Donors Choose - Assignment T-SNE

In [2]:

```
# We must import sufficient libraries and functions to start out Analysis

import warnings
warnings.filterwarnings('ignore')

import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import re
import pickle
import os
import sqlite3
import string
from collections import Counter
import nltk
from nltk.corpus import stopwords
from nltk.stem.porter import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer, TfidfTransformer
from sklearn import metrics
from sklearn.metrics import confusion_matrix, roc_curve, auc
from sklearn.preprocessing import StandardScaler
from sklearn.manifold import TSNE

from gensim.models import Word2Vec
from gensim.models import KeyedVectors
from tqdm import tqdm
from prettytable import PrettyTable

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

```
C:\Desktop\Python\Anaconda3\lib\site-packages\smart_open\ssh.py:34: UserWarning: paramiko missing, ope
ning SSH/SCP/SFTP paths will be disabled.  `pip install paramiko` to suppress
  warnings.warn('paramiko missing, opening SSH/SCP/SFTP paths will be disabled.  `pip install paramiko`
to suppress')
C:\Desktop\Python\Anaconda3\lib\site-packages\gensim\utils.py:1197: UserWarning: detected Windows; ali
asing chunkize to chunkize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_serial")
```

In [3]:

```
# We load the data of "Project" and "Resource".

project = pd.read_csv(r'C:\Users\Bharat Bhimshetty\Desktop\Python\Applied AI Course\Assignments\Assign
ment 2\train_data.csv')
resource = pd.read_csv(r'C:\Users\Bharat Bhimshetty\Desktop\Python\Applied AI Course\Assignments\Assig
nment 2\resources.csv')
```

In [4]:

```
# Checking the output for "project".

print('The Project dataset consists of ', project.shape[0],'datapoints and ',project.shape[1],'features
')
print()
print('The list of features are: \n\n',project.columns.values)
print()
print('The sample Project Dataframe: \n')
project.head(3)
```

```
The Project dataset consists of  109248 datapoints and  17 features

The list of features are:
```

```
 ['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']

The sample Project Dataframe:
```

Out[4]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ	2016-08-31 12:03:56

In [5]:

```
# Checking the output for "resource".

print('The Resource dataset consists of ', resource.shape[0],'datapoints and ',resource.shape[1],'featu
res')
print()
print('The list of features are: \n\n',resource.columns.values)
print()
print('The sample Resource Dataframe: \n')
resource.head(3)
```

```
The Resource dataset consists of  1541272 datapoints and  4 features

The list of features are:

 ['id' 'description' 'quantity' 'price']

The sample Resource Dataframe:
```

Out[5]:

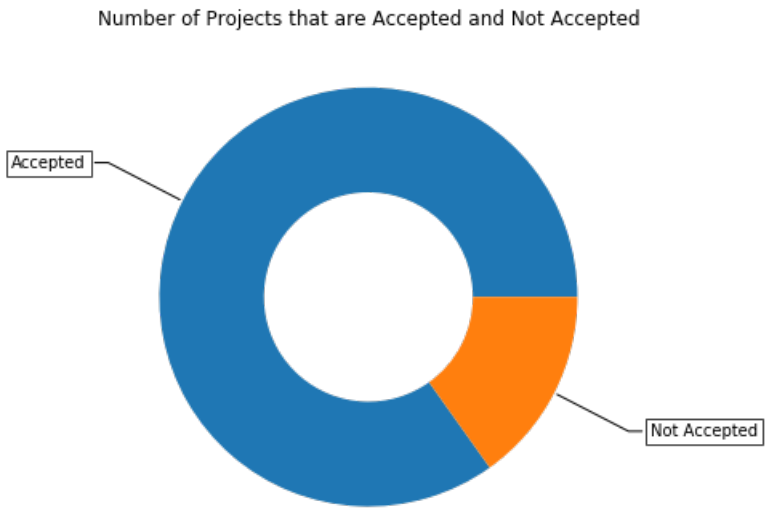
	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.00
1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95
2	p069063	Cory Stories: A Kid's Book About Living With Adhd	1	8.45

Data Analysis

In [6]:

```
# 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
```

```
plt.figure(figsize = (6,6))
recipe = ['Accepted', 'Not Accepted']
data = [92706, 16542]

wedges, text = plt.pie(data, wedgeprops=dict(width=0.5))

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

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

plt.title('Number of Projects that are Accepted and Not Accepted')
plt.show()

print('Projects Approved: ',project['project_is_approved'][project['project_is_approved'] == 1].count()
)
print()
print('Projects Not Approved: ',project['project_is_approved'][project['project_is_approved'] == 0].cou
nt())
print()
print('A total of {:.2f}% of Projects are Approved and {:.2f}% Projects are not Approved'.format(92706/
(92706 + 16542), 16542 / (92706 + 16542)))
```




```
Projects Approved:  92706

Projects Not Approved:  16542

A total of 0.85% of Projects are Approved and 0.15% Projects are not Approved
```

1.2.1 school_state

In [7]:

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

project_mean = project.groupby(project['school_state'])['project_is_approved'].agg(['mean']).reset_inde
x()
print('States with Highest Project Approvals: \n\n', project_mean.sort_values('mean', ascending = False
).head())
print()
print('States with Lowest Project Approvals: \n\n', project_mean.sort_values('mean', ascending = False)
.tail())
```

```
States with Highest Project Approvals:
```

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

States with Lowest Project Approvals:

    school_state      mean
18            LA  0.831245
26            MT  0.816327
43            TX  0.813142
7             DC  0.802326
46            VT  0.800000
```

In [8]:

```
# 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 = project_mean['school_state'],
        z = project_mean['mean'].astype(float),
        locationmode = 'USA-states',
        text = project_mean['school_state'],
        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')
```

In [9]:

```
#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='count'):
    ind = np.arange(data.shape[0])

    plt.figure(figsize = (20,8))
    p1 = plt.bar(ind, data[col3].values)
    p2 = plt.bar(ind, data[col2].values)

    plt.ylabel('Projects')
    plt.title('Projects Approved vs Not Approved')
    plt.xticks(ind, list(data[xtick].values))
    plt.legend((p1[0], p2[0]), ('Count', 'Accepted'))
    plt.show()
```

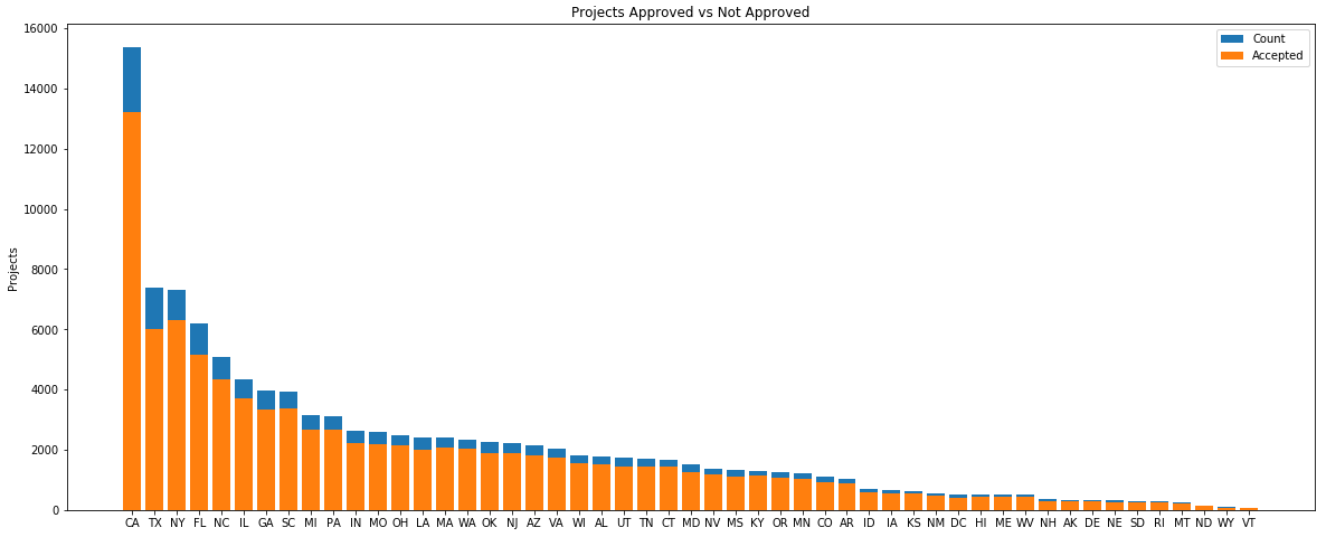
In [10]:

```
# We define own functions for our ease.

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

```
    a.sort_values(by = 'count', ascending = False, inplace=True)

    if top:
        a = a[0:top]

    stack_plot(a, xtick = col1, col2=col2, col3='count')
    print('These are top 5 values: \n\n',a.head())
    print()
    print('These are bottom 5 values: \n\n',a.tail())
```

In [11]:

```
univariate_barplots(project, col1 = 'school_state', col2 = 'project_is_approved', top=False)
```



These are top 5 values:

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

These are bottom 5 values:

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

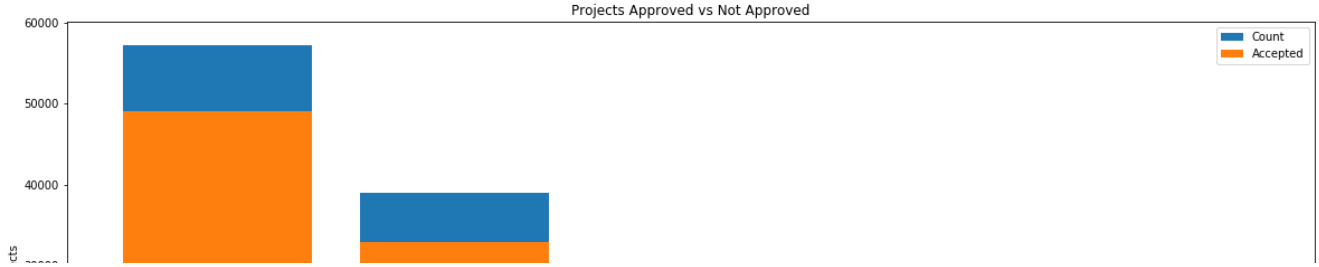
Observations

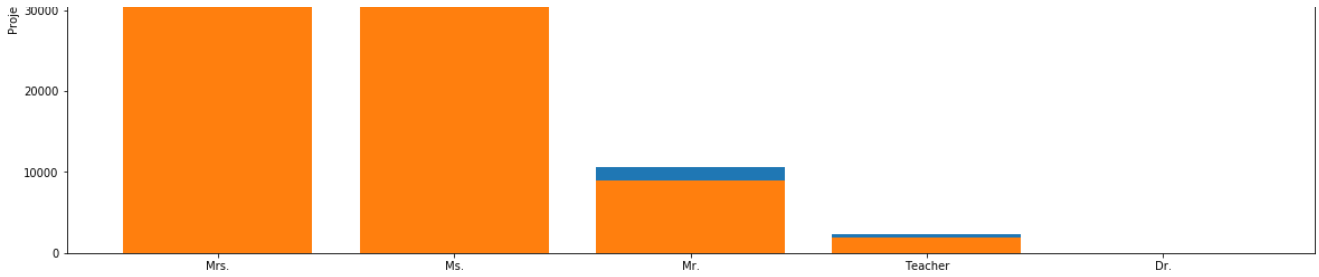
- Projects for every state has an average approval of 80%.
- Most projects are approved for California State at 14.25% on the whole with a submission count of 14%.
- Least Projects are approved for Vermont State.

1.2.2 : teacher_prefix

In [12]:

```
univariate_barplots(project, col1 = 'teacher_prefix')
```





These are top 5 values:

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

These are bottom 5 values:

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

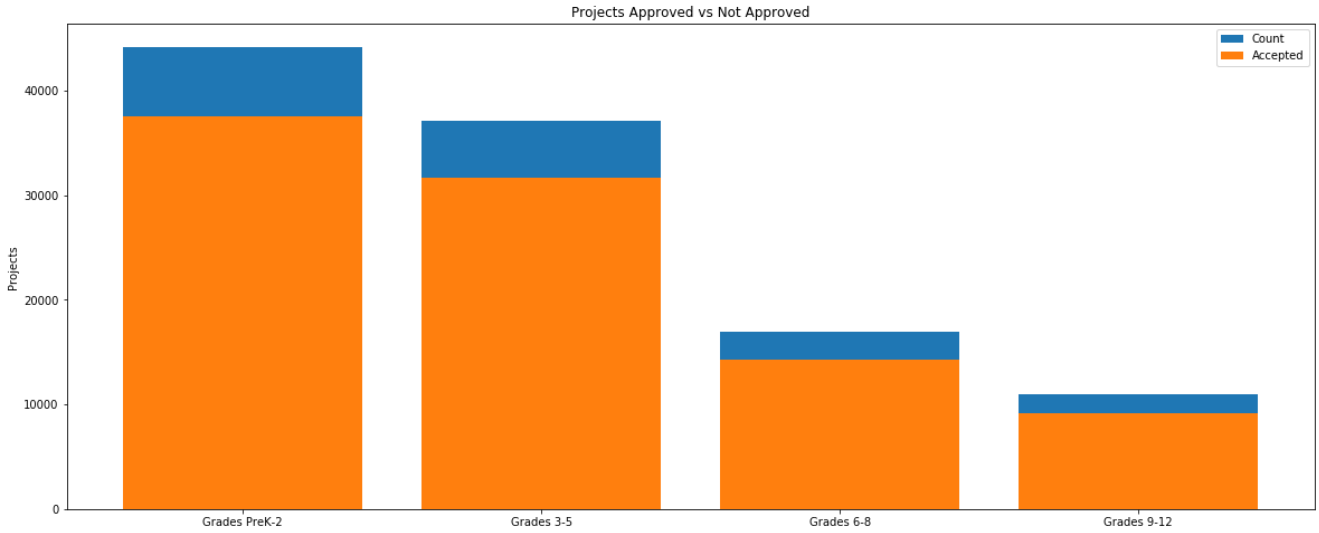
Observations

- The approval percentage of projects are higher for married woman almost at 53% and submission count at 52.5%.
- It seems that female teachers submission of projects are almost higher appx (75%) compared to male teachers.

1.2.3 : project_grade_category

In [13]:

```
univariate_barplots(project, col1 = 'project_grade_category')
```



These are top 5 values:

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

These are bottom 5 values:

	project_grade_category	project_is_approved	mean	count
3	Grades PreK-2	37536	0.848751	44225
0	Grades 3-5	31729	0.854377	37137
1	Grades 6-8	14258	0.842522	16923

```
2            Grades 9-12                9183  0.837636  10963
```

Observations

- Approved projects are higher for PreK-2 at 40.5% on the whole and submission count at 40.5% on the whole.
- Almost 40.5% of projects submitted are by PreK-2 and are approved at 100% success rate.
- Donors Choose Org does gives atmost importance to projects of PreK-2 Grades at 100% approval chance.
- We can observe least projects approved are for 9-12 Grades which is in proportion to their submission count.

1.2.4 : project_subject_categories

In [14]:

```
project['project_subject_categories'].head(8)
```

Out[14]:

```
0                   Literacy & Language
1      History & Civics, Health & Sports
2                        Health & Sports
3    Literacy & Language, Math & Science
4                        Math & Science
5     Literacy & Language, Special Needs
6     Literacy & Language, Special Needs
7                        Math & Science
Name: project_subject_categories, dtype: object
```

In [15]:

```
# designed by me and not copied
# we filter the data by removing some spl chars

psc = []
for i in project['project_subject_categories']:
    i = i.replace('&','_').replace(' ','').replace(',',' ')
    psc.append(i)
```

In [16]:

```
# A new column is created.

project['project_subject_cleaned_categories'] = psc
```

In [17]:

```
project['project_subject_cleaned_categories'].head()
```

Out[17]:

```
0                 Literacy_Language
1      History_Civics Health_Sports
2                   Health_Sports
3    Literacy_Language Math_Science
4                    Math_Science
Name: project_subject_cleaned_categories, dtype: object
```

In [18]:

```
# we drop existing column.

project.drop(['project_subject_categories'], axis=1, inplace= True)
```

In [19]:

```
project.head(2)
```

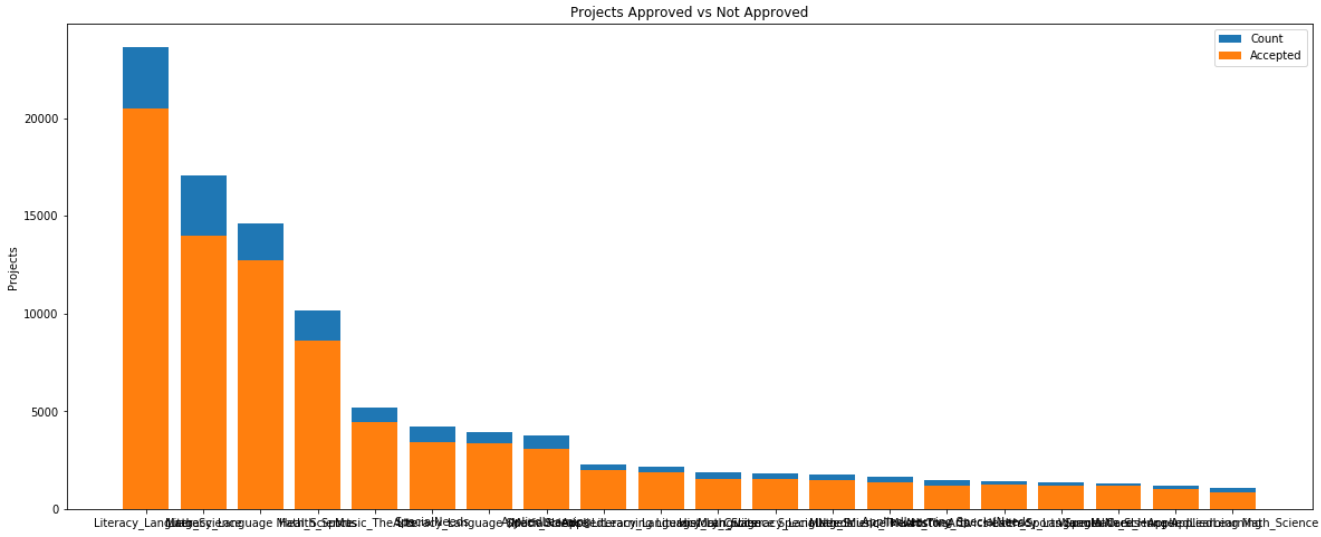
Out[19]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10

In [20]:

```
univariate_barplots(project, col1 = 'project_subject_cleaned_categories', top=20)
```



These are top 5 values:

	project_subject_cleaned_categories	project_is_approved	mean	count
24	Literacy_Language	20520	0.867470	23655
32	Math_Science	13991	0.819529	17072
28	Literacy_Language Math_Science	12725	0.869432	14636
8	Health_Sports	8640	0.848973	10177
40	Music_TheArts	4429	0.855019	5180

These are bottom 5 values:

	project_subject_cleaned_categories	project_is_approved	mean	count
19	History_Civics Literacy_Language	1271	0.894441	1421
14	Health_Sports SpecialNeeds	1215	0.873472	1391
50	Warmth Care_Hunger	1212	0.925898	1309
33	Math_Science AppliedLearning	1019	0.835246	1220
4	AppliedLearning Math_Science	855	0.812738	1052

In [21]:

```
# count all words in corpus https://stackoverflow.com/a/22898595/4084039

psc_counter = Counter()
for i in project['project_subject_cleaned_categories']:
    psc_counter.update(i.split())
```

In [22]:

```
print(psc_counter)
```

```
Counter({'Literacy_Language': 52239, 'Math_Science': 41421, 'Health_Sports': 14223, 'SpecialNeeds': 136
42, 'AppliedLearning': 12135, 'Music_TheArts': 10293, 'History_Civics': 5914, 'Warmth': 1388, 'Care_Hun
ger': 1388})
```

In [23]:

```
print(sum(psc_counter.values()))
```

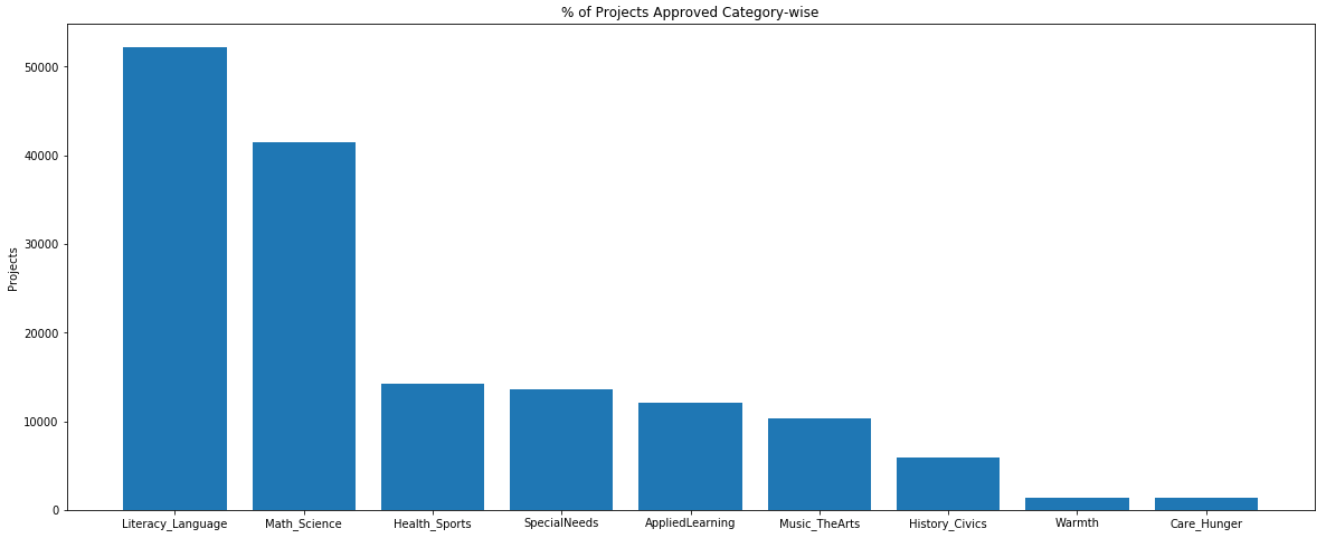
```
152643
```

In [24]:

```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039
```

```
"""my_counter is converted to dict and we extract values of items, then we sort,
and we make dictionary words as key and its occurences as values.
"""
sorted_sub_cat_dict = dict(sorted(dict(psc_counter).items(), key = lambda kv:kv[1], reverse = True))

print(sorted_sub_cat_dict)
print()
print('length of items in sorted sub category: ',len(sorted_sub_cat_dict))
plt.figure(figsize = (20,8))
p1 = plt.bar(range(len(sorted_sub_cat_dict)), list(sorted_sub_cat_dict.values()))

plt.ylabel('Projects')
plt.title('% of Projects Approved Category-wise')
plt.xticks(range(len(sorted_sub_cat_dict)), list(sorted_sub_cat_dict.keys()))
plt.show()
```

```
{'Literacy_Language': 52239, 'Math_Science': 41421, 'Health_Sports': 14223, 'SpecialNeeds': 13642, 'App
liedLearning': 12135, 'Music_TheArts': 10293, 'History_Civics': 5914, 'Warmth': 1388, 'Care_Hunger': 13
88}

length of items in sorted sub category:  9
```



Observations

- "Literacy_Language" subject has occupied 22% of total approved projects which is highest and at submission count of 21.65%.
- Least project approvals are for binary category of "AppliedLearning Math_science" at almost at 1%.
- Literacy_Language subject share occupies at 34% [52239/152643], both single as well as binary (combined with other sub).
- Care_Hunger subject is least at almost 1%.

1.2.5 project_subject_subcategories

In [25]:

```
project['project_subject_subcategories'].head(8)
```

Out[25]:

```
0                         ESL, Literacy
1       Civics & Government, Team Sports
2         Health & Wellness, Team Sports
3                  Literacy, Mathematics
4                         Mathematics
5    Literature & Writing, Special Needs
6                Literacy, Special Needs
7                         Mathematics
Name: project_subject_subcategories, dtype: object
```

In [26]:

```
# we filter the data by removing some spl chars
```

```
pssc = []
for i in project['project_subject_subcategories']:
    i = i.replace('&','_').replace(' ','').replace(',',' ')
    pssc.append(i)
```

In [27]:

```
# A new column is created.

project['project_subject_cleaned_subcategories'] = pssc
```

In [28]:

```
project['project_subject_cleaned_subcategories'].head(8)
```

Out[28]:

```
0                       ESL Literacy
1       Civics_Government TeamSports
2         Health_Wellness TeamSports
3               Literacy Mathematics
4                        Mathematics
5    Literature_Writing SpecialNeeds
6              Literacy SpecialNeeds
7                        Mathematics
Name: project_subject_cleaned_subcategories, dtype: object
```

In [29]:

```
# We drop existing column.

project.drop(['project_subject_subcategories'], axis=1, inplace=True)
```

In [30]:

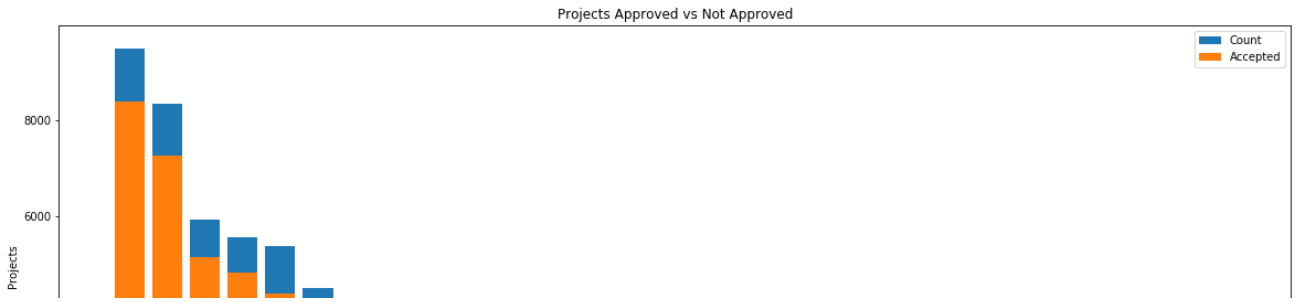
```
project.head(3)
```

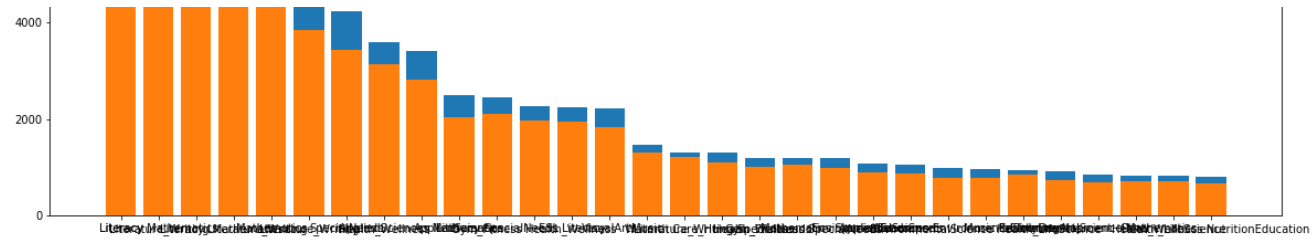
Out[30]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ	2016-08-31 12:03:56

In [31]:

```
univariate_barplots(project, col1 = 'project_subject_cleaned_subcategories', top=30)
```





These are top 5 values:

	project_subject_cleaned_subcategories	project_is_approved	mean	count
317	Literacy	8371	0.882458	9486
319	Literacy Mathematics	7260	0.872072	8325
331	Literature_Writing Mathematics	5140	0.867803	5923
318	Literacy Literature_Writing	4823	0.865733	5571
342	Mathematics	4385	0.815207	5379

These are bottom 5 values:

	project_subject_cleaned_subcategories	project_is_approved	mean	count
150	EarlyDevelopment	740	0.817680	905
198	EnvironmentalScience Mathematics	683	0.815036	838
368	Other	701	0.843562	831
273	Health_LifeScience	701	0.847642	827
295	Health_Wellness NutritionEducation	667	0.836888	797

In [32]:

```
# count all words in corpus https://stackoverflow.com/a/22898595/4084039

pssc_counter = Counter()
for i in project['project_subject_cleaned_subcategories']:
    pssc_counter.update(i.split())
```

In [33]:

```
# Checking the output.

print(pssc_counter)
```

```
Counter({'Literacy': 33700, 'Mathematics': 28074, 'Literature_Writing': 22179, 'SpecialNeeds': 13642, '
AppliedSciences': 10816, 'Health_Wellness': 10234, 'VisualArts': 6278, 'EnvironmentalScience': 5591, 'G
ym_Fitness': 4509, 'ESL': 4367, 'EarlyDevelopment': 4254, 'Health_LifeScience': 4235, 'History_Geograph
y': 3171, 'Music': 3145, 'College_CareerPrep': 2568, 'Other': 2372, 'TeamSports': 2192, 'CharacterEduca
tion': 2065, 'PerformingArts': 1961, 'SocialSciences': 1920, 'Warmth': 1388, 'Care_Hunger': 1388, 'Nutr
itionEducation': 1355, 'ForeignLanguages': 890, 'Civics_Government': 815, 'Extracurricular': 810, 'Pare
ntInvolvement': 677, 'FinancialLiteracy': 568, 'CommunityService': 441, 'Economics': 269})
```

In [34]:

```
sum(pssc_counter.values())
```

Out[34]:

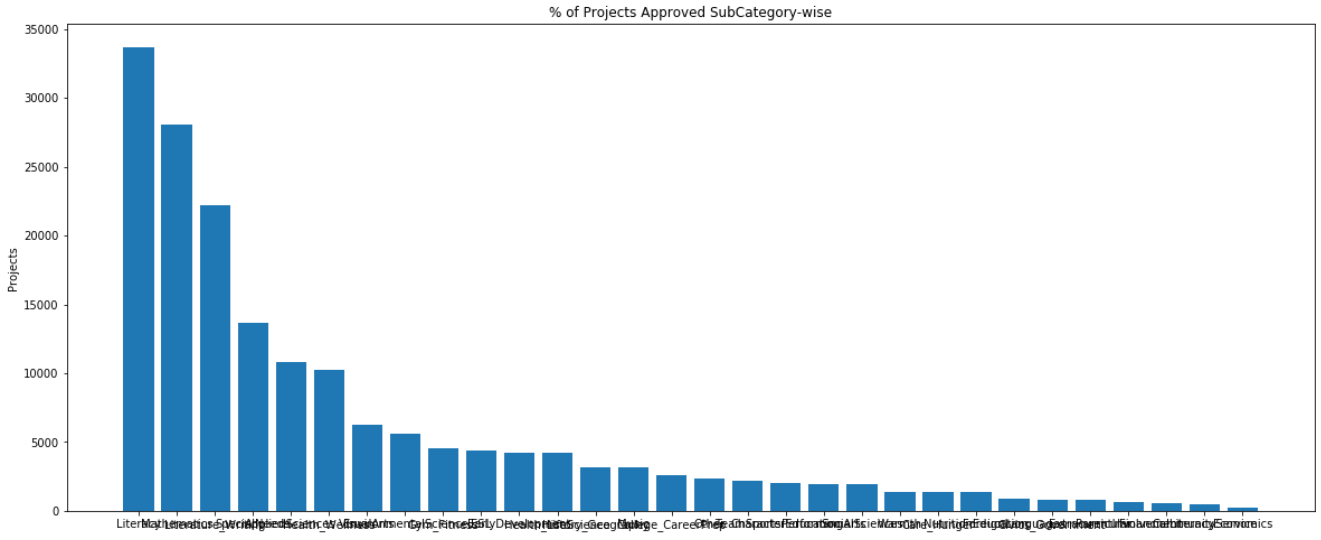
```
175874
```

In [35]:

```
# dict sort by value python: https://stackoverflow.com/a/613218/4084039

"""my_counter is converted to dict and we extract values of items, then we sort,
and we make dictionary words as key and its occurences as values.
"""
```

```
sorted_sub_subcat_dict = dict(sorted(dict(pssc_counter).items(), key = lambda kv:kv[1], reverse = True)
)

print(sorted_sub_subcat_dict)
print()
print('length of items in sorted sub category: ',len(sorted_sub_subcat_dict))
plt.figure(figsize = (20,8))
p1 = plt.bar(range(len(sorted_sub_subcat_dict)), list(sorted_sub_subcat_dict.values()))

plt.ylabel('Projects')
plt.title('% of Projects Approved SubCategory-wise')
plt.xticks(range(len(sorted_sub_subcat_dict)), sorted_sub_subcat_dict.keys())
plt.show()
```

```
{'Literacy': 33700, 'Mathematics': 28074, 'Literature_Writing': 22179, 'SpecialNeeds': 13642, 'AppliedS
ciences': 10816, 'Health_Wellness': 10234, 'VisualArts': 6278, 'EnvironmentalScience': 5591, 'Gym_Fitne
ss': 4509, 'ESL': 4367, 'EarlyDevelopment': 4254, 'Health_LifeScience': 4235, 'History_Geography': 3171
, 'Music': 3145, 'College_CareerPrep': 2568, 'Other': 2372, 'TeamSports': 2192, 'CharacterEducation': 2
065, 'PerformingArts': 1961, 'SocialSciences': 1920, 'Warmth': 1388, 'Care_Hunger': 1388, 'NutritionEdu
cation': 1355, 'ForeignLanguages': 890, 'Civics_Government': 815, 'Extracurricular': 810, 'ParentInvolv
ement': 677, 'FinancialLiteracy': 568, 'CommunityService': 441, 'Economics': 269}

length of items in sorted sub category:  30
```



Observations

- Literacy considered in solo, occupies 9% of subcategory in approval projects.
- Health_Wellness NutritionEducation together occupies less than 1%.
- Literacy when divided all subcategories individually occupies highest share of 19% [33700/175874].

1.2.6 project_title (Text features)

In [36]:

```
project['project_title'].head(2)
```

Out[36]:

```
0    Educational Support for English Learners at Home
1                Wanted: Projector for Hungry Learners
Name: project_title, dtype: object
```

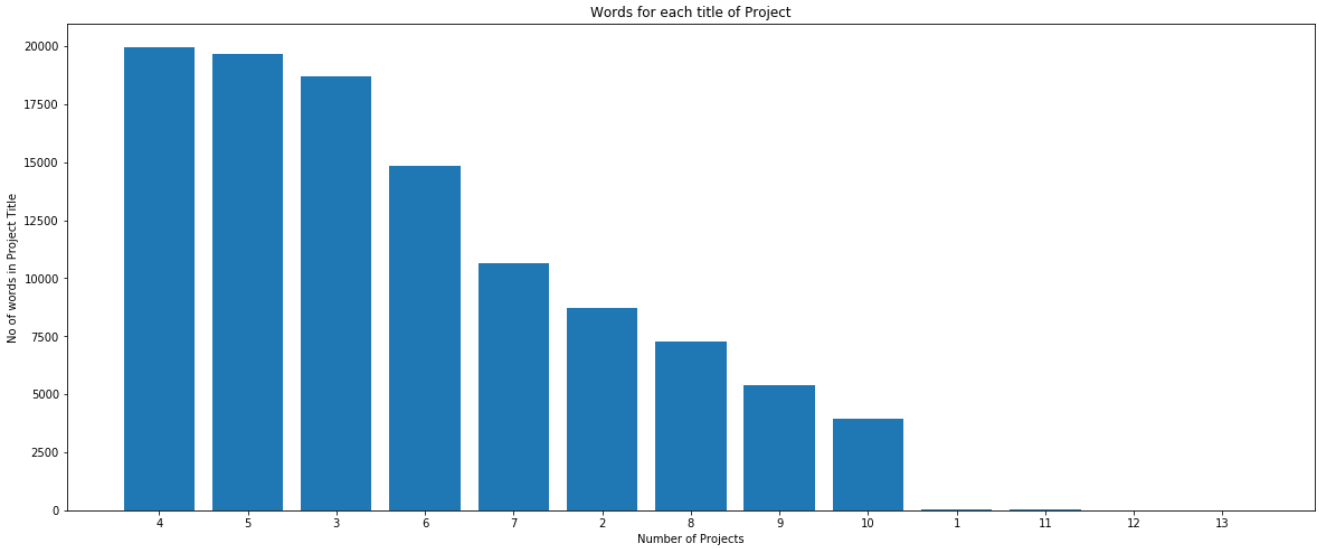
In [37]:

```
# we filter the data by removing some spl chars.

pt = []
for i in project['project_title'][:]:
    j = i.split()
    pt.append(len(j))
```

In [38]:

```
p t = dict(sorted(dict(Counter(pt)).items(), key = lambda kv:kv[1], reverse = True))
```

```
plt.figure(figsize=(20,8))
plt.bar(range(len(p_t)), list(p_t.values()))

plt.ylabel('No of words in Project Title')
plt.xlabel('Number of Projects')
plt.title('Words for each title of Project')
plt.xticks(range(len(p_t)), list(p_t.keys()))
plt.show()
```



In [39]:

```
project.head(1)
```

Out[39]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	p
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	C

In [40]:

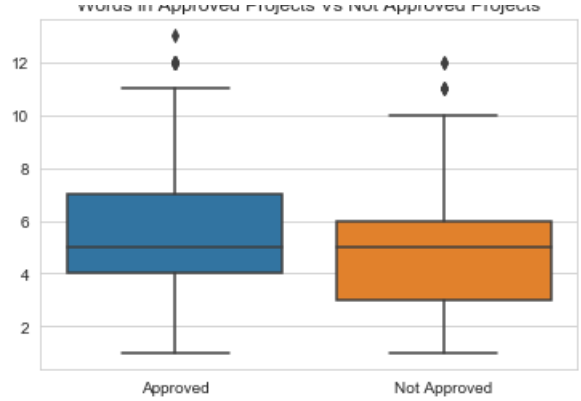
```
# Word count of "project_title" where project got approved".

approved_title_word_count = []
for i in project['project_title'][project['project_is_approved'] == 1][:]:
    j = i.split()
    approved_title_word_count.append(len(j))
```

In [41]:

```
# Word count of "project_title" where project not approved".

not_approved_title_word_count = []
for i in project['project_title'][project['project_is_approved'] == 0][:]:
    j = i.split()
    not_approved_title_word_count.append(len(j))
```

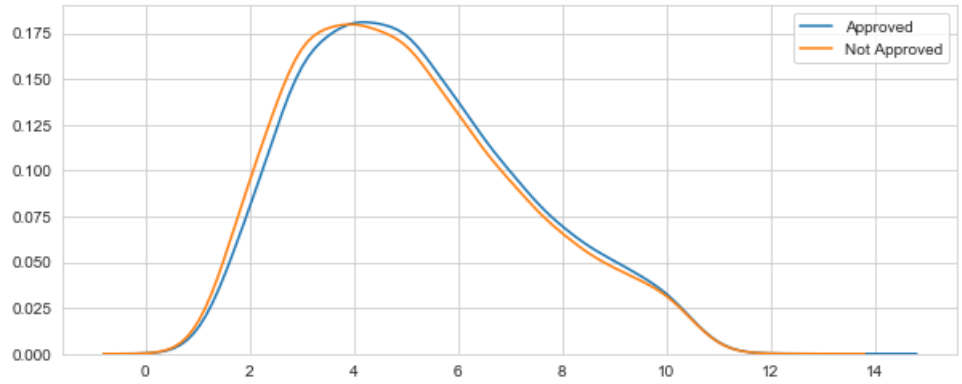
In [42]:

```
# Boxplot.

sns.set_style('whitegrid')
sns.boxplot(data = [approved_title_word_count, not_approved_title_word_count])
plt.title('Words in Approved Projects Vs Not Approved Projects')
plt.xticks([0,1], ('Approved', 'Not Approved'))
plt.show()
```



In [43]:

```
# Kernal density estimation plot.

plt.figure(figsize = (10,4))
sns.kdeplot(approved_title_word_count, bw = 0.6, label = 'Approved')
sns.kdeplot(not_approved_title_word_count, bw = 0.6, label = 'Not Approved')
plt.legend()
plt.show()
```



In [44]:

```
# https://stackoverflow.com/a/2258273/10219869

pt_dict = dict(Counter(pt))
print(sorted(pt_dict.items(), key = lambda x:x[1], reverse = True))
```

```
[(4, 19979), (5, 19677), (3, 18691), (6, 14824), (7, 10631), (2, 8733), (8, 7289), (9, 5383), (10, 3968
), (1, 31), (11, 30), (12, 11), (13, 1)]
```

Observations

- The 4 letter title is highest at 18.28%.
- the 1 letter title and 11, 12 and 13 letter titles are countable which add to miniscule 73.
- We can observe the approved title count IQR is for 4-7 title range and non approved IQR for 3-6 range.
- The kde plot peak is at 4 which is highest.

1.2.7 project_essays (total 4)

In [45]:

```
# We combine all 4 essay features to one feature 'essay'

project['essay'] = project['project_essay_1'].map(str) + project['project_essay_2'].map(str) + project[
'project_essay_3'].map(str) + project['project_essay_4'].map(str)
```

In [46]:

```
project['essay'].head()
```

Out[46]:

```
0    My students are English learners that are work...
```

```
1    Our students arrive to our school eager to lea...
2    \r\n\"True champions aren't always the ones th...
3    I work at a unique school filled with both ESL...
4    Our second grade classroom next year will be m...
Name: essay, dtype: object
```

In [47]:

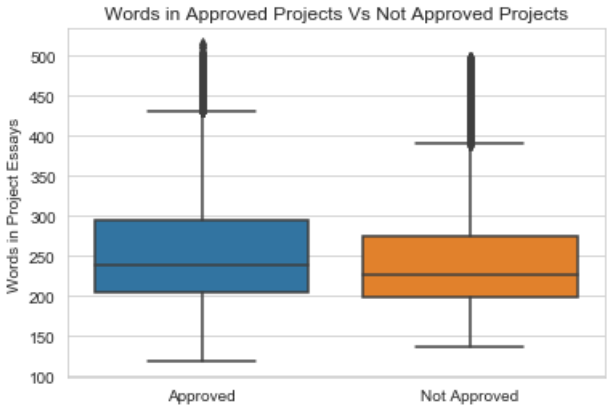
```
# Word count of "Essay" where project got approved.

approved_essay_word_count = []
for i in project['essay'][project['project_is_approved'] == 1][:]:
    j = i.split()
    approved_essay_word_count.append(len(j))
```

In [48]:

```
# Word count of "Essay" where project not approved.

not_approved_essay_word_count = []
for i in project['essay'][project['project_is_approved'] == 0][:]:
    j = i.split()
    not_approved_essay_word_count.append(len(j))
```

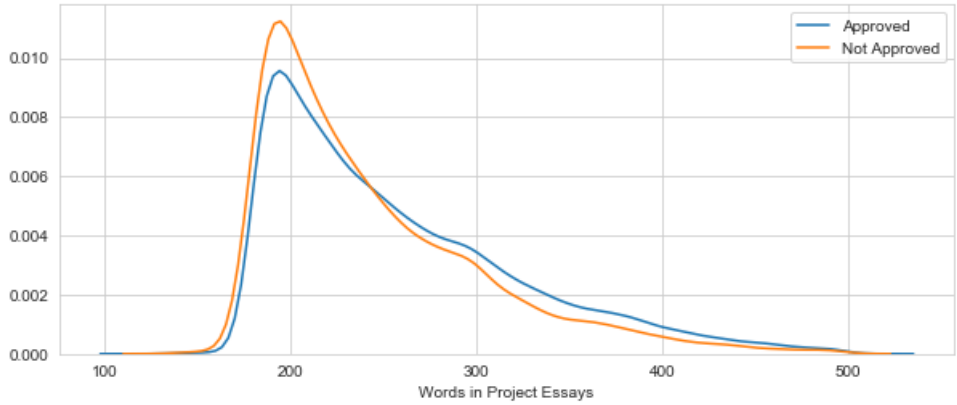
In [49]:

```
# Boxplot.

sns.boxplot(data = [approved_essay_word_count, not_approved_essay_word_count])
plt.title('Words in Approved Projects Vs Not Approved Projects')
plt.ylabel('Words in Project Essays')
plt.xticks([0,1], ('Approved', 'Not Approved'))
plt.show()
```



In [50]:

```
# Kernal density estimation plot.

plt.figure(figsize = (10,4))
sns.distplot(approved_essay_word_count, hist=False, label = 'Approved')
sns.distplot(not_approved_essay_word_count, hist=False, label = 'Not Approved')
plt.xlabel('Words in Project Essays')
plt.legend()
plt.show()
```



Observations

- The Box plot IQR for approved essay words are in between 200 and 300 appx, and for non approved it is 200-275 appx.
- In the dist plot we can see the peak at 190 appx for both approved and non approved projects.
- The words per essay count range between 160 appx to 530 appx.

1.2.8 cost_per_project

In [51]:

```
resource_data = resource.groupby('id').agg('sum').reset_index()
resource_data.head()
```

Out[51]:

	id	quantity	price
0	p000001	7	459.56
1	p000002	21	515.89
2	p000003	4	298.97
3	p000004	98	1113.69
4	p000005	8	485.99

In [52]:

```
print('Min Price:', resource_data['price'].min())
print()
print('Max Price: ', resource_data['price'].max())
```

```
Min Price: 0.66

Max Price:  9999.0
```

In [53]:

```
# Merging both df's

project_resource = pd.merge(project, resource_data, on = 'id')
```

In [54]:

```
project_resource.head(2)
```

Out[54]:

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

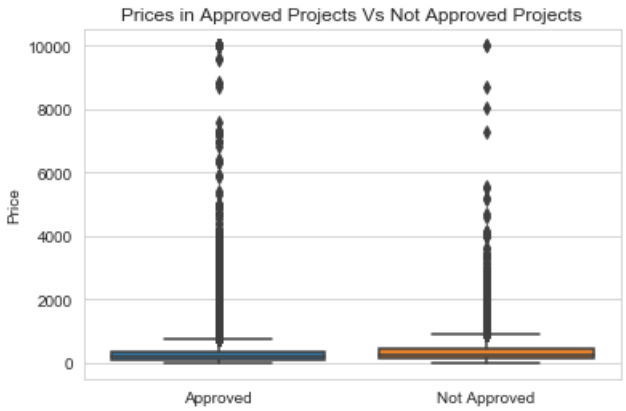
In [55]:

```
# Price where project got approved.
```

```
approved_price = list(project_resource['price'][project_resource['project_is_approved'] == 1])

# Price where project got approved.

not_approved_price = list(project_resource['price'][project_resource['project_is_approved'] == 0])
```

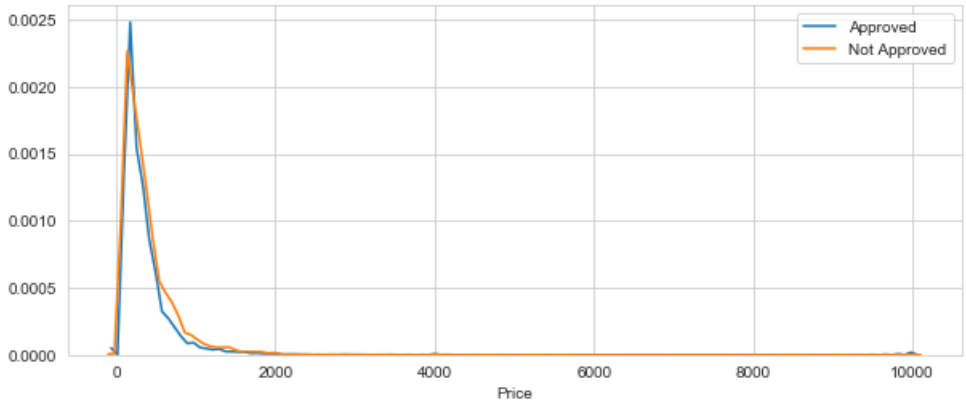
In [56]:

```
# Boxplot.

sns.boxplot(data = [approved_price, not_approved_price])
plt.title('Prices in Approved Projects Vs Not Approved Projects')
plt.xticks([0,1], ('Approved', 'Not Approved'))
plt.ylabel('Price')
plt.show()
```



In [57]:

```
# Kernal density estimation plot.

plt.figure(figsize = (10,4))
sns.distplot(approved_price, hist=False, label = 'Approved')
sns.distplot(not_approved_price, hist=False, label = 'Not Approved')
plt.xlabel('Price')
plt.legend()
plt.show()
```



In [58]:

```
# Table with contents "percentile","approved projects","unapproved projects".

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(not_approved_pri
ce,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         |
+--------------+---------------------+-------------------------+
```

Observations

- We can see the Highest price is '9999.0' and lowest is 0.66.
- Based on box plot the price IQR of approved projects is '266.125' and for non approved projects '309.053'.
- By the distplot we can see the graph is right skewed meaning the peak is at median which is at 199.

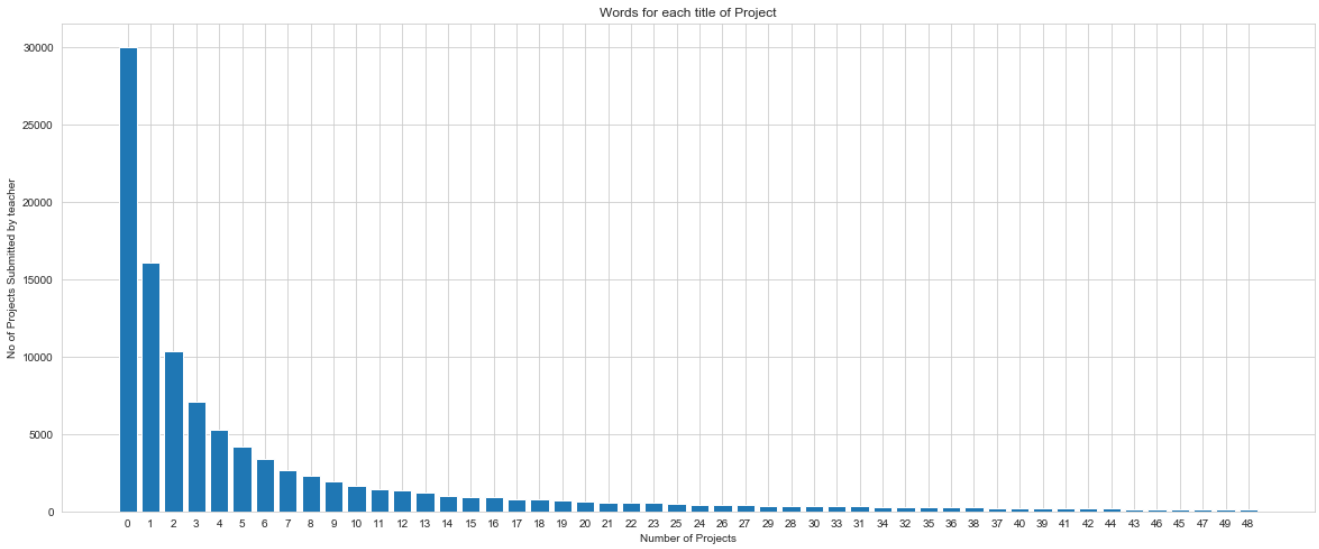
1.2.9 teacher_number_of_previously_posted_projects

In [59]:

```
# We create a list.

tnppp = []
for i in project['teacher_number_of_previously_posted_projects'][:]:
    tnppp.append(i)
```

In [60]:

```
# We are considering top 50 submits wherein the highest is at 30014 and 50th is at 140  using this comm
and (Counter(tnppp).most_common(50))

tnppp = dict(sorted(dict(Counter(tnppp)).items(), key = lambda kv:kv[1], reverse = True))

plt.figure(figsize=(20,8))
plt.bar(range(50), list(tnppp.values())[:50])

plt.ylabel('No of Projects Submitted by teacher')
plt.xlabel('Number of Projects')
plt.title('Words for each title of Project')
plt.xticks(range(50), list(tnppp.keys())[:50])
plt.show()
```



In [61]:

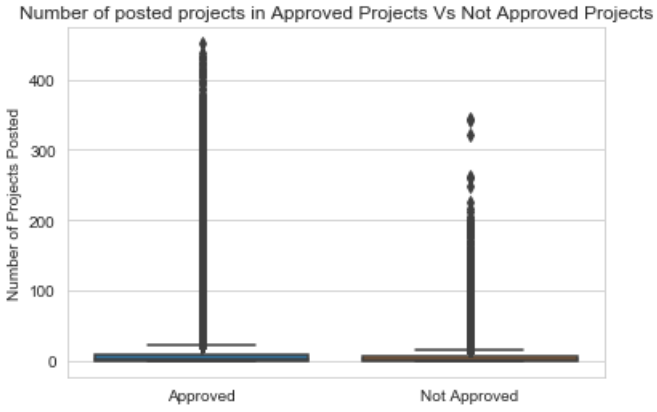
```
# previously posted projects for teachers where project got approved.

approved_posted_projects = []
for i in project['teacher_number_of_previously_posted_projects'][project['project_is_approved'] == 1][:
]:
    approved_posted_projects.append(i)
```

In [62]:

```
# previously posted projects for teachers where project not approved.

not_approved_posted_projects = []
for i in project['teacher_number_of_previously_posted_projects'][project['project_is_approved'] == 0][:
]:
    not_approved_posted_projects.append(i)
```

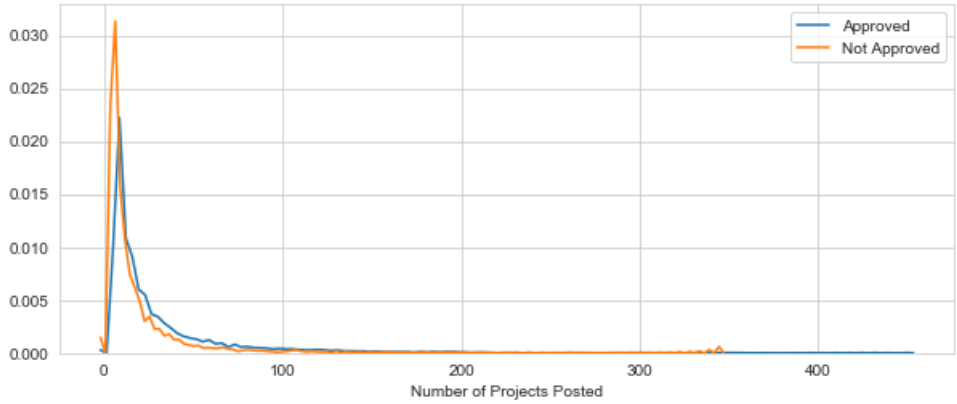
In [63]:

```
# Boxplot.

sns.boxplot(data = [approved_posted_projects, not_approved_posted_projects])
plt.title('Number of posted projects in Approved Projects Vs Not Approved Projects')
plt.xticks([0,1], ('Approved', 'Not Approved'))
plt.ylabel('Number of Projects Posted')
plt.show()
```



In [64]:

```
# Kernal density estimation plot.

plt.figure(figsize = (10,4))
sns.distplot(approved_posted_projects, hist=False, label = 'Approved')
sns.distplot(not_approved_posted_projects, hist=False, label = 'Not Approved')
plt.xlabel('Number of Projects Posted')
plt.legend()
plt.show()
```



Observations

- Based on distplot the graph is right skewed peak is at median which is at 140
- The highest is o at 30,014 wherein these are first time submitted projects

- The highest is 6 at 50,014 wherein these are first time submitted projects.

1.2.10 project_resource_summary

In [65]:

```
project['project_resource_summary'].head(3)
```

Out[65]:

```
0    My students need opportunities to practice beg...
1    My students need a projector to help with view...
2    My students need shine guards, athletic socks,...
Name: project_resource_summary, dtype: object
```

In [66]:

```
# we can find that almost all numbers are present atleast more than 2000 rows..!!

print('number 6 in',project['project_resource_summary'][project['project_resource_summary'].str.contain
s('6')].count(), 'rows')
print()
print('number 4 in',project['project_resource_summary'][project['project_resource_summary'].str.contain
s('4')].count(), 'rows')
```

```
number 6 in 1957 rows

number 4 in 2479 rows
```

In [67]:

```
from bs4 import BeautifulSoup
import contractions
import re

sw = set(stopwords.words('english'))

def clean_sentence(text):
    text = BeautifulSoup(text, 'lxml').get_text()           # removes html tags such as <br />
    text = text.lower()                                     # converts text to lower case
    text = contractions.fix(text)                           # converts (don't) to (do not)
    text = re.sub('\W+',' ',text)                           # removes all special chars, punc
    text = text.split()
    text1 = []
    for i in text:
        if "_" in i:
            del i                                           # removes string if it contains '_'
        else:
            text1.append(i)
    text = " ".join(text1)
    text = text.replace(' ','')
    return text
```

In [68]:

```
# attaching the list to variable 'prs' temporarily wherein 'prs' is cleaned text for 'project_resource_
summary'

prs = [clean_sentence(i) for i in project['project_resource_summary']]
```

In [69]:

```
prs[:2]
```

Out[69]:

```
['mystudentsneedopportunitiestopracticebeginningreadingskillsinenglishathome',
 'mystudentsneedaprojectortohelpwithviewingeducationalprograms']
```

In [70]:

```
# if there is a num in summary then we append it as 1 else 0
num_prs = []
for i in prs:
    if i.isalpha():
        num_prs.append(0)
    else:
```

```
        num_prs.append(1)
```

In [71]:

```
# presenting a new column

project['presence_of_digit_resource_summary'] = num_prs
```

In [72]:

```
project['presence_of_digit_resource_summary'].value_counts()
```

Out[72]:

```
0    93492
1    15756
Name: presence_of_digit_resource_summary, dtype: int64
```

In [73]:

```
# cross-checking the above column

project['project_resource_summary'][project['presence_of_digit_resource_summary'] == 1].head(7)
```

Out[73]:

```
12    My students need 3D and 4D life science activi...
14    My students need 5 tablets for our classroom t...
16    My students need 2 LeapPad that will engage th...
19    My students need 7 Hokki stools to encourage a...
25    My students need the learning centers and mult...
26    My students need 2 ipad minis to enhance learn...
39    My students need a class set of tablets to eng...
Name: project_resource_summary, dtype: object
```

In [74]:

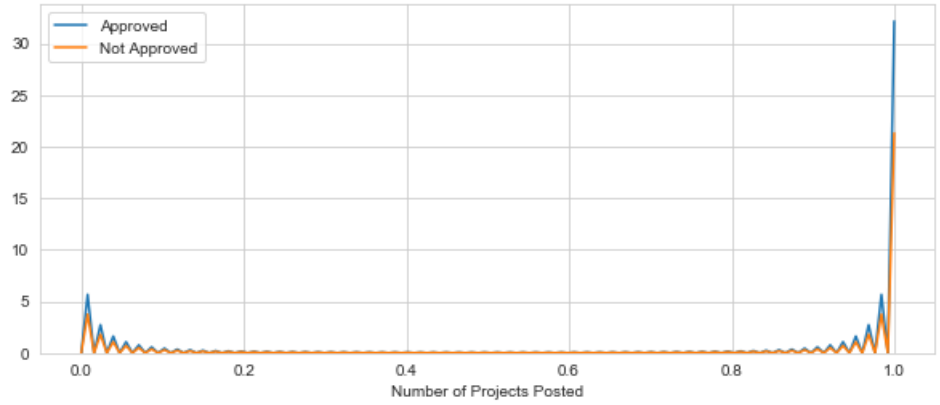
```
# digits for resource summary where project got approved.

approved_projects_digit = []
for i in project['presence_of_digit_resource_summary'][project['project_is_approved'] == 1][:]:
    approved_projects_digit.append(i)
```

In [75]:

```
# digits for resource summary where project not approved.

not_approved_projects_digit = []
for i in project['presence_of_digit_resource_summary'][project['project_is_approved'] == 0][:]:
    not_approved_projects_digit.append(i)
```

In [76]:

```
# Kernal density estimation plot.

plt.figure(figsize = (10,4))
sns.distplot(approved_projects_digit, hist=False, label = 'Approved')
sns.distplot(not_approved_projects_digit, hist=False, label = 'Not Approved')
plt.xlabel('Number of Projects Posted')
plt.legend()
plt.show()
```



Observations

- There are a total of 93492 summaries with no numericals and 15756 with numericals.
- In the above dist plot we can see the approved projects for numericals is higher almost at 89%.
- And the not approved projets with numericals stand at 11% which really is not an impact.
- We can see some figures below.

In [77]:

```
app = project['presence_of_digit_resource_summary'][(project['presence_of_digit_resource_summary'] == 1
) & (project['project_is_approved'] == 1)].count()
print('The approved projects containing digits: ',app)
```

```
The approved projects containing digits:  14090
```

In [78]:

```
napp = project['presence_of_digit_resource_summary'][(project['presence_of_digit_resource_summary'] ==
1) & (project['project_is_approved'] == 0)].count()
print('The projects not approved that contain digits: ',napp)
```

```
The projects not approved that contain digits:  1666
```

In [79]:

```
print('Approved percentage when there are digits in summary {:.2f}% and Not Approved are {:.2f}%'.forma
t(app/(app + napp), napp/(app + napp)))
```

```
Approved percentage when there are digits in summary 0.89% and Not Approved are 0.11%
```

1.3 Text Preprocessing

1.3.1 Project_Title

In [80]:

```
project['project_title'].head(10)
```

Out[80]:

```
0     Educational Support for English Learners at Home
1                 Wanted: Projector for Hungry Learners
2    Soccer Equipment for AWESOME Middle School Stu...
3                              Techie Kindergarteners
4                              Interactive Math Tools
5    Flexible Seating for Mrs. Jarvis' Terrific Thi...
6    Chromebooks for Special Education Reading Program
7                               It's the 21st Century
8                     Targeting More Success in Class
9      Just For the Love of Reading--\r\nPure Pleasure
Name: project_title, dtype: object
```

In [81]:

```
# Defining our function to remove punctuations and spl chars.

from bs4 import BeautifulSoup
import contractions
import re
from nltk.corpus import stopwords

sw = set(stopwords.words('english'))

def clean_sentence(text):
    text = BeautifulSoup(text, 'lxml').get_text()           # removes html tags such as <br />
    text = text.lower()                                     # converts text to lower case
    text = contractions.fix(text)                           # converts (don't) to (do not)
    text = re.sub('\W+',' ',text)                           # removes all special chars, punc
    text = ' '.join(e for e in text.split() if e not in sw) # removes stopwords
    text = ''.join([i for i in text if not i.isdigit()])    # removes numbers
    text = text.split()
    text1 = []
    for i in text:
        if "_" in i:
```

```
            del i                                       # removes string if it contains '_'
        else:
            text1.append(i)
    text = " ".join(text1)
    return text
```

In [82]:

```
# a new list

processed_title = [clean_sentence(i) for i in project['project_title']]
```

In [83]:

```
# checking the output.

processed_title[:10]
```

Out[83]:

```
['educational support english learners home',
 'wanted projector hungry learners',
 'soccer equipment awesome middle school students',
 'techie kindergarteners',
 'interactive math tools',
 'flexible seating mrs jarvis terrific third graders',
 'chromebooks special education reading program',
 'st century',
 'targeting success class',
 'love reading r npure pleasure']
```

1.3.2 Project_essay

In [84]:

```
# a sample row

project['essay'][20000]
```

Out[84]:

```
"My kindergarten students have varied disabilities ranging from speech and language delays, cognitive d
elays, gross/fine motor delays, to autism. They are eager beavers and always strive to work their harde
st working past their limitations. \\r\\n\\r\\nThe materials we have are the ones I seek out for my st
udents. I teach in a Title I school where most of the students receive free or reduced price lunch.  De
spite their disabilities and limitations, my students love coming to school and come eager to learn and
explore.Have you ever felt like you had ants in your pants and you needed to groove and move as you wer
e 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 g
ross motor and in Turn fine motor skills. \\r\\nThey also want to learn through games, my kids don't wa
nt 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 [85]:

```
processed_essay = [clean_sentence(i) for i in project['essay']]
```

In [86]:

```
processed_essay[20000]
```

Out[86]:

```
'kindergarten students varied disabilities ranging speech language delays cognitive delays gross fine m
otor delays autism eager beavers always strive work hardest working past limitations r n r nthe materia
ls ones seek students teach title school students receive free reduced price lunch despite disabilities
limitations students love coming school come eager learn explore ever felt like ants pants needed groov
e move meeting kids feel time want able move learn say wobble chairs answer love develop core enhances
gross motor turn fine motor skills r nthey also want learn games kids want sit worksheets want learn co
unt jumping playing physical engagement key success number toss color shape mats make happen students f
orget work fun year old deserves nannan'
```

Preparing Categorical, Text, Numerical Data

Categorical: ---> One hot encoding (some features require binary)

- teacher_prefix
- school_state
- project_grade_category
- cleaned_subject_categories
- project_subject_cleaned_subcategories

Text: ---> bow, tfidf, Average w2v, tfidf weighted w2v

- project_title
- essay
- project_resource_summary

Numerical: ---> standardization

- teacher_number_of_previously_posted_projects
- price
- quantity

1.4.1 Vectorizing Categorical Data

1.4.1.1 Cleaned_Subject_Categories

In [87]:

```
csc_vec = CountVectorizer(vocabulary = list(sorted_sub_cat_dict.keys()), lowercase = False, binary = True)
csc_vec.fit(project['project_subject_cleaned_categories'])
print(csc_vec.get_feature_names())
```

```
['Literacy_Language', 'Math_Science', 'Health_Sports', 'SpecialNeeds', 'AppliedLearning', 'Music_TheArts', 'History_Civics', 'Warmth', 'Care_Hunger']
```

In [88]:

```
csc_one_hot = csc_vec.transform(project['project_subject_cleaned_categories'])
print(csc_one_hot.shape)
```

```
(109248, 9)
```

In [89]:

```
# Checking the output

csc_one_hot_d = csc_one_hot.toarray()
csc_one_hot_d[:5]
```

Out[89]:

```
array([[1, 0, 0, 0, 0, 0, 0, 0, 0],
       [0, 0, 1, 0, 0, 0, 1, 0, 0],
       [0, 0, 1, 0, 0, 0, 0, 0, 0],
       [1, 1, 0, 0, 0, 0, 0, 0, 0],
       [0, 1, 0, 0, 0, 0, 0, 0, 0]], dtype=int64)
```

1.4.1.2 Cleaned_Subject_Subcategories

In [90]:

```
cssc_vec = CountVectorizer(vocabulary = list(sorted_sub_subcat_dict.keys()), lowercase = False,binary = True)
cssc_vec.fit(project['project_subject_cleaned_subcategories'])
print(cssc_vec.get_feature_names())
```

```
['Literacy', 'Mathematics', 'Literature_Writing', 'SpecialNeeds', 'AppliedSciences', 'Health_Wellness', 'VisualArts', 'EnvironmentalScience', 'Gym_Fitness', 'ESL', 'EarlyDevelopment', 'Health_LifeScience', 'History_Geography', 'Music', 'College_CareerPrep', 'Other', 'TeamSports', 'CharacterEducation', 'PerformingArts', 'SocialSciences', 'Warmth', 'Care_Hunger', 'NutritionEducation', 'ForeignLanguages', 'Civics_Government', 'Extracurricular', 'ParentInvolvement', 'FinancialLiteracy', 'CommunityService', 'Economics']
```

In [91]:

```
cssc_one_hot = cssc_vec.transform(project['project_subject_cleaned_subcategories'])
print(cssc_one_hot.shape)
```

```
(109248, 30)
```

In [92]:

```
# Checking the output

cssc_one_hot_d = cssc_one_hot.toarray()
cssc_one_hot_d[:5]
```

Out[92]:

```
array([[1, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0],
       [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
        0, 0, 1, 0, 0, 0, 0, 0],
       [0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0],
       [1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0],
       [0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0]], dtype=int64)
```

1.4.1.3 School_state

In [93]:

```
my_counter = Counter()
for i in project['school_state']:
    my_counter.update(i.split())

print(my_counter)
print()
print(len(my_counter))
```

```
Counter({'CA': 15388, 'TX': 7396, 'NY': 7318, 'FL': 6185, 'NC': 5091, 'IL': 4350, 'GA': 3963, 'SC': 393
6, 'MI': 3161, 'PA': 3109, 'IN': 2620, 'MO': 2576, 'OH': 2467, 'LA': 2394, 'MA': 2389, 'WA': 2334, 'OK'
: 2276, 'NJ': 2237, 'AZ': 2147, 'VA': 2045, 'WI': 1827, 'AL': 1762, 'UT': 1731, 'TN': 1688, 'CT': 1663,
'MD': 1514, 'NV': 1367, 'MS': 1323, 'KY': 1304, 'OR': 1242, 'MN': 1208, 'CO': 1111, 'AR': 1049, 'ID': 6
93, 'IA': 666, 'KS': 634, 'NM': 557, 'DC': 516, 'HI': 507, 'ME': 505, 'WV': 503, 'NH': 348, 'AK': 345,
'DE': 343, 'NE': 309, 'SD': 300, 'RI': 285, 'MT': 245, 'ND': 143, 'WY': 98, 'VT': 80})

51
```

In [94]:

```
ss_vec = CountVectorizer(vocabulary = list(my_counter.keys()), lowercase = False,binary = True)
ss_vec.fit(project['school_state'])
print(ss_vec.get_feature_names())
```

```
['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']
```

In [95]:

```
ss_one_hot = ss_vec.transform(project['school_state'])
print(ss_one_hot.shape)
```

```
(109248, 51)
```

In [96]:

```
# Checking the output

ss_one_hot_d = ss_one_hot.toarray()
ss_one_hot_d[:5]
```

Out[96]:

```
array([[1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
        0, 0, 0, 0, 0, 0, 0],
       [0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
```

```
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0],
[0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0],
[0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0],
[0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
 0, 0, 0, 0, 0, 0, 0]], dtype=int64)
```

1.4.1.4 Teacher_Prefix

In [97]:

```
project['teacher_prefix'].value_counts()
```

Out[97]:

```
Mrs.       57269
Ms.        38955
Mr.        10648
Teacher     2360
Dr.           13
Name: teacher_prefix, dtype: int64
```

In [98]:

```
project[['teacher_prefix']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 109248 entries, 0 to 109247
Data columns (total 1 columns):
teacher_prefix    109245 non-null object
dtypes: object(1)
memory usage: 853.6+ KB
```

In [99]:

```
# there are 3 null values and we ffill them

project['teacher_prefix'].ffill(inplace = True)
```

In [100]:

```
b=[]
for i in project['teacher_prefix'][:]:
    i = i.replace('.','')
    b.append(i)
```

In [101]:

```
project['teacher_prefix'] = b
```

In [102]:

```
my_counter = Counter()
for i in project['teacher_prefix'][:]:
    my_counter.update(i.split())

print(my_counter)
print()
print(len(my_counter))
```

```
Counter({'Mrs': 57271, 'Ms': 38956, 'Mr': 10648, 'Teacher': 2360, 'Dr': 13})

5
```

In [103]:

```
tp_vec = CountVectorizer(vocabulary = list(my_counter.keys()), lowercase = False)
tp_vec.fit(project['teacher_prefix'])
print(tp_vec.get_feature_names())
```

```
['Mrs', 'Mr', 'Ms', 'Teacher', 'Dr']
```

In [104]:

```
tp_one_hot = tp_vec.transform(project['teacher_prefix'])
print(tp_one_hot.shape)
```

```
(109248, 5)
```

In [105]:

```
# Checking the output

tp_one_hot_d = tp_one_hot.toarray()
tp_one_hot_d[:5]
```

Out[105]:

```
array([[1, 0, 0, 0, 0],
       [0, 1, 0, 0, 0],
       [0, 0, 1, 0, 0],
       [1, 0, 0, 0, 0],
       [1, 0, 0, 0, 0]], dtype=int64)
```

1.4.1.5 Project_grade_category

In [106]:

```
project['project_grade_category'].value_counts()
```

Out[106]:

```
Grades PreK-2    44225
Grades 3-5       37137
Grades 6-8       16923
Grades 9-12      10963
Name: project_grade_category, dtype: int64
```

In [107]:

```
a = []
for i in project['project_grade_category'][:]:
    i = i.replace(' ','').replace('-','_')
    a.append(i)
```

In [108]:

```
project['project_grade_category'] = a
```

In [109]:

```
my_counter = Counter()
for i in project['project_grade_category'][:]:
    my_counter.update(i.split())

print(my_counter)
print()
print(len(my_counter))
```

```
Counter({'GradesPreK_2': 44225, 'Grades3_5': 37137, 'Grades6_8': 16923, 'Grades9_12': 10963})

4
```

In [110]:

```
project['project_grade_category'].head()
```

Out[110]:

```
0    GradesPreK_2
1       Grades6_8
2       Grades6_8
3    GradesPreK_2
4    GradesPreK_2
Name: project_grade_category, dtype: object
```

In [111]:

```
pgc_vec = CountVectorizer(vocabulary = list(my_counter.keys()), binary = True, lowercase=False)
pgc_vec.fit(project['project_grade_category'])
```

```
print(pgc_vec.get_feature_names())
```

```
['GradesPreK_2', 'Grades6_8', 'Grades3_5', 'Grades9_12']
```

In [112]:

```
pgc_one_hot = pgc_vec.transform(project['project_grade_category'].values)
print(pgc_one_hot.shape)
```

```
(109248, 4)
```

In [113]:

```
# Checking the output

pgc_one_hot_d = pgc_one_hot.toarray()
pgc_one_hot_d[:5]
```

Out[113]:

```
array([[1, 0, 0, 0],
       [0, 1, 0, 0],
       [0, 1, 0, 0],
       [1, 0, 0, 0],
       [1, 0, 0, 0]], dtype=int64)
```

1.4.2 Vectorizing Data

1.4.2.1 bow on processed title

In [114]:

```
bow = CountVectorizer(min_df=10)
title_bow = bow.fit_transform(processed_title)
print(title_bow.shape)
```

```
(109248, 3191)
```

1.4.2.2 Tfidf on processed title

In [115]:

```
tfidf = TfidfVectorizer(min_df = 10)
title_tfidf = tfidf.fit_transform(processed_title)
print(title_tfidf.shape)
```

```
(109248, 3191)
```

1.4.2.3 bow on processed essay

In [116]:

```
essay_bow = bow.fit_transform(processed_essay)
print(essay_bow.shape)
```

```
(109248, 16840)
```

1.4.2.4 bow on processed resource summary

In [117]:

```
project['project_resource_summary'][26]
```

Out[117]:

```
'My students need 2 ipad minis to enhance learning in all content areas!'
```

In [118]:

```
processed_resource_summary = [clean_sentence(i) for i in project['project_resource_summary']]
```

In [119]:

```
processed_resource_summary[26]
```

Out[119]:

```
'students need ipad minis enhance learning content areas'
```

In [120]:

```
prs_bow = bow.fit_transform(processed_resource_summary)
print(prs_bow.shape)
```

```
(109248, 5652)
```

1.4.2.5 Tfidf on processed essay

In [121]:

```
essay_tfidf = tfidf.fit_transform(processed_essay) # fit and transform
print(essay_tfidf.shape)
```

```
(109248, 16840)
```

1.4.2.6 Tfidf on processed resource summary

In [122]:

```
tfidf_prs = tfidf.fit_transform(processed_resource_summary)
print(tfidf_prs.shape)
```

```
(109248, 5652)
```

Average W2V using glove vectors

In [123]:

```
with open(r'C:\Users\Bharat Bhimshetty\Desktop\Python\Applied AI Course\Assignments\Assignment 2\glove
_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words = set(model.keys())
```

In [124]:

```
# https://stackoverflow.com/a/40737853/10219869 , slicing a set using itertools.

import itertools
print(set(itertools.islice(glove_words,5)))
```

```
{'braincase', 'rewired', 'facial', 'schlosser', 'animator'}
```

In [125]:

```
# AAIC word corpus
len(glove_words)
```

Out[125]:

```
51510
```

1.4.2.7 Average W2V on Processed title

In [126]:

```
avg_w2v_pt = []
for i in tqdm(processed_title):
    vec = np.zeros(300)
    count_words = 0
    for j in i.split():
        try:
            if j in glove_words:
                vec += model[j]
                count_words = 1
        except:
            pass
        vec /= count_words
```

```
    avg_w2v_pt.append(vec)
```

```
100%|██████████| 109248/109248 [00:06<00:00, 17934.20it/s]
```

In [127]:

```
print(len(avg_w2v_pt))
print(len(avg_w2v_pt[0]))
```

```
109248
300
```

In [128]:

```
# fortunately there are no inf or -inf values.

len(np.where(np.isinf(avg_w2v_pt))[0])
```

Out[128]:

```
0
```

In [129]:

```
# We check for any nan values.

len(np.where(np.isnan(avg_w2v_pt))[0]) / 300
```

Out[129]:

```
784.0
```

In [130]:

```
# We convert nan values to zero
# https://stackoverflow.com/a/33490774/10219869

avg_w2v_pt = np.array(avg_w2v_pt)
avg_w2v_pt[np.isnan(avg_w2v_pt)] = 0
```

In [131]:

```
# We check for any nan values.

len(np.where(np.isnan(avg_w2v_pt))[0]) / 300
```

Out[131]:

```
0.0
```

1.4.2.8 Average W2V on Processed essay

In [132]:

```
avg_w2v_pe = []
for i in tqdm(processed_essay):
    vec = np.zeros(300)
    count_words = 0
    for j in i.split():
        try:
            if j in glove_words:
                vec += model[j]
                count_words += 1
        except:
            pass
        vec /= count_words
    avg_w2v_pe.append(vec)
```

```
100%|██████████| 109248/109248 [03:16<00:00, 555.64it/s]
```

In [133]:

```
print(len(avg_w2v_pe))
print()
print(len(avg_w2v_pe[0]))
```

```
109248

300
```

In [134]:

```
# We check for any inf or -inf values.

len(np.where(np.isinf(avg_w2v_pe))[0])
```

Out[134]:

```
0
```

In [135]:

```
# We check for any nan values.

len(np.where(np.isnan(avg_w2v_pe))[0]) / 300
```

Out[135]:

```
86.0
```

In [136]:

```
# We convert nan values to zero
# https://stackoverflow.com/a/33490774/10219869
avg_w2v_pe = np.array(avg_w2v_pe)
avg_w2v_pe[np.isnan(avg_w2v_pe)] = 0
```

In [137]:

```
# We check for any nan values.

len(np.where(np.isnan(avg_w2v_pe))[0]) / 300
```

Out[137]:

```
0.0
```

1.4.2.9 Average W2V on Processed resource summary

In [138]:

```
avg_w2v_prs = []
for i in tqdm(processed_resource_summary):
    vec = np.zeros(300)
    count_words = 0
    for j in i.split():
        try:
            if j in glove_words:
                vec += model[j]
                count_words = 1
        except:
            pass
        vec /= count_words
    avg_w2v_prs.append(vec)
```

```
100%|██████████| 109248/109248 [00:17<00:00, 6084.00it/s]
```

In [139]:

```
print(len(avg_w2v_prs))
print(len(avg_w2v_prs[0]))
```

```
109248
300
```

1.4.2.10 Tf-idf Weighted W2V on Processed title

In [140]:

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

In [141]:

```
tfidf_w2v_pt = []                       # tfidf for each row in cleaned text is stored
for title in tqdm(processed_title):
    vector = np.zeros(300)
    weighted_sum = 0
    for word in title.split():
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word]
            # here we are multiplying idf value(title_dict[j]) and the tf value((i.count(j)/len(i.split
())))
            Tfidf = title_dict[word] * (title.count(word) / len(title.split())) # # getting the tfidf v
alue for each word
            vector += (vec * Tfidf)     # calculating tfidf weighted w2v
            weighted_sum += Tfidf
    if weighted_sum != 0:
        vector /= weighted_sum
    tfidf_w2v_pt.append(vector)
```

```
100%|██████████| 109248/109248 [00:11<00:00, 9472.64it/s]
```

In [142]:

```
print(len(tfidf_w2v_pt))
print(len(tfidf_w2v_pt[0]))
```

```
109248
300
```

In [143]:

```
# We check for any inf or -inf.

len(np.where(np.isinf(tfidf_w2v_pt))[0]) / 300
```

Out[143]:

```
0.0
```

In [144]:

```
# We check for any nan values.

len(np.where(np.isnan(tfidf_w2v_pt))[0]) / 300
```

Out[144]:

```
0.0
```

1.4.2.11 Tf-idf Weighted W2V on Processed essay

In [145]:

```
tfidf = TfidfVectorizer()
tfidf.fit(processed_essay)
# we are converting a dictionary with word as a key, and the idf as a value
essay_dict = dict(zip(tfidf.get_feature_names(), tfidf.idf_))
essay_words = set(tfidf.get_feature_names())
```

In [146]:

```
tfidf_w2v_pe = []                       # tfidf for each row in cleaned text is stored
for essay in tqdm(processed_essay):
    vector = np.zeros(300)
    weighted_sum = 0
    for word in essay.split():
        if (word in glove_words) and (word in essay_words):
            vec = model[word]
            # here we are multiplying idf value(title_dict[j]) and the tf value((i.count(j)/len(i.split
())))
            Tfidf = essay_dict[word] * (essay.count(word) / len(essay.split())) # # getting the tfidf v
alue for each word
            vector += (vec * Tfidf)     # calculating tfidf weighted w2v
            weighted_sum += Tfidf
    if weighted_sum != 0:
        vector /= weighted_sum
    tfidf_w2v_pe.append(vector)
```

```
100%|██████████| 109248/109248 [08:33<00:00, 212.57it/s]
```

In [147]:

```
print(len(tfidf_w2v_pe))
print()
print(len(tfidf_w2v_pe[0]))
```

```
109248

300
```

In [148]:

```
# We check for any inf or -inf.

len(np.where(np.isinf(tfidf_w2v_pe))[0]) / 300
```

Out[148]:

```
0.0
```

In [149]:

```
# We check for any nan values.

len(np.where(np.isnan(tfidf_w2v_pe))[0]) / 300
```

Out[149]:

```
0.0
```

1.4.3 Vectorizing Numerical features

1.4.3.1 price standardization

In [150]:

```
price_scale = StandardScaler()
price_scale.fit(project_resource['price'].values.reshape(-1,1)) # we want (1 column and unknown row)
```

Out[150]:

```
StandardScaler(copy=True, with_mean=True, with_std=True)
```

In [151]:

```
mean = price_scale.mean_
std = np.sqrt(price_scale.var_)
print(f'Mean: {np.around(mean)} and Standard deviation {np.around(std)}')
```

```
Mean: [298.] and Standard deviation [367.]
```

In [152]:

```
# we standardize the data with above mean and variance

price_standardized = price_scale.transform(project_resource['price'].values.reshape(-1,1))
```

In [153]:

```
# Checking the output

price_standardized
```

Out[153]:

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

1.4.3.2 teacher number of previously posted projects - standardization

In [154]:

```
tnppp_scale = StandardScaler()
tnppp_scale.fit(project_resource['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
```

```
C:\Desktop\Python\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.
```

Out[154]:

```
StandardScaler(copy=True, with_mean=True, with_std=True)
```

In [155]:

```
print(f'Mean: {np.round(tnppp_scale.mean_)} and Standard deviation: {np.round(np.sqrt(tnppp_scale.var_
))}')
```

```
Mean: [11.] and Standard deviation: [28.]
```

In [156]:

```
tnppp_standardized = tnppp_scale.transform(project_resource['teacher_number_of_previously_posted_projec
ts'].values.reshape(-1,1))
```

```
C:\Desktop\Python\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.
```

In [157]:

```
# Checking the output

tnppp_standardized
```

Out[157]:

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

1.4.3.3 quantity standardization

In [158]:

```
quantity_scale = StandardScaler()
quantity_scale.fit(project_resource['quantity'].values.reshape(-1,1))
```

```
C:\Desktop\Python\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.
```

Out[158]:

```
StandardScaler(copy=True, with_mean=True, with_std=True)
```

In [159]:

```
print(f'Mean: {np.round(quantity_scale.mean_)} and Standard deviation: {np.round(np.sqrt(quantity_scal
e.var_))}')
```

```
Mean: [17.] and Standard deviation: [26.]
```

In [160]:

```
quantity_standardized = quantity_scale.transform(project_resource['quantity'].values.reshape(-1,1))
```

```
C:\Desktop\Python\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: DataConversionWarning:

Data with input dtype int64 was converted to float64 by StandardScaler.
```

In [161]:

```
# Checking the output
```

```
# Checking the output

quantity_standardized
```

Out[161]:

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

1.4.4 Merging the above features

In [162]:

```
print(csc_one_hot.shape, ': Cleaned subject caterogies')
print(cssc_one_hot.shape, ': Cleaned subject subcaterogies')
print(ss_one_hot.shape, ': School state')
print(tp_one_hot.shape, ': Teacher prefix')
print(pgc_one_hot.shape, ': Project grade category')
print(title_bow.shape, ': Processed Title BOW')
print(title_tfidf.shape, ': Processed Title Tfidf')
print(len(avg_w2v_pt), ': Processed Title Avg W2V')
print(len(tfidf_w2v_pt), ': Processed Title Tfidf Weighted W2V')
print(price_standardized.shape, ': Price Standardization')
print(tnppp_standardized.shape, ': Teacher numper of previously posted projects Standardization')
```

```
(109248, 9) : Cleaned subject caterogies
(109248, 30) : Cleaned subject subcaterogies
(109248, 51) : School state
(109248, 5) : Teacher prefix
(109248, 4) : Project grade category
(109248, 3191) : Processed Title BOW
(109248, 3191) : Processed Title Tfidf
109248 : Processed Title Avg W2V
109248 : Processed Title Tfidf Weighted W2V
(109248, 1) : Price Standardization
(109248, 1) : Teacher numper of previously posted projects Standardization
```

Assignment 2: Apply TSNE

1. In the above cells we have plotted and analyzed many features. Please observe the plots and write the observations in markdown cells below every plot.
2. EDA: Please complete the analysis of the feature: teacher_number_of_previously_posted_projects
3. Build the data matrix using these features
   - school_state : categorical data (one hot encoding)
   - clean_categories : categorical data (one hot encoding)
   - clean_subcategories : categorical data (one hot encoding)
   - teacher_prefix : categorical data (one hot encoding)
   - project_grade_category : categorical data (one hot encoding)
   - project_title : text data (BOW, TFIDF, AVG W2V, TFIDF W2V)
   - price : numerical
   - teacher_number_of_previously_posted_projects : numerical
4. Now, plot FOUR t-SNE plots with each of these feature sets.
   A. categorical, numerical features + project_title(BOW)
   B. categorical, numerical features + project_title(TFIDF)
   C. categorical, numerical features + project_title(AVG W2V)
   D. categorical, numerical features + project_title(TFIDF W2V)
5. Concatenate all the features and Apply TNSE on the final data matrix
6. Note 1: The TSNE accepts only dense matrices
7. Note 2: Consider only 5k to 6k data points to avoid memory issues. If you run into memory error issues, reduce the number of data points but clearly state the number of datat-poins you are using

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

In [163]:

```
# hstack of numerical (2) featurs and categorical features (5), Project_title BOW (1)

from scipy.sparse import hstack

title_bow = title_bow.tocsr()
x_title_bow = hstack((csc_one_hot, cssc_one_hot, ss_one_hot, tp_one_hot, pgc_one_hot, price_standardize
d, tnppp_standardized, title_bow))
x_title_bow.shape
```

Out[163]:

```
(109248, 3292)
```

In [164]:

```
# https://stackoverflow.com/a/30175105/10219869 (matrix 'x' output is coo_matrix (coordinate format)
# and we need to convert to csr_matrix (compressed sparse row format))
# Then we apply T-SNE


from sklearn.manifold import TSNE
tsne = TSNE()

x_title_bow = x_title_bow.tocsr()
x_bow5000 = x_title_bow[:5000]
tsne_title_bow = tsne.fit_transform(x_bow5000.toarray())

# bringing x_title_bow (3292) dimentions to 2 dimentions

tsne_title_bow.shape
```

Out[164]:

```
(5000, 2)
```

In [165]:

```
# https://stackoverflow.com/a/41989993/10219869

bow_tsne = np.column_stack((tsne_title_bow, project['project_is_approved'][:5000]))
bow_tsne.shape
```

Out[165]:

```
(5000, 3)
```

In [166]:

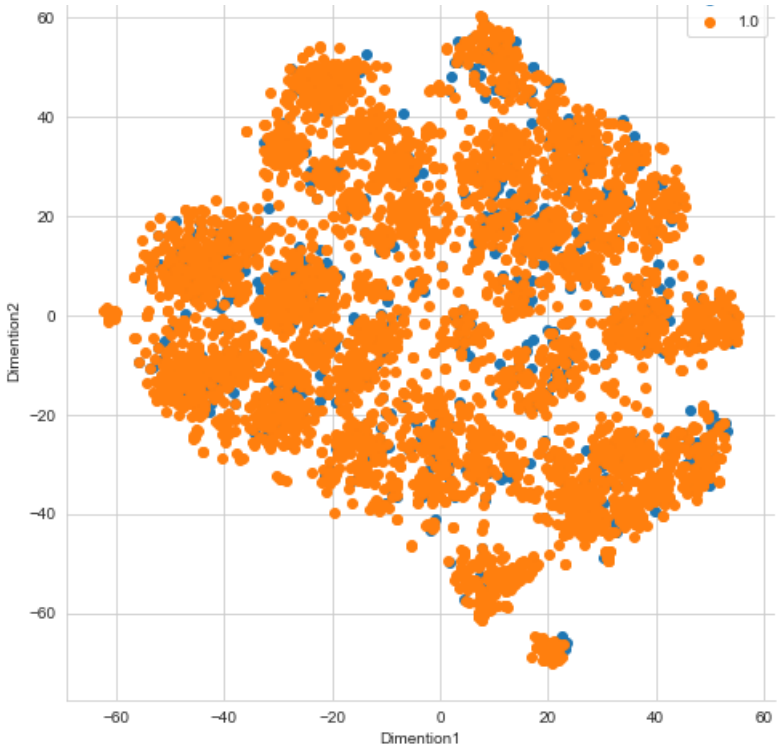
```
# We create a dataframe for 2 dimentions and a binary class label.

df_bow = pd.DataFrame(bow_tsne, columns = ['Dimention1', 'Dimention2', 'Project_approved_unapproved'])
df_bow.head()
```

Out[166]:

	Dimention1	Dimention2	Project_approved_unapproved
0	-48.135483	12.628063	0.0
1	48.738190	-26.293175	1.0
2	41.727901	-24.581388	0.0
3	-20.768230	46.092354	1.0
4	9.088734	27.165798	1.0

In [167]:

```
# We design T-SNE for first 5000 datapoints.

sns.FacetGrid(df_bow, hue = 'Project_approved_unapproved', height = 7).map(plt.scatter, 'Dimention1', '
Dimention2')
plt.title('T-SNE plot for Bag of Words vs Numerical and Categorical features')
plt.legend()
plt.show()
```



Observations

- The orange color depicts that projects are approved and assigned class label is 1. And for blue color it is projects not approved and assigned class label is 0.
- We can observe the points in BOW T-SNE are formed in clusters which are close to each other and are overlapped with blue dots..

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

In [168]:

```
# hstack of numerical (2) featurs and categorical (5) features , Project_title Tfidf (1)

title_tfidf = title_tfidf.tocsr()
x_title_tfidf = hstack((csc_one_hot, cssc_one_hot, ss_one_hot, tp_one_hot, pgc_one_hot, price_standardi
zed, tnppp_standardized, title_tfidf))
x_title_tfidf.shape
```

Out[168]:

```
(109248, 3292)
```

In [169]:

```
# https://stackoverflow.com/a/30175105/10219869 (matrix 'x' output is coo_matrix (coordinate format)
# and we need to convert to csr_matrix (compressed sparse row format))
# Then we apply T-SNE

x_title_tfidf = x_title_tfidf.tocsr()
x_tfidf5000 = x_title_tfidf[:5000]
tsne_title_tfidf = tsne.fit_transform(x_tfidf5000.toarray())

# bringing x_title_tfidf (3292) dimentions to 2 dimentions

tsne_title_tfidf.shape
```

Out[169]:

```
(5000, 2)
```

In [170]:

```
# https://stackoverflow.com/a/41989993/10219869

tfidf_tsne = np.column_stack((tsne_title_tfidf, project['project_is_approved'][:5000]))
tfidf_tsne.shape
```

Out[170]:

```
(5000, 3)
```

In [171]:

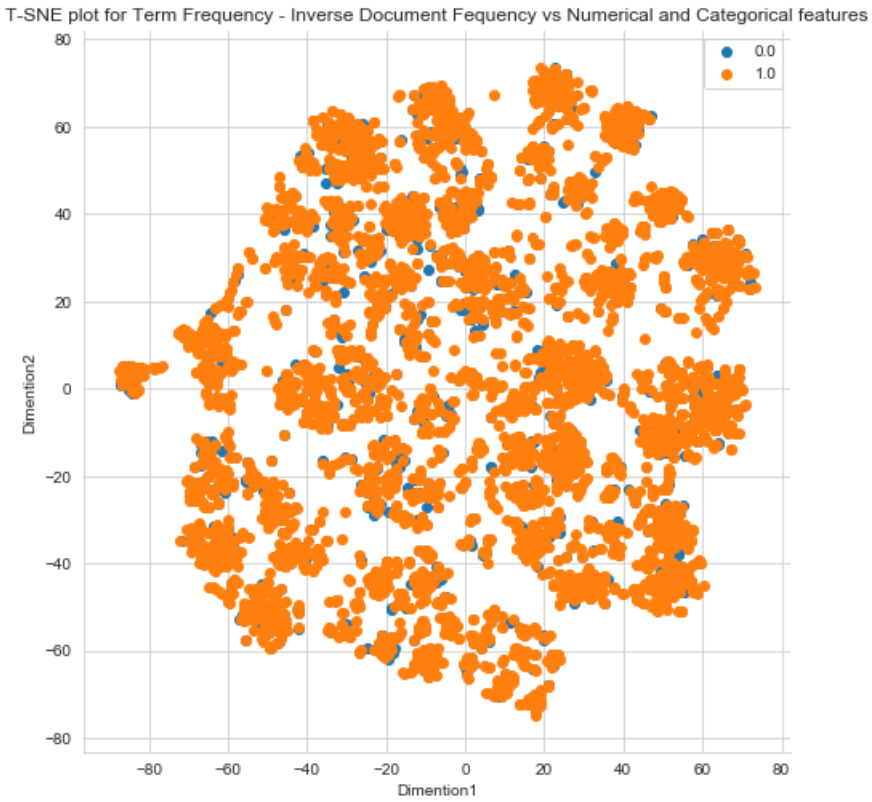
```
# We create a dataframe with 2 dimentions and a binary class label.

df_tfidf = pd.DataFrame(tfidf_tsne, columns = ['Dimention1', 'Dimention2', 'Project_approved_unapproved
'])
df_tfidf.head()
```

Out[171]:

	Dimention1	Dimention2	Project_approved_unapproved
0	69.691498	0.144981	0.0
1	-61.891365	-18.266775	1.0
2	-55.515419	-21.190441	0.0
3	63.076767	30.725538	1.0
4	-6.787931	59.004528	1.0

In [172]:

```
# We design T-SNE for first 5000 datapoints.

sns.FacetGrid(df_tfidf, hue = 'Project_approved_unapproved', height = 7).map(plt.scatter, 'Dimention1',
'Dimention2')
plt.title('T-SNE plot for Term Frequency - Inverse Document Fequency vs Numerical and Categorical featu
res')
plt.legend()
plt.show()
```



Observations

- The orange color depicts that projects are approved and assigned class label is 1. And for blue color it is projects not approved and assigned class label is 0.
- We can observe the points in Tfidf T-SNE are scattered and are overlapped but we can see some clusters not that dense as previouss.

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

In [173]:

```
# hstack of numerical (2) features and categorical (5) features , Project_title Average W2V (1)

avg_w2v_pt = np.array(avg_w2v_pt)
x_title_AvgW2V = hstack((csc_one_hot, cssc_one_hot, ss_one_hot, tp_one_hot, pgc_one_hot, price_standard
ized, tnppp_standardized, avg_w2v_pt))
x_title_AvgW2V.shape
```

Out[173]:

```
(109248, 401)
```

In [174]:

```
# https://stackoverflow.com/a/30175105/10219869 (matrix 'x' output is coo_matrix (coordinate format)
# and we need to convert to csr_matrix (compressed sparse row format))
# Then we apply T-SNE

x_title_AvgW2V = x_title_AvgW2V.tocsr()
x_AvgW2V5000 = x_title_AvgW2V[:5000]
tsne_title_AvgW2V = tsne.fit_transform(x_AvgW2V5000.toarray())

# bringing x_title_AvgW2V (401) dimentions to 2 dimentions

tsne_title_AvgW2V.shape
```

Out[174]:

```
(5000, 2)
```

In [175]:

```
# https://stackoverflow.com/a/41989993/10219869

avg_w2v_tsne = np.column_stack((tsne_title_AvgW2V, project['project_is_approved'][:5000]))
avg_w2v_tsne.shape
```

Out[175]:

```
(5000, 3)
```

In [176]:

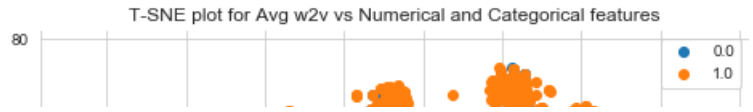
```
# We create a dataframe with 2 dimentions and a binary class label.

df_avg_w2v = pd.DataFrame(avg_w2v_tsne, columns = ['Dimention1', 'Dimention2', 'Project_approved_unappr
oved'])
df_avg_w2v.head()
```

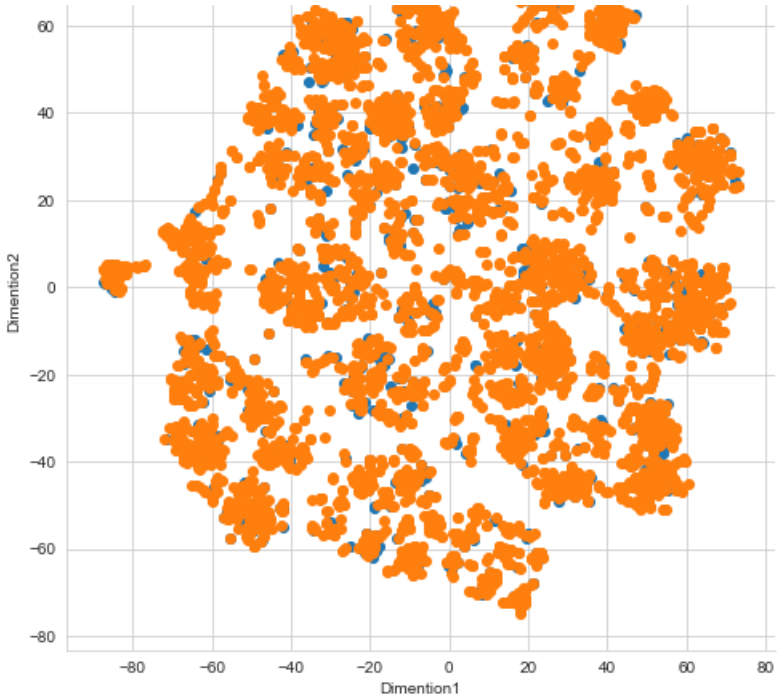
Out[176]:

	Dimention1	Dimention2	Project_approved_unapproved
0	40.590145	46.245464	0.0
1	-41.724751	-2.392165	1.0
2	-0.911976	66.311897	0.0
3	11.257945	-61.307606	1.0
4	28.081192	-8.649153	1.0

In [177]:

```
# We design T-SNE for first 5000 datapoints.

sns.FacetGrid(df_tfidf, hue = 'Project_approved_unapproved', height = 7).map(plt.scatter, 'Dimention1',
'Dimention2')
plt.title('T-SNE plot for Avg w2v vs Numerical and Categorical features')
plt.legend()
plt.show()
```





Observations

- The orange color depicts that projects are approved and assigned class label is 1. And for blue color it is projects not approved and assigned class label is 0.
- We can observe the points in Average W2V T-SNE are scattered and are overlapped but we can see clusters almost similar to Tfidf.

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

In [178]:

```
# hstack of numerical (2) features and categorical (5) features , Project_title Tfidf weighted W2V (1)

x_tfidf_w_w2v = np.array(tfidf_w2v_pt)
x_title_tfidfwW2V = hstack((csc_one_hot, cssc_one_hot, ss_one_hot, tp_one_hot, pgc_one_hot, price_stand
ardized, tnppp_standardized, x_tfidf_w_w2v))
x_title_tfidfwW2V.shape
```

Out[178]:

```
(109248, 401)
```

In [179]:

```
# https://stackoverflow.com/a/30175105/10219869 (matrix 'x' output is coo_matrix (coordinate format)
# and we need to convert to csr_matrix (compressed sparse row format))
# Then we apply T-SNE

x_title_tfidfwW2V = x_title_tfidfwW2V.tocsr()
x_tfidfwW2V5000 = x_title_tfidfwW2V[:5000]
tsne_title_tfidfwW2V = tsne.fit_transform(x_tfidfwW2V5000.toarray())

# bringing x_title_tfidfwW2V (401) dimentions to 2 dimentions

tsne_title_tfidfwW2V.shape
```

Out[179]:

```
(5000, 2)
```

In [180]:

```
# https://stackoverflow.com/a/41989993/10219869

tfidf_w2v_tsne = np.column_stack((tsne_title_tfidfwW2V, project['project_is_approved'][:5000]))
tfidf_w2v_tsne.shape
```

Out[180]:

```
(5000, 3)
```

In [181]:

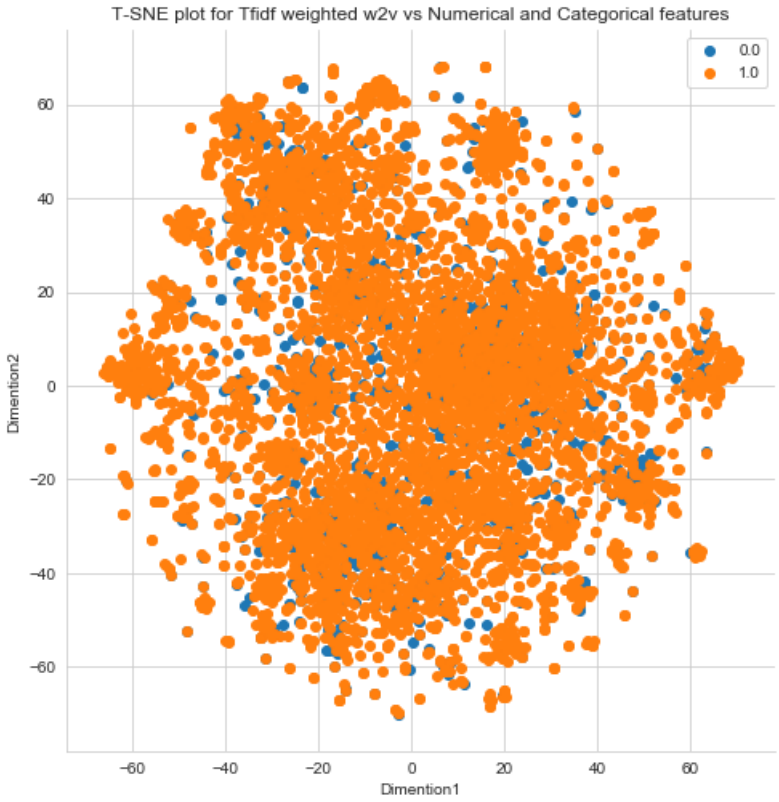
```
# We create a dataframe with 2 dimentions and a binary class label.

df_tfidf_w_w2v = pd.DataFrame(tfidf_w2v_tsne, columns = ['Dimention1', 'Dimention2', 'Project_approved_unapproved'])
df_tfidf_w_w2v.head()
```

Out[181]:

	Dimention1	Dimention2	Project_approved_unapproved
0	38.569233	-3.012925	0.0
1	-30.473494	54.201756	1.0
2	-37.659996	55.101582	0.0
3	25.728868	-33.869778	1.0
4	11.121451	-45.624763	1.0

In [182]:

```
# We design T-SNE for first 5000 datapoints.

sns.FacetGrid(df_tfidf_w_w2v, hue = 'Project_approved_unapproved', height = 7).map(plt.scatter, 'Dimention1', 'Dimention2')
plt.title('T-SNE plot for Tfidf weighted w2v vs Numerical and Categorical features')
plt.legend()
plt.show()
```



Observations

- The orange color depicts that projects are approved and assigned class label is 1. And for blue color it is projects not approved and assigned class label is 0.
- We can observe the points in Weighted W2V T-SNE are scattered and are overlapped worse than Average Tfidf.

2.5 TSNE with 'BOW', 'TFIDF', 'AVG W2V', `TFIDF Weighted W2V` encoding of `project_title` feature

In [183]:

```
# hstack of numerical (2) features and categorical (5) features , Project_title Tfidf weighted W2V (1)

x_title_all = hstack((csc_one_hot, cssc_one_hot, ss_one_hot, tp_one_hot, pgc_one_hot, price_standardize
d, tnppp_standardized, title_bow, title_tfidf, avg_w2v_pt, x_tfidf_w_w2v))
x_title_all.shape
```

Out[183]:

```
(109248, 7083)
```

In [184]:

```
# https://stackoverflow.com/a/30175105/10219869 (matrix 'x' output is coo_matrix (coordinate format)
# and we need to convert to csr_matrix (compressed sparse row format))
# Then we apply T-SNE

x_title_all = x_title_all.tocsr()
x_all5000 = x_title_all[:5000]
tsne_title_all = tsne.fit_transform(x_all5000.toarray())

# bringing x_title_tfidfwW2V (401) dimentions to 2 dimentions

tsne_title_all.shape
```

Out[184]:

```
(5000, 2)
```

In [185]:

```
# https://stackoverflow.com/a/41989993/10219869

all_tsne = np.column_stack((tsne_title_all, project['project_is_approved'][:5000]))
all_tsne.shape
```

Out[185]:

```
(5000, 3)
```

In [186]:

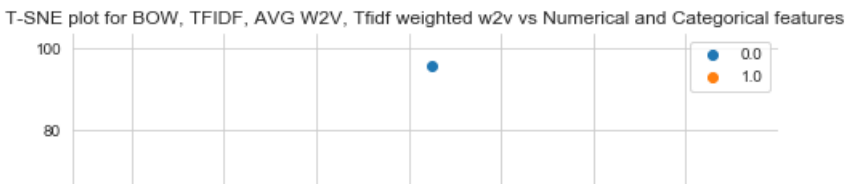
```
# We create a dataframe with 2 dimentions and a binary class label.

df_title_all = pd.DataFrame(all_tsne, columns = ['Dimention1', 'Dimention2', 'Project_approved_unapprov
ed'])
df_title_all.head()
```

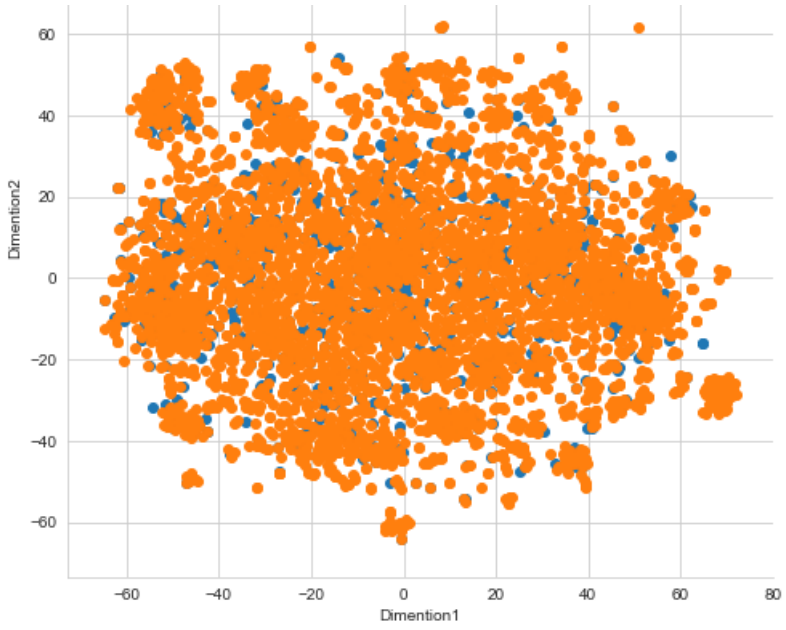
Out[186]:

	Dimention1	Dimention2	Project_approved_unapproved
0	-29.750196	-27.330162	0.0
1	-1.696946	54.051628	1.0
2	-52.176514	18.111908	0.0
3	54.596596	-15.566402	1.0
4	6.802349	-30.261414	1.0

In [187]:

```
# We design T-SNE for first 5000 datapoints.

sns.FacetGrid(df_title_all, hue = 'Project_approved_unapproved', height = 7).map(plt.scatter, 'Dimentio
n1', 'Dimention2')
plt.title('T-SNE plot for BOW, TFIDF, AVG W2V, Tfidf weighted w2v vs Numerical and Categorical features
')
plt.legend()
plt.show()
```





Observations

- The orange color depicts that projects are approved and assigned class label is 1. And for blue color it is projects not approved and assigned class label is 0.
- We can observe the points when we mix up the BOW, TFIDF, AVG W2V, Weighted W2V, the T-SNE are mixed up and are overlapped worse than Tfidf weighted W2V.

Conclusion

- The T-SNE plot with TFIDF and Avg W2V can be considered apart from other T-SNE's as there are clusters and not much overlapped.