Copy_of_8_DonorsChoose_DT_(1)

March 27, 2019

1 DonorsChoose

DonorsChoose.org receives hundreds of thousands of project proposals each year for classroom projects in need of funding. Right now, a large number of volunteers is needed to manually screen each submission before it's approved to be posted on the DonorsChoose.org website.

Next year, DonorsChoose.org expects to receive close to 500,000 project proposals. As a result, there are three main p

How to scale current manual processes and resources to screen 500,000 projects so that they can be posted as quickly a
How to increase the consistency of project vetting across different volunteers to improve the experience for teache
How to focus volunteer time on the applications that need the most assistance

The goal of the competition is to predict whether or not a DonorsChoose.org project proposal submitted by a teacher will be approved, using the text of project descriptions as well as additional metadata about the project, teacher, and school. DonorsChoose.org can then use this information to identify projects most likely to need further review before approval.

1.1 About the DonorsChoose Data Set

The train.csv data set provided by DonorsChoose contains the following features:

Feature	Description
project_id	A unique identifier for the proposed project. **Example:** p036502

project_title | Title of the project. **Examples:**
Art Will Make You Happy!
First Grade Fun
project_grade_category | Grade level of students for which the project is targeted. One of the following enumerated values:
Grades PreK-2
Grades 3-5
Grades 6-8
Grades 9-12
project_subject_categories | One or more (comma-separated) subject categories for the project from the following enumerated list of values:

Applied Learning
Care & Hunger
Health & Sports
History & Civics
Literacy & Language
Math & Science
Music & The Arts
Special Needs
Warmth
Examples:
Music & The Arts
Literacy & Language, Math & Science

school_state | State where school is located (Two-letter U.S. postal code). **Example:** WY

project_subject_subcategories | One or more (comma-separated) subject subcategories for the project. **Examples:**

Literacy
Literature & Writing, Social Sciences

project_resource_summary | An explanation of the resources needed for the project. **Example:**
My students need hands on literacy materials to manage sensory needs!

project_essay_1 | First application essay

project_essay_2 | *Second application essay* project_essay_3 | Third application essay

project_essay_4 | *Fourth application essay* project_submitted_datetime | Datetime when project application was submitted. **Example:** 2016-04-28 12:43:56.245

teacher_id | A unique identifier for the teacher of the proposed project. **Example:** bdf8baa8fedef6bfeec7ae4ff1c15c56

teacher_prefix | Teacher's title. One of the following enumerated values:

nan
Dr.
Mr.
Mrs.
Ms.
Teacher.

teacher_number_of_previously_posted_projects | Number of project applications previously submitted by the same teacher. **Example:** 2

* See the section Notes on the Essay Data for more details about these features.

Additionally, the resources.csv data set provides more data about the resources required for each project. Each line in this file represents a resource required by a project:

Feature	Description
id	A project_id value from the train.csv file. **Example:** p036502
description	Desciption of the resource. **Example:** Tenor Saxophone Reeds, Box of 25

Feature	Description
quantity	Quantity of the resource required. **Example:** 3
price	Price of the resource required. **Example:** 9.95

Note: Many projects require multiple resources. The id value corresponds to a project_id in train.csv, so you use it as a key to retrieve all resources needed for a project:

The data set contains the following label (the value you will attempt to predict):

Label	Description
project_is_approved	A binary flag indicating whether DonorsChoose approved the project. A value of 0 indicates the project was not approved, and a value of 1 indicates the project was approved.

1.1.1 Notes on the Essay Data

Prior to May 17, 2016, the prompts for the essays were as follows:

project_essay_1: "Introduce us to your classroom"

project_essay_2: "Tell us more about your students"

project_essay_3: "Describe how your students will use the materials you're requesting"

project_essay_3: "Close by sharing why your project will make a difference"

Starting on May 17, 2016, the number of essays was reduced from 4 to 2, and the prompts for the first 2 essays were changed to the following:

project_essay_1: "Describe your students: What makes your students special? Specific details about their background, your neighborhood, and your school are all helpful."

project_essay_2: "About your project: How will these materials make a difference in your students' learning and improve their school lives?"

For all projects with project_submitted_datetime of 2016-05-17 and later, the values of project_essay_3 and project_essay_4 will be NaN.

In [1]:
```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")

import sqlite3
import pandas as pd
```

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

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

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

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

from tqdm import tqdm
import os

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

1.2 1.1 Reading Data

In [2]: #since im using google_colab, i have to mount the gdrive folder for accessing the files

```
from google.colab import drive
drive.mount('/content/gdrive')
```

Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdgf

Enter your authorization code:
ůůůůůůůůůůů
Mounted at /content/gdrive

In [0]: #reading the datasets, i have taken only 5000 datapoints into consideration for avoiding mermory issues

```
project_data = pd.read_csv('/content/gdrive/My Drive/Colab Notebooks/Assignments_DonorsChoose_2
resource_data = pd.read_csv('/content/gdrive/My Drive/Colab Notebooks/Assignments_DonorsChoose_
```

In [4]:
```
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 (50000, 17)
--------------------------------------------------
The attributes of data : ['Unnamed: 0' 'id' 'teacher_id' 'teacher_prefix' 'school_state'
 'project_submitted_datetime' 'project_grade_category'
 'project_subject_categories' 'project_subject_subcategories'
 'project_title' 'project_essay_1' 'project_essay_2' 'project_essay_3'
 'project_essay_4' 'project_resource_summary'
 'teacher_number_of_previously_posted_projects' 'project_is_approved']
```

In [5]:
```
# how to replace elements in list python: https://stackoverflow.com/a/2582163/4084039
cols = ['Date' if x=='project_submitted_datetime' else x for x in list(project_data.columns)]


#sort dataframe based on time pandas python: https://stackoverflow.com/a/49702492/4084039
project_data['Date'] = pd.to_datetime(project_data['project_submitted_datetime'])
project_data.drop('project_submitted_datetime', axis=1, inplace=True)
project_data.sort_values(by=['Date'], inplace=True)


# how to reorder columns pandas python: https://stackoverflow.com/a/13148611/4084039
project_data = project_data[cols]


project_data.head(2)
```

Out[5]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	Date	project_grade_category	project_subject_categories	project_subject_subcategories	project_title
473	100660	p234804	cbc0e38f522143b86d372f8b43d4cff3	Mrs.	GA	2016-04-27 00:53:00	Grades PreK-2	Applied Learning	Early Development	Flexible Seating for Flexible Learning
41558	33679	p137682	06f6e62e17de34fcf81020c77549e1d5	Mrs.	WA	2016-04-27 01:05:25	Grades 3-5	Literacy & Language	Literacy	Going Deep: The Art of Inner Thinking!

```
                                    project_essay_1  \
473    I recently read an article about giving studen...
41558  My students crave challenge, they eat obstacle...

                                    project_essay_2  \
473    I teach at a low-income (Title 1) school. Ever...
41558  We are an urban, public k-5 elementary school...

                                    project_essay_3  \
473    We need a classroom rug that we can use as a c...
41558  With the new common core standards that have b...

                                    project_essay_4  \
473    Benjamin Franklin once said, \"Tell me and I f...
41558  These remarkable gifts will provide students w...

                               project_resource_summary  \
473    My students need flexible seating in the class...
41558  My students need copies of the New York Times ...

       teacher_number_of_previously_posted_projects  project_is_approved
473                                               2                   1
41558                                             2                   1
```

In [6]:
```
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[6]:

	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

1.3 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/47301924/4084039

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

```
cat_list = []
for i in catogories:
    temp = ""
    # consider we have text like this "Math & Science, Warmth, Care & Hunger"
    for j in i.split(','): # it will split it in three parts ["Math & Science", "Warmth", "Care & Hunger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "Math & Science"=> "Math
            j=j.replace('The','') # if we have the words "The" we are going to replace it with ''(i.e removing "
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math & Science"=>"Math&
        temp+=j.strip()+" " #" abc ".strip() will return "abc", remove the trailing spaces
        temp = temp.replace('&','_') # we are replacing the & value into
    cat_list.append(temp.strip())

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

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]))
```

1.4 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/47301924/4084039

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

        sub_cat_list = []
        for i in sub_catogories:
            temp = ""
            # consider we have text like this "Math & Science, Warmth, Care & Hunger"
            for j in i.split(','): # it will split it in three parts ["Math & Science", "Warmth", "Care & Hunger"]
                if 'The' in j.split(): # this will split each of the catogory based on space "Math & Science"=> "Math
                    j=j.replace('The','') # if we have the words "The" we are going to replace it with ''(i.e removing "
                j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math & Science"=>"Math&
                temp +=j.strip()+" "#" abc ".strip() will return "abc", remove the trailing spaces
                temp = temp.replace('&','_')
            sub_cat_list.append(temp.strip())

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

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

```
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]))
```

1.5 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 [10]: project_data.head(2)
```

Out[10]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	Date	project_grade_category	project_title	project_essay_1	project_essay_2	project_essay_3	project_essay_4	project_resource_summary
473	100660	p234804	cbc0e38f522143b86d372f8b43d4cff3	Mrs.	GA	2016-04-27 00:53:00	Grades PreK-2	Flexible Seating for Flexible Learning	I recently read an article about giving studen...	I teach at a low-income (Title 1) school. Ever...	We need a classroom rug that we can use as a c...	Benjamin Franklin once said, \"Tell me and I f...	My students need flexible seating in the class...
41558	33679	p137682	06f6e62e17de34fcf81020c77549e1d5	Mrs.	WA	2016-04-27 01:05:25	Grades 3-5	Going Deep: The Art of Inner Thinking!	My students crave challenge, they eat obstacle...	We are an urban, public k-5 elementary school...	With the new common core standards that have b...	These remarkable gifts will provide students w...	My students need copies of the New York Times ...

```
        teacher_number_of_previously_posted_projects  project_is_approved  \
473                                                2                   1
41558                                              2                   1

       clean_categories clean_subcategories  \
473     AppliedLearning    EarlyDevelopment
41558  Literacy_Language            Literacy

                                                   essay
473    I recently read an article about giving studen...
41558  My students crave challenge, they eat obstacle...
```

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

In [12]:
```
# 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)
```

```
I recently read an article about giving students a choice about how they learn. We already set goals; why not let t
==================================================
At the beginning of every class we start out with a Math Application problem to help students see the relevance o
==================================================
My students love coming to school and they love learning. I strive daily to make our classroom a relaxed, comfort
==================================================
I teach at a Title 1 school, with 73% of my students who receive free/reduced lunch. Our school provides free brea
==================================================
```

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 [14]:
```
sent = decontracted(project_data['essay'].values[20000])
print(sent)
print("="*50)
```

```
I teach at a Title 1 school, with 73% of my students who receive free/reduced lunch. Our school provides free brea
==================================================
```

In [15]:
```
# \r \n \t remove from string python: http://texthandler.com/info/remove-line-breaks-python/
sent = sent.replace('\\r', ' ')
sent = sent.replace('\\"', ' ')
sent = sent.replace('\\n', ' ')
print(sent)
```

```
I teach at a Title 1 school, with 73% of my students who receive free/reduced lunch. Our school provides free brea
```

In [16]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent = re.sub('[^A-Za-z0-9]+', ' ', sent)
print(sent)
```

```
I teach at a Title 1 school with 73 of my students who receive free reduced lunch Our school provides free breakfa
```

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've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his', 'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they', 'them', 'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll", 'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'having', 'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'until', 'while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'during', 'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', 'under', 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'each', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 'd', 'll', 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'doesn', "doesn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn', "mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn', "wasn't", 'weren', "
            'won', "won't", 'wouldn', "wouldn't"]
```

In [18]:
```
# 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.lower() not in stopwords)
    preprocessed_essays.append(sent.lower().strip())
```

100%|| 50000/50000 [00:32<00:00, 1533.78it/s]

In [19]:
```
# after preprocesing
preprocessed_essays[20000]
```

Out[19]: 'teach title 1 school 73 students receive free reduced lunch school provides free breakfast students special

1.4 Preprocessing of project_title

In [20]:
```
# similarly you can preprocess the titles also

from tqdm import tqdm
preprocessed_project_title = []
# 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 not in stopwords)
    preprocessed_project_title.append(sent.lower().strip())
```

100%|| 50000/50000 [00:01<00:00, 32202.32it/s]

1.6 1.5 Preparing data for models

In [21]:
```
project_data.columns
```

Out[21]:
```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'Date', 'project_grade_category', 'project_title', 'project_essay_1',
       'project_essay_2', 'project_essay_3', 'project_essay_4',
```

```
       'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'essay'],
      dtype='object')
```

we are going to consider

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

- project_title : text data
- text : text data
- project_resource_summary: text data (optinal)

- quantity : numerical (optinal)
- teacher_number_of_previously_posted_projects : numerical
- price : numerical

1.6.1 Modifying DataSet (essay & project_title)

```
In [0]: project_data['clean_essay'] = preprocessed_essays
        project_data['clean_project_title'] = preprocessed_project_title
        project_data.drop(['essay'], axis=1, inplace=True)
        project_data.drop(['project_title'], axis=1, inplace=True)
```

```
In [23]: project_data.head(1)
```

```
Out[23]:      Unnamed: 0       id                         teacher_id teacher_prefix  \
        473       100660  p234804  cbc0e38f522143b86d372f8b43d4cff3           Mrs.

           school_state                 Date project_grade_category  \
        473           GA 2016-04-27 00:53:00           Grades PreK-2

                                                project_essay_1  \
        473  I recently read an article about giving studen...

                                                project_essay_2  \
        473  I teach at a low-income (Title 1) school. Ever...

                                                project_essay_3  \
        473  We need a classroom rug that we can use as a c...

                                                project_essay_4  \
        473  Benjamin Franklin once said, \"Tell me and I f...

                                  project_resource_summary  \
```

```
473  My students need flexible seating in the class...

     teacher_number_of_previously_posted_projects  project_is_approved  \
473                                             2                   1

    clean_categories clean_subcategories  \
473  AppliedLearning    EarlyDevelopment

                                        clean_essay  \
473  recently read article giving students choice l...

                  clean_project_title
473  flexible seating flexible learning
```

In [24]:
```
y = project_data['project_is_approved'].values
project_data.drop(['project_is_approved'], axis=1, inplace=True)
project_data.head(1)
```

Out[24]:
```
     Unnamed: 0       id                         teacher_id teacher_prefix  \
473      100660  p234804  cbc0e38f522143b86d372f8b43d4cff3           Mrs.

    school_state                Date project_grade_category  \
473           GA 2016-04-27 00:53:00          Grades PreK-2

                                    project_essay_1  \
473  I recently read an article about giving studen...

                                    project_essay_2  \
473  I teach at a low-income (Title 1) school. Ever...

                                    project_essay_3  \
473  We need a classroom rug that we can use as a c...

                                    project_essay_4  \
473  Benjamin Franklin once said, \"Tell me and I f...

                           project_resource_summary  \
473  My students need flexible seating in the class...

     teacher_number_of_previously_posted_projects clean_categories  \
473                                             2  AppliedLearning

    clean_subcategories                                        clean_essay  \
473   EarlyDevelopment  recently read article giving students choice l...

                  clean_project_title
473  flexible seating flexible learning
```

In [0]:
```
X = project_data
```

2.1 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 subsection
        # 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 your code
        # 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


        # 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, stratify=y_train)
```

```
In [27]: X_train.head(2)
```

```
Out[27]:       Unnamed: 0       id                   teacher_id teacher_prefix  \
        27681      121134  p232727  db2f6b3da5f2276497a47e1c07dee18b           Ms.
        11658       75626  p114174  e04631b927506520db04cddf1d983e1c           Ms.

             school_state             Date project_grade_category  \
        27681           NC 2016-11-01 16:38:54         Grades PreK-2
        11658           NC 2017-02-09 13:44:59           Grades 6-8

                                             project_essay_1  \
        27681  My students are energetic learners who love an...
        11658  As the music/choir teacher, I have the privile...

                                             project_essay_2 project_essay_3  \
        27681  Many of the materials and books I use within s...            NaN
        11658  This year, our school is producing its first s...            NaN

             project_essay_4                    project_resource_summary  \
        27681             NaN  My students need adapted materials in order to...
        11658             NaN  My students need microphones to let their tale...

              teacher_number_of_previously_posted_projects clean_categories  \
        27681                                            2     SpecialNeeds
        11658                                            2      Music_Arts

             clean_subcategories                                      clean_essay  \
        27681       SpecialNeeds  students energetic learners love thrive hands ...
        11658      PerformingArts  music choir teacher privilege teaching majorit...
```

```
                                    clean_project_title
27681  supplies make materials growing speech languag...
11658                          let their voices be heard
```

In [28]:
```
resource_data.head(1)
```

Out[28]:

	id	description	quantity	price
0	p233245	LC652 - Lakeshore Double-Space Mobile Drying Rack	1	149.0

2.2 Make Data Model Ready: encoding numerical, categorical features

1.6.2 clean_categories

In [29]:
```
vectorizer = CountVectorizer()
vectorizer.fit(X_train['clean_categories'].values) # fit has to happen only on train data

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

feat_cc = vectorizer.get_feature_names()


print("After vectorizations")
print(X_train_cc_ohe.shape, y_train.shape)
#print(X_cv_cc_ohe.shape, y_cv.shape)
print(X_test_cc_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(33500, 9) (33500,)
(16500, 9) (16500,)
['appliedlearning', 'care_hunger', 'health_sports', 'history_civics', 'literacy_language', 'math_science', 'music_a
====================================================================================================
```

1.6.3 clean_subcategories

In [30]:
```
vectorizer = CountVectorizer()
vectorizer.fit(X_train['clean_subcategories'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_csc_ohe = vectorizer.transform(X_train['clean_subcategories'].values)
#X_cv_csc_ohe = vectorizer.transform(X_cv['clean_subcategories'].values)
X_test_csc_ohe = vectorizer.transform(X_test['clean_subcategories'].values)

feat_csc = vectorizer.get_feature_names()
```

```
print("After vectorizations")
print(X_train_csc_ohe.shape, y_train.shape)
#print(X_cv_csc_ohe.shape, y_cv.shape)
print(X_test_csc_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(33500, 30) (33500,)
(16500, 30) (16500,)
['appliedsciences', 'care_hunger', 'charactereducation', 'civics_government', 'college_careerprep', 'communityserv
====================================================================================================
```

1.6.4 school_state

```
In [31]: 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_state_ohe = vectorizer.transform(X_train['school_state'].values)
#X_cv_state_ohe = vectorizer.transform(X_cv['school_state'].values)
X_test_state_ohe = vectorizer.transform(X_test['school_state'].values)

feat_ss = vectorizer.get_feature_names()


print("After vectorizations")
print(X_train_state_ohe.shape, y_train.shape)
#print(X_cv_state_ohe.shape, y_cv.shape)
print(X_test_state_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(33500, 51) (33500,)
(16500, 51) (16500,)
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi', 'ia', 'id', 'il', 'in', 'ks', 'ky', 'la', 'ma', 'md', 'me', 'mi', 'm
====================================================================================================
```

1.6.5 teacher_prefix

```
In [32]: vectorizer = CountVectorizer()
vectorizer.fit(X_train['teacher_prefix'].values.astype('U')) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
```

```
X_train_teacher_ohe = vectorizer.transform(X_train['teacher_prefix'].values.astype('U'))
#X_cv_teacher_ohe = vectorizer.transform(X_cv['teacher_prefix'].values.astype('U'))
X_test_teacher_ohe = vectorizer.transform(X_test['teacher_prefix'].values.astype('U'))

feat_tp = vectorizer.get_feature_names()


print("After vectorizations")
print(X_train_teacher_ohe.shape, y_train.shape)
#print(X_cv_teacher_ohe.shape, y_cv.shape)
print(X_test_teacher_ohe.shape, y_test.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(33500, 5) (33500,)
(16500, 5) (16500,)
['mr', 'mrs', 'ms', 'nan', 'teacher']
====================================================================================================
```

1.6.6 project_grade_category

```
In [33]: vectorizer = CountVectorizer()
vectorizer.fit(X_train['project_grade_category'].values) # fit has to happen only on train data

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

feat_pgc = vectorizer.get_feature_names()


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(vectorizer.get_feature_names())
print("="*100)
```

```
After vectorizations
(33500, 3) (33500,)
(16500, 3) (16500,)
['12', 'grades', 'prek']
====================================================================================================
```

2.3 Make Data Model Ready: encoding eassay, and project_title

1.5.2.1 Bag of words

1.6.7 essays

In [34]:
```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(min_df=10,ngram_range=(2,2), max_features=5000)
vectorizer.fit(X_train['clean_essay'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_essay_bow = vectorizer.transform(X_train['clean_essay'].values)
#X_cv_essay_bow = vectorizer.transform(X_cv['clean_essay'].values)
X_test_essay_bow = vectorizer.transform(X_test['clean_essay'].values)

feat_bow_e = vectorizer.get_feature_names()


print("After vectorizations")
print(X_train_essay_bow.shape, y_train.shape)
#print(X_cv_essay_bow.shape, y_cv.shape)
print(X_test_essay_bow.shape, y_test.shape)
print("="*100)
```

```
After vectorizations
(33500, 5000) (33500,)
(16500, 5000) (16500,)
====================================================================================================
```

1.6.8 project_title

In [35]:
```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(min_df=10)
vectorizer.fit(X_train['clean_project_title'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_pt_bow = vectorizer.transform(X_train['clean_project_title'].values)
#X_cv_pt_bow = vectorizer.transform(X_cv['clean_project_title'].values)
X_test_pt_bow = vectorizer.transform(X_test['clean_project_title'].values)

feat_bow_pt = vectorizer.get_feature_names()


print("After vectorizations")
print(X_train_pt_bow.shape, y_train.shape)
#print(X_cv_pt_bow.shape, y_cv.shape)
print(X_test_pt_bow.shape, y_test.shape)
print("="*100)
```

```
After vectorizations
(33500, 1625) (33500,)
(16500, 1625) (16500,)
==========================================================================================
```

1.5.2.2 TFIDF vectorizer

1.6.9 essays

```
In [36]: from sklearn.feature_extraction.text import TfidfVectorizer
         vectorizer = TfidfVectorizer(min_df=10, ngram_range=(2,2), max_features=5000)
         X_train_essay_tfidf = vectorizer.fit_transform(X_train['clean_essay'].values)
         #X_cv_essay_tfidf = vectorizer.transform(X_cv['clean_essay'].values)
         X_test_essay_tfidf = vectorizer.transform(X_test['clean_essay'].values)

         feat_tfidf_e = vectorizer.get_feature_names()



         print("Shape of matrix after one hot encodig ",X_train_essay_tfidf.shape)
         #print("Shape of matrix after one hot encodig ",X_cv_essay_tfidf.shape)
         print("Shape of matrix after one hot encodig ",X_test_essay_tfidf.shape)

Shape of matrix after one hot encodig  (33500, 5000)
Shape of matrix after one hot encodig  (16500, 5000)
```

1.6.10 project_title

```
In [37]: from sklearn.feature_extraction.text import TfidfVectorizer
         vectorizer = TfidfVectorizer(min_df=10)
         X_train_pt_tfidf = vectorizer.fit_transform(X_train['clean_project_title'].values)
         #X_cv_pt_tfidf = vectorizer.transform(X_cv['clean_project_title'].values)
         X_test_pt_tfidf = vectorizer.transform(X_test['clean_project_title'].values)

         feat_tfidf_pt = vectorizer.get_feature_names()



         print("Shape of matrix after one hot encodig ",X_train_pt_tfidf.shape)
         #print("Shape of matrix after one hot encodig ",X_cv_pt_tfidf.shape)
         print("Shape of matrix after one hot encodig ",X_test_pt_tfidf.shape)

Shape of matrix after one hot encodig  (33500, 1625)
Shape of matrix after one hot encodig  (16500, 1625)
```

1.5.2.3 Using Pretrained Models: Avg W2V

1.6.11 essays

Train

```
In [0]: i=0
        list_of_sentanceTrain=[]
        for sentance in X_train['clean_essay']:
            list_of_sentanceTrain.append(sentance.split())
```

```
In [39]: is_your_ram_gt_16g=False
         want_to_use_google_w2v = False
         want_to_train_w2v = True

         if want_to_train_w2v:
             # min_count = 5 considers only words that occured atleast 5 times
             w2v_model=Word2Vec(list_of_sentanceTrain,min_count=5,size=50, workers=4)
             print(w2v_model.wv.most_similar('great'))
             print('='*50)
             #print(w2v_model.wv.most_similar('worst'))

         elif want_to_use_google_w2v and is_your_ram_gt_16g:
             if os.path.isfile('GoogleNews-vectors-negative300.bin'):
                 w2v_model=KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin', binary=T
                 #print(w2v_model.wv.most_similar('great'))
                 #print(w2v_model.wv.most_similar('worst'))
             else:
                 print("you don't have gogole's word2vec file, keep want_to_train_w2v = True, to train your own w
```

```
[('awesome', 0.7163534164428711), ('amazing', 0.701507031917572), ('wonderful', 0.7003672122955322), ('excellent
==================================================
```

```
In [40]: w2v_words = list(w2v_model.wv.vocab)
         print("number of words that occured minimum 5 times ",len(w2v_words))
         print("sample words ", w2v_words[0:50])
```

```
number of words that occured minimum 5 times  14710
sample words  ['students', 'energetic', 'learners', 'love', 'thrive', 'hands', 'learning', 'caseload', 'consists', 'autism', '
```

```
In [41]: sent_vectorsPPE_train = []; # the avg-w2v for each sentence/review is stored in this list
         for sent in tqdm(list_of_sentanceTrain): # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length 50, you might need to change this to 300
             cnt_words =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words:
                     vec = w2v_model.wv[word]
```

```
                sent_vec += vec
                cnt_words += 1
        if cnt_words != 0:
            sent_vec /= cnt_words
        sent_vectorsPPE_train.append(sent_vec)
    print(len(sent_vectorsPPE_train))
    print(len(sent_vectorsPPE_train[0]))
```

```
100%|| 33500/33500 [03:10<00:00, 176.30it/s]
```

```
33500
50
```

Test

```
In [0]: i=0
    list_of_sentanceTest=[]
    for sentance in X_test['clean_essay']:
        list_of_sentanceTest.append(sentance.split())
```

```
In [43]: is_your_ram_gt_16g=False
    want_to_use_google_w2v = False
    want_to_train_w2v = True

    if want_to_train_w2v:
        # min_count = 5 considers only words that occured atleast 5 times
        w2v_model=Word2Vec(list_of_sentanceTest,min_count=5,size=50, workers=4)
        print(w2v_model.wv.most_similar('great'))
        print('='*50)
        print(w2v_model.wv.most_similar('worst'))

    elif want_to_use_google_w2v and is_your_ram_gt_16g:
        if os.path.isfile('GoogleNews-vectors-negative300.bin'):
            w2v_model=KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin', binary=T
            print(w2v_model.wv.most_similar('great'))
            print(w2v_model.wv.most_similar('worst'))
        else:
            print("you don't have gogole's word2vec file, keep want_to_train_w2v = True, to train your own w
```

```
[('amazing', 0.6402102708816528), ('wonderful', 0.6270007491111755), ('excellent', 0.6005108952522278), ('awesom
==================================================
[('unfair', 0.8973550200462341), ('baton', 0.8861933946609497), ('greenville', 0.8802598714828491), ('minneapolis',
```

```
In [44]: w2v_words = list(w2v_model.wv.vocab)
    print("number of words that occured minimum 5 times ",len(w2v_words))
    print("sample words ", w2v_words[0:50])
```

```
number of words that occured minimum 5 times  11134
sample words  ['students', 'fun', 'energetic', 'group', 'kids', 'variety', 'needs', 'class', 'year', 'includes', 'emotional',
```

```
In [45]: sent_vectorsPPE_test = []; # the avg-w2v for each sentence/review is stored in this list
         for sent in tqdm(list_of_sentanceTest): # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length 50, you might need to change this to 300
             cnt_words =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words:
                     vec = w2v_model.wv[word]
                     sent_vec += vec
                     cnt_words += 1
             if cnt_words != 0:
                 sent_vec /= cnt_words
             sent_vectorsPPE_test.append(sent_vec)
         print(len(sent_vectorsPPE_test))
         print(len(sent_vectorsPPE_test[0]))
```

```
100%|| 16500/16500 [01:18<00:00, 209.72it/s]

16500
50
```

1.6.12 project_title

Train

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

         # Train your own Word2Vec model using your own text corpus
         i=0
         list_of_sentancePTtrain=[]
         for sentance in X_train['clean_project_title']:
             list_of_sentancePTtrain.append(sentance.split())
```

```
In [47]: is_your_ram_gt_16g=False
         want_to_use_google_w2v = False
         want_to_train_w2v = True

         try :


           if want_to_train_w2v:
```

```
        # min_count = 5 considers only words that occured atleast 5 times
        w2v_model=Word2Vec(list_of_sentancePTtrain,min_count=5,size=50, workers=4)
        print(w2v_model.wv.most_similar('great'))
        print('='*50)
        print(w2v_model.wv.most_similar('worst'))

      elif want_to_use_google_w2v and is_your_ram_gt_16g:
        if os.path.isfile('GoogleNews-vectors-negative300.bin'):
            w2v_model=KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin', binary=T
            print(w2v_model.wv.most_similar('great'))
            print(w2v_model.wv.most_similar('worst'))
        else:
            print("you don't have gogole's word2vec file, keep want_to_train_w2v = True, to train your own w

    except KeyError :

      pass

    finally :

      print("Execution Done")
```

```
[('right', 0.9930854439735413), ('clubs', 0.9900359511375427), ('picture', 0.9877787232398987), ('comic', 0.9871181
==================================================
Execution Done
```

In [48]:
```
w2v_words = list(w2v_model.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words))
print("sample words ", w2v_words[0:50])
```

```
number of words that occured minimum 5 times  2699
sample words  ['supplies', 'make', 'materials', 'growing', 'speech', 'language', 'skills', 'let', 'their', 'voices', 'be', 'hea
```

In [49]:
```
sent_vectorsPT_train = []; # the avg-w2v for each sentence/review is stored in this list
for sent in tqdm(list_of_sentancePTtrain): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length 50, you might need to change this to 300
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    sent_vectorsPT_train.append(sent_vec)
```

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

```
100%|| 33500/33500 [00:03<00:00, 9857.28it/s]

33500
50
```

Test

In [0]:
```
i=0
list_of_sentancePT_test=[]
for sentance in X_test['clean_project_title']:
    list_of_sentancePT_test.append(sentance.split())
```

In [51]:
```
# Using Google News Word2Vectors

# in this project we are using a pretrained model by google
# its 3.3G file, once you load this into your memory
# it occupies ~9Gb, so please do this step only if you have >12G of ram
# we will provide a pickle file wich contains a dict ,
# and it contains all our courpus words as keys and  model[word] as values
# To use this code-snippet, download "GoogleNews-vectors-negative300.bin"
# from https://drive.google.com/file/d/0B7XkCwpI5KDYNlNUTTlSS21pQmM/edit
# it's 1.9GB in size.


# http://kavita-ganesan.com/gensim-word2vec-tutorial-starter-code/#.W17SRFAzZPY
# you can comment this whole cell
# or change these varible according to your need

is_your_ram_gt_16g=False
want_to_use_google_w2v = False
want_to_train_w2v = True

if want_to_train_w2v:
    # min_count = 5 considers only words that occured atleast 5 times
    w2v_model=Word2Vec(list_of_sentancePT_test,min_count=5,size=50, workers=4)
    print(w2v_model.wv.most_similar('great'))
    print('='*50)
    #print(w2v_model.wv.most_similar('worst'))

elif want_to_use_google_w2v and is_your_ram_gt_16g:
    if os.path.isfile('GoogleNews-vectors-negative300.bin'):
        w2v_model=KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin', binary=T
```

```
        print(w2v_model.wv.most_similar('great'))
        print(w2v_model.wv.most_similar('worst'))
    else:
        print("you don't have gogole's word2vec file, keep want_to_train_w2v = True, to train your own w
```

```
[('station', 0.9996743202209473), ('club', 0.9995881915092468), ('today', 0.9995874762535095), ('program', 0.99958
==================================================
```

```
In [52]: w2v_words = list(w2v_model.wv.vocab)
         print("number of words that occured minimum 5 times ",len(w2v_words))
         print("sample words ", w2v_words[0:50])
```

```
number of words that occured minimum 5 times  1749
sample words  ['headphones', 'fostering', 'individualized', 'learning', 'wobble', 'why', 'you', 'work', 'sew', 'cut', 'col
```

```
In [53]: # average Word2Vec
         # compute average word2vec for each review.
         sent_vectorsPT_test = []; # the avg-w2v for each sentence/review is stored in this list
         for sent in tqdm(list_of_sentancePT_test): # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length 50, you might need to change this to 300
             cnt_words =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words:
                     vec = w2v_model.wv[word]
                     sent_vec += vec
                     cnt_words += 1
             if cnt_words != 0:
                 sent_vec /= cnt_words
             sent_vectorsPT_test.append(sent_vec)
         print(len(sent_vectorsPT_test))
         print(len(sent_vectorsPT_test[0]))
```

```
100%|| 16500/16500 [00:01<00:00, 12046.85it/s]

16500
50
```

1.5.2.3 Using Pretrained Models: TFIDF weighted W2V

1.6.13 essays

Train

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

```
In [55]: # TF-IDF weighted Word2Vec
         tfidf_feat = model.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

         tfidf_sent_vectors_essay_train = []; # the tfidf-w2v for each sentence/review is stored in this list
         row=0;
         for sent in tqdm(list_of_sentanceTrain): # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length
             weight_sum =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words and word in tfidf_feat:
                     vec = w2v_model.wv[word]
         #             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
                     # to reduce the computation we are
                     # dictionary[word] = idf value of word in whole courpus
                     # sent.count(word) = tf valeus of word in this review
                     tf_idf = dictionary[word]*(sent.count(word)/len(sent))
                     sent_vec += (vec * tf_idf)
                     weight_sum += tf_idf
             if weight_sum != 0:
                 sent_vec /= weight_sum
             tfidf_sent_vectors_essay_train.append(sent_vec)
             row += 1
```

```
100%|| 33500/33500 [29:09<00:00, 19.15it/s]
```

Test

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

```
In [57]: # TF-IDF weighted Word2Vec
         tfidf_feat = model.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

         tfidf_sent_vectors_essay_test = []; # the tfidf-w2v for each sentence/review is stored in this list
         row=0;
         for sent in tqdm(list_of_sentanceTest): # for each review/sentence
```

```
        sent_vec = np.zeros(50) # as word vectors are of zero length
        weight_sum =0; # num of words with a valid vector in the sentence/review
        for word in sent: # for each word in a review/sentence
            if word in w2v_words and word in tfidf_feat:
                vec = w2v_model.wv[word]
#                 tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
                # to reduce the computation we are
                # dictionary[word] = idf value of word in whole courpus
                # sent.count(word) = tf valeus of word in this review
                tf_idf = dictionary[word]*(sent.count(word)/len(sent))
                sent_vec += (vec * tf_idf)
                weight_sum += tf_idf
        if weight_sum != 0:
            sent_vec /= weight_sum
        tfidf_sent_vectors_essay_test.append(sent_vec)
        row += 1
```

```
100%|| 16500/16500 [11:23<00:00, 24.13it/s]
```

1.6.14 project_title

Train

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

```
In [59]: # TF-IDF weighted Word2Vec
         tfidf_feat = model.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

         tfidf_sent_vectorsPT_train = []; # the tfidf-w2v for each sentence/review is stored in this list
         row=0;
         for sent in tqdm(list_of_sentancePTtrain): # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length
             weight_sum =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words and word in tfidf_feat:
                     vec = w2v_model.wv[word]
         #             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
                     # to reduce the computation we are
                     # dictionary[word] = idf value of word in whole courpus
                     # sent.count(word) = tf valeus of word in this review
                     tf_idf = dictionary[word]*(sent.count(word)/len(sent))
                     sent_vec += (vec * tf_idf)
                     weight_sum += tf_idf
```

```
        if weight_sum != 0:
            sent_vec /= weight_sum
        tfidf_sent_vectorsPT_train.append(sent_vec)
        row += 1
```

100%|| 33500/33500 [00:22<00:00, 1460.57it/s]

Test

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

```
In [61]: # TF-IDF weighted Word2Vec
         tfidf_feat = model.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

         tfidf_sent_vectorsPT_test = []; # the tfidf-w2v for each sentence/review is stored in this list
         row=0;
         for sent in tqdm(list_of_sentancePT_test): # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length
             weight_sum =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words and word in tfidf_feat:
                     vec = w2v_model.wv[word]
         #            tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
                     # to reduce the computation we are
                     # dictionary[word] = idf value of word in whole courpus
                     # sent.count(word) = tf valeus of word in this review
                     tf_idf = dictionary[word]*(sent.count(word)/len(sent))
                     sent_vec += (vec * tf_idf)
                     weight_sum += tf_idf
             if weight_sum != 0:
                 sent_vec /= weight_sum
             tfidf_sent_vectorsPT_test.append(sent_vec)
             row += 1
```

100%|| 16500/16500 [00:08<00:00, 1840.51it/s]

1.6.15 1.5.3 Vectorizing Numerical features

1.6.16 price

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

```
#X_cv = pd.merge(X_cv, price_data, on='id', how='left')
X_test = pd.merge(X_test, price_data, on='id', how='left')
```

In [63]:
```
X_train.head(1)
```

Out[63]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	Date	project_grade_category	project_essay_1	project_essay_2	project_essay_3	project_essay_4	project_resource_summary	teacher_number_of_previously_posted_projects	clean_categories	clean_subcategories	clean_essay	clean_project_title	price	quantity
0	121134	p232727	db2f6b3da5f2276497a47e1c07dee18b	Ms.	NC	2016-11-01 16:38:54	Grades PreK-2	My students are energetic learners who love an...	Many of the materials and books I use within s...	NaN	NaN	My students need adapted materials in order to...	2	SpecialNeeds	SpecialNeeds	students energetic learners love thrive hands ...	supplies make materials growing speech languag...	302.85	18

In [64]:
```
from sklearn.preprocessing import Normalizer
normalizer = Normalizer()
# normalizer.fit(X_train['price'].values)
# this will rise an error Expected 2D array, got 1D array instead:
# array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
# Reshape your data either using
# array.reshape(-1, 1) if your data has a single feature
# array.reshape(1, -1)  if it contains a single sample.
normalizer.fit(X_train['price'].values.reshape(-1,1))

X_train_price_norm = normalizer.transform(X_train['price'].values.reshape(-1,1))
#X_cv_price_norm = normalizer.transform(X_cv['price'].values.reshape(-1,1))
X_test_price_norm = normalizer.transform(X_test['price'].values.reshape(-1,1))

print("After vectorizations")
print(X_train_price_norm.shape, y_train.shape)
#print(X_cv_price_norm.shape, y_cv.shape)
print(X_test_price_norm.shape, y_test.shape)
print("="*100)
```

```
After vectorizations
(33500, 1) (33500,)
(16500, 1) (16500,)
==========================================================================
```

1.6.17 tnppp

```
In [65]: from sklearn.preprocessing import Normalizer
         normalizerT = Normalizer()
         # normalizer.fit(X_train['price'].values)
         # this will rise an error Expected 2D array, got 1D array instead:
         # array=[105.22 215.96  96.01 ... 368.98  80.53 709.67].
         # Reshape your data either using
         # array.reshape(-1, 1) if your data has a single feature
         # array.reshape(1, -1)  if it contains a single sample.
         normalizerT.fit(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))

         X_train_tnppp_norm = normalizerT.transform(X_train['teacher_number_of_previously_posted_proje
         #X_cv_tnppp_norm = normalizerT.transform(X_cv['teacher_number_of_previously_posted_projects'
         X_test_tnppp_norm = normalizerT.transform(X_test['teacher_number_of_previously_posted_projects

         print("After vectorizations")
         print(X_train_tnppp_norm.shape, y_train.shape)
         #print(X_cv_tnppp_norm.shape, y_cv.shape)
         print(X_test_tnppp_norm.shape, y_test.shape)
         print("="*100)
```

```
After vectorizations
(33500, 1) (33500,)
(16500, 1) (16500,)
==========================================================================
```

1.6.18 1.5.4 Merging all the above features

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

SET1

```
In [66]: # merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
         from scipy.sparse import hstack
         X_tr1 = hstack((X_train_cc_ohe, X_train_csc_ohe, X_train_grade_ohe, X_train_teacher_ohe,  X_t
         #X_cr1 = hstack((X_cv_cc_ohe, X_cv_csc_ohe, X_cv_grade_ohe, X_cv_price_norm, X_cv_tnppp
         X_te1 = hstack((X_test_cc_ohe, X_test_csc_ohe, X_test_grade_ohe, X_test_state_ohe, X_test_tea

         print("Final Data matrix")
         print(X_tr1.shape, y_train.shape)
```

```
#print(X_cr1.shape, y_cv.shape)
print(X_te1.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(33500, 6725) (33500,)
(16500, 6725) (16500,)
====================================================================================================
```

SET2

In [67]:
```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
X_tr2 = hstack((X_train_cc_ohe, X_train_csc_ohe, X_train_grade_ohe, X_train_teacher_ohe,  X_t
#X_cr2 = hstack((X_cv_cc_ohe, X_cv_csc_ohe, X_cv_grade_ohe, X_cv_price_norm, X_cv_tnppp
X_te2 = hstack((X_test_cc_ohe, X_test_csc_ohe, X_test_grade_ohe, X_test_state_ohe, X_test_tea

print("Final Data matrix")
print(X_tr2.shape, y_train.shape)
#print(X_cr2.shape, y_cv.shape)
print(X_te2.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(33500, 6725) (33500,)
(16500, 6725) (16500,)
====================================================================================================
```

SET3

In [68]:
```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
X_tr3 = hstack((X_train_cc_ohe, X_train_csc_ohe, X_train_grade_ohe, X_train_teacher_ohe,  X_t
#X_cr3 = hstack((X_cv_cc_ohe, X_cv_csc_ohe, X_cv_grade_ohe, X_cv_price_norm, X_cv_tnppp
X_te3 = hstack((X_test_cc_ohe, X_test_csc_ohe, X_test_grade_ohe, X_test_state_ohe, X_test_tea

print("Final Data matrix")
print(X_tr3.shape, y_train.shape)
#print(X_cr3.shape, y_cv.shape)
print(X_te3.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(33500, 200) (33500,)
(16500, 200) (16500,)
====================================================================================================
```

SET4

```
In [69]: # merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
         from scipy.sparse import hstack
         X_tr4 = hstack((X_train_cc_ohe, X_train_csc_ohe, X_train_grade_ohe, X_train_teacher_ohe,  X_t
         #X_cr4 = hstack((X_cv_cc_ohe, X_cv_csc_ohe, X_cv_grade_ohe, X_cv_price_norm, X_cv_tnppp
         X_te4 = hstack((X_test_cc_ohe, X_test_csc_ohe, X_test_grade_ohe, X_test_state_ohe, X_test_tea

         print("Final Data matrix")
         print(X_tr4.shape, y_train.shape)
         #print(X_cr4.shape, y_cv.shape)
         print(X_te4.shape, y_test.shape)
         print("="*100)
```

```
Final Data matrix
(33500, 200) (33500,)
(16500, 200) (16500,)
====================================================================================================
```

1.6.19 Feature Aggregation

```
In [0]: feature_agg_bow = feat_cc + feat_csc + feat_ss + feat_tp + feat_pgc  + feat_bow_e + feat_bow_pt
        feature_agg_tfidf = feat_cc + feat_csc + feat_ss + feat_tp + feat_pgc  + feat_tfidf_e + feat_tfidf_pt

In [0]: feature_agg_bow.append('price')
        feature_agg_tfidf.append('price')

In [0]: feature_agg_bow.append('teacher_number_of_previously_posted_projects')
        feature_agg_tfidf.append('teacher_number_of_previously_posted_projects')

In [73]: len(feature_agg_bow)

Out[73]: 6725

In [74]: len(feature_agg_tfidf)

Out[74]: 6725
```

```
<li><strong>Apply Decision Tree Classifier(DecisionTreeClassifier) on these feature sets</strong>
    <ul>
     <li><font color='red'>Set 1</font>: categorical, numerical features + project_title(BOW) + preprocessed_e
     <li><font color='red'>Set 2</font>: categorical, numerical features + project_title(TFIDF)+  preprocessed_
     <li><font color='red'>Set 3</font>: categorical, numerical features + project_title(AVG W2V)+  preprocesse
     <li><font color='red'>Set 4</font>: categorical, numerical features + project_title(TFIDF W2V)+  preproce
</li>
<br>
<li><strong>Hyper paramter tuning (best `depth` in range [1, 5, 10, 50, 100, 500, 100], and the best `min_samples
    <ul>
```

Find the best hyper parameter which will give the maximum <a href='https://www.appliedaicourse.com/cours
ai-course-online/lessons/receiver-operating-characteristic-curve-roc-curve-and-auc-
1/'>AUC value
Find the best hyper paramter using k-fold cross validation or simple cross validation data
Use gridsearch cv or randomsearch cv or you can also write your own for loops to do this task of hyperparameter

Graphviz

Visualize your decision tree with Graphviz. It helps you to understand how a decision is being made, given a new
Since feature names are not obtained from word2vec related models, visualize only BOW & TFIDF decision tree
Make sure to print the words in each node of the decision tree instead of printing its index.
Just for visualization purpose, limit max_depth to 2 or 3 and either embed the generated images of graphviz in y

Representation of results

You need to plot the performance of model both on train data and cross validation data for each hyper parameter
<img src='train_cv_auc.JPG' width=300px>
Once after you found the best hyper parameter, you need to train your model with it, and find the AUC on test d
<img src='train_test_auc.JPG' width=300px>
Along with plotting ROC curve, you need to print the <a href='https://www.appliedaicourse.com/course/appl
ai-course-online/lessons/confusion-matrix-tpr-fpr-fnr-tnr-1/'>confusion matrix with predicted and original lab
<img src='confusion_matrix.png' width=300px>
Once after you plot the confusion matrix with the test data, get all the `false positive data points`

 Plot the WordCloud <a href='https://www.geeksforgeeks.org/generating-word-cloud-
python/' with the words of eassy text of these `false positive data points`>WordCloud
 Plot the box plot with the `price` of these `false positive data points`
 Plot the pdf with the `teacher_number_of_previously_posted_projects` of these `false positive data poi

[Task-2]

 Select 5k best features from features of Set 2 using<a href='https://scikit-
learn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassifier.html'>`feature_importances_`, disc

Conclusion

You need to summarize the results at the end of the notebook, summarize it in the table format. To print out a ta
<img src='summary.JPG' width=400px>

Note: Data Leakage

1. There will be an issue of data-leakage if you vectorize the entire data and then split it into train/cv/test.
2. To avoid the issue of data-leakag, make sure to split your data first and then vectorize it.
3. While vectorizing your data, apply the method fit_transform() on you train data, and apply the method transform() on cv/test data.
4. For more details please go through this link.

2. Decision Tree

2.4 Appling Decision Tree on different kind of featurization as mentioned in the instructions

Apply Decision Tree on different kind of featurization as mentioned in the instructions For Every model that you work on make sure you do the step 2 and step 3 of instrucations

1.6.20 SET1

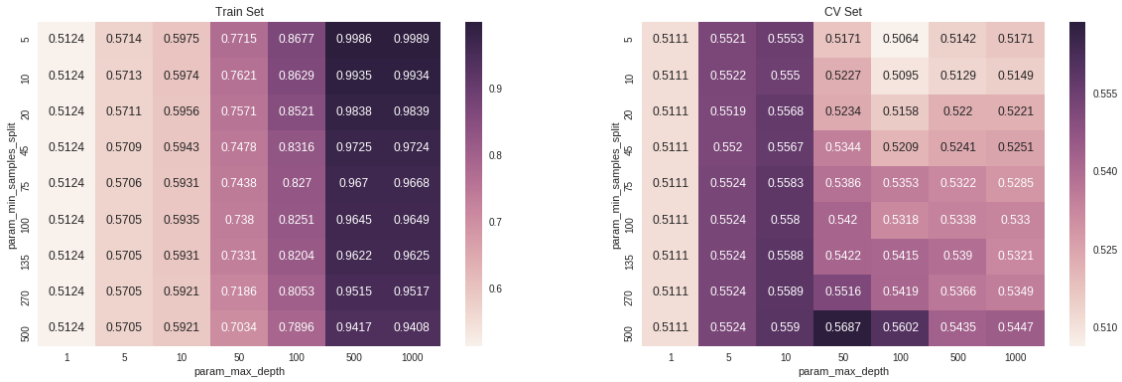
In [0]:
```
# https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.GridSearchCV.html
from sklearn.model_selection import GridSearchCV
from sklearn.tree import DecisionTreeClassifier
dt1 = DecisionTreeClassifier()


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

clf1 = GridSearchCV(dt1, parameters, cv=3, scoring='roc_auc')
se1 = clf1.fit(X_tr1, y_train)
```

In [76]:
```
import seaborn as sns; sns.set()


max_scores1 = pd.DataFrame(clf1.cv_results_).groupby(['param_min_samples_split', 'param_max_de


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()
```

1.6.21 SET2

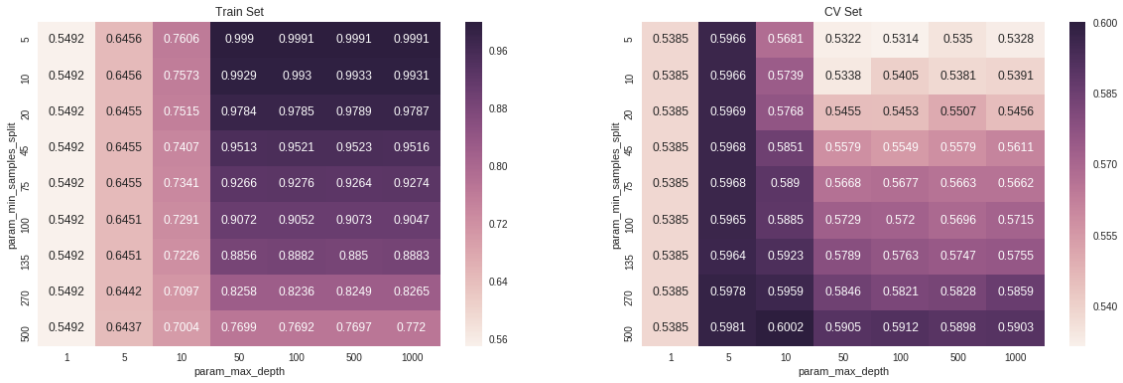
In [0]:
```
dt2 = DecisionTreeClassifier()
clf2 = GridSearchCV(dt2, parameters, cv=3, scoring='roc_auc')
se2 = clf2.fit(X_tr2, y_train)
```

In [78]:
```
max_scores2 = pd.DataFrame(clf2.cv_results_).groupby(['param_min_samples_split', 'param_max_de

fig, ax = plt.subplots(1,2, figsize=(20,6))

sns.heatmap(max_scores2.mean_train_score, annot = True, fmt='.4g', ax=ax[0])
sns.heatmap(max_scores2.mean_test_score, annot = True, fmt='.4g', ax=ax[1])

ax[0].set_title('Train Set')
ax[1].set_title('CV Set')

plt.show()
```



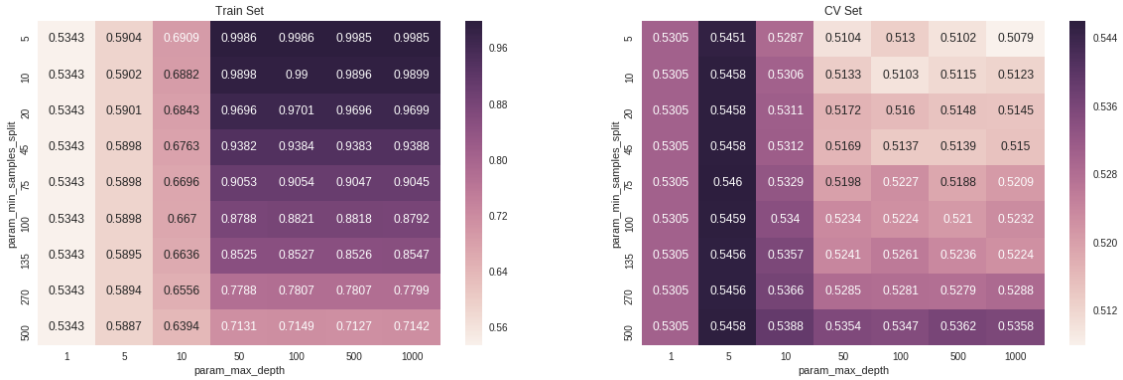
1.6.22 SET3

```
In [0]: dt3 = DecisionTreeClassifier()
        clf3 = GridSearchCV(dt3, parameters, cv=3, scoring='roc_auc')
        se3 = clf3.fit(X_tr3, y_train)

In [80]: max_scores3 = pd.DataFrame(clf3.cv_results_).groupby(['param_min_samples_split', 'param_max_de

         fig, ax = plt.subplots(1,2, figsize=(20,6))

         sns.heatmap(max_scores3.mean_train_score, annot = True, fmt='.4g', ax=ax[0])
         sns.heatmap(max_scores3.mean_test_score, annot = True, fmt='.4g', ax=ax[1])

         ax[0].set_title('Train Set')
         ax[1].set_title('CV Set')

         plt.show()
```



1.6.23 SET4

```
In [0]: dt4 = DecisionTreeClassifier()
        clf4 = GridSearchCV(dt4, parameters, cv=3, scoring='roc_auc')
        se4 = clf4.fit(X_tr4, y_train)

In [82]: max_scores4 = pd.DataFrame(clf4.cv_results_).groupby(['param_min_samples_split', 'param_max_de

         fig, ax = plt.subplots(1,2, figsize=(20,6))

         sns.heatmap(max_scores4.mean_train_score, annot = True, fmt='.4g', ax=ax[0])
         sns.heatmap(max_scores4.mean_test_score, annot = True, fmt='.4g', ax=ax[1])

         ax[0].set_title('Train Set')
         ax[1].set_title('CV Set')

         plt.show()
```



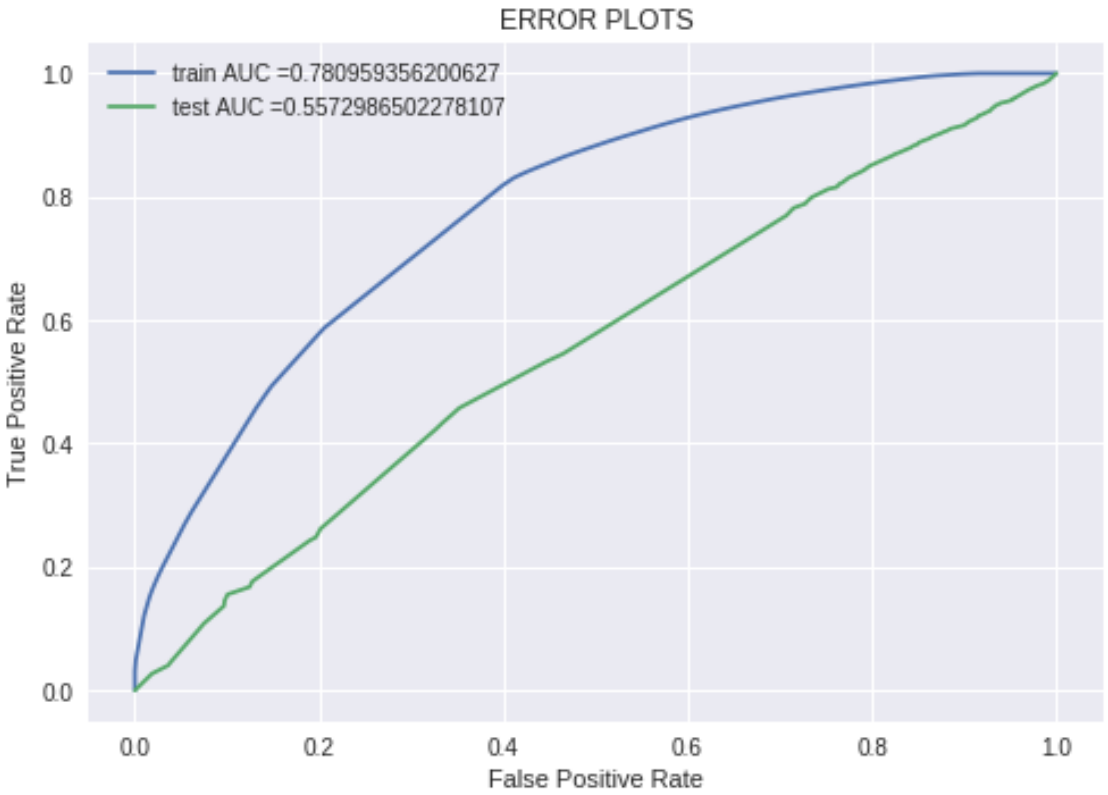
1.6.24 ROC Curve

SET1

In [0]:
```
def batch_predict(clf, data):
    # roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive cl
    # 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 cr_loop will be 49041 - 49041%1000 = 49000
    # 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
    y_data_pred.extend(clf.predict_proba(data[tr_loop:])[:,1])

    return y_data_pred
```

In [208]:
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc

from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import roc_curve, auc


clf11 = DecisionTreeClassifier(max_depth = 100, min_samples_split = 500)
clfV1 = DecisionTreeClassifier(max_depth = 3, min_samples_split = 500)

clf11.fit(X_tr1, y_train)
clfV1.fit(X_tr1, y_train)

# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive clas
# not the predicted outputs
```

```
y_train_pred1 = batch_predict(clf11, X_tr1)
y_test_pred1 = batch_predict(clf11, X_te1)

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()
```



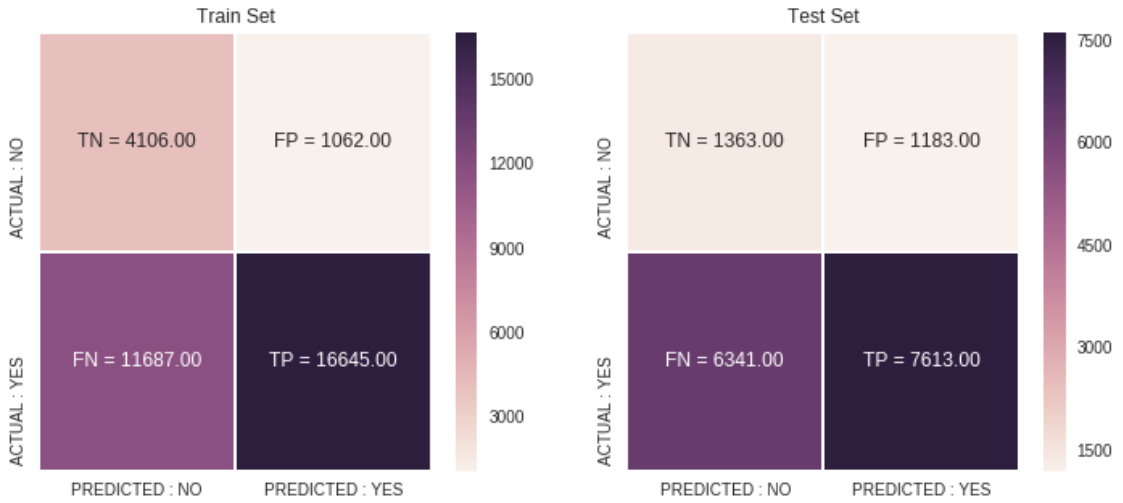
Confusion Matrix

```
In [0]: def predict(proba, threshould, fpr, tpr):

    t = threshould[np.argmax(fpr*(1-tpr))]

    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high
```

```
    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.round(t,3))
    predictions = []
    global predictions1
    for i in proba:
        if i>=t:
            predictions.append(1)
        else:
            predictions.append(0)

    predictions1 = predictions
    return predictions
```

In [210]:
```
#https://www.quantinsti.com/blog/creating-heatmap-using-python-seaborn
import seaborn as sns; sns.set()

con_m_train = confusion_matrix(y_train, predict(y_train_pred1, tr_thresholds1, train_fpr1, train_tp
con_m_test = confusion_matrix(y_test, predict(y_test_pred1, te_thresholds1, test_fpr1, test_tpr1))

key = (np.asarray([['TN','FP'], ['FN', 'TP']]))

fig, ax = plt.subplots(1,2, figsize=(12,5))

labels_train = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m
labels_test = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m_

sns.heatmap(con_m_train, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytic
sns.heatmap(con_m_test, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytick

ax[0].set_title('Train Set')
ax[1].set_title('Test Set')

plt.show()
```

```
the maximum value of tpr*(1-fpr) 0.4919176628162578 for threshold 0.899
the maximum value of tpr*(1-fpr) 0.2965430348465123 for threshold 0.899
```

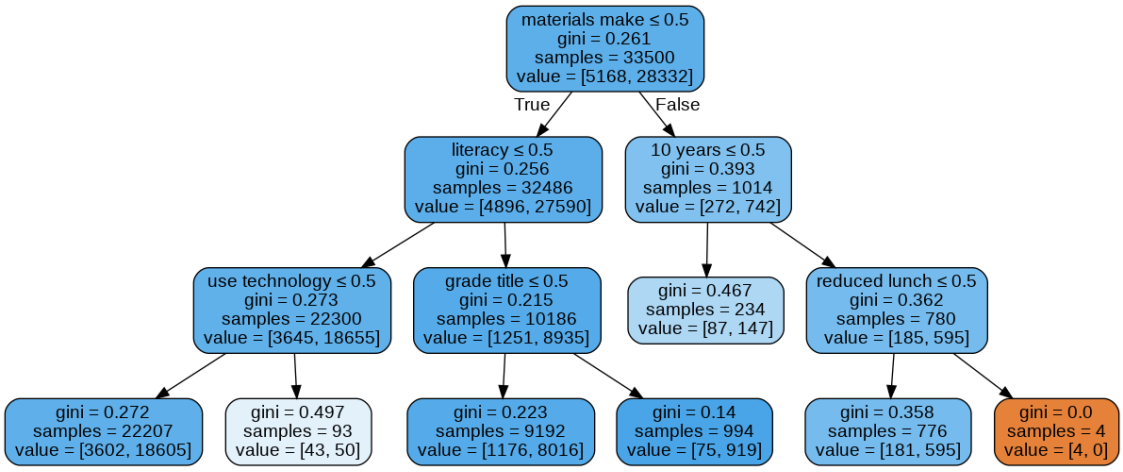


1.7 Visualizing Decision Tree

In [0]:
```
from sklearn.externals.six import StringIO
from IPython.display import Image
from sklearn.tree import export_graphviz
import pydotplus
```

In [212]:
```
dot_data = StringIO()

#dt_feat_names = list(X_test.columns)
#dt_target_names = [str(s) for s in [0,1]]
export_graphviz(clfV1, out_file=dot_data, filled=True, rounded=True, special_characters=True, feature

graph = pydotplus.graph_from_dot_data(dot_data.getvalue())
Image(graph.create_png())
```

Out[212]:



1.8 False Positives Retrieval

```
In [0]: fpi = []
        for i in range(len(y_test)) :
          if (y_test[i] == 0) & (predictions1[i] == 1) :
            fpi.append(i)
```

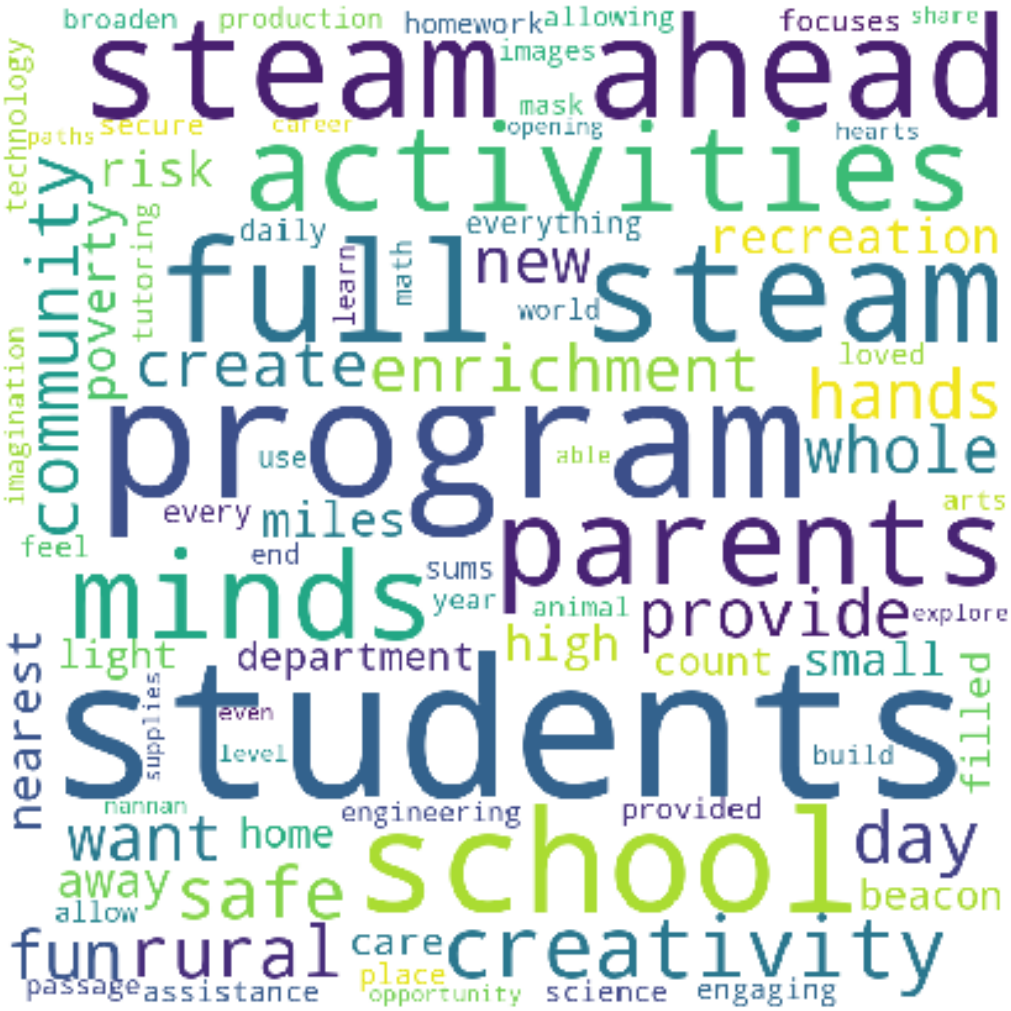
```
In [0]: fp_essay1 = []
        for i in fpi :
          fp_essay1.append(X_test['clean_essay'][i])
```

```
In [215]: len(fp_essay1)
```

```
Out[215]: 1183
```

1.9 Word Cloud (False positives essay)

```
In [216]: from wordcloud import WordCloud, STOPWORDS

          comment_words = ' '
          stopwords = set(STOPWORDS)

          for val in fp_essay1 :
            val = str(val)
            tokens = val.split()

          for i in range(len(tokens)):
            tokens[i] = tokens[i].lower()

          for words in tokens :
            comment_words = comment_words + words + ' '

          wordcloud = WordCloud(width = 800, height = 800, background_color ='white', stopwords = stopwords


          plt.figure(figsize = (6, 6), facecolor = None)
          plt.imshow(wordcloud)
          plt.axis("off")
          plt.tight_layout(pad = 0)

          plt.show()
```



1.10 Building DataFrame of False Positives

In [217]: X_test.head(2)

Out[217]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	Date	project_grade_category	project_essay_1
0	48844	p004342	2eb265ac8f1c0ec610418aa453c1b719	Mrs.	IN	2017-03-07 09:47:55	Grades 3-5	My students are a fun and energetic group of k...
1	163799	p259052	bb090460b4bb36582610caf63a9a6677	Mrs.	MI	2016-12-21 10:21:35	Grades 6-8	

```
1  Hi! My name is Michelle, and I am a resource r...

                                  project_essay_2 project_essay_3  \
0  Students will use the items in this project da...            NaN
1  These chairs are ideal for those who like to w...            NaN

  project_essay_4                       project_resource_summary  \
0             NaN  My students need high quality headphones to he...
1             NaN  My students need 6 wobble chairs to engage in ...

   teacher_number_of_previously_posted_projects  \
0                                             2
1                                             0

               clean_categories       clean_subcategories  \
0  Literacy_Language SpecialNeeds     Literacy SpecialNeeds
1      Math_Science SpecialNeeds  Mathematics SpecialNeeds

                                        clean_essay  \
0  students fun energetic group kids variety need...
1  hi name michelle resource room teacher student...

                          clean_project_title  price  quantity
0  headphones fostering individualized learning  19.99        27
1                          wobble why you work  69.99         6
```

In [0]:
```
cols = X_test.columns
X_test_falsePos1 = pd.DataFrame(columns=cols)
```

In [0]:
```
for i in fpi :
    X_test_falsePos1 = X_test_falsePos1.append(X_test.filter(items=[i], axis=0))
```

In [220]:
```
len(X_test_falsePos1)
```

Out[220]: 1183

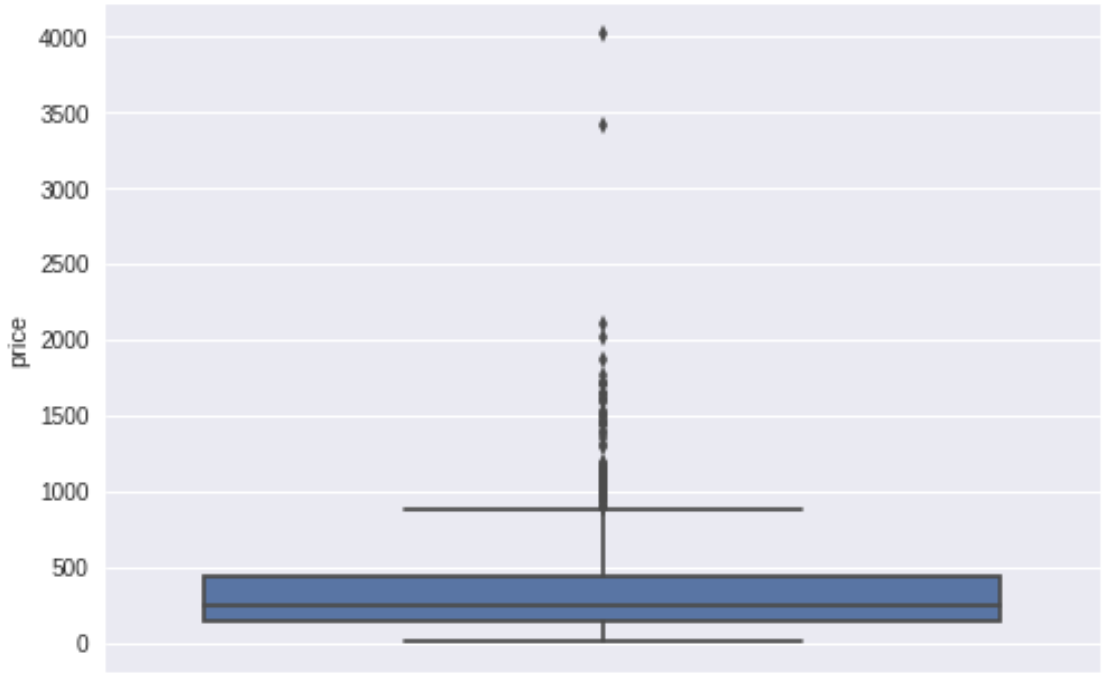
In [221]:
```
X_test_falsePos1.head(2)
```

Out[221]:
```
    Unnamed: 0       id                         teacher_id teacher_prefix  \
15       66363  p125808  11f8bb9e7eb14085480abad8189f48c4            Mr.
24      129076  p070479  7780f6d9ef0e335c031a02caf439d8b8            Ms.

   school_state             Date project_grade_category  \
15           CO 2016-11-27 20:20:34          Grades 3-5
24           SC 2016-07-28 23:09:23       Grades PreK-2

                                   project_essay_1  \
15  Students in my classroom are eager for knowled...
24  My students come from a wide range of backgrou...
```

```
                                  project_essay_2 project_essay_3  \
15  The implementation of chrome books in my class...         NaN
24  My project will give each student in my class ...          NaN

   project_essay_4                    project_resource_summary  \
15             NaN  My students need a set of 2 chrome books, so t...
24             NaN  My students need the resources, motivation (st...

   teacher_number_of_previously_posted_projects  \
15                                             1
24                                             0

              clean_categories          clean_subcategories  \
15  Literacy_Language Math_Science         Literacy Mathematics
24              Literacy_Language  Literacy Literature_Writing

                                        clean_essay  \
15  students classroom eager knowledge love learni...
24  students come wide range backgrounds including...

           clean_project_title   price quantity
15  chromebooks enhance learning  158.63        2
24       read with a buddy r wab  178.00        2
```

1.11 Box Plot (FP 'price')

In [222]: `ax = sns.boxplot(y='price', data=X_test_falsePos1)`



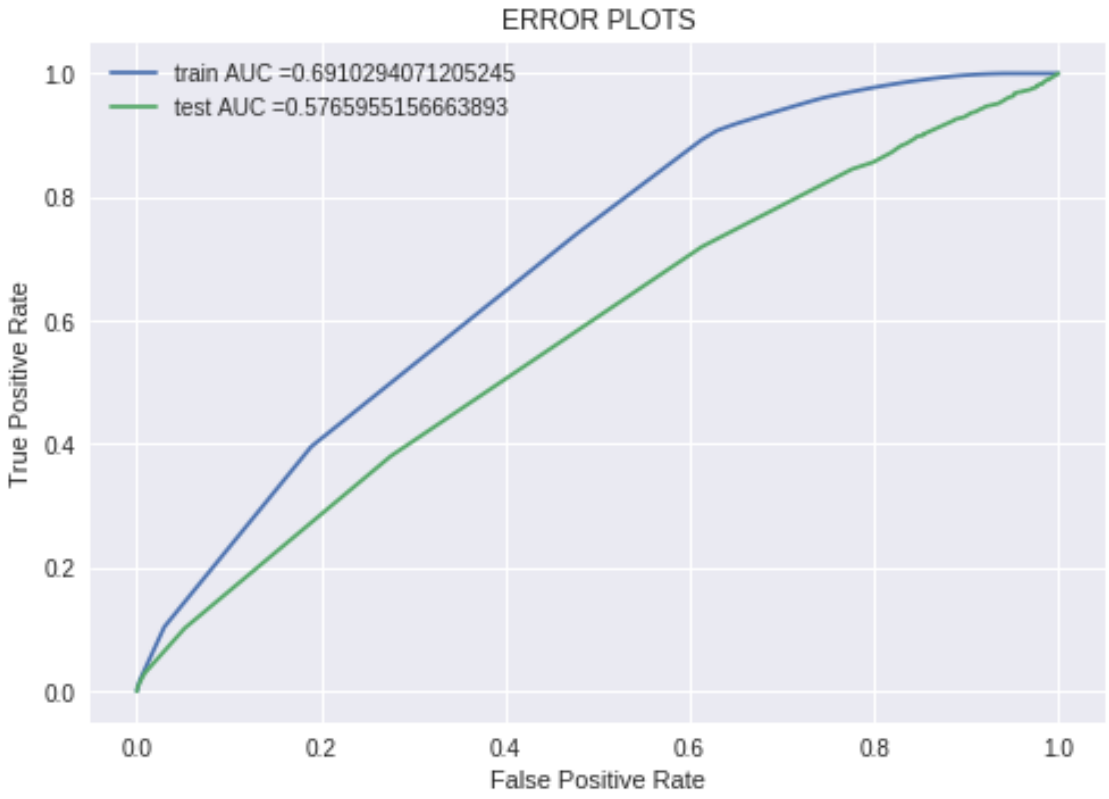
1.12 PDF on FP TNPPP

In [223]:
```
plt.figure(figsize=(8,5))

counts, bin_edges = np.histogram(X_test_falsePos1['teacher_number_of_previously_posted_projects']
pdf = counts/sum(counts)
cdf = np.cumsum(pdf)
pdfP, = plt.plot(bin_edges[1:], pdf)
cdfP, = plt.plot(bin_edges[1:], cdf)
plt.legend([pdfP, cdfP], ["PDF", "CDF"])
plt.xscale('log')
plt.xlabel('teacher_number_of_previously_posted_projects')
plt.show()
```

SET2

In [224]:
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc

from sklearn.metrics import roc_curve, auc
```

```
from sklearn.feature_extraction import DictVectorizer


clf2 = DecisionTreeClassifier(max_depth = 50, min_samples_split = 500)
clfV2 = DecisionTreeClassifier(max_depth = 3, min_samples_split = 500)

#vect = DictVectorizer(sparse=False)
#trans = vect.fit_transform(X_te2)

clf2.fit(X_tr2, y_train)
clfV2.fit(X_tr2, y_train)

# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive cla
# not the predicted outputs

y_train_pred2 = batch_predict(clf2, X_tr2)
y_test_pred2 = batch_predict(clf2, X_te2)

train_fpr2, train_tpr2, tr_thresholds2 = roc_curve(y_train, y_train_pred2)
test_fpr2, test_tpr2, te_thresholds2 = roc_curve(y_test, y_test_pred2)

plt.plot(train_fpr2, train_tpr2, label="train AUC ="+str(auc(train_fpr2, train_tpr2)))
plt.plot(test_fpr2, test_tpr2, label="test AUC ="+str(auc(test_fpr2, test_tpr2)))
plt.legend()
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()
```



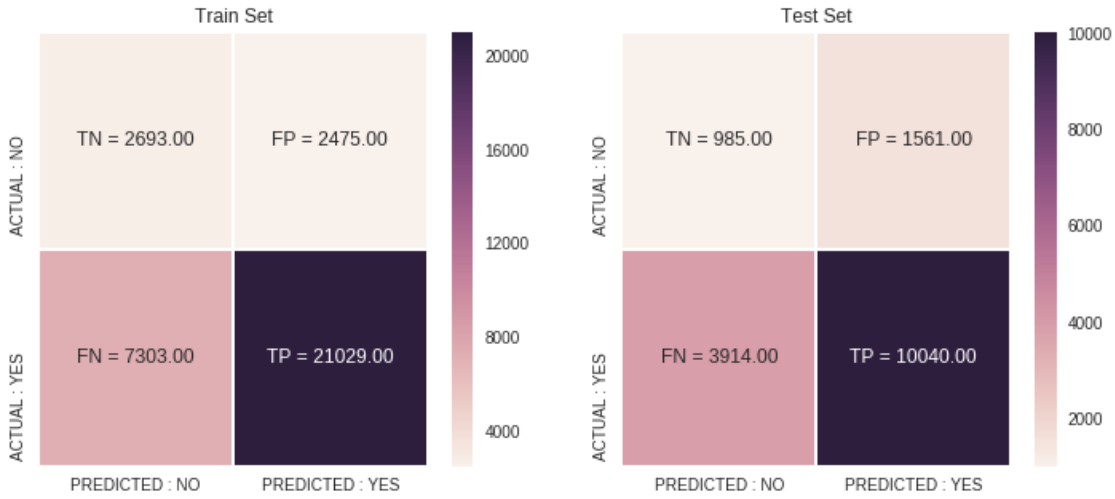
Confusion Matrix

In [0]:
```
def predict(proba, threshould, fpr, tpr):

    t = threshould[np.argmax(fpr*(1-tpr))]

    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high

    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.round(t,3))
    predictions = []
    global predictions2
    for i in proba:
        if i>=t:
            predictions.append(1)
        else:
            predictions.append(0)

    predictions2 = predictions
    return predictions
```

In [226]:
```
#https://www.quantinsti.com/blog/creating-heatmap-using-python-seaborn
import seaborn as sns; sns.set()
```

```
con_m_train = confusion_matrix(y_train, predict(y_train_pred2, tr_thresholds2, train_fpr2, train_tp
con_m_test = confusion_matrix(y_test, predict(y_test_pred2, te_thresholds2, test_fpr2, test_tpr2))

key = (np.asarray([['TN','FP'], ['FN', 'TP']]))

fig, ax = plt.subplots(1,2, figsize=(12,5))

labels_train = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m
labels_test = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m_

sns.heatmap(con_m_train, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytic
sns.heatmap(con_m_test, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytick

ax[0].set_title('Train Set')
ax[1].set_title('Test Set')

plt.show()
```

the maximum value of tpr*(1-fpr) 0.3867721871122109 for threshold 0.868
the maximum value of tpr*(1-fpr) 0.2783638441243538 for threshold 0.868

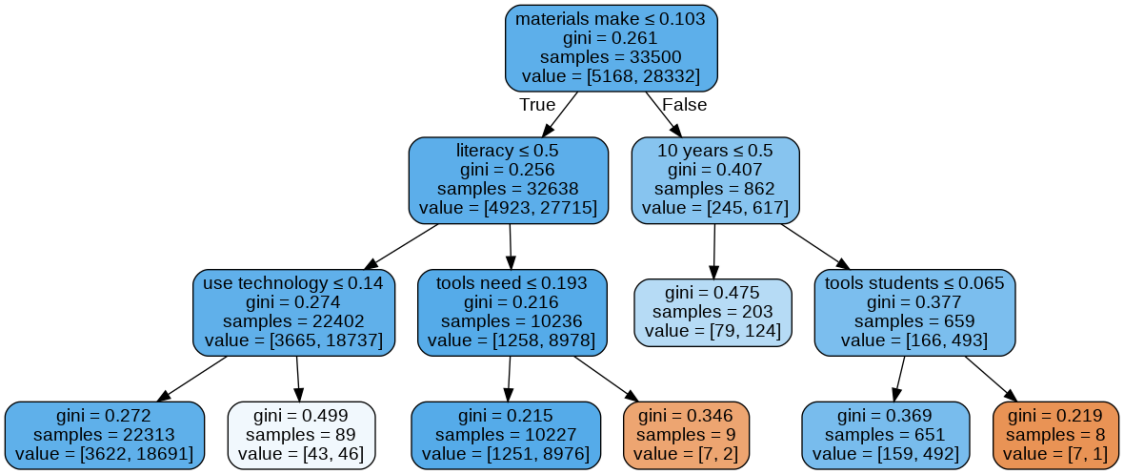


1.13 Visualizing Decision Tree

```
In [0]: from sklearn.externals.six import StringIO
        from IPython.display import Image
        from sklearn.tree import export_graphviz
        import pydotplus
```

In [228]:
```
dot_dataT = StringIO()

export_graphviz(clfV2, out_file=dot_dataT, filled=True, rounded=True, special_characters=True, featu

graph = pydotplus.graph_from_dot_data(dot_dataT.getvalue())
Image(graph.create_png())
```

Out[228]:



1.14 False Positives Retrieval

In [0]:
```
fpi = []
for i in range(len(y_test)) :
  if (y_test[i] == 0) & (predictions2[i] == 1) :
    fpi.append(i)
```

In [0]:
```
fp_essay2 = []
for i in fpi :
  fp_essay2.append(X_test['clean_essay'][i])
```

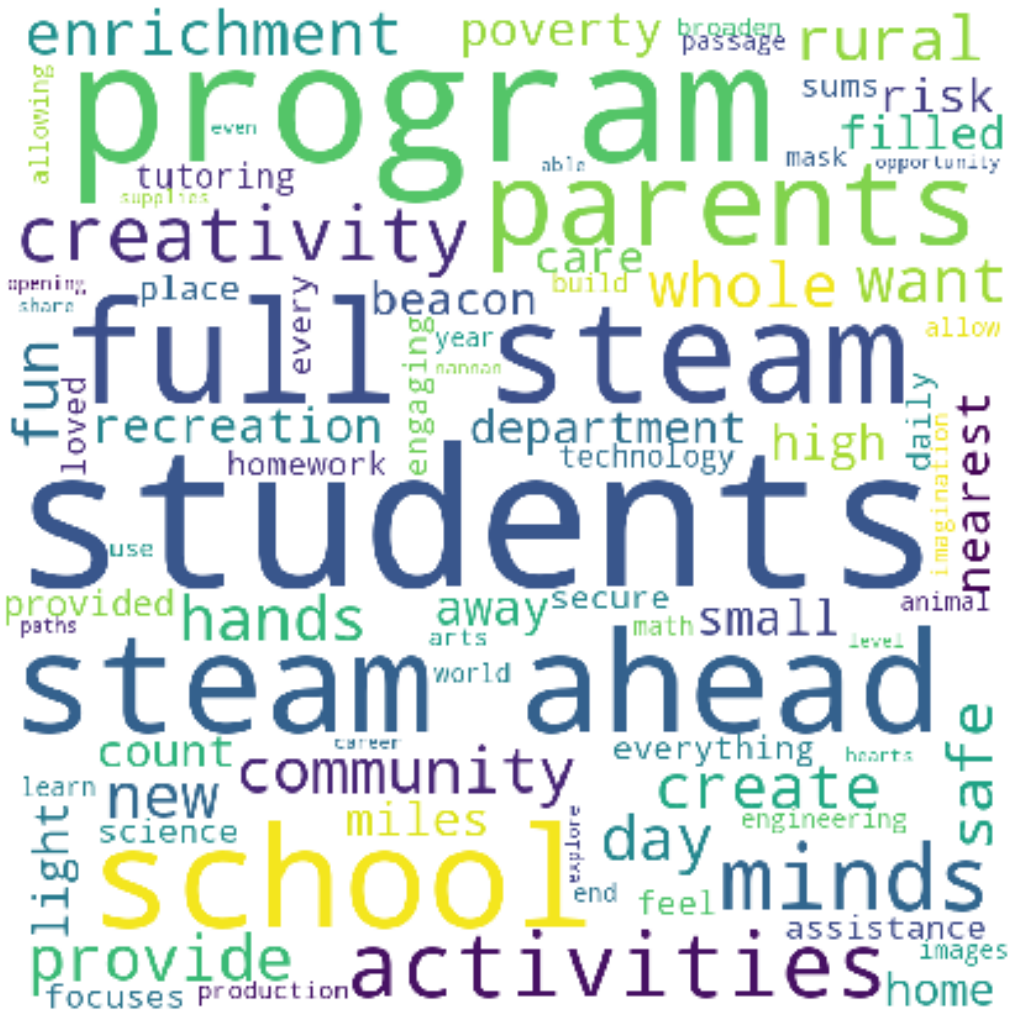
In [231]:
```
len(fp_essay2)
```

Out[231]: 1561

1.15 Word Cloud (False Positives Essay)

In [232]:
```
from wordcloud import WordCloud, STOPWORDS

comment_words = ' '
stopwords = set(STOPWORDS)

for val in fp_essay2 :
```

```
  val = str(val)
  tokens = val.split()

for i in range(len(tokens)):
  tokens[i] = tokens[i].lower()

for words in tokens :
  comment_words = comment_words + words + ' '

wordcloud = WordCloud(width = 800, height = 800, background_color ='white', stopwords = stopwords


plt.figure(figsize = (6, 6), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```

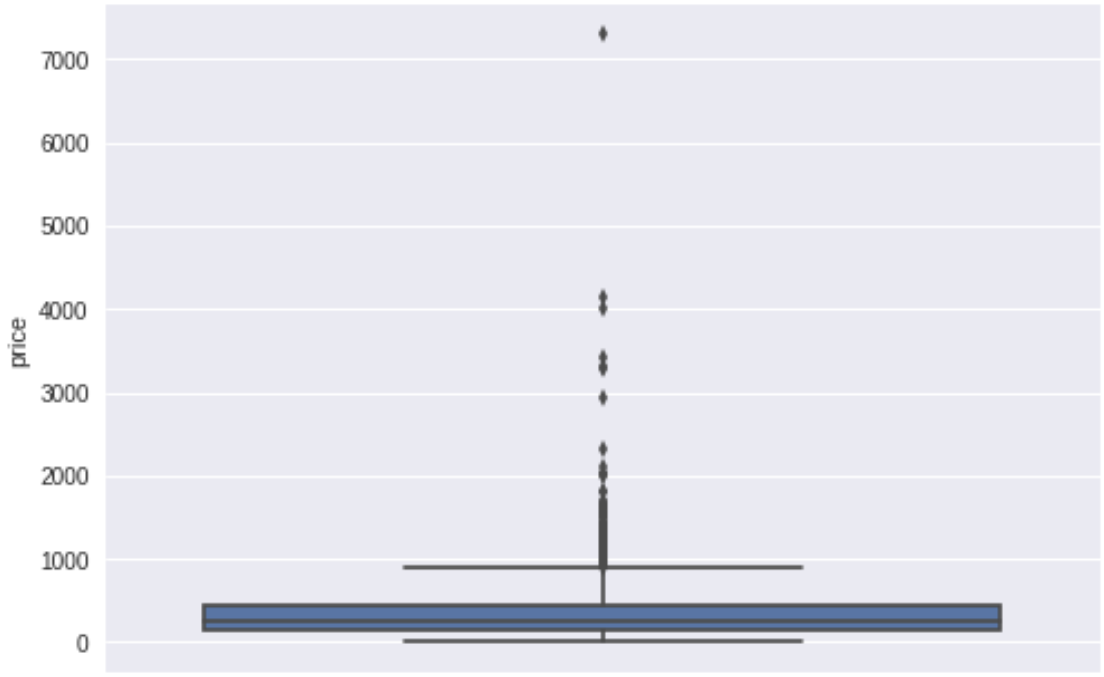


1.16 Building DataFrames of False Positives

In [0]:
```
cols = X_test.columns
X_test_falsePos2 = pd.DataFrame(columns=cols)

for i in fpi :
  X_test_falsePos2 = X_test_falsePos2.append(X_test.filter(items=[i], axis=0))
```

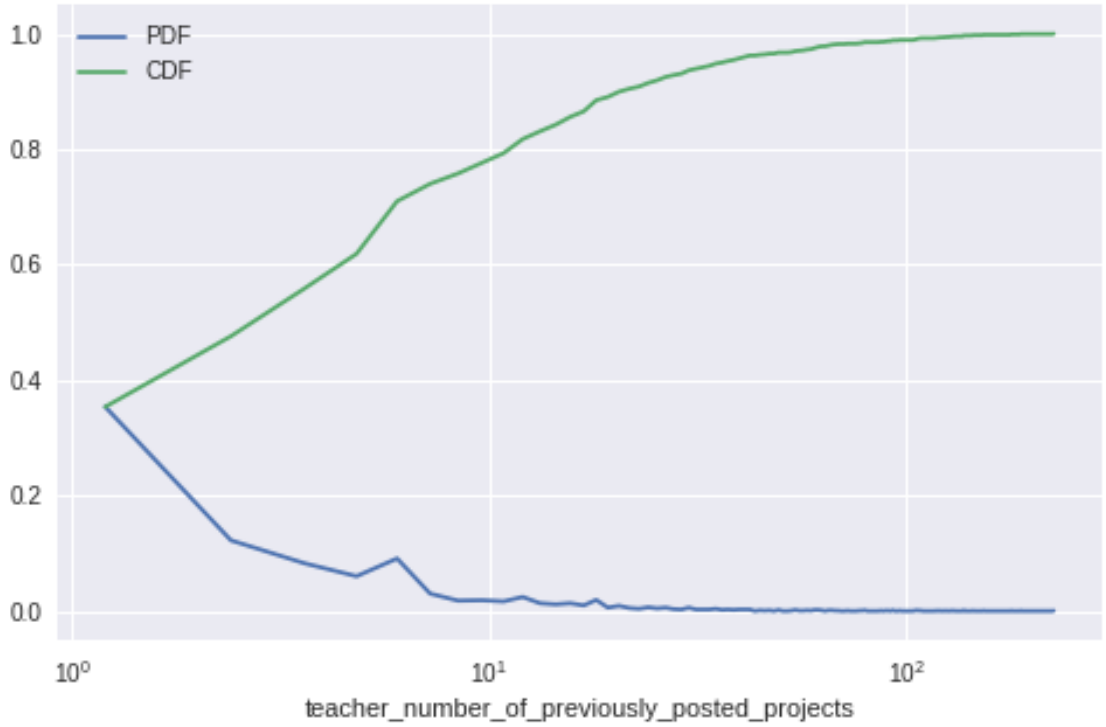
2 Box Plot on FP 'price'

In [234]:
```
ax = sns.boxplot(y='price', data=X_test_falsePos2)
```



2.1 PDF on FP TNPPP

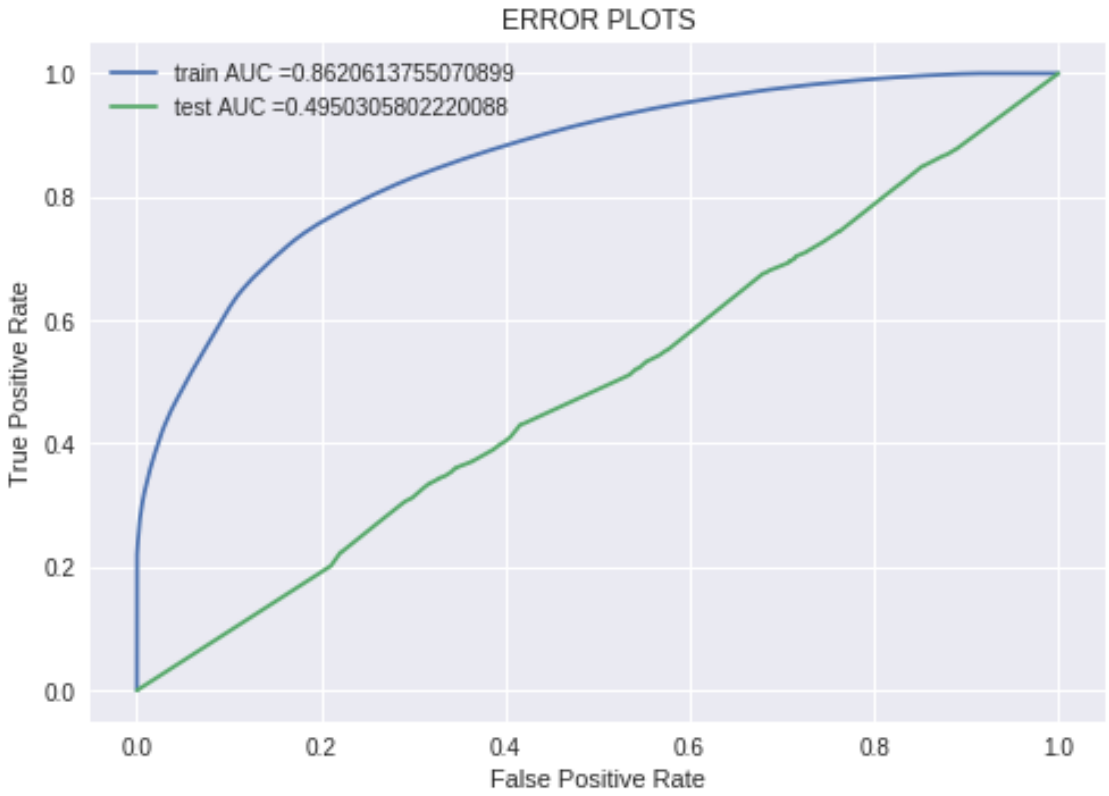
In [235]:
```
plt.figure(figsize=(8,5))

counts, bin_edges = np.histogram(X_test_falsePos2['teacher_number_of_previously_posted_projects']
pdf = counts/sum(counts)
cdf = np.cumsum(pdf)
pdfP, = plt.plot(bin_edges[1:], pdf)
cdfP, = plt.plot(bin_edges[1:], cdf)
plt.xscale('log')
plt.legend([pdfP, cdfP], ["PDF", "CDF"])
plt.xlabel('teacher_number_of_previously_posted_projects')
plt.show()
```



SET3

In [236]:
```
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc

from sklearn.metrics import roc_curve, auc


clf3 = DecisionTreeClassifier(max_depth = 25, min_samples_split = 135);
clf3.fit(X_tr3, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive clas
# not the predicted outputs

y_train_pred3 = batch_predict(clf3, X_tr3)
y_test_pred3 = batch_predict(clf3, X_te3)

train_fpr3, train_tpr3, tr_thresholds3 = roc_curve(y_train, y_train_pred3)
test_fpr3, test_tpr3, te_thresholds3 = roc_curve(y_test, y_test_pred3)

plt.plot(train_fpr3, train_tpr3, label="train AUC ="+str(auc(train_fpr3, train_tpr3)))
plt.plot(test_fpr3, test_tpr3, label="test AUC ="+str(auc(test_fpr3, test_tpr3)))
plt.legend()
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
```

```
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()
```



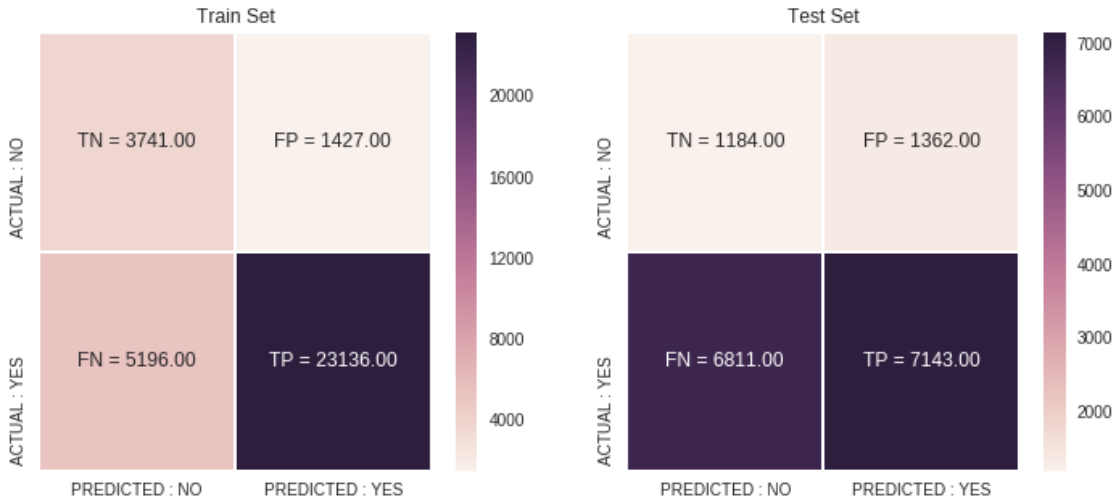
Confusion Matrix

```
In [0]: def predict(proba, threshould, fpr, tpr):

    t = threshould[np.argmax(fpr*(1-tpr))]

    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high

    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.round(t,3))
    predictions = []
    global predictions3
    for i in proba:
        if i>=t:
            predictions.append(1)
        else:
            predictions.append(0)
```

```
    predictions3 = predictions
    return predictions
```

In [238]:
```
#https://www.quantinsti.com/blog/creating-heatmap-using-python-seaborn
import seaborn as sns; sns.set()

con_m_train = confusion_matrix(y_train, predict(y_train_pred3, tr_thresholds3, train_fpr3, train_tp
con_m_test = confusion_matrix(y_test, predict(y_test_pred3, te_thresholds3, test_fpr3, test_tpr3))

key = (np.asarray([['TN','FP'], ['FN', 'TP']]))

fig, ax = plt.subplots(1,2, figsize=(12,5))

labels_train = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m
labels_test = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m_

sns.heatmap(con_m_train, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytic
sns.heatmap(con_m_test, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytick

ax[0].set_title('Train Set')
ax[1].set_title('Test Set')

plt.show()
```

```
the maximum value of tpr*(1-fpr) 0.6073275921416518 for threshold 0.786
the maximum value of tpr*(1-fpr) 0.2515922871254343 for threshold 0.775
```



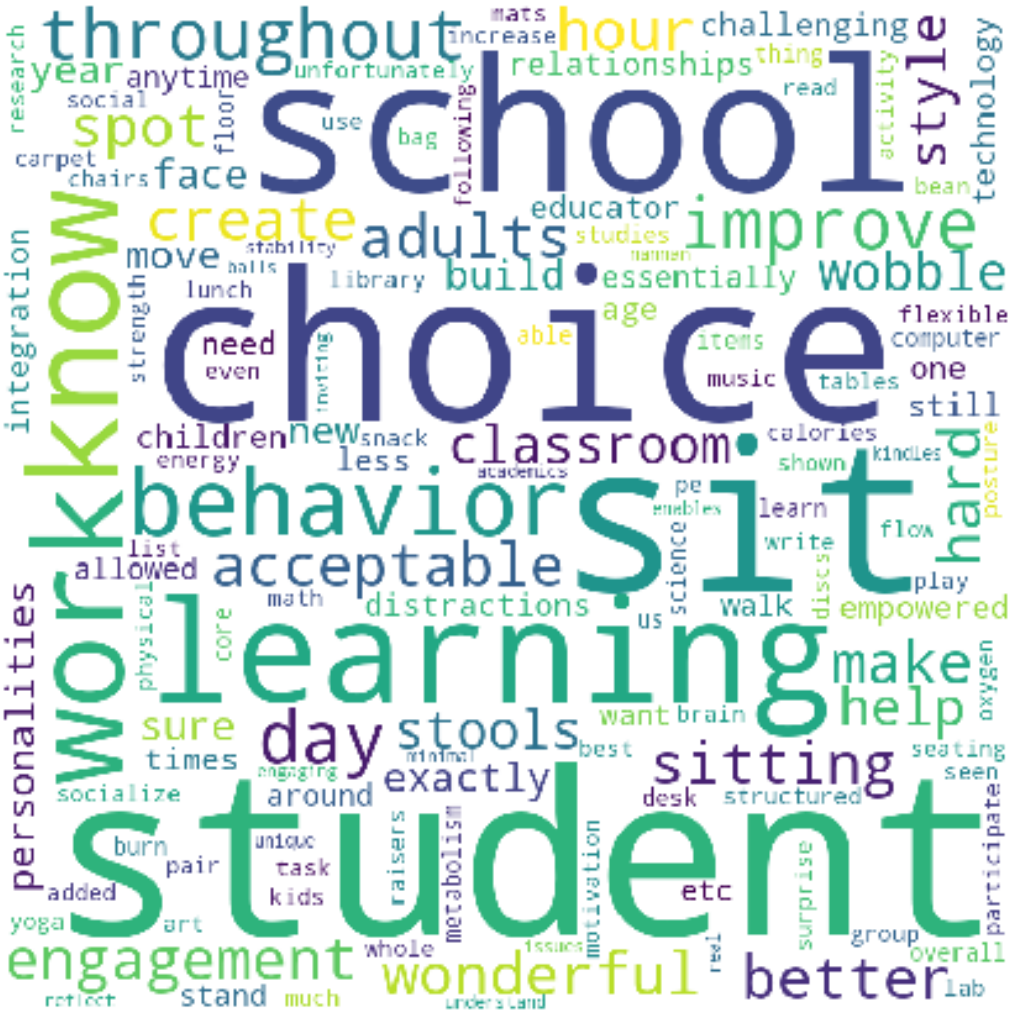
2.2 False Positives Retrieval

In [0]:
```
fpi = []
for i in range(len(y_test)) :
```

```
    if (y_test[i] == 0) & (predictions3[i] == 1) :
      fpi.append(i)


fp_essay3 = []
for i in fpi :
  fp_essay3.append(X_test['clean_essay'][i])
```

2.3 WordCloud on FP 'essay'

In [240]:
```
from wordcloud import WordCloud, STOPWORDS

comment_words = ' '
stopwords = set(STOPWORDS)

for val in fp_essay3 :
  val = str(val)
  tokens = val.split()

for i in range(len(tokens)):
  tokens[i] = tokens[i].lower()

for words in tokens :
  comment_words = comment_words + words + ' '

wordcloud = WordCloud(width = 800, height = 800, background_color ='white', stopwords = stopwords


plt.figure(figsize = (6, 6), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```

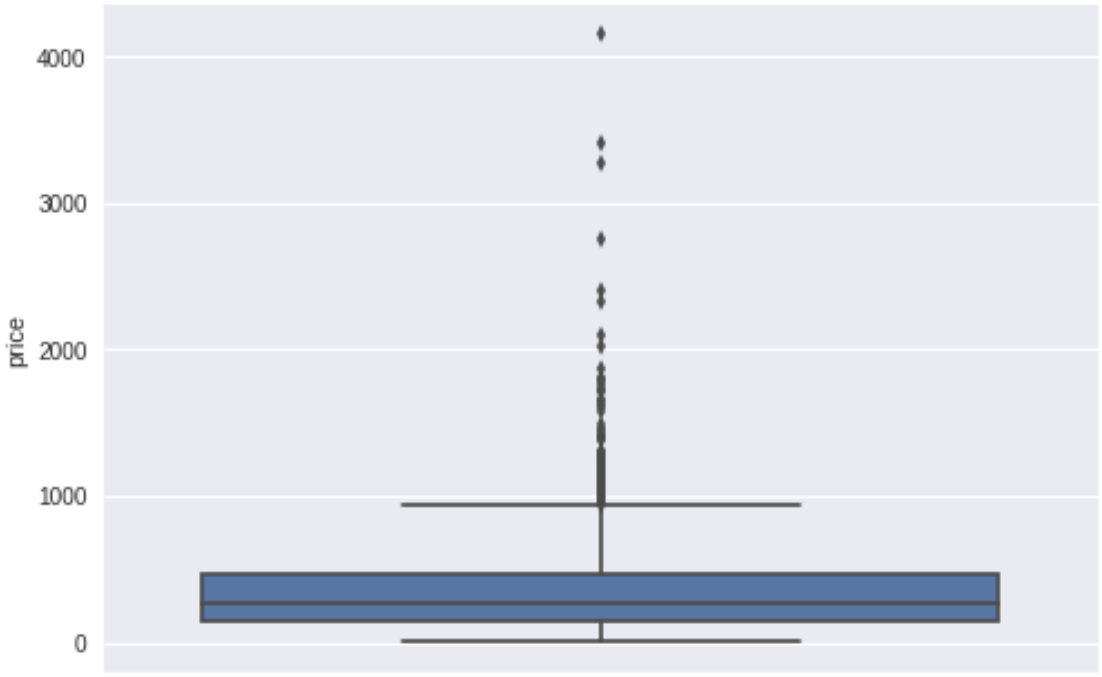


2.4 Building DataFrames of False Positives

```
In [0]: cols = X_test.columns
        X_test_falsePos3 = pd.DataFrame(columns=cols)

        for i in fpi :
          X_test_falsePos3 = X_test_falsePos3.append(X_test.filter(items=[i], axis=0))
```

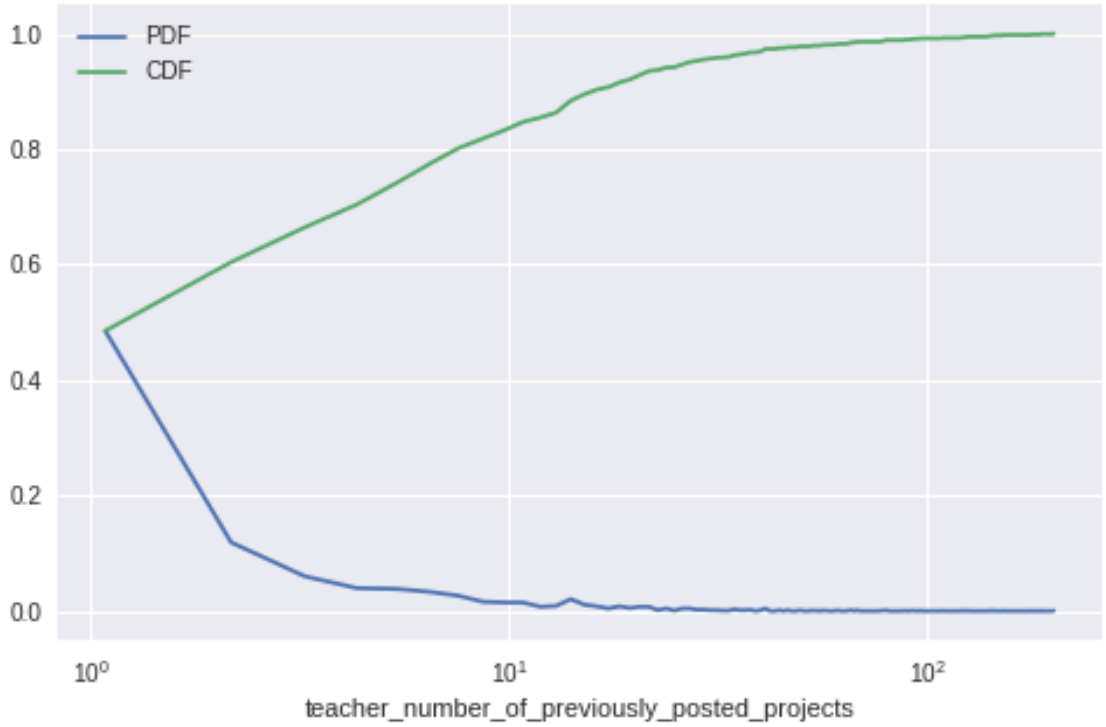
2.5 BoxPlot on FP 'price'

```
In [242]: ax = sns.boxplot(y='price', data=X_test_falsePos3)
```



2.6 PDF on FP TNPPP

In [243]:
```
plt.figure(figsize=(8,5))

counts, bin_edges = np.histogram(X_test_falsePos3['teacher_number_of_previously_posted_projects'],
pdf = counts/sum(counts)
cdf = np.cumsum(pdf)
pdfP, = plt.plot(bin_edges[1:], pdf)
cdfP, = plt.plot(bin_edges[1:], cdf)
plt.xscale('log')
plt.legend([pdfP, cdfP], ["PDF", "CDF"])
plt.xlabel('teacher_number_of_previously_posted_projects')
plt.show()
```

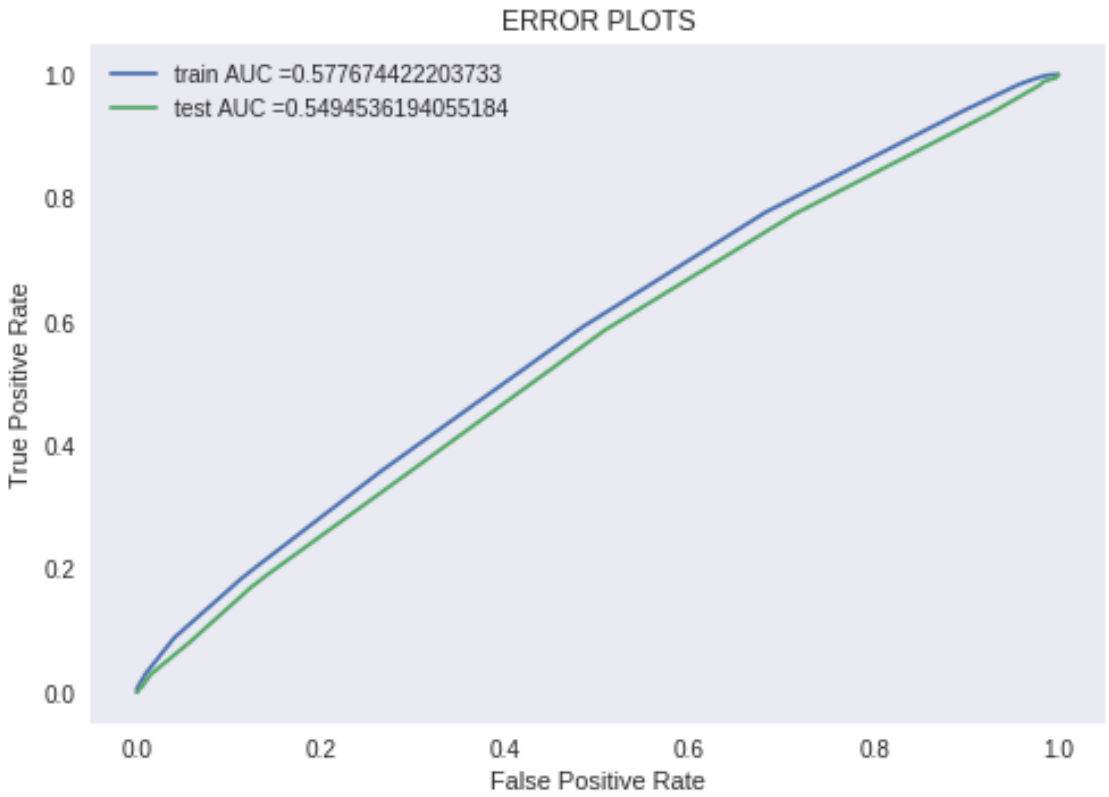


SET4

In [244]: # https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc

```
from sklearn.metrics import roc_curve, auc


clf4 = DecisionTreeClassifier(max_depth = 5, min_samples_split = 100);
clf4.fit(X_tr4, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive clas
# not the predicted outputs

y_train_pred4 = batch_predict(clf4, X_tr4)
y_test_pred4 = batch_predict(clf4, X_te4)

train_fpr4, train_tpr4, tr_thresholds4 = roc_curve(y_train, y_train_pred4)
test_fpr4, test_tpr4, te_thresholds4 = roc_curve(y_test, y_test_pred4)

plt.plot(train_fpr4, train_tpr4, label="train AUC ="+str(auc(train_fpr4, train_tpr4)))
plt.plot(test_fpr4, test_tpr4, label="test AUC ="+str(auc(test_fpr4, test_tpr4)))
plt.legend()
plt.xlabel("False Positive Rate")
```

```
plt.ylabel("True Positive Rate")
plt.title("ERROR PLOTS")
plt.grid()
plt.show()
```



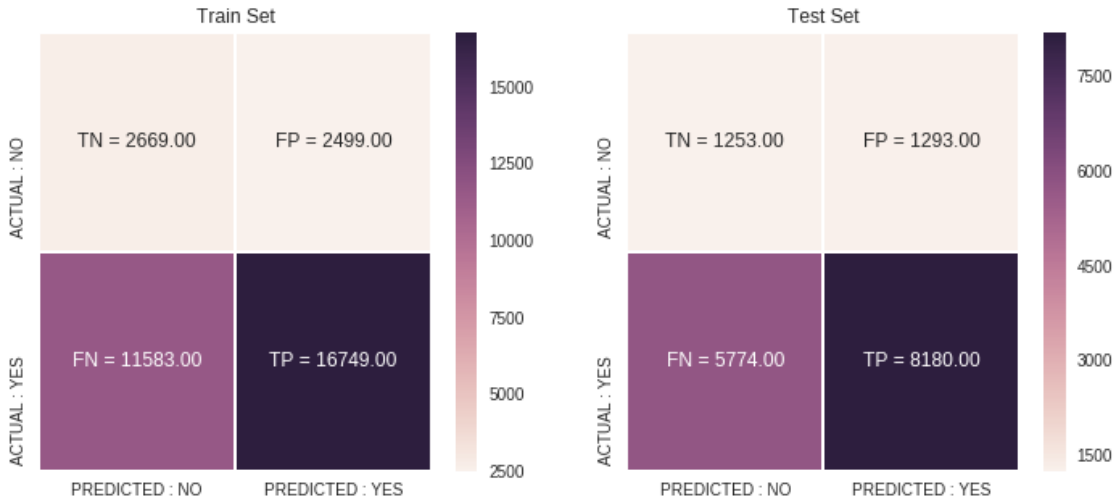
Confusion Matrix

In [0]:
```
def predict(proba, threshould, fpr, tpr):

    t = threshould[np.argmax(fpr*(1-tpr))]

    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high

    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.round(t,3))
    predictions = []
    global predictions4
    for i in proba:
        if i>=t:
            predictions.append(1)
        else:
            predictions.append(0)
```

```
    predictions4 = predictions
    return predictions
```

In [246]:
```
#https://www.quantinsti.com/blog/creating-heatmap-using-python-seaborn
import seaborn as sns; sns.set()

con_m_train = confusion_matrix(y_train, predict(y_train_pred4, tr_thresholds4, train_fpr4, train_tp
con_m_test = confusion_matrix(y_test, predict(y_test_pred4, te_thresholds4, test_fpr4, test_tpr4))

key = (np.asarray([['TN','FP'], ['FN', 'TP']]))

fig, ax = plt.subplots(1,2, figsize=(12,5))

labels_train = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m
labels_test = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m_

sns.heatmap(con_m_train, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytic
sns.heatmap(con_m_test, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytick

ax[0].set_title('Train Set')
ax[1].set_title('Test Set')

plt.show()
```

```
the maximum value of tpr*(1-fpr) 0.3053076723734368 for threshold 0.854
the maximum value of tpr*(1-fpr) 0.2885009560647086 for threshold 0.854
```

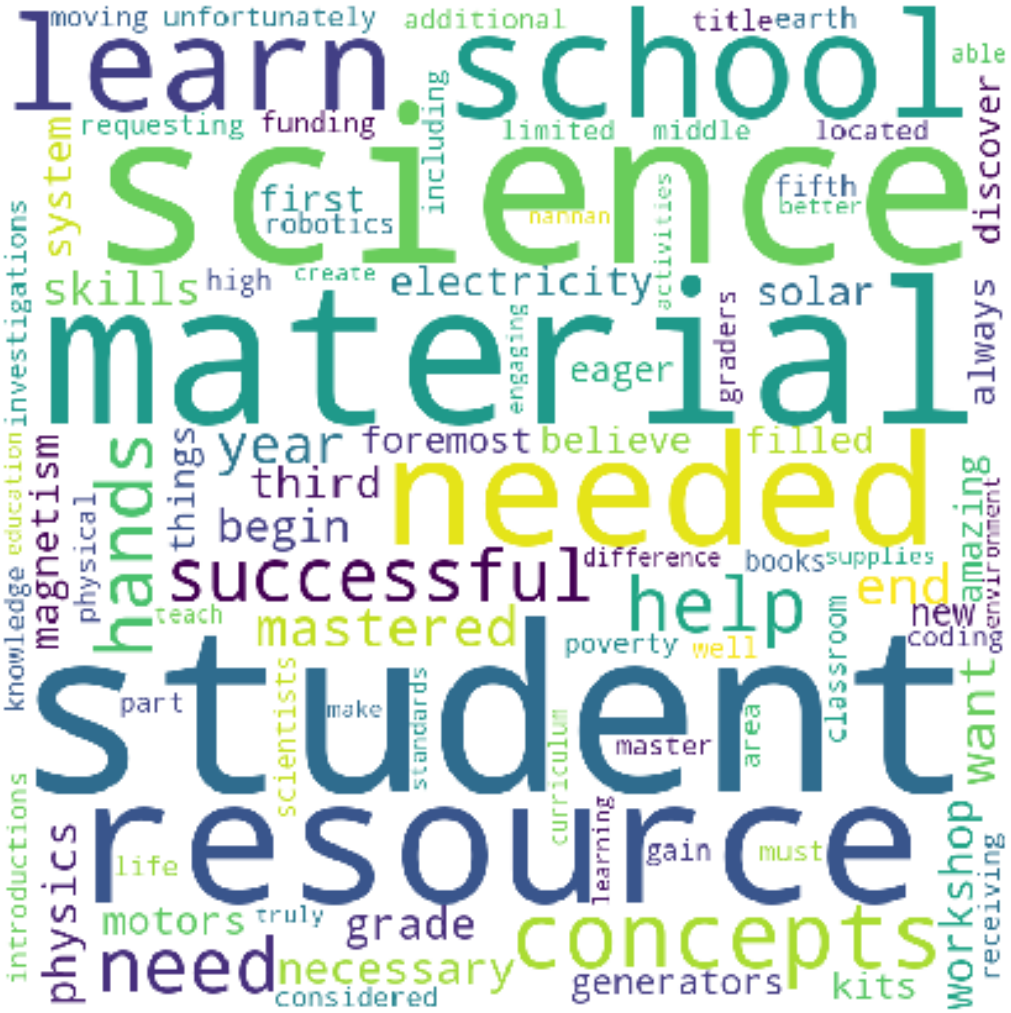


In [0]:
```
## Flase Positives Retrieval
```

In [0]:
```
fpi = []
for i in range(len(y_test)) :
  if (y_test[i] == 0) & (predictions4[i] == 1) :
    fpi.append(i)


fp_essay4 = []
for i in fpi :
  fp_essay4.append(X_test['clean_essay'][i])
```

2.7 WordCloud on FP 'essay'

In [248]:
```
from wordcloud import WordCloud, STOPWORDS

  comment_words = ' '
  stopwords = set(STOPWORDS)

  for val in fp_essay4 :
    val = str(val)
    tokens = val.split()

  for i in range(len(tokens)):
    tokens[i] = tokens[i].lower()

  for words in tokens :
    comment_words = comment_words + words + ' '

  wordcloud = WordCloud(width = 800, height = 800, background_color ='white', stopwords = stopwords


  plt.figure(figsize = (6, 6), facecolor = None)
  plt.imshow(wordcloud)
  plt.axis("off")
  plt.tight_layout(pad = 0)

  plt.show()
```

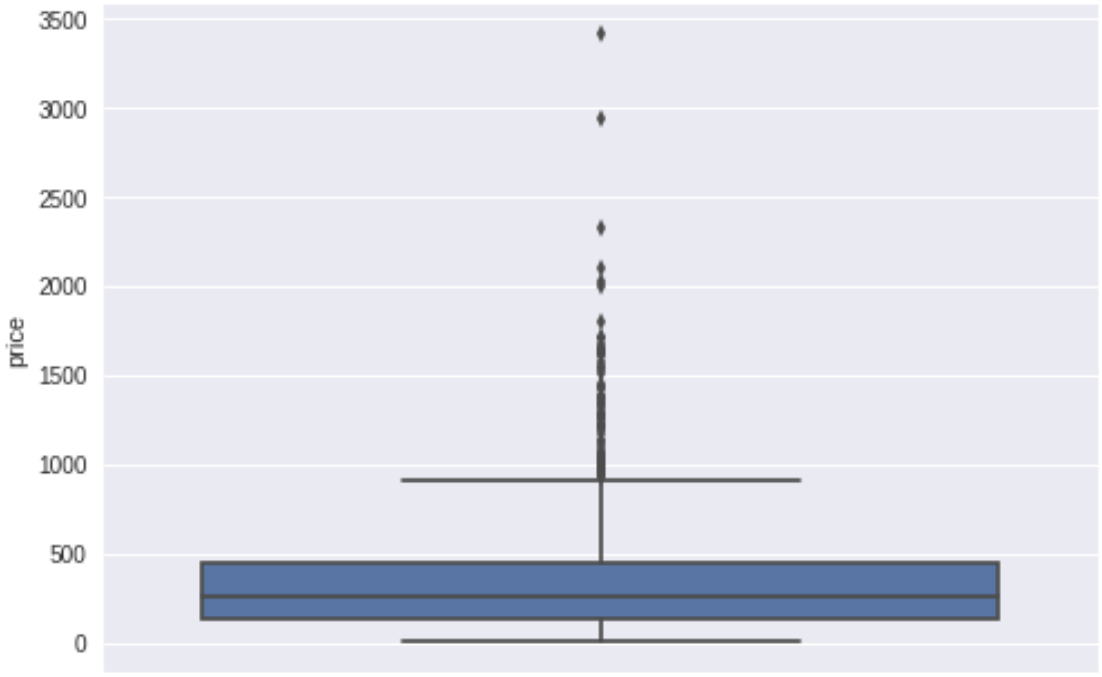


2.8 Building DataFrames of False Positives

```
In [0]: cols = X_test.columns
        X_test_falsePos4 = pd.DataFrame(columns=cols)

        for i in fpi :
          X_test_falsePos4 = X_test_falsePos4.append(X_test.filter(items=[i], axis=0))
```

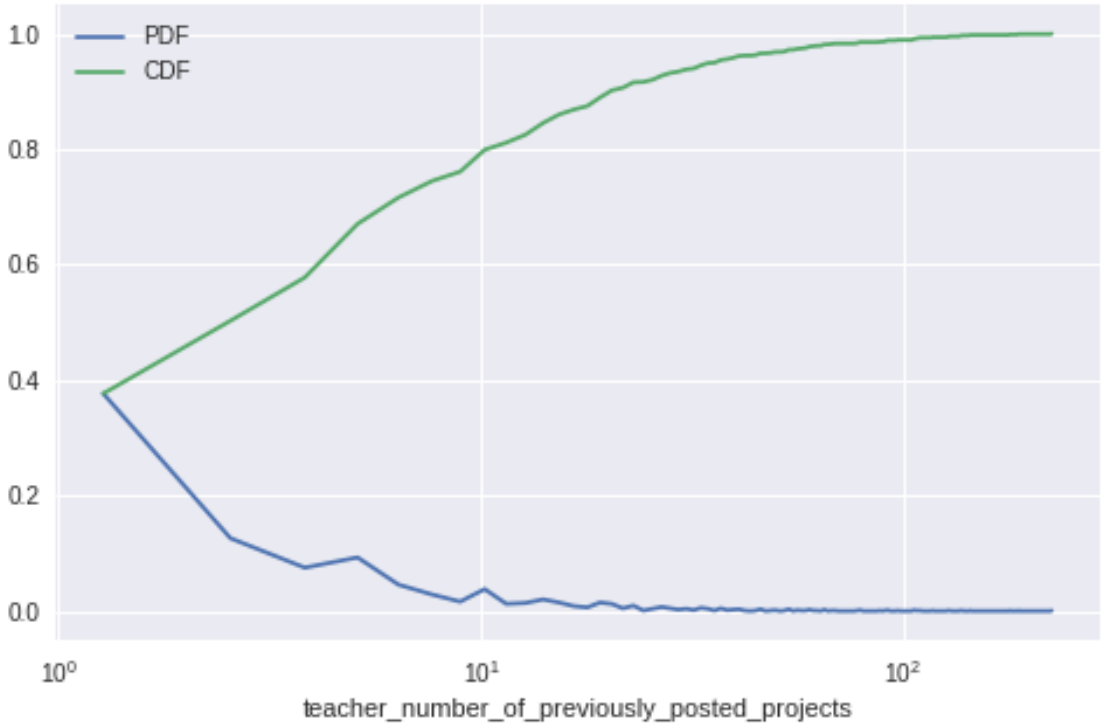
2.9 BoxPlot on FP 'price'

```
In [250]: ax = sns.boxplot(y='price', data=X_test_falsePos4)
```



2.10 PDF on FP TNPPP

In [251]:
```
plt.figure(figsize=(8,5))

counts, bin_edges = np.histogram(X_test_falsePos4['teacher_number_of_previously_posted_projects'],
pdf = counts/sum(counts)
cdf = np.cumsum(pdf)
pdfP, = plt.plot(bin_edges[1:], pdf)
cdfP, = plt.plot(bin_edges[1:], cdf)
plt.xscale('log')
plt.legend([pdfP, cdfP], ["PDF", "CDF"])
plt.xlabel('teacher_number_of_previously_posted_projects')
plt.show()
```



3 Selecting 5K best features using feature_importance_

In [0]: # https://datascience.stackexchange.com/questions/6683/feature-selection-using-feature-importances-in-ra

```
def selectKImportance(model, X, k=5):
    return X[:,model.feature_importances_.argsort()[::-1][:k]]
```

In [0]:
```
newX_tr = selectKImportance(clf2, X_tr2, 5000)
newX_te = selectKImportance(clf2, X_te2, 5000)
```

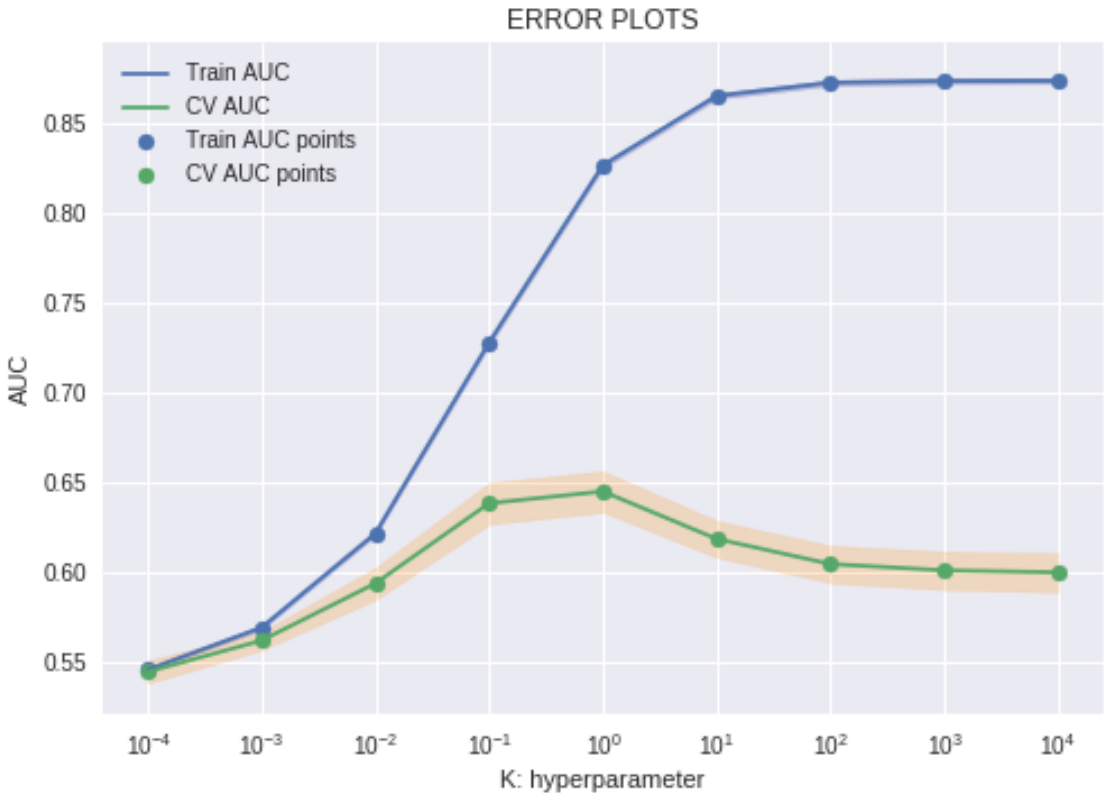
In [0]:
```
newX_tr.shape
```

2.5 Logistic Regression with added Features Set 5

3.1 Learning Curve (AUC)

In [254]:
```
# https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.GridSearchCV.html
from sklearn.model_selection import GridSearchCV
from sklearn.linear_model import LogisticRegression

lr1 = LogisticRegression()

parameters = {'C': [10**-4, 10**-3, 10**-2, 10**-1, 10**0, 10**1, 10**2, 10**3, 10**4]}
```

```
#parameters = {'alpha':[0.0001, 0.0025, 0.0005, 0.0075, 0.001, 0.025, .005, 0.075, 0.1, 0.25, 0.5, 0.75, 1]}

clf = GridSearchCV(lr1, parameters, cv=7, scoring='roc_auc')
clr4 = clf.fit(newX_tr, y_train)

train_auc4= clf.cv_results_['mean_train_score']
train_auc_std4= clf.cv_results_['std_train_score']
cv_auc4 = clf.cv_results_['mean_test_score']
cv_auc_std4 = clf.cv_results_['std_test_score']

plt.plot(parameters['C'], train_auc4, label='Train AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],train_auc4 - train_auc_std4,train_auc4 + train_auc_std4,alpha=

plt.plot(parameters['C'], cv_auc4, label='CV AUC')
# this code is copied from here: https://stackoverflow.com/a/48803361/4084039
plt.gca().fill_between(parameters['C'],cv_auc4 - cv_auc_std4, cv_auc4 + cv_auc_std4,alpha=0.2,color=

plt.scatter(parameters['C'], train_auc4, label='Train AUC points')
plt.scatter(parameters['C'], cv_auc4, label='CV AUC points')

plt.xscale('log')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()

print(train_auc4)
print(cv_auc4)       #k_best = 10**-2
```



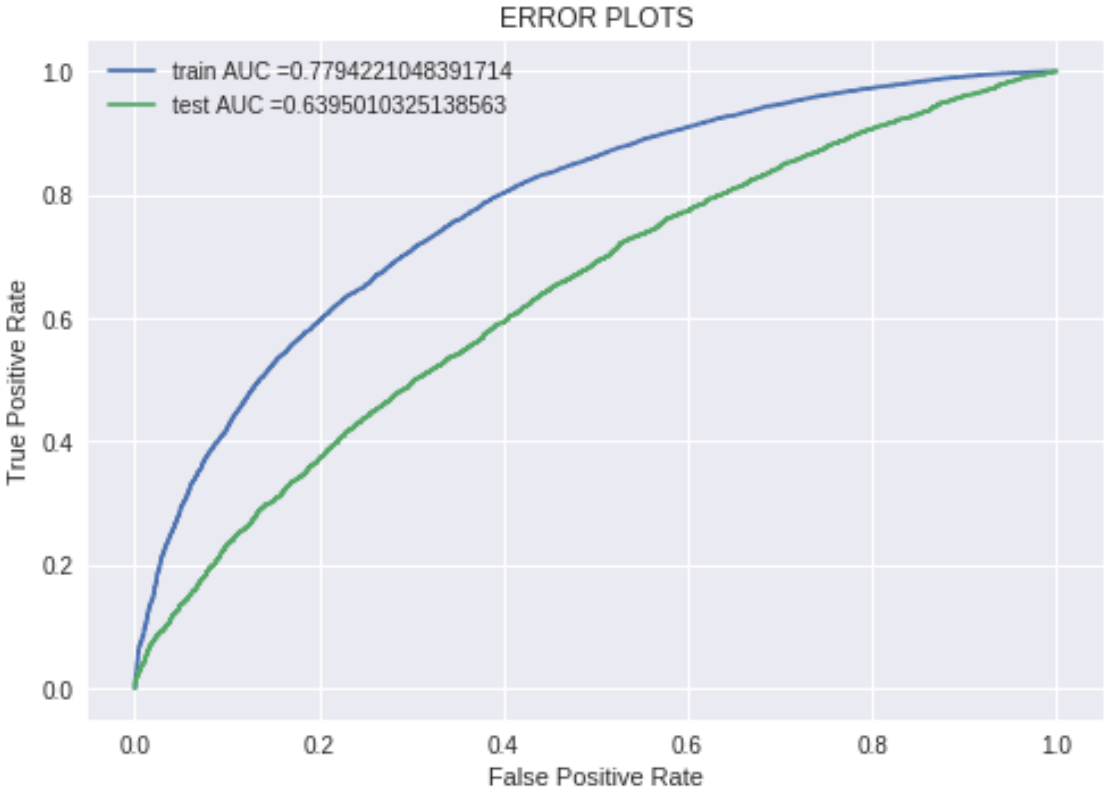
[0.54616847 0.56961267 0.62197373 0.72827207 0.82697625 0.8656096
 0.87298182 0.87389093 0.87400034]
[0.54497274 0.56236013 0.59414645 0.63877817 0.64537214 0.61894395
 0.60495494 0.60143483 0.60031549]

3.1.1 ROC Curve

In [255]: # https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc

```
from sklearn.metrics import roc_curve, auc


clf5 = LogisticRegression(C=1, penalty='l1');
clf5.fit(newX_tr, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the positive clas
# not the predicted outputs

y_train_pred4 = batch_predict(clf5, newX_tr)
y_test_pred4 = batch_predict(clf5, newX_te)
```

```
train_fpr4, train_tpr4, tr_thresholds4 = roc_curve(y_train, y_train_pred4)
test_fpr4, test_tpr4, te_thresholds4 = roc_curve(y_test, y_test_pred4)

plt.plot(train_fpr4, train_tpr4, label="train AUC ="+str(auc(train_fpr4, train_tpr4)))
plt.plot(test_fpr4, test_tpr4, label="test AUC ="+str(auc(test_fpr4, test_tpr4)))
plt.legend()
plt.xlabel("False Positive Rate")
plt.ylabel("True Positive Rate")
plt.title("ERROR PLOTS")
plt.grid(True)
plt.show()
```



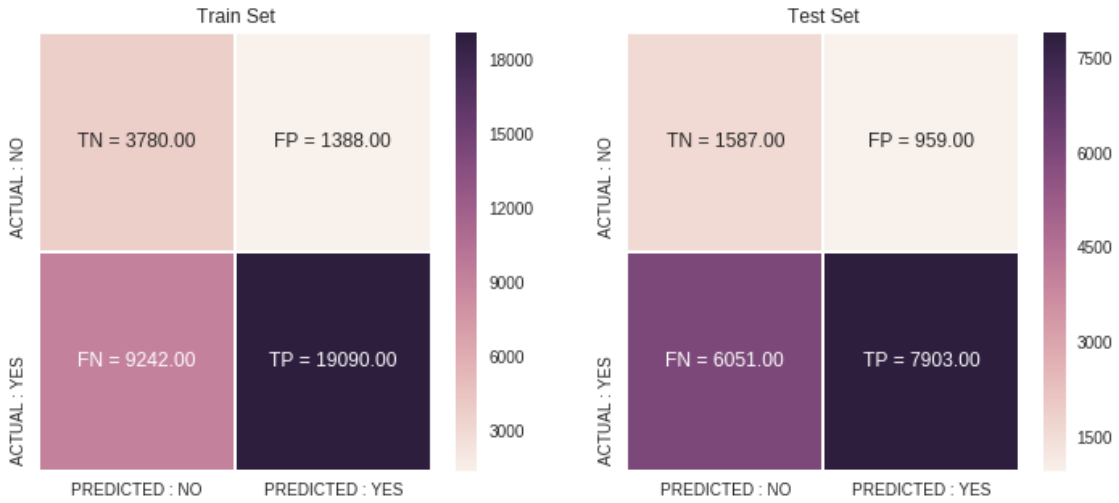
3.1.2 Confusion Matrix

In [0]:
```
def predict(proba, threshould, fpr, tpr):

    t = threshould[np.argmax(fpr*(1-tpr))]

    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high

    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.round(t,3))
    predictions = []
```

```
    for i in proba:
        if i>=t:
            predictions.append(1)
        else:
            predictions.append(0)
    return predictions
```

In [257]:
```
#https://www.quantinsti.com/blog/creating-heatmap-using-python-seaborn
import seaborn as sns; sns.set()

con_m_train = confusion_matrix(y_train, predict(y_train_pred4, tr_thresholds4, train_fpr4, train_tp
con_m_test = confusion_matrix(y_test, predict(y_test_pred4, te_thresholds4, test_fpr4, test_tpr4))

key = (np.asarray([['TN','FP'], ['FN', 'TP']]))

fig, ax = plt.subplots(1,2, figsize=(12,5))

labels_train = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m
labels_test = (np.asarray(["{0} = {1:.2f}" .format(key, value) for key, value in zip(key.flatten(), con_m_

sns.heatmap(con_m_train, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytic
sns.heatmap(con_m_test, linewidths=.5, xticklabels=['PREDICTED : NO', 'PREDICTED : YES'], ytick

ax[0].set_title('Train Set')
ax[1].set_title('Test Set')

plt.show()
```

the maximum value of tpr*(1-fpr) 0.4981432972551468 for threshold 0.84
the maximum value of tpr*(1-fpr) 0.35834299456152696 for threshold 0.866



3. Conclusions

In [259]:
```
# Please compare all your models using Prettytable library

# Please compare all your models using Prettytable library

from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ["Vectorizer", "Model", "HyperParameter1(max_depth)/C", "Hyperparameter2(min sm

x.add_row(["BOW",         "Decision Trees",      10**2, 500, 0.557])
x.add_row(["TFIDF",       "Decision Trees",      50, 500   ,  0.576])
x.add_row(["Avg W2V",     "Decision Treesn",     25, 135,    0.495])
x.add_row(["TFIDF-W2v",   "Decision Trees",      5, 100 ,  0.549])
x.add_row(["Best 5K",     "Logistic Regression", 1, "NULL",  0.639])



print(x)
```

```
+-----------+--------------------+---------------------------+---------------------------------+-------+
| Vectorizer |       Model        | HyperParameter1(max_depth)/C | Hyperparameter2(min smaple split) |  AUC
+-----------+--------------------+---------------------------+---------------------------------+-------+
|    BOW     |    Decision Trees   |            100            |              500                | 0.557 |
|   TFIDF    |    Decision Trees   |             50            |              500                | 0.576 |
|  Avg W2V   |    Decision Treesn  |             25            |              135                | 0.495 |
| TFIDF-W2v  |    Decision Trees   |              5            |              100                | 0.549 |
|  Best 5K   | Logistic Regression |              1            |              NULL               | 0.639 |
+-----------+--------------------+---------------------------+---------------------------------+-------+
```

3.1.3 Observations

As it can be seen from the above table, that the model is performing better than random model, from all the sets, TFIDF is working fairly well having AUC score of 0.577

3.1.4 Conclusions

I took **50000 datapoints** for my analysis and building my model

- I splitted the dataset into train, cv and test dataset
- Preprocessed all the text fetaures
- Vectorized all the text, categorical and numerical features, for text i used BOW & TFIDF
- Merged all features using hstack as instructed
- Using train dataset, i plotted my AUC curve using GridSearchCV using 3Fold Cross Validation for both categories
- from AUC curve, i picked best alpha. using best alpha, i plotted ROC curve on train and test data.

- Then i plotted my confusion matrix for both the sets.
- Atlast you can see my result in tabular format.