Donor Choose

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

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

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

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

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

from tqdm import tqdm
import os



#from plotly import plotly
import plotly.offline as offline
import plotly.graph_objs as go
offline.init_notebook_mode()
from collections import
from keras.layers import Input, Embedding, LSTM, Dropout, BatchNormalization, Dense, concaten
from keras.preprocessing.text import Tokenizer, one_hot
from keras.preprocessing.sequence import pad_sequences
from keras.models import Model, load_model
from keras import regularizers
from keras.optimizers import *
from keras.callbacks import ModelCheckpoint, EarlyStopping, TensorBoard, ReduceLROnPlateau
```

```
# Run this cell to mount your Google Drive.
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.moun
```

```
!ls /content/drive/My\ Drive/Colab\ Notebooks
```

```
Donors_Choose_1.ipynb                  Model_1.ipynb          train_data.csv
DonorsChoose_Model_1_13_Aug_19.ipynb   Model_2.ipynb          Untitled0.ipynb
DonorsChoose_Model_2_13_Aug_19.ipynb   preprocessed_data.csv
glove_vectors                          resources.csv
```

1.1 Reading Data

```
project_data = pd.read_csv("/content/drive/My Drive/Colab Notebooks/train_data.csv")
resource_data = pd.read_csv('/content/drive/My Drive/Colab Notebooks/resources.csv')
```

```
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']
```

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

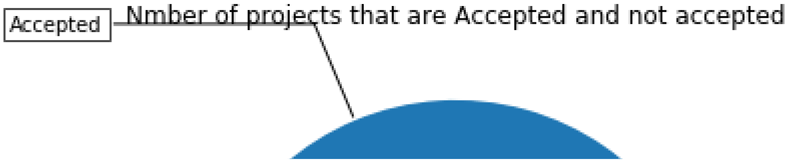
```
Number of data points in train data (1541272, 4)
['id' 'description' 'quantity' 'price']
```

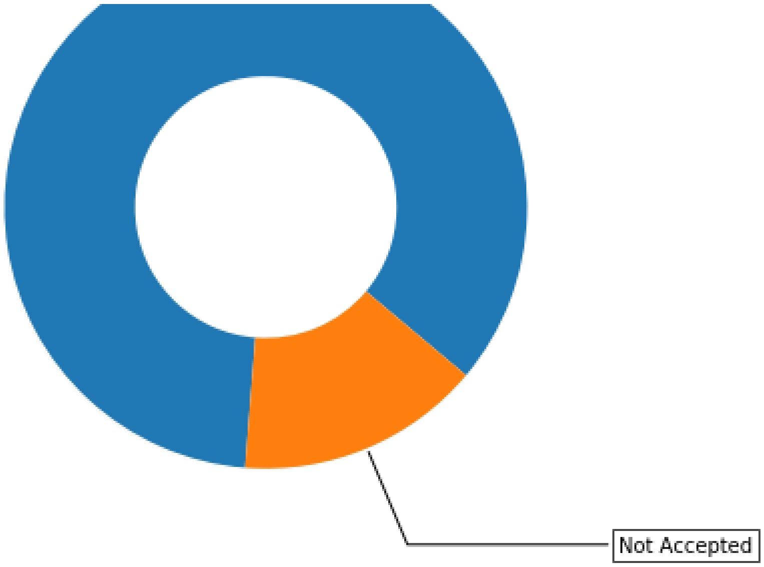
	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.00
1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95

1.2 Data Analysis

```
# this code is taken from
# https://matplotlib.org/gallery/pie_and_polar_charts/pie_and_donut_labels.html#sphx-glr-gall


y_value_counts = project_data['project_is_approved'].value_counts()
print("Number of projects thar are approved for funding ", y_value_counts[1], ", (", (y_value
print("Number of projects thar are not approved for funding ", y_value_counts[0], ", (", (y_v

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

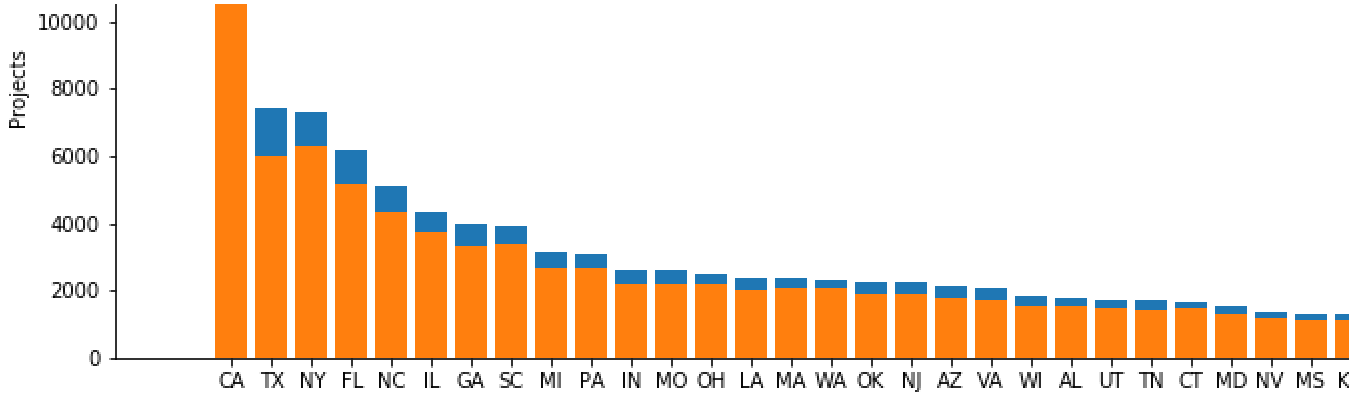
```
# Pandas dataframe grouby count, mean: https://stackoverflow.com/a/19385591/4084039

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

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

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

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

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

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

```
# 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
```

```
#stacked bar plots matplotlib: https://matplotlib.org/gallery/lines_bars_and_markers/bar_stac
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('% of projects aproved state wise')
    plt.xticks(ind, list(data[xtick].values))
    plt.legend((p1[0], p2[0]), ('total', 'accepted'))
    plt.show()


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_

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

    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))


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



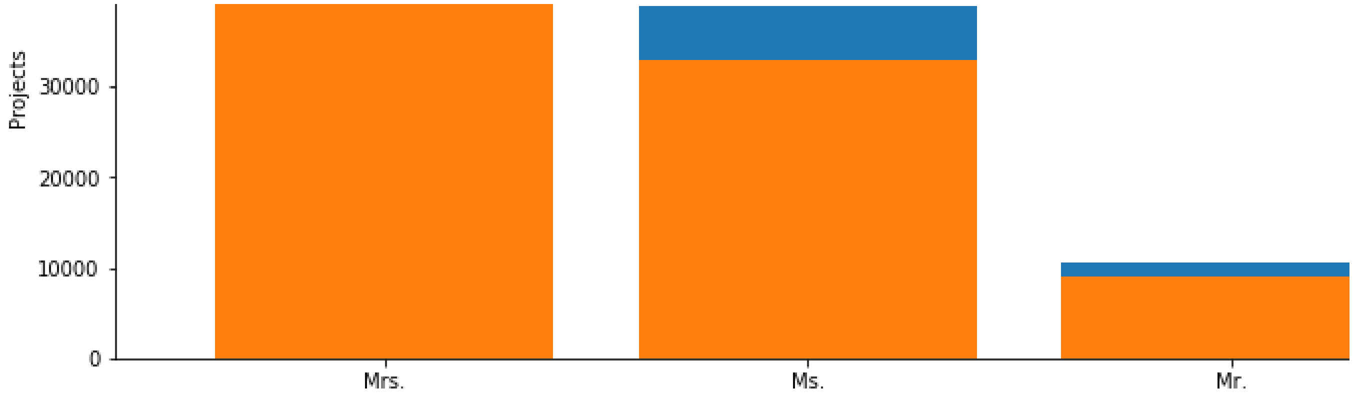
```
   school_state  project_is_approved  total       Avg
4            CA                13205  15388  0.858136
43           TX                 6014   7396  0.813142
34           NY                 6291   7318  0.859661
9            FL                 5144   6185  0.831690
27           NC           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

Every state is having more than 80% success rate in approval

1.2.2 Univariate Analysis: teacher_prefix

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

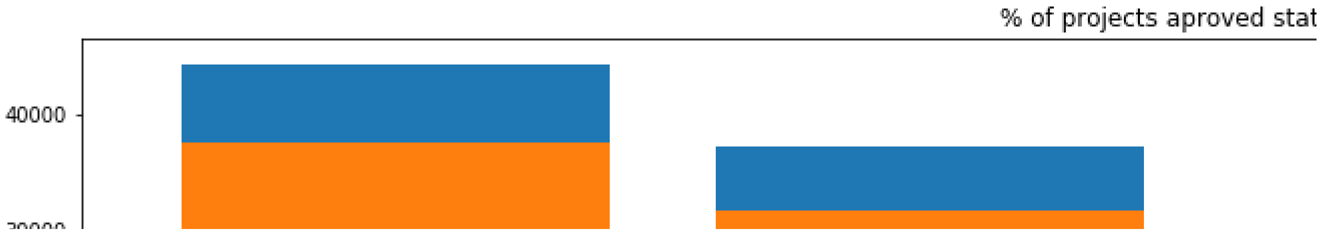
% of projects aproved stat
60000
50000
40000

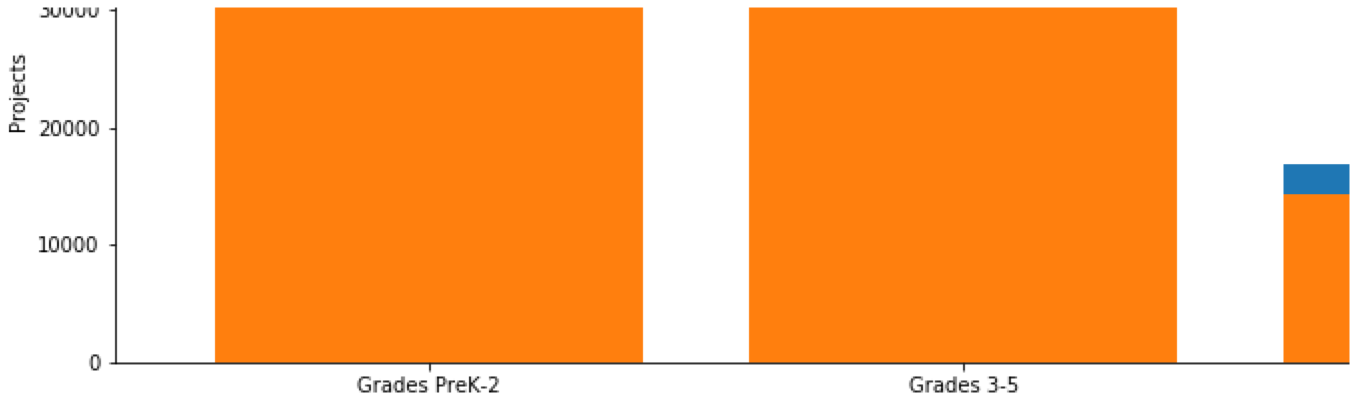


```
  teacher_prefix  project_is_approved  total       Avg
2           Mrs.                48997  57269  0.855559
3            Ms.                32860  38955  0.843537
1            Mr.                 8960  10648  0.841473
4        Teacher                 1877   2360  0.795339
0            Dr.     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

1.2.3 Univariate Analysis: project_grade_category

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





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

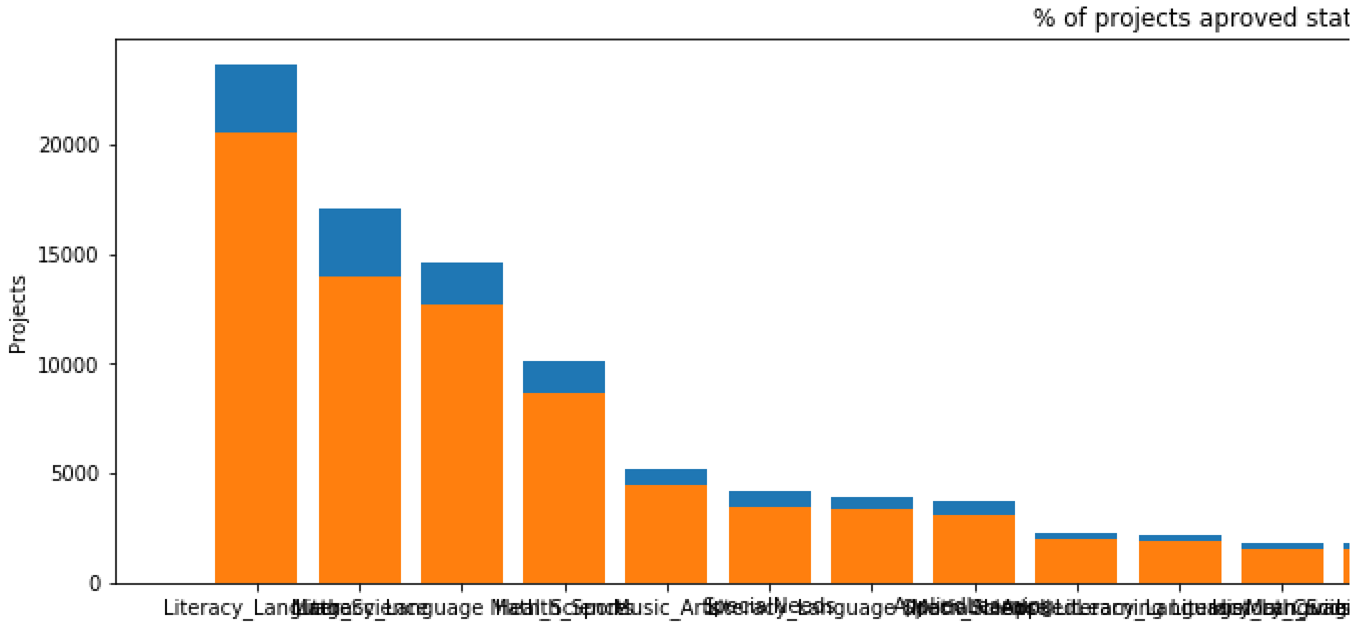
1.2.4 Univariate Analysis: project_subject_categories

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

# 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", "Ca
        if 'The' in j.split(): # this will split each of the catogory based on space "Math &
            j=j.replace('The','') # if we have the words "The" we are going to replace it wit
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math &
        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())


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

Unnamed: 0	id	teacher_id	teacher_prefix	school_state	pr

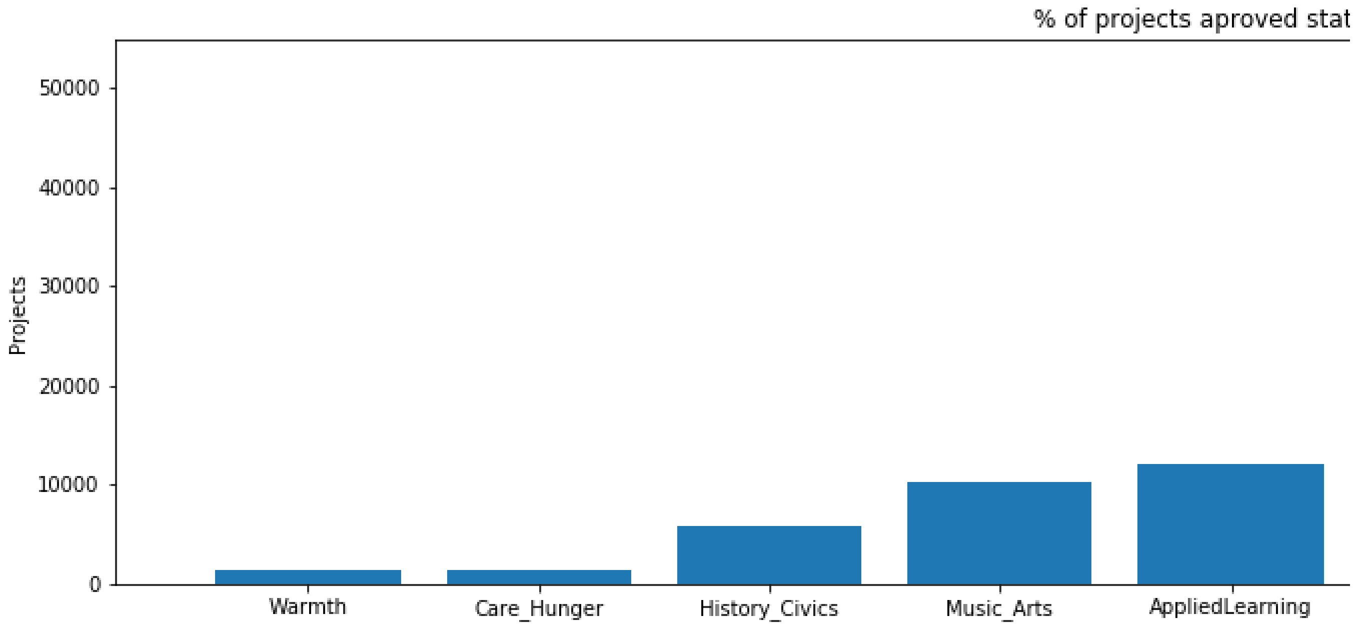
```
0    160221   p253737    c90749f5d961ff158d4b4d1e7dc665fc          Mrs.        IN


1    140945   p258326   897464ce9ddc600bced1151f324dd63a           Mr.         FL
```

```
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
```

```
# 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())


# 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]))
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 state wise')
plt.xticks(ind, list(sorted_cat_dict.keys()))
plt.show()
```



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

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

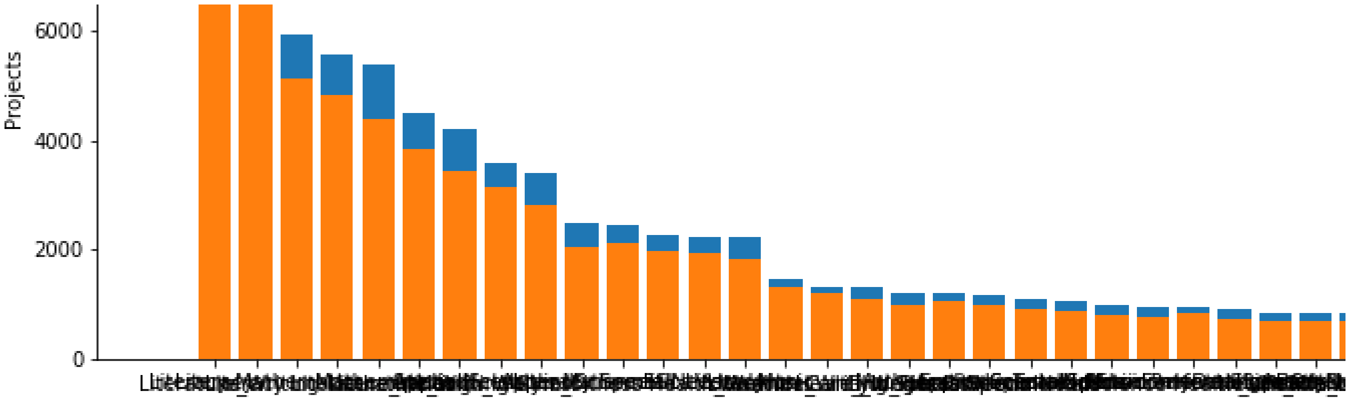
1.2.5 Univariate Analysis: project_subject_subcategories

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

# 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", "Ca
        if 'The' in j.split(): # this will split each of the catogory based on space "Math &
            j=j.replace('The','') # if we have the words "The" we are going to replace it wit
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math &
        temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spaces
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())


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

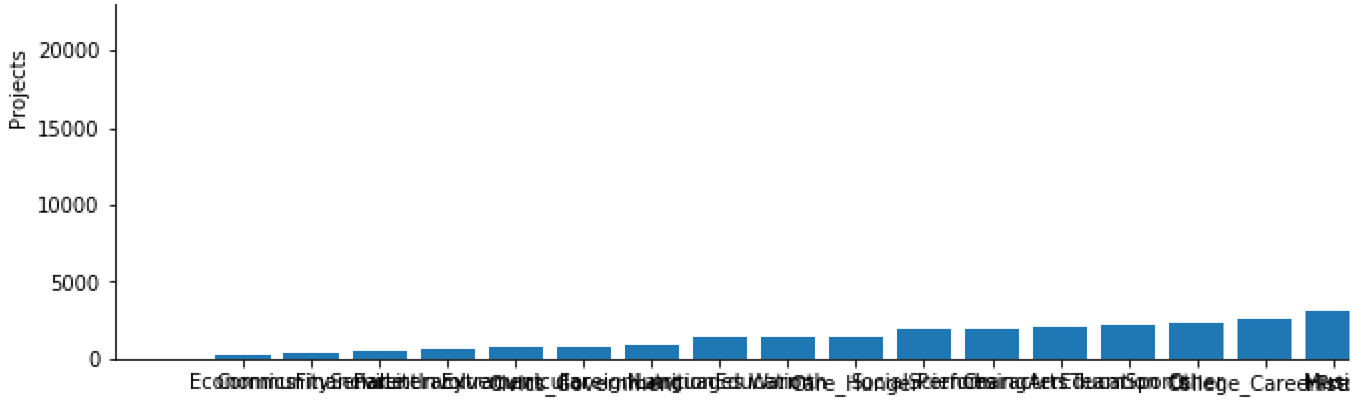
	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	pr
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	

```
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
```

```
# 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())


# 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()
```



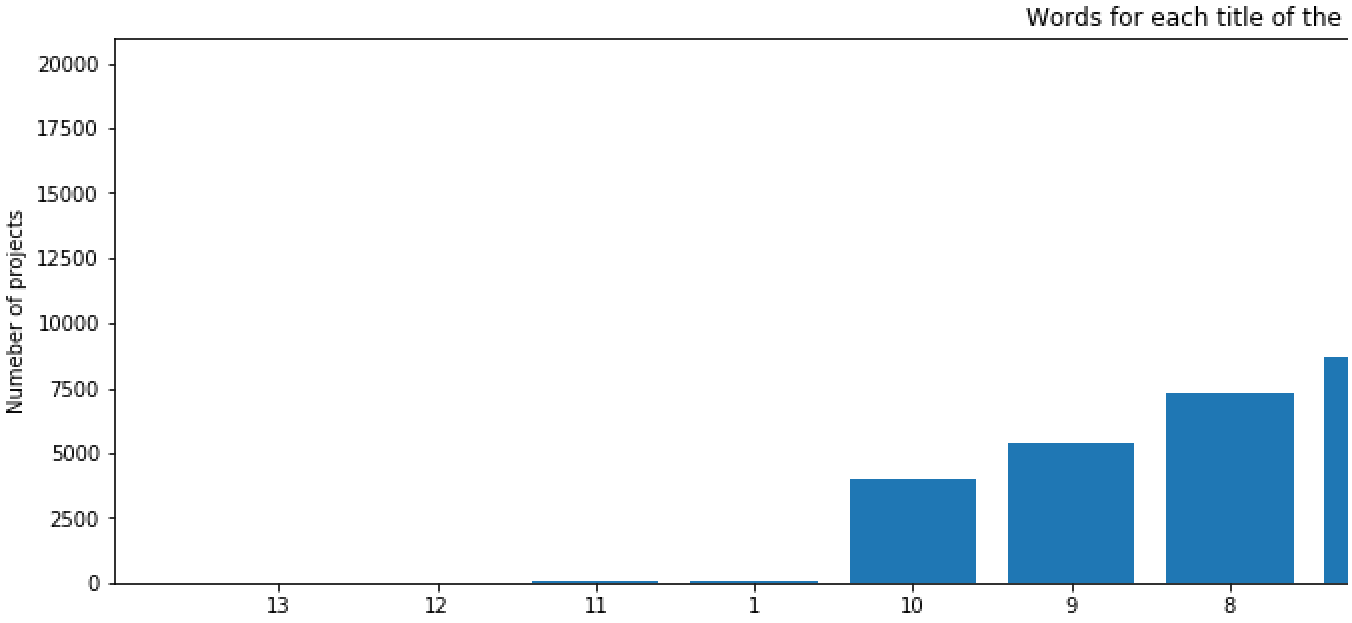
```
for i, j in sorted_sub_cat_dict.items():
    print("{:20} :{:10}".format(i,j))
```

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

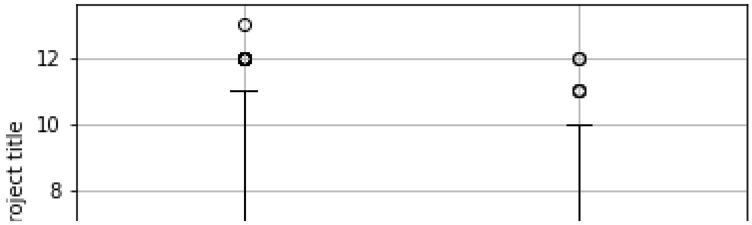
1.2.6 Univariate Analysis: Text features (Title)

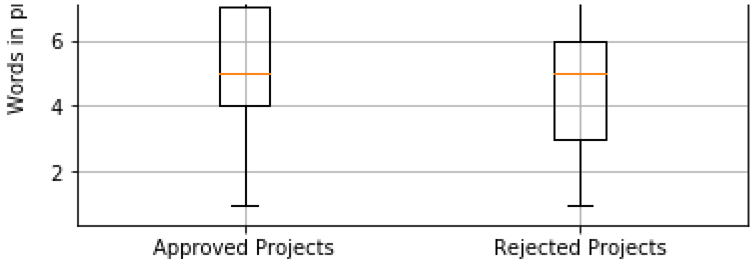
```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/37483
word_count = project_data['project_title'].str.split().apply(len).value_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))
```

```
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.title('Words for each title of the project')
plt.xticks(ind, list(word_dict.keys()))
plt.show()
```

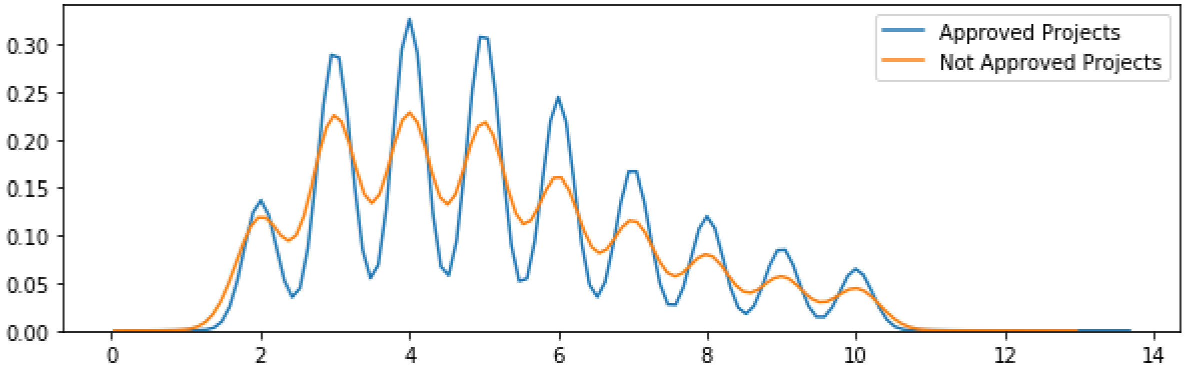


```
approved_word_count = project_data[project_data['project_is_approved']==1]['project_title'].s
approved_word_count = approved_word_count.values

rejected_word_count = project_data[project_data['project_is_approved']==0]['project_title'].s
rejected_word_count = rejected_word_count.values


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





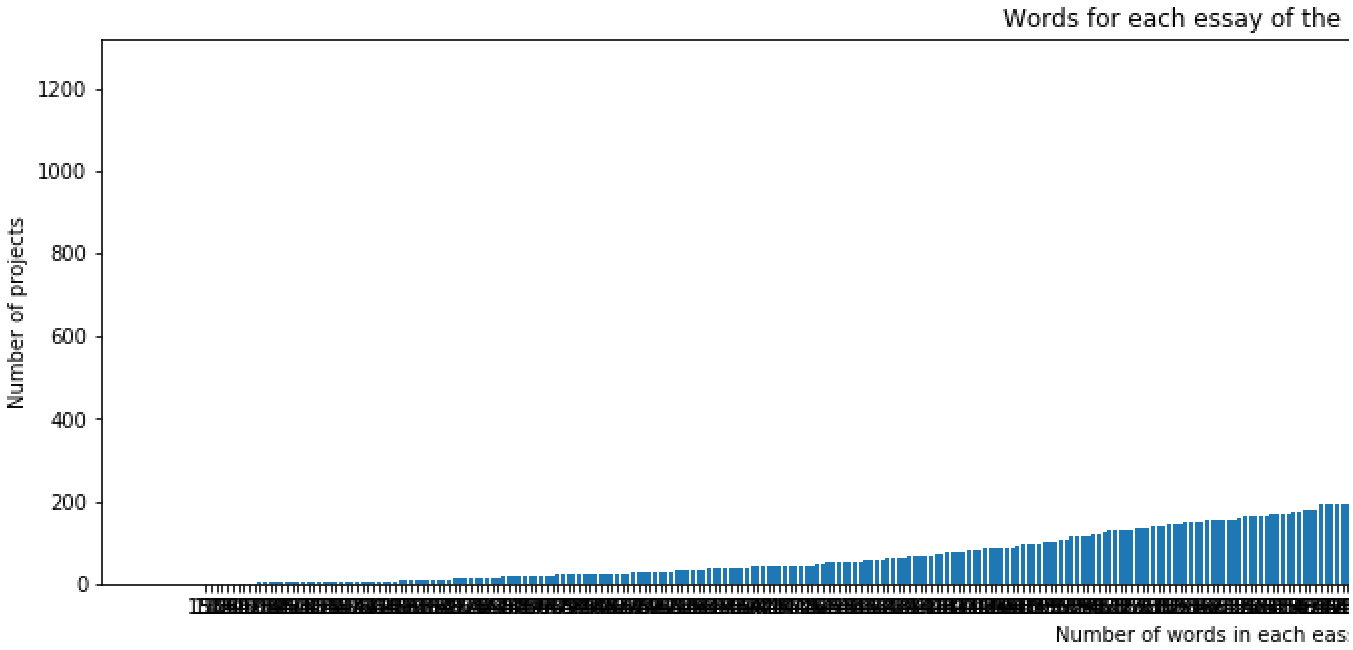
```
plt.figure(figsize=(10,3))
sns.distplot(approved_word_count, hist=False, label="Approved Projects")
sns.distplot(rejected_word_count, hist=False, label="Not Approved Projects")
plt.legend()
plt.show()
```



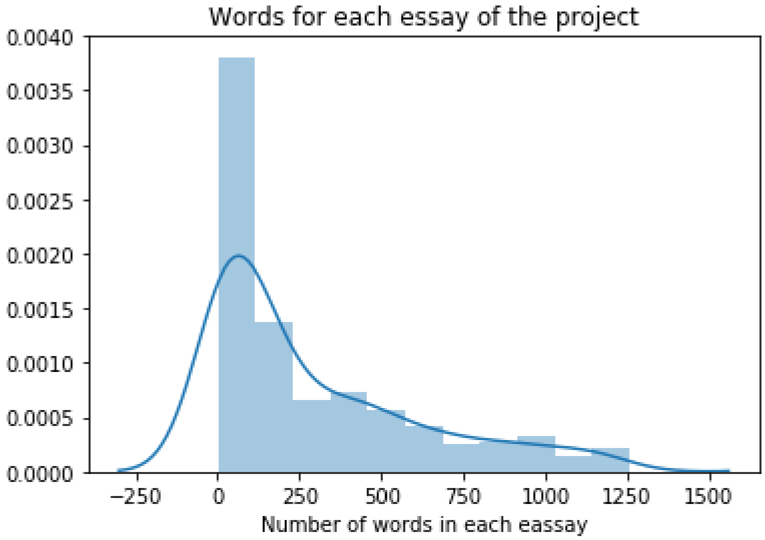
1.2.7 Univariate Analysis: Text features (Project Essay's)

```
# 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)
```

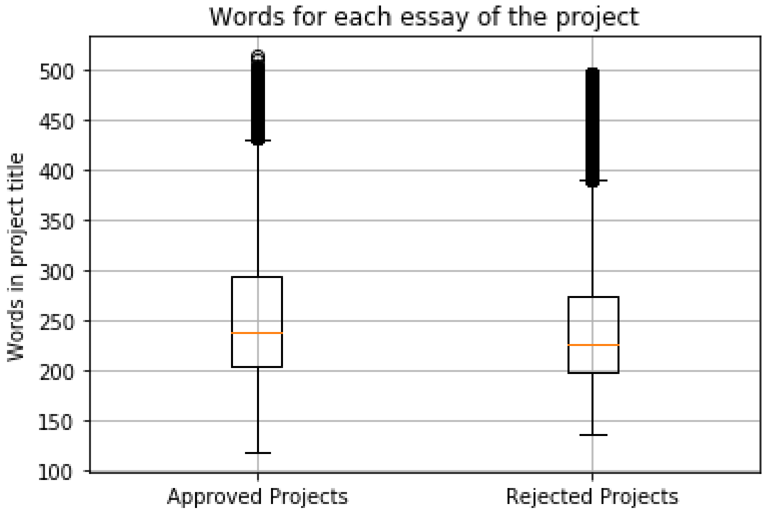
```
#How to calculate number of words in a string in DataFrame: https://stackoverflow.com/a/37483
word_count = project_data['essay'].str.split().apply(len).value_counts()
word_dict = dict(word_count)
word_dict = dict(sorted(word_dict.items(), key=lambda kv: kv[1]))


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

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



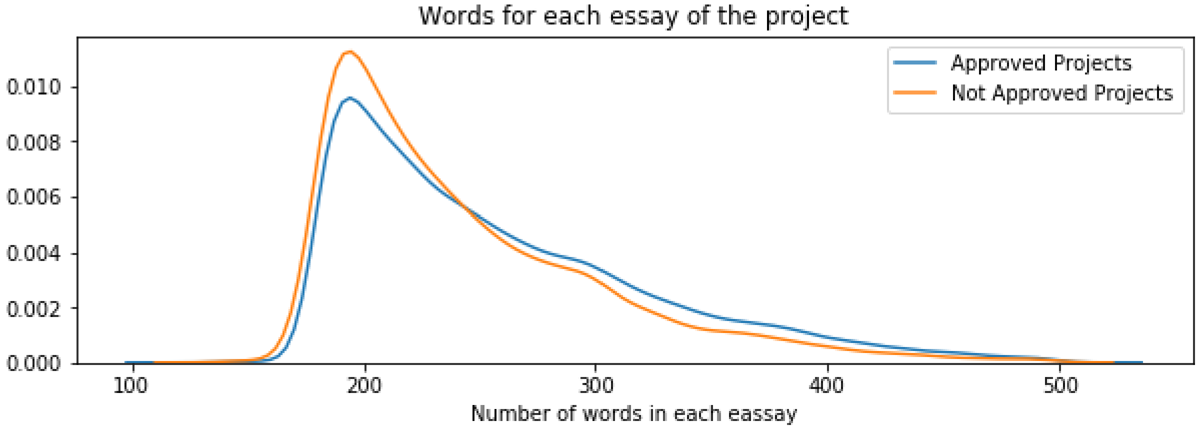
```
sns.distplot(word_count.values)
plt.title('Words for each essay of the project')
plt.xlabel('Number of words in each eassay')
plt.show()
```



```
approved_word_count = project_data[project_data['project_is_approved']==1]['essay'].str.split
approved_word_count = approved_word_count.values

rejected_word_count = project_data[project_data['project_is_approved']==0]['essay'].str.split
rejected_word_count = rejected_word_count.values


# 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 title')
plt.grid()
plt.show()
```



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



1.2.8 Univariate Analysis: Cost per project

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

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

1	p069063	Bouncy Bands for Desks (Blue support pipes)	3	14.95

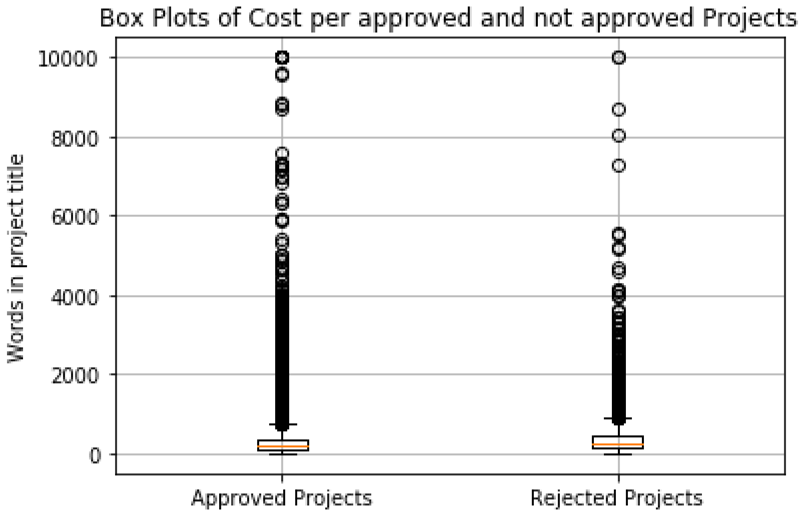
```
# https://stackoverflow.com/questions/22407798/how-to-reset-a-dataframes-indexes-for-all-grou
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
price_data.head(2)
```

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

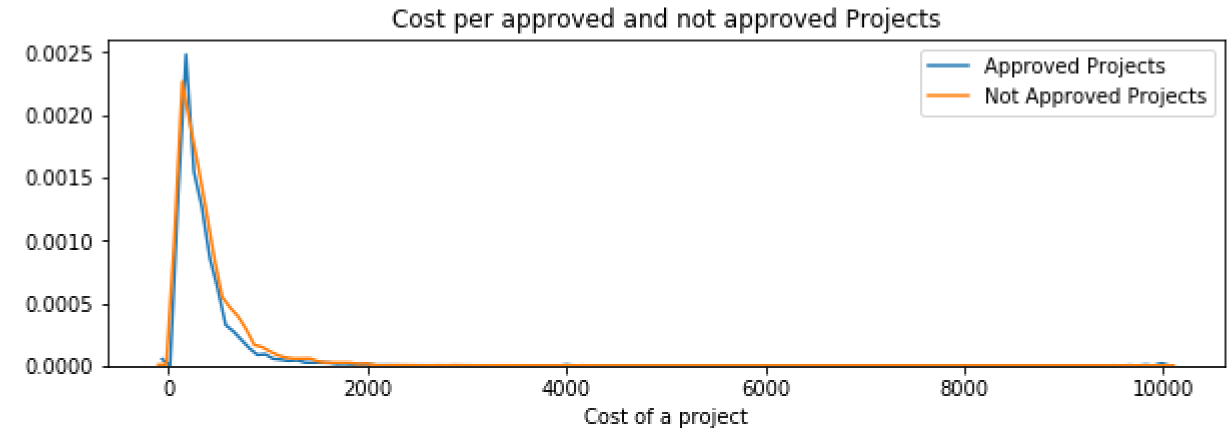
```
# join two dataframes in python:
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

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

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

```
# 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('Words in project title')
plt.grid()
plt.show()
```



```
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()
```



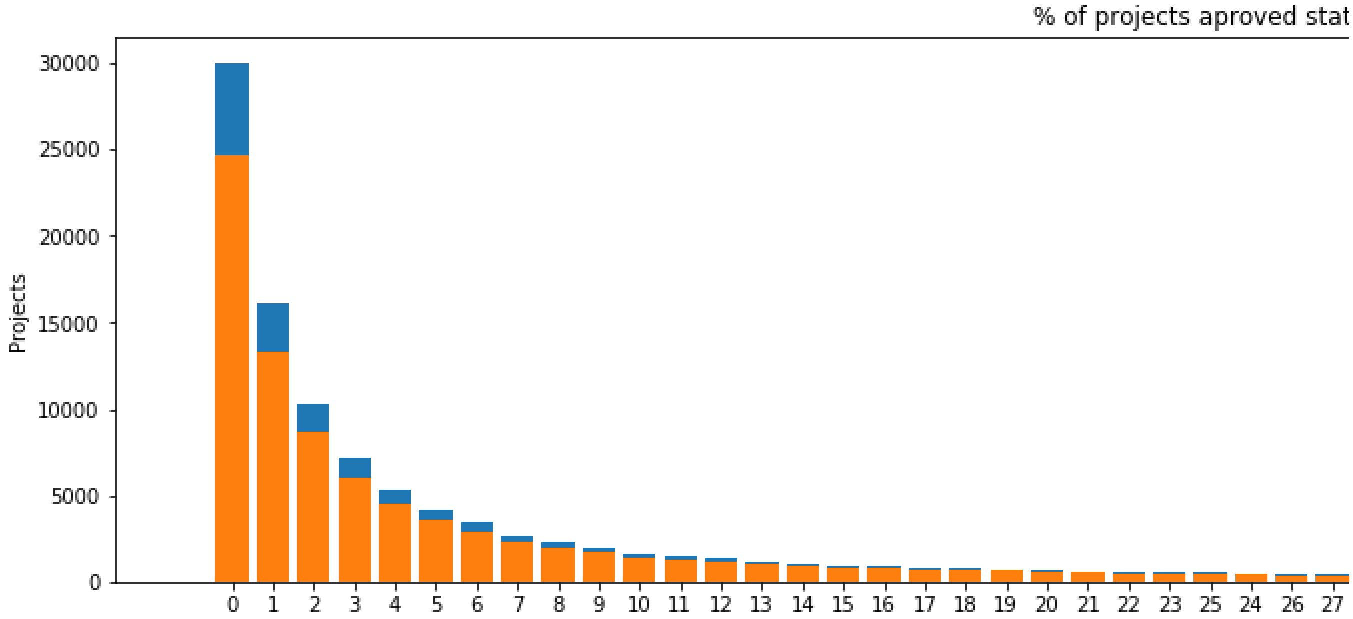
```
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

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(rejecte
print(x)
```

```
    +------------+------------------+----------------------+
```

1.2.9 Univariate Analysis: teacher_number_of_previously_posted_projects

```
    |     5      |      13.59       |         41.9         |
```

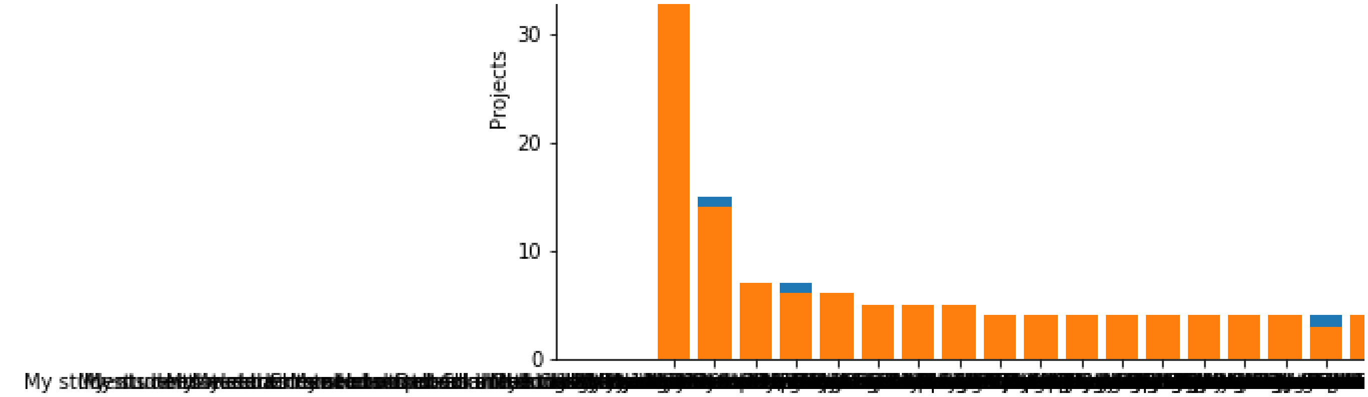
```
univariate_barplots(project_data, 'teacher_number_of_previously_posted_projects', 'project_is
```



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

[5 rows x 4 columns]
==================================================
    teacher_number_of_previously_posted_projects  ...       Avg
46                                            46  ...  0.908537
45                                            45  ...  0.921569
47                                            47  ...  0.895833
49                                            49  ...  0.895105
48                                            48  ...  0.964286

[5 rows x 4 columns]
```

1.2.10 Univariate Analysis: project_resource_summary

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



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

[5 rows x 4 columns]
==================================================
                                 project_resource_summary  ...  Avg
34033  My students need a variety of books for our cl...  ...  1.0
42108  My students need an iPad to be prepared for th...  ...  1.0
1705   My students need 2 Chromebooks, and 2 console ...  ...  1.0
7837   My students need 7 Hokki stools to get ACTIVE ...  ...  1.0
91743  My students need technology in the classroom. ...  ...  1.0

[5 rows x 4 columns]
```

2. Preprocessing Categorical Features: project_grade_cat

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

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

we need to remove the spaces, replace the '-' with '_' and convert all the letters to small

```
# https://stackoverflow.com/questions/36383821/pandas-dataframe-apply-function-to-column-stri
project_data['project_grade_category'] = project_data['project_grade_category'].str.replace('
project_data['project_grade_category'] = project_data['project_grade_category'].str.replace('
project_data['project_grade_category'] = project_data['project_grade_category'].str.lower()
project_data['project_grade_category'].value_counts()
```

```
grades_prek_2    44225
grades_3_5       37137
```

```
grades_6_8       16923
grades_9_12      10963
Name: project_grade_category, dtype: int64
```

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

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

3. Preprocessing Categorical Features: clean_categories

```
project_data['clean_categories'].value_counts()
```

```
Literacy_Language                          23655
Math_Science                               17072
Literacy_Language Math_Science             14636
Health_Sports                              10177
Music_Arts                                  5180
SpecialNeeds                                4226
Literacy_Language SpecialNeeds              3961
```

```
AppliedLearning                          3771
Math_Science Literacy_Language           2289
AppliedLearning Literacy_Language        2191
History_Civics                           1851
Math_Science SpecialNeeds                1840
Literacy_Language Music_Arts             1757
Math_Science Music_Arts                  1642
AppliedLearning SpecialNeeds             1467
History_Civics Literacy_Language         1421
Health_Sports SpecialNeeds               1391
Warmth Care_Hunger                       1309
Math_Science AppliedLearning             1220
AppliedLearning Math_Science             1052
Literacy_Language History_Civics          809
Health_Sports Literacy_Language           803
AppliedLearning Music_Arts                758
Math_Science History_Civics               652
Literacy_Language AppliedLearning         636
AppliedLearning Health_Sports             608
Math_Science Health_Sports                414
History_Civics Math_Science               322
History_Civics Music_Arts                 312
SpecialNeeds Music_Arts                   302
Health_Sports Math_Science                271
History_Civics SpecialNeeds               252
Health_Sports AppliedLearning             192
AppliedLearning History_Civics            178
Health_Sports Music_Arts                  155
Music_Arts SpecialNeeds                   138
Literacy_Language Health_Sports            72
Health_Sports History_Civics               43
History_Civics AppliedLearning             42
SpecialNeeds Health_Sports                 42
SpecialNeeds Warmth Care_Hunger            23
Health_Sports Warmth Care_Hunger           23
Music_Arts Health_Sports                   19
Music_Arts History_Civics                  18
History_Civics Health_Sports               13
Math_Science Warmth Care_Hunger            11
Music_Arts AppliedLearning                 10
AppliedLearning Warmth Care_Hunger         10
Literacy_Language Warmth Care_Hunger        9
Music_Arts Warmth Care_Hunger               2
History_Civics Warmth Care_Hunger           1
Name: clean_categories, dtype: int64
```

> remove spaces, 'the'
> replace '&' with '_', and ',' with '_'

```
project_data['clean_categories'] = project_data['clean_categories'].str.replace(' The ','')
project_data['clean_categories'] = project_data['clean_categories'].str.replace(' ','')
project_data['clean_categories'] = project_data['clean_categories'].str.replace('&','_')
project_data['clean_categories'] = project_data['clean_categories'].str.replace(',','_')
project_data['clean_categories'] = project_data['clean_categories'].str.lower()
```

```
project_data['clean_categories'].value_counts()
```

```
literacy_language                      23655
math_science                           17072
literacy_languagemath_science          14636
health_sports                          10177
music_arts                              5180
specialneeds                            4226
literacy_languagespecialneeds           3961
```

```
appliedlearning                         3771
math_scienceliteracy_language           2289
appliedlearningliteracy_language        2191
history_civics                          1851
math_sciencespecialneeds                1840
literacy_languagemusic_arts             1757
math_sciencemusic_arts                  1642
appliedlearningspecialneeds             1467
history_civicsliteracy_language         1421
health_sportsspecialneeds               1391
warmthcare_hunger                       1309
math_scienceappliedlearning             1220
appliedlearningmath_science             1052
literacy_languagehistory_civics          809
health_sportsliteracy_language           803
appliedlearningmusic_arts                758
math_sciencehistory_civics               652
literacy_languageappliedlearning         636
appliedlearninghealth_sports             608
math_sciencehealth_sports                414
history_civicsmath_science               322
history_civicsmusic_arts                 312
specialneedsmusic_arts                   302
health_sportsmath_science                271
history_civicsspecialneeds               252
health_sportsappliedlearning             192
appliedlearninghistory_civics            178
health_sportsmusic_arts                  155
music_artsspecialneeds                   138
literacy_languagehealth_sports            72
health_sportshistory_civics               43
history_civicsappliedlearning             42
specialneedshealth_sports                 42
specialneedswarmthcare_hunger             23
health_sportswarmthcare_hunger            23
music_artshealth_sports                   19
music_artshistory_civics                  18
history_civicshealth_sports               13
math_sciencewarmthcare_hunger             11
appliedlearningwarmthcare_hunger          10
music_artsappliedlearning                 10
literacy_languagewarmthcare_hunger         9
music_artswarmthcare_hunger                2
history_civicswarmthcare_hunger            1
Name: clean_categories, dtype: int64
```

4. Preprocessing Categorical Features: teacher_prefix

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

```
Mrs.       57269
Ms.        38955
Mr.        10648
Teacher     2360
```

```
Dr.            13
Name: teacher_prefix, dtype: int64
```

```
# check if we have any nan values are there
print(project_data['teacher_prefix'].isnull().values.any())
print("number of nan values",project_data['teacher_prefix'].isnull().values.sum())
```

```
True
number of nan values 3
```

> numebr of missing values are very less in number, we can replace it with Mrs. as most of the projects are subn

```
project_data['teacher_prefix']=project_data['teacher_prefix'].fillna('Mrs.')
```

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

```
Mrs.       57272
Ms.        38955
Mr.        10648
Teacher     2360
Dr.           13
Name: teacher_prefix, dtype: int64
```

> Remove '.'
> convert all the chars to small

```
project_data['teacher_prefix'] = project_data['teacher_prefix'].str.replace('.','')
project_data['teacher_prefix'] = project_data['teacher_prefix'].str.lower()
project_data['teacher_prefix'].value_counts()
```

```
mrs        57272
ms         38955
mr         10648
teacher     2360
dr            13
Name: teacher_prefix, dtype: int64
```

5. Preprocessing Categorical Features: clean_subcategoi

```
project_data['clean_subcategories'].value_counts()
```

```
Literacy                                   9486
Literacy Mathematics                       8325
Literature_Writing Mathematics             5923
Literacy Literature_Writing                5571
Mathematics                                5379
Literature_Writing                         4501
```

same process we did in project_subject_categories same process we did in project_subject_categories

```
project_data['clean_subcategories'] = project_data['clean_subcategories'].str.replace(' The '
project_data['clean_subcategories'] = project_data['clean_subcategories'].str.replace(' ','')
project_data['clean_subcategories'] = project_data['clean_subcategories'].str.replace('&','_'
project_data['clean_subcategories'] = project_data['clean_subcategories'].str.replace(',','_'
project_data['clean_subcategories'] = project_data['clean_subcategories'].str.lower()
project_data['clean_subcategories'].value_counts()
```

```
literacy                                 9486
literacymathematics                      8325
literature_writingmathematics            5923
literacyliterature_writing               5571
mathematics                              5379
literature_writing                       4501
specialneeds                             4226
```

```
health_wellness                           3583
appliedsciencesmathematics                3399
appliedsciences                           2492
literacyspecialneeds                      2440
gym_fitnesshealth_wellness                2264
eslliteracy                               2234
visualarts                                2217
music                                     1472
warmthcare_hunger                         1309
literature_writingspecialneeds            1306
gym_fitness                               1195
health_wellnessspecialneeds               1189
mathematicsspecialneeds                   1187
environmentalscience                      1079
teamsports                                1061
appliedsciencesenvironmentalscience        984
environmentalsciencehealth_lifescience     964
musicperformingarts                        948
earlydevelopment                           905
environmentalsciencemathematics            838
other                                      831
health_lifescience                         827
health_wellnessnutritioneducation          797
                                          ... 
charactereducationnutritioneducation         2
financialliteracyhealth_wellness             2
financialliteracyparentinvolvement           2
nutritioneducationsocialsciences             2
socialsciencesteamsports                     2
college_careerprepteamsports                 2
literature_writingnutritioneducation         1
financialliteracyforeignlanguages            1
otherwarmthcare_hunger                       1
parentinvolvementteamsports                  1
gym_fitnessparentinvolvement                 1
communityservicemusic                        1
gym_fitnesssocialsciences                    1
college_careerprepwarmthcare_hunger          1
communityservicefinancialliteracy            1
financialliteracyperformingarts              1
esleconomics                                 1
civics_governmentparentinvolvement           1
history_geographywarmthcare_hunger           1
civics_governmentforeignlanguages            1
economicsmusic                               1
parentinvolvementwarmthcare_hunger           1
civics_governmentnutritioneducation          1
extracurricularfinancialliteracy             1
economicsother                               1
gym_fitnesswarmthcare_hunger                 1
economicsforeignlanguages                    1
economicsnutritioneducation                  1
communityservicegym_fitness                  1
eslteamsports                                1
Name: clean_subcategories, Length: 401, dtype: int64
```

6. Preprocessing Categorical Features: school_state

```
project_data['school_state'].value_counts()
```

```
CA    15388
TX     7396
NY     7318
FL     6185
NC     5091
IL     4350
GA     3963
```

```
SC     3936
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      693
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
Name: school_state, dtype: int64
```

> convert all of them into small letters

```
project_data['school_state'] = project_data['school_state'].str.lower()
project_data['school_state'].value_counts()
```

```
ca    15388
tx     7396
ny     7318
fl     6185
```

```
nc     5091
il     4350
ga     3963
sc     3936
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      693
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
Name: school_state, dtype: int64
```

7. Preprocessing Categorical Features: project_title

```
# 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


# 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", "yo
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his',
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they',
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll"
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'h
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'unt
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'dur
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', '
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'bo
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'ver
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 'd
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'does
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn', "
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn',
            'won', "won't", 'wouldn', "wouldn't"]
```

```
project_data['project_title'].head(5)
```

```
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
Name: project_title, dtype: object
```

```
print("printing some random reviews")
print(9, project_data['project_title'].values[9])
print(34, project_data['project_title'].values[34])
print(147, project_data['project_title'].values[147])
```

```
printing some random reviews
9 Just For the Love of Reading--\r\nPure Pleasure
```

```
34 \"Have A Ball!!!\"
147 Who needs a Chromebook?\r\nWE DO!!
```

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

```
preprocessed_titles = preprocess_text(project_data['project_title'].values)
```

```
100%|██████████| 109248/109248 [00:02<00:00, 43031.42it/s]
```

```
print("printing some random reviews")
print(9, preprocessed_titles[9])
print(34, preprocessed_titles[34])
print(147, preprocessed_titles[147])
```

```
printing some random reviews
9 love reading pure pleasure
34 ball
147 needs chromebook
```

8. Preprocessing Categorical Features: essay

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

```
print("printing some random essay")
print(9, project_data['essay'].values[9])
print('-'*50)
print(34, project_data['essay'].values[34])
print('-'*50)
print(147, project_data['essay'].values[147])
```

```
printing some random essay
9 Over 95% of my students are on free or reduced lunch.  I have a few who are homeless,
--------------------------------------------------
34 My students mainly come from extremely low-income families, and the majority of them
--------------------------------------------------
147 My students are eager to learn and make their mark on the world.\r\n\r\nThey come fr
```

```
preprocessed_essays = preprocess_text(project_data['essay'].values)
```

```
100%|██████████| 109248/109248 [00:57<00:00, 1899.81it/s]
```

```
print("printing some random essay")
print(9, preprocessed_essays[9])
print('-'*50)
print(34, preprocessed_essays[34])
print('-'*50)
print(147, preprocessed_essays[147])
```

```
printing some random essay
9 95 students free reduced lunch homeless despite come school eagerness learn students i
--------------------------------------------------
34 students mainly come extremely low income families majority come homes parents work f
--------------------------------------------------
147 students eager learn make mark world come title 1 school need extra love fourth grad
```

```
project_data.head(1)
```

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	proj
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	mrs	in	

9. Preprocessing Numerical Values: price

```
project_data.head(1)
```

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	proj

0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	mrs	in

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

	id	price	quantity
0	p000001	459.56	7
1	p000002	515.89	21

```
project_data.head(1)
```

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	proj
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	mrs	in	

```
project_data['price'].head()
```

```
0    154.60
1    299.00
2    516.85
3    232.90
4     67.98
Name: price, dtype: float64
```

9.1 applying StandardScaler

```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
scaler.fit(project_data['price'].values.reshape(-1, 1))
project_data['std_price']=scaler.transform(project_data['price'].values.reshape(-1, 1) )
```

```
project_data['std_price'].head()
```

```
0   -0.390533
1    0.002396
```

```
1    0.002398
2    0.595191
3   -0.177469
4   -0.626236
Name: std_price, dtype: float64
```

9.2 applying MinMaxScaler

```
from sklearn.preprocessing import MinMaxScaler

scaler = MinMaxScaler()
scaler.fit(project_data['price'].values.reshape(-1, 1))
project_data['nrm_price']=scaler.transform(project_data['price'].values.reshape(-1, 1))
```

```
project_data['nrm_price'].head()
```

```
0    0.015397
1    0.029839
2    0.051628
3    0.023228
4    0.006733
Name: nrm_price, dtype: float64
```

```
project_data.columns
```

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_grade_category', 'project_title',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'essay', 'price', 'quantity',
       'std_price', 'nrm_price'],
      dtype='object')
```

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

```
My students are English learners that are working on English as their second or third la
==================================================
The 51 fifth grade students that will cycle through my classroom this year all love lear
```

```
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


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

```
My kindergarten students have varied disabilities ranging from speech and language delay
==================================================
```

```
# \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 delay
```

```
#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 delay
```

```
# 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", "yo
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his',
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they',
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll"
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'h
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'unt
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'dur
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', '
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'bo
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'ver
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 'd
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'does
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn', "
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn',
            'won', "won't", 'wouldn', "wouldn't"]
```

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

```
100%|██████████| 109248/109248 [00:57<00:00, 1890.18it/s]
```

```
# after preprocesing
preprocessed_essays[2000]
```

```
'describing students not easy task many would say inspirational creative hard working th
```

```
project_data['cleaned_text'] = preprocessed_essays
```

```
project_data.columns
```

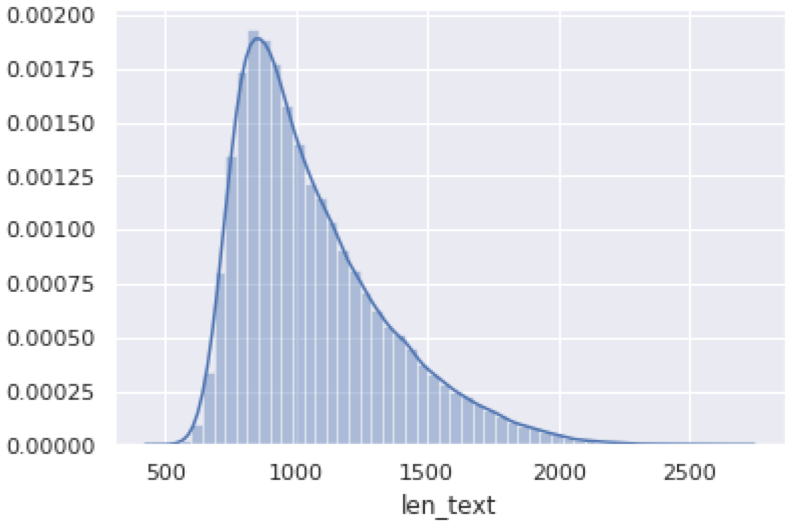
```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_grade_category', 'project_title',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'essay', 'price', 'quantity',
       'std_price', 'nrm_price', 'cleaned_text'],
      dtype='object')
```

Model -1

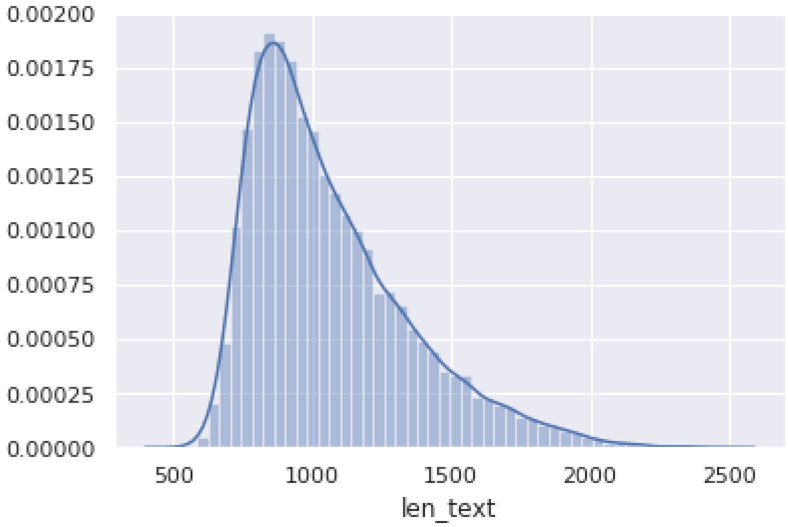
```
# We split our dataset into train,cross-validation and test set
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(project_data, project_data['project_is_ap
```

```
# Preparing Text Data As per Our Model

X_train["len_text"] = X_train["clean_text"].apply(len)
```

```
X_test["len_text"] = X_test["clean_text"].apply(len)


sns.set()
ax = sns.distplot(X_train["len_text"])
```



```
ax = sns.distplot(X_test["len_text"])
```



```
MAX_SEQUENCE_LENGTH = 800
MAX_VOCAB_SIZE = 1000000
EMBEDDING_DIM = 300


# convert the sentences (strings) into integers
tokenizer = Tokenizer(num_words=MAX_VOCAB_SIZE)
tokenizer.fit_on_texts(X_train["clean_text"].tolist())
sequences_train = tokenizer.texts_to_sequences(X_train["clean_text"])
sequences_test = tokenizer.texts_to_sequences(X_test["clean_text"])


# get word -> integer mapping
word2idx = tokenizer.word_index
```

```
word2idx = tokenizer.word_index
print('Found %s unique tokens.' % len(word2idx))
```

```
Found 49064 unique tokens.
```

```
encoded_train = pad_sequences(sequences_train,maxlen=MAX_SEQUENCE_LENGTH,padding='post', trun
print('Shape of data tensor:', encoded_train.shape)
```

```
Shape of data tensor: (76473, 800)
```

```
encoded_test = pad_sequences(sequences_test, maxlen=MAX_SEQUENCE_LENGTH,padding='post', trunc
print('Shape of data tensor:', encoded_test.shape)
```

```
Shape of data tensor: (32775, 800)
```

```
# Loading Embedding File

pickle_in = open("/content/drive/My Drive/Colab Notebooks/glove_vectors","rb")
glove_words = pickle.load(pickle_in)
```

```
num_words = min(MAX_VOCAB_SIZE, len(word2idx) + 1)
embedding_matrix = np.zeros((num_words, 300))
for word, i in word2idx.items():
  if i < MAX_VOCAB_SIZE:
    embedding_vector = glove_words.get(word)
    if embedding_vector is not None:
      # words not found in embedding index will be all zeros.
      embedding_matrix[i] = embedding_vector
```

```
# load pre-trained word embeddings into an Embedding layer
# note that we set trainable = False so as to keep the embeddings fixed
embedding_layer = Embedding(
  num_words,
  300,
  weights=[embedding_matrix],
  input_length=MAX_SEQUENCE_LENGTH,
  trainable=False
)
inputs_1 = Input(shape=(MAX_SEQUENCE_LENGTH,))

embedding_1 = embedding_layer(inputs_1)
lstm_1 = LSTM(128,recurrent_dropout=0.5,kernel_regularizer=regularizers.l2(0.001),return_sequ
flat_1 = Flatten()(lstm_1)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
```

```
# Now will prepare all the remaining categorical features
# Teacher Prefix
no_of_unique_prefix  = X_train["teacher_prefix"].nunique()
embedding_size_prefix = int(min(np.ceil((no_of_unique_prefix)/2), 50 ))
print('Unique Categories:', no_of_unique_prefix,'Embedding Size:', embedding_size_prefix)


# Defining Input and Embedding Layer for the same

input_prefix = Input(shape=(1,),name="teacher_prefix")
embedding_prefix = Embedding(no_of_unique_prefix,embedding_size_prefix,name="emb_pre",trainab
flat_2 = Flatten()(embedding_prefix)

lb = LabelEncoder()
encoder_prefix_train = lb.fit_transform(X_train["teacher_prefix"])
encoder_prefix_test = lb.transform(X_test["teacher_prefix"])
```

```
Unique Categories: 5 Embedding Size: 3
```

```
# School State
no_of_unique_state  = X_train["school_state"].nunique()
embedding_size_state= int(min(np.ceil((no_of_unique_state)/2), 50 ))
print('Unique Categories:', no_of_unique_state,'Embedding Size:', embedding_size_state)


# Defining Input and Embedding Layer for the same

input_state = Input(shape=(1,),name="school_prefix")
embedding_state = Embedding(no_of_unique_state,embedding_size_state,name="emb_state",trainabl
flat_3 = Flatten()(embedding_state)


encoder_state_train = lb.fit_transform(X_train["school_state"])
encoder_state_train = lb.fit_transform(X_train["school_state"])
encoder_state_test = lb.transform(X_test["school_state"])
```

```
Unique Categories: 51 Embedding Size: 26
```

```
# For project_grade_category
no_of_unique_grade  = X_train["project_grade_category"].nunique()
embedding_size_grade = int(min(np.ceil((no_of_unique_grade)/2), 50 ))
print('Unique Categories:', no_of_unique_grade,'Embedding Size:', embedding_size_grade)


# Defining Input and Embedding Layer for the same

input_grade= Input(shape=(1,),name="grade_cat")
embedding_grade = Embedding(no_of_unique_grade,embedding_size_grade,name="emb_grade",trainabl
flat_4 = Flatten()(embedding_grade)


encoder_grade_train = lb.fit_transform(X_train["project_grade_category"])
encoder_grade_test = lb.transform(X_test["project_grade_category"])
```

```
Unique Categories: 4 Embedding Size: 2
```

```
# For project_subject_categories
no_of_unique_subcat  = X_train["clean_categories"].nunique()
embedding_size_subcat = int(min(np.ceil((no_of_unique_subcat)/2), 50 ))
print('Unique Categories:', no_of_unique_subcat,'Embedding Size:', embedding_size_subcat)


# Defining Input and Embedding Layer for the same

input_subcat= Input(shape=(1,),name="sub_cat")
embedding_subcat = Embedding(no_of_unique_subcat,embedding_size_subcat,name="emb_subcat",trai
flat_5 = Flatten()(embedding_subcat)



le = LabelEncoder()
le.fit(X_train["clean_categories"])

encoder_subcat_train = le.transform(X_train["clean_categories"])
encoder_subcat_test= le.transform(X_test["clean_categories"])
```

```
Unique Categories: 51 Embedding Size: 26
```

```
# For project_subject_subcategories
no_of_unique_subcat_1  = X_train["clean_subcategories"].nunique()
embedding_size_subcat_1 = int(min(np.ceil((no_of_unique_subcat_1)/2), 50 ))
print('Unique Categories:', no_of_unique_subcat_1,'Embedding Size:', embedding_size_subcat_1)
```

```
input_subcat_1= Input(shape=(1,),name="sub_cat_1")
embedding_subcat_1 = Embedding(no_of_unique_subcat_1,embedding_size_subcat_1,name="emb_subcat
flat_6 = Flatten()(embedding_subcat_1)


le = LabelEncoder()
le.fit(X_train["clean_subcategories"])

encoder_subcat_1_train = le.transform(X_train["clean_subcategories"])
encoder_subcat_1_test= le.transform(X_test["clean_subcategories"])
```

```
Unique Categories: 391 Embedding Size: 50
```

```
# Now we will prepare numerical features for our model
num_train_1 = X_train['price'].values.reshape(-1, 1)
num_train_2 = X_train['quantity'].values.reshape(-1, 1)
num_train_3 = X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1)

num_test_1 = X_test['price'].values.reshape(-1, 1)
num_test_2 = X_test['quantity'].values.reshape(-1, 1)
num_test_3 = X_test['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1)


num_train=np.concatenate((num_train_1,num_train_2,num_train_3),axis=1)

num_test=np.concatenate((num_test_1,num_test_2,num_test_3),axis=1)



from sklearn.preprocessing import StandardScaler
norm=StandardScaler()
norm_train=norm.fit_transform(num_train)
norm_test=norm.transform(num_test)


# Defining the Input and Embedding Layer for the same

num_feats = Input(shape=(3,),name="numerical_features")
num_feats_ = Dense(100,activation="relu",kernel_initializer="he_normal",kernel_regularizer=re
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
```

```
print("Building Model-1")
merged = concatenate([flat_1,flatten_2,flatten_3,flatten_4,flatten_5,flatten_6,num_feats_])
# x_concatenate = BatchNormalization()(x_concatenate)
dense_1 = Dense(128,activation="relu", kernel_initializer="he_normal",kernel_regularizer=regu
drop_1 = Dropout(0.5)(dense_1)
dense_2 = Dense(256,activation="relu",kernel_initializer="he_normal",kernel_regularizer=regul
drop_2 = Dropout(0.5)(dense_2)
dense_3 = Dense(64,activation="relu", kernel_initializer="he_normal",kernel_regularizer=regul
batch_1 = BatchNormalization()(dense_3)
```

```
batch_1 = BatchNormalization()(dense_3)
output = Dense(2, activation='softmax', name='output')(batch_1)
model_1 = Model(inputs=[inputs_1,input_prefix,input_state,input_grade,
                        input_subcat,input_subcat_1,num_feats],outputs=[output])
```

```
Building Model-1
```

```
train_data = [encoded_train,encoder_prefix_train,encoder_state_train,
              encoder_grade_train,encoder_subcat_train,encoder_subcat_1_train,norm_train]
test_data = [encoded_test,encoder_prefix_test,encoder_state_test,encoder_grade_test,
             encoder_subcat_test,encoder_subcat_1_test,norm_test]

from keras.utils import np_utils
Y_train = np_utils.to_categorical(y_train, 2)
Y_test = np_utils.to_categorical(y_test, 2)



checkpoint = ModelCheckpoint("model_3.h5",
                             monitor="val_auroc",
                             mode="max",
                             save_best_only = True,
                             verbose=1)


tensorboard = TensorBoard(log_dir='graph_3', histogram_freq=0, batch_size=512, write_graph=Tr

callbacks = [tensorboard,checkpoint]


# Defining Custom ROC-AUC Metrics
from sklearn.metrics import roc_auc_score

def auc1(y_true, y_pred):
    if len(np.unique(y_true[:,1])) == 1:
        return 0.5
    else:
        return roc_auc_score(y_true, y_pred)

def auc(y_true, y_pred):
    return tf.py_func(auc1, (y_true, y_pred), tf.double)


adam = Adam(lr=0.001, beta_1=0.9, beta_2=0.999, epsilon=None, decay=0.0, amsgrad=False)
rms = RMSprop(lr=0.001, rho=0.9, epsilon=None, decay=0.0)
# ,clipvalue=0.4


#model.compile(loss='binary_crossentropy',optimizer='adam',metrics=[auc])
model_1.compile(optimizer=adam, loss='categorical_crossentropy', metrics=[auc])
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793:

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
```

```
WARNING:tensorflow:From <ipython-input-43-2affa1a8a367>:10: py_func (from tensorflow.pyt
Instructions for updating:
tf.py_func is deprecated in TF V2. Instead, there are two
    options available in V2.
    - tf.py_function takes a python function which manipulates tf eager
    tensors instead of numpy arrays. It's easy to convert a tf eager tensor to
    an ndarray (just call tensor.numpy()) but having access to eager tensors
    means `tf.py_function`s can use accelerators such as GPUs as well as
    being differentiable using a gradient tape.
    - tf.numpy_function maintains the semantics of the deprecated tf.py_func
    (it is not differentiable, and manipulates numpy arrays). It drops the
    stateful argument making all functions stateful.
```

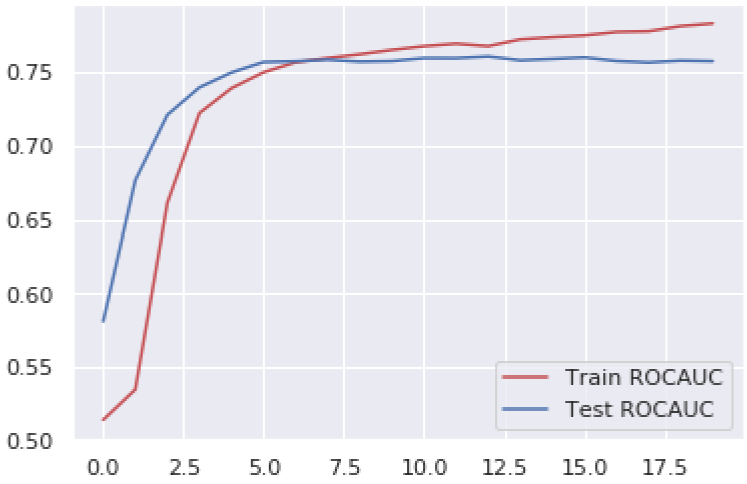
```
history_1 = model_1.fit(train_data,Y_train,batch_size=1000,
                        epochs=20,validation_data=(test_data,Y_test),callbacks=callbacks)
```

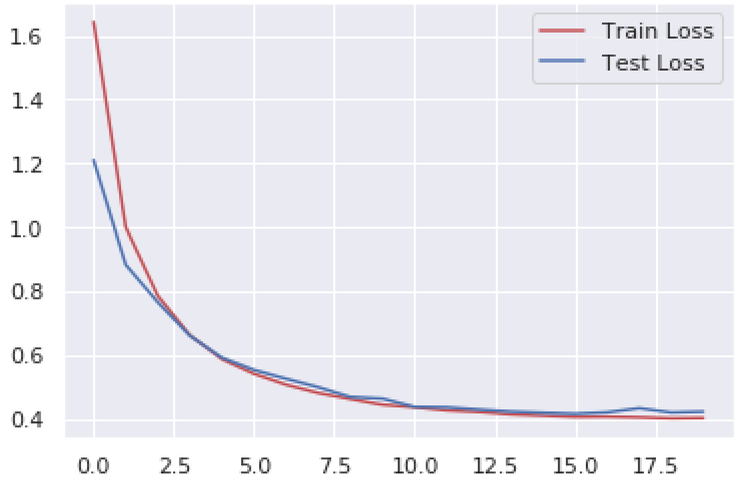
```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/op
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
```

```
Train on 76473 samples, validate on 32775 samples
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122:

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125:

Epoch 1/20
76473/76473 [==============================] - 243s 3ms/step - loss: 1.6430 - auc: 0.514
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265:

Epoch 2/20
76473/76473 [==============================] - 239s 3ms/step - loss: 1.0013 - auc: 0.534
Epoch 3/20
76473/76473 [==============================] - 239s 3ms/step - loss: 0.7869 - auc: 0.661
Epoch 4/20
76473/76473 [==============================] - 238s 3ms/step - loss: 0.6637 - auc: 0.722
Epoch 5/20
76473/76473 [==============================] - 236s 3ms/step - loss: 0.5884 - auc: 0.739
Epoch 6/20
76473/76473 [==============================] - 237s 3ms/step - loss: 0.5425 - auc: 0.750
Epoch 7/20
76473/76473 [==============================] - 236s 3ms/step - loss: 0.5083 - auc: 0.756
Epoch 8/20
76473/76473 [==============================] - 235s 3ms/step - loss: 0.4825 - auc: 0.759
Epoch 9/20
76473/76473 [==============================] - 236s 3ms/step - loss: 0.4636 - auc: 0.762
Epoch 10/20
76473/76473 [==============================] - 235s 3ms/step - loss: 0.4456 - auc: 0.765
Epoch 11/20
76473/76473 [==============================] - 233s 3ms/step - loss: 0.4378 - auc: 0.767
Epoch 12/20
76473/76473 [==============================] - 235s 3ms/step - loss: 0.4279 - auc: 0.769
Epoch 13/20
76473/76473 [==============================] - 236s 3ms/step - loss: 0.4232 - auc: 0.767
Epoch 14/20
76473/76473 [==============================] - 235s 3ms/step - loss: 0.4155 - auc: 0.772
Epoch 15/20
76473/76473 [==============================] - 236s 3ms/step - loss: 0.4116 - auc: 0.773
Epoch 16/20
76473/76473 [==============================] - 237s 3ms/step - loss: 0.4075 - auc: 0.775
Epoch 17/20
76473/76473 [==============================] - 237s 3ms/step - loss: 0.4081 - auc: 0.777
Epoch 18/20
76473/76473 [==============================] - 236s 3ms/step - loss: 0.4063 - auc: 0.777
Epoch 19/20
76473/76473 [==============================] - 235s 3ms/step - loss: 0.4030 - auc: 0.781
Epoch 20/20
76473/76473 [==============================] - 235s 3ms/step - loss: 0.4041 - auc: 0.783
```

```
plt.plot(history_1.history['auc'], 'r')
plt.plot(history_1.history['val_auc'], 'b')
plt.legend({'Train ROCAUC': 'r', 'Test ROCAUC':'b'})
plt.show()
```

```
plt.plot(history_1.history['loss'], 'r')
plt.plot(history_1.history['loss'], 'r')
plt.plot(history_1.history['val_loss'], 'b')
plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
plt.show()
```





Model - 2

```
#split the data as train and test
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(project_data, project_data["project_is_ap


print("The shape of train data", x_train.shape)
print("The shape of test data ", x_test.shape)
```

```
The shape of train data (81936, 23)
The shape of test data  (27312, 23)
```

```
from sklearn.feature_extraction.text import TfidfVectorizer
```

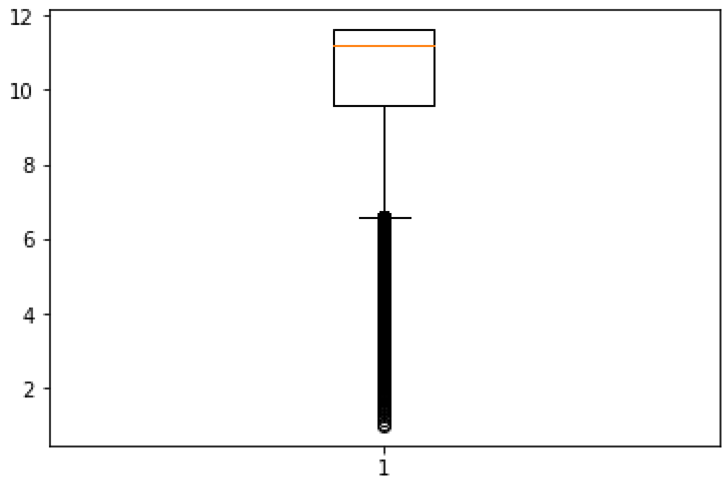
```
tf_idf_vect = TfidfVectorizer()
tf_idf_vect.fit(x_train["cleaned_text"])
print("some sample features(unique words in the corpus)",tf_idf_vect.get_feature_names()[0:10
print('='*50)
```

```
some sample features(unique words in the corpus) ['00', '000', '001', '002', '003', '005
==================================================
```

```
vocualbary=tf_idf_vect.get_feature_names()
```

```
idf = tf_idf_vect.idf_
```

```
import matplotlib.pyplot as plt

box_plot_data=[ idf ]
plt.boxplot(box_plot_data)
plt.show()
```



```
print(dict(zip(vocualbary,idf)))
```

```
{'00': 7.219955737468623, '000': 5.91013174034057, '001': 11.215093649607276, '002': 11.
```

```
d=dict(zip(vocualbary,idf))
previous_vocabulary=d.keys()
print(previous_vocabulary)
high_idf= 10
print("high_idf: ",high_idf)
low_idf= 2
print("low_idf: ",low_idf)
final_vocabulary=[]
for k in d:
    if(d[k]<=high_idf and d[k]>=low_idf ):
       final_vocabulary.append(k)
print(final_vocabulary)
print(final_vocabulary)
```

```
dict_keys(['00', '000', '001', '002', '003', '005nannan', '00am', '00pm', '01', '01075rm
high_idf:  10
low_idf:  2
['00', '000', '00pm', '10', '100', '1000', '100th', '101', '102', '103', '104', '105', '
```

```
len(final_vocabulary)
```

```
14873
```

```
EMBEDDING_DIM = 300
```

```
# convert the sentences (strings) into integers
tokenizer = Tokenizer(num_words = 300)
tokenizer.fit_on_texts(final_vocabulary)
text_train = tokenizer.texts_to_sequences(x_train["cleaned_text"])
text_test = tokenizer.texts_to_sequences(x_test["cleaned_text"])
```

```
max_words = 300 #more words for more accuracy
tokenizer = Tokenizer(num_words=max_words)
tokenizer.fit_on_texts(final_vocabulary)

text_train = tokenizer.texts_to_matrix(x_train["cleaned_text"], mode='binary')
text_test = tokenizer.texts_to_matrix(x_test["cleaned_text"], mode='binary')

#text_test = tokenizer.texts_to_matrix((x_test["cleaned_text"], mode='binary')
print(text_train.shape)
print(text_test.shape)
```

```
(81936, 300)
(27312, 300)
```

```
# get word -> integer mapping
word2idx = tokenizer.word_index
print('Found %s unique tokens.' % len(word2idx))
```

```
Found 14873 unique tokens.
```

```
# Loading Embedding File

pickle_in = open("/content/drive/My Drive/Colab Notebooks/glove_vectors","rb")
glove_words = pickle.load(pickle_in)
```

```
num_words = len(word2idx) + 1
embedding_matrix = np.zeros((num_words, 300))
for word, i in word2idx.items():
  if i < len(final_vocabulary):
    embedding_vector = glove_words.get(word)
    if embedding_vector is not None:
      # words not found in embedding index will be all zeros.
      embedding_matrix[i] = embedding_vector


print("The Number of words ",num_words)
print("The shapoe of embedding_matrix ", embedding_matrix.shape)
```

```
The Number of words  14874
The shapoe of embedding_matrix  (14874, 300)
```

```
# load pre-trained word embeddings into an Embedding layer
# note that we set trainable = False so as to keep the embeddings fixed
embedding_layer = Embedding(
  num_words,
  300,
  weights=[embedding_matrix],
  input_length=300,
  trainable=False
)
inputs_1 = Input(shape=(300,),name="input_text")
embedding_1 = embedding_layer(inputs_1)
# x = SpatialDropout1D(0.4)(x)
lstm_1 =  LSTM(100,recurrent_dropout=0.5,kernel_regularizer=regularizers.l2(0.001),return_seq
flat_1 = Flatten()(lstm_1)
```

```
project_data.columns
```

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_grade_category', 'project_title',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'essay', 'price', 'quantity',
       'std_price', 'nrm_price', 'cleaned_text'],
      dtype='object')
```

```
# Now will prepare all the remaining categorical features
# Teacher Prefix
no_of_unique_prefix  = x_train["teacher_prefix"].nunique()
embedding_size_prefix = int(min(np.ceil((no_of_unique_prefix)/2), 50 ))
print('Unique Categories:', no_of_unique_prefix,'Embedding Size:', embedding_size_prefix)


# Defining Input and Embedding Layer for the same

input_prefix = Input(shape=(1,),name="teacher_prefix")
embedding_prefix = Embedding(no_of_unique_prefix,embedding_size_prefix,name="emb_pre",trainab
flatten_2 = Flatten()(embedding_prefix)

lb = LabelEncoder()
encoder_prefix_train = lb.fit_transform(x_train["teacher_prefix"])
```

```
encoder_prefix_test = lb.transform(x_test["teacher_prefix"])
```

```
Unique Categories: 5 Embedding Size: 3
```

```
# School State
no_of_unique_state  = x_train["school_state"].nunique()
embedding_size_state= int(min(np.ceil((no_of_unique_state)/2), 50 ))
print('Unique Categories:', no_of_unique_state,'Embedding Size:', embedding_size_state)


# Defining Input and Embedding Layer for the same

input_state = Input(shape=(1,),name="school_prefix")
embedding_state = Embedding(no_of_unique_state,embedding_size_state,name="emb_state",trainabl
flatten_3 = Flatten()(embedding_state)


encoder_state_train = lb.fit_transform(x_train["school_state"])
encoder_state_test = lb.transform(x_test["school_state"])
```

```
Unique Categories: 51 Embedding Size: 26
```

```
# For project_grade_category
no_of_unique_grade  = x_train["project_grade_category"].nunique()
embedding_size_grade = int(min(np.ceil((no_of_unique_grade)/2), 50 ))
print('Unique Categories:', no_of_unique_grade,'Embedding Size:', embedding_size_grade)


# Defining Input and Embedding Layer for the same

input_grade= Input(shape=(1,),name="grade_cat")
embedding_grade = Embedding(no_of_unique_grade,embedding_size_grade,name="emb_grade",trainabl
flatten_4 = Flatten()(embedding_grade)


encoder_grade_train = lb.fit_transform(x_train["project_grade_category"])
encoder_grade_test = lb.transform(x_test["project_grade_category"])
```

```
Unique Categories: 4 Embedding Size: 2
```

```
# For project_subject_categories
no_of_unique_subcat  = x_train["clean_categories"].nunique()
embedding_size_subcat = int(min(np.ceil((no_of_unique_subcat)/2), 50 ))
print('Unique Categories:', no_of_unique_subcat,'Embedding Size:', embedding_size_subcat)


# Defining Input and Embedding Layer for the same

input_subcat= Input(shape=(1,),name="sub_cat")
embedding_subcat = Embedding(no_of_unique_subcat,embedding_size_subcat,name="emb_subcat",trai
flatten_5 = Flatten()(embedding_subcat)
```

```
flatten_5 = Flatten()(embedding_subcat)

le = LabelEncoder()

encoder_subcat_train = le.fit_transform(x_train["clean_categories"])
encoder_subcat_test= le.fit_transform(x_test["clean_categories"])
```

```
Unique Categories: 51 Embedding Size: 26
```

```
# For project_subject_subcategories
no_of_unique_subcat_1  = x_train["clean_subcategories"].nunique()
embedding_size_subcat_1 = int(min(np.ceil((no_of_unique_subcat_1)/2), 50 ))
print('Unique Categories:', no_of_unique_subcat_1,'Embedding Size:', embedding_size_subcat_1)

# Defining Input and Embedding Layer for the same

input_subcat_1= Input(shape=(1,),name="sub_cat_1")
embedding_subcat_1 = Embedding(no_of_unique_subcat_1,embedding_size_subcat_1,name="emb_subcat
flatten_6 = Flatten()(embedding_subcat_1)


le = LabelEncoder()

encoder_subcat_1_train = le.fit_transform(x_train["clean_subcategories"])
encoder_subcat_1_test= le.fit_transform(x_test["clean_subcategories"])
```

```
Unique Categories: 392 Embedding Size: 50
```

```
# Now we will prepare numerical features for our model
num_train_1=x_train['price'].values.reshape(-1, 1)
num_train_2=x_train['quantity'].values.reshape(-1, 1)
num_train_3=x_train['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1)

num_test_1=x_test['price'].values.reshape(-1, 1)
num_test_2=x_test['quantity'].values.reshape(-1, 1)
num_test_3=x_test['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1)


num_train=np.concatenate((num_train_1,num_train_2,num_train_3),axis=1)

num_test=np.concatenate((num_test_1,num_test_2,num_test_3),axis=1)



from sklearn.preprocessing import StandardScaler
norm=StandardScaler()
norm_train=norm.fit_transform(num_train)
norm_test=norm.transform(num_test)


# Defining the Input and Embedding Layer for the same

num_feats = Input(shape=(3,),name="numerical_features")
num_feats = Input(shape=(3,),name="numerical_features")
num_feats_ = Dense(100,activation="relu",kernel_initializer="he_normal",kernel_regularizer=re


print("Building Model-2")
merged = concatenate([flat_1,flatten_2,flatten_3,flatten_4,flatten_5,flatten_6,num_feats_])
# x_concatenate = BatchNormalization()(x_concatenate)
dense_1 = Dense(128,activation="relu", kernel_initializer="he_normal",kernel_regularizer=regu
drop_1 = Dropout(0.5)(dense_1)
dense_2 = Dense(256,activation="relu",kernel_initializer="he_normal",kernel_regularizer=regul
drop_2 = Dropout(0.5)(dense_2)
dense_3 = Dense(64,activation="relu", kernel_initializer="he_normal",kernel_regularizer=regul
batch_1 = BatchNormalization()(dense_3)
output = Dense(2, activation='softmax', name='output')(batch_1)
model-_2 = Model(inputs=[inputs_1,input_prefix,input_state,input_grade,
                        input_subcat,input_subcat_1,num_feats],outputs=[output])
```

```
Building Model-2
```

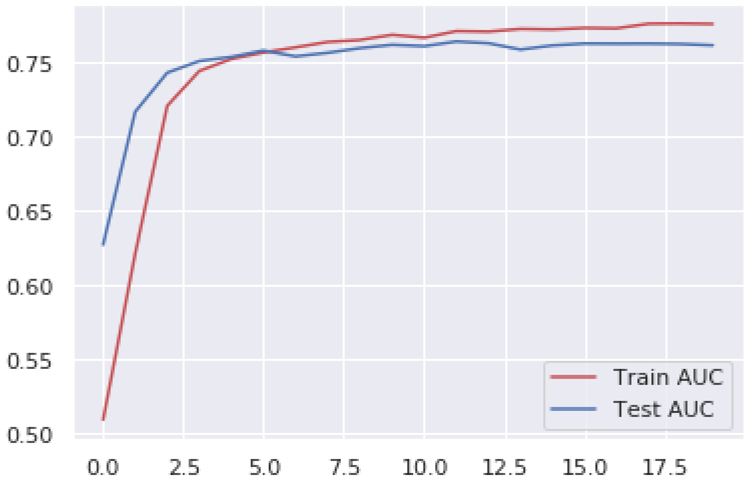
```
train_data = [text_train,encoder_prefix_train,encoder_state_train,
              encoder_grade_train,encoder_subcat_train,encoder_subcat_1_train,norm_train]
test_data = [text_test,encoder_prefix_test,encoder_state_test,encoder_grade_test,
             encoder_subcat_test,encoder_subcat_1_test,norm_test]

from keras.utils import np_utils
Y_train = np_utils.to_categorical(y_train, 2)
Y_test = np_utils.to_categorical(y_test, 2)



checkpoint = ModelCheckpoint("model_3.h5",
                             monitor="val_auroc",
                             mode="max",
                             save_best_only = True,
                             verbose=1)

tensorboard_ = TensorBoard(log_dir='graph_3', histogram_freq=0, batch_size=512, write_graph=T

callbacks = [tensorboard,checkpoint]


# Defining Custom ROC-AUC Metrics
from sklearn.metrics import roc_auc_score

def auc1(y_true, y_pred):
    if len(np.unique(y_true[:,1])) == 1:
        return 0.5
    else:
        return roc_auc_score(y_true, y_pred)

def auc(y_true, y_pred):
    return tf.py_func(auc1, (y_true, y_pred), tf.double)
```

```
adam = Adam(lr=0.001, beta_1=0.9, beta_2=0.999, epsilon=None, decay=0.0, amsgrad=False)
rms = RMSprop(lr=0.001, rho=0.9, epsilon=None, decay=0.0)
# ,clipvalue=0.4


#model.compile(loss='binary_crossentropy',optimizer='adam',metrics=[auc])
model_2.compile(optimizer=adam, loss='categorical_crossentropy', metrics=[auc])


history_2 = model_2.fit(train_data,Y_train,batch_size=1000,
                        epochs=20,validation_data=(test_data,Y_test),callbacks=callbacks_3)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/op
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
```

```
Train on 87398 samples, validate on 21850 samples
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122:

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125:

Epoch 1/20
87398/87398 [==============================] - 71s 818us/step - loss: 1.4589 - auc: 0.50
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265:

Epoch 2/20
87398/87398 [==============================] - 70s 798us/step - loss: 0.7881 - auc: 0.62
Epoch 3/20
87398/87398 [==============================] - 70s 795us/step - loss: 0.6026 - auc: 0.72
Epoch 4/20
87398/87398 [==============================] - 69s 793us/step - loss: 0.5200 - auc: 0.74
Epoch 5/20
87398/87398 [==============================] - 69s 794us/step - loss: 0.4742 - auc: 0.75
Epoch 6/20
87398/87398 [==============================] - 69s 794us/step - loss: 0.4463 - auc: 0.75
Epoch 7/20
87398/87398 [==============================] - 69s 794us/step - loss: 0.4290 - auc: 0.76
Epoch 8/20
87398/87398 [==============================] - 70s 799us/step - loss: 0.4165 - auc: 0.76
Epoch 9/20
87398/87398 [==============================] - 70s 803us/step - loss: 0.4081 - auc: 0.76
Epoch 10/20
87398/87398 [==============================] - 70s 802us/step - loss: 0.4008 - auc: 0.76
Epoch 11/20
87398/87398 [==============================] - 70s 798us/step - loss: 0.3967 - auc: 0.76
Epoch 12/20
87398/87398 [==============================] - 69s 793us/step - loss: 0.3920 - auc: 0.77
Epoch 13/20
87398/87398 [==============================] - 70s 795us/step - loss: 0.3904 - auc: 0.77
Epoch 14/20
87398/87398 [==============================] - 69s 794us/step - loss: 0.3868 - auc: 0.77
Epoch 15/20
87398/87398 [==============================] - 70s 796us/step - loss: 0.3861 - auc: 0.77
Epoch 16/20
87398/87398 [==============================] - 70s 798us/step - loss: 0.3844 - auc: 0.77
Epoch 17/20
87398/87398 [==============================] - 70s 800us/step - loss: 0.3843 - auc: 0.77
Epoch 18/20
87398/87398 [==============================] - 70s 800us/step - loss: 0.3826 - auc: 0.77
Epoch 19/20
87398/87398 [==============================] - 70s 800us/step - loss: 0.3820 - auc: 0.77
Epoch 20/20
87398/87398 [==============================] - 70s 801us/step - loss: 0.3823 - auc: 0.77
```

```
sns.set()
plt.plot(history_2.history['auc'], 'r')
plt.plot(history_2.history['val_auc'], 'b')
plt.legend({'Train AUC': 'r', 'Test AUC':'b'})
plt.show()
```



Model - 3

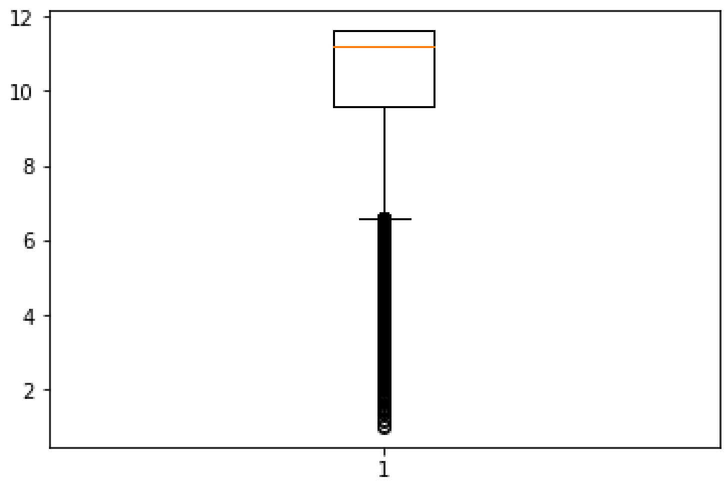
```
#split the data as train and test
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(project_data, project_data["project_is_ap


print("The shape of train data", x_train.shape)
print("The shape of test data ", x_test.shape)
```

```
The shape of train data (81936, 23)
The shape of test data  (27312, 23)
```

```
from sklearn.feature_extraction.text import TfidfVectorizer


tf_idf_vect = TfidfVectorizer()
tf_idf_vect.fit(x_train["cleaned_text"])
print("some sample features(unique words in the corpus)",tf_idf_vect.get_feature_names()[0:10
print('='*50)
```

```
some sample features(unique words in the corpus) ['00', '000', '001', '005nannan', '00am
==================================================
```

```
vocualbary=tf_idf_vect.get_feature_names()

idf = tf_idf_vect.idf_


import matplotlib.pyplot as plt

box_plot_data=[ idf ]
plt.boxplot(box_plot_data)
plt.show()
plt.show()
```



```
print(dict(zip(vocualbary,idf)))
```

```
{'00': 7.160414343777607, '000': 5.887217480817695, '001': 11.62055875771544, '005nannan
```

```
d=dict(zip(vocualbary,idf))
previous_vocabulary=d.keys()
print(previous_vocabulary)
high_idf= 10
print("high_idf: ",high_idf)
low_idf= 2
print("low_idf: ",low_idf)
final_vocabulary=[]
for k in d:
    if(d[k]<=high_idf and d[k]>=low_idf ):
       final_vocabulary.append(k)
print(final_vocabulary)
```

```
dict_keys(['00', '000', '001', '005nannan', '00am', '00p', '00pm', '01', '010', '01075rm
high_idf:  10
low_idf:  2
['00', '000', '00pm', '10', '100', '1000', '100th', '101', '102', '103', '104', '105', '
```

```
len(final_vocabulary)
```

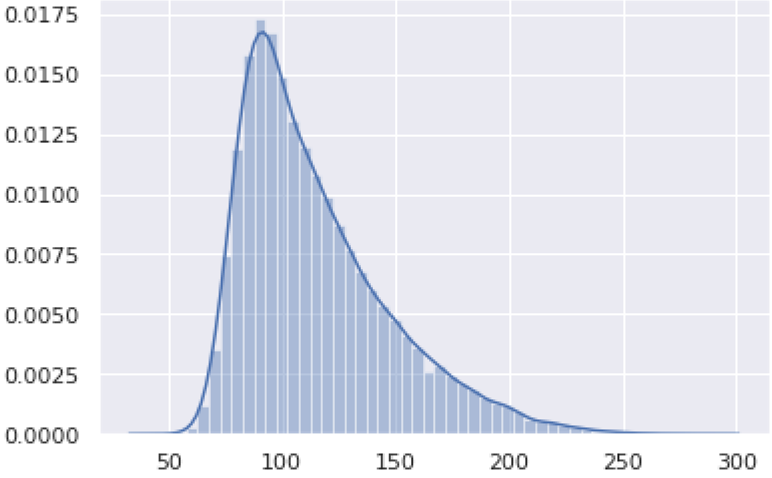
```
14872
```

```
# MAX_SEQUENCE_LENGTH = 800
# MAX_VOCAB_SIZE = 1000000
EMBEDDING_DIM = 300
```

```
# convert the sentences (strings) into integers
tokenizer = Tokenizer()
```

```
tokenizer.fit_on_texts(final_vocabulary)
text_train = tokenizer.texts_to_sequences(x_train["cleaned_text"])
text_test = tokenizer.texts_to_sequences(x_test["cleaned_text"])


length = []

for i in text_train:

  length.append(len(i))


sns.set()
sns.distplot(length)
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f38acfa2c18>
```



```
# get word -> integer mapping
word2idx = tokenizer.word_index
print('Found %s unique tokens.' % len(word2idx))
```

```
Found 14872 unique tokens.
```

```
max_len_seq = 100


text_train = pad_sequences(text_train,maxlen=max_len_seq)
print('Shape of data tensor:', text_train.shape)
```

```
Shape of data tensor: (81936, 100)
```

```
text_test = pad_sequences(text_test, maxlen=max_len_seq)
print('Shape of data tensor:', text_test.shape)
```

```
Shape of data tensor: (27312, 100)
```

```
# Loading Embedding File

pickle_in = open("/content/drive/My Drive/Colab Notebooks/Donors for AFR Classroom/glove_vect
pickle_in = open('/content/drive/My Drive/Colab Notebooks/Donors for AFR Classroom/glove_vect
glove_words = pickle.load(pickle_in)


num_words = len(word2idx) + 1
embedding_matrix = np.zeros((num_words, 300))
for word, i in word2idx.items():
  if i < len(final_vocabulary):
    embedding_vector = glove_words.get(word)
    if embedding_vector is not None:
      embedding_matrix[i] = embedding_vector


print("The Number of words ",num_words)
print("The shapoe of embedding_matrix ", embedding_matrix.shape)
```

```
The Number of words  14873
The shapoe of embedding_matrix  (14873, 300)
```

```
from sklearn.preprocessing import OneHotEncoder


#cat_features
cat_feature_x_train_school_state = x_train['school_state'].values
cat_feature_x_train_teacher_prefix = x_train['teacher_prefix'].values
cat_feature_x_train_project_grade_category = x_train['project_grade_category'].values
cat_feature_x_train_clean_categories = x_train['clean_categories'].values
cat_feature_x_train_clean_subcategories =x_train['clean_subcategories'].values

cat_feature_x_test_school_state = x_test['school_state'].values
cat_feature_x_test_teacher_prefix = x_test['teacher_prefix'].values
cat_feature_x_test_project_grade_category = x_test['project_grade_category'].values
cat_feature_x_test_clean_categories = x_test['clean_categories'].values
cat_feature_x_test_clean_subcategories = x_test['clean_subcategories'].values


school_state = x_train['school_state'].values
ohe = OneHotEncoder(sparse=False, handle_unknown='ignore')
school_state_train = school_state.reshape(-1, 1)
ohe.fit(school_state_train)
cat_feature_x_train_school_state = ohe.transform(school_state_train)
school_state_test = cat_feature_x_test_school_state.reshape(-1,1)
cat_feature_x_test_school_state = ohe.transform(school_state_test)


cat_feature_x_train_school_state.shape
```

```
(81936, 51)
```

```
train_teacher_prefix = cat_feature_x_train_teacher_prefix.reshape(-1,1)
test_teacher_prefix = cat_feature_x_test_teacher_prefix.reshape(-1,1)
ohe.fit(train_teacher_prefix)
cat_feature_x_train_teacher_prefix = ohe.transform(train_teacher_prefix)
cat_feature_x_test_teacher_prefix = ohe.transform(test_teacher_prefix)
```

```
cat_feature_x_train_teacher_prefix.shape
```

```
(81936, 5)
```

```
train_project_grade_category = cat_feature_x_train_project_grade_category.reshape(-1,1)
test_project_grade_category = cat_feature_x_test_project_grade_category.reshape(-1,1)
ohe.fit(train_project_grade_category)
cat_feature_x_train_project_grade_category = ohe.transform(train_project_grade_category)
cat_feature_x_test_project_grade_category = ohe.transform(test_project_grade_category)
```

```
train_clean_categories = cat_feature_x_train_clean_categories.reshape(-1,1)
test_clean_categories = cat_feature_x_test_clean_categories.reshape(-1,1)
ohe.fit(train_clean_categories)
cat_feature_x_train_clean_categories = ohe.transform(train_clean_categories)
cat_feature_x_test_clean_categories = ohe.transform(test_clean_categories)
```

```
train_clean_subcategories = cat_feature_x_train_clean_subcategories.reshape(-1,1)
test_clean_subcategories = cat_feature_x_test_clean_subcategories.reshape(-1,1)
ohe.fit(train_teacher_prefix)
cat_feature_x_train_clean_subcategories = ohe.transform(train_clean_subcategories)
cat_feature_x_test_clean_subcategories = ohe.transform(test_clean_subcategories)
```

```
cat_feat_train = np.hstack((cat_feature_x_train_school_state,cat_feature_x_train_teacher_pref
cat_feat_test = np.hstack((cat_feature_x_test_school_state,cat_feature_x_test_teacher_prefix,
```

```
cat_feat_train.shape
```

```
(81936, 116)
```

```
#target
target_x_train = 'project_is_approved'
target_x_test = 'project_is_approved'
```

```
#Numerical features
real_feature_x_train_price = ['price']
real_feature_x_train_quantity = ['quantity']
real_feature_x_train_teacher_number_of_previously_posted_projects = ['teacher_number_of_previ

real_feature_x_test_price = ['price']
real_feature_x_test_quantity = ['quantity']
real_feature_x_test_teacher_number_of_previously_posted_projects = ['teacher_number_of_previo
```

```
from sklearn.preprocessing import StandardScaler
```

```
SS = StandardScaler()
```

```
SS.fit(x_train[real_feature_x_train_price])
x_train_real_feature_price_scale = SS.transform(x_train[real_feature_x_train_price])
x_test_real_feature_price_scale = SS.transform(x_test[real_feature_x_test_price])
```

```
SS.fit(x_train[real_feature_x_train_quantity])
x_train_real_feature_quantity_scale = SS.transform(x_train[real_feature_x_train_quantity])
x_test_real_feature_quantity_scale = SS.transform(x_test[real_feature_x_test_quantity])
```

```
SS.fit(x_train[real_feature_x_train_teacher_number_of_previously_posted_projects])
x_train_real_feature_teacher_number_of_previously_posted_projects_scale = SS.transform(x_trai
x_test_real_feature_teacher_number_of_previously_posted_projects_scale = SS.transform(x_test[
```

```
real_feature_x_train = np.concatenate((x_train_real_feature_price_scale,x_train_real_feature_
real_feature_x_test = np.concatenate((x_test_real_feature_price_scale,x_test_real_feature_qua
```

```
real_feature_x_train.shape
```

```
(81936, 3)
```

```
other_all_train = np.hstack((cat_feat_train,real_feature_x_train))
other_all_test = np.hstack((cat_feat_test,real_feature_x_test))
```

```
other_all_train.shape
```

```
(81936, 119)
```

```
other_train = np.expand_dims(other_all_train,2)
other_test = np.expand_dims(other_all_test,2)
```

```
print(other_train.shape)
print("++++++++++++++")
print(other_test.shape)
```

```
(81936, 119, 1)
++++++++++++++
(27312, 119, 1)
```

```
len_oth_train = other_all_train.shape[1]
```

```
len_oth_train
```

```
119
```

```
embedding_layer = Embedding(
  num_words,
  300,
  weights=[embedding_matrix],
  input_length=max_len_seq,
  trainable=False
)
inputs_1 = Input(shape=(max_len_seq,),name="input_text")
embedding_1 = embedding_layer(inputs_1)
# x = SpatialDropout1D(0.4)(x)
lstm_1 = LSTM(256,dropout=0.5,kernel_regularizer=regularizers.l2(0.001),return_sequences=True
flat_1 = Flatten()(lstm_1)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
```

```
inputs_2 = Input(shape=(len_oth_train,1))
conv_1 = Conv1D(filters=128, kernel_size=3, activation='relu',kernel_initializer="he_normal")
conv_2 = Conv1D(filters=128, kernel_size=3, activation='relu',kernel_initializer="he_normal")

flat_2 = Flatten()(conv_2)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
```

```
from keras.layers.merge import concatenate
merged = concatenate([flat_1, flat_2])
```

```
from keras.models import Model
# interpretation
dense1 = Dense(128,activation="relu",kernel_initializer="he_normal",kernel_regularizer=regula
drop1 = Dropout(0.5)(dense1)
```

```
dense2 = Dense(64,activation="relu",kernel_initializer="he_normal",kernel_regularizer=regular
drop2 = Dropout(0.3)(dense2)

dense_3 = Dense(32,activation="relu",kernel_initializer="he_normal",kernel_regularizer=regula

outputs = Dense(2, activation='softmax', name='output')(dense_3)
model_3 = Model(inputs=(inputs_1, inputs_2), outputs=outputs)

model_3.summary()
```

```
Model: "model_1"
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_text (InputLayer)         (None, 100)          0
__________________________________________________________________________________________________
input_1 (InputLayer)            (None, 119, 1)       0
```

```
________________________________________________________________________________________
embedding_1 (Embedding)         (None, 100, 300)     4461900     input_text[0][0]
________________________________________________________________________________________
conv1d_1 (Conv1D)               (None, 117, 128)     512         input_1[0][0]
________________________________________________________________________________________
lstm_1 (LSTM)                   (None, 100, 256)     570368      embedding_1[0][0]
________________________________________________________________________________________
conv1d_2 (Conv1D)               (None, 115, 128)     49280       conv1d_1[0][0]
________________________________________________________________________________________
flatten_1 (Flatten)             (None, 25600)        0           lstm_1[0][0]
________________________________________________________________________________________
flatten_2 (Flatten)             (None, 14720)        0           conv1d_2[0][0]
________________________________________________________________________________________
concatenate_1 (Concatenate)     (None, 40320)        0           flatten_1[0][0]
                                                                 flatten_2[0][0]
________________________________________________________________________________________
dense_1 (Dense)                 (None, 128)          5161088     concatenate_1[0][0]
________________________________________________________________________________________
dropout_1 (Dropout)             (None, 128)          0           dense_1[0][0]
________________________________________________________________________________________
dense_2 (Dense)                 (None, 64)           8256        dropout_1[0][0]
________________________________________________________________________________________
dropout_2 (Dropout)             (None, 64)           0           dense_2[0][0]
________________________________________________________________________________________
dense_3 (Dense)                 (None, 32)           2080        dropout_2[0][0]
________________________________________________________________________________________
output (Dense)                  (None, 2)            66          dense_3[0][0]
========================================================================================
Total params: 10,253,550
Trainable params: 5,791,650
Non-trainable params: 4,461,900
________________________________________________________________________________________
```

```
train_dat = [text_train,other_train]
test_data = [text_test,other_test]

from keras.utils import np_utils
Y_train = np_utils.to_categorical(y_train, 2)
Y_test = np_utils.to_categorical(y_test, 2)
```

```
other_train.shape
```

```
(81936, 119, 1)
```

```
checkpoint_3 = ModelCheckpoint("model_3.h5",
                             monitor="val_auroc",
                             mode="max",
                             save_best_only = True,
                             verbose=1)
```

```
tensorboard_3 = TensorBoard(log_dir='graph_3', histogram_freq=0, batch_size=512, write_graph=
callbacks_3 = [tensorboard_3,checkpoint_3]


# Defining Custom ROC-AUC Metrics
from sklearn.metrics import roc_auc_score

def auc1(y_true, y_pred):
    if len(np.unique(y_true[:,1])) == 1:
        return 0.5
    else:
        return roc_auc_score(y_true, y_pred)

def auc(y_true, y_pred):
    return tf.py_func(auc1, (y_true, y_pred), tf.double)


adam = Adam(lr=0.001, beta_1=0.9, beta_2=0.999, epsilon=None, decay=0.0, amsgrad=False)
rms = RMSprop(lr=0.001, rho=0.9, epsilon=None, decay=0.0)


model_3.compile(optimizer=adam, loss='categorical_crossentropy', metrics=[auc])
```

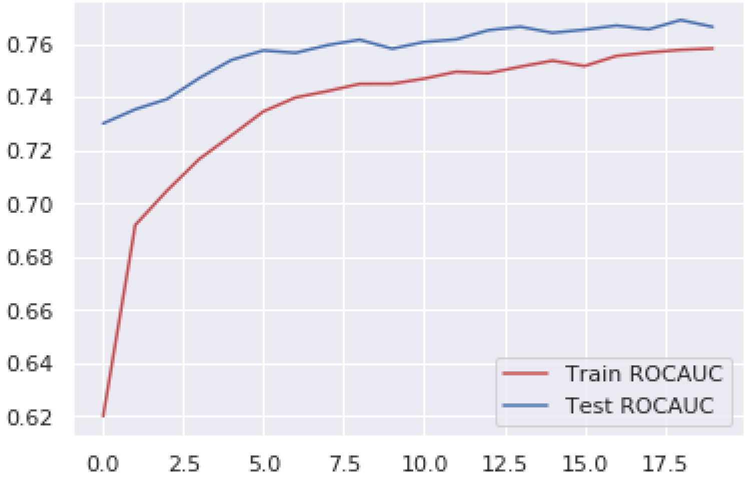
```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793:

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From <ipython-input-143-2affa1a8a367>:10: py_func (from tensorflow.py
Instructions for updating:
tf.py_func is deprecated in TF V2. Instead, there are two
    options available in V2.
    - tf.py_function takes a python function which manipulates tf eager
    tensors instead of numpy arrays. It's easy to convert a tf eager tensor to
    an ndarray (just call tensor.numpy()) but having access to eager tensors
    means `tf.py_function`s can use accelerators such as GPUs as well as
    being differentiable using a gradient tape.
    - tf.numpy_function maintains the semantics of the deprecated tf.py_func
    (it is not differentiable, and manipulates numpy arrays). It drops the
    stateful argument making all functions stateful.
```

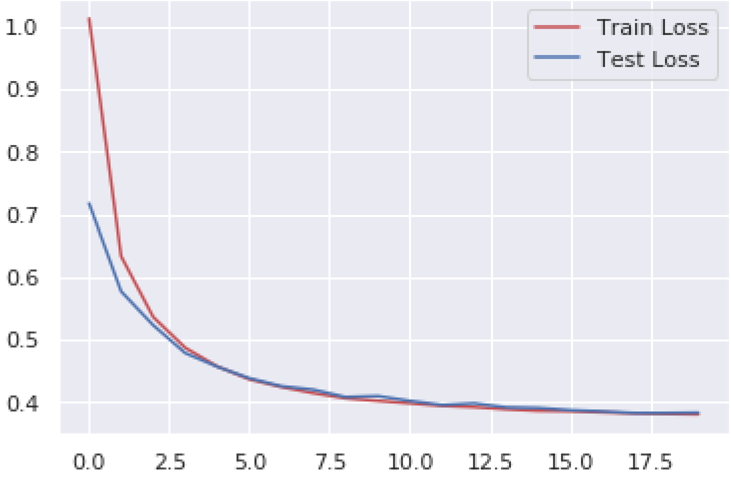
```
history_3 = model_3.fit([text_train,other_train],Y_train,batch_size=1000,
                        epochs=20,validation_data=([text_test,other_test],Y_test),callbacks=c
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/op
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_
```

```
Train on 81936 samples, validate on 27312 samples
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1122:

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1125:

Epoch 1/20
81936/81936 [==============================] - 839s 10ms/step - loss: 1.0128 - auc: 0.62
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/callbacks.py:1265:

Epoch 2/20
81936/81936 [==============================] - 829s 10ms/step - loss: 0.6333 - auc: 0.69
Epoch 3/20
81936/81936 [==============================] - 830s 10ms/step - loss: 0.5363 - auc: 0.70
Epoch 4/20
81936/81936 [==============================] - 825s 10ms/step - loss: 0.4869 - auc: 0.71
Epoch 5/20
81936/81936 [==============================] - 818s 10ms/step - loss: 0.4570 - auc: 0.72
Epoch 6/20
81936/81936 [==============================] - 821s 10ms/step - loss: 0.4363 - auc: 0.73
Epoch 7/20
81936/81936 [==============================] - 825s 10ms/step - loss: 0.4241 - auc: 0.73
Epoch 8/20
81936/81936 [==============================] - 826s 10ms/step - loss: 0.4143 - auc: 0.74
Epoch 9/20
81936/81936 [==============================] - 828s 10ms/step - loss: 0.4060 - auc: 0.74
Epoch 10/20
81936/81936 [==============================] - 832s 10ms/step - loss: 0.4019 - auc: 0.74
Epoch 11/20
81936/81936 [==============================] - 824s 10ms/step - loss: 0.3980 - auc: 0.74
Epoch 12/20
81936/81936 [==============================] - 818s 10ms/step - loss: 0.3939 - auc: 0.74
Epoch 13/20
81936/81936 [==============================] - 816s 10ms/step - loss: 0.3920 - auc: 0.74
Epoch 14/20
81936/81936 [==============================] - 828s 10ms/step - loss: 0.3885 - auc: 0.75
Epoch 15/20
81936/81936 [==============================] - 844s 10ms/step - loss: 0.3860 - auc: 0.75
Epoch 16/20
81936/81936 [==============================] - 827s 10ms/step - loss: 0.3854 - auc: 0.75
Epoch 17/20
81936/81936 [==============================] - 824s 10ms/step - loss: 0.3836 - auc: 0.75
Epoch 18/20
81936/81936 [==============================] - 876s 11ms/step - loss: 0.3819 - auc: 0.75
Epoch 19/20
81936/81936 [==============================] - 925s 11ms/step - loss: 0.3810 - auc: 0.75
Epoch 20/20
81936/81936 [==============================] - 915s 11ms/step - loss: 0.3804 - auc: 0.75
```

```
sns.set()
plt.plot(history_3.history['auc'], 'r')
plt.plot(history_3.history['val_auc'], 'b')
plt.legend({'Train ROCAUC': 'r', 'Test ROCAUC':'b'})
plt.show()
plt.plot(history_3.history['loss'], 'r')
plt.plot(history_3.history['val_loss'], 'b')
plt.legend({'Train Loss': 'r', 'Test Loss':'b'})
plt.show()
```





Conclusion:

1. We take the data do some univariate anlysis and preprocessing steps
2. After the we split the data into train data and test data
3. We use AUC as metrics because this is highly imbalanced data set
4. After that we build three models. In model - 1 we apply LSTM layer on text feature, Embeding layer on categor features
5. Label Encoder is used to encode the categorical data in model-1 and finally flat the all layers and add dense la
6. We finally we get AUC = 0.757 with model -1
7. In model - 2 same as model -1 except text feature. In text feature we remove top and low idf value words beca not give best results. We get AUC = 0.76
8. In model -3 same as model -2 apply lstm layer on text features and concatinate all the categorical features an

9. Flat the all layers and concatinate apply dense layer on top of it we get Auc = 0.765
10. In model -3 we use OneHotEncoder to encode the categorical data