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

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

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

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

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

from tqdm import tqdm
import os

# from plotly import plotly
# import plotly.offline as offline
# import plotly.graph_objs as go
# offline.init_notebook_mode()
from collections import Counter
print('done all modules imported ')
```

```
done all modules imported
```

```
#getting the file from google drive (test data)
import gdown

url = 'https://drive.google.com/uc?id=1bDLwb_Vq7q2W9S89JB96PgmZG3LsLns9'
output = 'train.csv'
```

```
# https://drive.google.com/file/d/1bDLwb_Vq7q2W9S89JB96PgmZG3LsLns9/view?usp=sharing
gdown.download(url, output, quiet=False)
```

```
Downloading...
From: https://drive.google.com/uc?id=1bDLwb_Vq7q2W9S89JB96PgmZG3LsLns9
To: /content/train.csv
201MB [00:01, 109MB/s]
'train.csv'
```

```
#getting the data from google drive (resources data)resources data
import gdown
url = 'https://drive.google.com/uc?id=14OVXWu_SJU-lJD-jKMOCld14EZ21lYYe'
output = 'resources.csv'
gdown.download(url, output, quiet=False)

```

```
Downloading...
From: https://drive.google.com/uc?id=14OVXWu_SJU-lJD-jKMOCld14EZ21lYYe
To: /content/resources.csv
127MB [00:00, 136MB/s]
'resources.csv'
```

```
dft = pd.read_csv('train.csv',nrows=50000)
dfr = pd.read_csv('resources.csv')
```

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

```
Number of data points in train data (50000, 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']
^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^
(1541272, 4)
['id' 'description' 'quantity' 'price']
```

```
#sort the datapoints by date and time column
# list comprehension python : https://stackoverflow.com/a/2582163/4084039
# cols = ['Date' if x=='project_submitted_datetime' else x for x in list(dft.columns)]
# #sort dataframe based on time  uisng pandas to_datetime function  : https://stackoverflow.com/a/49702492/4084039
# dft['Date'] = pd.to_datetime(dft['project_submitted_datetime'])
# dft.drop('project_submitted_datetime', axis=1, inplace=True)# we drop the col
# dft.sort_values(by=['Date'], inplace=True)# sort the values y date
dft.head(2)
```

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

1.1 Text preprocessing

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

```
# 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 so as to get btter prediction : that is , no , not ,etc .
stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you're", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'having', 'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'until', 'while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'during', 'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 'd', 'll', 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'doesn', "doesn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn', "wasn't", 'weren', "weren't", \
            'won', "won't", 'wouldn', "wouldn't"]
```

Preprocessing of the **project_subject_categories**

```python
categories = list(dft['project_subject_categories'].values)
# remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039
# https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-string
# https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-python
cat_list = []
for i in categories:
    temp = ""
    for j in i.split(','):
        if 'The' in j.split():
            j=j.replace('The','')
        j = j.replace(' ','')
        temp+=j.strip()+" "
        temp = temp.replace('&','_')
    cat_list.append(temp.strip())

dft['clean_categories'] = cat_list
dft.drop(['project_subject_categories'], axis=1, inplace=True)

from collections import Counter
my_counter = Counter()
for word in dft['clean_categories'].values:
    my_counter.update(word.split())

cat_dict = dict(my_counter)
project_subject_categories_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
print(project_subject_categories_dict)
```

```
{'Warmth': 643, 'Care_Hunger': 643, 'History_Civics': 2689, 'Music_Arts': 4699, 'AppliedLearning': 5569, 'SpecialNeeds'
```

preprocessing of the **project_subject_subcategories**

```python
sub_catogories = list(dft['project_subject_subcategories'].values)
# # remove special characters from list of strings python: https://stackoverflow.com/a/47301924/4084039
# # https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
# # https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-string
# # https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-python

sub_cat_list = []
for i in sub_catogories:
    temp = ""
    for j in i.split(','):
        if 'The' in j.split():
            j=j.replace('The','')
        j = j.replace(' ','')
        temp +=j.strip()+" "
        temp = temp.replace('&','_')
    sub_cat_list.append(temp.strip())

dft['clean_subcategories'] = sub_cat_list
dft.drop(['project_subject_subcategories'], axis=1, inplace=True)

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

sub_cat_dict = dict(my_counter)
project_subject_subcategories_dict = dict(sorted(sub_cat_dict.items(), key=lambda kv: kv[1]))
project_subject_subcategories_dict
```

```
{'AppliedSciences': 4901,
```

preprocessing of the **project_grade_category**

```
 'Civics_Government': 380,
```

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

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

grade_cat_list = []
for i in Grade:
    # consider we have text like this:
    for j in i.split(' '): #    # split by spae
        j=j.replace('Grades','')# clean grades from the row
    grade_cat_list.append(j.strip())



dft['clean_grade'] = grade_cat_list
dft.drop(['project_grade_category'], axis=1, inplace=True)

# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
my_counter = Counter()
for word in dft['clean_grade'].values:
    my_counter.update(word.split())

project_grade_category_dict= dict(my_counter)
sorted_project_grade_category_dict = dict(sorted(project_grade_category_dict.items(), key=lambda kv: kv[1]))
sorted_project_grade_category_dict
```

```
{'3-5': 16968, '6-8': 7750, '9-12': 4966, 'PreK-2': 20316}
```

Preparing data matrix for the models for Model

Spliting the Data for test , train and cv using the SKlearn Module train_test_split

↳ 3 cells hidden

Pre-processing the Text Features ,

here we are independtenly doing the preprocessing as i observed that if we pre-processes and then divide the data , it is casuing in lower AUC score

↳ 6 cells hidden

2.1 vectorizing the Categorical Data

The vectorizing Processes used here is One-hot Encoding

```
from collections import Counter
my_counter = Counter()
for word in X_train['clean_categories'].values:
    my_counter.update(word.split())

cat_dict = dict(my_counter)
project_subject_categories_dict = dict(sorted(cat_dict.items(), key=lambda kv: kv[1]))
print(project_subject_categories_dict)

#  vectorizing Processes of clean_categories
from sklearn.feature_extraction.text import CountVectorizer
vectorizer1 = CountVectorizer(vocabulary=list(project_subject_categories_dict.keys()), lowercase=False, binary=True)
vectorizer1.fit(X_train['clean_categories'].values)

# The fit is only to be happen on the train data orelse it may casue data leakage
# we use the fitted CountVectorizer on X_train data for converting the text to vector form (i.e using One- hot encoding )
X_train_cat = vectorizer1.transform(X_train['clean_categories'].values)
X_cv_cat = vectorizer1.transform(X_cv['clean_categories'].values)
X_test_cat = vectorizer1.transform(X_test['clean_categories'].values)

print(vectorizer1.get_feature_names())

```

```
{'Warmth': 289, 'Care_Hunger': 289, 'History_Civics': 1246, 'Music_Arts': 2103, 'AppliedLearning': 2485, 'SpecialNeeds'
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning', 'SpecialNeeds', 'Health_Sports', 'Math_Scie
```

```
print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_cat.shape, y_train.shape)
print("="*100)
print(X_cv_cat.shape, y_cv.shape)
print("="*100)
print(X_test_cat.shape, y_test.shape)
```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 9) (22445,)
====================================================================================================
(11055, 9) (11055,)
====================================================================================================
(16500, 9) (16500,)
```

```python
# The fit is only to be happen on the train data orelse it may casue data leakage
# we use the fitted CountVectorizer on X_train data for converting the text to vector form (i.e using One- hot encoding )
from sklearn.feature_extraction.text import CountVectorizer
vectorizer2 = CountVectorizer(vocabulary=list(project_subject_subcategories_dict.keys()), lowercase=False, binary=True)
vectorizer2.fit(X_train['clean_subcategories'].values)


X_train_subcat = vectorizer2.transform(X_train['clean_subcategories'].values)
X_cv_subcat = vectorizer2.transform(X_cv['clean_subcategories'].values)
X_test_subcat = vectorizer2.transform(X_test['clean_subcategories'].values)

print(vectorizer2.get_feature_names())
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Extracurricular', 'Civics_Government', 'Fo
```

```python
print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_subcat.shape, y_train.shape)
print("="*100)
print(X_cv_subcat.shape, y_cv.shape)
print("="*100)
print(X_test_subcat.shape, y_test.shape)

```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 30) (22445,)
====================================================================================================
(11055, 30) (11055,)
====================================================================================================
(16500, 30) (16500,)
```

```python
#school_state data column convert categorical to vectors
# 1st the vocabulary of the words are taken into account then it is used to do one - hot - encodng
# then sort the dictonary and apply the one - hot - encoding
from collections import Counter
```

```
my_counter = Counter()
for word in dft['school_state'].values:
    my_counter.update(word.split())

school_state_dict = dict(my_counter)
sorted_school_state_dict = dict(sorted(school_state_dict.items(), key=lambda kv: kv[1]))

# here the data is converted into ector form
from sklearn.feature_extraction.text import CountVectorizer
vectorizer3 = CountVectorizer(vocabulary=list(sorted_school_state_dict.keys()), lowercase=False, binary=True)
vectorizer3.fit(dft['school_state'].values)


X_train_school_state = vectorizer3.transform(X_train['school_state'].values)
X_cv_school_state = vectorizer3.transform(X_cv['school_state'].values)
X_test_school_state = vectorizer3.transform(X_test['school_state'].values)

print(vectorizer3.get_feature_names())
```

```
['VT', 'WY', 'ND', 'MT', 'RI', 'NH', 'SD', 'NE', 'AK', 'DE', 'WV', 'ME', 'NM', 'HI', 'DC', 'KS', 'ID', 'IA', 'AR', 'CO'
```

```
print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_school_state .shape, y_train.shape)
print(X_cv_school_state .shape, y_cv.shape)
print(X_test_school_state .shape, y_test.shape)

```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 51) (22445,)
(11055, 51) (11055,)
(16500, 51) (16500,)
```

```
# here i am converting the clean_grade into vectors
#Fillna is used to fill all he spaces that are present in the data coloumn
#https://stackoverflow.com/questions/42224700/attributeerror-float-object-has-no-attribute-split
dft['clean_grade']=dft['clean_grade'].fillna("")# fill the nulll values with space

## here i am using the data from the unsplitted data as there as small number of values and may not present in the X_train data
#  so i am fitting it withe original data then converting into vectors
from sklearn.feature_extraction.text import CountVectorizer
vectorizer4 = CountVectorizer(vocabulary=list(sorted_project_grade_category_dict.keys()), lowercase=False, binary=True)
vectorizer4.fit(dft['clean_grade'].values)

# firstly convert fit the train data into the vectoriaer then it learn hte vocablery
```

```python

# we use the fitted CountVectorizer to convert the text to vector
X_train_project_grade_category = vectorizer4.transform(X_train['clean_grade'].values)
X_cv_project_grade_category = vectorizer4.transform(X_cv['clean_grade'].values)
X_test_project_grade_category = vectorizer4.transform(X_test['clean_grade'].values)

print(vectorizer4.get_feature_names())
```

```
['9-12', '6-8', '3-5', 'PreK-2']
```

```python
print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_project_grade_category  .shape, y_train.shape)
print(X_cv_project_grade_category  .shape, y_cv.shape)
print(X_test_project_grade_category  .shape, y_test.shape)

```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 4) (22445,)
(11055, 4) (11055,)
(16500, 4) (16500,)
```

```python
##https://stackoverflow.com/questions/42224700/attributeerror-float-object-has-no-attribute-split
dft['teacher_prefix']=dft['teacher_prefix'].fillna(" ")# filll the null values with space
my_counter = Counter()
for word in dft['teacher_prefix'].values:
    my_counter.update(word.split())

# dict sort by value python: https://stackoverflow.com/a/613218/4084039
teacher_cat_dict = dict(my_counter)
sorted_teacher_prefix_dict = dict(sorted(teacher_cat_dict.items(), key=lambda kv: kv[1]))
## here i am using the data from the unsplitted data as there as small number of values and may not present in the X_train data
#  so i am fitting it withe original data then converting into vectors
# after counting the frequency of the words we then transform into vectors
from sklearn.feature_extraction.text import CountVectorizer
vectorizer5 = CountVectorizer(vocabulary=list(sorted_teacher_prefix_dict.keys()), lowercase=False, binary=True)
vectorizer5.fit(dft['teacher_prefix'].values.astype('U'))

#  the fitted CountVectorizer to convert the text to vector
X_train_teacher_prefix = vectorizer5.transform(X_train['teacher_prefix'].values.astype('U'))
X_cv_teacher_prefix= vectorizer5.transform(X_cv['teacher_prefix'].values.astype('U'))
X_test_teacher_prefix = vectorizer5.transform(X_test['teacher_prefix'].values.astype('U'))

print(vectorizer5.get_feature_names())


# when i executeed this error comes
#np.nan is an invalid document, expected byte or unicode string.
```

```
# then iconvert to unicode just write .astype('U') after the .values in fit and transform
#https://stackoverflow.com/questions/39303912/tfidfvectorizer-in-scikit-learn-valueerror-np-nan-is-an-invalid-document
```

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

```
print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_teacher_prefix.shape, y_train.shape)
print(X_cv_teacher_prefix.shape, y_cv.shape)
print(X_test_teacher_prefix.shape, y_test.shape)
print("="*100)
```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 5) (22445,)
(11055, 5) (11055,)
(16500, 5) (16500,)
====================================================================================================
```

3.1 BOW Vectorization of the data : Processed essay and Project titles

```
# i am assigning the values of diffrent preprocessing to avoid confusion
# Changing the termonilogy
X_train_essay=preprocessed_essays_train
X_cv_essay=preprocessed_essays_cv
X_test_essay=preprocessed_essays_test
```

```
vectorizer6 = CountVectorizer(min_df=10,max_features=5000,ngram_range=(1, 2))
# here i am using the DF to be 10 and max features to be 5000 and uni and bi grams , refrence given below
# https://scikit-learn.org/stable/modules/generated/sklearn.feature_extraction.text.CountVectorizer.html
vectorizer6.fit(X_train_essay)

# we use the fitted CountVectorizer to convert the text to vector
X_train_bow = vectorizer6.transform(X_train_essay)
X_cv_bow = vectorizer6.transform(X_cv_essay)
X_test_bow = vectorizer6.transform(X_test_essay)

print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_bow.shape, y_train.shape)
print(X_cv_bow.shape, y_cv.shape)
print(X_test_bow.shape, y_test.shape)
print("so the dimension of all are the same and there will be no data leakage")
# print(vectorizer6.get_feature_names())
```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 5000) (22445,)
(11055, 5000) (11055,)
(16500, 5000) (16500,)
so the dimension of all are the same and there will be no data leakage
```

```
# i am assigning the values of diffrent preprocessing to avoid confusion
# Changing the termonilogy
X_train_title=preprocessed_titles_train
X_cv_title=preprocessed_titles_cv
X_test_title=preprocessed_titles_test
```

```
# Project title BOW
vectorizer7 = CountVectorizer(min_df=10,max_features=5000,ngram_range=(1, 2))
vectorizer7.fit(X_train_title)
# here i am using the DF to be 10 and max features to be 5000 and uni and bi grams , refrence given below
# https://scikit-learn.org/stable/modules/generated/sklearn.feature_extraction.text.CountVectorizer.html
X_train_bow_title = vectorizer7.transform(X_train_title)
X_cv_bow_title= vectorizer7.transform(X_cv_title)
X_test_bow_title = vectorizer7.transform(X_test_title)

print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_bow_title.shape, y_train.shape)
print(X_cv_bow_title.shape, y_cv.shape)
print(X_test_bow_title.shape, y_test.shape)
print("so the dimension of all are the same and there will be no data leakage")

```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 1619) (22445,)
(11055, 1619) (11055,)
(16500, 1619) (16500,)
so the dimension of all are the same and there will be no data leakage
```

3.2 TFIDF Vectorization of the data : Processed essay and Project titles

```
from sklearn.feature_extraction.text import TfidfVectorizer
# We are considering only the words which appeared in at least 10 documents and max of 5000 features .
vectorizer8 = TfidfVectorizer(min_df=10,max_features=5000,ngram_range=(1, 2))
vectorizer8.fit(X_train_title)# that is learned from trainned  data
```

```


# we use the fitted CountVectorizer to convert the text to vector
X_train_tf_title = vectorizer8.transform(X_train_title)
X_cv_tf_title= vectorizer8.transform(X_cv_title)
X_test_tf_title = vectorizer8.transform(X_test_title)

print("After vectorizations the shape of the data changes : it would be a spare matix form")
print(X_train_tf_title.shape, y_train.shape)
print(X_cv_tf_title.shape, y_cv.shape)
print(X_test_tf_title.shape, y_test.shape)
print("so the dimension of all are the same and there will be no data leakage")
```

```
After vectorizations the shape of the data changes : it would be a spare matix form
(22445, 1619) (22445,)
(11055, 1619) (11055,)
(16500, 1619) (16500,)
so the dimension of all are the same and there will be no data leakage
```

```
#for essay
from sklearn.feature_extraction.text import TfidfVectorizer
# We are considering only the words which appeared in at least 10 documents(rows or projects).
vectorizer9 = TfidfVectorizer(min_df=10,max_features=5000,ngram_range=(1, 2))# its a countvectors used for convert text to vectors
vectorizer9.fit(X_train_essay)# that is learned from trainned  data



# we use the fitted CountVectorizer to convert the text to vector
X_train_tf_essay = vectorizer9.transform(X_train_essay)
X_cv_tf_essay= vectorizer9.transform(X_cv_essay)
X_test_tf_essay = vectorizer9.transform(X_test_essay)



print("After vectorizations")
print(X_train_tf_essay.shape, y_train.shape)
print(X_cv_tf_essay.shape, y_cv.shape)
print(X_test_tf_essay.shape, y_test.shape)
print("="*100)
# so the dimension of alll are the same by using first fit and then transform

```

```
After vectorizations
```

3.3 AVG W2V Vectorization of the data : Processed essay and Project titles

```
(16500, 5000) (16500,)
```

```
import gdown

url = 'https://drive.google.com/uc?id=1MqUasf7jYoPbG35MJ28VQcOjjNp-ZDDp'
output = 'glove_vectors'
gdown.download(url, output, quiet=False)
```

```
Downloading...
From: https://drive.google.com/uc?id=1MqUasf7jYoPbG35MJ28VQcOjjNp-ZDDp
To: /content/glove_vectors
128MB [00:02, 63.3MB/s]
'glove_vectors'
```

```
import pickle
with open('glove_vectors', 'rb') as f:
    model = pickle.load(f)
    glove_words =  set(model.keys())
```

```
def AVG_W2V(values):
# AVG W2V Vectorization.

  train_avg_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this list
  for sentence in tqdm(values): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length    # we are taking the 300 dimensions  very large
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if word in glove_words:
            vector += model[word]
            cnt_words += 1
    if cnt_words != 0:
        vector /= cnt_words
    train_avg_w2v_vectors.append(vector)

  print(len(train_avg_w2v_vectors))
  print(len(train_avg_w2v_vectors[0]))
  return train_avg_w2v_vectors

```

```
train_avg_w2v_vectors=AVG_W2V(preprocessed_essays_train)
test_avg_w2v_vectors=AVG_W2V(preprocessed_essays_test)
cv_avg_w2v_vectors=AVG_W2V(preprocessed_essays_cv)
```

```
100%|██████████| 22445/22445 [00:05<00:00, 3863.97it/s]
  2%|▏         | 363/16500 [00:00<00:04, 3627.11it/s]22445
300
100%|██████████| 16500/16500 [00:04<00:00, 3752.85it/s]
  3%|▎         | 382/11055 [00:00<00:02, 3810.13it/s]16500
300
100%|██████████| 11055/11055 [00:02<00:00, 3764.67it/s]11055
300
```

```python
#  AVG W2V for preprocessed_titles
train_avg_w2v_vectors_title=AVG_W2V(preprocessed_titles_train)
test_avg_w2v_vectors_title=AVG_W2V(preprocessed_titles_test)
cv_avg_w2v_vectors_title=AVG_W2V(preprocessed_titles_cv)

```

```
100%|██████████| 22445/22445 [00:00<00:00, 64309.34it/s]
 41%|████      | 6771/16500 [00:00<00:00, 67703.77it/s]22445
300
100%|██████████| 16500/16500 [00:00<00:00, 66732.51it/s]
100%|██████████| 11055/11055 [00:00<00:00, 65830.20it/s]16500
300
11055
300
```

3.4 TFIDF weighted W2V vectorization using the Pretrained Models

```python
#here i am converting the dictionary with word as a key, and the idf as a value for the vectorization processes
tfidf_model = TfidfVectorizer()
tfidf_model.fit(preprocessed_essays_train)
dictionary = dict(zip(tfidf_model.get_feature_names(), list(tfidf_model.idf_)))
tfidf_words = set(tfidf_model.get_feature_names())
```

```python
# average Word2Vec
# compute average word2vec for each review.
def tf_idf_done(word_list):

  train_title_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this list
  for sentence in tqdm(word_list): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split():#.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sentence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # getting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    train_title_tfidf_w2v_vectors.append(vector)

  print(len(train_title_tfidf_w2v_vectors))
  print(len(train_title_tfidf_w2v_vectors[0]))
  return train_title_tfidf_w2v_vectors
```

```
# Vectorization the Processed titles
train_title_tfidf_w2v_vectors=tf_idf_done(preprocessed_titles_train)
test_title_tfidf_w2v_vectors=tf_idf_done(preprocessed_titles_test)
cv_title_tfidf_w2v_vectors=tf_idf_done(preprocessed_titles_cv)
```

```
100%|██████████| 22445/22445 [00:00<00:00, 33230.60it/s]
 23%|██▎        | 3765/16500 [00:00<00:00, 37645.91it/s]22445
300
100%|██████████| 16500/16500 [00:00<00:00, 35520.68it/s]
 33%|███▎       | 3682/11055 [00:00<00:00, 36810.82it/s]16500
300
100%|██████████| 11055/11055 [00:00<00:00, 35964.09it/s]11055
300
```

```
# Vectrozation of the preprocessed_essays
train_tfidf_w2v_vectors=tf_idf_done(preprocessed_essays_train)
test_tfidf_w2v_vectors=tf_idf_done(preprocessed_essays_test)
cv_tfidf_w2v_vectors=tf_idf_done(preprocessed_essays_cv)
```

```
100%|██████████| 22445/22445 [00:37<00:00, 602.21it/s]
  0%|          | 59/16500 [00:00<00:28, 579.82it/s]22445
300
100%|██████████| 16500/16500 [00:27<00:00, 605.52it/s]
  1%|          | 59/11055 [00:00<00:18, 583.36it/s]16500
300
100%|██████████| 11055/11055 [00:18<00:00, 597.67it/s]11055
300
```

4. 1 Vectorization of the Numerical features

```
#  there are 2 numerical features in the Resources data.csv so have to merge th dataframes
price_data = dfr.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
dft = pd.merge(dft, price_data, on='id', how='left')
print(price_data.head(7))

# same has to be done foe the train and test data
X_train = pd.merge(X_train, price_data, on = "id", how = "left")
X_test = pd.merge(X_test, price_data, on = "id", how = "left")
X_cv = pd.merge(X_cv, price_data, on = "id", how = "left")
```

```
         id    price  quantity
0  p000001   459.56         7
1  p000002   515.89        21
2  p000003   298.97         4
3  p000004  1113.69        98
4  p000005   485.99         8
5  p000006   130.62         5
6  p000007   157.98         6
```

```
from sklearn.preprocessing import StandardScaler
# https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html

scalar =  StandardScaler()
scalar.fit(X_train['price'].values.reshape(-1,1))

train_price_standar = scalar.transform(X_train['price'].values.reshape(-1, 1))
test_price_standar = scalar.transform(X_test['price'].values.reshape(-1, 1))
cv_price_standar = scalar.transform(X_cv['price'].values.reshape(-1, 1))
```

```
scalar.fit(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
train_prev_proj_standar = scalar.transform(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
test_prev_proj_standar = scalar.transform(X_test['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
cv_prev_proj_standar = scalar.transform(X_cv['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))


```

```
scalar.fit(X_train['quantity'].values.reshape(-1,1))
train_qnty_standar = scalar.transform(X_train['quantity'].values.reshape(-1, 1))
cv_qnty_standar = scalar.transform(X_cv['quantity'].values.reshape(-1, 1))
test_qnty_standar = scalar.transform(X_test['quantity'].values.reshape(-1, 1))

```

*Mergaing of all the Data matrix for diffrent sets of opeations *

1. Set 1: categorical, numerical features + project_title(BOW) + preprocessed_eassay (`BOW with bi-grams` with `min_df=10` and max_features=5000`)
2. Set 2: categorical, numerical features + project_title(TFIDF)+ preprocessed_eassay (`TFIDF with bi-grams` with `min_df=10` and `max_features=50`
3. Set 3: categorical, numerical features + project_title(AVG W2V)+ preprocessed_eassay (AVG W2V)
4. Set 4: categorical, numerical features + project_title(TFIDF W2V)+ preprocessed_essay (TFIDF W2V)

Set 1: categorical, numerical features + project_title(BOW) + preprocessed_eassay (BOW with bi-grams with min_df=10 and max_features=5000`)

```
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix and a dense matirx :)
X_set1_train = hstack((X_train_bow_title,X_train_bow,X_train_teacher_prefix,X_train_cat,X_train_subcat ,X_train_project_grade_cate
                       X_train_school_state,train_qnty_standar,train_price_standar,train_prev_proj_standar))
# printing the shape of X_set1_train data metrix
print(" printing the shape of X_set1_train data metrix",X_set1_train.shape, y_train.shape)

X_set1_cv = hstack((X_cv_bow_title,X_cv_bow,X_cv_teacher_prefix,X_cv_cat,X_cv_subcat,X_cv_project_grade_category,X_cv_school_state
                    cv_qnty_standar,cv_price_standar,cv_prev_proj_standar))
# printing the shape of X_set1_cv data metrix
print("printing the shape of X_set1_cv data metrix",X_set1_cv.shape, y_cv.shape)

X_set1_test = hstack((X_test_bow_title,X_test_bow,X_test_teacher_prefix,X_test_cat,X_test_subcat,X_test_project_grade_category,X_
                      test_qnty_standar,test_price_standar,test_prev_proj_standar))

# printing the shape of X_set1_test data metrix
print("printing the shape of X_set1_test data metrix ",X_set1_test.shape, y_test.shape)

```

```
 printing the shape of X_set1_train data metrix (22445, 6721) (22445,)
printing the shape of X_set1_cv data metrix (11055, 6721) (11055,)
printing the shape of X_set1_test data metrix  (16500, 6721) (16500,)
```

Set 2: categorical, numerical features + project_title(TFIDF)+ preprocessed_eassay (TFIDF with bi-grams with min_df=10 and max_features=5000)

```
X_set2_train = hstack((X_train_tf_essay,X_train_tf_title,X_train_teacher_prefix,X_train_cat,X_train_subcat,X_train_project_grade_
                       train_qnty_standar,train_price_standar,train_prev_proj_standar))


print("printing the shape of X_set2_train data metrix",X_set2_train.shape, y_train.shape)

print("*"*50)
X_set2_cv = hstack((X_cv_tf_essay,X_cv_tf_title,X_cv_teacher_prefix,X_cv_cat,X_cv_subcat,X_cv_project_grade_category,X_cv_school_
                   cv_qnty_standar,cv_price_standar,cv_prev_proj_standar))

print("printing the shape of X_set2_cv data metrix",X_set2_cv.shape, y_cv.shape)

print("*"*50)
X_set2_test = hstack((X_test_tf_essay,X_test_tf_title,X_test_teacher_prefix,X_test_cat,X_test_subcat, X_test_project_grade_catego
                     test_qnty_standar,test_price_standar,test_prev_proj_standar))

print("printing the shape of X_set2_test data metrix",X_set2_test.shape, y_test.shape)


```

```
printing the shape of X_set2_train data metrix (22445, 6721) (22445,)
**************************************************
printing the shape of X_set2_cv data metrix (11055, 6721) (11055,)
**************************************************
printing the shape of X_set2_test data metrix (16500, 6721) (16500,)
```

Set 3: categorical, numerical features + project_title(AVG W2V)+ preprocessed_eassay (AVG W2V)

```
X_set3_train = hstack((train_avg_w2v_vectors,train_avg_w2v_vectors_title,train_prev_proj_standar,train_price_standar,train_qnty_s
                      X_train_teacher_prefix,X_train_cat,X_train_subcat,
                      X_train_project_grade_category,X_train_school_state))


print("printing the shape of X_set3_train data metrix",X_set3_train.shape, y_train.shape)
print("*"*50)

```

```
X_set3_cv = hstack((cv_avg_w2v_vectors,cv_avg_w2v_vectors_title,cv_prev_proj_standar,cv_price_standar,cv_qnty_standar,
                      X_cv_teacher_prefix,X_cv_cat,X_cv_subcat,
                      X_cv_project_grade_category,X_cv_school_state))


print("printing the shape of X_set3_cv data metrix",X_set3_cv.shape, y_cv.shape)
print("*"*50)

X_set3_test = hstack((test_avg_w2v_vectors,test_avg_w2v_vectors_title,test_prev_proj_standar,test_price_standar,test_qnty_standar
                      X_test_teacher_prefix,X_test_cat,X_test_subcat,
                      X_test_project_grade_category,X_test_school_state))


print("printing the shape of X_set3_test data metrix",X_set3_test.shape, y_test.shape)
```

```
printing the shape of X_set3_train data metrix (22445, 702) (22445,)
**************************************************
printing the shape of X_set3_cv data metrix (11055, 702) (11055,)
**************************************************
printing the shape of X_set3_test data metrix (16500, 702) (16500,)
```

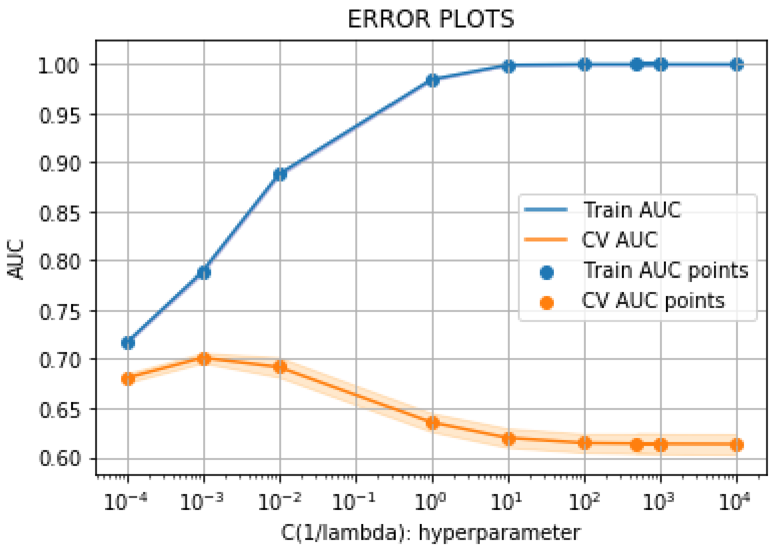
Set 4: categorical, numerical features + project_title(TFIDF W2V)+ preprocessed_essay (TFIDF W2V)

```
X_set4_train = hstack((train_tfidf_w2v_vectors,train_title_tfidf_w2v_vectors,train_prev_proj_standar,train_price_standar,train_qn
                      X_train_teacher_prefix,X_train_cat,X_train_subcat,
                      X_train_project_grade_category,X_train_school_state))


print("printing the shape of X_set4_train data metrix",X_set4_train.shape, y_train.shape)
print("*"*50)

X_set4_cv = hstack((cv_tfidf_w2v_vectors,cv_title_tfidf_w2v_vectors,cv_prev_proj_standar,cv_price_standar,cv_qnty_standar,
                      X_cv_teacher_prefix,X_cv_cat,X_cv_subcat,
                      X_cv_project_grade_category,X_cv_school_state))


print("printing the shape of X_set4_CV data metrix",X_set4_cv.shape, y_cv.shape)

print("*"*50)
X_set4_test = hstack((test_title_tfidf_w2v_vectors,test_tfidf_w2v_vectors,test_prev_proj_standar,test_price_standar,test_qnty_sta
                      X_test_teacher_prefix,X_test_cat,X_test_subcat,
                      X_test_project_grade_category,X_test_school_state))


print("printing the shape of X_set4_test data metrix",X_set4_test.shape, y_test.shape)
```

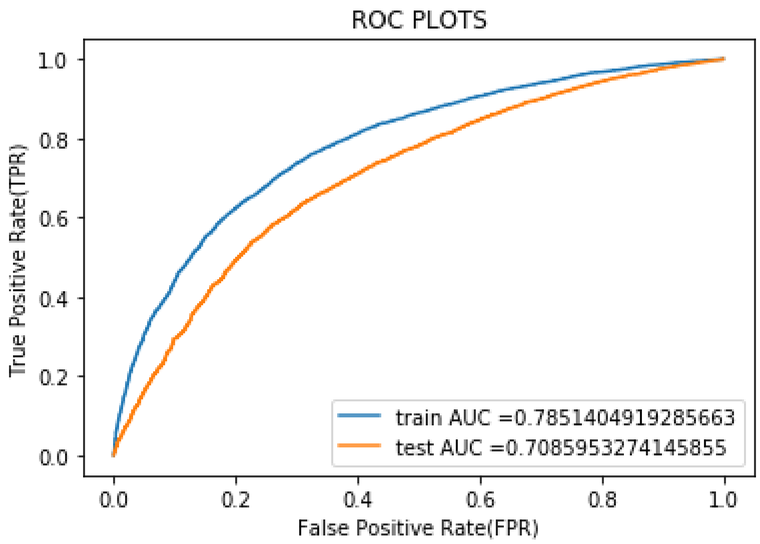
```
printing the shape of X_set4_train data metrix (22445, 702) (22445,)
**************************************************
printing the shape of X_set4_CV data metrix (11055, 702) (11055,)
**************************************************
printing the shape of X_set4_test data metrix (16500, 702) (16500,)
```

Applying the Logistic Regression model on SET:1

```python
import warnings
warnings.filterwarnings('ignore')
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV


clf = LogisticRegression(class_weight='balanced');
parameters ={'C':[10**-4, 10**-3,10**-2,1,10,100,1000,500,1000,10000]}
sd=GridSearchCV(clf, parameters, cv=5, scoring='roc_auc',return_train_score=True)
sd.fit(X_set1_train, y_train);


train_auc= sd.cv_results_['mean_train_score']
train_auc_std= sd.cv_results_['std_train_score']
cv_auc = sd.cv_results_['mean_test_score']
cv_auc_std= sd.cv_results_['std_test_score']

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,alpha=0.2,color='darkblue')

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.2,color='darkorange')

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')
plt.xscale('log')

plt.legend()
plt.xlabel("C(1/lambda): hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()
```

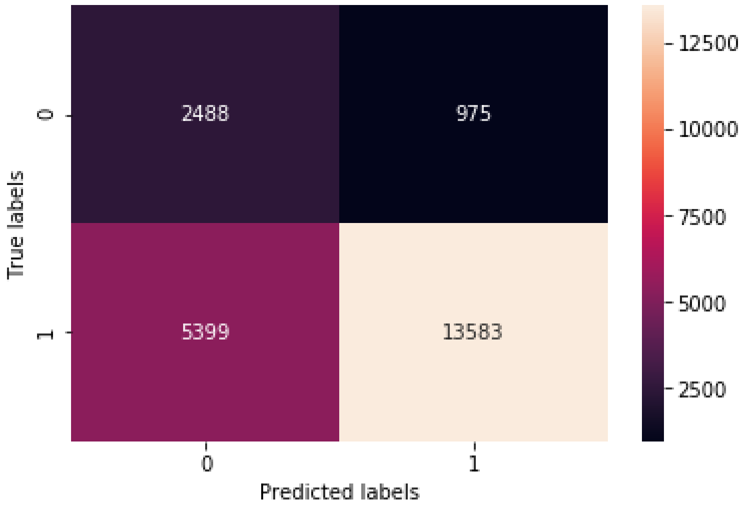


```
##Fitting Model to Hyper-Parameter Curve
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc


neigh = LogisticRegression(C=10**-3,class_weight='balanced');
neigh.fit(X_set1_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set1_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set1_test)[:,1])

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.ylabel("True Positive Rate(TPR)")
plt.xlabel("False Positive Rate(FPR)")
plt.title("ROC PLOTS")
plt.show()
```



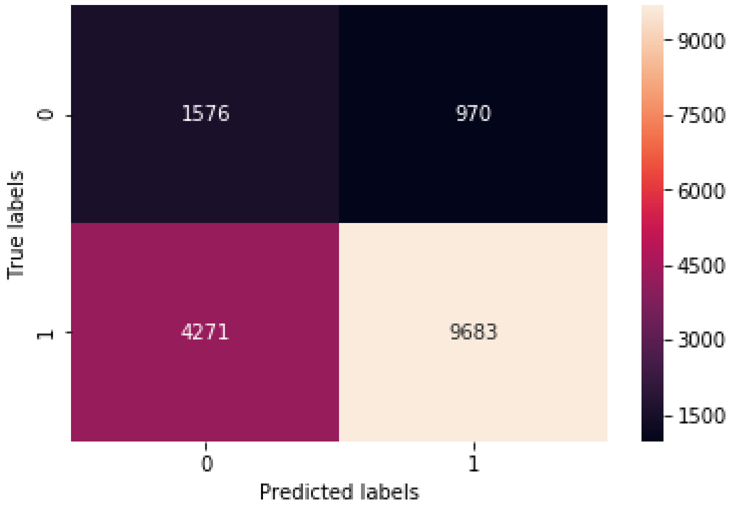
```
# Heat map representaion of the Confusion metrix
# https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set1_train )), annot=True, ax = ax,fmt='g'); #annot=True to annotate cells

# labels, title and ticks
ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels');
print("The Confusion metrix for Train data ")
```

```
The Confusion metrix for Train data
```



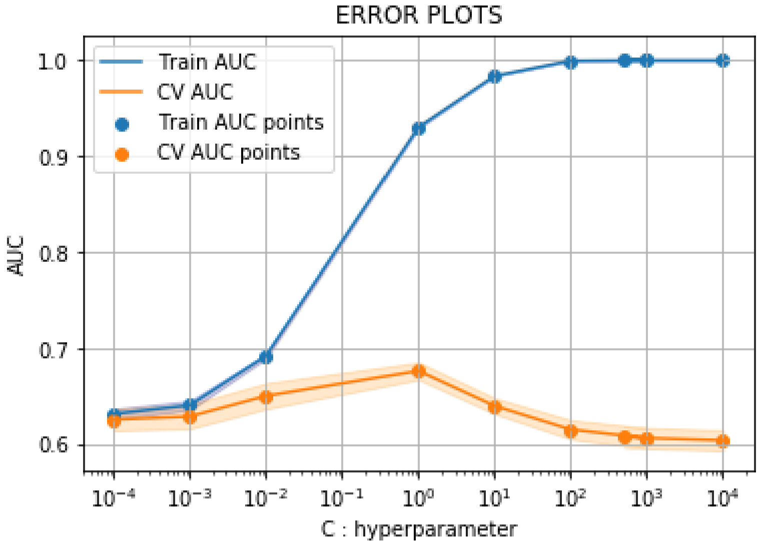
```python
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
import seaborn as sns
import matplotlib.pyplot as plt

ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set1_test )), annot=True, ax = ax,fmt='g'); #annot=True to annotate cells

# labels, title and ticks
ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels');
print("The Confusion metrix for Test data ")
```

```
The Confusion metrix for Test data
```

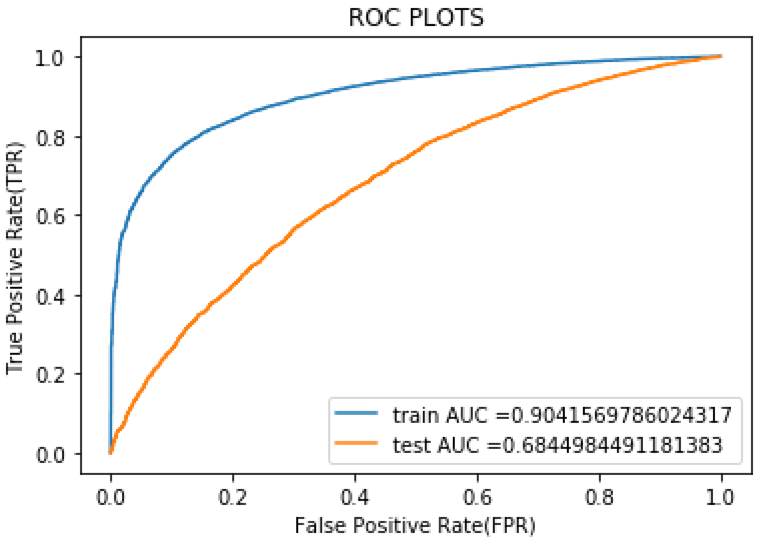


Applying the Logistic Regression model on SET:2

```python
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
#from sklearn.grid_search import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV

clf = LogisticRegression(class_weight='balanced');
parameters ={'C':[10**-4, 10**-3,10**-2,1,10,100,1000,500,1000,10000]}
sd = GridSearchCV(clf, parameters, cv=3, scoring='roc_auc',return_train_score=True)
sd.fit(X_set2_train, y_train);

train_auc= sd.cv_results_['mean_train_score']
train_auc_std= sd.cv_results_['std_train_score']
cv_auc =sd.cv_results_['mean_test_score']
cv_auc_std=sd.cv_results_['std_test_score']

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,alpha=0.2,color='darkblue')

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.2,color='darkorange')

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')
plt.xscale('log')

plt.legend()
plt.xlabel("C : hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()
```

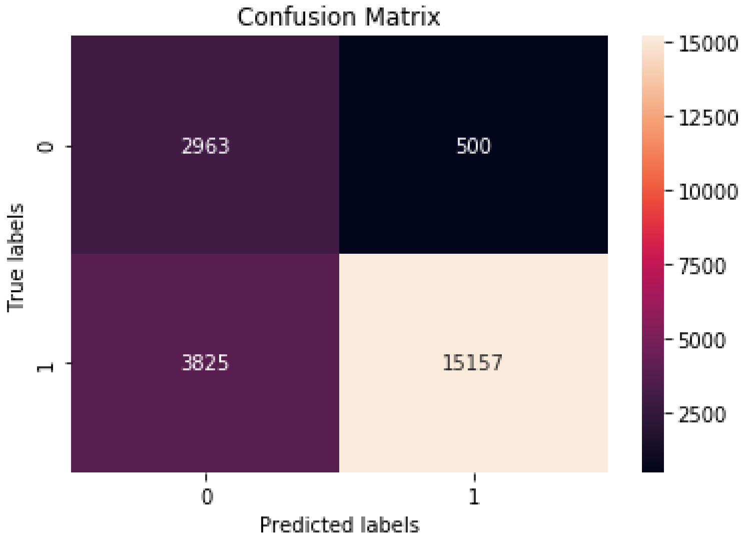


```python
#Fitting Model to Hyper-Parameter Curve
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc


neigh = LogisticRegression(C=1,class_weight='balanced');
neigh.fit(X_set2_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set2_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set2_test)[:,1])

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.ylabel("True Positive Rate(TPR)")
plt.xlabel("False Positive Rate(FPR)")
plt.title("ROC PLOTS")
plt.show()

```



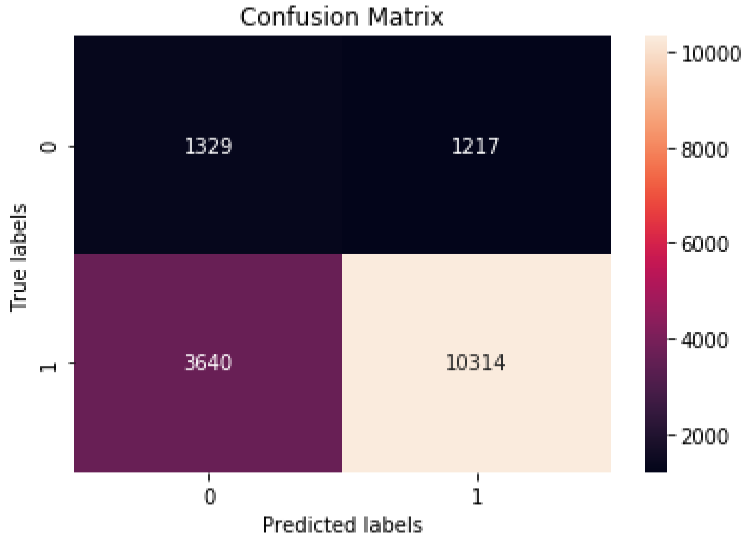
```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set2_train )), annot=True, ax = ax,fmt='g'); #annot=True to annotate cells
ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels');
ax.set_title('Confusion Matrix')
print("The Confusion metrix for Train data ")
```

```
The Confusion metrix for Train data
```



```python
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set2_test )), annot=True, ax = ax,fmt='g')
ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels')
ax.set_title('Confusion Matrix')
print("The Confusion metrix for Test data ")
```

```
The Confusion metrix for Test data
```

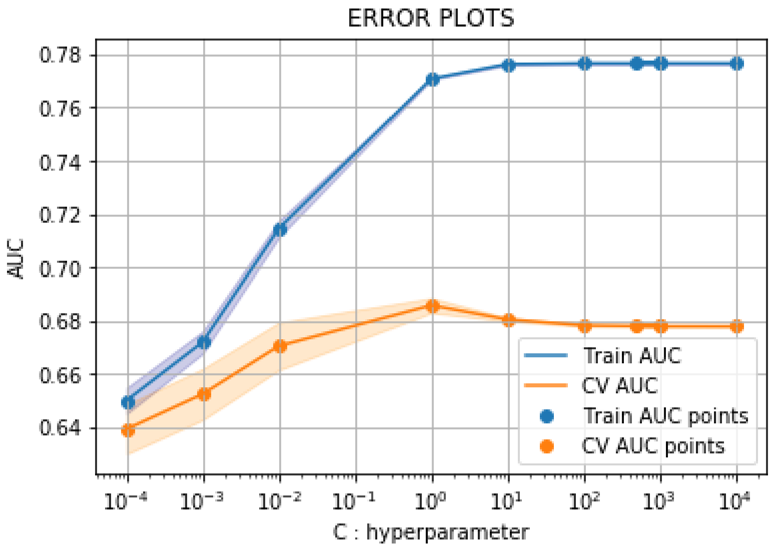

Confusion Matrix

Applying the Logistic Regression model on SET:3

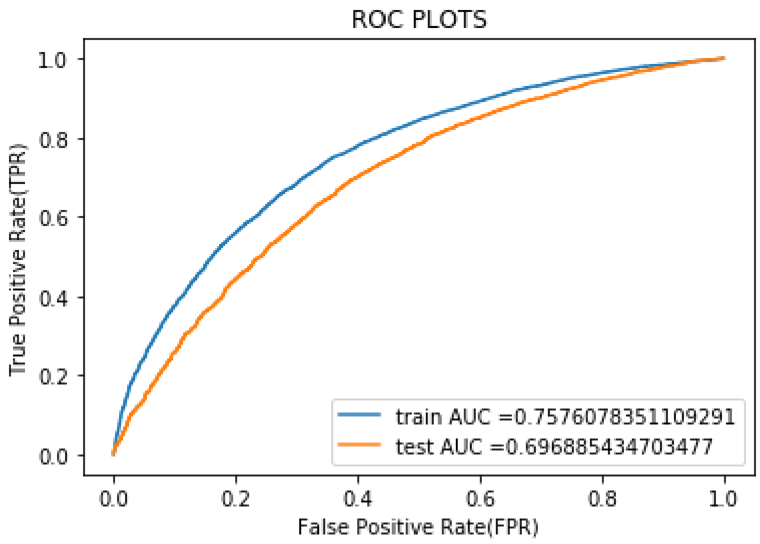
Set 3: categorical, numerical features + project_title(AVG W2V)+ preprocessed_eassay (AVG W2V)

```
clf = LogisticRegression(class_weight='balanced');
parameters ={'C':[10**-4, 10**-3,10**-2,1,10,100,1000,500,1000,10000]}
cl = GridSearchCV(clf , parameters, cv=3, scoring='roc_auc',return_train_score=True)
cl.fit(X_set3_train, y_train);

train_auc= cl.cv_results_['mean_train_score']
train_auc_std= cl.cv_results_['std_train_score']
cv_auc = cl.cv_results_['mean_test_score']
cv_auc_std= cl.cv_results_['std_test_score']

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,alpha=0.2,color='darkblue')

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.2,color='darkorange')

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')
plt.xscale('log')
```

```python

plt.legend()
plt.xlabel("C : hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()
```



```python
#Fitting Model to Hyper-Parameter Curve:
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc


neigh = LogisticRegression(C=1,class_weight='balanced');
neigh.fit(X_set3_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set3_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set3_test)[:,1])

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.ylabel("True Positive Rate(TPR)")
plt.xlabel("False Positive Rate(FPR)")
plt.title("ROC PLOTS")
plt.show()
print("="*100)
```

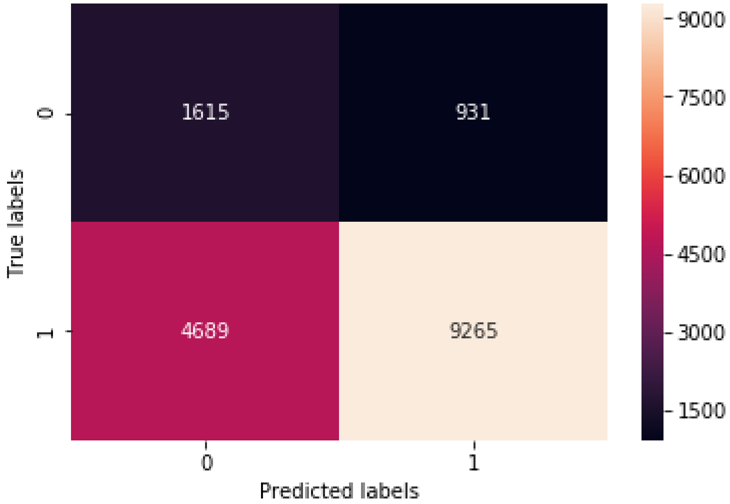


```
====================================================================================================
```

```
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set3_train )), annot=True, ax = ax,fmt='g'); #annot=True to annotate cells
ax.set_xlabel('Predicted labels');
ax.set_ylabel('True labels');
print("The Confusion metrix for Train data ")
```

```
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set3_test )), annot=True, ax = ax,fmt='g')
ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels')
print("The Confusion metrix for Test data ")
```

```
The Confusion metrix for Test data
```



Applying the Logistic Regression model on SET:4

categorical, numerical features + project_title(TFIDF W2V)+ preprocessed_essay (TFIDF W2V)

↳ *4 cells hidden*

Logistic Regression on SET:5

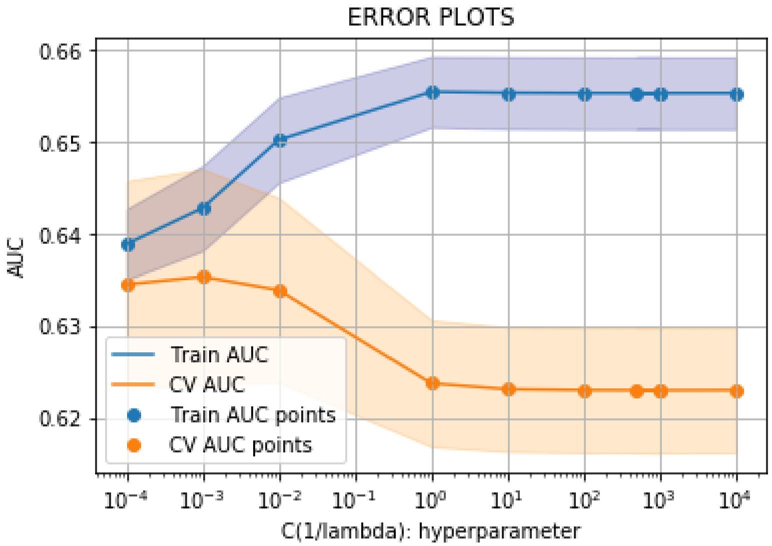
1. school_state : categorical data
2. clean_categories : categorical data
3. clean_subcategories : categorical data
4. project_grade_category :categorical data
5. teacher_prefix : categorical data
6. quantity : numerical data

7. teacher_number_of_previously_posted_projects : numerical data
8. price : numerical data
9. sentiment score's of each of the essay : numerical data
10. number of words in the title : numerical data
11. number of words in the combine essays : numerical data

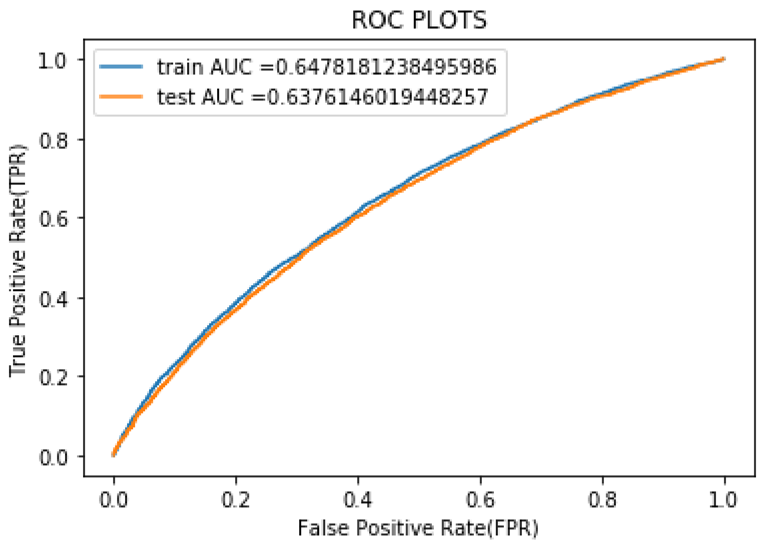
↳ *11 cells hidden*

Applying the Logistic Regression model on SET:5

```

from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt
#from sklearn.grid_search import GridSearchCV
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import learning_curve, GridSearchCV

"""
y_true : array, shape = [n_samples] or [n_samples, n_classes]
True binary labels or binary label indicators.

y_score : array, shape = [n_samples] or [n_samples, n_classes]
Target scores, can either be probability estimates of the positive class, confidence values, or non-thresholded measure of
decisions (as returned by “decision_function” on some classifiers).
For binary y_true, y_score is supposed to be the score of the class with greater label.

"""

clf = LogisticRegression(class_weight='balanced');
parameters ={'C':[10**-4, 10**-3,10**-2,1,10,100,1000,500,1000,10000]}
cl = GridSearchCV(clf, parameters, cv=3, scoring='roc_auc',return_train_score=True)
cl.fit(X_set5_train, y_train);

train_auc= cl.cv_results_['mean_train_score']
train_auc_std= cl.cv_results_['std_train_score']
cv_auc = cl.cv_results_['mean_test_score']
cv_auc_std= cl.cv_results_['std_test_score']

plt.plot(parameters['C'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc - train_auc_std,train_auc + train_auc_std,alpha=0.2,color='darkblue')

plt.plot(parameters['C'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.2,color='darkorange')

plt.scatter(parameters['C'], train_auc, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc, label='CV AUC points')
plt.xscale('log')

plt.legend()
plt.xlabel("C(1/lambda): hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()
```



```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc
neigh = LogisticRegression(C=10**-2,class_weight='balanced');
neigh.fit(X_set5_train ,y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive class
# not the predicted outputs

train_fpr, train_tpr, thresholds = roc_curve(y_train, neigh.predict_proba(X_set5_train)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_set5_test)[:,1])

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.ylabel("True Positive Rate(TPR)")
plt.xlabel("False Positive Rate(FPR)")
plt.title("ROC PLOTS")
plt.show()
```

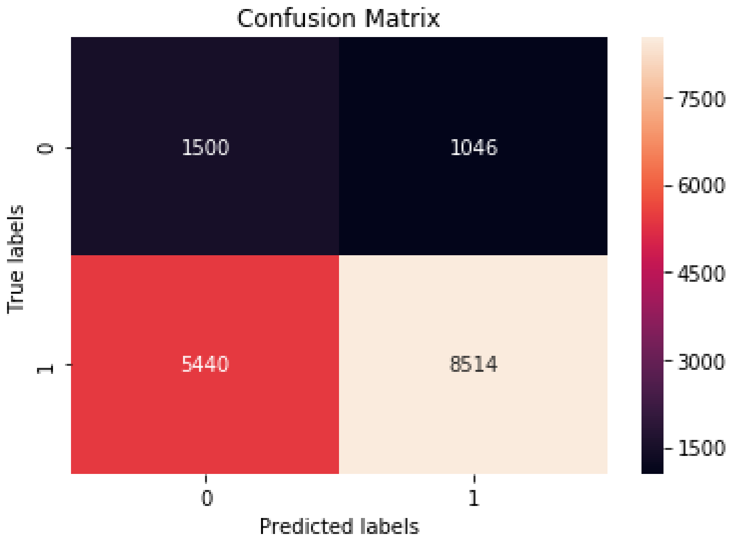


```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, neigh.predict(X_set5_train)), annot=True, ax = ax,fmt='g'); #annot=True to annotate cells
ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels')
ax.set_title('Confusion Matrix')
```

```
Text(0.5, 1.0, 'Confusion Matrix')
```

```
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, neigh.predict(X_set5_test )), annot=True, ax = ax,fmt='g'); #annot=True to annotate cells

ax.set_xlabel('Predicted labels')
ax.set_ylabel('True labels')
ax.set_title('Confusion Matrix')
```

```
Text(0.5, 1.0, 'Confusion Matrix')
```



Conclusion :

1. If we compare the roc curves between model with Text features and model without the text features , the model with the text features included is bet auc and the Confusion metrix gives better results .

```
#how to use pretty table http://zetcode.com/python/prettytable/
from prettytable import PrettyTable

tb = PrettyTable()
tb.field_names= ("Vectorizer", "HyperParameter", "AUC")
tb.add_row(["BOW",10**-3, 70])
tb.add_row(["Tf-Idf",1, 66])
tb.add_row(["AVGW2V",1, 69])
tb.add_row(["Tf-Idf w2v", 10**-2, 60])
tb.add_row(["Set 5",10**-3, 64])
print(tb.get_string(titles = "Logistic Reg> - Observations"))
```

```
+------------+---------------+-----+
| Vectorizer | HyperParameter | AUC |
+------------+---------------+-----+
|    BOW     |     0.001     |  70 |
|   Tf-Idf   |       1       |  66 |
|   AVGW2V   |       1       |  69 |
| Tf-Idf w2v |      0.01     |  60 |
|   Set 5    |     0.001     |  64 |
+------------+---------------+-----+
```