8_DonorsChoose_DT (1)

March 12, 2020

1 Assignment 8: DT

```
<li><strong>Apply Decision Tree Classifier(DecisionTreeClassifier) on these feature sets</stro
    <ul>
        <li><font color='red'>Set 1</font>: categorical, numerical features + project_title(TF
        <li><font color='red'>Set 2</font>: categorical, numerical features + project_title(TF
</li>
<li><strong>The hyper paramter tuning (best `depth` in range [1, 5, 10, 50], and the best `min_
    <ul>
<li>Find the best hyper parameter which will give the maximum <a href='https://www.appliedaicou
<li>find the best hyper paramter using k-fold cross validation(use gridsearch cv or randomsearc
    </ul>
</li>
<li>
<strong>Representation of results</strong>
    <ul>
<li>You need to plot the performance of model both on train data and cross validation data for
<img src='https://i.imgur.com/Gp2DQmh.jpg' width=500px> with X-axis as <strong>min_sample_split
        <p style="text-align:center;font-size:30px;color:red;"><strong>or</strong></p> <br>
<li>You need to plot the performance of model both on train data and cross validation data for
<img src='https://i.imgur.com/fgN9aUP.jpg' width=300px> <a href='https://seaborn.pydata.org/ger
<li>You choose either of the plotting techniques out of 3d plot or heat map</li>
<li>Once after you found the best hyper parameter, you need to train your model with it, and fi
<img src='https://i.imgur.com/wMQDTFe.jpg' width=300px></li>
<li>Along with plotting ROC curve, you need to print the <a href='https://www.appliedaicourse.c
<img src='https://i.imgur.com/IdN5Ctv.png' width=300px></li>
<li>Once after you plot the confusion matrix with the test data, get all the `false positive da
    <ul>
        <li> Plot the WordCloud(https://www.geeksforgeeks.org/generating-word-cloud-python/) wi
        <li> Plot the box plot with the `price` of these `false positive data points`</li>
        <li> Plot the pdf with the `teacher_number_of_previously_posted_projects` of these `fal
    </ul>
    </ul>
</li>
```

Task 2: For this task consider set-1 features. Select all the features which are having non-zero feature importance.You can get the feature importance using 'feature_importances_'

(https://scikit-learn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassifier.html), discard the all other remaining features and then apply any of the model of you choice i.e. (Dession tree, Logistic Regression, Linear SVM), you need to do hyperparameter tuning corresponding to the model you selected and procedure in step 2 and step 3 Note: when you want to find the feature importance make sure you don't use max_depth parameter keep it None.

```
<br>
<li>You need to summarize the results at the end of the notebook, summarize it in the table fo
    <img src='http://i.imgur.com/YVpIGGE.jpg' width=400px>
</li>
```

```
In [0]: import nltk
        from nltk.sentiment.vader import SentimentIntensityAnalyzer

        # import nltk
        # nltk.download('vader_lexicon')

        sid = SentimentIntensityAnalyzer()

        for_sentiment = 'a person is a person no matter how small dr seuss i teach the smalles
        for learning my students learn in many different ways using all of our senses and multi
        of techniques to help all my students succeed students in my class come from a variety
        for wonderful sharing of experiences and cultures including native americans our schoo
        learners which can be seen through collaborative student project based learning in and
        in my class love to work with hands on materials and have many different opportunities
        mastered having the social skills to work cooperatively with friends is a crucial aspe
        montana is the perfect place to learn about agriculture and nutrition my students love
        in the early childhood classroom i have had several kids ask me can we try cooking wit
        and create common core cooking lessons where we learn important math and writing concep
        food for snack time my students will have a grounded appreciation for the work that wen
        of where the ingredients came from as well as how it is healthy for their bodies this
        nutrition and agricultural cooking recipes by having us peel our own apples to make hom
        and mix up healthy plants from our classroom garden in the spring we will also create
        shared with families students will gain math and literature skills as well as a life l
        nannan'
        ss = sid.polarity_scores(for_sentiment)

        for k in ss:
            print('{0}: {1}, '.format(k, ss[k]), end='')

        # we can use these 4 things as features/attributes (neg, neu, pos, compound)
        # neg: 0.0, neu: 0.753, pos: 0.247, compound: 0.93
```

```
D:\installed\Anaconda3\lib\site-packages\nltk\twitter\__init__.py:20: UserWarning:

The twython library has not been installed. Some functionality from the twitter package will no
```

neg: 0.01, neu: 0.745, pos: 0.245, compound: 0.9975,

1. Decision Tree

1.1 1.1 Loading Data

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

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

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

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

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

        from tqdm import tqdm
        import os


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

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

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6

Enter your authorization code:
ůůůůůůůůůů
Mounted at /content/drive
```

```
In [0]: #taking 50000 datapoints for both project and resource data, due to Memory issues
        project_data = pd.read_csv('/content/drive/My Drive/Assignments_DonorsChoose_2018/train
        resource_data = pd.read_csv('/content/drive/My Drive/Assignments_DonorsChoose_2018/reso
```

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

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

```
In [0]: print("Number of data points in train data", resource_data.shape)
        print(resource_data.columns.values)
        resource_data.head(2)
```

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

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

1.2 1.2 preprocessing of `project_subject_categories`

```
In [0]: catogories = list(project_data['project_subject_categories'].values)
        # remove special characters from list of strings python: https://stackoverflow.com/a/4

        # https://www.geeksforgeeks.org/removing-stop-words-nltk-python/
        # https://stackoverflow.com/questions/23669024/how-to-strip-a-specific-word-from-a-str
        # https://stackoverflow.com/questions/8270092/remove-all-whitespace-in-a-string-in-pyt
        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", "Warmt
        if 'The' in j.split(): # this will split each of the catogory based on space "
            j=j.replace('The','') # if we have the words "The" we are going to replace
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"
        temp+=j.strip()+" " #" abc ".strip() will return "abc", remove the trailing sp
        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)

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

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

1.3 1.3 preprocessing of project_subject_subcategories

```
In [0]: sub_catogories = list(project_data['project_subject_subcategories'].values)
        # remove special characters from list of strings python: https://stackoverflow.com/a/4

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

        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", "Warmt
                if 'The' in j.split(): # this will split each of the catogory based on space "
                    j=j.replace('The','') # if we have the words "The" we are going to replace
                j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"
                temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing sp
                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)

        # count of all the words in corpus python: https://stackoverflow.com/a/22898595/408403
        my_counter = Counter()
        for word in project_data['clean_subcategories'].values:
            my_counter.update(word.split())
```

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

Preprocessing of project_grade_category

```
In [0]: project_grade = list(project_data['project_grade_category'].values)
        # remove special characters from list of strings python: https://stackoverflow.com/a/4

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

        grade_cat_list = []
        for i in project_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())



        project_data['grade_cat_list'] = grade_cat_list
        project_data.drop(['project_grade_category'], axis=1, inplace=True)
```

1.4 1.3 Text preprocessing

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

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

```
Out[0]:    Unnamed: 0  ...                                              essay
        0      160221  ...  My students are English learners that are work...
        1      140945  ...  Our students arrive to our school eager to lea...

        [2 rows x 18 columns]
```

```
In [0]: #### 1.4.2.3 Using Pretrained Models: TFIDF weighted W2V
```

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

```
print(project_data['essay'].values[20000])
print("="*50)
print(project_data['essay'].values[99999])
print("="*50)
```

```
My students are English learners that are working on English as their second or third languages
==================================================
The 51 fifth grade students that will cycle through my classroom this year all love learning, a
==================================================
How do you remember your days of school? Was it in a sterile environment with plain walls, rows
==================================================
My kindergarten students have varied disabilities ranging from speech and language delays, cogn
==================================================
The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The g
==================================================
```

In [0]:
```
# https://stackoverflow.com/a/47091490/4084039
import re

def decontracted(phrase):
    # specific
    phrase = re.sub(r"won't", "will not", phrase)
    phrase = re.sub(r"can\'t", "can not", phrase)

    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    return phrase
```

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

```
My kindergarten students have varied disabilities ranging from speech and language delays, cogn
==================================================
```

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

```
My kindergarten students have varied disabilities ranging from speech and language delays, cogr
```

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

```
My kindergarten students have varied disabilities ranging from speech and language delays cogni
```

```
In [0]: # https://gist.github.com/sebleier/554280
        # we are removing the words from the stop words list: 'no', 'nor', 'not'
        stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you're
                    "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him',
                    'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', '
                    'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "th
                    'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'ha
                    'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as
                    'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through
                    'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'o
                    'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any
                    'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too
                    's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'no
                    've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't"
                    "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'migh
                    "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'w
                    'won', "won't", 'wouldn', "wouldn't"]
```

```
In [0]: # Combining all the above stundents
        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 [01:02<00:00, 1752.94it/s]
```

```
In [0]: # Merging preprocessed_essays in project_data

        project_data['preprocessed_essays'] = preprocessed_essays

        project_data.head(3)
```

```
Out[0]:    Unnamed: 0  ...                                preprocessed_essays
        0      160221  ...  my students english learners working english s...
        1      140945  ...  our students arrive school eager learn they po...
        2       21895  ...  true champions not always ones win guts by mia...

        [3 rows x 19 columns]
```

```
In [0]: # Combining all the above stundents
        from tqdm import tqdm
        train_preprocessed_essays = []
        # tqdm is for printing the status bar
        for sentance in tqdm(X_train['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.lower() not in stopwords)
            train_preprocessed_essays.append(sent.lower().strip())
```

```
100%|| 49041/49041 [00:27<00:00, 1779.98it/s]
```

```
In [0]: # Combining all the above stundents
        from tqdm import tqdm
        cv_preprocessed_essays = []
        # tqdm is for printing the status bar
        for sentance in tqdm(X_cv['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.lower() not in stopwords)
            cv_preprocessed_essays.append(sent.lower().strip())
```

```
100%|| 24155/24155 [00:13<00:00, 1777.57it/s]
```

```
In [0]: # Combining all the above stundents
        from tqdm import tqdm
        test_preprocessed_essays = []
        # tqdm is for printing the status bar
        for sentance in tqdm(X_test['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.lower() not in stopwords)
    test_preprocessed_essays.append(sent.lower().strip())
```

```
100%|| 36052/36052 [00:20<00:00, 1757.77it/s]
```

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

```
Out[0]: 'my kindergarten students varied disabilities ranging speech language delays cognitive
```

1.4 Preprocessing of project_title

```
In [0]: # similarly you can preprocess the titles also
```

```
In [0]: # https://stackoverflow.com/a/47091490/4084039
        import re

        def decontracted(phrase):
            # specific
            phrase = re.sub(r"won't", "will not", phrase)
            phrase = re.sub(r"can\'t", "can not", phrase)

            # general
            phrase = re.sub(r"n\'t", " not", phrase)
            phrase = re.sub(r"\'re", " are", phrase)
            phrase = re.sub(r"\'s", " is", phrase)
            phrase = re.sub(r"\'d", " would", phrase)
            phrase = re.sub(r"\'ll", " will", phrase)
            phrase = re.sub(r"\'t", " not", phrase)
            phrase = re.sub(r"\'ve", " have", phrase)
            phrase = re.sub(r"\'m", " am", phrase)
            return phrase
```

```
In [0]: sent = decontracted(project_data['project_title'].values[2000])
        print(sent)
        print("="*50)
```

```
Steady Stools for Active Learning
==================================================
```

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

```
Steady Stools for Active Learning
```

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

```
Steady Stools for Active Learning
```

```
In [0]: # https://gist.github.com/sebleier/554280
        # we are removing the words from the stop words list: 'no', 'nor', 'not'
        stopwords= ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you're
                    "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him',
                    'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', '
                    'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "th
                    'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'ha
                    'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as
                    'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through
                    'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'o
                    'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'an
                    'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too
                    's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'n
                    've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't"
                    "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mig
                    "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", '
                    'won', "won't", 'wouldn', "wouldn't"]
```

```
In [0]: # Combining all the above stundents
        from tqdm import tqdm
        preprocessed_titles = []
        # tqdm is for printing the status bar
        for sentance in tqdm(project_data['project_title'].values):
            sent = decontracted(sentance)
            sent = sent.replace('\\r', ' ')
            sent = sent.replace('\\"', ' ')
            sent = sent.replace('\\n', ' ')
            sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
            # https://gist.github.com/sebleier/554280
            sent = ' '.join(e for e in sent.split() if e.lower() not in stopwords)
            preprocessed_titles.append(sent.lower().strip())
```

```
100%|| 109248/109248 [00:02<00:00, 41869.85it/s]
```

```
In [0]: # Merging preprocessed_titles in project_data

        project_data['preprocessed_titles'] = preprocessed_titles

        project_data.head(3)
```

```
Out[0]:    Unnamed: 0  ...                                preprocessed_titles
        0      160221  ...        educational support english learners home
        1      140945  ...                wanted projector hungry learners
        2       21895  ...  soccer equipment awesome middle school students

        [3 rows x 20 columns]
```

```
In [0]: # Combining all the above stundents
        from tqdm import tqdm
        train_preprocessed_titles = []
        # tqdm is for printing the status bar
        for sentance in tqdm(X_train['project_title'].values):
            sent = decontracted(sentance)
            sent = sent.replace('\\r', ' ')
            sent = sent.replace('\\"', ' ')
            sent = sent.replace('\\n', ' ')
            sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
            # https://gist.github.com/sebleier/554280
            sent = ' '.join(e for e in sent.split() if e.lower() not in stopwords)
            train_preprocessed_titles.append(sent.lower().strip())
```

```
100%|| 49041/49041 [00:01<00:00, 42143.57it/s]
```

```
In [0]: # Combining all the above stundents
        from tqdm import tqdm
        cv_preprocessed_titles = []
        # tqdm is for printing the status bar
        for sentance in tqdm(X_cv['project_title'].values):
            sent = decontracted(sentance)
            sent = sent.replace('\\r', ' ')
            sent = sent.replace('\\"', ' ')
            sent = sent.replace('\\n', ' ')
            sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
            # https://gist.github.com/sebleier/554280
            sent = ' '.join(e for e in sent.split() if e.lower() not in stopwords)
            cv_preprocessed_titles.append(sent.lower().strip())
```

```
100%|| 24155/24155 [00:00<00:00, 41875.10it/s]
```

```
In [0]: # Combining all the above stundents
        from tqdm import tqdm
        test_preprocessed_titles = []
        # tqdm is for printing the status bar
        for sentance in tqdm(X_test['project_title'].values):
            sent = decontracted(sentance)
            sent = sent.replace('\\r', ' ')
            sent = sent.replace('\\"', ' ')
```

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

```
100%|| 36052/36052 [00:00<00:00, 40129.09it/s]
```

```
In [0]: preprocessed_titles[2000]
```

```
Out[0]: 'steady stools active learning'
```

1.5 1.5 Preparing data for models

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

```
Out[0]: Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
               'project_submitted_datetime', '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', 'grade_cat_list', 'essay',
               'preprocessed_essays', 'preprocessed_titles'],
              dtype='object')
```

1.5.1 1.5.1 Vectorizing Categorical data

```
In [0]: # we use count vectorizer to convert the values into one
        from sklearn.feature_extraction.text import CountVectorizer
        vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False,
        categories_one_hot = vectorizer.fit_transform(project_data['clean_categories'].values)
        #print(vectorizer.get_feature_names())
        print("Shape of matrix after one hot encodig ",categories_one_hot.shape)

        cat_features = vectorizer.get_feature_names()
        print(cat_features)
        print(len(cat_features))
```

```
Shape of matrix after one hot encodig  (109248, 9)
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning', 'SpecialNeeds', 'I
9
```

```
In [0]: # we use count vectorizer to convert the values into one
        vectorizer1 = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=Fa
        sub_categories_one_hot = vectorizer1.fit_transform(project_data['clean_subcategories']
        #print(vectorizer1.get_feature_names())
        print("Shape of matrix after one hot encodig ",sub_categories_one_hot.shape)
```

```
        sub_cat_features=vectorizer1.get_feature_names()
        print(sub_cat_features)
        print(len(sub_cat_features))
```

```
Shape of matrix after one hot encodig  (109248, 30)
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Extracurricular',
30
```

```
In [0]: # you can do the similar thing with state, teacher_prefix and project_grade_category a
```

```
In [0]: # count of all the words in corpus python: https://stackoverflow.com/a/22898595/408403
        my_counter = Counter()
        for word in project_data['school_state'].values:
            my_counter.update(word.split())

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

```
In [0]: # we use count vectorizer to convert the values into one
        from sklearn.feature_extraction.text import CountVectorizer
        vectorizer2 = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=Fa
        categories_one_hot = vectorizer2.fit_transform(project_data['school_state'].values)
        #print(vectorizer.get_feature_names())
        print("Shape of matrix after one hot encodig ",categories_one_hot.shape)

        state_features=vectorizer2.get_feature_names()
        print(state_features)
        print(len(state_features))
```

```
Shape of matrix after one hot encodig  (109248, 51)
['VT', 'WY', 'ND', 'MT', 'RI', 'SD', 'NE', 'DE', 'AK', 'NH', 'WV', 'ME', 'HI', 'DC', 'NM', 'KS
51
```

```
In [0]: project_data['teacher_prefix'].value_counts()
        #df_new = df[df['ColumnName'].notnull()]
```

```
Out[0]: Mrs.       57269
        Ms.        38955
        Mr.        10648
        Teacher     2360
        Dr.           13
        Name: teacher_prefix, dtype: int64
```

```
In [0]: # count of all the words in corpus python: https://stackoverflow.com/a/22898595/408403
        project_data['teacher_prefix'] = project_data['teacher_prefix'].fillna(" ")
        my_counter = Counter()
```

```
        for word in project_data['teacher_prefix'].values.astype('str'):  #https://stackoverfl
            my_counter.update(word.split())

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

```
In [0]: # we use count vectorizer to convert the values into one
        from sklearn.feature_extraction.text import CountVectorizer
        vectorizer3 = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=Fa
        prefix_one_hot = vectorizer3.fit_transform(project_data['teacher_prefix'].values.astype
        #print(vectorizer.get_feature_names())
        print("Shape of matrix after one hot encodig ",prefix_one_hot.shape)

        prefix_features=vectorizer3.get_feature_names()
        print(prefix_features)
        print(len(prefix_features))
```

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

```
In [0]: # count of all the words in corpus python: https://stackoverflow.com/a/22898595/408403
        my_counter = Counter()
        for word in project_data['grade_cat_list'].values:
            my_counter.update(word.split())

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

```
In [0]: # we use count vectorizer to convert the values into one
        from sklearn.feature_extraction.text import CountVectorizer
        vectorizer4 = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=Fa
        categories_one_hot = vectorizer4.fit_transform(project_data['grade_cat_list'].values)
        #print(vectorizer.get_feature_names())
        print("Shape of matrix after one hot encodig ",categories_one_hot.shape)

        grade_features=vectorizer4.get_feature_names()
        print(grade_features)
        print(len(grade_features))
```

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

1.5.2 1.5.2 Vectorizing Text data

1.5.2.2 TFIDF vectorizer

```
In [168]: from sklearn.feature_extraction.text import TfidfVectorizer
          vectorizer5 = TfidfVectorizer(min_df=10,ngram_range=(2,2),max_features=5000)
          text_tfidf = vectorizer5.fit_transform(preprocessed_essays)
          print("Shape of matrix after one hot encodig ",text_tfidf.shape)

          essays_features_tf=vectorizer5.get_feature_names()
          #print(essays_features)
          print(len(essays_features_tf))
```

```
Shape of matrix after one hot encodig  (109248, 5000)
5000
```

```
In [200]: from sklearn.feature_extraction.text import TfidfVectorizer
          vectorizer6 = TfidfVectorizer(min_df=10,ngram_range=(2,2),max_features=5000)
          title_tfidf = vectorizer6.fit_transform(preprocessed_titles)
          print("Shape of matrix after one hot encodig ",title_tfidf.shape)

          #titles_features_tf=vectorizer6.get_feature_names()
          #print(essays_features)
          #print(len(titles_features_tf))
```

```
Shape of matrix after one hot encodig  (109248, 3247)
3247
```

1.5.2.3 Using Pretrained Models: TFIDF weighted W2V

```
In [0]: # stronging variables into pickle files python: http://www.jessicayung.com/how-to-use-
        # make sure you have the glove_vectors file
        with open('/content/drive/My Drive/Assignments_DonorsChoose_2018/glove_vectors', 'rb')
            model = pickle.load(f)
            glove_words =  set(model.keys())
```

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

```
In [0]: # average tfidf Word2Vec
        # compute average tfidf Word2Vec for each review.
        tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this list
        for sentence in tqdm(preprocessed_essays): # for each review/sentence
            vector = np.zeros(300) # as word vectors are of zero length
            tf_idf_weight =0; # num of words with a valid vector in the sentence/review
            for word in sentence.split(): # for each word in a review/sentence
                if (word in glove_words) and (word in tfidf_words):
```

```
                    vec = model[word] # getting the vector for each word
                    # here we are multiplying idf value(dictionary[word]) and the tf value((se
                    tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
                    vector += (vec * tf_idf) # calculating tfidf weighted w2v
                    tf_idf_weight += tf_idf
            if tf_idf_weight != 0:
                vector /= tf_idf_weight
            tfidf_w2v_vectors.append(vector)

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

```
100%|| 109248/109248 [03:43<00:00, 488.92it/s]

109248
300
```

```
In [0]: # average tfidf Word2Vec
        # compute average tfidf Word2Vec for each review.
        train_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this
        for sentence in tqdm(train_preprocessed_essays): # for each review/sentence
            vector = np.zeros(300) # as word vectors are of zero length
            tf_idf_weight =0; # num of words with a valid vector in the sentence/review
            for word in sentence.split(): # for each word in a review/sentence
                if (word in glove_words) and (word in tfidf_words):
                    vec = model[word] # getting the vector for each word
                    # here we are multiplying idf value(dictionary[word]) and the tf value((se
                    tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
                    vector += (vec * tf_idf) # calculating tfidf weighted w2v
                    tf_idf_weight += tf_idf
            if tf_idf_weight != 0:
                vector /= tf_idf_weight
            train_tfidf_w2v_vectors.append(vector)

        print(len(train_tfidf_w2v_vectors))
        print(len(train_tfidf_w2v_vectors[0]))
```

```
100%|| 49041/49041 [01:29<00:00, 544.93it/s]

49041
300
```

In [0]:
```
# average tfidf Word2Vec
# compute average tfidf Word2Vec for each review.
test_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this
for sentence in tqdm(test_preprocessed_essays): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((se
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    test_tfidf_w2v_vectors.append(vector)

print(len(test_tfidf_w2v_vectors))
print(len(test_tfidf_w2v_vectors[0]))
```

```
100%|| 36052/36052 [01:07<00:00, 534.89it/s]

36052
300
```

In [0]:
```
# average tfidf Word2Vec
# compute average tfidf Word2Vec for each review.
cv_tfidf_w2v_vectors = []; # the avg-w2v for each sentence/review is stored in this li
for sentence in tqdm(cv_preprocessed_essays): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_words) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((se
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    cv_tfidf_w2v_vectors.append(vector)

print(len(cv_tfidf_w2v_vectors))
print(len(cv_tfidf_w2v_vectors[0]))
```

```
100%|| 24155/24155 [00:44<00:00, 537.41it/s]

24155
300
```

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

```
In [0]: # average Word2Vec
        # compute average word2vec for each review.
        tfidf_w2v_vectors1 = []; # the avg-w2v for each sentence/review is stored in this list
        for sentence in tqdm(preprocessed_titles): # for each review/sentence
            vector = np.zeros(300) # as word vectors are of zero length
            tf_idf_weight =0; # num of words with a valid vector in the sentence/review
            for word in sentence.split(): # for each word in a review/sentence
                if (word in glove_words) and (word in tfidf_words):
                    vec = model[word] # getting the vector for each word
                    # here we are multiplying idf value(dictionary[word]) and the tf value((se
                    tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
                    vector += (vec * tf_idf) # calculating tfidf weighted w2v
                    tf_idf_weight += tf_idf
            if tf_idf_weight != 0:
                vector /= tf_idf_weight
            tfidf_w2v_vectors1.append(vector)

        print(len(tfidf_w2v_vectors1))
        print(len(tfidf_w2v_vectors1[0]))
```

```
100%|| 109248/109248 [00:03<00:00, 30030.40it/s]

109248
300
```

```
In [0]: # average Word2Vec
        # compute average word2vec for each review.
        train_tfidf_w2v_vectors1 = []; # the avg-w2v for each sentence/review is stored in thi
        for sentence in tqdm(train_preprocessed_titles): # for each review/sentence
            vector = np.zeros(300) # as word vectors are of zero length
            tf_idf_weight =0; # num of words with a valid vector in the sentence/review
            for word in sentence.split(): # for each word in a review/sentence
                if (word in glove_words) and (word in tfidf_words):
                    vec = model[word] # getting the vector for each word
```

```
                # here we are multiplying idf value(dictionary[word]) and the tf value((se
                tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
                vector += (vec * tf_idf) # calculating tfidf weighted w2v
                tf_idf_weight += tf_idf
        if tf_idf_weight != 0:
            vector /= tf_idf_weight
        train_tfidf_w2v_vectors1.append(vector)

    print(len(train_tfidf_w2v_vectors1))
    print(len(train_tfidf_w2v_vectors1[0]))
```

```
100%|| 49041/49041 [00:01<00:00, 31250.85it/s]

49041
300
```

```
In [0]: # average Word2Vec
    # compute average word2vec for each review.
    test_tfidf_w2v_vectors1 = []; # the avg-w2v for each sentence/review is stored in this
    for sentence in tqdm(test_preprocessed_titles): # for each review/sentence
        vector = np.zeros(300) # as word vectors are of zero length
        tf_idf_weight =0; # num of words with a valid vector in the sentence/review
        for word in sentence.split(): # for each word in a review/sentence
            if (word in glove_words) and (word in tfidf_words):
                vec = model[word] # getting the vector for each word
                # here we are multiplying idf value(dictionary[word]) and the tf value((se
                tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
                vector += (vec * tf_idf) # calculating tfidf weighted w2v
                tf_idf_weight += tf_idf
        if tf_idf_weight != 0:
            vector /= tf_idf_weight
        test_tfidf_w2v_vectors1.append(vector)

    print(len(test_tfidf_w2v_vectors1))
    print(len(test_tfidf_w2v_vectors1[0]))
```

```
100%|| 36052/36052 [00:01<00:00, 29392.39it/s]

36052
300
```

```
In [0]: # average Word2Vec
        # compute average word2vec for each review.
        cv_tfidf_w2v_vectors1 = []; # the avg-w2v for each sentence/review is stored in this l
        for sentence in tqdm(cv_preprocessed_titles): # for each review/sentence
            vector = np.zeros(300) # as word vectors are of zero length
            tf_idf_weight =0; # num of words with a valid vector in the sentence/review
            for word in sentence.split(): # for each word in a review/sentence
                if (word in glove_words) and (word in tfidf_words):
                    vec = model[word] # getting the vector for each word
                    # here we are multiplying idf value(dictionary[word]) and the tf value((se
                    tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # g
                    vector += (vec * tf_idf) # calculating tfidf weighted w2v
                    tf_idf_weight += tf_idf
            if tf_idf_weight != 0:
                vector /= tf_idf_weight
            cv_tfidf_w2v_vectors1.append(vector)

        print(len(cv_tfidf_w2v_vectors1))
        print(len(cv_tfidf_w2v_vectors1[0]))
```

```
100%|| 24155/24155 [00:00<00:00, 33260.73it/s]

24155
300
```

1.2 Splitting data into Train and cross validation(or test): Stratified Sampling

```
In [0]: # please write all the code with proper documentation, and proper titles for each subs
        # go through documentations and blogs before you start coding
        # first figure out what to do, and then think about how to do.
        # reading and understanding error messages will be very much helpfull in debugging you
        # when you plot any graph make sure you use
            # a. Title, that describes your plot, this will be very helpful to the reader
            # b. Legends if needed
            # c. X-axis label
            # d. Y-axis label
```

```
In [126]: y = project_data['project_is_approved'].values
          X = project_data.drop(['project_is_approved'], axis=1)
          X.head(1)
```

```
Out[126]:    Unnamed: 0       id  ...  price quantity
          0      160221  p253737  ...  154.6       23

          [1 rows x 21 columns]
```

```
In [0]: # train test split
        from sklearn.model_selection import train_test_split
        X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33, stratify=y)
        X_train, X_cv, y_train, y_cv = train_test_split(X_train, y_train, test_size=0.33, strat
```

1.5.3 1.5.3 Vectorizing Numerical features

```
In [0]: price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_
        project_data = pd.merge(project_data, price_data, on='id', how='left')
```

```
In [0]: #Since we have merged our project_data and Price_data in to single entity of price
        #it is also mandatory to merge it for Train , test data
        X_train = pd.merge(X_train, price_data, on = "id", how = "left")
        #print(x_train.columns)
        X_test = pd.merge(X_test, price_data, on = "id", how = "left")
        X_cv = pd.merge(X_cv, price_data, on = "id", how = "left")
```

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

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

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

        # Now standardize the data with above maen and variance.
        price_standardized = price_scalar.transform(project_data['price'].values.reshape(-1, 1
        tr_price_standardized = price_scalar.transform(X_train['price'].values.reshape(-1, 1))
        cv_price_standardized = price_scalar.transform(X_cv['price'].values.reshape(-1, 1))
        te_price_standardized = price_scalar.transform(X_test['price'].values.reshape(-1, 1))
```

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

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

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

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

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

        quantity_scalar = StandardScaler()
        quantity_scalar.fit(project_data['quantity'].values.reshape(-1,1)) # finding the mean
        print(f"Mean : {quantity_scalar.mean_[0]}, Standard deviation : {np.sqrt(quantity_scala

        # Now standardize the data with above maen and variance.
        quantity_standardized = quantity_scalar.transform(project_data['quantity'].values.resha
        tr_quantity_standardized = quantity_scalar.transform(X_train['quantity'].values.reshape
        cv_quantity_standardized = quantity_scalar.transform(X_cv['quantity'].values.reshape(-1
        te_quantity_standardized = quantity_scalar.transform(X_test['quantity'].values.reshape

Mean : 16.965610354422964, Standard deviation : 26.182821919093175


In [0]: quantity_standardized

Out[0]: array([[ 0.23047132],
               [-0.60977424],
               [ 0.19227834],
               ...,
               [-0.4951953 ],
               [-0.03687954],
               [-0.45700232]])

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

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

        number_projects_scalar = StandardScaler()
        number_projects_scalar.fit(project_data['teacher_number_of_previously_posted_projects']
        print(f"Mean : {number_projects_scalar.mean_[0]}, Standard deviation : {np.sqrt(number_

        # Now standardize the data with above mean and variance.
        number_projects_standardized = number_projects_scalar.transform(project_data['teacher_n
        tr_number_projects_standardized = number_projects_scalar.transform(X_train['teacher_num
```

```
        cv_number_projects_standardized = number_projects_scalar.transform(X_cv['teacher_numbe
        te_number_projects_standardized = number_projects_scalar.transform(X_test['teacher_numb
```

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

1.3 Make Data Model Ready: encoding eassay, and project_title

```
In [0]: # please write all the code with proper documentation, and proper titles for each subs
        # go through documentations and blogs before you start coding
        # first figure out what to do, and then think about how to do.
        # reading and understanding error messages will be very much helpfull in debugging you
        # make sure you featurize train and test data separatly

        # when you plot any graph make sure you use
            # a. Title, that describes your plot, this will be very helpful to the reader
            # b. Legends if needed
            # c. X-axis label
            # d. Y-axis label
```

2 Encoding - Categorical

```
In [0]: print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)


        vectorizer = CountVectorizer()
        vectorizer.fit(X_train['clean_categories'].values) # fit has to happen only on train d

        # we use the fitted CountVectorizer to convert the text to vector
        X_train_cl_categories_ohe = vectorizer.transform(X_train['clean_categories'].values)
        X_cv_cl_categories_ohe = vectorizer.transform(X_cv['clean_categories'].values)
        X_test_cl_categories_ohe = vectorizer.transform(X_test['clean_categories'].values)

        print("After vectorizations")
        print(X_train_cl_categories_ohe.shape, y_train.shape)
        print(X_cv_cl_categories_ohe.shape, y_cv.shape)
        print(X_test_cl_categories_ohe.shape, y_test.shape)
        print("="*100)


        # print("YOU SHOULD NOT DO SOMETHING LIKE THIS")
        # vectorizer = CountVectorizer()
        # x_train_bow = vectorizer.fit_transform(X_train['essay'].values)
        # x_cv_bow = vectorizer.fit_transform(X_cv['essay'].values)
```

```
        # x_test_bow = vectorizer.fit_transform(X_test['essay'].values)

        # 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("NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME")
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
(36052, 20) (36052,)
====================================================================================================
After vectorizations
(49041, 9) (49041,)
(24155, 9) (24155,)
(36052, 9) (36052,)
====================================================================================================
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

```
In [0]: print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)


        vectorizer = CountVectorizer()
        vectorizer.fit(X_train['clean_subcategories'].values) # fit has to happen only on trai

        # we use the fitted CountVectorizer to convert the text to vector
        X_train_cl_subcategories_ohe = vectorizer.transform(X_train['clean_subcategories'].valu
        X_cv_cl_subcategories_ohe = vectorizer.transform(X_cv['clean_subcategories'].values)
        X_test_cl_subcategories_ohe = vectorizer.transform(X_test['clean_subcategories'].values

        print("After vectorizations")
        print(X_train_cl_subcategories_ohe.shape, y_train.shape)
        print(X_cv_cl_subcategories_ohe.shape, y_cv.shape)
        print(X_test_cl_subcategories_ohe.shape, y_test.shape)
        print("="*100)


        # print("YOU SHOULD NOT DO SOMETHING LIKE THIS")
        # vectorizer = CountVectorizer()
        # x_train_bow = vectorizer.fit_transform(X_train['essay'].values)
        # x_cv_bow = vectorizer.fit_transform(X_cv['essay'].values)
        # x_test_bow = vectorizer.fit_transform(X_test['essay'].values)
```

```
        # 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("NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME")
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
(36052, 20) (36052,)
==========================================================================================
After vectorizations
(49041, 30) (49041,)
(24155, 30) (24155,)
(36052, 30) (36052,)
==========================================================================================
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

```
In [0]: print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)


        vectorizer = CountVectorizer()
        vectorizer.fit(X_train['school_state'].values) # fit has to happen only on train data

        # we use the fitted CountVectorizer to convert the text to vector
        X_train_school_state_ohe = vectorizer.transform(X_train['school_state'].values)
        X_cv_school_state_ohe = vectorizer.transform(X_cv['school_state'].values)
        X_test_school_state_ohe = vectorizer.transform(X_test['school_state'].values)

        print("After vectorizations")
        print(X_train_school_state_ohe.shape, y_train.shape)
        print(X_cv_school_state_ohe.shape, y_cv.shape)
        print(X_test_school_state_ohe.shape, y_test.shape)
        print("="*100)


        # print("YOU SHOULD NOT DO SOMETHING LIKE THIS")
        # vectorizer = CountVectorizer()
        # x_train_bow = vectorizer.fit_transform(X_train['essay'].values)
        # x_cv_bow = vectorizer.fit_transform(X_cv['essay'].values)
        # x_test_bow = vectorizer.fit_transform(X_test['essay'].values)

        # 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("NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME")
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
(36052, 20) (36052,)
==================================================================================================
After vectorizations
(49041, 51) (49041,)
(24155, 51) (24155,)
(36052, 51) (36052,)
==================================================================================================
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

```
In [0]: print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)


        vectorizer = CountVectorizer()
        vectorizer.fit(X_train['teacher_prefix'].values.astype('U')) # fit has to happen only
        #https://stackoverflow.com/questions/39303912/tfidfvectorizer-in-scikit-learn-valueerr
        # we use the fitted CountVectorizer to convert the text to vector
        X_train_teacher_prefix_ohe = vectorizer.transform(X_train['teacher_prefix'].values.asty
        X_cv_teacher_prefix_ohe = vectorizer.transform(X_cv['teacher_prefix'].values.astype('U
        X_test_teacher_prefix_ohe = vectorizer.transform(X_test['teacher_prefix'].values.astype

        print("After vectorizations")
        print(X_train_teacher_prefix_ohe.shape, y_train.shape)
        print(X_cv_teacher_prefix_ohe.shape, y_cv.shape)
        print(X_test_teacher_prefix_ohe.shape, y_test.shape)
        print("="*100)


        # print("YOU SHOULD NOT DO SOMETHING LIKE THIS")
        # vectorizer = CountVectorizer()
        # x_train_bow = vectorizer.fit_transform(X_train['essay'].values)
        # x_cv_bow = vectorizer.fit_transform(X_cv['essay'].values)
        # x_test_bow = vectorizer.fit_transform(X_test['essay'].values)

        # 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("NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME")
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
(36052, 20) (36052,)
==========================================================================================
After vectorizations
(49041, 6) (49041,)
(24155, 6) (24155,)
(36052, 6) (36052,)
==========================================================================================
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

```
In [0]: print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)


        vectorizer = CountVectorizer()
        vectorizer.fit(X_train['grade_cat_list'].values) # fit has to happen only on train dat

        # we use the fitted CountVectorizer to convert the text to vector
        X_train_grade_ohe = vectorizer.transform(X_train['grade_cat_list'].values)
        X_cv_grade_ohe = vectorizer.transform(X_cv['grade_cat_list'].values)
        X_test_grade_ohe = vectorizer.transform(X_test['grade_cat_list'].values)

        print("After vectorizations")
        print(X_train_grade_ohe.shape, y_train.shape)
        print(X_cv_grade_ohe.shape, y_cv.shape)
        print(X_test_grade_ohe.shape, y_test.shape)
        print("="*100)


        # print("YOU SHOULD NOT DO SOMETHING LIKE THIS")
        # vectorizer = CountVectorizer()
        # x_train_bow = vectorizer.fit_transform(X_train['essay'].values)
        # x_cv_bow = vectorizer.fit_transform(X_cv['essay'].values)
        # x_test_bow = vectorizer.fit_transform(X_test['essay'].values)

        # 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("NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME")
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
```

```
(36052, 20) (36052,)
==========================================================================================
After vectorizations
(49041, 2) (49041,)
(24155, 2) (24155,)
(36052, 2) (36052,)
==========================================================================================
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

3 Text - TfIdf

```
In [0]: print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)


        vectorizer = TfidfVectorizer(ngram_range=(2,2), min_df=10, max_features=5000)
        vectorizer.fit(train_preprocessed_essays) # fit has to happen only on train data

        # we use the fitted CountVectorizer to convert the text to vector
        X_train_essay_tf = vectorizer.transform(train_preprocessed_essays)
        X_cv_essay_tf = vectorizer.transform(cv_preprocessed_essays)
        X_test_essay_tf = vectorizer.transform(test_preprocessed_essays)



        print("After vectorizations")
        print(X_train_essay_tf.shape, y_train.shape)
        print(X_cv_essay_tf.shape, y_cv.shape)
        print(X_test_essay_tf.shape, y_test.shape)
        print("="*100)


        # print("YOU SHOULD NOT DO SOMETHING LIKE THIS")
        # vectorizer = CountVectorizer()
        # x_train_bow = vectorizer.fit_transform(X_train['essay'].values)
        # x_cv_bow = vectorizer.fit_transform(X_cv['essay'].values)
        # x_test_bow = vectorizer.fit_transform(X_test['essay'].values)

        # 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("NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME")
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
(36052, 20) (36052,)
====================================================================================================
After vectorizations
(49041, 5000) (49041,)
(24155, 5000) (24155,)
(36052, 5000) (36052,)
====================================================================================================
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

```
In [203]: print(X_train.shape, y_train.shape)
          print(X_cv.shape, y_cv.shape)
          print(X_test.shape, y_test.shape)

          print("="*100)


          vectorizer1 = TfidfVectorizer(min_df=10, ngram_range=(2,2), max_features=5000)
          vectorizer1.fit(train_preprocessed_titles) # fit has to happen only on train data

          # we use the fitted CountVectorizer to convert the text to vector
          X_train_title_tf = vectorizer1.transform(train_preprocessed_titles)
          X_cv_title_tf = vectorizer1.transform(cv_preprocessed_titles)
          X_test_title_tf = vectorizer1.transform(test_preprocessed_titles)

          titles_features_tf=vectorizer1.get_feature_names()

          print("After vectorizations")
          print(X_train_title_tf.shape, y_train.shape)
          print(X_cv_title_tf.shape, y_cv.shape)
          print(X_test_title_tf.shape, y_test.shape)
          print("="*100)
          print(len(titles_features_tf))


          # print("YOU SHOULD NOT DO SOMETHING LIKE THIS")
          # vectorizer = CountVectorizer()
          # x_train_bow = vectorizer.fit_transform(X_train['essay'].values)
          # x_cv_bow = vectorizer.fit_transform(X_cv['essay'].values)
          # x_test_bow = vectorizer.fit_transform(X_test['essay'].values)

          # 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("NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME")
```

```
(49041, 21) (49041,)
(24155, 21) (24155,)
(36052, 23) (36052,)
==================================================================================================
After vectorizations
(49041, 1234) (49041,)
(24155, 1234) (24155,)
(36052, 1234) (36052,)
==================================================================================================
1234
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

4 Text - TfIdf Weighted W2vec

```
In [0]: #https://stackoverflow.com/questions/21015674/list-object-has-no-attribute-shape
        #List to Numpy array
        #for Essays

        X_train_es_tfidf_w2v = np.array(train_tfidf_w2v_vectors)
        X_cv_es_tfidf_w2v = np.array(cv_tfidf_w2v_vectors)
        X_test_es_tfidf_w2v = np.array(test_tfidf_w2v_vectors)

        #similarly, we are doing it for titles

        X_train_title_tfidf_w2v = np.array(train_tfidf_w2v_vectors1)
        X_cv_title_tfidf_w2v = np.array(cv_tfidf_w2v_vectors1)
        X_test_title_tfidf_w2v = np.array(test_tfidf_w2v_vectors1)
```

```
In [0]: #For Essays - TfIdf weighted W2vec
        print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)

        print("After vectorizations")
        print(X_train_es_tfidf_w2v.shape, y_train.shape)
        print(X_cv_es_tfidf_w2v.shape, y_cv.shape)
        print(X_test_es_tfidf_w2v.shape, y_test.shape)
        print("="*100)
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
(36052, 20) (36052,)
==================================================================================================
After vectorizations
(49041, 300) (49041,)
```

```
(24155, 300) (24155,)
(36052, 300) (36052,)
==================================================================================================
```

```
In [0]: #For Titles - TfIdf Weighted W2Vec
        print(X_train.shape, y_train.shape)
        print(X_cv.shape, y_cv.shape)
        print(X_test.shape, y_test.shape)

        print("="*100)

        print("After vectorizations")
        print(X_train_title_tfidf_w2v.shape, y_train.shape)
        print(X_cv_title_tfidf_w2v.shape, y_cv.shape)
        print(X_test_title_tfidf_w2v.shape, y_test.shape)
        print("="*100)
```

```
(49041, 20) (49041,)
(24155, 20) (24155,)
(36052, 20) (36052,)
==================================================================================================
After vectorizations
(49041, 300) (49041,)
(24155, 300) (24155,)
(36052, 300) (36052,)
==================================================================================================
```

1.4 Make Data Model Ready: encoding numerical, categorical features

```
In [0]: # please write all the code with proper documentation, and proper titles for each subs
        # go through documentations and blogs before you start coding
        # first figure out what to do, and then think about how to do.
        # reading and understanding error messages will be very much helpfull in debugging you
        # make sure you featurize train and test data separatly

        # when you plot any graph make sure you use
            # a. Title, that describes your plot, this will be very helpful to the reader
            # b. Legends if needed
            # c. X-axis label
            # d. Y-axis label
```

5 Concatinate all the features

```
In [0]: #TfIdf
```

```
In [215]: from scipy.sparse import hstack
          # with the same hstack function we are concatinating a sparse matrix and a dense mat
```

```
X_tf_train = hstack((X_train_essay_tf, X_train_title_tf, tr_price_standardized, tr_qu
                     X_train_cl_subcategories_ohe, X_train_school_state_ohe, X_train_
```

```
print(X_tf_train.shape, y_train.shape)
```

```
(49041, 6334) (49041,)
```

In [207]:
```
X_tf_cv = hstack((X_cv_essay_tf, X_cv_title_tf, cv_price_standardized, cv_quantity_st
                  X_cv_cl_subcategories_ohe, X_cv_school_state_ohe, X_cv_teacher_p
```

```
print(X_tf_cv.shape, y_cv.shape)
```

```
(24155, 6334) (24155,)
```

In [208]:
```
X_tf_test = hstack((X_test_essay_tf, X_test_title_tf, te_price_standardized, te_quant
                    X_test_cl_subcategories_ohe, X_test_school_state_ohe, X_test_tea
```

```
print(X_tf_test.shape, y_test.shape)
```

```
(36052, 6334) (36052,)
```

In [0]:
```
#TfIdf weighted W2V
```

In [104]:
```
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix and a dense mat
X_tf_w2v_train = hstack((X_train_es_tfidf_w2v, X_train_title_tfidf_w2v, tr_price_star
                         X_train_cl_subcategories_ohe, X_train_school_state_ohe, X_train_
```

```
print(X_tf_w2v_train.shape, y_train.shape)
```

```
(49041, 700) (49041,)
```

In [106]:
```
X_tf_w2v_cv = hstack((X_cv_es_tfidf_w2v, X_cv_title_tfidf_w2v, cv_price_standardized
                      X_cv_cl_subcategories_ohe, X_cv_school_state_ohe, X_cv_teacher_p
```

```
print(X_avg_w2v_cv.shape, y_cv.shape)
```

```
(24155, 700) (24155,)
```

In [107]:
```
X_tf_w2v_test = hstack((X_test_es_tfidf_w2v, X_test_title_tfidf_w2v, te_price_standar
                        X_test_cl_subcategories_ohe, X_test_school_state_ohe, X_test_tea
```

```
print(X_avg_w2v_test.shape, y_test.shape)
```

```
(36052, 700) (36052,)
```

6 Set1 - TfIdf

```
In [0]: #https://scikit-learn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassifier
        from sklearn.tree import DecisionTreeClassifier
        from sklearn.model_selection import GridSearchCV

        parameters1={'max_depth': [1, 5, 10, 50, 100, 500, 1000],
                     'min_samples_split': [5, 10, 20, 45, 75, 100, 135, 270, 500]}

        clf_tree = DecisionTreeClassifier(random_state=11,class_weight='balanced')

        clf=GridSearchCV(clf_tree ,parameters1, scoring="roc_auc", cv=5, return_train_score=Tru
        clf.fit(X_tf_train,y_train)
```

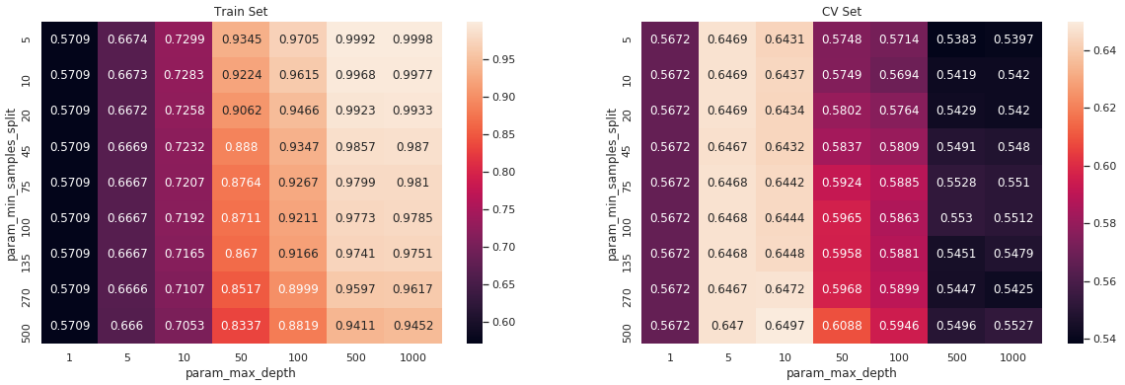
```
Out[0]: GridSearchCV(cv=5, error_score=nan,
                     estimator=DecisionTreeClassifier(ccp_alpha=0.0,
                                                      class_weight='balanced',
                                                      criterion='gini', max_depth=None,
                                                      max_features=None,
                                                      max_leaf_nodes=None,
                                                      min_impurity_decrease=0.0,
                                                      min_impurity_split=None,
                                                      min_samples_leaf=1,
                                                      min_samples_split=2,
                                                      min_weight_fraction_leaf=0.0,
                                                      presort='deprecated',
                                                      random_state=11,
                                                      splitter='best'),
                     iid='deprecated', n_jobs=None,
                     param_grid={'max_depth': [1, 5, 10, 50, 100, 500, 1000],
                                 'min_samples_split': [5, 10, 20, 45, 75, 100, 135, 270,
                                                       500]},
                     pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
                     scoring='roc_auc', verbose=0)
```

```
In [0]: a=clf.best_params_['max_depth']
        p= clf.best_params_['min_samples_split']
        print(clf.best_score_)
        print(a)
        print(p)
```

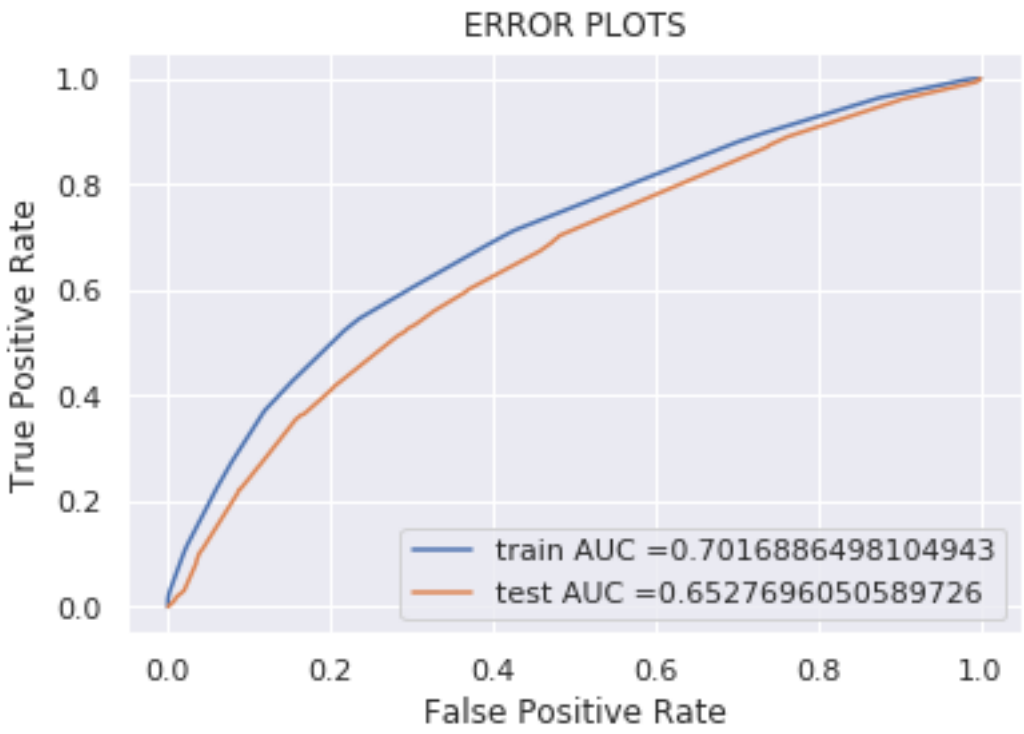
```
0.6497223216657874
10
500
```

```
In [0]: #https://towardsdatascience.com/using-3d-visualizations-to-tune-hyperparameters-of-ml-
        #https://github.com/xoelop/Medium-posts/blob/master/3d%20cross%20validation/ML%206%20-
        import seaborn as sns; sns.set()
```

```
max_scores1 = pd.DataFrame(clf.cv_results_).groupby(['param_min_samples_split', 'param
fig, ax = plt.subplots(1,2, figsize=(20,6))
sns.heatmap(max_scores1.mean_train_score, annot = True, fmt='.4g', ax=ax[0])
sns.heatmap(max_scores1.mean_test_score, annot = True, fmt='.4g', ax=ax[1])
ax[0].set_title('Train Set')
ax[1].set_title('CV Set')
plt.show()
```

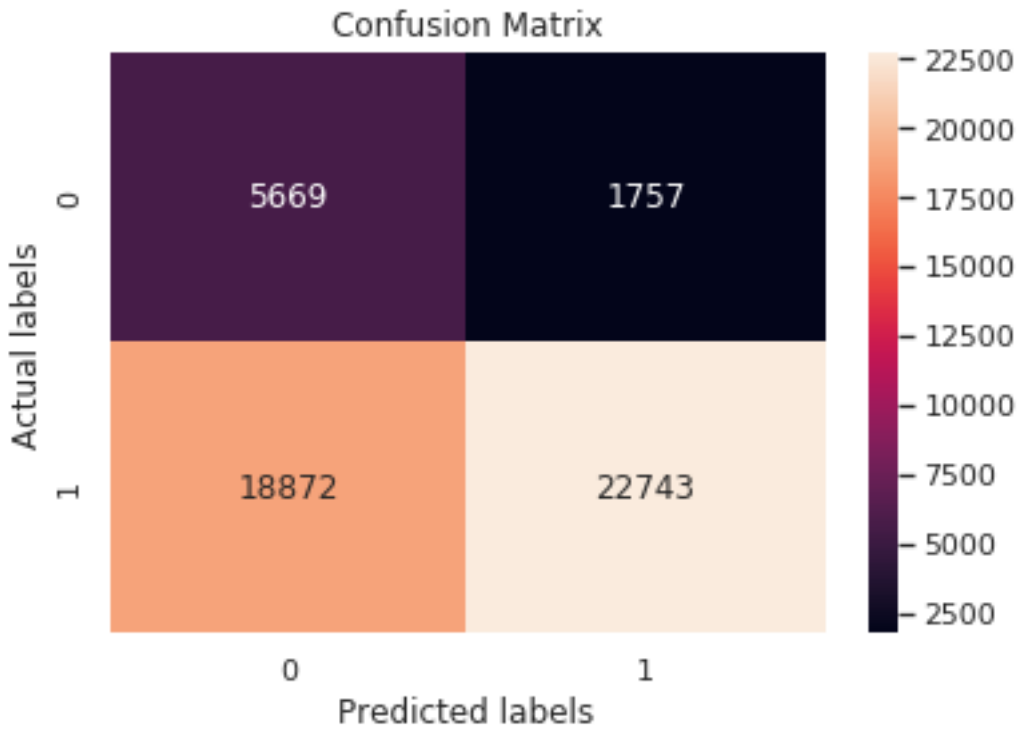


In [0]:
```
# Train new model
DT_tfidf = DecisionTreeClassifier(max_depth=a, min_samples_split=p, class_weight='balan
DT_tfidf.fit(X_tf_train,y_train)

#https://scikitlearn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier.h
y_train_pred1 = DT_tfidf.predict_proba(X_tf_train) [:,1]
y_test_pred1 = DT_tfidf.predict_proba(X_tf_test) [:,1]

train_fpr1, train_tpr1, tr_thresholds1 = roc_curve(y_train, y_train_pred1)
test_fpr1, test_tpr1, te_thresholds1 = roc_curve(y_test, y_test_pred1)
plt.plot(train_fpr1, train_tpr1, label="train AUC ="+str(auc(train_fpr1, train_tpr1)))
plt.plot(test_fpr1, test_tpr1, label="test AUC ="+str(auc(test_fpr1, test_tpr1)))
plt.legend()
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()
```



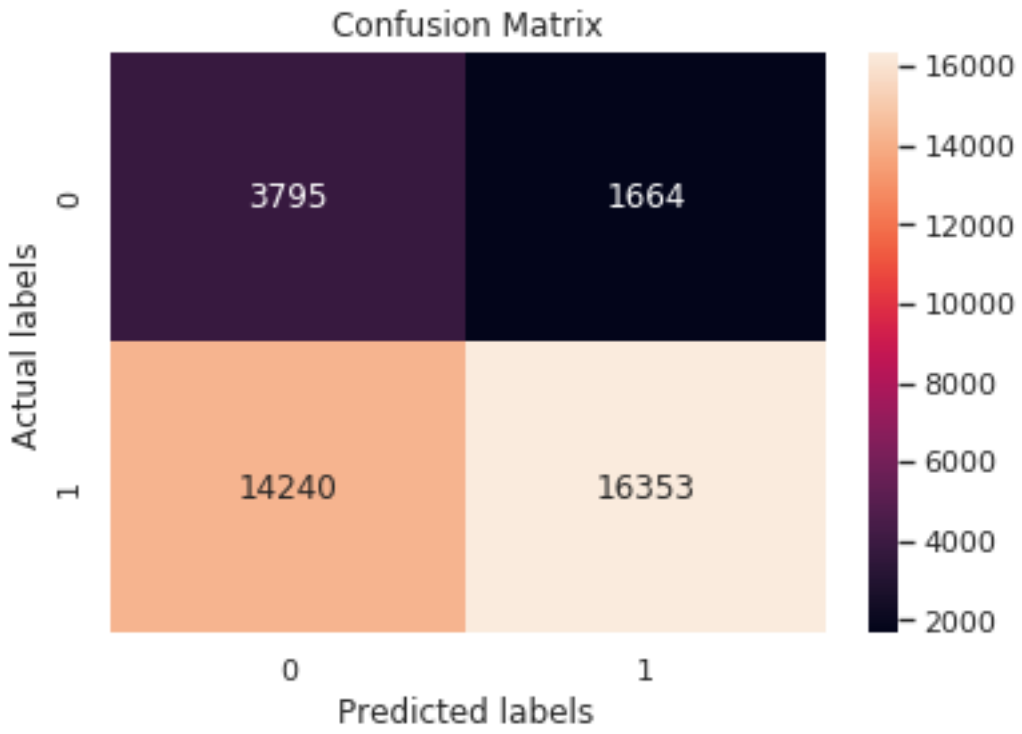
In [0]:
```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#Train dataset - COnfusion Matrix
import seaborn as sns
import matplotlib.pyplot as plt
print("Confusin Matrix On train")
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, DT_tfidf.predict(X_tf_train)), annot=True, ax = a

# labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('Actual labels');
ax.set_title('Confusion Matrix');
```

```
Confusin Matrix On train
```



In [0]:
```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#Train dataset - COnfusion Matrix
import seaborn as sns
import matplotlib.pyplot as plt
print("Confusin Matrix On test")
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, DT_tfidf.predict(X_tf_test)), annot=True, ax = ax

# labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('Actual labels');
ax.set_title('Confusion Matrix');
```

```
Confusin Matrix On test
```



Extracting False positives

```
In [140]: # Get FP points
          pred = DT_tfidf.predict(X_tf_test)
          actual=y_test
          print(pred.shape)
          print(actual.shape)

(36052,)
(36052,)


In [141]: X_test_wc=pd.DataFrame(X_test)

          print(X_test_wc.shape)

(36052, 23)


In [0]: X_test_wc["pred"]=pred
        X_test_wc["actual"]=actual

In [143]: X_test_wc.head(2)
```

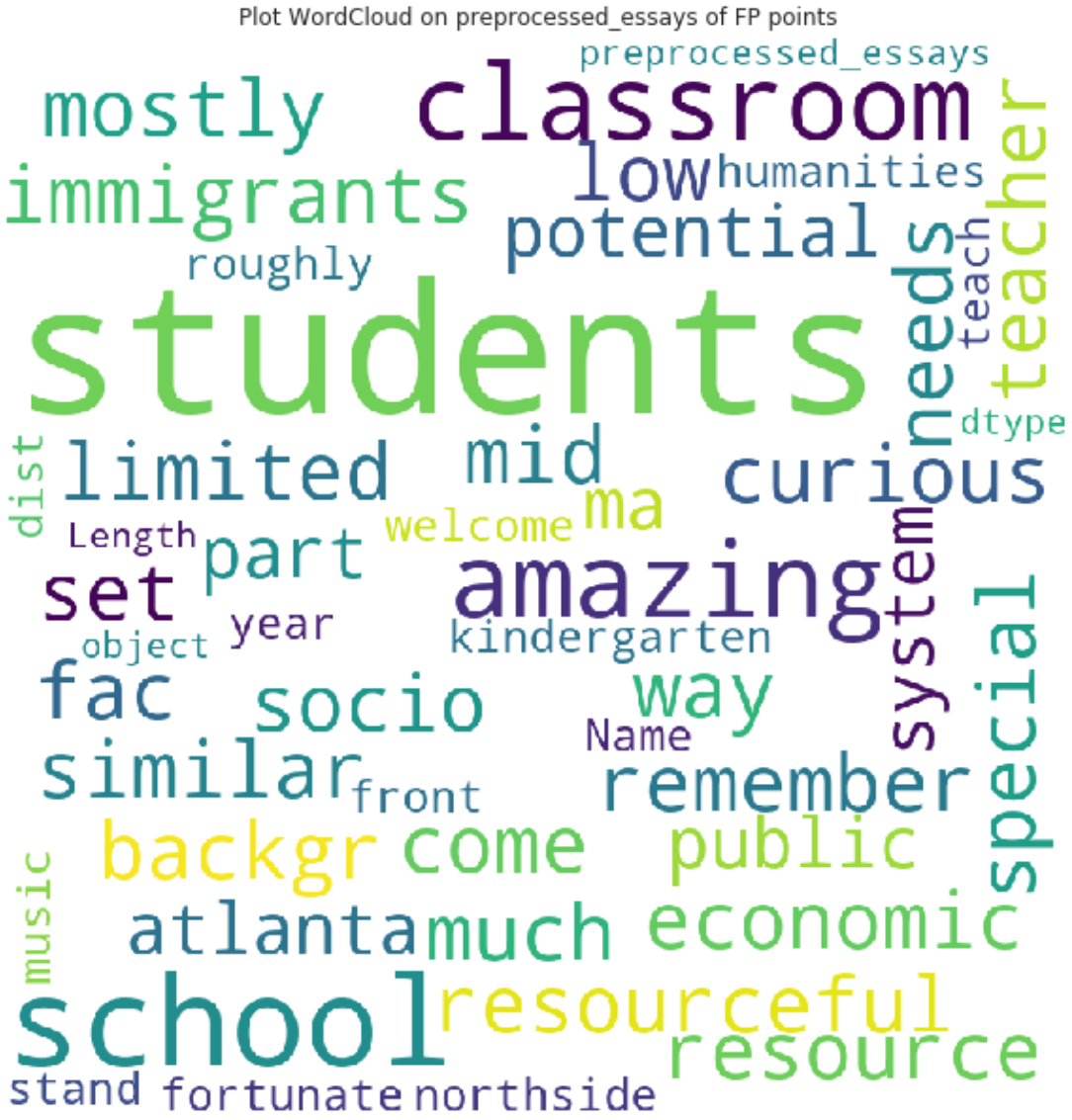
```
Out[143]:         Unnamed: 0       id  ... pred actual
          102952       92661  p009851  ...    1      0
          56473        42874  p085351  ...    1      1

          [2 rows x 23 columns]
```

```
In [144]: X_fp = (X_test_wc["actual"]==0)
          Y_fp = (X_test_wc["pred"]==1)
          FP=X_test_wc[X_fp&Y_fp]
          FP.head(2)
```

```
Out[144]:         Unnamed: 0       id  ... pred actual
          102952       92661  p009851  ...    1      0
          19348        85551  p059921  ...    1      0

          [2 rows x 23 columns]
```

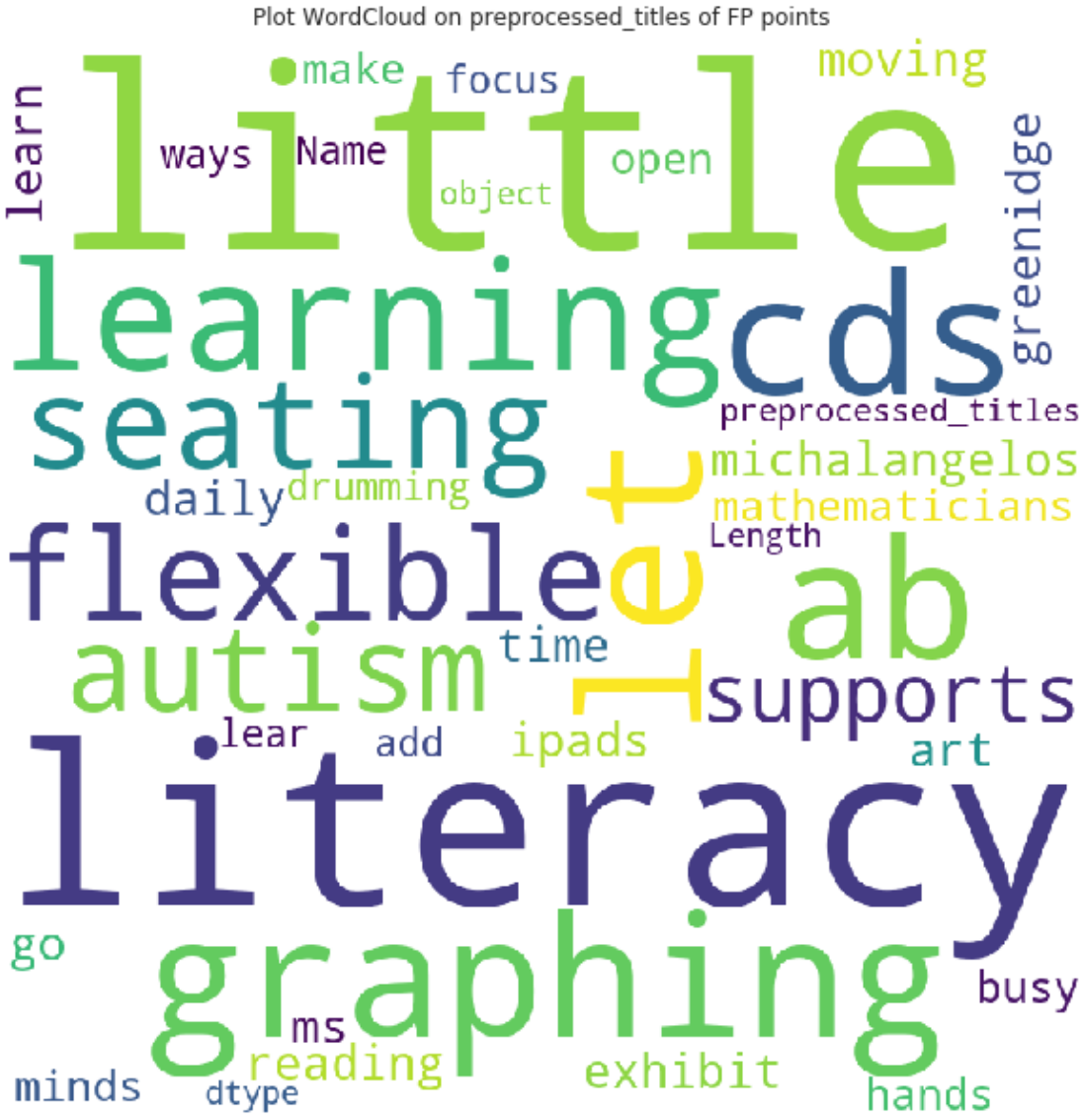
Plot WordCloud on preprocessed_essays of FP points

```
In [145]: from wordcloud import WordCloud
          word=str(FP["preprocessed_essays"])
          wordcloud = WordCloud(width = 800, height = 800,
                          background_color ='white').generate(word)

          # plot the WordCloud image
          plt.figure(figsize = (8, 8), facecolor = None)
          plt.imshow(wordcloud)
          plt.axis("off")
          plt.tight_layout(pad = 0)
          plt.title("Plot WordCloud on preprocessed_essays of FP points")
          plt.show()
```



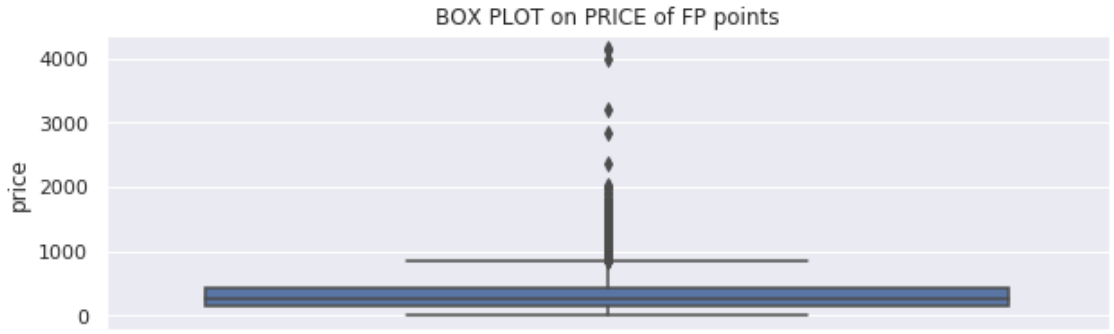
Plot WordCloud on preprocessed_titles of FP points

```
In [146]: from wordcloud import WordCloud
          word=str(FP["preprocessed_titles"])
          wordcloud = WordCloud(width = 800, height = 800,
                          background_color ='white').generate(word)

          # plot the WordCloud image
          plt.figure(figsize = (8, 8), facecolor = None)
          plt.imshow(wordcloud)
          plt.axis("off")
          plt.tight_layout(pad = 0)
          plt.title("Plot WordCloud on preprocessed_titles of FP points")
          plt.show()
```



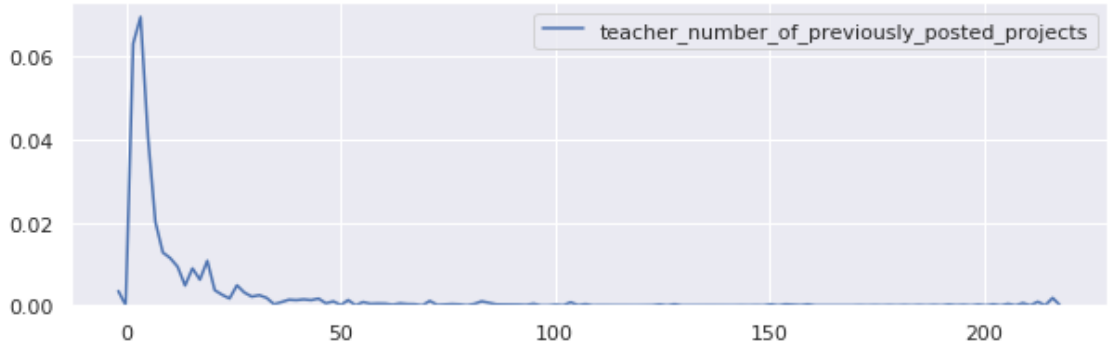
BOX PLOT on PRICE of FP points

```
In [147]: import seaborn as sns
          plt.figure(figsize=(10,3))
          sns.boxplot(FP["price"],orient="v")
          plt.title("BOX PLOT on PRICE of FP points")

Out[147]: Text(0.5, 1.0, 'BOX PLOT on PRICE of FP points')
```



PDF of teacher_number_of_previously_posted_projects of FP points

```
In [148]: plt.figure(figsize=(10,3))
          sns.kdeplot(FP["teacher_number_of_previously_posted_projects"],label="teacher_number_

          plt.legend()
          plt.show()
```



7 Set2 - TfIdf avg W2Vec

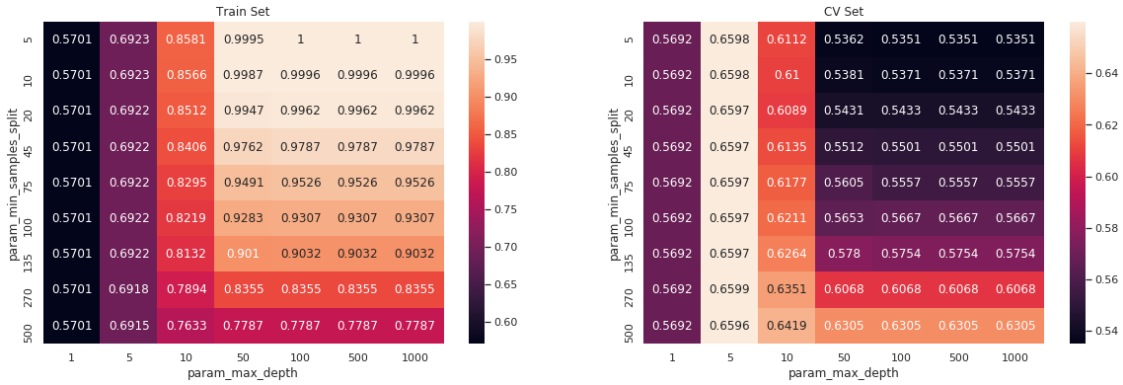
```
In [83]: #https://scikit-learn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassifie
         from sklearn.tree import DecisionTreeClassifier
         from sklearn.model_selection import GridSearchCV

         parameters2={'max_depth': [1, 5, 10, 50, 100, 500, 1000],
                      'min_samples_split': [5, 10, 20, 45, 75, 100, 135, 270, 500]}

         clf_tree = DecisionTreeClassifier(random_state=11,class_weight='balanced')

         clf1=GridSearchCV(clf_tree ,parameters2, scoring="roc_auc", cv=5, return_train_score=
         clf1.fit(X_tf_w2v_train,y_train)
```

```
Out[83]: GridSearchCV(cv=5, error_score=nan,
                      estimator=DecisionTreeClassifier(ccp_alpha=0.0,
                                                       class_weight='balanced',
                                                       criterion='gini', max_depth=None,
                                                       max_features=None,
                                                       max_leaf_nodes=None,
                                                       min_impurity_decrease=0.0,
                                                       min_impurity_split=None,
                                                       min_samples_leaf=1,
                                                       min_samples_split=2,
                                                       min_weight_fraction_leaf=0.0,
                                                       presort='deprecated',
                                                       random_state=11,
                                                       splitter='best'),
                      iid='deprecated', n_jobs=None,
                      param_grid={'max_depth': [1, 5, 10, 50, 100, 500, 1000],
                                  'min_samples_split': [5, 10, 20, 45, 75, 100, 135, 270,
                                                        500]},
                      pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
                      scoring='roc_auc', verbose=0)
```

```
In [84]: a1=clf1.best_params_['max_depth']
         p1= clf1.best_params_['min_samples_split']
         print(clf1.best_score_)
         print(a1)
         print(p1)
```

```
0.6599429777092334
5
270
```

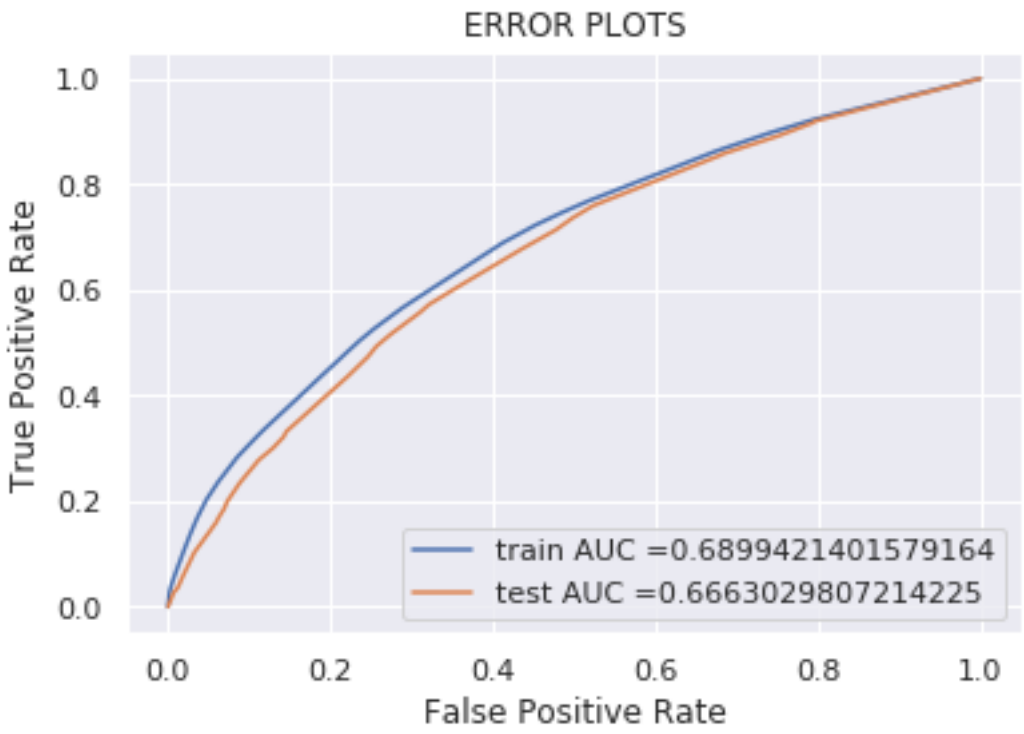
```
In [85]: #https://towardsdatascience.com/using-3d-visualizations-to-tune-hyperparameters-of-ml
         #https://github.com/xoelop/Medium-posts/blob/master/3d%20cross%20validation/ML%206%20
         import seaborn as sns; sns.set()
         max_scores1 = pd.DataFrame(clf1.cv_results_).groupby(['param_min_samples_split', 'para
         fig, ax = plt.subplots(1,2, figsize=(20,6))
         sns.heatmap(max_scores1.mean_train_score, annot = True, fmt='.4g', ax=ax[0])
         sns.heatmap(max_scores1.mean_test_score, annot = True, fmt='.4g', ax=ax[1])
         ax[0].set_title('Train Set')
         ax[1].set_title('CV Set')
         plt.show()
```



In [92]:
```
# Train new model
DT_tfidf1 = DecisionTreeClassifier(max_depth=a1, min_samples_split=p1, class_weight='
DT_tfidf1.fit(X_tf_train,y_train)
```

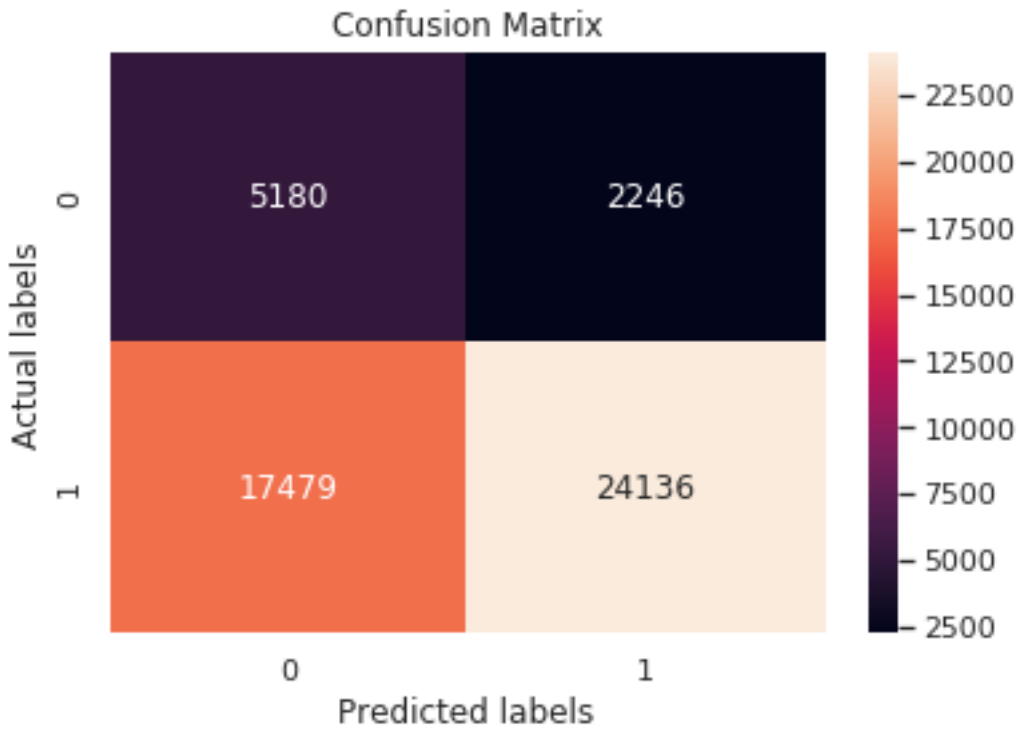
Out[92]:
```
DecisionTreeClassifier(ccp_alpha=0.0, class_weight='balanced', criterion='gini',
                       max_depth=5, max_features=None, max_leaf_nodes=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=270,
                       min_weight_fraction_leaf=0.0, presort='deprecated',
                       random_state=None, splitter='best')
```

In [109]:
```
#https://scikitlearn.org/stable/modules/generated/sklearn.linear_model.SGDClassifier
y_train_pred = clf1.predict_proba(X_tf_w2v_train) [:,1]
y_test_pred = clf1.predict_proba(X_tf_w2v_test) [:,1]

train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
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.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()
```



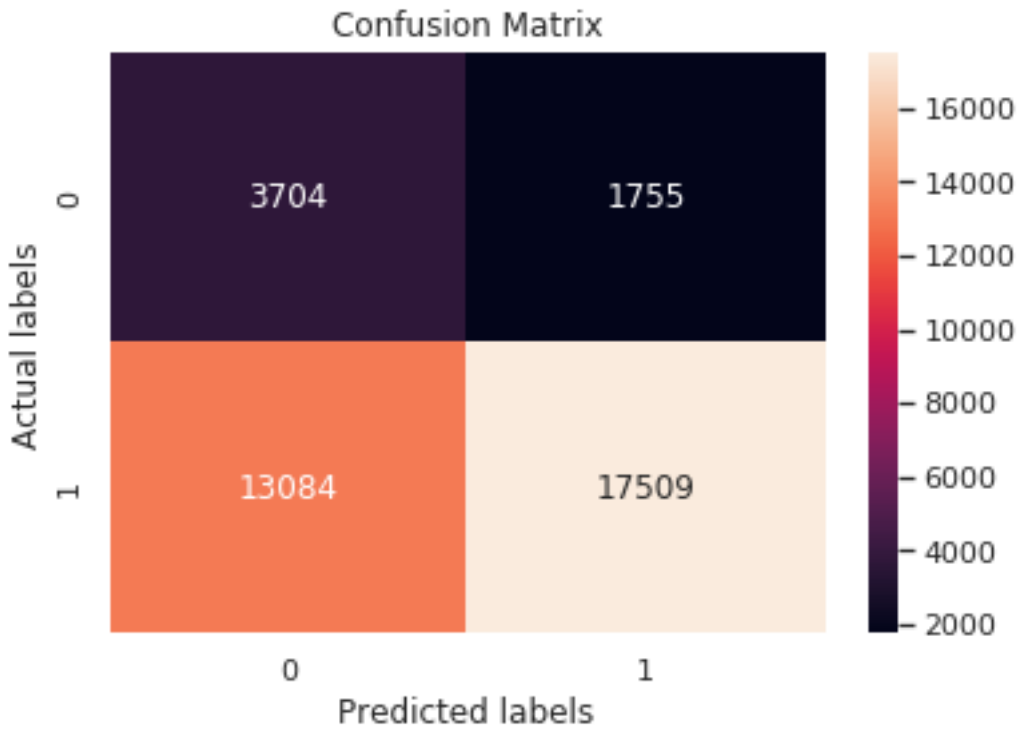
In [110]:
```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#Train dataset - COnfusion Matrix
import seaborn as sns
import matplotlib.pyplot as plt
print("Confusin Matrix On train")
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, clf1.predict(X_tf_w2v_train)), annot=True, ax =

# labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('Actual labels');
ax.set_title('Confusion Matrix');
```

```
Confusin Matrix On train
```



In [112]:
```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#Train dataset - COnfusion Matrix
import seaborn as sns
import matplotlib.pyplot as plt
print("Confusin Matrix On test")
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, clf1.predict(X_tf_w2v_test)), annot=True, ax = a

# labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('Actual labels');
ax.set_title('Confusion Matrix');
```

```
Confusin Matrix On test
```



Extracting False positives

```
In [0]: #https://datascience.stackexchange.com/questions/28493/confusion-matrix-get-items-fp-f
        #https://www.google.com/search?q=geeks+for+geeks+false+positive&rlz=1C1SQJL_enIN849IN8
        #https://github.com/pskadasi/DecisionTrees_DonorsChoose/blob/master/Copy_of_8_DonorsCh
```

```
In [128]: # Get FP points
          pred = clf1.predict(X_tf_w2v_test)
          actual=y_test
          print(pred.shape)
          print(actual.shape)
```

```
(36052,)
(36052,)
```

```
In [129]: X_test_wc=pd.DataFrame(X_test)

          print(X_test_wc.shape)
```

```
(36052, 21)
```

```
In [0]: X_test_wc["pred"]=pred
        X_test_wc["actual"]=actual
```

```
In [131]: X_test_wc.head(2)
```

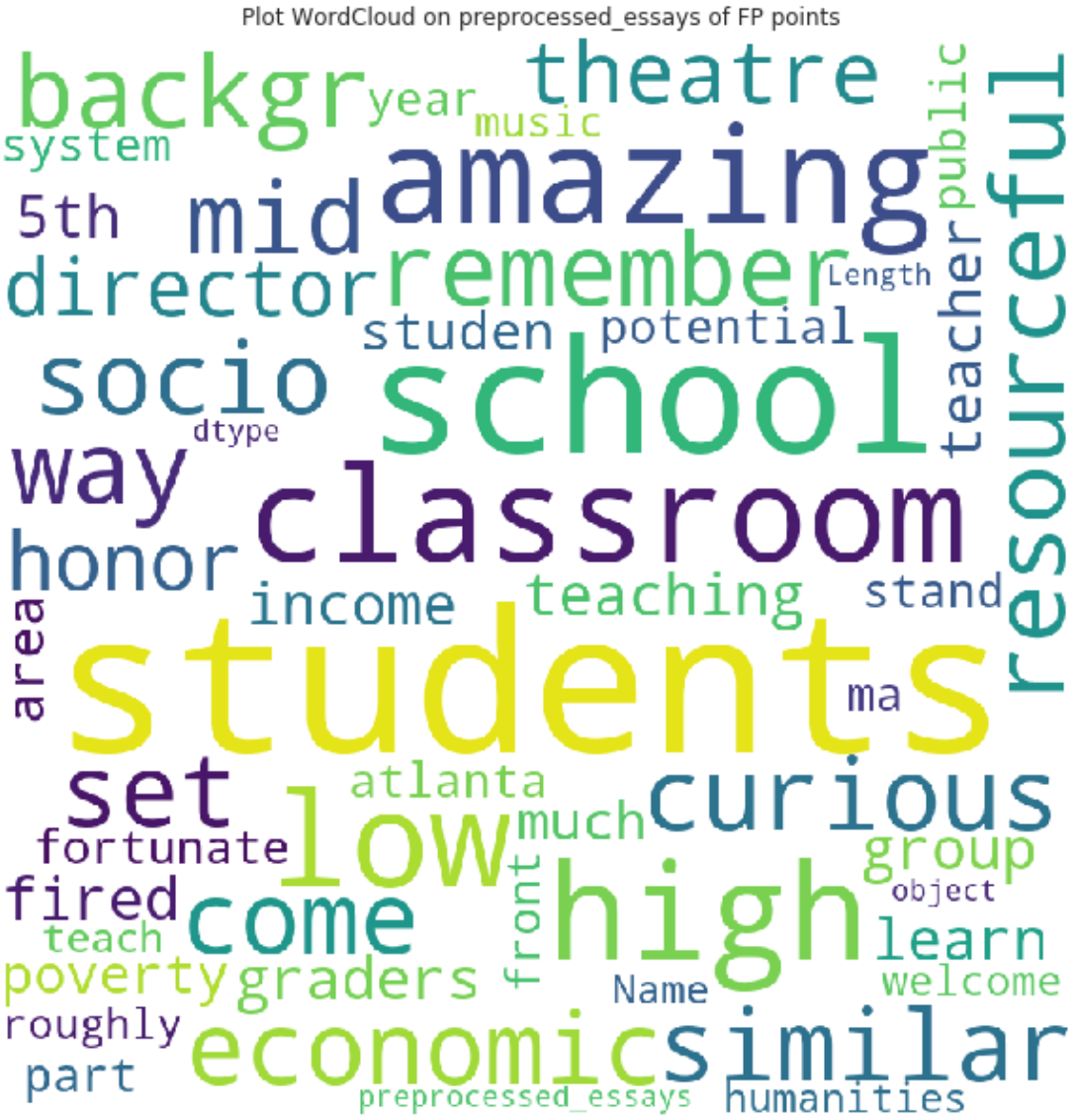
```
Out[131]:         Unnamed: 0       id  ... pred actual
          102952       92661  p009851  ...    1      0
          56473        42874  p085351  ...    0      1

          [2 rows x 23 columns]
```

```
In [132]: X_fp = (X_test_wc["actual"]==0)
          Y_fp = (X_test_wc["pred"]==1)
          FP=X_test_wc[X_fp&Y_fp]
          FP.head(2)
```

```
Out[132]:         Unnamed: 0       id  ... pred actual
          102952       92661  p009851  ...    1      0
          19348        85551  p059921  ...    1      0

          [2 rows x 23 columns]
```

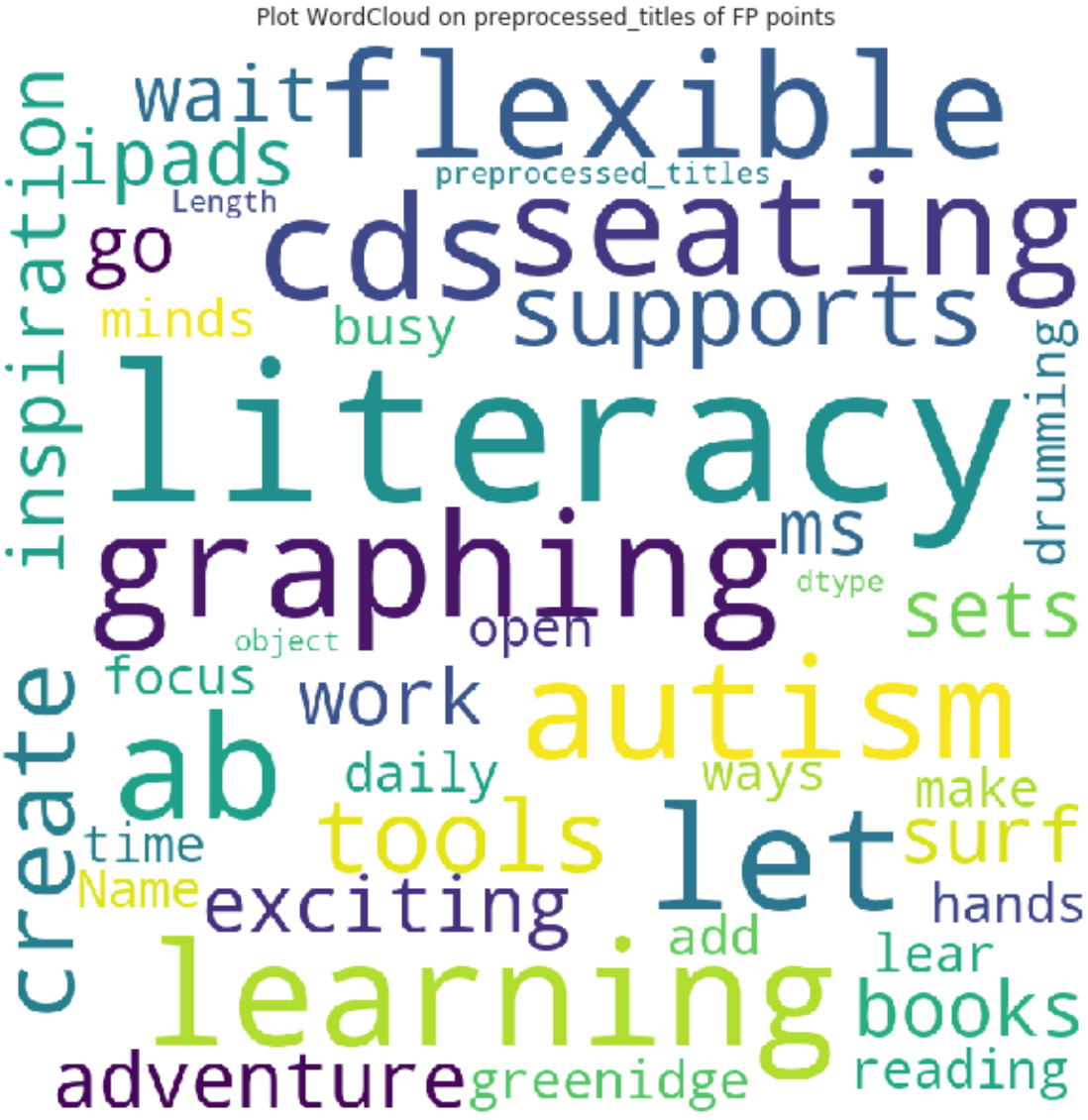
8 Plot WordCloud on preprocessed_essays of FP points

```
In [133]: from wordcloud import WordCloud
          word=str(FP["preprocessed_essays"])
          wordcloud = WordCloud(width = 800, height = 800,
                          background_color ='white').generate(word)

          # plot the WordCloud image
          plt.figure(figsize = (8, 8), facecolor = None)
          plt.imshow(wordcloud)
          plt.axis("off")
          plt.tight_layout(pad = 0)
          plt.title("Plot WordCloud on preprocessed_essays of FP points")
          plt.show()
```



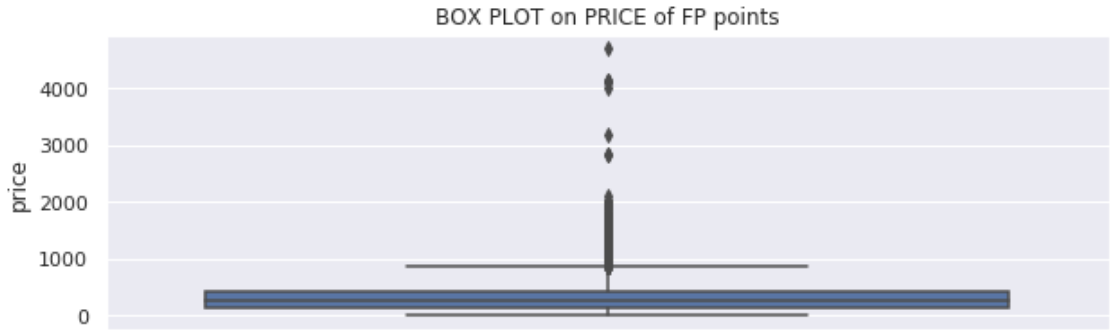
Plot WordCloud on preprocessed_titles of FP points

```
In [134]: from wordcloud import WordCloud
          word=str(FP["preprocessed_titles"])
          wordcloud = WordCloud(width = 800, height = 800,
                          background_color ='white').generate(word)

          # plot the WordCloud image
          plt.figure(figsize = (8, 8), facecolor = None)
          plt.imshow(wordcloud)
          plt.axis("off")
          plt.tight_layout(pad = 0)
          plt.title("Plot WordCloud on preprocessed_titles of FP points")
          plt.show()
```



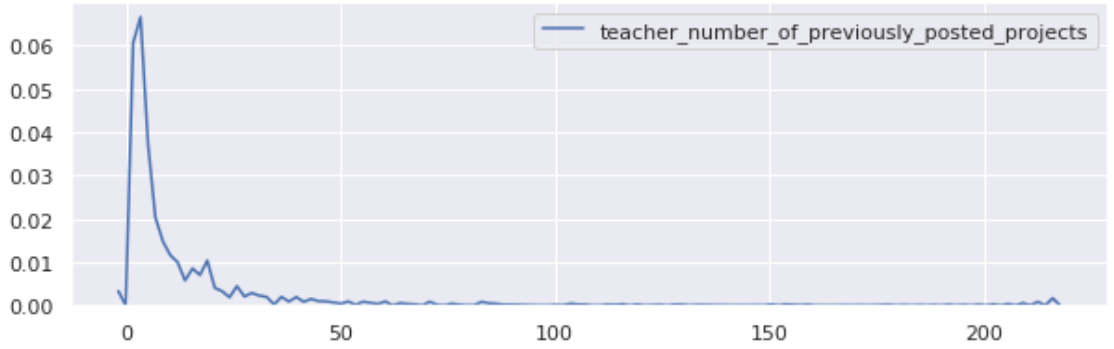
BOX PLOT on PRICE of FP points

```
In [135]: import seaborn as sns
          plt.figure(figsize=(10,3))
          sns.boxplot(FP["price"],orient="v")
          plt.title("BOX PLOT on PRICE of FP points")

Out[135]: Text(0.5, 1.0, 'BOX PLOT on PRICE of FP points')
```



PDF of teacher_number_of_previously_posted_projects of FP points

```
In [136]: plt.figure(figsize=(10,3))
          sns.kdeplot(FP["teacher_number_of_previously_posted_projects"],label="teacher_number_

          plt.legend()
          plt.show()
```



1.6 Getting top features using `feature_importances_`

```
In [0]: # please write all the code with proper documentation, and proper titles for each subs
        # go through documentations and blogs before you start coding
        # first figure out what to do, and then think about how to do.
        # reading and understanding error messages will be very much helpfull in debugging you
        # when you plot any graph make sure you use
            # a. Title, that describes your plot, this will be very helpful to the reader
            # b. Legends if needed
            # c. X-axis label
            # d. Y-axis label
```

Task 2

```
In [0]: set1_features = cat_features+sub_cat_features+state_features+prefix_features+grade_feat
        set1_features.append("price")
```

```
In [219]: print(len(set1_features))
```

```
6334
```

```
In [0]: set2 = hstack((categories_one_hot,sub_categories_one_hot,prefix_one_hot,state_one_hot,g
```

```
In [220]: dt_1 =DecisionTreeClassifier(max_depth = 10, min_samples_split= 500)
          dt_1.fit(X_tf_train,y_train)
```

```
Out[220]: DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, criterion='gini',
                                 max_depth=10, max_features=None, max_leaf_nodes=None,
                                 min_impurity_decrease=0.0, min_impurity_split=None,
                                 min_samples_leaf=1, min_samples_split=500,
                                 min_weight_fraction_leaf=0.0, presort='deprecated',
                                 random_state=None, splitter='best')
```

```
In [222]: #picking Top features using "feature_importances_"
          top_features=dt_1.feature_importances_
          top_features.shape
```

```
Out[222]: (6334,)
```

```
In [0]: df_features = pd.DataFrame(data=set1_features,columns=["Feature Name"])
        df_features["Feature Value"] = top_features
```

```
In [224]: df_features = df_features.sort_values(by = ["Feature Value"],ascending=False)
          df_features.head()
```

```
Out[224]:         Feature Name  Feature Value
          1438    focus better       0.116747
          5475     get wiggles       0.113079
          1676         grow my       0.111897
          3935  students grade       0.110576
          4653      unique way       0.093587
```

```
In [0]: # selecting top 5k features
        df_features = df_features[:5000]
```

```
In [0]: #since, we have already picked top 5k features, our next step is to build a model on t
        #before, that we need to rearrange the indices
```

```
In [0]: # getting the list of indices of top  features
        index_list = df_features.index.tolist()
```

```
In [232]: # converting to csr to access elements
          X_tf_train = X_tf_train.tocsr()
          X_tf_test = X_tf_test.tocsr()
          print(X_tf_train.shape)
          print(X_tf_test.shape)
```

```
(49041, 6334)
(36052, 6334)
```

```
In [0]: #Concatinating 5k features
        # Extracting specific columns in numpy array
        # https://stackoverflow.com/questions/8386675/extracting-specific-columns-in-numpy-arr
        X_tf_tr = X_tf_train[:,index_list]
        X_tf_te = X_tf_test[:,index_list]
```

```
In [234]: print(X_tf_tr.shape)
          print(X_tf_te.shape)
```

```
(49041, 5000)
(36052, 5000)
```

Model : Logistic Regression

```
In [239]: from sklearn.linear_model import SGDClassifier
          from sklearn.model_selection import GridSearchCV

          parameters1={'alpha': [10**x for x in range(-4,3)] ,
                       'penalty' : ['l1','l2']}

          clf_LR = SGDClassifier(loss = 'log',random_state=11,class_weight='balanced')

          clf8=GridSearchCV(clf_LR ,param_grid = parameters1, scoring="roc_auc", cv=10, return
          clf8.fit(X_tf_tr,y_train)
```

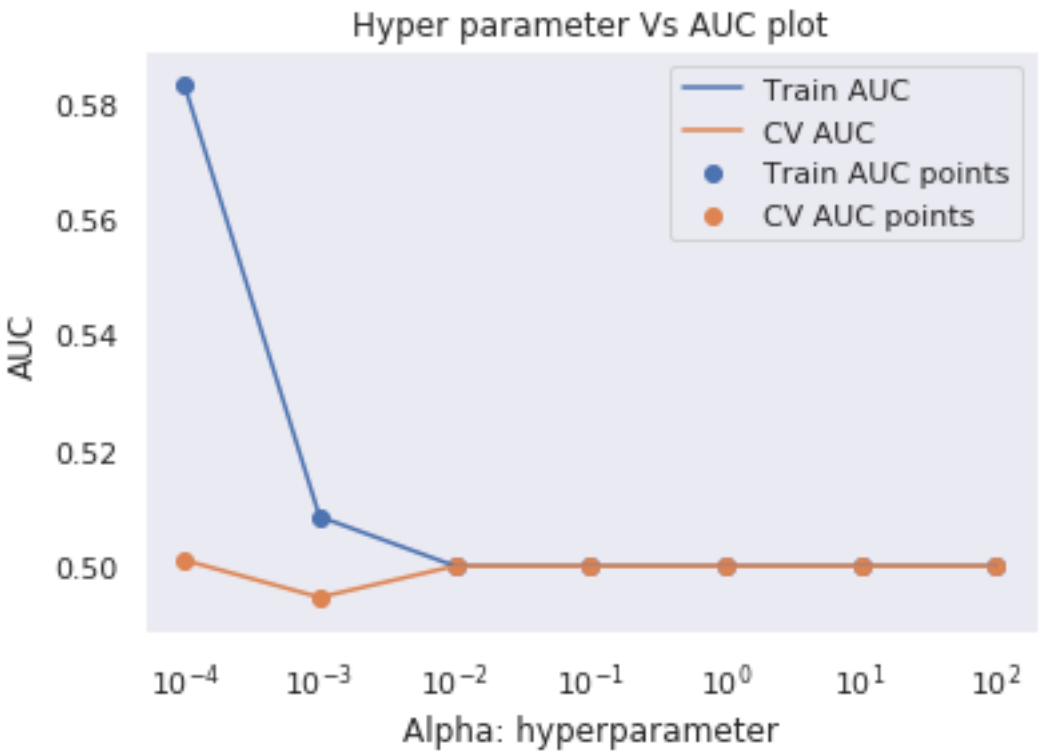
```
Out[239]: GridSearchCV(cv=10, error_score=nan,
                       estimator=SGDClassifier(alpha=0.0001, average=False,
                                               class_weight='balanced',
                                               early_stopping=False, epsilon=0.1,
                                               eta0=0.0, fit_intercept=True,
                                               l1_ratio=0.15, learning_rate='optimal',
                                               loss='log', max_iter=1000,
                                               n_iter_no_change=5, n_jobs=None,
                                               penalty='l2', power_t=0.5, random_state=11,
                                               shuffle=True, tol=0.001,
                                               validation_fraction=0.1, verbose=0,
                                               warm_start=False),
                       iid='deprecated', n_jobs=None,
                       param_grid={'alpha': [0.0001, 0.001, 0.01, 0.1, 1, 10, 100],
                                   'penalty': ['l1', 'l2']},
                       pre_dispatch='2*n_jobs', refit=True, return_train_score=True,
                       scoring='roc_auc', verbose=0)
```

```
In [240]: a8=clf8.best_params_['alpha']
          p8= clf8.best_params_['penalty']
```

```
print(clf8.best_score_)
print(a8)
print(p8)
```

```
0.5010181951985 32
0.0001
l1
```

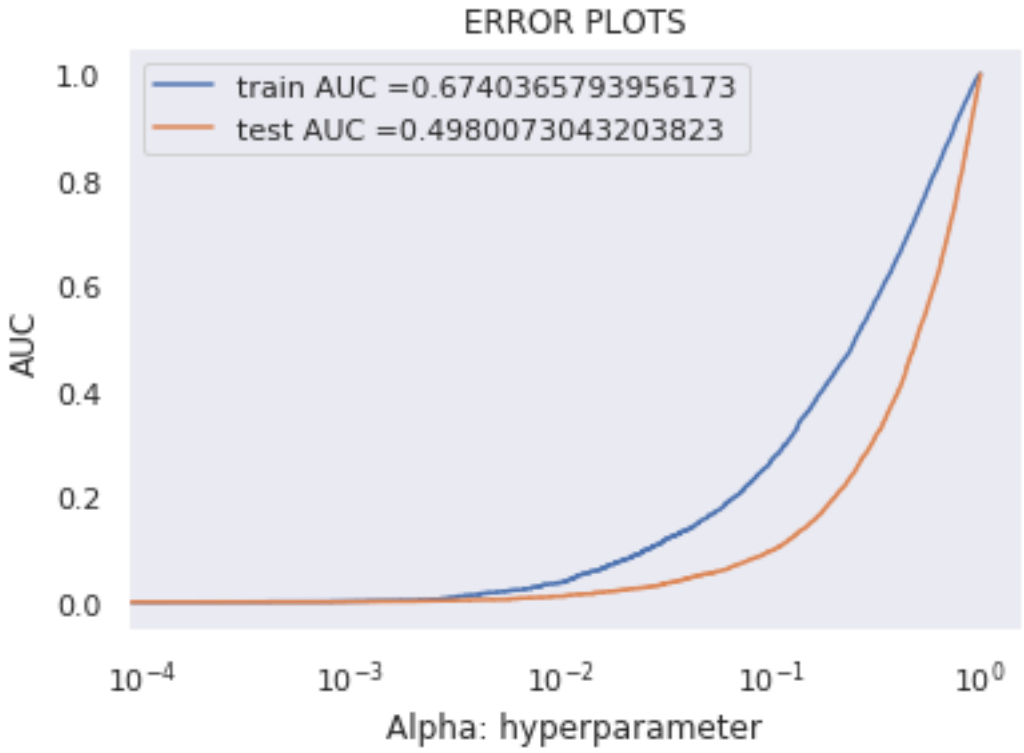
In [241]:
```
train_auc= clf8.cv_results_['mean_train_score'][clf8.cv_results_['param_penalty']==p8
train_auc_std= clf8.cv_results_['std_train_score'][clf8.cv_results_['param_penalty']=
cv_auc = clf8.cv_results_['mean_test_score'][clf8.cv_results_['param_penalty']==p8]
cv_auc_std= clf8.cv_results_['std_test_score'][clf8.cv_results_['param_penalty']==p8]

plt.plot(parameters1['alpha'], train_auc, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
# plt.gca().fill_between(K, train_auc - train_auc_std,train_auc + train_auc_std,alpha

plt.plot(parameters1['alpha'], cv_auc, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
# plt.gca().fill_between(K, cv_auc - cv_auc_std,cv_auc + cv_auc_std,alpha=0.2,color=

plt.scatter(parameters1['alpha'], train_auc, label='Train AUC points')
plt.scatter(parameters1['alpha'], cv_auc, label='CV AUC points')

plt.xscale('log')# we take the log in the x axis
plt.legend()
plt.xlabel("Alpha: hyperparameter")
plt.ylabel("AUC")
plt.title("Hyper parameter Vs AUC plot")
plt.grid()
plt.show()
```




```
In [0]: def batch_predict(clf, data):
            # roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates
            # not the predicted outputs

            y_data_pred = []
            tr_loop = data.shape[0] - data.shape[0]%1000
            # consider you X_tr shape is 49041, then your tr_loop will be 49041 - 49041%1000 =
            # in this for loop we will iterate unti the last 1000 multiplier
            for i in range(0, tr_loop, 1000):
                y_data_pred.extend(clf.predict_proba(data[i:i+1000])[:,1])
            # we will be predicting for the last data points
            if data.shape[0]%1000 !=0:
                y_data_pred.extend(clf.predict_proba(data[tr_loop:])[:,1])

            return y_data_pred
```

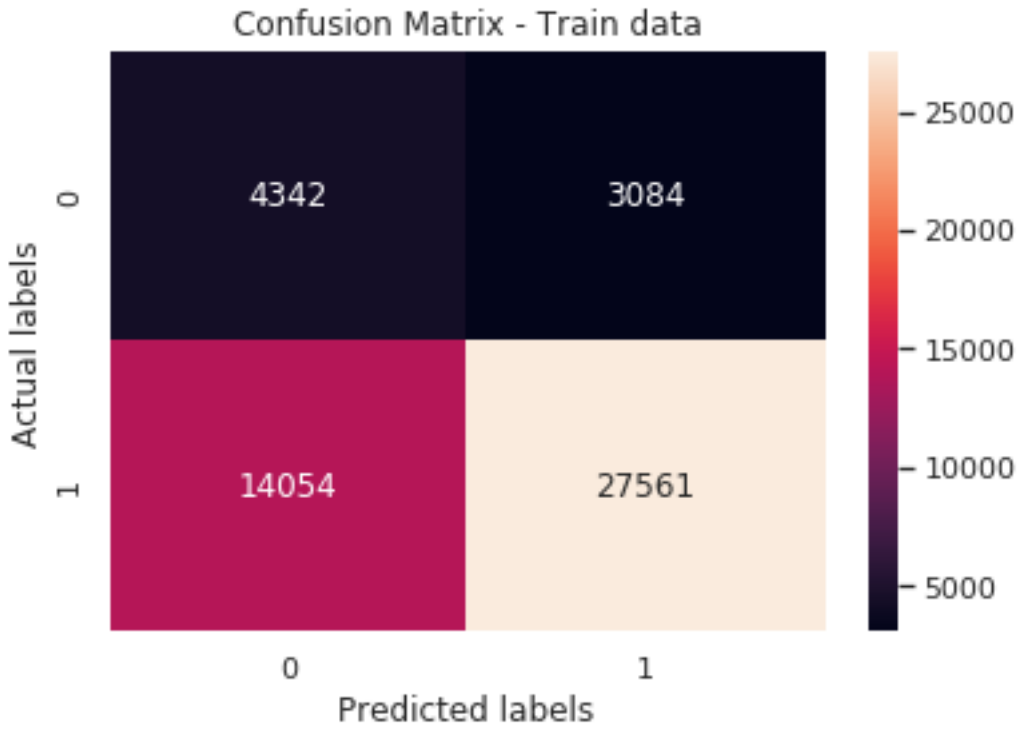
```
In [243]: # https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#s
          from sklearn.metrics import roc_curve, auc


          LR = SGDClassifier(loss = 'log',alpha=a8, class_weight='balanced') # n_jobs=-1 means
          LR.fit(X_tf_tr, y_train)
          # roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates o
```

```
# not the predicted outputs

y_train_pred = batch_predict(LR, X_tf_tr) #computing probability scores
y_test_pred = batch_predict(LR, X_tf_te) #computing probability scores

#Since the thresholds are sorted from low to high values,
#they are reversed upon returning them to ensure they correspond to both fpr and tpr
#which are sorted in reversed order during their calculation.
train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)

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.xlabel("Alpha: hyperparameter")
plt.xscale('log')# we take the log in the x axis
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()
```

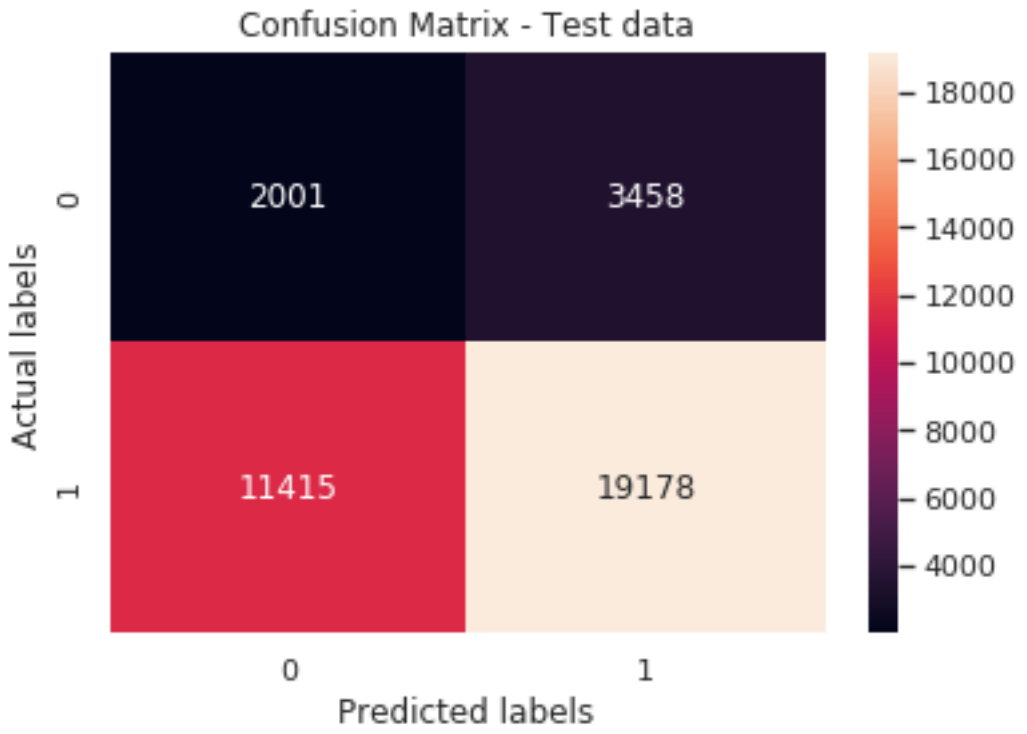


In [244]:
```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#Train dataset - COnfusion Matrix
```

```
import seaborn as sns
import matplotlib.pyplot as plt
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_train, LR.predict(X_tf_tr)), annot=True, ax = ax,fmt=

# labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('Actual labels');
ax.set_title('Confusion Matrix - Train data');
```



In [245]:
```
#https://stackoverflow.com/questions/35572000/how-can-i-plot-a-confusion-matrix
#Test dataset - confusion Matrix
import seaborn as sns
import matplotlib.pyplot as plt
ax= plt.subplot()
sns.heatmap(confusion_matrix(y_test, LR.predict(X_tf_te)), annot=True, ax = ax,fmt='

# labels, title and ticks
ax.set_xlabel('Predicted labels');
ax.set_ylabel('Actual labels');
ax.set_title('Confusion Matrix - Test data');
```



2. Summary

```
In [0]: from prettytable import PrettyTable
        summary = PrettyTable()

In [0]: summary.field_names = ["Vectorizer", "Model", "Alpha", "Max_depth ", " Min_sample_split

In [0]: summary.add_row(["TFIDF","DT","", "10", "500","0.652"])
        summary.add_row(["TFIDF W2V","DT","", "5","270","0.666"])
        summary.add_row(["TFIDF top 5k","LR","0.0001","","","0.498"])

In [5]: print(summary)
```

```
+--------------+-------+--------+------------+--------------------+-------+
|  Vectorizer  | Model | Alpha  | Max_depth  |  Min_sample_split  |  Test |
+--------------+-------+--------+------------+--------------------+-------+
|    TFIDF     |   DT  |        |     10     |        500         | 0.652 |
|  TFIDF W2V   |   DT  |        |     5      |        270         | 0.666 |
| TFIDF top 5k |   LR  | 0.0001 |            |                    | 0.498 |
+--------------+-------+--------+------------+--------------------+-------+
```