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`
`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*

Feature	Description
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 [1]:

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

import sqlite3
import pandas as pd
import numpy as np
import nltk
import string
import matplotlib.pyplot as plt
import 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_notebook
import os

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

1.1 Reading Data

In [2]:

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

In [3]:

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

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

In [4]:

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

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

Out[4]:

	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.00

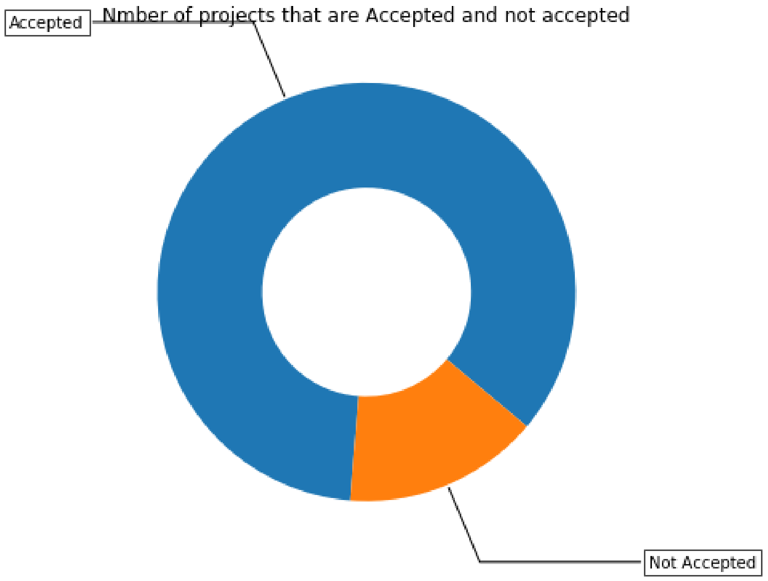
	id	description	quantity	price
1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95

1.2 Data Analysis

In [5]:

```
# 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-an
d-polar-charts-pie-and-donut-labels-py

# Return the number of each classes present in train_data
y_value_counts = project_data['project_is_approved'].value_counts()

# Converting count into percentage with overall train_data
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_count
s[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 , ( 84.85830404217927 %)
Number of projects thar are not approved for funding  16542 , ( 15.141695957820739 %)
```



1.2.1 Univariate Analysis: School State

In [6]:

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

temp = pd.DataFrame(project_data.groupby("school_state")["project_is_approved"].apply(np.mean)).reset_i
ndex()
# if you have data which contain only 0 and 1, then the mean = percentage (think about it)
temp.columns = ['state_code', 'num_proposals']
temp.head()
# 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[6]:

	state_code	num_proposals
0	AK	0.840580
1	AL	0.854711
2	AR	0.831268
3	AZ	0.838379
4	CA	0.858136

In [7]:

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

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

```
   state_code  num_proposals
30         NH       0.873563
35         OH       0.875152
47         WA       0.876178
28         ND       0.888112
8          DE       0.897959
```

In [8]:

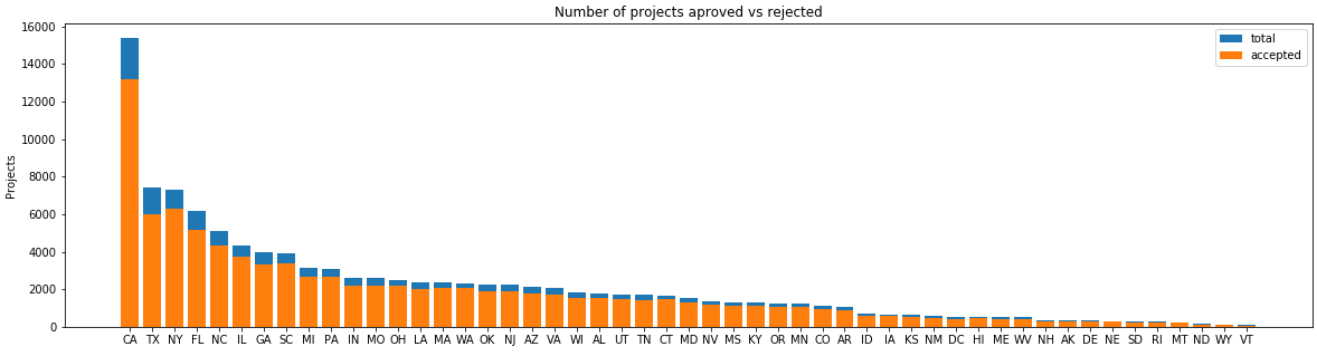
```
#stacked bar plots matplotlib: https://matplotlib.org/gallery/lines_bars_and_markers/bar_stacked.html
def stack_plot(data, xtick, col2='project_is_approved', col3='total'):
    ind = np.arange(data.shape[0])

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

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

In [9]:

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

    # Pandas dataframe grouby count: https://stackoverflow.com/a/19385591/4084039
    temp['total'] = pd.DataFrame(project_data.groupby(col1)[col2].agg({'total':'count'})).reset_index()
['total']
    temp['Avg'] = pd.DataFrame(project_data.groupby(col1)[col2].agg({'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 [10]:

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



```
   school_state  project_is_approved  total       Avg
4            CA                13205  15388  0.858136
43           TX                 6014   7396  0.813142
34           NY                 6291   7318  0.859661
9            FL                 5144   6185  0.831690
27           NC                 4353   5091  0.855038
==================================================
   school_state  project_is_approved  total       Avg
   school_state  project_is_approved  total       Avg
39           RI                  243    285  0.852632
26           MT                  200    245  0.816327
28           ND                  127    143  0.888112
50           WY                   82     98  0.836735
46           VT                   64     80  0.800000
```

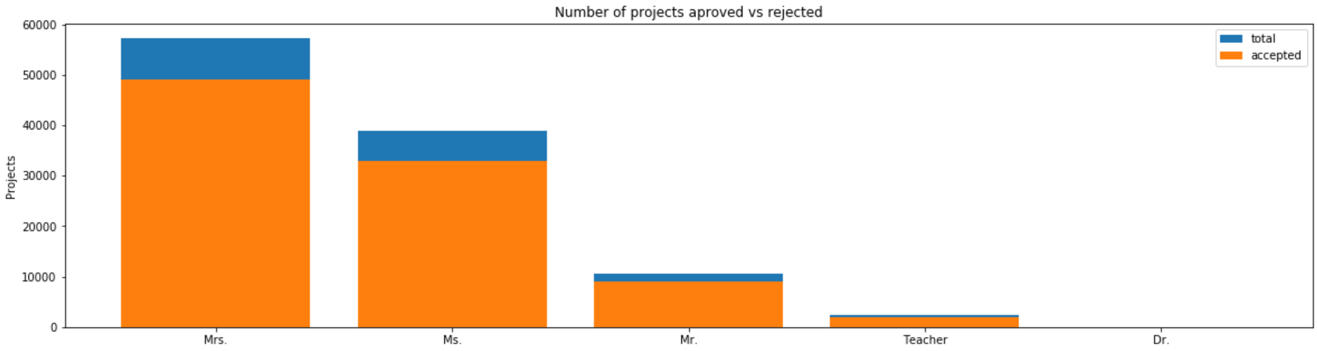
Observation

- Every state has greater than 80% success rate in approval
- CA have done more proposal projects than the others. Also we observed from that eventhough they had done many projects, 85% of projects as been approved by this state.
- VT state had done only 80 projects (lowest number of projects) and out of these 64 has been appreoved.

1.2.2 Univariate Analysis: teacher_prefix

In [11]:

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



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

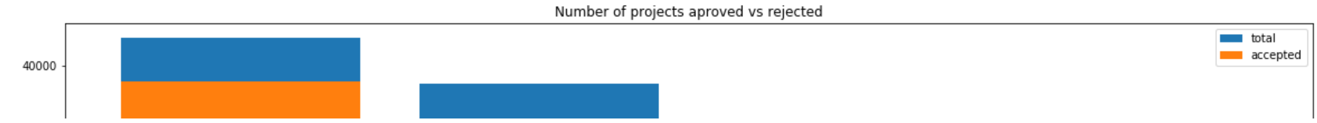
Observation

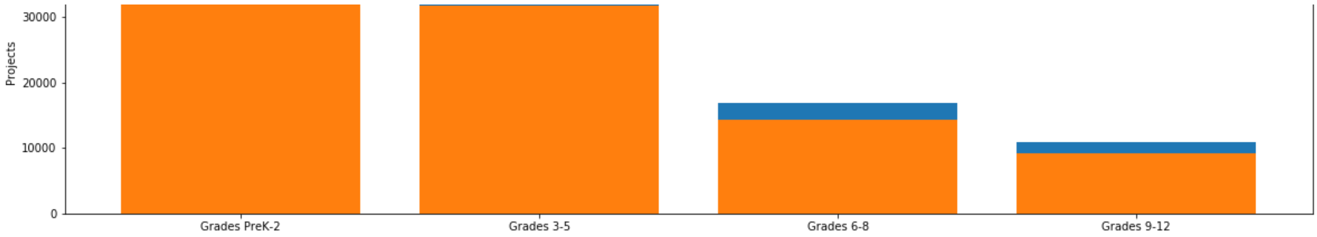
- People's (Other than teacher and Dr.) project is approved above 84% and also done above 10K projects.
- Teacher with prefix (Mrs and Ms) had done more around around in the 10K number of project than the other with less than 10K projects.

1.2.3 Univariate Analysis: project_grade_category

In [12]:

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





```
  project_grade_category  project_is_approved  total       Avg
3          Grades PreK-2                37536  44225  0.848751
0             Grades 3-5                31729  37137  0.854377
1             Grades 6-8                14258  16923  0.842522
2            Grades 9-12                 9183  10963  0.837636
==================================================
  project_grade_category  project_is_approved  total       Avg
3          Grades PreK-2                37536  44225  0.848751
0             Grades 3-5                31729  37137  0.854377
1             Grades 6-8                14258  16923  0.842522
2            Grades 9-12                 9183  10963  0.837636
```

Summary : These all project_grade_category had equivalent(more or less) project's approved 83%and also done above 10K projects.

1.2.4 Univariate Analysis: project_subject_categories

In [13]:

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

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

In [14]:

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

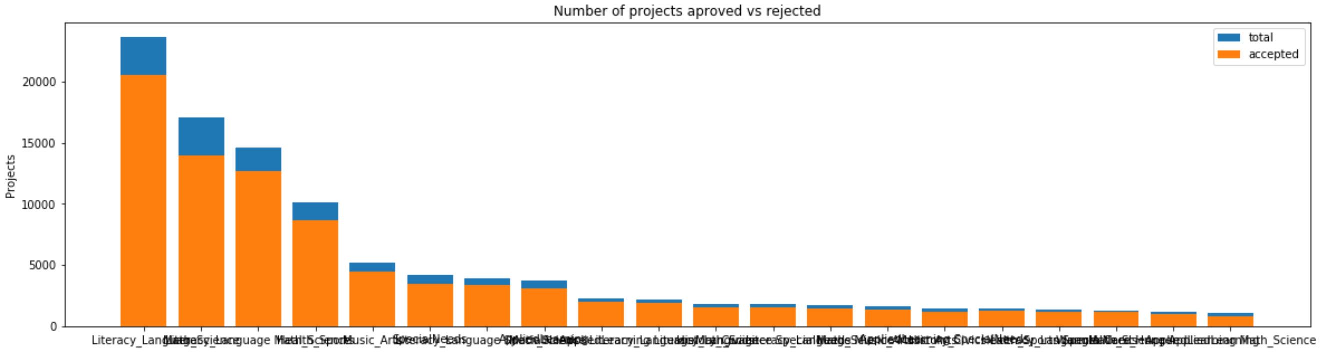
Out[14]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_grade_c
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grades
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra

Unnamed:

In [15]:

```
univariate_barplots(project_data, 'clean_categories', 'project_is_approved', top=20)
```



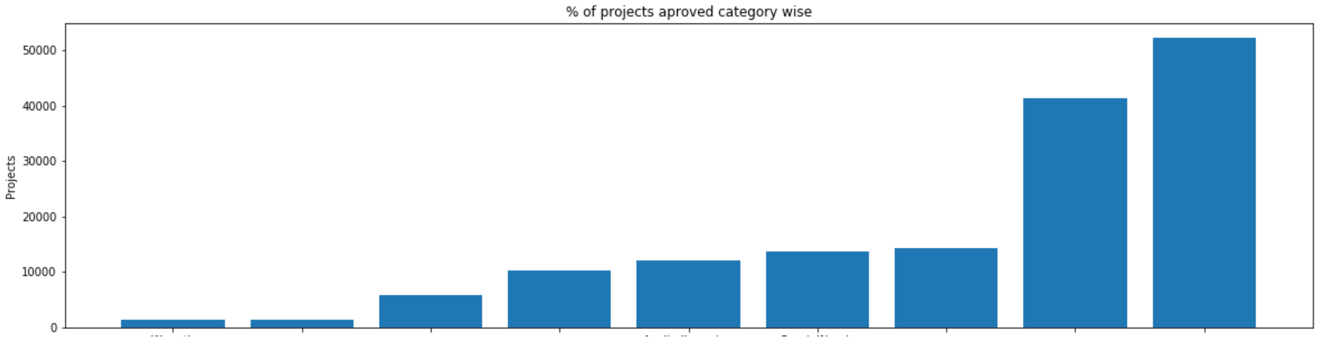
```
                    clean_categories  project_is_approved  total       Avg
24                 Literacy_Language                20520  23655  0.867470
32                      Math_Science                13991  17072  0.819529
28  Literacy_Language Math_Science                  12725  14636  0.869432
8                      Health_Sports                 8640  10177  0.848973
40                        Music_Arts                 4429   5180  0.855019
==================================================
                      clean_categories  project_is_approved  total       Avg
19  History_Civics Literacy_Language                  1271   1421  0.894441
14        Health_Sports SpecialNeeds                  1215   1391  0.873472
50                Warmth Care_Hunger                  1212   1309  0.925898
33      Math_Science AppliedLearning                  1019   1220  0.835246
4       AppliedLearning Math_Science                   855   1052  0.812738
```

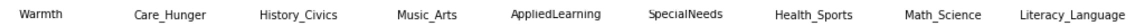
In [16]:

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

In [17]:

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


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

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





In [18]:

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

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

Summary : We found that Literacy_language and Math_Science categories are trending fields that people are focus the most projects

1.2.5 Univariate Analysis: project_subject_subcategories

In [19]:

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

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

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

In [20]:

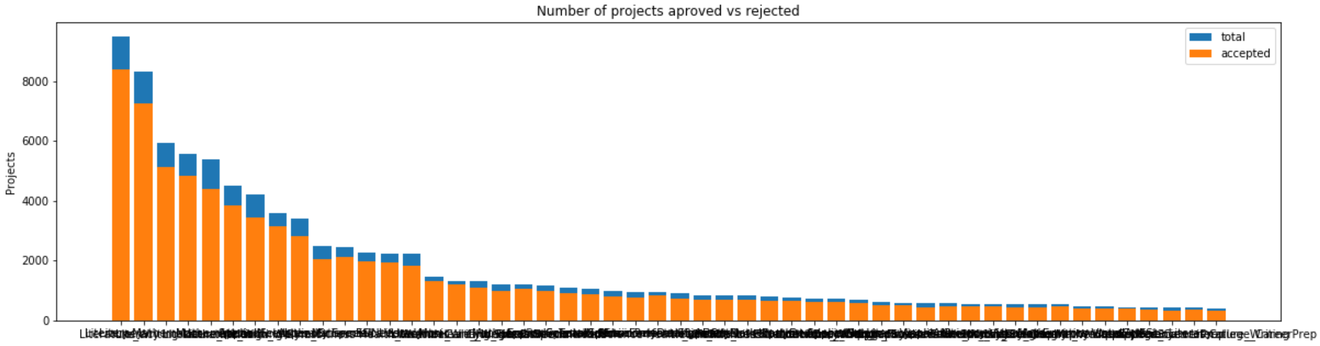
```
project_data['clean_subcategories'] = sub_cat_list
project_data.drop(['project_subject_subcategories'], axis=1, inplace=True)
project_data.head(2)
```

Out[20]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_grade_c
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grades
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra

In [21]:

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



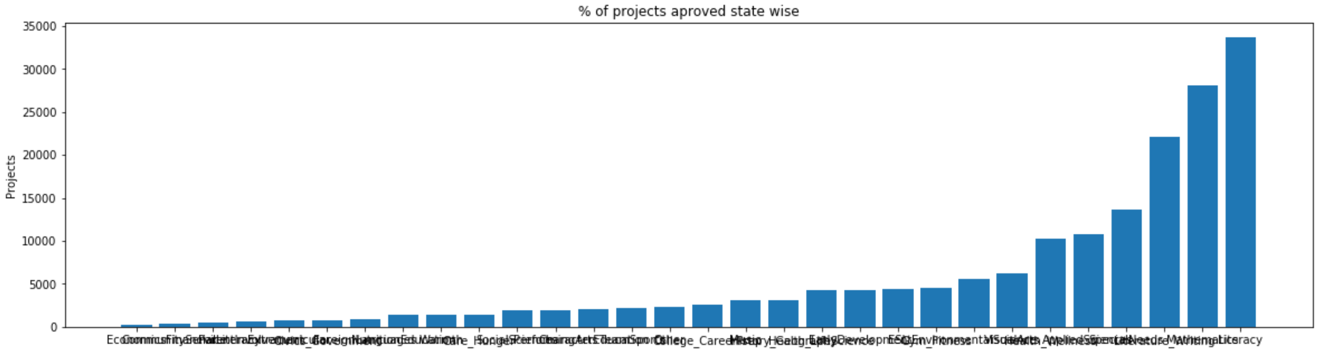
```
                 clean_subcategories  project_is_approved  total       Avg
317                         Literacy                 8371   9486  0.882458
319             Literacy Mathematics                 7260   8325  0.872072
331  Literature_Writing Mathematics                  5140   5923  0.867803
318     Literacy Literature_Writing                  4823   5571  0.865733
342                      Mathematics                 4385   5379  0.815207
==================================================
                   clean_subcategories  project_is_approved  total       Avg
196        EnvironmentalScience Literacy                  389    444  0.876126
127                                  ESL                  349    421  0.828979
79                    College_CareerPrep                  343    421  0.814727
17   AppliedSciences Literature_Writing                  361    420  0.859524
3    AppliedSciences College_CareerPrep                  330    405  0.814815
```

In [22]:

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

In [23]:

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


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

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



In [24]:

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

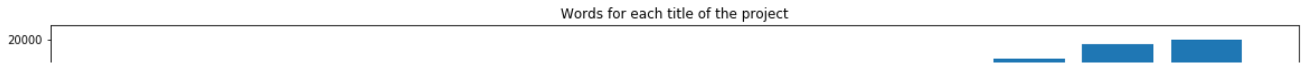
```
Economics            :       269
CommunityService     :       441
FinancialLiteracy    :       568
ParentInvolvement    :       677
Extracurricular      :       810
Civics_Government    :       815
ForeignLanguages     :       890
NutritionEducation   :      1355
Warmth               :      1388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

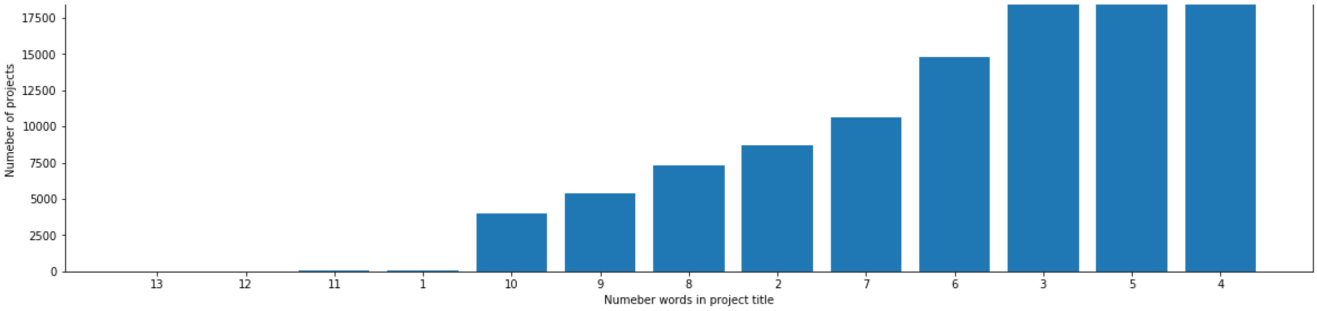
> Summary : As we already seen Literacy_language and Math_Science categories have the most trending field where people are most considerate on this field to make project
>
> > Literacy is the sub-category of Literacty_language and Mathematics is the sub-category of Math_Science which have most trending as we observed from previous point (which has to be expected)

1.2.6 Univariate Analysis: Text features (Title)

In [25]:

```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/37483537/408403
9
word_count = project_data['project_title'].str.split().apply(len).value_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))


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

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



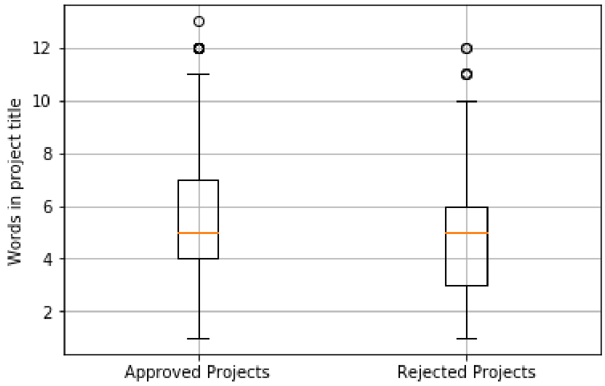


In [26]:

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

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

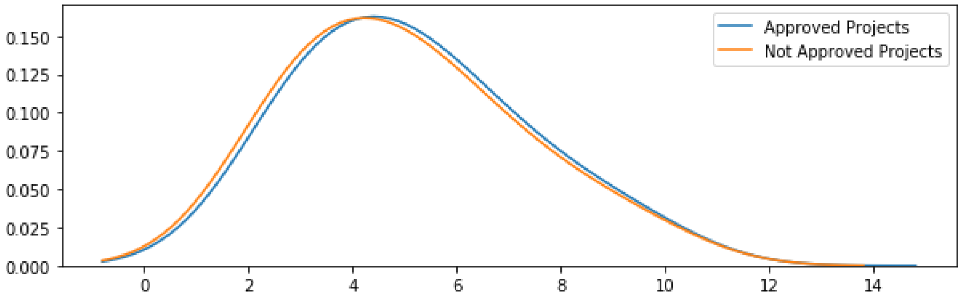
In [27]:

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



In [28]:

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



Summary : We observed that for the project title which 4 tends to have more density however, we cannot find the differentation of project's approval (Approved and not approved projects). So, we can't get any information from this.

differentiation of project's approval (Approved and not approved projects). So, we can't get any information from this.

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

In [29]:

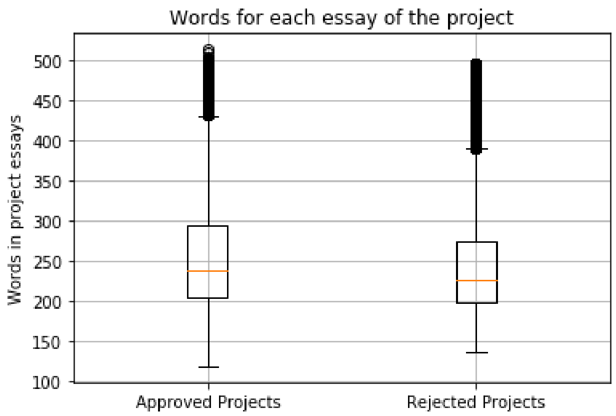
```
# merge two column text dataframe:
project_data["essay"] = project_data["project_essay_1"].map(str) +\
                        project_data["project_essay_2"].map(str) + \
                        project_data["project_essay_3"].map(str) + \
                        project_data["project_essay_4"].map(str)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

In [30]:

```
approved_word_count = project_data[project_data['project_is_approved']==1]['essay'].str.split().apply(l
en)
approved_word_count = approved_word_count.values

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

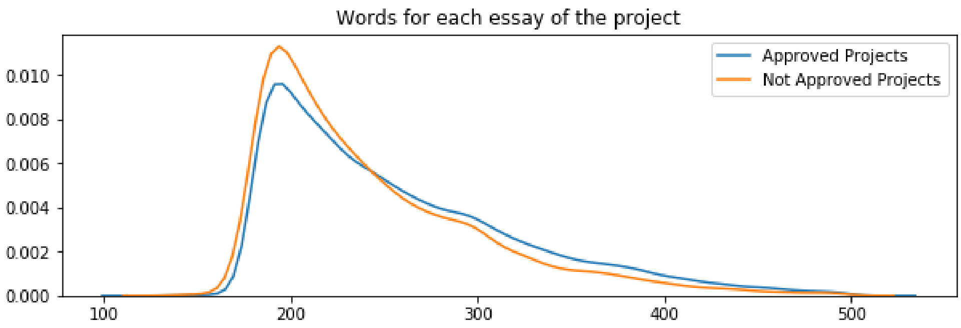
In [31]:

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



In [32]:

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



Summary : We observed that most of the essay which have 200 words have more density than the others for both approved and not approved project and approved project have more at the peak and not approved project have more for 200 words later. We cannot find any information helpful for further processing

1.2.8 Univariate Analysis: Cost per project

In [33]:

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

Out[33]:

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

In [34]:

```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-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[34]:

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

In [35]:

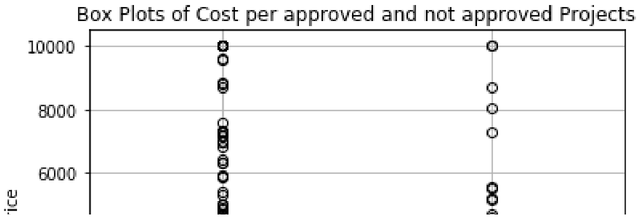
```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

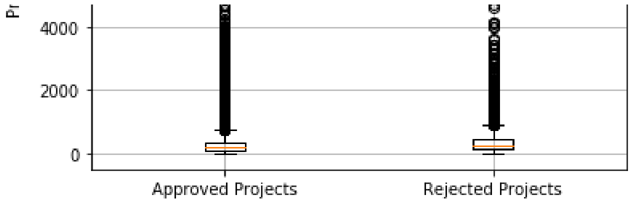
In [36]:

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

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

In [37]:

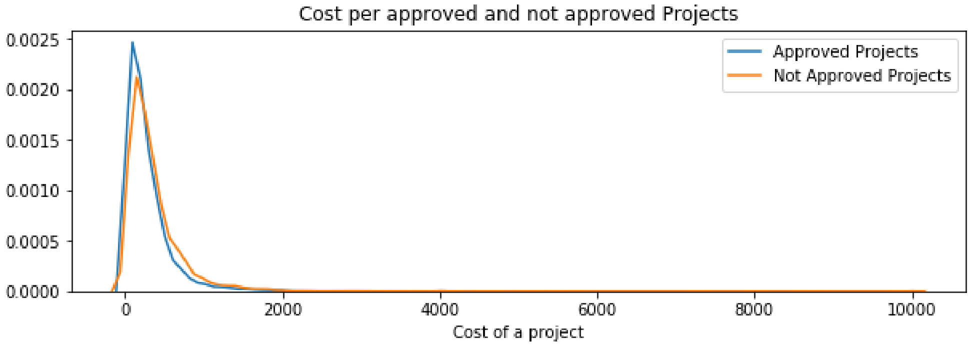
```
# https://glowingpython.blogspot.com/2012/09/boxplot-with-matplotlib.html
plt.boxplot([approved_price, rejected_price])
plt.title('Box Plots of Cost per approved and not approved Projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Price')
plt.grid()
plt.show()
```





In [38]:

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



In [39]:

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

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

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

for i in range(0,101,5):
    x.add_row([i,np.round(np.percentile(approved_price,i), 3), np.round(np.percentile(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        |
+------------+-------------------+-----------------------+
```

Observation

- From the plot graph, we can say for sure that most people are spending on projects about less than 1000 cost price.
- From the percentile table, if we observed on 95th percentile, the cost project (for which the project is rejected) has gotten more costlier than the approved project's ones (which is 124% times of approved ones). Not only that 95% percentile, other less than 95% percentile, rejected project's ones had gotten more expense than the approved ones.

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

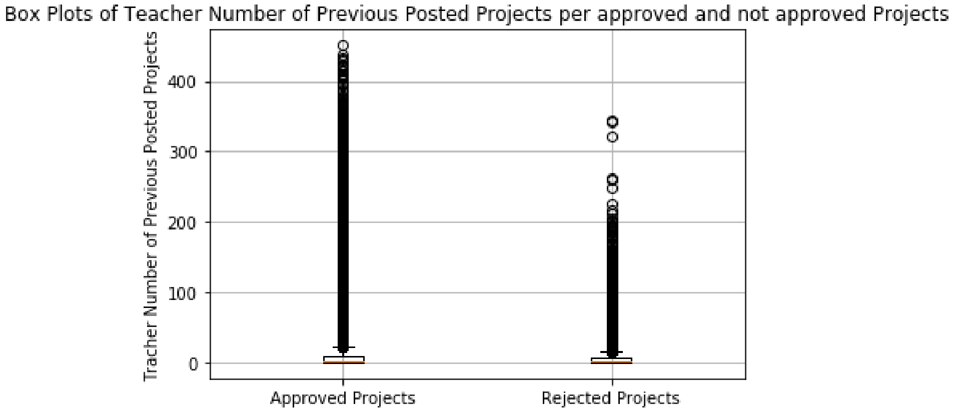
Please do this on your own based on the data analysis that was done in the above cells

In [40]:

```
prev_proj_approved = project_data[project_data['project_is_approved']==1]['teacher_number_of_previously_posted_projects'].values
prev_proj_reject = project_data[project_data['project_is_approved']==0]['teacher_number_of_previously_posted_projects'].values
```

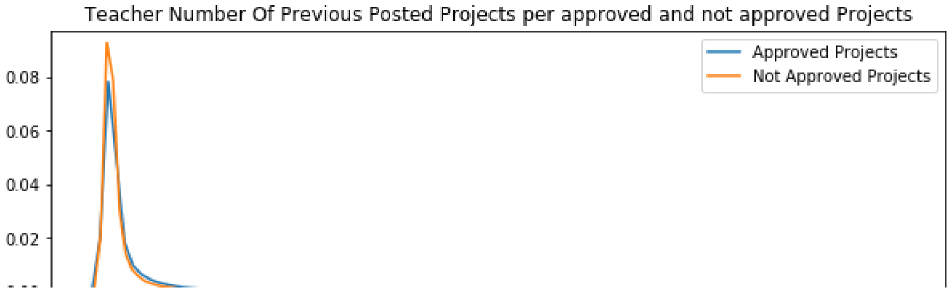
In [41]:

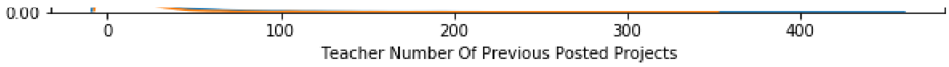
```
plt.boxplot([prev_proj_approved, prev_proj_reject])
plt.title('Box Plots of Teacher Number of Previous Posted Projects per approved and not approved Projects')
plt.xticks([1,2],('Approved Projects','Rejected Projects'))
plt.ylabel('Tracher Number of Previous Posted Projects')
plt.grid()
plt.show()
```



In [42]:

```
plt.figure(figsize=(10,3))
sns.distplot(prev_proj_approved, hist=False, label="Approved Projects")
sns.distplot(prev_proj_reject, hist=False, label="Not Approved Projects")
plt.title('Teacher Number Of Previous Posted Projects per approved and not approved Projects')
plt.xlabel('Teacher Number Of Previous Posted Projects')
plt.legend()
plt.show()
```





In [43]:

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

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

```
+------------+-------------------+-----------------------+
| Percentile | Approved Projects | Not Approved Projects |
+------------+-------------------+-----------------------+
|     0      |        0.0        |          0.0          |
|     5      |        0.0        |          0.0          |
|     10     |        0.0        |          0.0          |
|     15     |        0.0        |          0.0          |
|     20     |        0.0        |          0.0          |
|     25     |        0.0        |          0.0          |
|     30     |        1.0        |          0.0          |
|     35     |        1.0        |          1.0          |
|     40     |        1.0        |          1.0          |
|     45     |        2.0        |          1.0          |
|     50     |        2.0        |          2.0          |
|     55     |        3.0        |          2.0          |
|     60     |        4.0        |          3.0          |
|     65     |        5.0        |          3.0          |
|     70     |        7.0        |          4.0          |
|     75     |        9.0        |          6.0          |
|     80     |        13.0       |          8.0          |
|     85     |        19.0       |          11.0         |
|     90     |        30.0       |          17.0         |
|     95     |        57.0       |          31.0         |
|    100     |       451.0       |         345.0         |
+------------+-------------------+-----------------------+
```

Observation

- From the plot graph, we observed that most of the teachers had posted maximum of 10 previously projects which should more dense in that area.
- From the percentile observation, if we observe 90th and 95th percentile, it showing more gaps about 20-30 projects but from that 95th to 100th percentile, there is huge variation gap between them (300-400)

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 [44]:

```
summary_text = project_data[project_data['project_is_approved']==1]['project_resource_summary'].values
print('Total number of data row',summary_text.shape[0])

present_numeric = []
for i in summary_text:
    txt = i.split()
    for j in txt:
        if j.isnumeric():
            present_numeric.append(i)
            break
        else:
            continue
            continue
print('Number of data row that contain numeric value',len(present_numeric))
print('%age of data row that contain numeric value in all project approved {0}%'.format(summary_text.sh
ape[0]/len(present_numeric)))
```

```
Total number of data row 92706
Number of data row that contain numeric value 10144
%age of data row that contain numeric value in all project approved 9.138998422712934%
```

In [45]:

```
summary_text = project_data[project_data['project_is_approved']==0]['project_resource_summary'].values
print('Total number of data row',summary_text.shape[0])

present_numeric = []
for i in summary_text:
    txt = i.split()
    for j in txt:
        if j.isnumeric():
            present_numeric.append(i)
            break
        else:
            continue
print('Number of data row that contain numeric value',len(present_numeric))
print('%age of data row that contain numeric value in all project not approved {0}%'.format(summary_tex
t.shape[0]/len(present_numeric)))
```

```
Total number of data row 16542
Number of data row that contain numeric value 1093
%age of data row that contain numeric value in all project not approved 15.134492223238793%
```

Observation

1. A list of text, which is approved project only, has got 9% that contain numeric value.
2. A list of text, which is not approved project only, has got 15% that contain numeric value

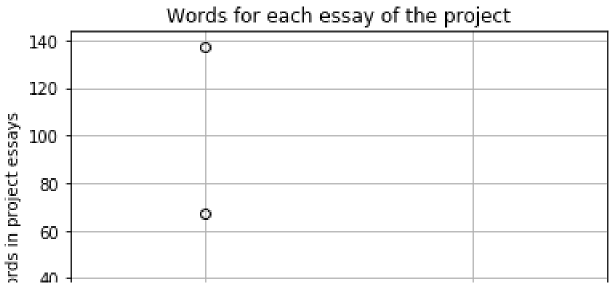
From the above points, we can say that there is no relation between numeric text to project approval which we can further process

In [46]:

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

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

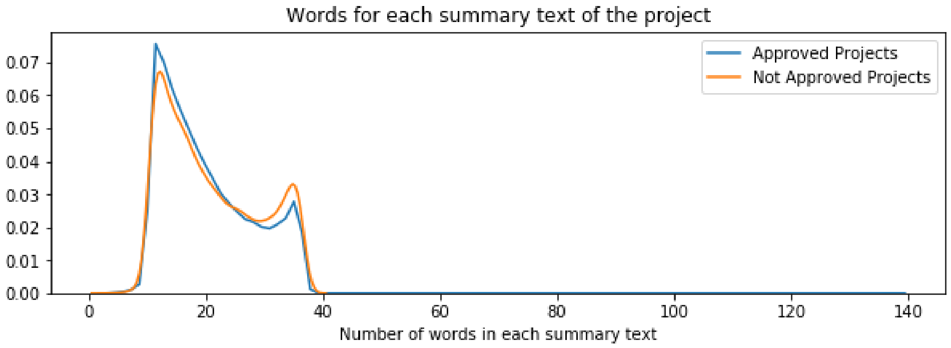
In [47]:

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



In [48]:

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



Summary : We cant find any useful informatio in from this plot

1.3 Text preprocessing

1.3.1 Essay Text

In [49]:

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

Out[49]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_grade_c
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grades
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra

In [50]:

```
# 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 second or third languages. We are
a melting pot of refugees, immigrants, and native-born Americans bringing the gift of language to our s
chool. \r\n\r\n We have over 24 languages represented in our English Learner program with students at e
very level of mastery.  We also have over 40 countries represented with the families within our school.
Each student brings a wealth of knowledge and experiences to us that open our eyes to new cultures, bel
iefs, and respect.\"The limits of your language are the limits of your world.\"-Ludwig Wittgenstein  Ou
r English learner's have a strong support system at home that begs for more resources.  Many times our
parents are learning to read and speak English along side of their children.  Sometimes this creates ba
rriers for parents to be able to help their child learn phonetics, letter recognition, and other readin
g skills.\r\n\r\nBy providing these dvd's and players, students are able to continue their mastery of t
he English language even if no one at home is able to assist.  All families with students within the Le
vel 1 proficiency status, will be a offered to be a part of this program.  These educational videos wil
l be specially chosen by the English Learner Teacher and will be sent home regularly to watch.  The vid
eos 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 dvd player to use for the year.  The plan is to use the
se videos and educational 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 year all love learning, at least
most of the time. At our school, 97.3% of the students receive free or reduced price lunch. Of the 560
students, 97.3% are minority students. \r\nThe school has a vibrant community that loves to get togethe
r and celebrate. Around Halloween there is a whole school parade to show off the beautiful costumes tha
t students wear. On Cinco de Mayo we put on a big festival with crafts made by the students, dances, an
d games. At the end of the year the school hosts a carnival to celebrate the hard work put in during th
e school year, with a dunk tank being the most popular activity.My students will use these five brightl
y colored Hokki stools in place of regular, stationary, 4-legged chairs. As I will only have a total of
ten in the classroom and not enough for each student to have an 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 readin
g times. 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 school.\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. Wh
en the students are sitting in group with me on the Hokki Stools, they are always moving, but at the sa
me time doing their work. Anytime the students get to pick where they can sit, the Hokki Stools are the
first to be taken. There are always students who head over to the kidney table to get one of the stools
who are disappointed as there are not enough of them. \r\n\r\nWe ask a lot of students to sit for 7 hou
rs a day. The Hokki stools will be a compromise that allow my students 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 t
ake away the barrier that exists in schools for a child who can't sit still.nannan
==================================================
How do you remember your days of school? Was it in a sterile environment with plain walls, rows of desk
s, and a teacher in front of the room? A typical day in our room is nothing like that. I work hard to c
reate a warm inviting themed room for my students look forward to coming to each day.\r\n\r\nMy class i
s made up of 28 wonderfully unique boys and girls of mixed races in Arkansas.\r\nThey attend a Title I
school, which means there is a high enough percentage of free and reduced-price lunch to qualify. Our s
chool is an \"open classroom\" concept, which is very unique as there are no walls separating the class
rooms. These 9 and 10 year-old students are very eager learners; they are like sponges, absorbing all t
he information and experiences and keep on wanting more.With these resources such as the comfy red thro
w pillows and the whimsical nautical hanging decor and the blue fish nets, I will be able to help creat
e the mood in our classroom setting to be one of a themed nautical environment. Creating a classroom en
vironment is very important in the success in each and every child's education. The nautical photo prop
s will be used with each child as they step foot into our classroom for the first time on Meet the Teac
her evening. I'll take pictures of each child with them, have them developed, and then hung in our clas
sroom ready for their first day of 4th grade.  This kind gesture will set the tone before even the firs
t day of school! The nautical thank you cards will be used throughout the year by the students as they
create thank you cards to their team groups.\r\n\r\nYour generous donations will help me to help make o
ur classroom a fun, inviting, learning environment from day one.\r\n\r\nIt costs lost of money out of m
y own pocket on resources to get our classroom ready. Please consider helping with this project to make
our new school year a very successful one. Thank you!nannan
==================================================
My kindergarten students have varied disabilities ranging from speech and language delays, cognitive de
lays, gross/fine motor delays, to autism. They are eager beavers and always strive to work their hardes
t working 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 disabilities and limitations, 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 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 develop their core, which enhances gross
motor and in Turn fine motor skills. \r\nThey also want to learn through games, my kids don't want to s
it and do worksheets. They want to learn to count by jumping and playing. Physical engagement is the ke
```

```
y to our success. The number toss and color and shape mats can make that happen. My students will forge
t 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 teacher demonstrates. The great tea
cher inspires. -William A. Ward\r\n\r\nMy school has 803 students which is makeup is 97.6% African-Amer
ican, making up the largest segment of the student body. A typical school in Dallas is made up of 23.2%
African-American students. Most of the students are on free or reduced lunch. We aren't receiving docto
rs, lawyers, or engineers children from rich backgrounds or neighborhoods. As an educator I am inspirin
g minds of young children and we focus not only on academics but one smart, effective, efficient, and d
isciplined students with good character.In our classroom we can utilize the Bluetooth for swift transit
ions during class. I use a speaker which doesn't amplify the sound enough to receive the message. Due t
o the volume of my speaker my students can't hear videos or books clearly and it isn't making the lesso
ns 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 n
eeded for the day and has an extra part to it I can use.  The table top chart has all of the letter, wo
rds and pictures for students to learn about different letters and it is more accessible.nannan
==================================================
```

In [51]:

```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 [52]:

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

```
My kindergarten students have varied disabilities ranging from speech and language delays, cognitive de
lays, gross/fine motor delays, to autism. They are eager beavers and always strive to work their hardes
t working 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 disabilities and limitations, 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 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 develop their core, which enhances gross
motor and in Turn fine motor skills. \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 playing. Physical engagement is the k
ey to our success. The number toss and color and shape mats can make that happen. My students will forg
et they are doing work and just have the fun a 6 year old deserves.nannan
==================================================
```

In [53]:

```python
# \r \n \t remove from string python: http://texthandler.com/info/remove-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 and language delays, cognitive de
lays, gross/fine motor delays, to autism. They are eager beavers and always strive to work their hardes
t working past 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 receive free or reduced price lunch.  Despite thei
```

```
r disabilities and limitations, my students love coming to school and come eager to learn and explore.H
ave you ever felt like you had ants in your pants and you needed to groove and move as you were in a me
eting? 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 develop their core, which enhances gross moto
r and in Turn fine motor skills.   They also want to learn through games, my kids do not want to sit an
d do worksheets. They 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 make that happen. My students will forget the
y are doing work and just have the fun a 6 year old deserves.nannan
```

In [54]:

```
#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 and language delays cognitive del
ays gross fine motor delays to autism They are eager beavers and always strive to work their hardest wo
rking past 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 receive free or reduced price lunch Despite their disabilitie
s and limitations my students love coming to school and come eager to learn and explore Have you ever f
elt 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 ar
e the answer and I love then because they develop their core which enhances gross motor and in Turn fin
e motor skills 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 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 [55]:

```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you're", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his', 'himself'
, \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they', 'them', 't
heir',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll", 'these',
'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'having', 'd
o', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'until', 'whil
e', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'during', 'bef
ore', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', 'under', 'a
gain', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'each
', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", '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', "isn'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 [56]:

```
# 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)
    sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
    # https://gist.github.com/sebleier/554280
    sent = ' '.join(e for e in sent.split() if e not in stopwords)
    preprocessed_essays.append(sent.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████| 109248/109248 [00:47<00:
00, 2302.15it/s]
```

In [57]:

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

Out[57]:

```
'my kindergarten students varied disabilities ranging speech language delays cognitive delays gross fin
e motor delays autism they eager beavers always strive work hardest working past limitations the materi
als ones i seek students i teach title i school students receive free reduced price lunch despite disab
ilities limitations students love coming school 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 chairs answer i love
develop core enhances gross motor turn fine motor skills they also want learn games kids not want sit w
orksheets they want learn count jumping playing physical engagement key success the number toss color s
hape mats make happen my students forget work fun 6 year old deserves nannan'
```

In [58]:

```
# update dataframe for clean essay and remove old essay
project_data['clean_essay'] = preprocessed_essays
project_data.drop(['essay'], axis=1, inplace=True)
project_data.head(2)
```

Out[58]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_grade_c
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grades
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra

1.3.2 Project title Text

In [59]:

```
# similarly you can preprocess the titles also
project_data.head(2)
```

Out[59]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_grade_c
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grades
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra

In [60]:

```
#
preprocessed_title = []
for sentance in tqdm(project_data['project_title'].values):
    sent = decontracted(sentance)
    # Replacing \r, \, \n into space
    sent = sent.replace('\\r', ' ')
    sent = sent.replace('\\"', ' ')
    sent = sent.replace('\\n', ' ')
    # Removing special characters other than A-Z a-z and 0-9
    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%|████████████████████████████████████████████████████████████████| 109248/109248 [00:02<00:0
0, 51397.77it/s]
```

In [61]:

```
# Updating dataframe for clean project title and remove old project title
project_data['clean_project_title'] = preprocessed_title
project_data.drop(['project_title'], axis=1, inplace=True)
project_data.head(2)
```

Out[61]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_grade_c
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grades
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra

1.3.3 Project Resource Summary

In [62]:

```
#
preprocessed_project_resource_summary = []
for sentance in tqdm(project_data['project_resource_summary'].values):
    sent = decontracted(sentance)
    # Removing special characters other than A-Z a-z and 0-9
    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_project_resource_summary.append(sent.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████████| 109248/109248 [00:04<00:0
0, 22386.39it/s]
```

In [63]:

```
# Updating dataframe for clean project resource summary and remove old project resource summary
project_data['clean_project_resource_summary'] = preprocessed_project_resource_summary
project_data.drop(['project_resource_summary'], axis=1, inplace=True)
project_data.head(2)
```

Out[63]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	project_grade_c
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grades
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra

1. 4 Preparing data for models

In [64]:

```
project_data.columns
```

Out[64]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_grade_category',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'teacher_number_of_previously_posted_projects',
       'project_is_approved', 'clean_categories', 'clean_subcategories',
       'price', 'quantity', 'clean_essay', 'clean_project_title',
       'clean_project_resource_summary'],
      dtype='object')
```

we are going to consider

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

       - project_title : text data (clean)
       - text : text data (clean essay)
       - 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 [65]:

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


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

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

In [66]:

```
# 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', 'NutritionEducation', 'Warmth', 'Care_Hunger', 'SocialSciences', 'Perf
ormingArts', 'CharacterEducation', 'TeamSports', 'Other', 'College_CareerPrep', 'Music', 'History_Geogr
aphy', 'Health_LifeScience', 'EarlyDevelopment', 'ESL', 'Gym_Fitness', 'EnvironmentalScience', 'VisualA
rts', 'Health_Wellness', 'AppliedSciences', 'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Liter
acy']
Shape of matrix after one hot encodig  (109248, 30)
```

In [67]:

```
# Please do the similar feature encoding with state, teacher_prefix and project_grade_category also
# One hot encoding for school state

# Count Vectorize with vocuabulary contains unique code of school state and we are doing boolen BoW
vectorizer = CountVectorizer(vocabulary=project_data['school_state'].unique(), lowercase=False, binary=
True)
vectorizer.fit(project_data['school_state'].values)
print(vectorizer.get_feature_names())


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

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

In [68]:

```
# One hot encoding for project_grade_category

# Count Vectorize with vocuabulary contains unique code of project_grade_category and we are doing bool
en BoW
vectorizer = CountVectorizer(vocabulary=project_data['project_grade_category'].unique(), lowercase=Fals
e, binary=True)
vectorizer.fit(project_data['project_grade_category'].values)
print(vectorizer.get_feature_names())


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

```
['Grades PreK-2', 'Grades 6-8', 'Grades 3-5', 'Grades 9-12']
Shape of matrix after one hot encodig  (109248, 4)
```

In [69]:

```
# One hot encoding for teacher_prefix

# Count Vectorize with vocuabulary contains unique code of teacher_prefix and we are doing boolen BoW
# Since some of the data is filled with nan. So we update the nan to 'None' as a string
project_data['teacher_prefix'] = project_data['teacher_prefix'].fillna('None')
vectorizer = CountVectorizer(vocabulary=project_data['teacher_prefix'].unique(), lowercase=False, binar
y=True)
vectorizer.fit(project_data['teacher_prefix'].values)
```

```
print(vectorizer.get_feature_names())


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

```
['Mrs.', 'Mr.', 'Ms.', 'Teacher', 'None', 'Dr.']
Shape of matrix after one hot encodig  (109248, 6)
```

1.4.2 Vectorizing Text data

1.4.2.1 Bag of words

In [70]:

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

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

1.4.2.2 Bag of Words on `project_title`

In [71]:

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

# Already Preprocessed the project_title in text preprocessing steps
```

In [72]:

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

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

1.4.2.3 Bag of Words on `project_resource_summary`

In [73]:

```
# Similarly you can vectorize for project resource summary also
vectorizer = CountVectorizer(min_df=10)
pr_summary_bow = vectorizer.fit_transform(preprocessed_project_resource_summary)
print("Shape of matrix after one hot encodig ",pr_summary_bow.shape)
```

```
Shape of matrix after one hot encodig  (109248, 5804)
```

1.4.2.3 TFIDF vectorizer

In [74]:

```
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 [75]:

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

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

1.4.2.5 TFIDF Vectorizer on `project_resource_summary`

In [76]:

```
# Similarly you can vectorize for project resource summary also
vectorizer = TfidfVectorizer(min_df=10)
pr_summary_tfidf = vectorizer.fit_transform(preprocessed_project_resource_summary)
print("Shape of matrix after one hot encodig ",pr_summary_tfidf.shape)
```

```
Shape of matrix after one hot encodig  (109248, 5804)
```

1.4.2.5 Using Pretrained Models: Avg W2V

In [77]:

```
'''
# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039
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 our coupus", \
      len(inter_words),"(",np.round(len(inter_words)/len(words)*100,3),"%)")

words_courpus = {}
words_glove = set(model.keys())
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-an
d-load-variables-in-python/

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


'''
```

Out[77]:

```
'\n# Reading glove vectors in python: https://stackoverflow.com/a/38230349/4084039\ndef loadGloveModel(
gloveFile):\n    print ("Loading Glove Model")\n    f = open(gloveFile,\'r\', encoding="utf8")\n    mod
el = {}\n    for line in tqdm(f):\n        splitLine = line.split()\n        word = splitLine[0]\n
embedding = np.array([float(val) for val in splitLine[1:]])\n        model[word] = embedding\n    print
("Done.",len(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 preproced_titles:\n    words.extend(i.split(\' \'))\npr
int("all the words in the coupus", len(words))\nwords = set(words)\nprint("the unique words in the coup
us", len(words))\n\ninter_words = set(model.keys()).intersection(words)\nprint("The number of words tha
t are present in both glove vectors and our coupus",       len(inter_words),"(",np.round(len(inter_word
s)/len(words)*100,3),"%)")\n\nwords_courpus = {}\nwords_glove = set(model.keys())\nfor i in words:\n
if i in words_glove:\n        words_courpus[i] = model[i]\nprint("word 2 vec length", len(words_courpus
))\n\n\n# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-pickle-to
-save-and-load-variables-in-python/\n\nimport pickle\nwith open(\'glove_vectors\', \'wb\') as f:\n    p
ickle.dump(words_courpus, f)\n\n\n'
```

In [78]:

```
# stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-pickle-to-save-an
d-load-variables-in-python/
# make sure you have the glove_vectors file
with open('glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

In [79]:

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

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

```
100%|████████████████████████████████████████████████████████| 109248/109248 [00:24<00:
00, 4432.31it/s]
```

```
109248
300
```

1.4.2.6 Using Pretrained Models: AVG W2V on `project_title`

In [80]:

```
# Similarly you can vectorize for title also
avg_w2v_title = []; # the avg-w2v for each project title is stored in this list
for sentence in tqdm(preprocessed_title): # for each project title
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the project title
    for word in sentence.split(): # for each word in a project title
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_title.append(vector)

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

```
100%|████████████████████████████████████████████████| 109248/109248 [00:01<00:0
0, 87210.92it/s]
```

```
109248
300
```

1.4.2.7 Using Pretrained Models: AVG W2V on `project_resource_summary`

In [81]:

```
# Similarly you can vectorize for project resource summary also
avg_w2v_summary = []; # the avg-w2v for each project resource summary is stored in this list
for sentence in tqdm(preprocessed_project_resource_summary): # for each project resource summary
    vector = np.zeros(300) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the project resource summary
    for word in sentence.split(): # for each word in a project resource summary
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    avg_w2v_summary.append(vector)

print(len(avg_w2v_summary))
print(len(avg_w2v_summary[0]))
```

```
100%|████████████████████████████████████████████████| 109248/109248 [00:02<00:0
0, 40019.68it/s]
```

```
109248
300
```

1.4.2.7 Using Pretrained Models: TFIDF weighted W2V

In [82]:

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

In [83]:

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

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

```
100%|████████████████████████████████████████████████████████████████████████| 109248/109248 [03:10<00
:00, 572.77it/s]
```

```
109248
300
```

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

In [84]:

```
tfidf_model = TfidfVectorizer()
tfidf_model.fit(preprocessed_title)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [85]:

```
# Similarly you can vectorize for title also
# compute average word2vec for each project title.
tfidf_w2v_title = []; # the avg-w2v for each project title is stored in this list
for sentence in tqdm(preprocessed_title): # for each project title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the project title
    for word in sentence.split(): # for each word in a project title
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentence.count(word
)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tfidf
value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_title.append(vector)

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

```
100%|██████████████████████████████████████████████████████████████████████| 109248/109248 [00:02<00:0
0, 40361.41it/s]
```

```
109248
300
```

1.4.2.10 Using Pretrained Models: TFIDF weighted W2V on `project_resource_summary`

In [86]:

```
tfidf_model = TfidfVectorizer()
tfidf_model.fit(preprocessed_project_resource_summary)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

In [87]:

```
# Similarly you can vectorize for title also
# compute average word2vec for each project title.
tfidf_w2v_summary = []; # the avg-w2v for each project title is stored in this list
for sentence in tqdm(preprocessed_project_resource_summary): # for each project title
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the project title
    for word in sentence.split(): # for each word in a project title
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentence.count(word
)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tfidf
value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_summary.append(vector)

print(len(tfidf_w2v_summary))
print(len(tfidf_w2v_summary[0]))
```

```
100%|████████████████████████████████████████████████████████████| 109248/109248 [00:07<00:0
0, 13881.52it/s]
```

```
109248
300
```

1.4.3 Vectorizing Numerical features

For price

In [88]:

```
# the cost feature is already in numerical values,  we are going to represent the money, as numerical v
alues within the range 0-1
# normalization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.Standa
rdScaler.html
from sklearn.preprocessing import StandardScaler

# price_normalized = 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 mean and variance.
price_normalized = price_scalar.transform(project_data['price'].values.reshape(-1, 1))
```

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

In [89]:

```
price_normalized
```

Out[89]:

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

For teacher_number_of_previously_projects

In [90]:

```
# We are going to represent the teacher_number_of_previously_posted_projects, as numerical values within the range 0-1
# normalization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

# teacher_number_of_previously_posted_projects_normalized = standardScalar.fit(project_data['teacher_number_of_previously_posted_projects'].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)

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

# Now standardize the data with above mean and variance.
teacher_number_of_previously_posted_projects_normalized = teacher_number_of_previously_posted_projects_scalar.transform(project_data['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
```

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

In [91]:

```
teacher_number_of_previously_posted_projects_normalized
```

Out[91]:

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

For quantity

In [92]:

```
# We are going to represent the quantity, as numerical values within the range 0-1
# normalization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

# quantity_normalized = standardScalar.fit(project_data['quantity'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.   ... 399.   287.73
# 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)

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

# Now standardize the data with above mean and variance.
quantity_normalized = quantity_scalar.transform(project_data['quantity'].values.reshape(-1, 1))
```

```
Mean : 16.965610354422964, Standard deviation : 26.182821919093175
```

In [93]:

```
quantity_normalized
```

Out[93]:

```
array([[ 0.23047132],
       [-0.60977424],
       [ 0.19227834],
       ...,
       [-0.4951953 ],
       [-0.03687954],
       [-0.45700232]])
```

1.4.4 Merging all the above features

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

```
- 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 (clean)
- text : text data (clean essay)
- project_resource_summary: text data

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

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_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 [94]:

```
from sklearn.manifold import TSNE
from scipy.sparse import hstack
```

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

In [95]:

```
# please write all of the code with proper documentation and proper titles for each subsection
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
print('.....Categorical attributes.....')
print('School State data shape',school_state_one_hot.shape)
print('Categories data shape',categories_one_hot.shape)
print('SubCategory data shape',sub_categories_one_hot.shape)
print('projecy_grade category shape',project_grade_category_one_hot.shape)
print('teacher_prefix data shape',teacher_prefix_one_hot.shape)
print('*'*60)
print('.....Text attributes.....')
# print(text_bow.shape)
print('project title Bow data shape',title_bow.shape)
print('project title TFIDF data shape',title_tfidf.shape)
print('avg weight project title data shape',np.array(avg_w2v_title).shape)
print('tfidf weight project title data shape',np.array(tfidf_w2v_title).shape)
# print(pr_summary_bow.shape)
print('*'*60)
print('.....Numerics attributes.....')
print('price data shape',price_normalized.shape)
print('teacher number of previously project posted',teacher_number_of_previously_posted_projects_normal
ized.shape)
print('quantity data shape',quantity_normalized.shape)
```

```
.....Categorical attributes.....
School State data shape (109248, 51)
Categories data shape (109248, 9)
SubCategory data shape (109248, 30)
projecy_grade category shape (109248, 4)
teacher_prefix data shape (109248, 6)
************************************************************
.....Text attributes.....
project title Bow data shape (109248, 3329)
project title TFIDF data shape (109248, 3329)
avg weight project title data shape (109248, 300)
tfidf weight project title data shape (109248, 300)
************************************************************
.....Numerics attributes.....
price data shape (109248, 1)
teacher number of previously project posted (109248, 1)
quantity data shape (109248, 1)
```

In [96]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
# with the same hstack function we are concatinating a sparse matrix and a dense matirx :)
X = hstack((categories_one_hot, sub_categories_one_hot, project_grade_category_one_hot, \
            title_bow, \
            price_normalized, teacher_number_of_previously_posted_projects_normalized, quantity_normali
            price_normalized, teacher_number_of_previously_posted_projects_normalized, quantity_normali
zed))
X.shape
```

Out[96]:

```
(109248, 3375)
```

In [97]:

```
# To convert sparse to dense array
X = X.toarray()
X.shape
```

Out[97]:

```
(109248, 3375)
```

In [98]:

```
# Taking 6k data points only
X_s = X[:6000]
X_s.shape
```

Out[98]:

```
(6000, 3375)
```

In [99]:

```
# Taking class value of 6k data points only
Y = project_data['project_is_approved'].values
Y.shape
```

Out[99]:

```
(109248,)
```

In [100]:

```
Y_s = Y[:6000]
Y_s.shape
```

Out[100]:

```
(6000,)
```

In [101]:

```
# Applying TSNE: https://scikit-learn.org/stable/modules/generated/sklearn.manifold.TSNE.html
X_embedded = TSNE(n_components=2).fit_transform(X_s)
X_embedded.shape
```

Out[101]:

```
(6000, 2)
```

In [102]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[102]:

	Dim_0	Dim_1

	Dim_0	Dim_1
0	-43.575531	-15.316840
1	27.357765	54.058769
2	30.608727	51.953495
3	-5.845784	-48.235226
4	30.141809	-31.252855

In [103]:

```
df_plot['Label'] = Y_s
df_plot.head()
```

Out[103]:

	Dim_0	Dim_1	Label
0	-43.575531	-15.316840	0
1	27.357765	54.058769	1
2	30.608727	51.953495	0
3	-5.845784	-48.235226	1
4	30.141809	-31.252855	1

In [104]:

```
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[104]:

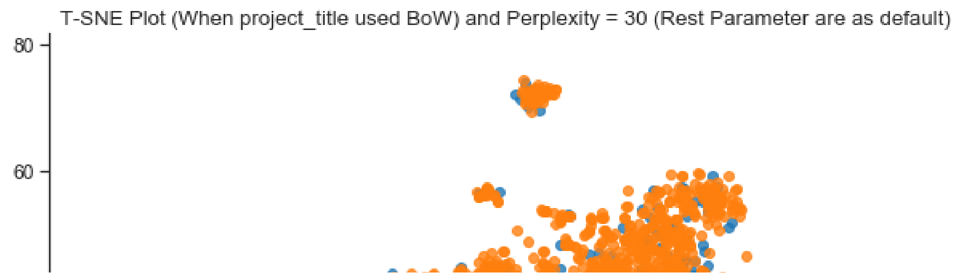
	Dim_0	Dim_1	Label
0	-43.575531	-15.316840	Not Approved
1	27.357765	54.058769	Approved
2	30.608727	51.953495	Not Approved
3	-5.845784	-48.235226	Approved
4	30.141809	-31.252855	Approved

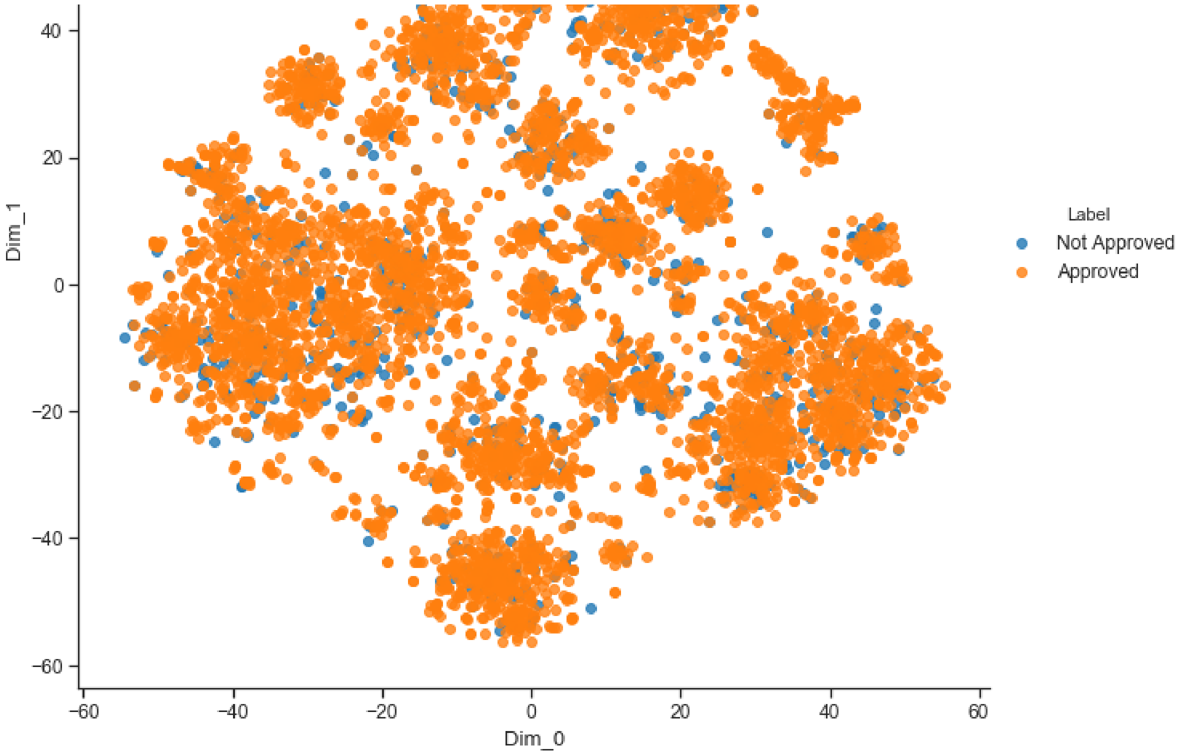
In [105]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used BoW) and Perplexity = 30 (Rest Parameter are as default)
')
```

Out[105]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used BoW) and Perplexity = 30 (Rest Parameter are as def
ault)')
```





In [106]:

```
X_embedded = TSNE(n_components=2, perplexity= 10).fit_transform(X_s)
```

In [107]:

```
X_embedded.shape
```

Out[107]:

```
(6000, 2)
```

In [108]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[108]:

	Dim_0	Dim_1
0	29.665512	-64.789413
1	-73.974831	28.903862
2	-70.387238	30.896889
3	73.401680	-0.216138
4	38.051998	32.656528

In [109]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[109]:

	Dim_0	Dim_1	Label
0	29.665512	-64.789413	Not Approved

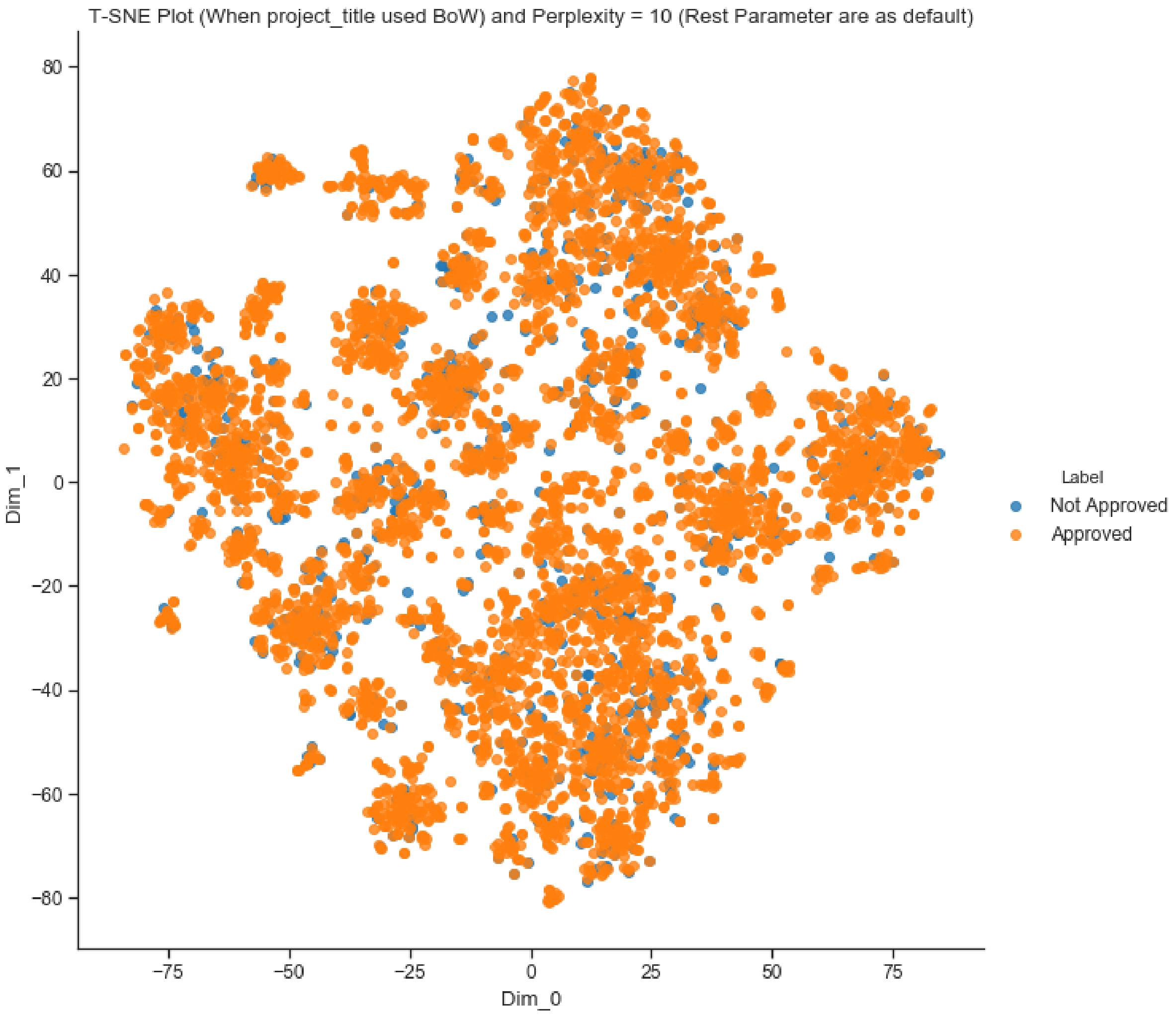
	Dim_0	Dim_1	Label
1	-73.974831	28.903862	Approved
2	-70.387238	30.896889	Not Approved
3	73.401680	-0.216138	Approved
4	38.051998	32.656528	Approved

In [110]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used BoW) and Perplexity = 10 (Rest Parameter are as default)
')
```

Out[110]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used BoW) and Perplexity = 10 (Rest Parameter are as def
ault)')
```



In [111]:

```
X_embedded = TSNE(n_components=2, perplexity= 10, learning_rate=750).fit_transform(X_s)
X_embedded.shape
```

Out[111]:

```
(6000, 2)
```

In [112]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[112]:

	Dim_0	Dim_1
0	69.886604	-16.025370
1	-49.180511	60.098587
2	-43.683739	58.258110
3	10.146492	-78.909409
4	-45.115955	-47.382080

In [113]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[113]:

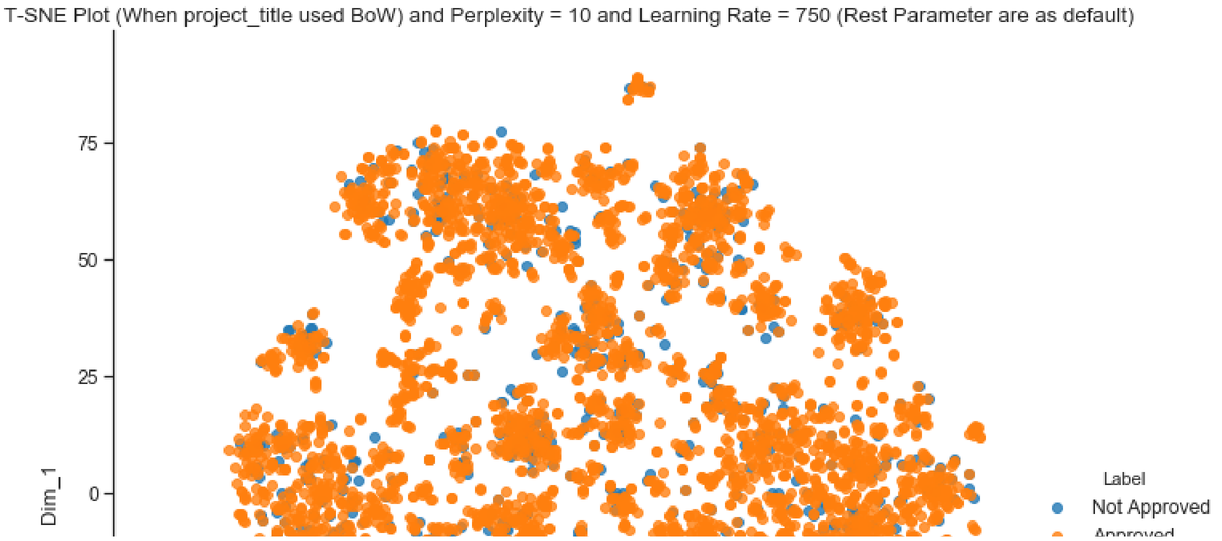
	Dim_0	Dim_1	Label
0	69.886604	-16.025370	Not Approved
1	-49.180511	60.098587	Approved
2	-43.683739	58.258110	Not Approved
3	10.146492	-78.909409	Approved
4	-45.115955	-47.382080	Approved

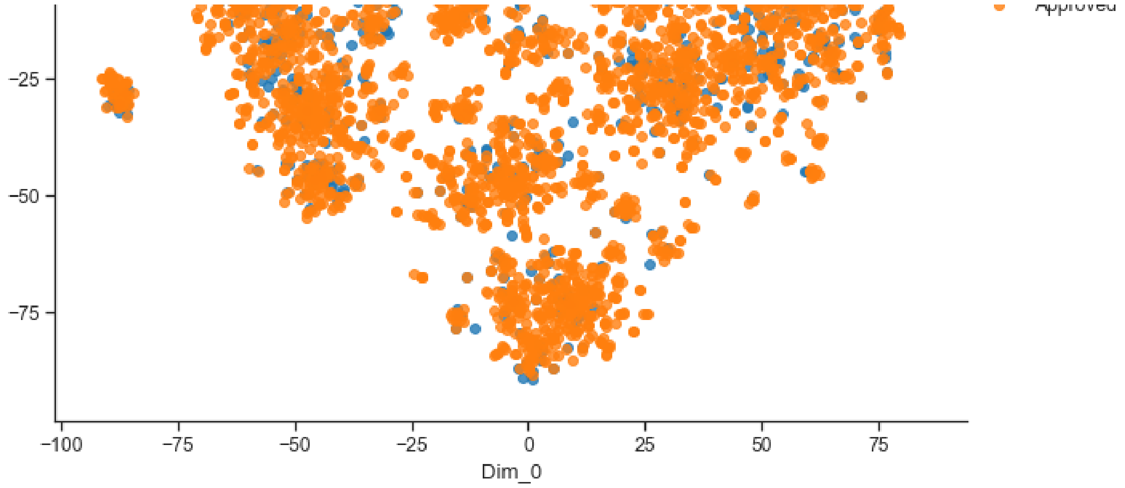
In [114]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used BoW) and Perplexity = 10 and Learning Rate = 750 (Rest P
arameter are as default)')
```

Out[114]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used BoW) and Perplexity = 10 and Learning Rate = 750 (R
est Parameter are as default)')
```





Observation:

By using project_title as a BoW, we observed from the graph that there is no separation of cluster between them by changing perplexity and learning rate in above three graphs.

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

In [115]:

```
# please write all the code with proper documentation, and proper titles for each subsection
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
# with the same hstack function we are concatinating a sparse matrix and a dense matirx :)
X = hstack((categories_one_hot, sub_categories_one_hot, project_grade_category_one_hot, \
            title_tfidf, \
            price_normalized, teacher_number_of_previously_posted_projects_normalized, quantity_normali
zed))
X.shape
```

Out[115]:

```
(109248, 3375)
```

In [116]:

```
# To convert sparse to dense array
X = X.toarray()
X.shape
```

Out[116]:

```
(109248, 3375)
```

In [117]:

```
# Taking 6k data points only
X_s = X[:6000]
X_s.shape
```

Out[117]:

```
(6000, 3375)
```

In [118]:

In [118]:

```
# Applying TSNE: https://scikit-learn.org/stable/modules/generated/sklearn.manifold.TSNE.html
X_embedded = TSNE(n_components=2).fit_transform(X_s)
X_embedded.shape
```

Out[118]:

```
(6000, 2)
```

In [119]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[119]:

	Dim_0	Dim_1
0	-16.328360	-74.173912
1	-52.106667	28.615175
2	-70.634323	8.704515
3	39.542957	-39.484619
4	56.640121	-6.871465

In [120]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[120]:

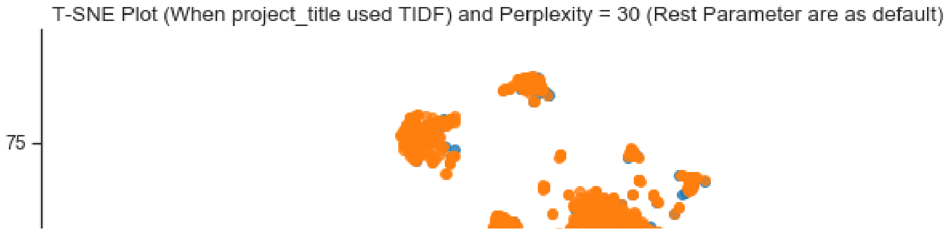
	Dim_0	Dim_1	Label
0	-16.328360	-74.173912	Not Approved
1	-52.106667	28.615175	Approved
2	-70.634323	8.704515	Not Approved
3	39.542957	-39.484619	Approved
4	56.640121	-6.871465	Approved

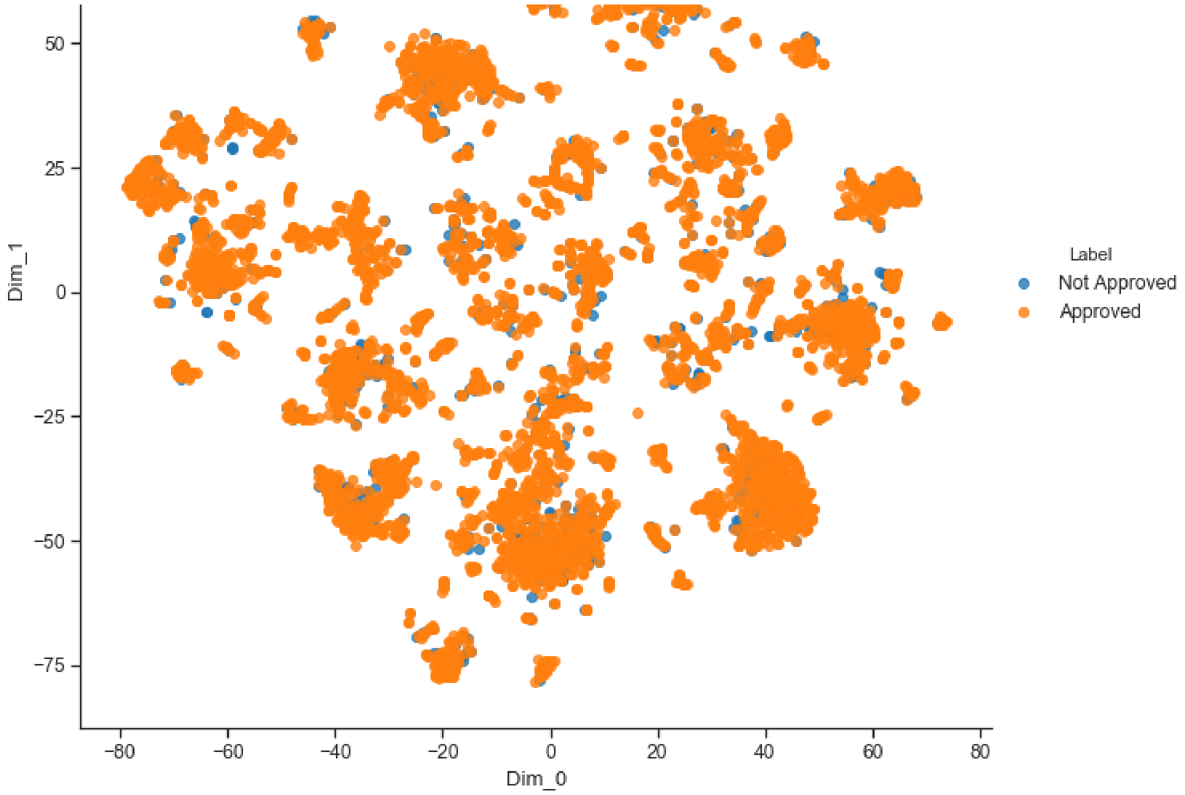
In [121]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used TIDF) and Perplexity = 30 (Rest Parameter are as default
)')
```

Out[121]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used TIDF) and Perplexity = 30 (Rest Parameter are as de
fault)')
```





In [122]:

```
X_embedded = TSNE(n_components=2, perplexity= 10).fit_transform(X_s)
X_embedded.shape
```

Out[122]:

```
(6000, 2)
```

In [123]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[123]:

	Dim_0	Dim_1
0	-32.490196	72.885406
1	-85.426224	-22.961451
2	-87.044930	-8.580714
3	60.785446	38.720440
4	48.608006	7.805057

In [124]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[124]:

	Dim_0	Dim_1	Label
0	-32.490196	72.885406	Not Approved
1	-85.426224	-22.961451	Approved
2	-87.044930	-8.580714	Not Approved

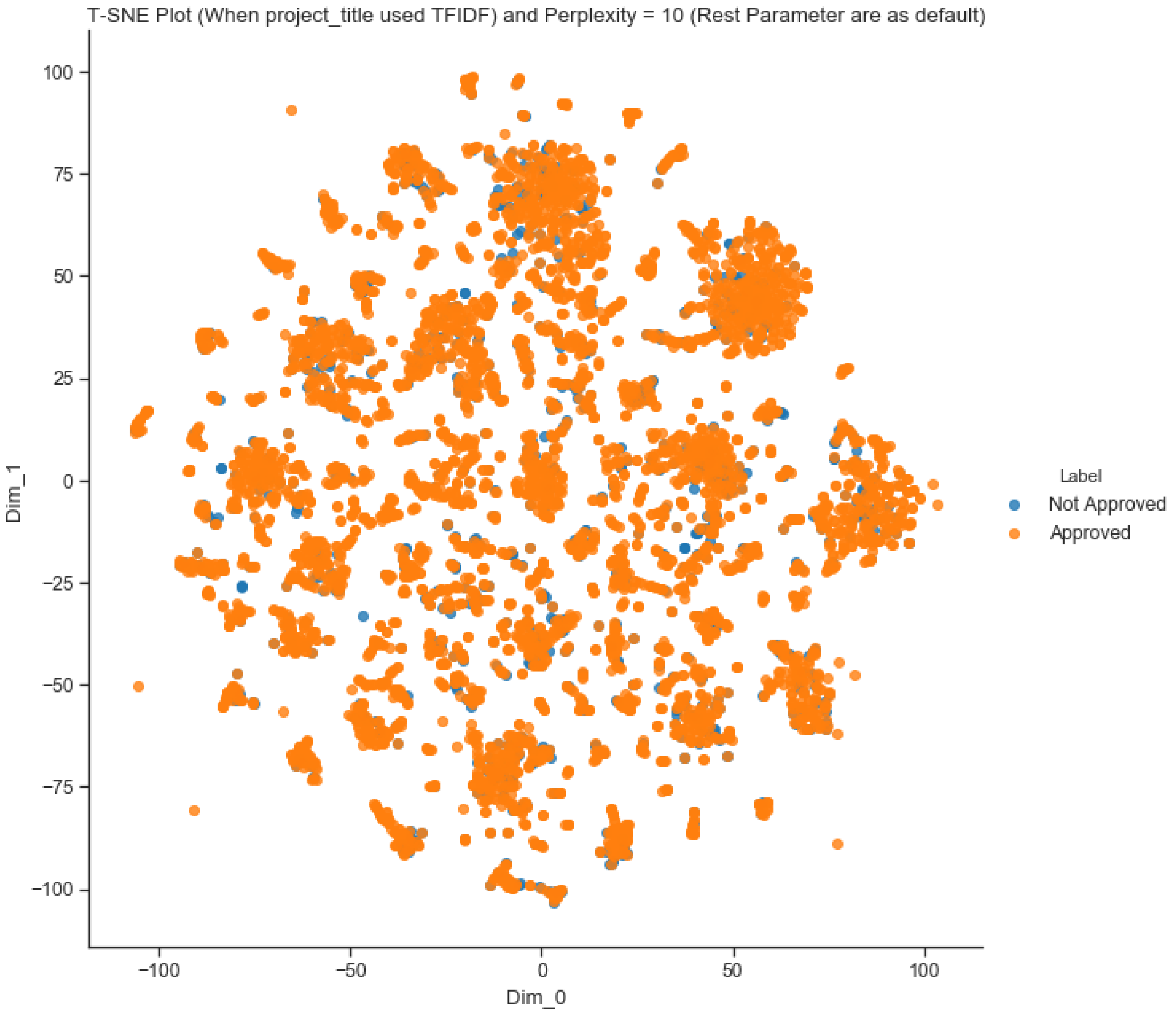
	Dim_0	Dim_1	Label
2	-87.044930	-8.580714	Not Approved
3	60.785446	38.720440	Approved
4	48.608006	7.805057	Approved

In [125]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used TFIDF) and Perplexity = 10 (Rest Parameter are as defaul
t)')
```

Out[125]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used TFIDF) and Perplexity = 10 (Rest Parameter are as d
efault)')
```



In [126]:

```
X_embedded = TSNE(n_components=2, perplexity= 10, learning_rate=750).fit_transform(X_s)
X_embedded.shape
```

Out[126]:

```
(6000, 2)
```

In [127]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
```

```
df_plot.head()
```

Out[127]:

	Dim_0	Dim_1
0	-30.092499	72.867645
1	38.655273	-56.753853
2	44.092979	-46.375217
3	56.586575	81.393333
4	-75.102043	36.755798

In [128]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[128]:

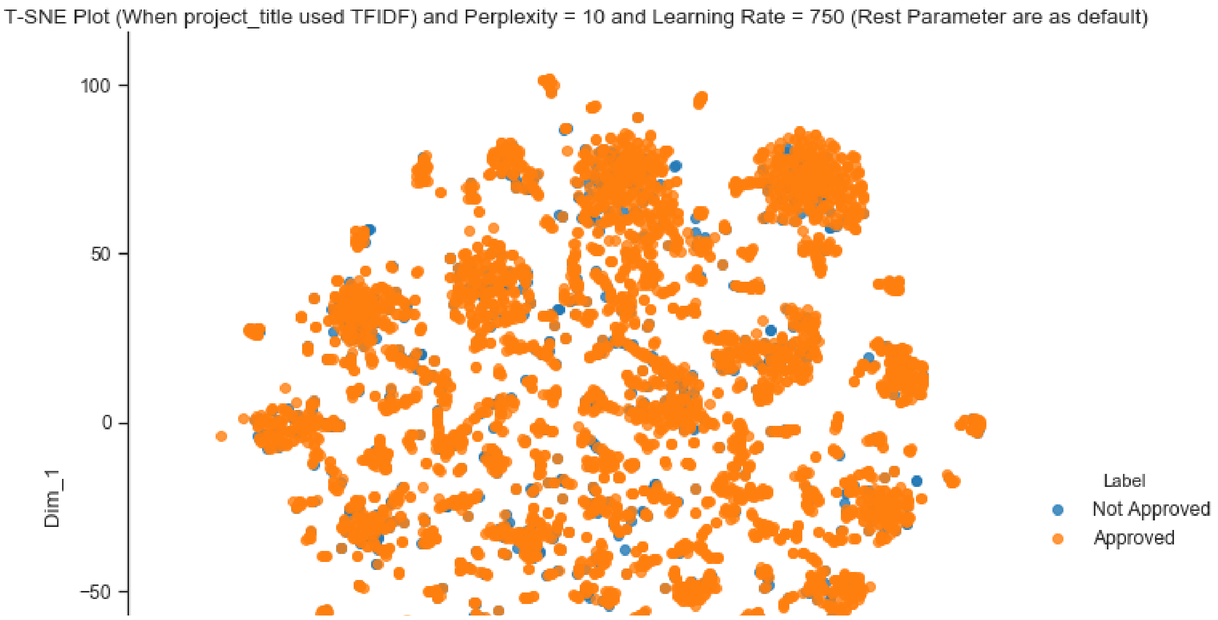
	Dim_0	Dim_1	Label
0	-30.092499	72.867645	Not Approved
1	38.655273	-56.753853	Approved
2	44.092979	-46.375217	Not Approved
3	56.586575	81.393333	Approved
4	-75.102043	36.755798	Approved

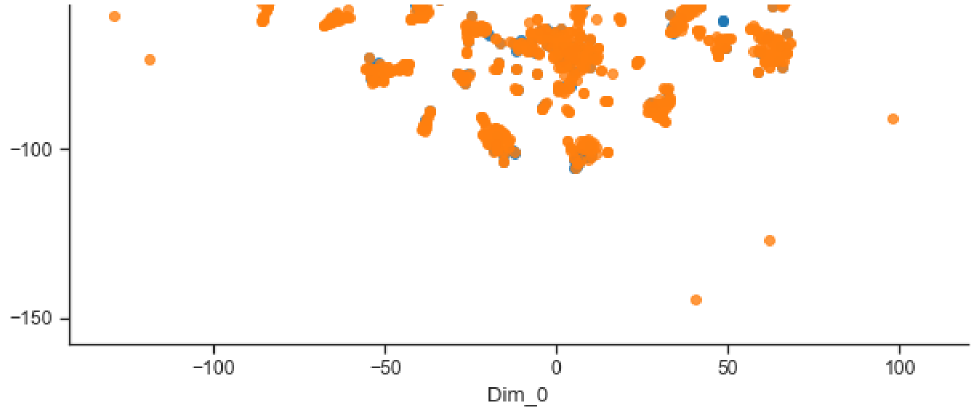
In [129]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used TFIDF) and Perplexity = 10 and Learning Rate = 750 (Rest
Parameter are as default)')
```

Out[129]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used TFIDF) and Perplexity = 10 and Learning Rate = 750
(Rest Parameter are as default)')
```





Observation

From the above graph (while changing hyperparameter like learning rate and perplexity), it is well separated cluster than the BoW features but it still overlapping of two different classes. So we cant find usefulness for further processing

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

In [130]:

```
# please write all the code with proper documentation, and proper titles for each subsection
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
X = hstack((categories_one_hot, sub_categories_one_hot, project_grade_category_one_hot, \
            avg_w2v_title, \
            price_normalized, teacher_number_of_previously_posted_projects_normalized, quantity_normali
zed))
X.shape
```

Out[130]:

```
(109248, 346)
```

In [131]:

```
# To convert sparse to dense array
X = X.toarray()
X.shape
```

Out[131]:

```
(109248, 346)
```

In [132]:

```
# Taking 6k data points only
X_s = X[:6000]
X_s.shape
```

Out[132]:

```
(6000, 346)
```

In [133]:

```
# Applying TSNE: https://scikit-learn.org/stable/modules/generated/sklearn.manifold.TSNE.html
X_embedded = TSNE(n_components=2).fit_transform(X_s)
X_embedded.shape
```

Out[133]:

```
(6000, 2)
```

In [134]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[134]:

	Dim_0	Dim_1
0	33.192589	30.390368
1	-19.908981	-52.656906
2	4.593211	-74.119164
3	-17.891525	41.729424
4	-28.962248	28.248508

In [135]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[135]:

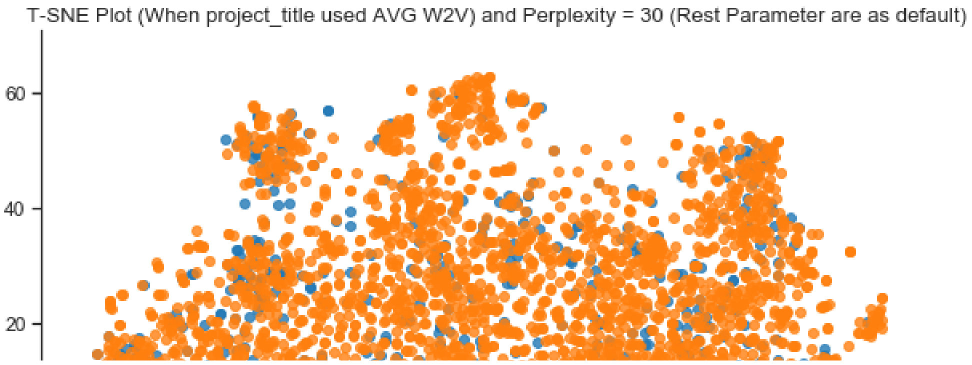
	Dim_0	Dim_1	Label
0	33.192589	30.390368	Not Approved
1	-19.908981	-52.656906	Approved
2	4.593211	-74.119164	Not Approved
3	-17.891525	41.729424	Approved
4	-28.962248	28.248508	Approved

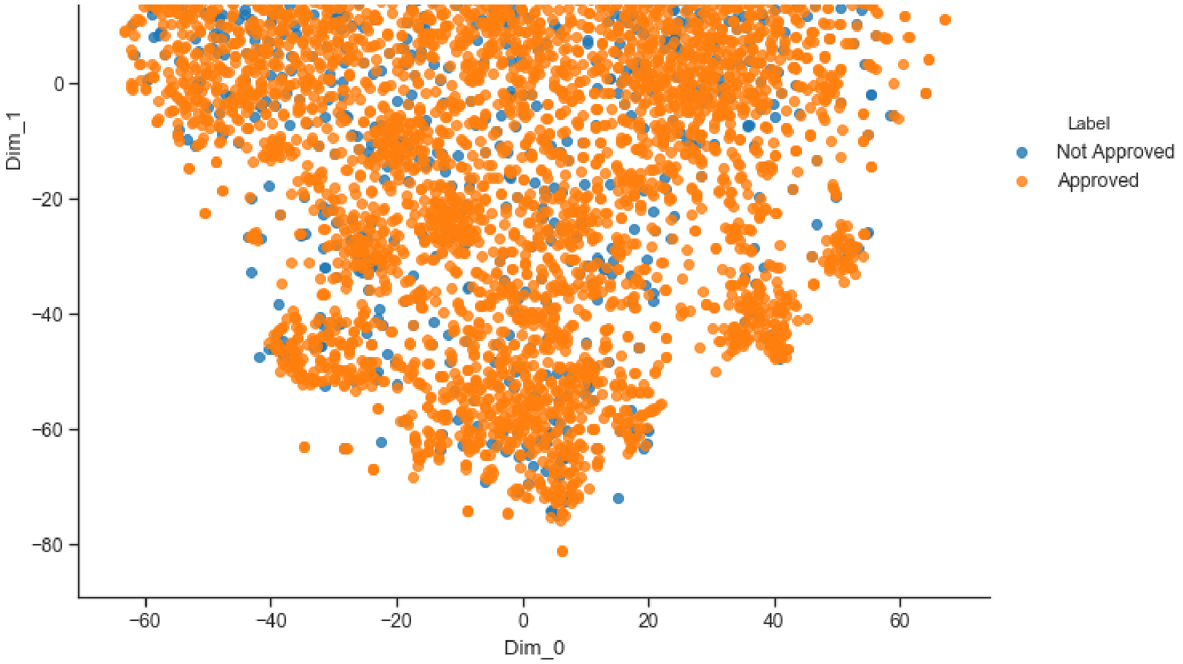
In [136]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used AVG W2V) and Perplexity = 30 (Rest Parameter are as defa
ult)')
```

Out[136]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used AVG W2V) and Perplexity = 30 (Rest Parameter are as
default)')
```





In [137]:

```
X_embedded = TSNE(n_components=2, perplexity= 10).fit_transform(X_s)
X_embedded.shape
```

Out[137]:

```
(6000, 2)
```

In [138]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[138]:

	Dim_0	Dim_1
0	49.674850	64.728668
1	-56.778660	-47.074661
2	-90.073212	5.593504
3	72.835648	-10.607857
4	60.441189	-41.263275

In [139]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[139]:

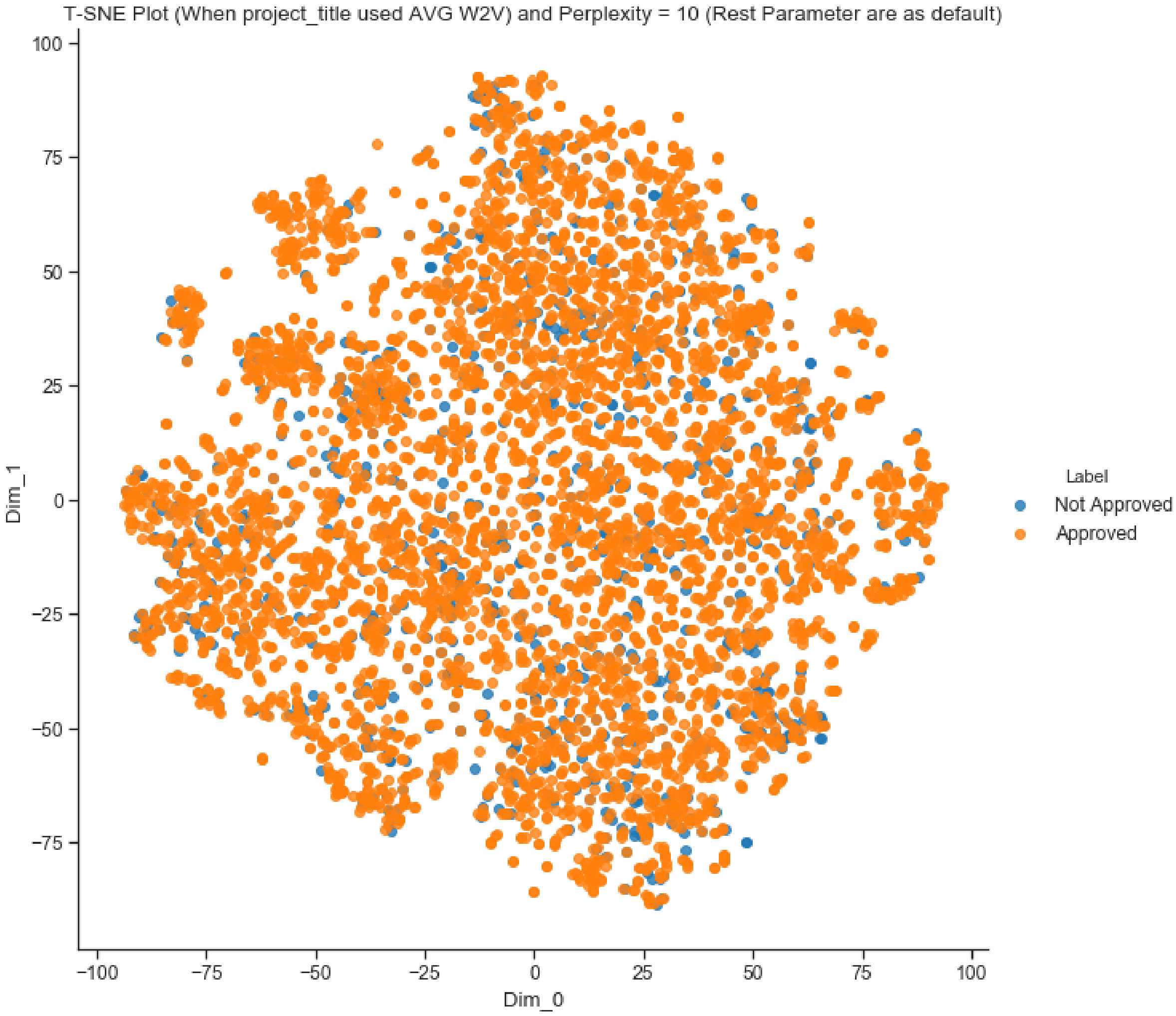
	Dim_0	Dim_1	Label
0	49.674850	64.728668	Not Approved
1	-56.778660	-47.074661	Approved
2	-90.073212	5.593504	Not Approved
3	72.835648	-10.607857	Approved
4	60.441189	-41.263275	Approved

In [140]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used AVG W2V) and Perplexity = 10 (Rest Parameter are as defa
ult)')
```

Out[140]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used AVG W2V) and Perplexity = 10 (Rest Parameter are as
default)')
```



In [141]:

```
X_embedded = TSNE(n_components=2, perplexity= 10, learning_rate=750).fit_transform(X_s)
X_embedded.shape
```

Out[141]:

```
(6000, 2)
```

In [142]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[142]:

	Dim_0	Dim_1
0	68.245911	-36.790573
1	-44.206573	60.677536
2	-14.259713	100.377907
3	11.500110	-72.251472
4	-30.099688	-67.343964

In [143]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[143]:

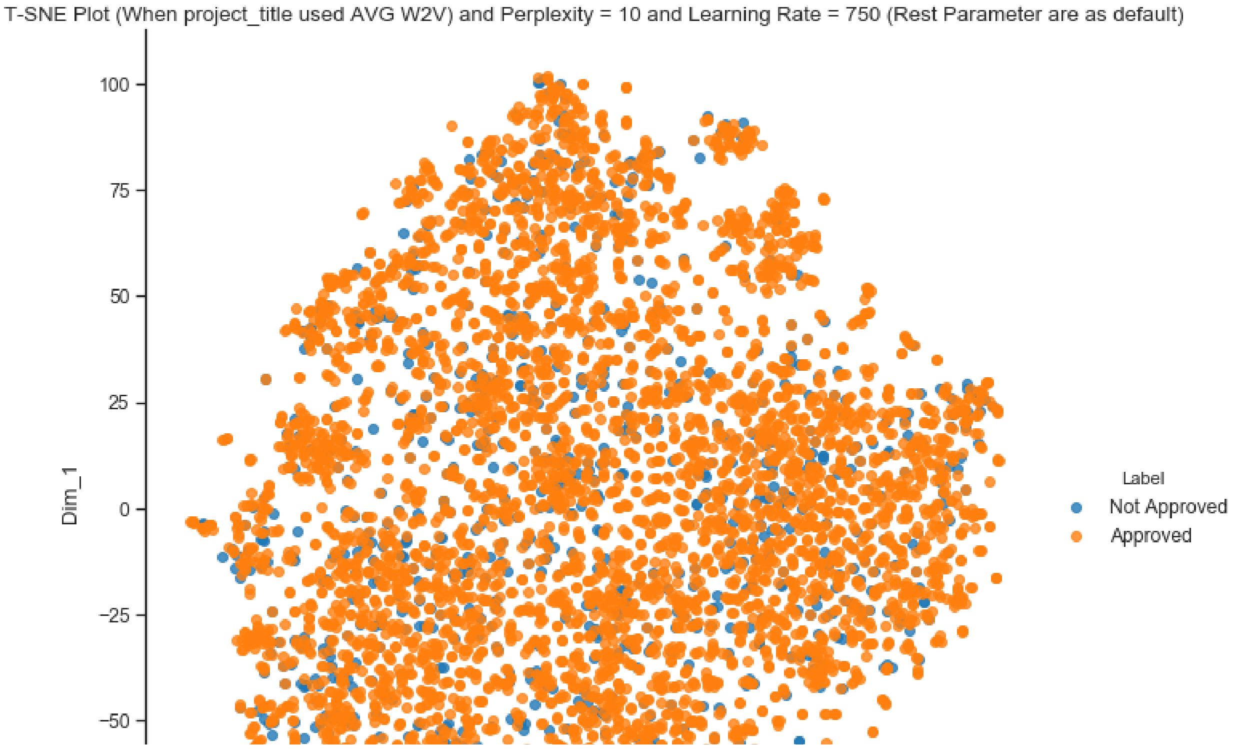
	Dim_0	Dim_1	Label
0	68.245911	-36.790573	Not Approved
1	-44.206573	60.677536	Approved
2	-14.259713	100.377907	Not Approved
3	11.500110	-72.251472	Approved
4	-30.099688	-67.343964	Approved

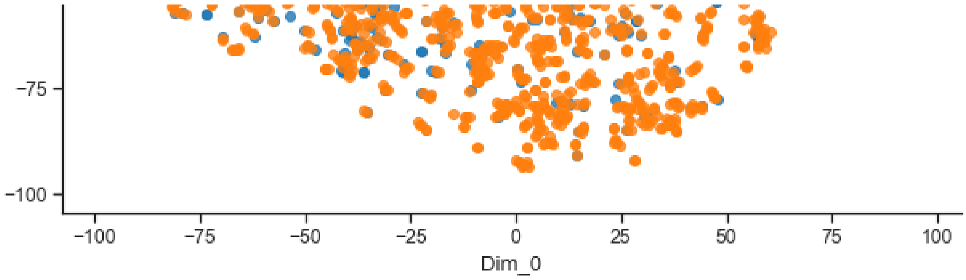
In [144]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used AVG W2V) and Perplexity = 10 and Learning Rate = 750 (Re
st Parameter are as default)')
```

Out[144]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used AVG W2V) and Perplexity = 10 and Learning Rate = 75
0 (Rest Parameter are as default)')
```





Observation

From the above plot even after changing perplexity and learning rate to get different distinguish plot. However, we observed that it has gotten even worsen than the other two above (BoW and TFIDF features)

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

In [145]:

```
# please write all the code with proper documentation, and proper titles for each subsection
# when you plot any graph make sure you use
    # a. Title, that describes your plot, this will be very helpful to the reader
    # b. Legends if needed
    # c. X-axis label
    # d. Y-axis label
X = hstack((categories_one_hot, sub_categories_one_hot, project_grade_category_one_hot, \
            tfidf_w2v_title, \
            price_normalized, teacher_number_of_previously_posted_projects_normalized, quantity_normali
zed))
X.shape
```

Out[145]:

```
(109248, 346)
```

In [146]:

```
# To convert sparse to dense array
X = X.toarray()
X.shape
```

Out[146]:

```
(109248, 346)
```

In [147]:

```
# Taking 6k data points only
X_s = X[:6000]
X_s.shape
```

Out[147]:

```
(6000, 346)
```

In [148]:

```
# Applying TSNE: https://scikit-learn.org/stable/modules/generated/sklearn.manifold.TSNE.html
X_embedded = TSNE(n_components=2).fit_transform(X_s)
X_embedded.shape
```

Out[148]:

```
(6000, 2)
```

In [149]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[149]:

	Dim_0	Dim_1
0	-41.374023	9.146647
1	43.807129	-21.236679
2	53.446846	-43.219006
3	-70.965126	9.081133
4	2.945698	51.389301

In [150]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[150]:

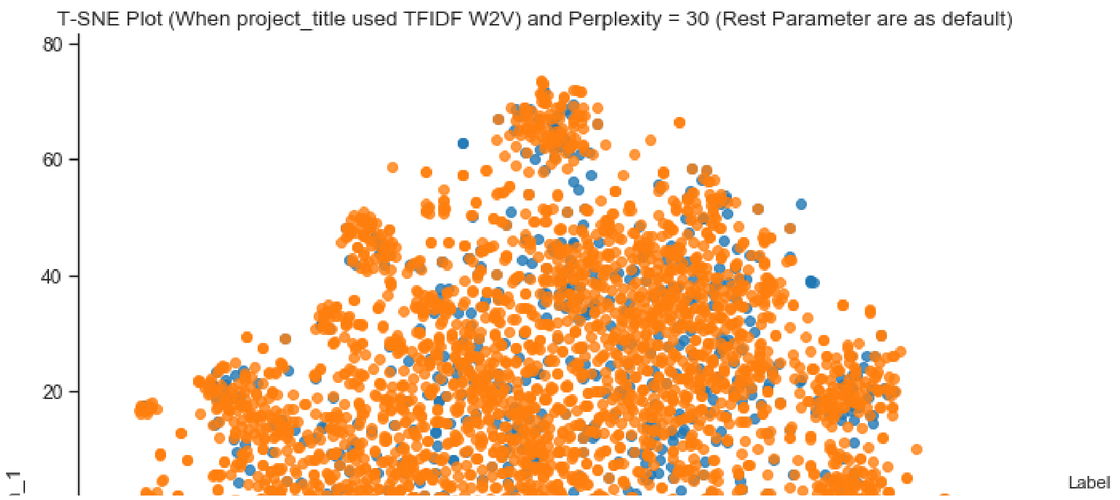
	Dim_0	Dim_1	Label
0	-41.374023	9.146647	Not Approved
1	43.807129	-21.236679	Approved
2	53.446846	-43.219006	Not Approved
3	-70.965126	9.081133	Approved
4	2.945698	51.389301	Approved

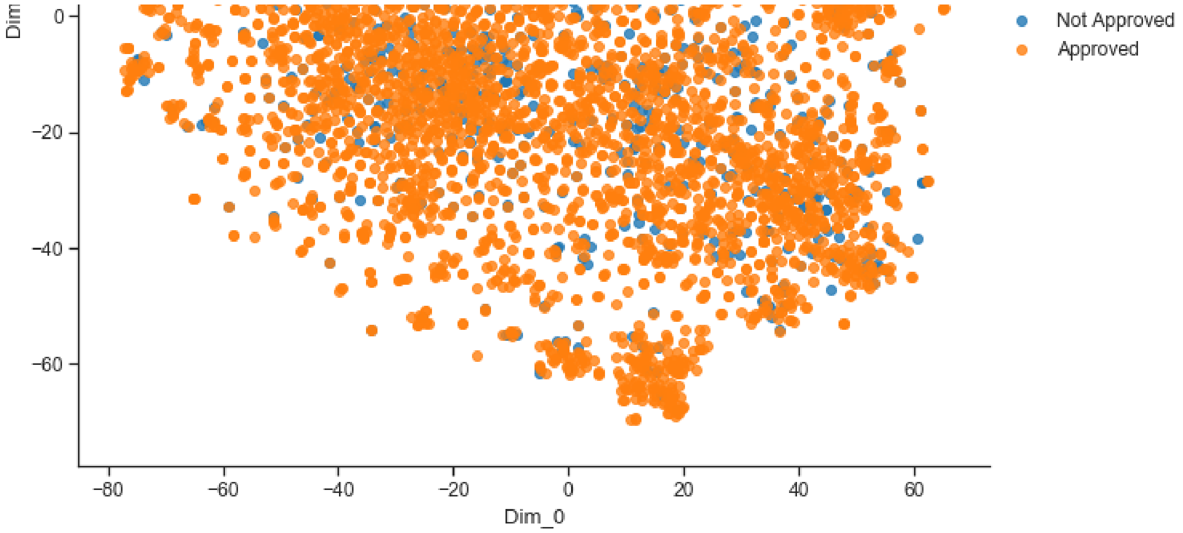
In [151]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used TFIDF W2V) and Perplexity = 30 (Rest Parameter are as de
fault)')
```

Out[151]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used TFIDF W2V) and Perplexity = 30 (Rest Parameter are
as default)')
```





In [152]:

```
X_embedded = TSNE(n_components=2, perplexity= 10).fit_transform(X_s)
X_embedded.shape
```

Out[152]:

```
(6000, 2)
```

In [153]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[153]:

	Dim_0	Dim_1
0	50.144363	-57.056713
1	-64.433037	-19.428961
2	-75.449860	28.891426
3	54.545826	5.443674
4	56.801991	33.888901

In [154]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[154]:

	Dim_0	Dim_1	Label
0	50.144363	-57.056713	Not Approved
1	-64.433037	-19.428961	Approved
2	-75.449860	28.891426	Not Approved
3	54.545826	5.443674	Approved
4	56.801991	33.888901	Approved

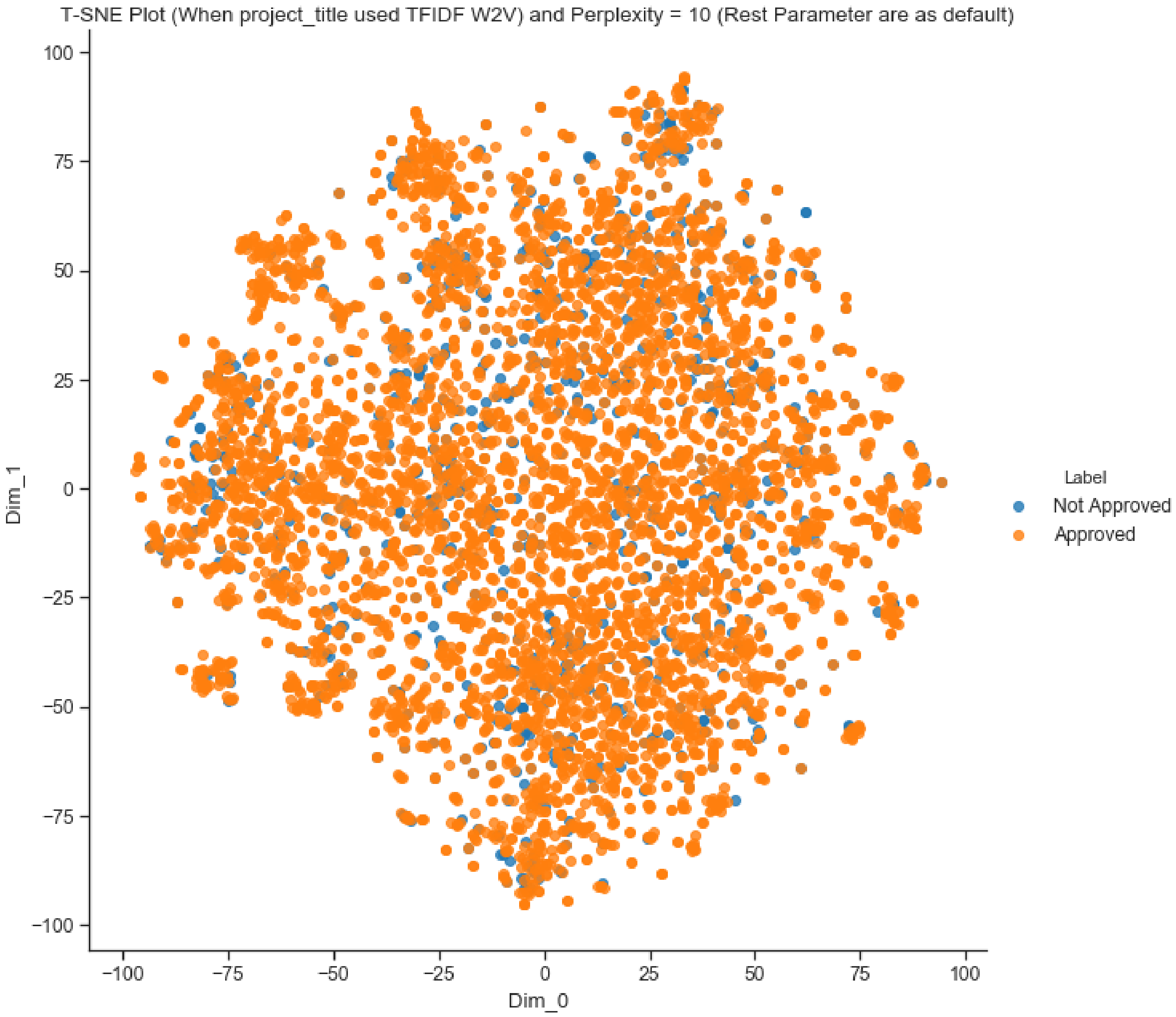
In [155]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
```

```
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used TFIDF W2V) and Perplexity = 10 (Rest Parameter are as de
fault)')
```

Out[155]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used TFIDF W2V) and Perplexity = 10 (Rest Parameter are
as default)')
```



In [156]:

```
X_embedded = TSNE(n_components=2, perplexity= 10, learning_rate=750).fit_transform(X_s)
X_embedded.shape
```

Out[156]:

```
(6000, 2)
```

In [157]:

```
df_plot = pd.DataFrame(data=X_embedded, columns=['Dim_0','Dim_1'])
df_plot.head()
```

Out[157]:

	Dim_0	Dim_1
0	68.828461	-31.453283
1	-72.384598	21.288073

	Dim_0	Dim_1
2	-53.838390	82.955421
3	-11.016937	-68.138939
4	-9.308908	-59.672318

In [158]:

```
df_plot['Label'] = Y_s
df_plot['Label'] = df_plot['Label'].replace({0: 'Not Approved', 1: 'Approved'})
df_plot.head()
```

Out[158]:

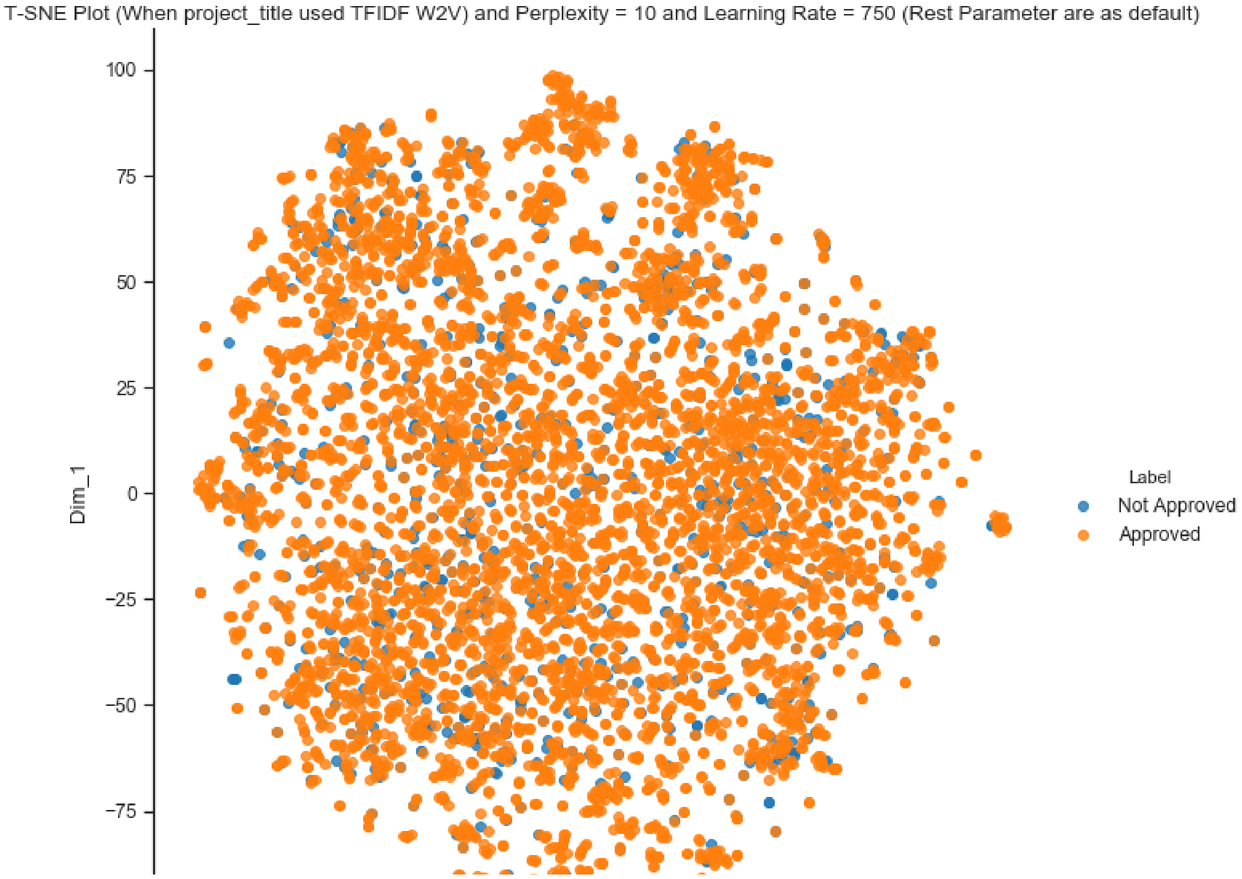
	Dim_0	Dim_1	Label
0	68.828461	-31.453283	Not Approved
1	-72.384598	21.288073	Approved
2	-53.838390	82.955421	Not Approved
3	-11.016937	-68.138939	Approved
4	-9.308908	-59.672318	Approved

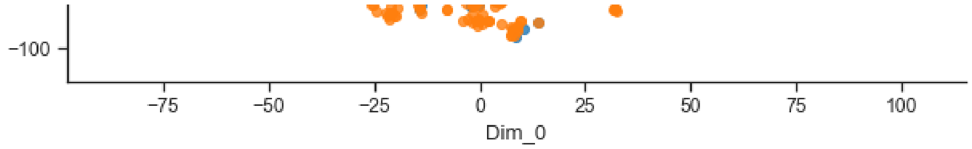
In [159]:

```
# Plot T-SNE: https://towardsdatascience.com/an-introduction-to-t-sne-with-python-example-5a3a293108d1
sns.set_context("notebook", font_scale=1.1)
sns.set_style("ticks")

sns.lmplot(x = 'Dim_0', y = 'Dim_1', data = df_plot, fit_reg=False, legend=True, size=9, hue='Label')
plt.title('T-SNE Plot (When project_title used TFIDF W2V) and Perplexity = 10 and Learning Rate = 750 (
Rest Parameter are as default)')
```

Out[159]:

```
Text(0.5, 1.0, 'T-SNE Plot (When project_title used TFIDF W2V) and Perplexity = 10 and Learning Rate =
750 (Rest Parameter are as default)')
```





Observation

From the above plot, there still not get any cluster of different class belonging. So this is not going to be helpful information for further process

2.5 Conclusions

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

1. Number of approved project and not approved project of all data points are 85% and 15%
2. From the state_code analysis, we observed that CA state_code had done more projects above (15K) and had been approved about 85%. VT state_code had done only 80 projects and out of these, 64 projects had been approved (80%)
3. From the teacher_prefix analysis, Teacher with prefix (Mrs and Ms) had done more around around in the 10K number of project than the other with less than 10K projects.
4. From the project_grade_category analysis, These all project_grade_category had equivalent(more or less) project's approved 83% (+- 2%)and also done above 10K projects on every grades.
5. From the project_subject_categories analysis, We found that Literacy_language and Math_Science categories are trending fields that people are focus the most projects
6. From the project_subject_subcategory, As we already seen Literacy_language and Math_Science categories have the most trending field where people are most considerate on this field to make project. Literacy is the sub-category of Literacty_language and Mathematics is the sub-category of Math_Science which have most trending as we observed from previous point (which has to be expected)
7. From the project_title analysis, We observed that for the project title which around 4 words tends to have more density however, we cannot find the differentation of project's approval (Approved and not approved projects).
8. From the essay, We observed that most of the essay which have 200 words have more density than the others for both approved and not approved project and approved project have more at the peak and not approved project have more for 200 words later.
9. From the cost_per_project analysis, we observed from the percentile table (percentile of 5 interval) that, rejected projects had spent more expense than the approved one.
10. From the teacher_number_of_previously_posted_project analysis, if we observe 90th and 95th percentile, it showing more gaps about 20-30 projects but from that 95th to 100th percentile, there is huge variation gap between them (300-400).
11. From the proejct_resource_summary analysis, All list of text, which is approved project only, has got 9% that contain numeric value. and for all list of text, which is not approved project only, has got 15% that contain numeric value. We can say that there is no relation between numeric text to project approval which we can further process
12. We performed text preprocessing on essay, project_tile, project_resource_summary like decontract, remove special character, converting to lowercase and removal of stopwords and keeping the clean ones.
13. We performed Feature extraction on essay, project_tile, project_resource_summary the text to vector are Bag of Words (BoW), TF-IDF , Average w2v and TF-IDF w2V. And words are taken from pretained from glove vector.
14. Converting the numeric features into range value (-1,1) by Standization to neglecence the units.
15. Converting the catorgical attibutes into oneHot encode for further processing.
16. Applying t-SNE by taking attributes are project_subject_categories, project_subject_subcategory, project_grade_category, project_tile (taking different feature extraction on this attributes only), price, teacher_number_of_previously_posted_project and quantity. We conclude that we didnt get any information even applying this techniques. So, we need to think other powerful technique which can be ddifferentiated from each other classes

```
In [ ]:
```