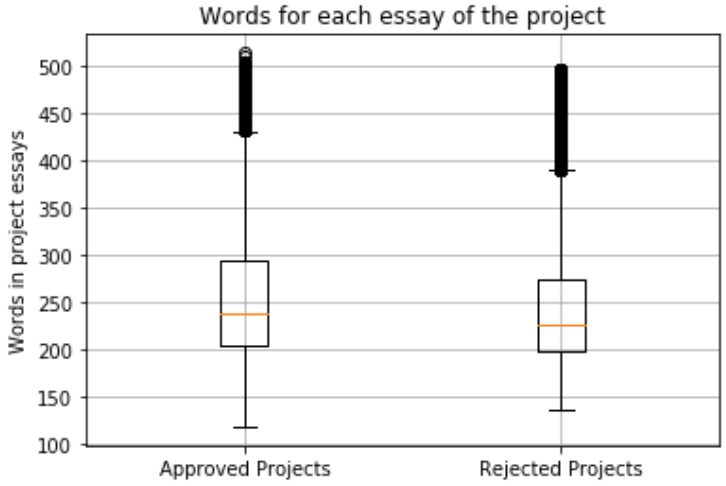
1.2.7 Univariate Analysis: Text features (Project Essay's)

In [0]:
```
# merge two column text dataframe:
project_data["essay"] = project_data["project_essay_1"].map(str) +\
                        project_data["project_essay_2"].map(str) + \
                        project_data["project_essay_3"].map(str) + \
                        project_data["project_essay_4"].map(str)
```

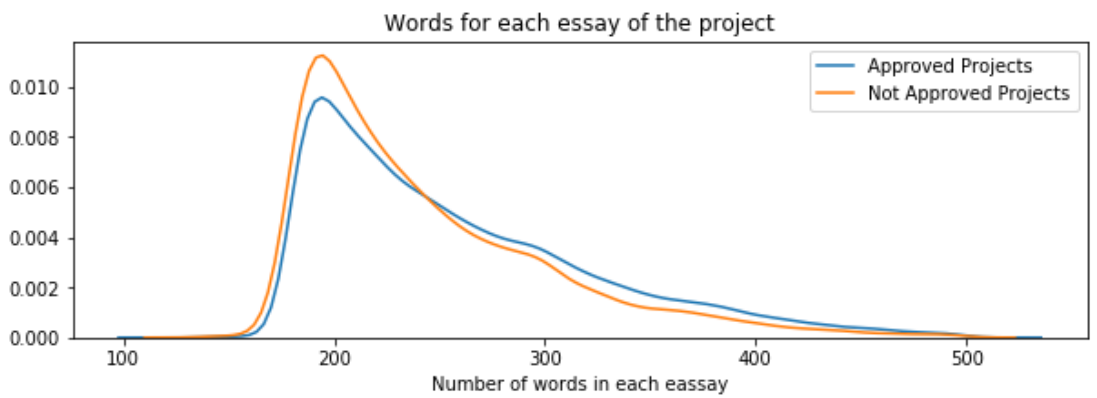
In [0]:
```
approved_word_count = project_data[project_data['project_is_approved']=
=1]['essay'].str.split().apply(len)
approved_word_count = approved_word_count.values

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

In [0]:
```
    # https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotli
b.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 [0]:
```
plt.figure(figsize=(10,3))
sns.distplot(approved_word_count, hist=False, label="Approved Projects"
)
sns.distplot(rejected_word_count, hist=False, label="Not Approved Proje
cts")
plt.title('Words for each essay of the project')
plt.xlabel('Number of words in each eassay')
plt.legend()
plt.show()
```



1.2.8 Univariate Analysis: Cost per project

In [0]:
```
# we get the cost of the project using resource.csv file
resource_data.head(2)
```

Out[0]:

	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 [0]:
```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframes-indexes-for-all-groups-in-one-step
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
price_data.head(2)
```

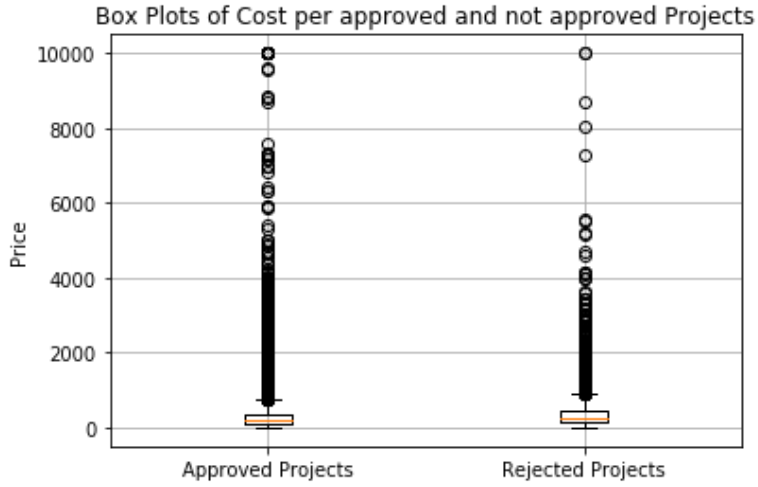
Out[0]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

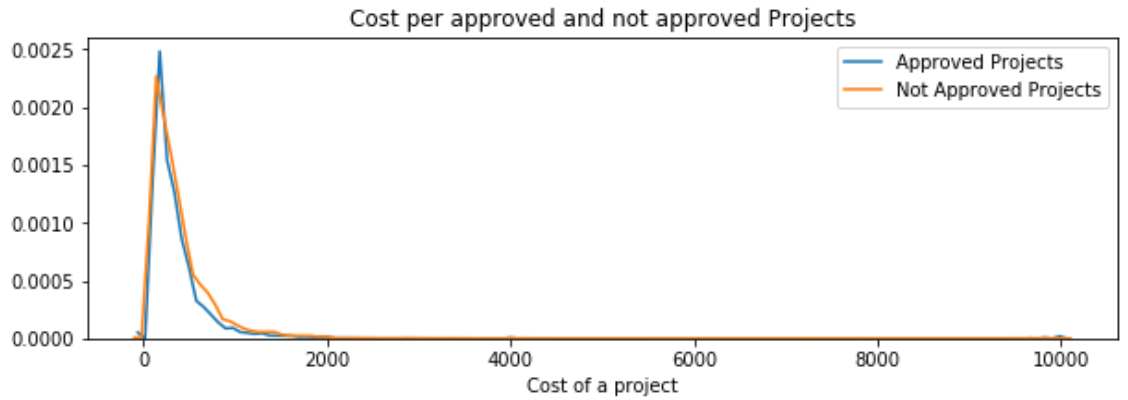
In [0]:
```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [0]:
```
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 [0]:
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.ht
ml
plt.boxplot([approved_price, rejected_price])
plt.title('Box Plots of Cost per approved and not approved Projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Price')
plt.grid()
plt.show()
```



In [0]:
```
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 [0]:
```
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

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

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

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

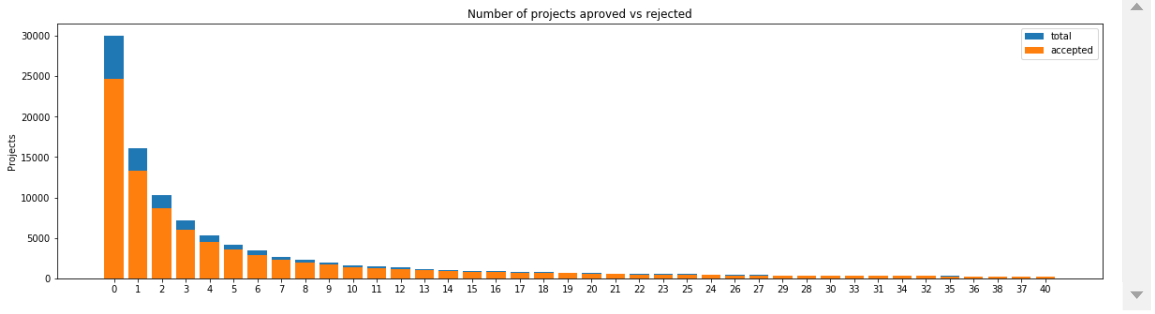
```
+------------+------------------+-----------------------+
| Percentile | Approved Projects | Not Approved Projects |
+------------+------------------+-----------------------+
|     0      |        0.66      |          1.97         |
|     5      |       13.59      |          41.9         |
|     10     |       33.88      |         73.67         |
|     15     |        58.0      |         99.109        |
|     20     |       77.38      |         118.56        |
|     25     |       99.95      |        140.892        |
|     30     |       116.68     |         162.23        |
|     35     |      137.232     |        184.014        |
|     40     |       157.0      |        208.632        |
```

```
|     45     |       178.265      |         235.106        |
|     50     |        198.99      |         263.145        |
|     55     |        223.99      |          292.61        |
|     60     |        255.63      |         325.144        |
|     65     |       285.412      |          362.39        |
|     70     |       321.225      |          399.99        |
|     75     |       366.075      |         449.945        |
|     80     |        411.67      |         519.282        |
|     85     |        479.0       |         618.276        |
|     90     |        593.11      |         739.356        |
|     95     |       801.598      |         992.486        |
|    100     |        9999.0      |          9999.0        |
+------------+--------------------+------------------------+
```

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

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

In [0]:
```
univariate_barplots(project_data, 'teacher_number_of_previously_posted_
projects', 'project_is_approved', top=40)
```




```
   teacher_number_of_previously_posted_projects  ...       Avg
0                                             0  ...  0.821350
1                                             1  ...  0.830054
2                                             2  ...  0.841063
3                                             3  ...  0.843460
4                                             4  ...  0.845423
```

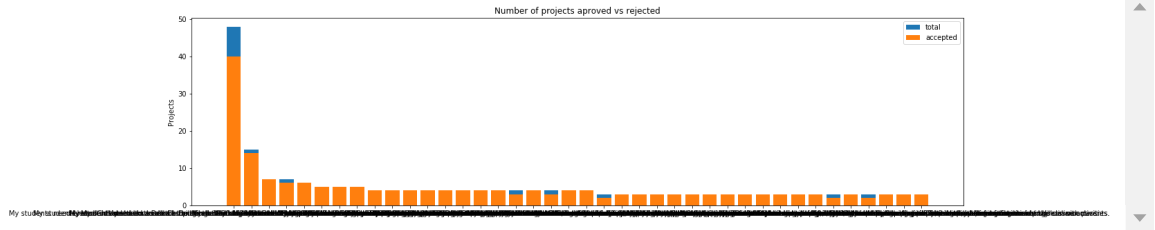
```
[5 rows x 4 columns]
==================================================
    teacher_number_of_previously_posted_projects  ...       Avg
35                                            35  ...  0.910112
36                                            36  ...  0.885057
38                                            38  ...  0.910569
37                                            37  ...  0.867257
40                                            40  ...  0.914027

[5 rows x 4 columns]
```

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 [0]:
```
univariate_barplots(project_data, 'project_resource_summary', 'project_is_approved', top=40)
```

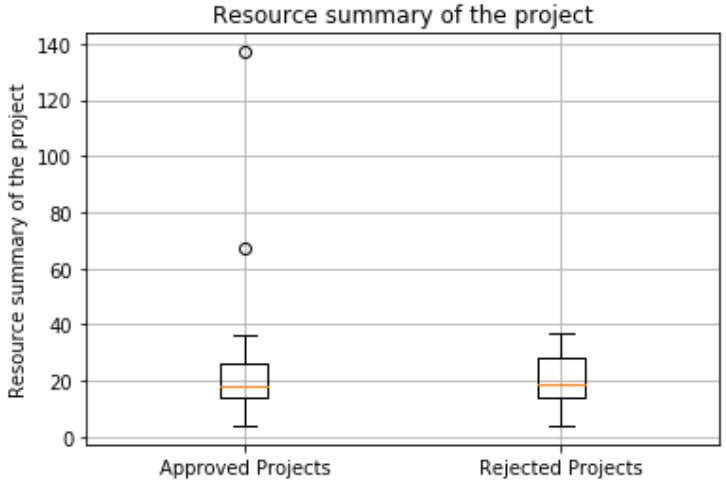



```
                                project_resource_summary  ...       Avg
56539  My students need electronic tablets to do all ...  ...  0.833333
10193  My students need Chromebooks to do all the thi...  ...  0.933333
18828  My students need a Dell Chromebook 3120 and a ...  ...  1.000000
51417  My students need chromebooks to do all the thi...  ...  0.857143
18819  My students need a Dell Chromebook 3120 11 6 C...  ...  1.000000

[5 rows x 4 columns]
```

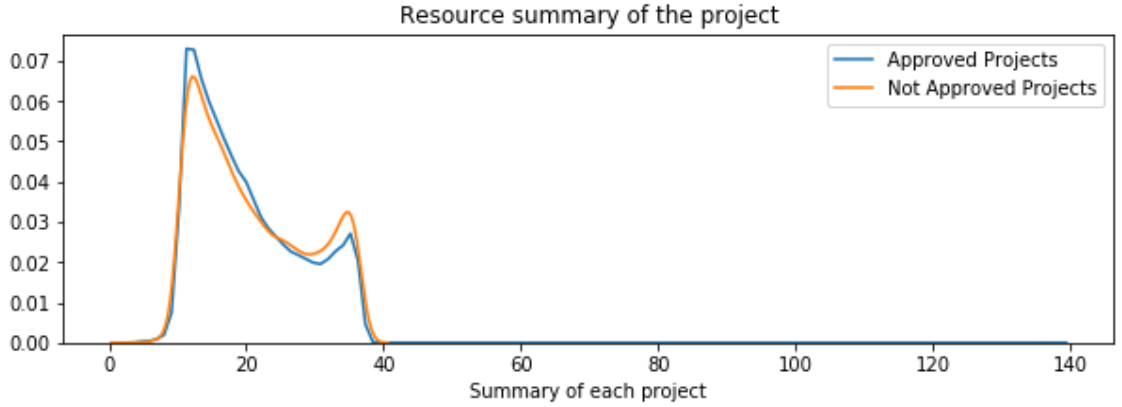
```
==================================================
                                project_resource_summary  ...       Avg
1886   My students need 2 Lenovo Chromebooks to use i...  ...  1.000000
39664  My students need an Asus Chromebook, wireless ...  ...  0.666667
3553   My students need 3 Chromebooks to use for indi...  ...  1.000000
88300  My students need stand-up desks to be more act...  ...  1.000000
66903  My students need iPad minis and iPad mini case...  ...  1.000000

[5 rows x 4 columns]
```

In [0]:
```
approved_resource_summary = project_data[project_data['project_is_approved']==1]['project_resource_summary'].str.split().apply(len)
approved_resource_summary = approved_resource_summary.values
rejected_resource_summary = project_data[project_data['project_is_approved']==0]['project_resource_summary'].str.split().apply(len)
rejected_resource_summary = rejected_resource_summary.values
```

In [0]:
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_resource_summary, rejected_resource_summary])
plt.title('Resource summary of the project')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Resource summary of the project')
plt.grid()
plt.show()
```



In [0]:
```
plt.figure(figsize=(10,3))
sns.distplot(approved_resource_summary, hist=False, label="Approved Pro
jects")
sns.distplot(rejected_resource_summary, hist=False, label="Not Approved
 Projects")
plt.title('Resource summary of the project')
plt.xlabel('Summary of each project')
plt.legend()
plt.show()
```



1.3 Text preprocessing

1.3.1 Essay Text

In [0]:
```
project_data.head(2)
```

Out[0]:

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

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

```
My students are English learners that are working on English as their s
econd or third languages. We are a melting pot of refugees, immigrants,
and native-born Americans bringing the gift of language to our school.
\r\n\r\n We have over 24 languages represented in our English Learner p
rogram with students at every level of mastery.  We also have over 40 c
ountries represented with the families within our school.  Each student
brings a wealth of knowledge and experiences to us that open our eyes t
o new cultures, beliefs, and respect.\"The limits of your language are
the limits of your world.\"-Ludwig Wittgenstein  Our English learner's
have a strong support system at home that begs for more resources.  Man
y times our parents are learning to read and speak English along side o
f their children.  Sometimes this creates barriers for parents to be ab
```

le to help their child learn phonetics, letter recognition, and other r
eading skills.\r\n\r\nBy providing these dvd's and players, students ar
e able to continue their mastery of the English language even if no one
at home is able to assist. All families with students within the Level
1 proficiency status, will be a offered to be a part of this program.
These educational videos will be specially chosen by the English Learne
r Teacher and will be sent home regularly to watch. The videos are to
help the child develop early reading skills.\r\n\r\nParents that do not
have access to a dvd player will have the opportunity to check out a dv
d player to use for the year. The plan is to use these videos and educ
ational dvd's for the years to come for other EL students.\r\nnannan
==========
The 51 fifth grade students that will cycle through my classroom this y
ear all love learning, at least most of the time. At our school, 97.3%
of the students receive free or reduced price lunch. Of the 560 student
s, 97.3% are minority students. \r\nThe school has a vibrant community
that loves to get together and celebrate. Around Halloween there is a w
hole school parade to show off the beautiful costumes that students wea
r. On Cinco de Mayo we put on a big festival with crafts made by the st
udents, dances, and games. At the end of the year the school hosts a ca
rnival to celebrate the hard work put in during the school year, with a
dunk tank being the most popular activity.My students will use these fi
ve brightly colored Hokki stools in place of regular, stationary, 4-leg
ged chairs. As I will only have a total of ten in the classroom and not
enough for each student to have an individual one, they will be used in
a variety of ways. During independent reading time they will be used as
special chairs students will each use on occasion. I will utilize them
in place of chairs at my small group tables during math and reading tim
es. The rest of the day they will be used by the students who need the
highest amount of movement in their life in order to stay focused on sc
hool.\r\n\r\nWhenever asked what the classroom is missing, my students
always say more Hokki Stools. They can't get their fill of the 5 stools
we already have. When the students are sitting in group with me on the
Hokki Stools, they are always moving, but at the same time doing their
work. Anytime the students get to pick where they can sit, the Hokki St
ools are the first to be taken. There are always students who head over
to the kidney table to get one of the stools who are disappointed as th
ere are not enough of them. \r\n\r\nWe ask a lot of students to sit for
7 hours a day. The Hokki stools will be a compromise that allow my stud
ents to do desk work and move at the same time. These stools will help
students to meet their 60 minutes a day of movement by allowing them to
activate their core muscles for balance while they sit. For many of my

students, these chairs will take away the barrier that exists in school
s for a child who can't sit still.nannan
==========
How do you remember your days of school? Was it in a sterile environmen
t with plain walls, rows of desks, and a teacher in front of the room?
A typical day in our room is nothing like that. I work hard to create a
warm inviting themed room for my students look forward to coming to eac
h day.\r\n\r\nMy class is made up of 28 wonderfully unique boys and gir
ls of mixed races in Arkansas.\r\nThey attend a Title I school, which m
eans there is a high enough percentage of free and reduced-price lunch
to qualify. Our school is an \"open classroom\" concept, which is very
unique as there are no walls separating the classrooms. These 9 and 10
year-old students are very eager learners; they are like sponges, absor
bing all the information and experiences and keep on wanting more.With
these resources such as the comfy red throw pillows and the whimsical n
autical hanging decor and the blue fish nets, I will be able to help cr
eate the mood in our classroom setting to be one of a themed nautical e
nvironment. Creating a classroom environment is very important in the s
uccess in each and every child's education. The nautical photo props wi
ll be used with each child as they step foot into our classroom for the
first time on Meet the Teacher evening. I'll take pictures of each chil
d with them, have them developed, and then hung in our classroom ready
for their first day of 4th grade. This kind gesture will set the tone
before even the first day of school! The nautical thank you cards will
be used throughout the year by the students as they create thank you ca
rds to their team groups.\r\n\r\nYour generous donations will help me t
o help make our classroom a fun, inviting, learning environment from da
y one.\r\n\r\nIt costs lost of money out of my own pocket on resources
to get our classroom ready. Please consider helping with this project t
o make our new school year a very successful one. Thank you!nannan
==========
My kindergarten students have varied disabilities ranging from speech a
nd language delays, cognitive delays, gross/fine motor delays, to autis
m. They are eager beavers and always strive to work their hardest worki
ng past their limitations. \r\n\r\nThe materials we have are the ones I
seek out for my students. I teach in a Title I school where most of the
students receive free or reduced price lunch. Despite their disabiliti
es and limitations, my students love coming to school and come eager to
learn and explore.Have you ever felt like you had ants in your pants an
d you needed to groove and move as you were in a meeting? This is how m
y kids feel all the time. The want to be able to move as they learn or
so they say.Wobble chairs are the answer and I love then because they d

```
evelop their core, which enhances gross motor and in Turn fine motor sk
ills. \r\nThey also want to learn through games, my kids don't want to
sit and do worksheets. They want to learn to count by jumping and playi
ng. Physical engagement is the key to our success. The number toss and
color and shape mats can make that happen. My students will forget they
are doing work and just have the fun a 6 year old deserves.nannan
==================================================
The mediocre teacher tells. The good teacher explains. The superior tea
cher demonstrates. The great teacher inspires. -William A. Ward\r\n\r\n
My school has 803 students which is makeup is 97.6% African-American, m
aking up the largest segment of the student body. A typical school in D
allas is made up of 23.2% African-American students. Most of the studen
ts are on free or reduced lunch. We aren't receiving doctors, lawyers,
or engineers children from rich backgrounds or neighborhoods. As an edu
cator I am inspiring minds of young children and we focus not only on a
cademics but one smart, effective, efficient, and disciplined students
with good character.In our classroom we can utilize the Bluetooth for s
wift transitions during class. I use a speaker which doesn't amplify th
e sound enough to receive the message. Due to the volume of my speaker
my students can't hear videos or books clearly and it isn't making the
lessons as meaningful. But with the bluetooth speaker my students will
be able to hear and I can stop, pause and replay it at any time.\r\nThe
cart will allow me to have more room for storage of things that are nee
ded for the day and has an extra part to it I can use.  The table top c
hart has all of the letter, words and pictures for students to learn ab
out different letters and it is more accessible.nannan
==================================================
```

In [0]:

```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 [0]:
```
sent = decontracted(project_data['essay'].values[20000])
print(sent)
print("="*50)
```

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

In [0]:
```
# \r \n \t remove from string python: http://texthandler.com/info/remov
e-line-breaks-python/
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\"', ' ')
```

```
sent = sent.replace('\\n', ' ')
print(sent)
```

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

In [0]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

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

In [0]:
```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'no
t'
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves'
, 'you', "you're", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselve
s', 'he', 'him', 'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'it
s', 'itself', 'they', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'th
is', 'that', "that'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'h
ave', 'has', 'had', 'having', 'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or',
 'because', 'as', 'until', 'while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between',
'into', 'through', 'during', 'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out',
'on', 'off', 'over', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'h
ow', 'all', 'any', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 's
o', 'than', 'too', 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should',
"should've", 'now', 'd', 'll', 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't",
'didn', "didn't", 'doesn', "doesn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "is
n't", 'ma', 'mightn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn',
 "shouldn't", 'wasn', "wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

In [0]:
```
# 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%|â–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆ| 109248/109248 [00:56<00:00, 1943.5
5it/s]
```

In [0]:
```
# after preprocesing
preprocessed_essays[20000]
```

Out[0]:
```
'my kindergarten students varied disabilities ranging speech language d
elays cognitive delays gross fine motor delays autism they eager beaver
s always strive work hardest working past limitations the materials one
s i seek students i teach title i school students receive free reduced
price lunch despite disabilities limitations students love coming schoo
l come eager learn explore have ever felt like ants pants needed groove
move meeting this kids feel time the want able move learn say wobble ch
airs answer i love develop core enhances gross motor turn fine motor sk
ills they also want learn games kids not want sit worksheets they want
learn count jumping playing physical engagement key success the number
toss color shape mats make happen my students forget work fun 6 year ol
d deserves nannan'
```

1.3.2 Project title Text

In [0]:
```
# similarly you can preprocess the titles also
# Combining all the above statemennts
preprocessed_title = []
# 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_title.append(sent.lower().strip())
```

```
100%|â–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆ| 109248/109248 [00:02<00:00, 43891.
90it/s]
```

In [0]:
```
# after preprocesing
preprocessed_title[0:4]
```

Out[0]:
```
['educational support english learners home',
 'wanted projector hungry learners',
 'soccer equipment awesome middle school students',
 'techie kindergarteners']
```

1. 4 Preparing data for models

we are going to consider

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

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

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

1.4.1 Vectorizing Categorical data

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

In [0]:

In [0]:
```
# 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 encoding ",categories_one_hot.shape)
```

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

In [0]:
```
# 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)
```

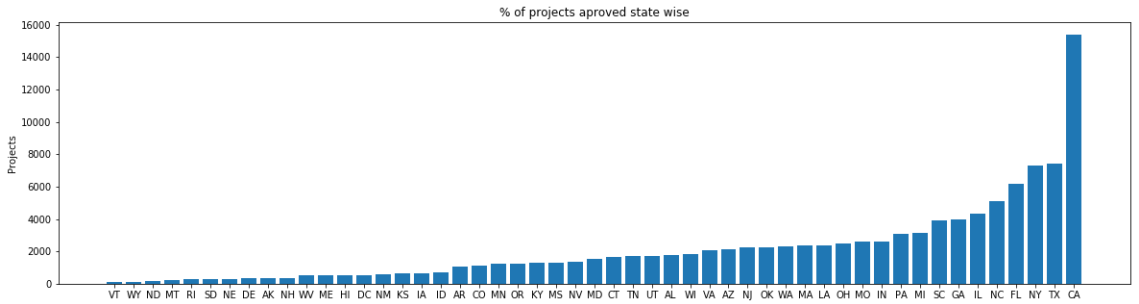
```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Extracurricular', 'Civics_Government', 'ForeignLanguages', 'Nutri
```

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

In [0]:
```
# Please do the similar feature encoding with state, teacher_prefix and
 project_grade_category also
```

State Dictionary

In [0]:
```
from collections import Counter
my_counter1 = Counter()
for word in project_data['school_state'].values:
    my_counter1.update(word.split())

state_dict = dict(my_counter1)
sorted_state_dict = dict(sorted(state_dict.items(), key=lambda kv: kv[1
]))
ind1 = np.arange(len(sorted_state_dict))
plt.figure(figsize=(20,5))
p2 = plt.bar(ind1, list(sorted_state_dict.values()))
plt.ylabel('Projects')
plt.title('% of projects aproved state wise')
plt.xticks(ind1, list(sorted_state_dict.keys()))
plt.show()


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




```
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
```

state

In [0]:
```
vectorizer = CountVectorizer(vocabulary=list(sorted_state_dict.keys()),
 lowercase=False, binary=True)
vectorizer.fit(project_data['school_state'].values)
print(vectorizer.get_feature_names())


state_one_hot = vectorizer.transform(project_data['school_state'].value
s)
print("Shape of matrix after one hot encodig ",state_one_hot.shape)
```

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

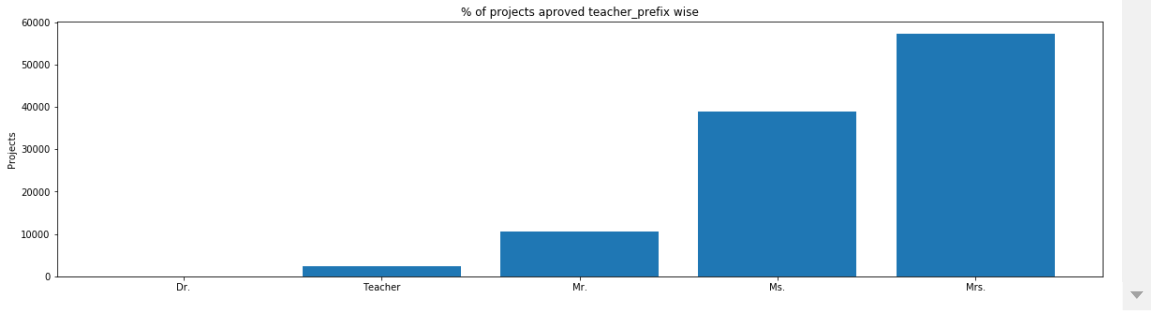
Teacher_prefix Dictionary

In [0]:
```
project_data['teacher_prefix']=project_data['teacher_prefix'].fillna(me
thod='ffill')
```

In [0]:
```
project_data['teacher_prefix'][30368:30372]
```

Out[0]:
```
30368    Mrs.
30369    Mrs.
30370     Ms.
30371     Ms.
Name: teacher_prefix, dtype: object
```

In [0]:
```
from collections import Counter
my_counter2 = Counter()
for word in project_data['teacher_prefix'].values:
    my_counter2.update(word.split())

prefix_dict = dict(my_counter2)
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))
p2 = plt.bar(ind2, list(sorted_prefix_dict.values()))
plt.ylabel('Projects')
plt.title('% of projects aproved teacher_prefix wise')
plt.xticks(ind2, list(sorted_prefix_dict.keys()))
plt.show()


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




```
Dr.                 :        13
Teacher             :      2360
Mr.                 :     10648
Ms.                 :     38956
Mrs.                :     57271
```

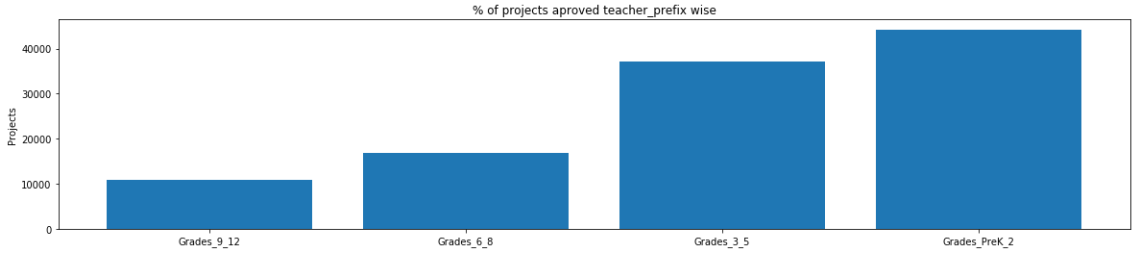
In [0]:
```
#Teacher_prefix

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


teacher_prefix_one_hot = vectorizer.transform(project_data['teacher_pre
fix'].values)
print("Shape of matrix after one hot encodig ",teacher_prefix_one_hot.s
hape)
```

```
['Dr.', 'Teacher', 'Mr.', 'Ms.', 'Mrs.']
Shape of matrix after one hot encodig  (109248, 5)
```

In [0]:
```
#project_grade_category Dictionary

#How_to_update_keys: https://www.geeksforgeeks.org/python-ways-to-chang
e-keys-in-dictionary/


from collections import Counter
my_counter3 = Counter()
for word in project_data['project_grade_category'].values:
```

```
    my_counter3.update(word.split('_'))


grade_dict = dict(my_counter3)
sorted_grade_dict = dict(sorted(grade_dict.items(), key=lambda kv: kv[1
]))
dict((sorted_grade_dict[key], value) for (key, value) in sorted_grade_d
ict.items())
updt_keys = ['Grades_9_12', 'Grades_6_8', 'Grades_3_5', 'Grades_PreK_2'
]
sorted_grade_dict = dict(zip(updt_keys, list(sorted_grade_dict.values
())))
ind3 = np.arange(len(sorted_grade_dict))
plt.figure(figsize=(20,4))
p3 = plt.bar(ind3, list(sorted_grade_dict.values()))
plt.ylabel('Projects')
plt.title('% of projects aproved teacher_prefix wise')
plt.xticks(ind3, list(sorted_grade_dict.keys()))
plt.show()


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

```
{'Grades_9_12': 10963, 'Grades_6_8': 16923, 'Grades_3_5': 37137, 'Grade
s_PreK_2': 44225}
```




```
Grades_9_12          :     10963
Grades_6_8           :     16923
Grades_3_5           :     37137
Grades_PreK_2        :     44225
```

In [0]:
```
#project_grade_category
```

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


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

```
['Grades_9_12', 'Grades_6_8', 'Grades_3_5', 'Grades_PreK_2']
Shape of matrix after one hot encoding  (109248, 4)
```

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

In [0]:
```
# We are considering only the words which appeared in at least 10 docum
ents(rows or projects).
vectorizer = CountVectorizer(min_df=10)
text_bow = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after one hot encodig ",text_bow.shape)
```

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

In [0]:
```
# you can vectorize the title also
# before you vectorize the title make sure you preprocess it
preprocessed_title = []
# 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_title.append(sent.lower().strip())
```

```
100%|â–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆ| 109248/109248 [00:02<00:00, 43622.
51it/s]
```

In [0]:

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

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

1.4.2.3 TFIDF vectorizer

In [0]:

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

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

1.4.2.4 TFIDF Vectorizer on `project_title`

In [0]:

```
# Similarly you can vectorize for title also

vectorizer = TfidfVectorizer(min_df=10)
text_tfidf = vectorizer.fit_transform(preprocessed_title)
print("Shape of matrix after one hot encoding ",text_tfidf.shape)
```

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

1.4.2.5 Using Pretrained Models: Avg W2V

In [0]:

```
'''
# Reading glove vectors in python: https://stackoverflow.com/a/3823034
9/4084039
def loadGloveModel(gloveFile):
```

```
    print ("Loading Glove Model")
    f = open(gloveFile,'r', encoding="utf8")
    model = {}
    for line in tqdm(f):
        splitLine = line.split()
        word = splitLine[0]
        embedding = np.array([float(val) for val in splitLine[1:]])
        model[word] = embedding
    print ("Done.",len(model)," words loaded!")
    return model
model = loadGloveModel('glove.42B.300d.txt')

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

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

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

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

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

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

words_courpus = {}
words_glove = set(model.keys())
for i in words:
    if i in words_glove:
        words_courpus[i] = model[i]
```

```
print("word 2 vec length", len(words_courpus))


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

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


'''
```

Out[0]:

```
'\n# Reading glove vectors in python: https://stackoverflow.com/a/38230
349/4084039\ndef loadGloveModel(gloveFile):\n    print ("Loading Glove
Model")\n    f = open(gloveFile,\'r\', encoding="utf8")\n    model = {}
\n    for line in tqdm(f):\n        splitLine = line.split()\n        w
ord = splitLine[0]\n        embedding = np.array([float(val) for val in
splitLine[1:]])\n        model[word] = embedding\n    print ("Done.",le
n(model)," words loaded!")\n    return model\nmodel = loadGloveModel
(\'glove.42B.300d.txt\')\n\n# ============================\nOutput:\n
  \nLoading Glove Model\n1917495it [06:32, 4879.69it/s]\nDone. 1917495
words loaded!\n\n# ============================\n\nwords = []\nfor i in
preproced_texts:\n    words.extend(i.split(\' \'))\n\nfor i in preproce
d_titles:\n    words.extend(i.split(\' \'))\nprint("all the words in th
e coupus", len(words))\nwords = set(words)\nprint("the unique words in
the coupus", len(words))\n\ninter_words = set(model.keys()).intersectio
n(words)\nprint("The number of words that are present in both glove vec
tors and our coupus",       len(inter_words),"(",np.round(len(inter_wor
ds)/len(words)*100,3),"%)")\n\nwords_courpus = {}\nwords_glove = set(mo
del.keys())\nfor i in words:\n    if i in words_glove:\n        words_c
ourpus[i] = model[i]\nprint("word 2 vec length", len(words_courpus))\n
\n\n# stronging variables into pickle files python: http://www.jessicay
ung.com/how-to-use-pickle-to-save-and-load-variables-in-python/\n\nimpo
rt pickle\nwith open(\'glove_vectors\', \'wb\') as f:\n    pickle.dump
(words_courpus, f)\n\n\n'
```

In [0]:

```
# stronging variables into pickle files python: http://www.jessicayung.
com/how-to-use-pickle-to-save-and-load-variables-in-python/
# make sure you have the glove_vectors file
with open(r'/content/drive/My Drive/glove_vectors', 'rb') as f:
```

```
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

In [0]:

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

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

```
100%|â–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆ| 109248/109248 [00:37<00:00, 2911.0
1it/s]
```

```
109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on `project_title`

In [0]:

```
# Similarly you can vectorize for title also
avg_w2v_vectors1 = []; # the avg-w2v for each title is stored in this l
ist
for sentence in tqdm(preprocessed_title): # for each title
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/re
view
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
```

```
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_vectors1.append(vector)

print(len(avg_w2v_vectors1))
print(len(avg_w2v_vectors1[0]))
```

```
100%|â–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆ| 109248/109248 [00:01<00:00, 59865.
99it/s]
```

```
109248
300
```

In [0]:

```
# Conversion of a list to sparse matrix

from scipy.sparse import coo_matrix
avg_w2v_matrix=np.reshape(np.asarray(avg_w2v_vectors1),(109248,300))
sparse_avg_w2v_matrix=coo_matrix(avg_w2v_matrix).tocsr()

print(type(sparse_avg_w2v_matrix))
print("Shape of matrix after one hot encoding ",sparse_avg_w2v_matrix.s
hape)
```

```
<class 'scipy.sparse.csr.csr_matrix'>
Shape of matrix after one hot encoding  (109248, 300)
```

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

In [0]:

```
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
tfidf_model1 = TfidfVectorizer()
tfidf_model1.fit(preprocessed_essays)
# we are converting a dictionary with word as a key1, and the idf1 as a
 value
dictionary = dict(zip(tfidf_model1.get_feature_names(), list(tfidf_mode
l1.idf_)))
tfidf_words = set(tfidf_model1.get_feature_names())
```

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

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

```
100%|â–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆ| 109248/109248 [03:31<00:00, 517.49
it/s]
```

```
109248
300
```

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

In [0]:
```
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
tfidf_model = TfidfVectorizer()
tfidf_model.fit(preprocessed_essays)
# we are converting a dictionary with word as a key, and the idf as a v
alue
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model
.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [0]:
```
# Similarly you can vectorize for title also

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

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

```
100%|â–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆâ–ˆ| 109248/109248 [00:03<00:00, 27523.
35it/s]
```

```
109248
300
```

In [0]:
```
# Conversion of a list to sparse matrix

tfidf_w2v_matrix=np.reshape(np.asarray(tfidf_w2v_vectors),(109248,300))
sparse_tfidf_w2v_matrix=coo_matrix(tfidf_w2v_matrix).tocsr()

print("Shape of matrix after one hot encoding ",sparse_tfidf_w2v_matrix
.shape)
```

```
Shape of matrix after one hot encoding  (109248, 300)
```

1.4.3 Vectorizing Numerical features

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

# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.   ... 399.   287.73   5.5 ].
# Reshape your data either using array.reshape(-1, 1)

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

Out[0]:
```
array([[-0.3905327 ],
       [ 0.00239637],
       [ 0.59519138],
       ...,
       [-0.15825829],
       [-0.61243967],
       [-0.51216657]])
```

In [0]:
```
#Now standardize teacher number of previously posted projects

import warnings
warnings.filterwarnings('ignore')
```

```
prev_proj_scalar = StandardScaler()
prev_proj_scalar.fit(project_data['teacher_number_of_previously_posted_
projects'].values.reshape(-1,1)) # finding the mean and standard deviat
ion of this data
print(f"Mean : {prev_proj_scalar.mean_[0]}, Standard deviation : {np.sq
rt(prev_proj_scalar.var_[0])}")

# Now standardize the data with above maen and variance.
prev_proj_standardized = prev_proj_scalar.transform(project_data['teach
er_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

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

In [0]:
```
prev_proj_standardized
```

Out[0]:
```
array([[-0.40152481],
       [-0.14951799],
       [-0.36552384],
       ...,
       [-0.29352189],
       [-0.40152481],
       [-0.40152481]])
```

1.4.4 Merging all the above features

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

In [0]:
```
print(categories_one_hot.shape)
print(sub_categories_one_hot.shape)
print(text_bow.shape)
print(price_standardized.shape)
```

```
(109248, 9)
(109248, 30)
(109248, 3329)
(109248, 1)
```

In [0]:
```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/40840
39
from scipy.sparse import hstack
```

```
# with the same hstack function we are concatinating a sparse matrix an
d a dense matirx :)
X = hstack((categories_one_hot, sub_categories_one_hot, text_bow, price
_standardized))
X.shape
```

Out[0]: (109248, 3369)

Assignment 2: Apply TSNE

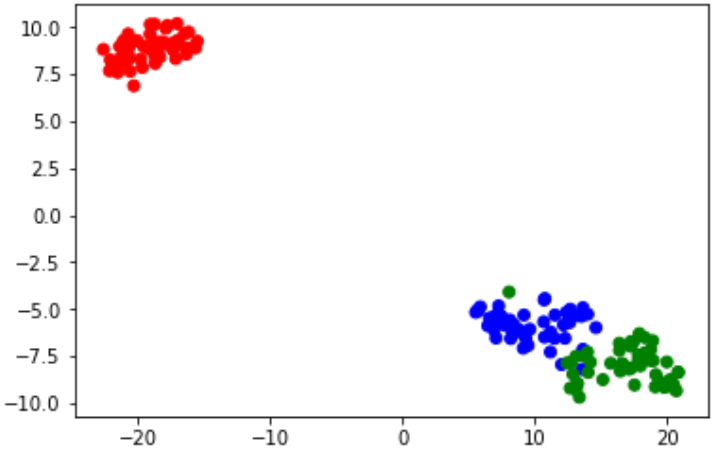
If you are using any code snippet from the internet, you have to provide the reference/citations, as we did in the above cells. Otherwise, it will be treated as plagiarism without citations.

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

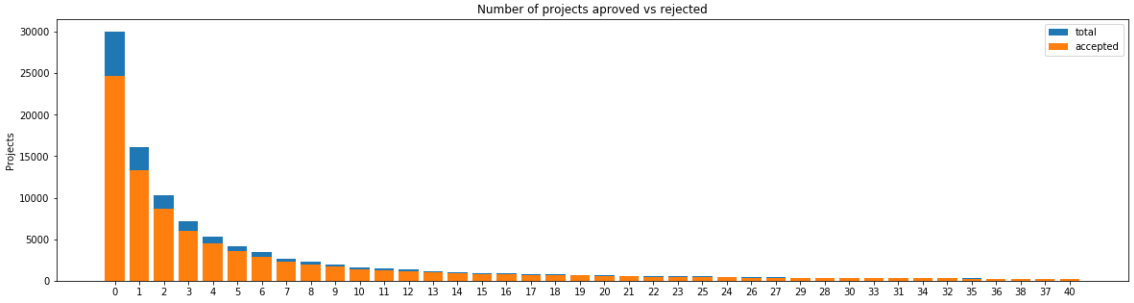
In [0]:

```
# 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
import matplotlib.patches as mpatches

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

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


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



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

plt.show()
```



2.1 EDA for teacher_number_of_previously_posted_projects

In [0]:
```
univariate_barplots(project_data, 'teacher_number_of_previously_posted_projects', 'project_is_approved', top=40)
```

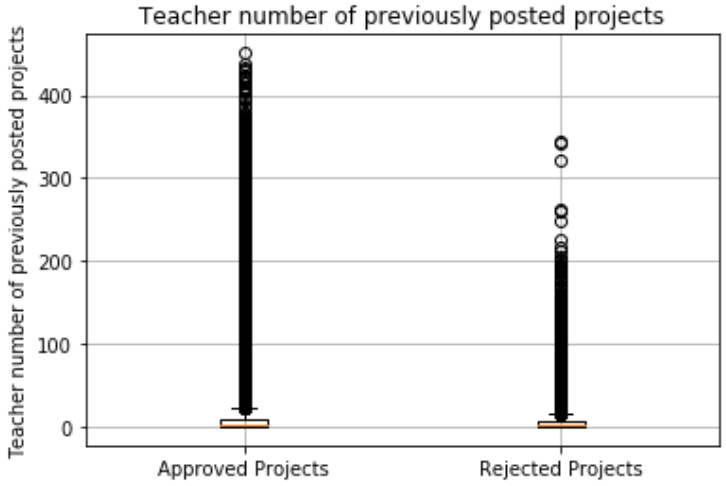


	teacher_number_of_previously_posted_projects	...	Avg
0	0	...	0.821350
1	1	...	0.830054

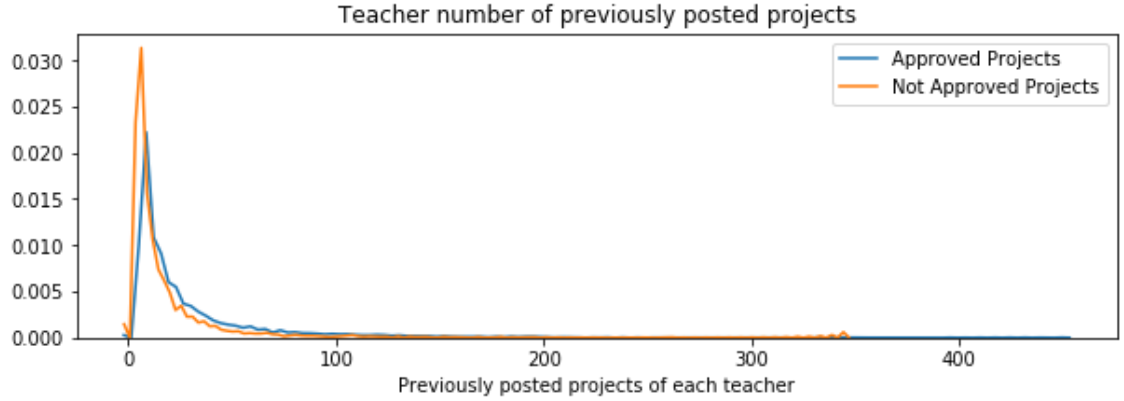
```
2                                                  2  ...  0.841063
3                                                  3  ...  0.843460
4                                                  4  ...  0.845423

[5 rows x 4 columns]
==================================================
    teacher_number_of_previously_posted_projects  ...       Avg
35                                                35  ...  0.910112
36                                                36  ...  0.885057
38                                                38  ...  0.910569
37                                                37  ...  0.867257
40                                                40  ...  0.914027

[5 rows x 4 columns]
```

In [0]:
```
approved_posted_projects = project_data[project_data['project_is_approved']==1]['teacher_number_of_previously_posted_projects']
approved_posted_projects = approved_posted_projects.values
rejected_posted_projects = project_data[project_data['project_is_approved']==0]['teacher_number_of_previously_posted_projects']
rejected_posted_projects = rejected_posted_projects.values
```

In [0]:
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_posted_projects, rejected_posted_projects])
plt.title('Teacher number of previously posted projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Teacher number of previously posted projects')
plt.grid()
plt.show()
```



In [0]:
```
plt.figure(figsize=(10,3))
sns.distplot(approved_posted_projects, hist=False, label="Approved Proj
ects")
sns.distplot(rejected_posted_projects, hist=False, label="Not Approved
 Projects")
plt.title('Teacher number of previously posted projects')
plt.xlabel('Previously posted projects of each teacher')
plt.legend()
plt.show()
```



Summary:

Maximum number of projects is maximum for 0 number of previously posted projects per teacher and then the value is gradually decreasing .

3.1 Building data matrix

In [0]:
```
project_data.columns.values
```

Out[0]:
```
array(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_stat
e',
       'project_submitted_datetime', 'project_grade_category',
       'project_title', 'project_essay_1', 'project_essay_2',
       'project_essay_3', 'project_essay_4', 'project_resource_summar
y',
       'teacher_number_of_previously_posted_projects',
       'project_is_approved', 'clean_categories', 'clean_subcategorie
s',
       'essay', 'price', 'quantity'], dtype=object)
```

In [0]:
```
#Merging of standardized categorical and numerical features

project_data_final_= hstack((state_one_hot,categories_one_hot,sub_categ
ories_one_hot,teacher_prefix_one_hot,grade_cat_one_hot,price_standardiz
ed,prev_proj_standardized))
project_data_final_.shape
```

Out[0]:
```
(109248, 101)
```

In [0]:
```
# Conversion of sparse matrix to dense matrix

project_data_final_=project_data_final_.toarray()

#To reduce the execution time, only 10K points have been taken into con
sideration

project_data_final_=project_data_final_[0:5000,:]

project_data_final_.shape
```

Out[0]:
```
(5000, 101)
```

4.1 T-SNE Plots

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

In [0]:
```
tsne_ = TSNE(n_components=1, perplexity=200, learning_rate=200)
X_embedding_ = tsne_.fit_transform(project_data_final_)

y_bow=text_bow.toarray()
y_bow= y_bow.reshape(-1,1)
y_bow=y_bow[0:5000,:]
y_bow.shape
```

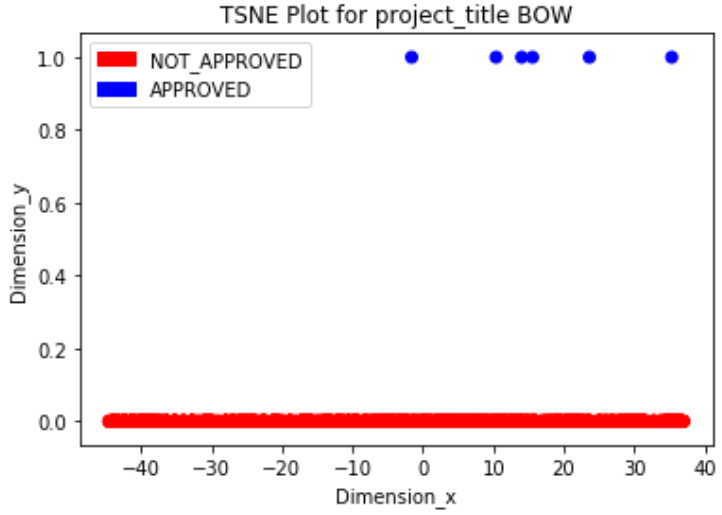
Out[0]:
```
(5000, 1)
```

In [0]:
```
print(type(y_bow))
print(type(X_embedding_))
print(y_bow.shape)
print(X_embedding_.shape)
```

```
<class 'numpy.ndarray'>
<class 'numpy.ndarray'>
(5000, 1)
(5000, 1)
```

In [0]:
```
project_data_tsne_= np.hstack((X_embedding_,y_bow))
```

```
for_tsne_df_ = pd.DataFrame(data=project_data_tsne_, columns=['NOT_APPR
OVED','APPROVED'])

colors = {0:'red', 1:'blue'}
plt.scatter(for_tsne_df_['NOT_APPROVED'], for_tsne_df_['APPROVED'], c=f
or_tsne_df_['APPROVED'].apply(lambda x: colors[int(x)]))
plt.title('TSNE Plot for project_title BOW')
plt.xlabel('Dimension_x')
plt.ylabel('Dimension_y')

red_patch = mpatches.Patch(color='red', label='NOT_APPROVED')
blue_patch = mpatches.Patch(color='blue', label='APPROVED')



plt.legend(handles=[red_patch,blue_patch])
plt.show()
```



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

In [0]:
```
y_tfidf=text_tfidf.toarray()
y_tfidf= y_tfidf.reshape(-1,1)
y_tfidf=y_tfidf[0:5000,:]


y_tfidf.shape
```

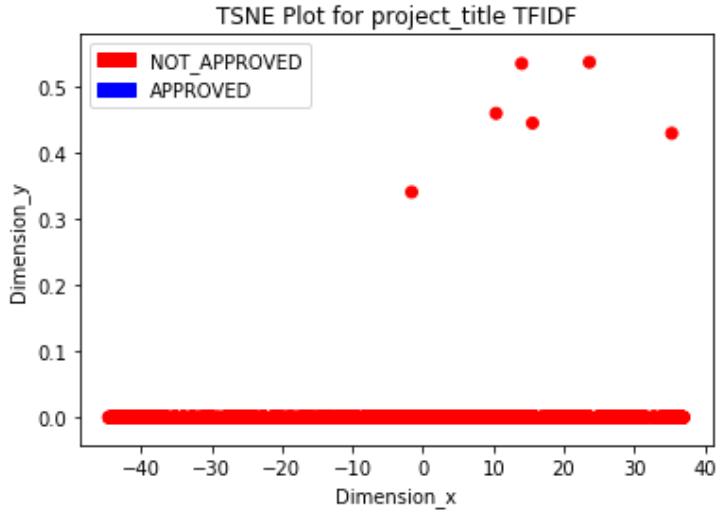
Out[0]:
```
(5000, 1)
```

In [0]:
```
X_embedding_.shape
```

Out[0]:
```
(5000, 2)
```

In [0]:
```
# please write all the code with proper documentation, and proper title
s for each subsection


project_data_tsne__= np.hstack((X_embedding_,y_tfidf))
for_tsne_df__ = pd.DataFrame(data=project_data_tsne__, columns=['NOT_AP
PROVED','APPROVED'])

colors = {0:'red', 1:'blue'}
plt.scatter(for_tsne_df__['NOT_APPROVED'],for_tsne_df__['APPROVED'], c=
for_tsne_df__['APPROVED'].apply(lambda x: colors[int(x)]))
plt.title('TSNE Plot for project_title TFIDF')
plt.xlabel('Dimension_x')
plt.ylabel('Dimension_y')

red_patch = mpatches.Patch(color='red', label='NOT_APPROVED')
```

```
blue_patch = mpatches.Patch(color='blue', label='APPROVED')



plt.legend(handles=[red_patch,blue_patch])
plt.show()
```



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

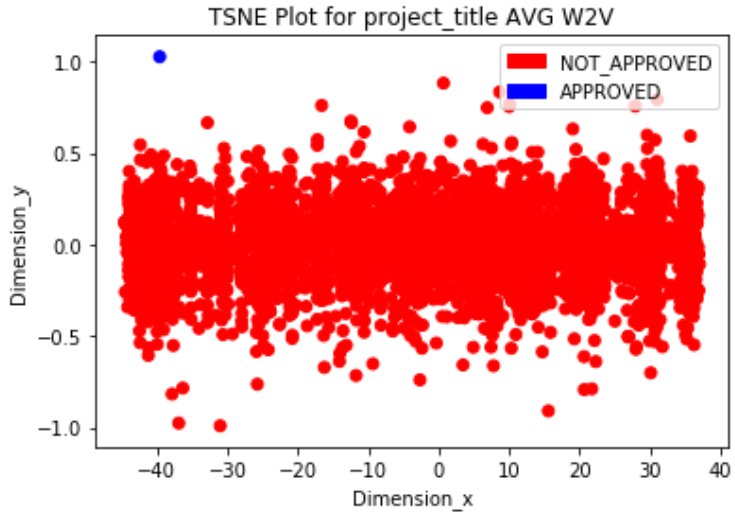
In [0]:
```
y_avg_w2v=sparse_avg_w2v_matrix.toarray()
y_avg_w2v= y_avg_w2v.reshape(-1,1)
```

In [0]:
```
y_avg_w2v=y_avg_w2v[0:6000,:]
count=[]
for elements in y_avg_w2v:
  if elements<=-1:
    count.append(elements)

t_lst=list(y_avg_w2v)
```

```
cmp_lst = [x for x in t_lst if x not in count]

y_avg_w2v = np.asarray(b, dtype=np.float32)
y_avg_w2v=y_avg_w2v[0:5000,:]
y_avg_w2v.shape
```

Out[0]:
```
(5000, 1)
```

In [0]:
```
# please write all the code with proper documentation, and proper title
s for each subsection


project_data_tsne_1_= np.hstack((X_embedding_,y_avg_w2v))
for_tsne_df_1_ = pd.DataFrame(data=project_data_tsne_1_, columns=['NOT_
APPROVED','APPROVED'])
colors = {0:'red', 1:'blue'}

plt.scatter(for_tsne_df_1_['NOT_APPROVED'], for_tsne_df_1_['APPROVED'],
 c=for_tsne_df_1_['APPROVED'].apply(lambda x: colors[int(x)]))
plt.title('TSNE Plot for project_title AVG W2V')
plt.xlabel('Dimension_x')
plt.ylabel('Dimension_y')

red_patch = mpatches.Patch(color='red', label='NOT_APPROVED')
blue_patch = mpatches.Patch(color='blue', label='APPROVED')



plt.legend(handles=[red_patch,blue_patch],loc='upper right')
plt.show()
```



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

In [0]:
```
y_tfidf_w2v=sparse_tfidf_w2v_matrix.toarray()
y_tfidf_w2v= y_tfidf_w2v.reshape(-1,1)



y_tfidf_w2v.shape
```

Out[0]:
```
(32774400, 1)
```

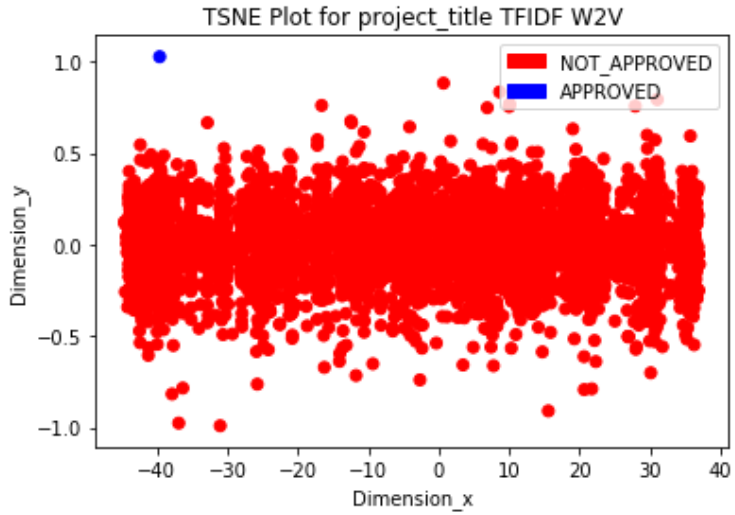
In [0]:
```
y_tfidf_w2v=y_tfidf_w2v[0:6000,:]
count=[]
for elements in y_tfidf_w2v:
  if elements<=-1:
    count.append(elements)

t_lst=list(y_tfidf_w2v)
cmp_lst = [x for x in t_lst if x not in count]

y_tfidf_w2v = np.asarray(b, dtype=np.float32)
```

```
y_tfidf_w2v=y_tfidf_w2v[0:5000,:]
y_tfidf_w2v.shape
```

Out[0]:
```
(5000, 1)
```

In [0]:
```
# please write all the code with proper documentation, and proper title
s for each subsection


project_data_tsne_2_= np.hstack((X_embedding_,y_tfidf_w2v))
for_tsne_df_2_ = pd.DataFrame(data=project_data_tsne_2_, columns=['NOT_
APPROVED','APPROVED'])
colors = {0:'red',1:'blue'}
print(type(for_tsne_df_2_['APPROVED']))
plt.scatter(for_tsne_df_2_['NOT_APPROVED'], for_tsne_df_2_['APPROVED'],
 c=for_tsne_df_2_['APPROVED'].apply(lambda x: colors[int(x)]))
plt.title('TSNE Plot for project_title TFIDF W2V')
plt.xlabel('Dimension_x')
plt.ylabel('Dimension_y')

red_patch = mpatches.Patch(color='red', label='NOT_APPROVED')
blue_patch = mpatches.Patch(color='blue', label='APPROVED')


plt.legend(handles=[red_patch,blue_patch],loc='upper right')
plt.show()
```

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



4.2 Concatenating all features

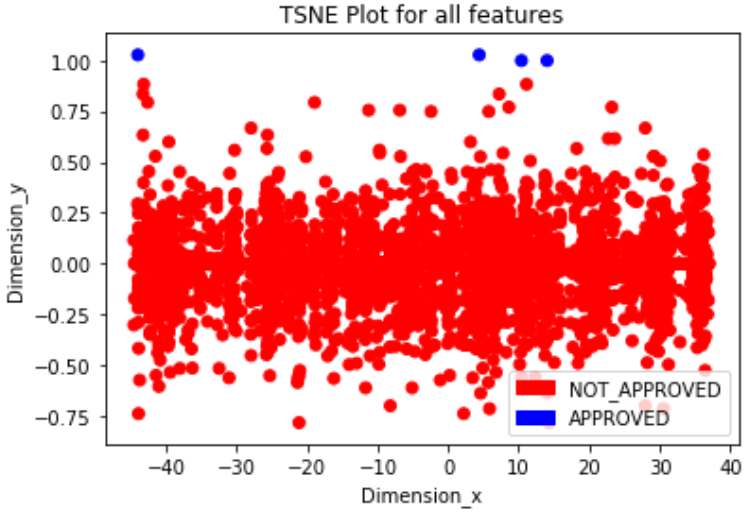
In [0]:
```
#How to concatenate https://cmdlinetips.com/2018/04/how-to-concatenate-arrays-in-numpy/

final_y=np.concatenate((y_bow[0:1250,:],y_tfidf[0:1250,:],y_avg_w2v[0:1250,:],y_tfidf_w2v[0:1250,:]))
final_y.shape
```

Out[0]: (5000, 1)

4.2.1 TSNE PLOT

In [0]:
```
project_data_tsne_3_= np.hstack((X_embedding_,final_y))
for_tsne_df_3_ = pd.DataFrame(data=project_data_tsne_3_, columns=['NOT_APPROVED','APPROVED'])
colors = {0:'red',1:'blue'}
plt.scatter(for_tsne_df_3_['NOT_APPROVED'], for_tsne_df_3_['APPROVED'],
 c=for_tsne_df_3_['APPROVED'].apply(lambda x: colors[int(x)]))
plt.title('TSNE Plot for all features')
plt.xlabel('Dimension_x')
```

```
plt.ylabel('Dimension_y')

red_patch = mpatches.Patch(color='red', label='NOT_APPROVED')
blue_patch = mpatches.Patch(color='blue', label='APPROVED')


plt.legend(handles=[red_patch,blue_patch],loc='lower right')
plt.show()
```



2.5 Summary

1) For Bag of words plot we observed that target variable of project_title_BOW is of value 0 for all rows, hence giving us plot with just one color.

2) Just like bag_of_words, one hot encoded value of TFIDF project title column also consisted of 0 integer value only, hence giving us no other plot but of red points only.

3) For Avg word2vec plot, apart from 0 column values there were few other values as well. But the avg_w2v plot is not seperable for value 0 from other values.

4) Just like avg w2v plot, tfidf w2v plot also had a few non zero values but they also turned out to be statistically inseperable as count of non zero values is very less and they don't

fall on the plot together seggregated.

5) The data we have for project title under min_df of 10 bends almost the axis value of 0. To avoid such scenarios in future we can update the min_df or perplexity or learning rate accordingly.

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