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 problems they need to solve:

- How to scale current manual processes and resources to screen 500,000 projects so that they can be posted as quickly and as efficiently as possible
- How to increase the consistency of project vetting across different volunteers to improve the experience for teachers
- 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.

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`

Feature	Description
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

Feature	Description
`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`
`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.

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
```

1.1 Reading Data

In [2]:
```
project_data = pd.read_csv('train_data.csv')
resource_data = pd.read_csv('resources.csv')
```

In [3]:
```
print("Number of data points in train data", project_data.shape)
print('-'*50)
print("The attributes of data :", project_data.columns.values)
```

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

In [4]:
```
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[4]:

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

1.2 preprocessing of project_subject_categories

In [5]:
```
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","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math & Science"=>"Math&Science"
        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]))
```

1.3 preprocessing of project_subject_subcategories

In [6]:
```
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","&", "Science"
            j=j.replace('The','') # if we have the words "The" we are going to replace it with ''(i.e removing 'The')
        j = j.replace(' ','') # we are placeing all the ' '(space) with ''(empty) ex:"Math & Science"=>"Math&Science"
        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]))
```

1.4 preprocessing of project_grade_category

In [7]:

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

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

prj_grade_cat_list = []
for i in prj_grade_cat:
    for j in i.split(' '): # it will split by space
        j=j.replace('Grades','') # if we have the words "Grades" we are going to replace it with ''(i.e removing 'Grades')
    prj_grade_cat_list.append(j.strip())

project_data['clean_grade'] = prj_grade_cat_list
project_data.drop(['project_grade_category'], axis=1, inplace=True)

# count of all the words in corpus python: https://stackoverflow.com/a/22898595/4084039
my_counter = Counter()
```

```
for word in project_data['clean_grade'].values:
    my_counter.update(word.split())

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

project_data['clean_grade'].values
```

Out[7]:
```
array(['PreK-2', '6-8', '6-8', ..., 'PreK-2', '3-5', '6-8'], dtype=object)
```

1.5 preprocessing of teacher_prefix

In [8]:
```
#tea_pfx_cat = list(project_data['teacher_prefix'].values)
tea_pfx_cat = list(project_data['teacher_prefix'].astype(str).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

##https://stackoverflow.com/questions/52736900/how-to-solve-the-attribute-error-float-object-has-no-attribute-split-in-pyth
#vectorizer.fit(project_data['teacher_prefix'].astype(str).values)

tea_pfx_cat_list = []
for i in tea_pfx_cat:
    #for j in i.split(' '): # it will split by space
    #j=j.replace('.','') # if we have the words "Grades" we are going to replace it with ''(i.e removing 'Grades')
    i=i.replace('.','') # if we have the words "Grades" we are going to replace it with ''(i.e removing 'Grades')
    i=i.replace('nan','') # if we have the words "Grades" we are going to replace it with ''(i.e removing 'Grades')
    tea_pfx_cat_list.append(i.strip())

project_data['clean_tea_pfx'] = tea_pfx_cat_list
project_data.drop(['teacher_prefix'], 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_tea_pfx'].values:
    my_counter.update(word.split())

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

project_data['clean_tea_pfx'].values
```

Out[8]:
```
array(['Mrs', 'Mr', 'Ms', ..., 'Mrs', 'Mrs', 'Ms'], dtype=object)
```

1.6 Text preprocessing

In [9]:
```
# 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	school_state	project_submitted_datetime	project_title	project_essay_1	project_essay_2	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	IN	2016-12-05 13:43:57	Educational Support for English Learners at Home	My students are English learners that are work...	\"The limits of your language are the limits o...	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	FL	2016-10-25 09:22:10	Wanted: Projector for Hungry Learners	Our students arrive to our school eager to lea...	The projector we need for our school is very c...	

In [11]:
```
#### 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)
```

```
My students are English learners that are working on English as their second or third languages. We are a melting pot of refugees, immigrants, and native-born Americans bringing the gift of language to our school. \r\n\r\n We have over 24 languages represented in our English Learner program with students at every level of mastery.  We also have over 40 countries represented with the famil ies within our school.  Each student brings a wealth of knowledge and experiences to us that open our eyes to new cultures, belief s, and respect.\"The limits of your language are the limits of your world.\"-Ludwig Wittgenstein  Our English learner's have a str ong support system at home that begs for more resources.  Many times our parents are learning to read and speak English along side of their children.  Sometimes this creates barriers for parents to be able to help their child learn phonetics, letter recognitio n, and other reading skills.\r\n\r\nBy providing these dvd's and players, students are able to continue their mastery of the Engli sh language even if no one at home is able to assist.  All families with students within the Level 1 proficiency status, will be a offered to be a part of this program.  These educational videos will be specially chosen by the English Learner Teacher and will b e sent home regularly to watch.  The videos are to help the child develop early reading skills.\r\n\r\nParents that do not have ac cess to a dvd player will have the opportunity to check out a dvd player to use for the year.  The plan is to use these videos and educational dvd's for the years to come for other EL students.\r\nnannan
==================================================
The 51 fifth grade students that will cycle through my classroom this year all love learning, at least most of the time. At our sc hool, 97.3% of the students receive free or reduced price lunch. Of the 560 students, 97.3% are minority students. \r\nThe school has a vibrant community that loves to get together and celebrate. Around Halloween there is a whole school parade to show off the beautiful costumes that students wear. On Cinco de Mayo we put on a big festival with crafts made by the students, dances, and gam es. At the end of the year the school hosts a carnival to celebrate the hard work put in during the school year, with a dunk tank being the most popular activity.My students will use these five brightly colored Hokki stools in place of regular, stationary, 4-l egged chairs. As I will only have a total of ten in the classroom and not enough for each student to have an individual one, they will be used in a variety of ways. During independent reading time they will be used as special chairs students will each use on o ccasion. I will utilize them in place of chairs at my small group tables during math and reading times. The rest of the day they w ill be used by the students who need the highest amount of movement in their life in order to stay focused on school.\r\n\r\nWhene ver asked what the classroom is missing, my students always say more Hokki Stools. They can't get their fill of the 5 stools we al ready have. When the students are sitting in group with me on the Hokki Stools, they are always moving, but at the same time doing their work. Anytime the students get to pick where they can sit, the Hokki Stools are the first to be taken. There are always stud ents who head over to the kidney table to get one of the stools who are disappointed as there are not enough of them. \r\n\r\nWe a sk a lot of students to sit for 7 hours a day. The Hokki stools will be a compromise that allow my students to do desk work and mo ve at the same time. These stools will help students to meet their 60 minutes a day of movement by allowing them to activate their core muscles for balance while they sit. For many of my students, these chairs will take away the barrier that exists in schools f or a child who can't sit still.nannan
==================================================
How do you remember your days of school? Was it in a sterile environment with plain walls, rows of desks, and a teacher in front o f the room? A typical day in our room is nothing like that. I work hard to create a warm inviting themed room for my students look forward to coming to each day.\r\n\r\nMy class is made up of 28 wonderfully unique boys and girls of mixed races in Arkansas.\r\nT hey attend a Title I school, which means there is a high enough percentage of free and reduced-price lunch to qualify. Our school is an \"open classroom\" concept, which is very unique as there are no walls separating the classrooms. These 9 and 10 year-old st udents are very eager learners; they are like sponges, absorbing all the information and experiences and keep on wanting more.With these resources such as the comfy red throw pillows and the whimsical nautical hanging decor and the blue fish nets, I will be abl e to help create the mood in our classroom setting to be one of a themed nautical environment. Creating a classroom environment is
```

```
very important in the success in each and every child's education. The nautical photo props will be used with each child as they s
tep foot into our classroom for the first time on Meet the Teacher evening. I'll take pictures of each child with them, have them
developed, and then hung in our classroom ready for their first day of 4th grade.  This kind gesture will set the tone before even
the first day of school! The nautical thank you cards will be used throughout the year by the students as they create thank you ca
rds to their team groups.\r\n\r\nYour generous donations will help me to help make our classroom a fun, inviting, learning environ
ment from day one.\r\n\r\nIt costs lost of money out of my own pocket on resources to get our classroom ready. Please consider hel
ping with this project to make our new school year a very successful one. Thank you!nannan
==================================================
My kindergarten students have varied disabilities ranging from speech and language delays, cognitive delays, gross/fine motor dela
ys, to autism. They are eager beavers and always strive to work their hardest working past their limitations. \r\n\r\nThe material
s we have are the ones I seek out for my students. I teach in a Title I school where most of the students receive free or reduced
price lunch.  Despite their disabilities and limitations, my students love coming to school and come eager to learn and explore.Ha
ve you ever felt like you had ants in your pants and you needed to groove and move as you were in a meeting? This is how my kids f
eel all the time. The want to be able to move as they learn or so they say.Wobble chairs are the answer and I love then because th
ey develop their core, which enhances gross motor and in Turn fine motor skills. \r\nThey also want to learn through games, my kid
s don't want to sit and do worksheets. They want to learn to count by jumping and playing. Physical engagement is the key to our s
uccess. The number toss and color and shape mats can make that happen. My students will forget they are doing work and just have t
he fun a 6 year old deserves.nannan
==================================================
The mediocre teacher tells. The good teacher explains. The superior teacher demonstrates. The great teacher inspires. -William A.
Ward\r\n\r\nMy school has 803 students which is makeup is 97.6% African-American, making up the largest segment of the student bod
y. A typical school in Dallas is made up of 23.2% African-American students. Most of the students are on free or reduced lunch. We
aren't receiving doctors, lawyers, or engineers children from rich backgrounds or neighborhoods. As an educator I am inspiring min
ds of young children and we focus not only on academics but one smart, effective, efficient, and disciplined students with good ch
aracter.In our classroom we can utilize the Bluetooth for swift transitions during class. I use a speaker which doesn't amplify th
e sound enough to receive the message. Due to the volume of my speaker my students can't hear videos or books clearly and it isn't
making the lessons as meaningful. But with the bluetooth speaker my students will be able to hear and I can stop, pause and replay
it at any time.\r\nThe cart will allow me to have more room for storage of things that are needed for the day and has an extra par
t to it I can use.  The table top chart has all of the letter, words and pictures for students to learn about different letters an
d it is more accessible.nannan
==================================================
```

In [13]:

```
# 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)
```

```
My kindergarten students have varied disabilities ranging from speech and language delays, cognitive delays, gross/fine motor dela
ys, to autism. They are eager beavers and always strive to work their hardest working past their limitations. \r\n\r\nThe material
s we have are the ones I seek out for my students. I teach in a Title I school where most of the students receive free or reduced
price lunch.  Despite their disabilities and limitations, my students love coming to school and come eager to learn and explore.Ha
ve you ever felt like you had ants in your pants and you needed to groove and move as you were in a meeting? This is how my kids f
eel all the time. The want to be able to move as they learn or so they say.Wobble chairs are the answer and I love then because th
ey develop their core, which enhances gross motor and in Turn fine motor skills. \r\nThey also want to learn through games, my kid
s do not want to sit and do worksheets. They want to learn to count by jumping and playing. Physical engagement is the key to our
success. The number toss and color and shape mats can make that happen. My students will forget they are doing work and just have
the fun a 6 year old deserves.nannan
==================================================
```

In [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)
```

```
My kindergarten students have varied disabilities ranging from speech and language delays, cognitive delays, gross/fine motor dela
ys, to autism. They are eager beavers and always strive to work their hardest working past their limitations.     The materials we
have are the ones I seek out for my students. I teach in a Title I school where most of the students receive free or reduced price
lunch.  Despite their disabilities and limitations, my students love coming to school and come eager to learn and explore.Have you
ever felt like you had ants in your pants and you needed to groove and move as you were in a meeting? This is how my kids feel all
the time. The want to be able to move as they learn or so they say.Wobble chairs are the answer and I love then because they devel
op their core, which enhances gross motor and in Turn fine motor skills.   They also want to learn through games, my kids do not w
ant to sit and do worksheets. They want to learn to count by jumping and playing. Physical engagement is the key to our success. T
he number toss and color and shape mats can make that happen. My students will forget they are doing work and just have the fun a
6 year old deserves.nannan
```

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

```
My kindergarten students have varied disabilities ranging from speech and language delays cognitive delays gross fine motor delays
to autism They are eager beavers and always strive to work their hardest working past their limitations The materials we have are
the ones I seek out for my students I teach in a Title I school where most of the students receive free or reduced price lunch Des
pite their disabilities and limitations my students love coming to school and come eager to learn and explore Have you ever felt l
```

```
ike you had ants in your pants and you needed to groove and move as you were in a meeting This is how my kids feel all the time Th
e want to be able to move as they learn or so they say Wobble chairs are the answer and I love then because they develop their cor
e which enhances gross motor and in Turn fine motor skills They also want to learn through games my kids do not want to sit and do
worksheets They want to learn to count by jumping and playing Physical engagement is the key to our success The number toss and co
lor and shape mats can make that happen My students will forget they are doing work and just have the fun a 6 year old deserves na
nnan
```

In [17]:
```
# 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', "weren't", \
            '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 not in stopwords)
    preprocessed_essays.append(sent.lower().strip())
```

```
100%|██████████████████████████████████████████████████████████████████████████████| 109248/109248 [01:48<00:00, 1002.33it/s]
```

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

Out[19]:
```
'my kindergarten students varied disabilities ranging speech language delays cognitive delays gross fine motor delays autism they
eager beavers always strive work hardest working past limitations the materials ones i seek students i teach title i school studen
ts receive free reduced price lunch despite disabilities limitations students love coming school come eager learn explore have eve
r felt like ants pants needed groove move meeting this kids feel time the want able move learn say wobble chairs answer i love dev
elop core enhances gross motor turn fine motor skills they also want learn games kids not want sit worksheets they want learn coun
t jumping playing physical engagement key success the number toss color shape mats make happen my students forget work fun 6 year
old deserves nannan'
```

1.4 Preprocessing of $project_tit \leq$

In [20]:
```
# similarly you can preprocess the titles also
project_data.head(2)
```

Out[20]:

	Unnamed: 0	id	teacher_id	school_state	project_submitted_datetime	project_title	project_essay_1	project_essay_2	project
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	IN	2016-12-05 13:43:57	Educational Support for English Learners at Home	My students are English learners that are work...	\"The limits of your language are the limits o...	
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	FL	2016-10-25 09:22:10	Wanted: Projector for Hungry Learners	Our students arrive to our school eager to lea...	The projector we need for our school is very c...	

In [21]:
```
# printing some random essays.
print(project_data['project_title'].values[0])
print("="*50)
print(project_data['project_title'].values[150])
print("="*50)
print(project_data['project_title'].values[1000])
print("="*50)
print(project_data['project_title'].values[20000])
print("="*50)
```

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

```
Educational Support for English Learners at Home
==================================================
More Movement with Hokki Stools
==================================================
Sailing Into a Super 4th Grade Year
==================================================
We Need To Move It While We Input It!
==================================================
Inspiring Minds by Enhancing the Educational Experience
==================================================
```

In [22]:
```
sent_title = decontracted(project_data['project_title'].values[20000])
print(sent_title)
print("="*50)
```

```
We Need To Move It While We Input It!
==================================================
```

In [23]:
```
# \r \n \t remove from string python: http://texthandler.com/info/remove-line-breaks-python/
sent_title = sent_title.replace('\\r', ' ')
sent_title = sent_title.replace('\\"', ' ')
sent_title = sent_title.replace('\\n', ' ')
print(sent_title)
```

```
We Need To Move It While We Input It!
```

In [24]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent_title = re.sub('[^A-Za-z0-9]+', ' ', sent_title)
print(sent_title)
```

```
We Need To Move It While We Input It
```

In [25]:
```
# Combining all the above statemennts
from tqdm import tqdm
preprocessed_title = []
# tqdm is for printing the status bar
for sentance in tqdm(project_data['project_title'].values):
    sent_title = decontracted(sentance)
    sent_title = sent_title.replace('\\r', ' ')
    sent_title = sent_title.replace('\\"', ' ')
    sent_title = sent_title.replace('\\n', ' ')
    sent_title = re.sub('[^A-Za-z0-9]+', ' ', sent_title)
    # https://gist.github.com/sebleier/554280
```

```
    sent_title = ' '.join(e for e in sent_title.split() if e not in stopwords)
    preprocessed_title.append(sent_title.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████████| 109248/109248 [00:04<00:00, 23003.85it/s]
```

In [26]:
```
# after preprocesing
preprocessed_title[10]
```

Out[26]:
```
'reading changes lives'
```

In [27]:
```
# Combining all the above statemennts
from tqdm import tqdm
preprocessed_prj_sum = []
# tqdm is for printing the status bar
for sentance in tqdm(project_data['project_resource_summary'].values):
    sent_title = decontracted(sentance)
    sent_title = sent_title.replace('\\r', ' ')
    sent_title = sent_title.replace('\\"', ' ')
    sent_title = sent_title.replace('\\n', ' ')
    sent_title = re.sub('[^A-Za-z0-9]+', ' ', sent_title)
    # https://gist.github.com/sebleier/554280
    sent_title = ' '.join(e for e in sent_title.split() if e not in stopwords)
    preprocessed_prj_sum.append(sent_title.lower().strip())
```

```
100%|████████████████████████████████████████████████████████████████| 109248/109248 [00:11<00:00, 9473.09it/s]
```

1.9 Preparing data for models

In [28]:
```
project_data.columns
```

Out[28]:
```
Index(['Unnamed: 0', 'id', 'teacher_id', 'school_state',
       'project_submitted_datetime', 'project_title', 'project_essay_1',
       'project_essay_2', 'project_essay_3', 'project_essay_4',
       'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'clean_grade',
       'clean_tea_pfx', '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

1.5.3 Vectorizing Numerical features

In [29]:
```
price_data = resource_data.groupby('id').agg({'price':'sum', 'quantity':'sum'}).reset_index()
project_data = pd.merge(project_data, price_data, on='id', how='left')
```

In [30]:
```
# check this one: https://www.youtube.com/watch?v=0HOqOcln3Z4&t=530s
# standardization sklearn: https://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html
from sklearn.preprocessing import StandardScaler

# price_standardized = standardScalar.fit(project_data['price'].values)
# this will rise the error
# ValueError: Expected 2D array, got 1D array instead: array=[725.05 213.03 329.   ... 399.   287.73   5.5 ].
# Reshape your data either using array.reshape(-1, 1)

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

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

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

In [31]:
```
price_standardized
```

Out[31]:
```
array([[-0.3905327 ],
       [ 0.00239637],
       [ 0.59519138],
       ...,
       [-0.15825829],
```

```
[-0.61243967],
[-0.51216657]])
```

Assignment 10: Clustering

- step 1: Choose any vectorizer (data matrix) that you have worked in any of the assignments, and got the best AUC value.
- step 2: Choose any of the feature selection/reduction algorithms ex: selectkbest features, pretrained word vectors, model based feature selection etc and reduce the number of features to 5k features
- step 3: Apply all three kmeans, Agglomerative clustering, DBSCAN
  - **K-Means Clustering:**
    - Find the best 'k' using the elbow-knee method (plot k vs inertia_)
  - **Agglomerative Clustering:**
    - Apply agglomerative algorithm and try a different number of clusters like 2,5 etc.
    - You can take less data points (as this is very computationally expensive one) to perform hierarchical clustering because they do take a considerable amount of time to run.
  - **DBSCAN Clustering:**
    - Find the best 'eps' using the elbow-knee method.
    - You can take a smaller sample size for this as well.
- step 4: Summarize each cluster by manually observing few points from each cluster.
- step 5: You need to plot the word cloud with essay text for each cluster for each of algorithms mentioned in step 3.

In [32]:
```
##taking 50K datapoint
#project_data50K=project_data[:50000]
project_data20K=project_data[:20000]
#project_data100K=project_data[:100000]
X=project_data20K
#X=project_data50K
#X=project_data100K
print(project_data20K.shape)
#print(project_data50K.shape)
#print(project_data100K.shape)
print(X.shape)
```

```
(20000, 20)
(20000, 20)
```

In [33]:
```
# makins Xi as 19 column matrix, where we create the modle and Yi as single colum matrix as a class label.
```

```
y = project_data20K['project_is_approved'].values
#y = project_data50K['project_is_approved'].values
#project_data50K.drop(['project_is_approved'], axis=1, inplace=True)
#rint(y.shape)
#(project_data50K.head(1)
print(project_data20K.columns)
#print(project_data50K.columns)
y20K=y[:20000]
#y50K=y[:50000]
y=y20K
#y=y50K

#y = project_data['project_is_approved'].values
#project_data.drop(['project_is_approved'], axis=1, inplace=True)
##print(y.shape)
#project_data.head(1)
#
#y100K=y[:100000]
#y=y100K

#y = project_data['project_is_approved'].values
#project_data.drop(['project_is_approved'], axis=1, inplace=True)
#print(y.shape)
#project_data.head(1)
```

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

In [34]:
```
print(X.shape)
print(y.shape)
```

```
(20000, 20)
(20000,)
```

2. Clustering

2.1 Choose the best data matrix on which you got the best AUC

In [35]:
```
# 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
```

In [36]:
```
print(X.columns)
```

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

2.1.1 Make Data Model Ready: encoding school_state categorical data

In [37]:
```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(min_df=10,ngram_range=(1,2), max_features=5000)
vectorizer.fit(X['school_state'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_state_ohe = vectorizer.transform(X['school_state'].values)

print("school_state After vectorizations")
print(X_state_ohe.shape, y.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
school_state After vectorizations
(20000, 51) (20000,)
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi', 'ia', 'id', 'il', 'in', 'ks', 'ky', 'la', 'ma', 'md', 'm
e', 'mi', 'mn', 'mo', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh', 'nj', 'nm', 'nv', 'ny', 'oh', 'ok', 'or', 'pa', 'ri', 'sc', 'sd', 'tn',
'tx', 'ut', 'va', 'vt', 'wa', 'wi', 'wv', 'wy']
====================================================================================================
```

2.1.2 Make Data Model Ready: encoding clean_categories

In [40]:
```
from sklearn.feature_extraction.text import CountVectorizer
#vectorizer = CountVectorizer(min_df=10,ngram_range=(1,2), max_features=5000)
vectorizer = CountVectorizer(vocabulary =list(sorted_cat_dict.keys()),lowercase =False,binary=True)
vectorizer.fit(X['clean_categories'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_clean_ohe = vectorizer.transform(X['clean_categories'].values)

print("clean_categories After vectorizations")
print(X_clean_ohe.shape, y.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
clean_categories After vectorizations
(20000, 9) (20000,)
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning', 'SpecialNeeds', 'Health_Sports', 'Math_Science', 'Lit
eracy_Language']
====================================================================================================
```

2.1.3 Make Data Model Ready: encoding clean_subcategories

In [41]:
```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary =list(sorted_sub_cat_dict.keys()),lowercase =False,binary=True)
vectorizer.fit(X['clean_subcategories'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_cleanSub_ohe = vectorizer.transform(X['clean_subcategories'].values)

print("clean_subcategories After vectorizations")
print(X_cleanSub_ohe.shape, y.shape)
#print(vectorizer.get_feature_names())
print("="*100)
```

```
clean_subcategories After vectorizations
(20000, 30) (20000,)
====================================================================================================
```

2.1.4 Make Data Model Ready: encoding project_grade_category

In [42]:
```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary =list(sorted_prj_grade_cat_dict.keys()),lowercase =False,binary=True)
vectorizer.fit(X['clean_grade'].values) # fit has to happen only on train data

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

```
X_grade_ohe = vectorizer.transform(X['clean_grade'].values)

print("project_grade_category After vectorizations")
print(X_grade_ohe.shape, y.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
project_grade_category After vectorizations
(20000, 4) (20000,)
['9-12', '6-8', '3-5', 'PreK-2']
====================================================================================================
```

2.1.5 Make Data Model Ready: encoding teacher_prefix

In [43]:
```
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary =list(sorted_tea_pfx_cat_dict.keys()),lowercase =False,binary=True)
#https://stackoverflow.com/questions/52736900/how-to-solve-the-attribute-error-float-object-has-no-attribute-split-in-pyth
vectorizer.fit(X['clean_tea_pfx'].astype(str).values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_teacher_ohe = vectorizer.transform(X['clean_tea_pfx'].astype(str).values)

print("teacher_prefix After vectorizations")
print(X_teacher_ohe.shape, y.shape)
print(vectorizer.get_feature_names())
print("="*100)
```

```
teacher_prefix After vectorizations
(20000, 5) (20000,)
['Dr', 'Teacher', 'Mr', 'Ms', 'Mrs']
====================================================================================================
```

2.1.6 Make Data Model Ready: encoding project_resource_summary

In [44]:
```
vectorizer = CountVectorizer(min_df=10,ngram_range=(1,2))
vectorizer.fit(X['project_resource_summary'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_prjResSum_ohe = vectorizer.transform(X['project_resource_summary'].values)

print("project_resource_summary After vectorizations")
print(X_prjResSum_ohe.shape, y.shape)
#print(vectorizer.get_feature_names())
print("="*100)
```

```
project_resource_summary After vectorizations
(20000, 6925) (20000,)
==========================================================================================
```

2.2 Make Data Model Ready: encoding numerical, categorical features

In [45]:
```
# 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
# make sure you featurize train and test data separatly

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

2.2.1 Make Data Model Ready: encoding numerical | quantity

In [46]:
```
from sklearn.preprocessing import Normalizer
normalizer = Normalizer()
# normalizer.fit(X['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['quantity'].values.reshape(-1,1))

X_quantity_norm = normalizer.transform(X['quantity'].values.reshape(-1,1))

print("quantity After vectorizations")
print(X_quantity_norm.shape, y.shape)
print("="*100)
```

```
quantity After vectorizations
(20000, 1) (20000,)
==========================================================================================
```

2.2.2 Make Data Model Ready: encoding numerical|

teacher_number_of_previously_posted_projects

In [47]:
```
from sklearn.preprocessing import Normalizer
normalizer = Normalizer()
# normalizer.fit(X['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['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))

X_TprevPrj_norm = normalizer.transform(X['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))

print("teacher_number_of_previously_posted_projects After vectorizations")
print(X_TprevPrj_norm.shape, y.shape)
print("="*100)
```

```
teacher_number_of_previously_posted_projects After vectorizations
(20000, 1) (20000,)
====================================================================================================
```

2.2.3 Make Data Model Ready: encoding numerical | price

In [48]:
```
from sklearn.preprocessing import Normalizer
normalizer = Normalizer()
# normalizer.fit(X['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['price'].values.reshape(-1,1))

X_price_norm = normalizer.transform(X['price'].values.reshape(-1,1))

print("Price After vectorizations")
print(X_price_norm.shape, y.shape)
print("="*100)
```

```
Price After vectorizations
(20000, 1) (20000,)
====================================================================================================
```

In [49]:
```
h=['price','quantity','teacher_number_of_previously_posted_projects']
print(type(h))
```

```
<class 'list'>
```

2.3 Make Data Model Ready: encoding eassay, and project_title

In [0]:
```
# please write all the code with proper documentation, and proper titles for each 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
# make sure you featurize train and test data separatly

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

2.3.1 Make Data Model Ready: project_essay | BOW

In [50]:
```
from sklearn.feature_extraction.text import CountVectorizer
# categorical, numerical features + project_title(BOW) + preprocessed_eassay
# (BOW with bi-grams with min_df=10 and max_features=5000)
vectorizer = CountVectorizer(min_df=10,ngram_range=(1,2), max_features=5000)
vectorizer.fit(X['essay'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_essay_bow = vectorizer.transform(X['essay'].values)

print("Essay After vectorizations")
print(X_essay_bow.shape, y.shape)
print("="*100)
g=vectorizer.get_feature_names()
```

```
Essay After vectorizations
(20000, 5000) (20000,)
====================================================================================================
```

2.3.2 Make Data Model Ready: project_title | BOW

In [51]:
```
vectorizer = CountVectorizer()
```

```
# categorical, numerical features + project_title(BOW) + preprocessed_eassay
# (BOW with bi-grams with min_df=10 and max_features=5000)
vectorizer = CountVectorizer(min_df=10,ngram_range=(1,2), max_features=5000)
vectorizer.fit(X['project_title'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_title_bow = vectorizer.transform(X['project_title'].values)

print("project_title After vectorizations")
print(X_title_bow.shape, y.shape)
#print(vectorizer.get_feature_names())
print("="*100)
k=vectorizer.get_feature_names()
```

```
project_title After vectorizations
(20000, 2089) (20000,)
====================================================================================================
```

In [52]:
```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
X_tr_bow = hstack((X_essay_bow, X_title_bow, X_state_ohe, X_clean_ohe, X_cleanSub_ohe, X_grade_ohe, X_teacher_ohe, X_prjResSum_ohe

print("Final Data matrix | BOW")
print(X_tr_bow.shape, y.shape)
print("="*100)
```

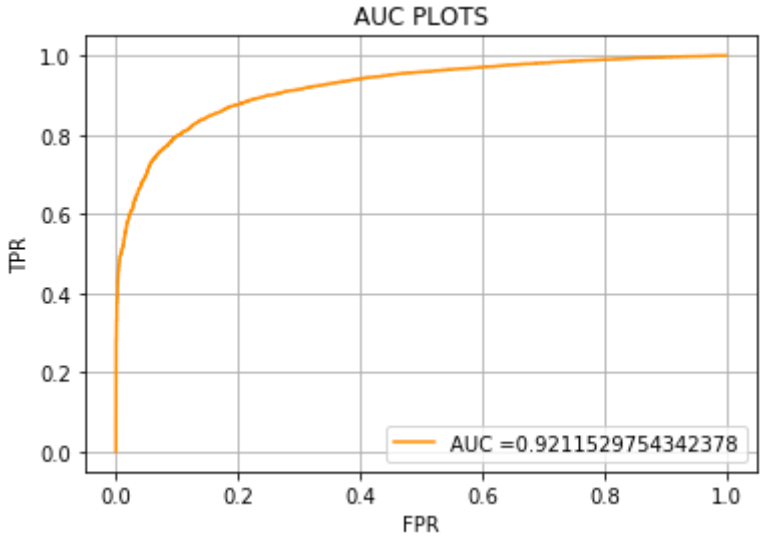
```
Final Data matrix | BOW
(20000, 14116) (20000,)
====================================================================================================
```

In [53]:
```
best_tuned_parameters = [{'C': [0.01]}]
```

In [59]:
```
#code source: http://occam.olin.edu/sites/default/files/DataScienceMaterials/machine_learning_lecture_2/Machine%20Learning%20Lectu
from sklearn.model_selection import train_test_split
#from sklearn.grid_search import GridSearchCV
from sklearn.model_selection import GridSearchCV
from sklearn.datasets import *
from sklearn.linear_model import LogisticRegression

# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html#sklearn.metrics.roc_curve
from sklearn.metrics import roc_curve, auc

model = GridSearchCV(LogisticRegression(class_weight="balanced"), best_tuned_parameters)
model.fit(X_tr_bow, y)
#model.fit(X_tr_bow)
```

```
#y_bow_pred = model.predict_proba(X_tr_bow)[:,1]
x_bow_pred = model.predict_proba(X_tr_bow)[:,1]

print(model.best_estimator_)
print(model.score(X_tr_bow, y))
#print(model.score(X_tr_bow))

X_fpr, X_tpr, X_thresholds = roc_curve(y, y_bow_pred)

plt.plot(X_fpr, X_tpr, label="AUC ="+str(auc(X_fpr, X_tpr)),color='darkorange')
plt.legend()
plt.xlabel("FPR")
plt.ylabel("TPR")
plt.title("AUC PLOTS")
plt.grid(True)
plt.show()
```

```
LogisticRegression(C=0.01, class_weight='balanced', dual=False,
          fit_intercept=True, intercept_scaling=1, max_iter=100,
          multi_class='ovr', n_jobs=1, penalty='l2', random_state=None,
          solver='liblinear', tol=0.0001, verbose=0, warm_start=False)
0.8227
```



2.4 Dimensionality Reduction on the selected features

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
```

In [267…
```
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import chi2
print(X_tr_bow.shape)

bow_Feature= SelectKBest(chi2,k=5000)
X_tr_bow_5K=bow_Feature.fit_transform(X_tr_bow,y)

print("Final Data matrix ")
print(X_tr_bow_5K.shape, y.shape)
```

```
(20000, 14116)
Final Data matrix
(20000, 5000) (20000,)
```

2.5 Apply Kmeans

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
```

In [268…
```
# https://scikit-learn.org/stable/modules/generated/sklearn.cluster.KMeans.html
# https://stackoverflow.com/questions/51514158/how-to-run-gridsearchcv-for-k-means-using-spark-sklearn

from sklearn.cluster import KMeans
import numpy as np

k=[3,5,7,9,11,13,15,19,27,33]
```

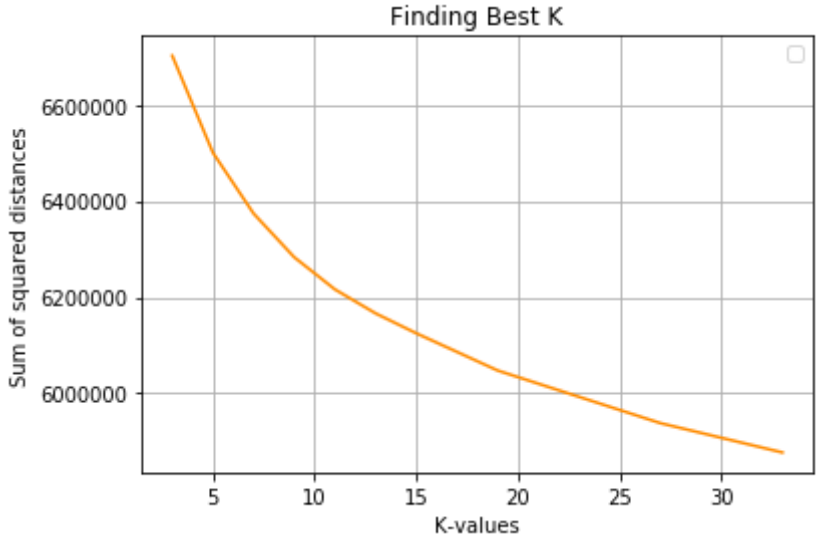
```
inertList=[]

for i in k:
    kmeans=KMeans(n_clusters=i,n_init =10).fit(X_tr_bow_5K)
    inertList.append(kmeans.inertia_)
print(k)
print(inertList)
```

```
[3, 5, 7, 9, 11, 13, 15, 19, 27, 33]
[6702130.853643525, 6500398.249518574, 6373875.096416284, 6283008.331486244, 6216142.207386503, 6166273.4483066145, 6124907.112133
581, 6047497.883974317, 5938016.168225641, 5877028.967765003]
```

In [269…

```
plt.plot(k, inertList,color='darkorange')
plt.legend()
plt.xlabel("K-values")
plt.ylabel("Sum of squared distances")
plt.title("Finding Best K")
plt.grid(True)
plt.show()
```

```
No handles with labels found to put in legend.
```



Best K is 10

In [389…

```
# https://scikit-learn.org/stable/modules/generated/sklearn.cluster.KMeans.html
# https://stackoverflow.com/questions/51514158/how-to-run-gridsearchcv-for-k-means-using-spark-sklearn
```

```
from sklearn.cluster import KMeans
import numpy as np

inertList=[]

kmeans=KMeans(n_clusters=10,n_init =10).fit(X_tr_bow_5K)
inertList.append(kmeans.inertia_)

print(k)
print(inertList)
```

```
[3, 5, 7, 9, 11, 13, 15, 19, 27, 33]
[6248508.940029501]
```

In [390…
```
#kmeans.cluster_centers_
#kmeansns.inertia_
KmLabel=kmeans.labels_
np.unique(KmLabel)
```

Out[390…
```
array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9])
```

In [391…
```
X_working_kmean = X.copy(deep=True)
X_working_kmean["KmLabel"]=KmLabel
X_working_kmean.columns
```

Out[391…
```
Index(['Unnamed: 0', 'id', 'teacher_id', 'school_state',
       'project_submitted_datetime', 'project_title', 'project_essay_1',
       'project_essay_2', 'project_essay_3', 'project_essay_4',
       'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'clean_grade',
       'clean_tea_pfx', 'essay', 'price', 'quantity', 'KmLabel'],
      dtype='object')
```

step 4: Summarize each cluster by manually observing few points from each cluster.

In [392…
```
X_working_Kmean_clus0=X_working_kmean[X_working_kmean.KmLabel==0]
print(X_working_Kmean_clus0.head(3))

X_working_Kmean_clus7=X_working_kmean[X_working_kmean.KmLabel==7]
print(X_working_Kmean_clus7.head(3))
```

```
   Unnamed: 0       id                         teacher_id school_state  \
```

```
3           45  p246581  f3cb9bffbba169bef1a77b243e620b60           KY
16      127215  p174627  4ad7e280fddff889e1355cc9f29c3b89           FL
24       21478  p126524  74f8690562c44fc88f65f845b9fe61d0           FL

   project_submitted_datetime  \
3         2016-10-06 21:16:17
16        2017-01-18 10:59:05
24        2017-03-31 12:34:44

                                     project_title  \
3                              Techie Kindergarteners
16                 Making Great LEAP's With Leapfrog!
24  S.T.E.A.M. Challenges(Science Technology Engin...

                                    project_essay_1  \
3   I work at a unique school filled with both ESL...
16  My Preschool children, ages 3-5 years old with...
24  This year, I am teaching in an EFL (Extended F...

                                    project_essay_2 project_essay_3  \
3   My students live in high poverty conditions wi...             NaN
16  Having a set of Leapfrog iPads and educational...             NaN
24  I will use these items to create S.T.E.A.M. bi...             NaN

   project_essay_4   ...    teacher_number_of_previously_posted_projects  \
3              NaN   ...                                               4
16             NaN   ...                                               1
24             NaN   ...                                               0

    project_is_approved               clean_categories  \
3                     1  Literacy_Language Math_Science
16                    1  Literacy_Language SpecialNeeds
24                    1                    Math_Science

           clean_subcategories clean_grade clean_tea_pfx  \
3          Literacy Mathematics      PreK-2          Mrs
16        Literacy SpecialNeeds      PreK-2          Mrs
24  AppliedSciences Mathematics      PreK-2          Mrs

                                            essay   price  quantity  \
3   I work at a unique school filled with both ESL...  232.90         4
16  My Preschool children, ages 3-5 years old with...  298.43         7
24  This year, I am teaching in an EFL (Extended F...  250.00         6

    KmLabel
3         0
16        0
```

```
24        0

[3 rows x 21 columns]
    Unnamed: 0       id                         teacher_id school_state  \
15       67303  p132832  bb6d6d054824fa01576ab38dfa2be160           TX
22       84810  p165540  30f08fbe02eba5453c4ce2e857e88eb4           CA
30      110606  p244865  afa940a60a5c946afc08955ab7583f2f           IN

   project_submitted_datetime  \
15        2016-10-05 21:05:38
22        2016-09-01 10:09:15
30        2017-04-06 16:58:25

                                  project_title  \
15                          Making Recess Active
22                 Books for Budding Intellectuals
30  2nd Grade Explores the World of Charlotte's Web

                                  project_essay_1  \
15  Located in West Dallas, my students face sever...
22  Every day in my English classroom, we work to ...
30  I work in a low income school on the east side...

                                  project_essay_2 project_essay_3  \
15  Due to the size of our school, and the tiny na...             NaN
22  My students need books that interest them so t...             NaN
30  Many of the students in my class have begun re...             NaN

   project_essay_4   ...    teacher_number_of_previously_posted_projects  \
15             NaN   ...                                               3
22             NaN   ...                                               0
30             NaN   ...                                               0

    project_is_approved   clean_categories clean_subcategories clean_grade  \
15                    1      Health_Sports     Health_Wellness         3-5
22                    0  Literacy_Language            Literacy        9-12
30                    1  Literacy_Language            Literacy      PreK-2

   clean_tea_pfx                                              essay   price  \
15            Ms  Located in West Dallas, my students face sever...  435.84
22            Ms  Every day in my English classroom, we work to ...  278.09
30           Mrs  I work in a low income school on the east side...    4.99

    quantity  KmLabel
15        24        7
22        21        7
30        25        7
```

```
[3 rows x 21 columns]
```

step 5: You need to plot the word cloud with essay text for each cluster for each of algorithms mentioned in step 3.

In [393…

```
# https://www.geeksforgeeks.org/generating-word-cloud-python/
# Python program to generate WordCloud

# importing all necessery modules
from wordcloud import WordCloud, STOPWORDS
import matplotlib.pyplot as plt
import pandas as pd

# Reads 'Youtube04-Eminem.csv' file
#df = pd.read_csv(r"Youtube04-Eminem.csv", encoding ="latin-1")

comment_words = ' '
stopwords = set(STOPWORDS)

# iterate through the csv file
for val in X_working_Kmean_clus0["essay"][:1]:

    # typecaste each val to string
    val = str(val)

    # split the value
    tokens = val.split()

    # Converts each token into lowercase
    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,
                min_font_size = 10).generate(comment_words)

# plot the WordCloud image
```

```
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```

2.6 Apply AgglomerativeClustering

In [ ]:
```
# 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
```

In [112…
```
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import chi2
print(X_tr_bow.shape)

bow_Feature= SelectKBest(chi2,k=2000)
X_tr_bow_2K=bow_Feature.fit_transform(X_tr_bow,y)

print("Final Data matrix ")
print(X_tr_bow_2K.shape, y.shape)
```

```
(20000, 14116)
Final Data matrix
(20000, 2000) (20000,)
```

In [113…
```
# TypeError: A sparse matrix was passed, but dense data is required. Use X.toarray() to convert to a dense numpy array.
X_tr_bow_2K=X_tr_bow_2K.toarray()
```

In [98]:
```
# https://stackabuse.com/hierarchical-clustering-with-python-and-scikit-learn/

from sklearn.cluster import AgglomerativeClustering
import numpy as np

noOfCluster = [2, 5]
labelList=[]

for i in noOfCluster:
    clusterAgg =AgglomerativeClustering(n_clusters=i)
    clusterAgg.fit(X_tr_bow_2K)
    labelList.append(clusterAgg.labels_)

print(noOfCluster)
```

```
print(labelList)


#https://stackoverflow.com/questions/34611038/grid-search-for-hyperparameter-evaluation-of-clustering-in-scikit-learn
```

```
[2, 5]
[array([1, 0, 0, ..., 1, 1, 0], dtype=int64), array([1, 0, 2, ..., 1, 1, 4], dtype=int64)]
```

In [379…
```
print(labelList)
labelList0=labelList[0]

# ValueError: Length of values does not match length of index
# so taking label for first columns
print(labelList0)
AggLabel=labelList0
np.unique(AggLabel)
```

```
[array([1, 0, 0, ..., 1, 1, 0], dtype=int64), array([1, 0, 2, ..., 1, 1, 4], dtype=int64)]
[1 0 0 ... 1 1 0]
```

Out[379… `array([0, 1], dtype=int64)`

In [380…
```
X_working_agg = X.copy(deep=True)
X_working_agg["AggLabel"]=AggLabel
X_working_agg.columns
```

Out[380…
```
Index(['Unnamed: 0', 'id', 'teacher_id', 'school_state',
       'project_submitted_datetime', 'project_title', 'project_essay_1',
       'project_essay_2', 'project_essay_3', 'project_essay_4',
       'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'clean_grade',
       'clean_tea_pfx', 'essay', 'price', 'quantity', 'AggLabel'],
      dtype='object')
```

step 4: Summarize each cluster by manually observing few points from each cluster.

In [381…
```
X_working_agg_clus0=X_working_agg[X_working_agg.AggLabel==0]
print(X_working_agg_clus0.head(3))

X_working_agg_clus1=X_working_agg[X_working_agg.AggLabel==1]
print(X_working_agg_clus1.head(3))
```

```
   Unnamed: 0       id                         teacher_id school_state  \
1      140945  p258326  897464ce9ddc600bced1151f324dd63a           FL
```

```
2       21895  p182444  3465aaf82da834c0582ebd0ef8040ca0           AZ
5      141660  p154343  a50a390e8327a95b77b9e495b58b9a6e           FL

  project_submitted_datetime  \
1        2016-10-25 09:22:10
2        2016-08-31 12:03:56
5        2017-04-08 22:40:43

                                    project_title  \
1             Wanted: Projector for Hungry Learners
2  Soccer Equipment for AWESOME Middle School Stu...
5  Flexible Seating for Mrs. Jarvis' Terrific Thi...

                                   project_essay_1  \
1  Our students arrive to our school eager to lea...
2  \r\n\"True champions aren't always the ones th...
5  I will be moving from 2nd grade to 3rd grade a...

                                   project_essay_2 project_essay_3  \
1  The projector we need for our school is very c...             NaN
2  The students on the campus come to school know...             NaN
5  These flexible seating options will allow my s...             NaN

  project_essay_4    ...    teacher_number_of_previously_posted_projects  \
1             NaN    ...                                               7
2             NaN    ...                                               1
5             NaN    ...                                               1

   project_is_approved               clean_categories  \
1                    1    History_Civics Health_Sports
2                    0                   Health_Sports
5                    1  Literacy_Language SpecialNeeds

              clean_subcategories clean_grade clean_tea_pfx  \
1    Civics_Government TeamSports         6-8            Mr
2      Health_Wellness TeamSports         6-8            Ms
5  Literature_Writing SpecialNeeds         3-5           Mrs

                                           essay   price  quantity  \
1  Our students arrive to our school eager to lea...  299.00         1
2  \r\n\"True champions aren't always the ones th...  516.85        22
5  I will be moving from 2nd grade to 3rd grade a...  113.22        11

   AggLabel
1         0
2         0
5         0
```

```
[3 rows x 21 columns]
   Unnamed: 0       id                         teacher_id school_state  \
0      160221  p253737  c90749f5d961ff158d4b4d1e7dc665fc           IN
3          45  p246581  f3cb9bffbba169bef1a77b243e620b60           KY
4      172407  p104768  be1f7507a41f8479dc06f047086a39ec           TX

  project_submitted_datetime  \
0        2016-12-05 13:43:57
3        2016-10-06 21:16:17
4        2016-07-11 01:10:09

                                    project_title  \
0  Educational Support for English Learners at Home
3                           Techie Kindergarteners
4                           Interactive Math Tools

                                   project_essay_1  \
0  My students are English learners that are work...
3  I work at a unique school filled with both ESL...
4  Our second grade classroom next year will be m...

                                   project_essay_2 project_essay_3  \
0  \"The limits of your language are the limits o...             NaN
3  My students live in high poverty conditions wi...             NaN
4  For many students, math is a subject that does...             NaN

  project_essay_4    ...    teacher_number_of_previously_posted_projects  \
0             NaN    ...                                               0
3             NaN    ...                                               4
4             NaN    ...                                               1

   project_is_approved               clean_categories   clean_subcategories  \
0                    0              Literacy_Language          ESL Literacy
3                    1  Literacy_Language Math_Science  Literacy Mathematics
4                    1                    Math_Science           Mathematics

  clean_grade clean_tea_pfx  \
0     PreK-2           Mrs
3     PreK-2           Mrs
4     PreK-2           Mrs

                                          essay   price  quantity  \
0  My students are English learners that are work...  154.60        23
3  I work at a unique school filled with both ESL...  232.90         4
4  Our second grade classroom next year will be m...   67.98         4
```

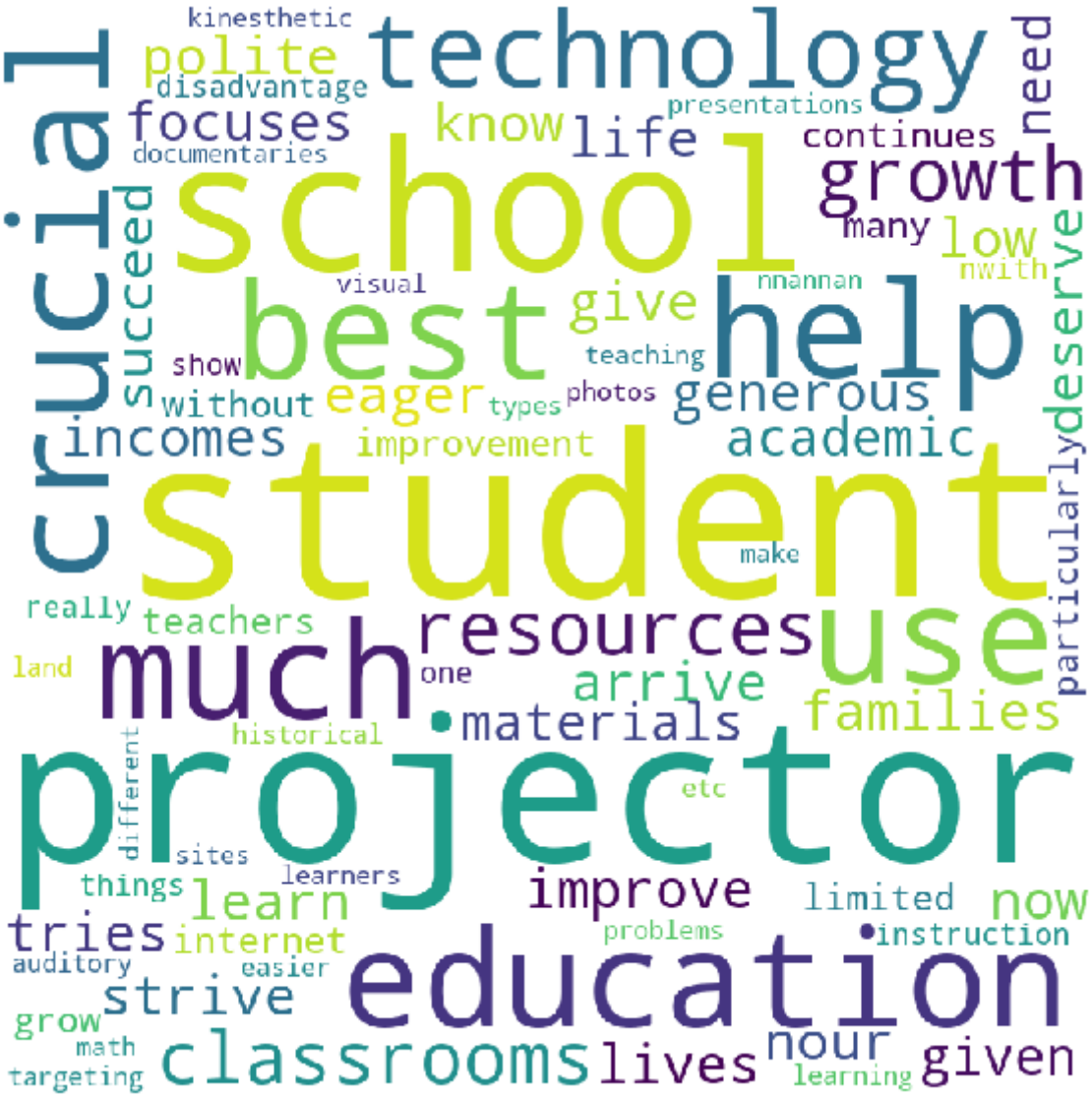
```
   AggLabel
0         1
3         1
4         1

[3 rows x 21 columns]
```

step 5: You need to plot the word cloud with essay text for each cluster for each of algorithms mentioned in step 3.

In [382…

```
# https://www.geeksforgeeks.org/generating-word-cloud-python/
# Python program to generate WordCloud

# importing all necessery modules
from wordcloud import WordCloud, STOPWORDS
import matplotlib.pyplot as plt
import pandas as pd

# Reads 'Youtube04-Eminem.csv' file
#df = pd.read_csv(r"Youtube04-Eminem.csv", encoding ="latin-1")

comment_words = ' '
stopwords = set(STOPWORDS)

# iterate through the csv file
for val in X_working_agg_clus0["essay"][:1]:

    # typecaste each val to string
    val = str(val)

    # split the value
    tokens = val.split()

    # Converts each token into lowercase
    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,
                min_font_size = 10).generate(comment_words)

# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



2.7 Apply DBSCAN

1. For each point, in dataset, find the kth neighbour distance.

2. Put distance and indexes in a dictionary as key value pairs and then sort the dictionary according to the keys? And plot the final result ?" For example: x1 20 x2 15 x3 18 x4 9 So after sorting in increasing order = > x4 9; x2 15; x3 18; x1 20

3. Draw the polt with K and distance

In [120…
```
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import chi2
print(X_tr_bow.shape)

bow_Feature= SelectKBest(chi2,k=50)
X_tr_bow_50=bow_Feature.fit_transform(X_tr_bow,y)

print("Final Data matrix ")
print(X_tr_bow_50.shape, y.shape)
```

```
(20000, 14116)
Final Data matrix
(20000, 50) (20000,)
```

In [121…
```
X_tr_bow_1000_50=X_tr_bow_50[:1000]
```

In [282…
```
#print(X_tr_bow_1000_50[1].shape)
#print(X_tr_bow_1000_50[1])
print(type(X_tr_bow_50))
X_tr_bow_1000_50=X_tr_bow_50[:1000]
print(type(X_tr_bow_1000_50))
print(type(X_tr_bow_1000_50[1]))
#print(X_tr_bow_1000_50.todense())
print(type(X_tr_bow_2K))
```

```
<class 'scipy.sparse.csr.csr_matrix'>
<class 'scipy.sparse.csr.csr_matrix'>
<class 'scipy.sparse.csr.csr_matrix'>
<class 'numpy.ndarray'>
```

In [273…
```
import operator
def getNeighbors(trainingSet, pivotInstance, k):
    distances = []
    #print(pivotInstance)
    #pivotInstance=pivotInstance.todense()
    #trainingSet=trainingSet.todense()
    for x in range(trainingSet.shape[0]):
        dist = euclideanDistance(pivotInstance, trainingSet[x])
```

```
            distances.append(dist)
        # sorrting the distances.
        distances.sort()
        neighbors = []
        # takes points, which are near neighbour
        neighbors=distances[k]
        return neighbors
```

In [274…

```
# https://www.edureka.co/community/18851/plot-a-k-distance-graph-in-python

# https://machinelearningmastery.com/tutorial-to-implement-k-nearest-neighbors-in-python-from-scratch/#
import math
def euclideanDistance(instance1, instance2):
    # how to find euclidean distance in python

    # https://stackoverflow.com/questions/1401712/how-can-the-euclidean-distance-be-calculated-with-numpy
    EUdist=np.linalg.norm((instance1 - instance2),ord=2)
    #print(EUdist)
    return EUdist
```

In [275…

```
# https://stackoverflow.com/questions/12893492/choosing-eps-and-minpts-for-dbscan-r/48558030#48558030
minPoint=100
epi=[]
for i in tqdm(range(X_tr_bow_2K.shape[0])):
    epi.append(getNeighbors(X_tr_bow_2K,X_tr_bow_2K[i],minPoint))
```

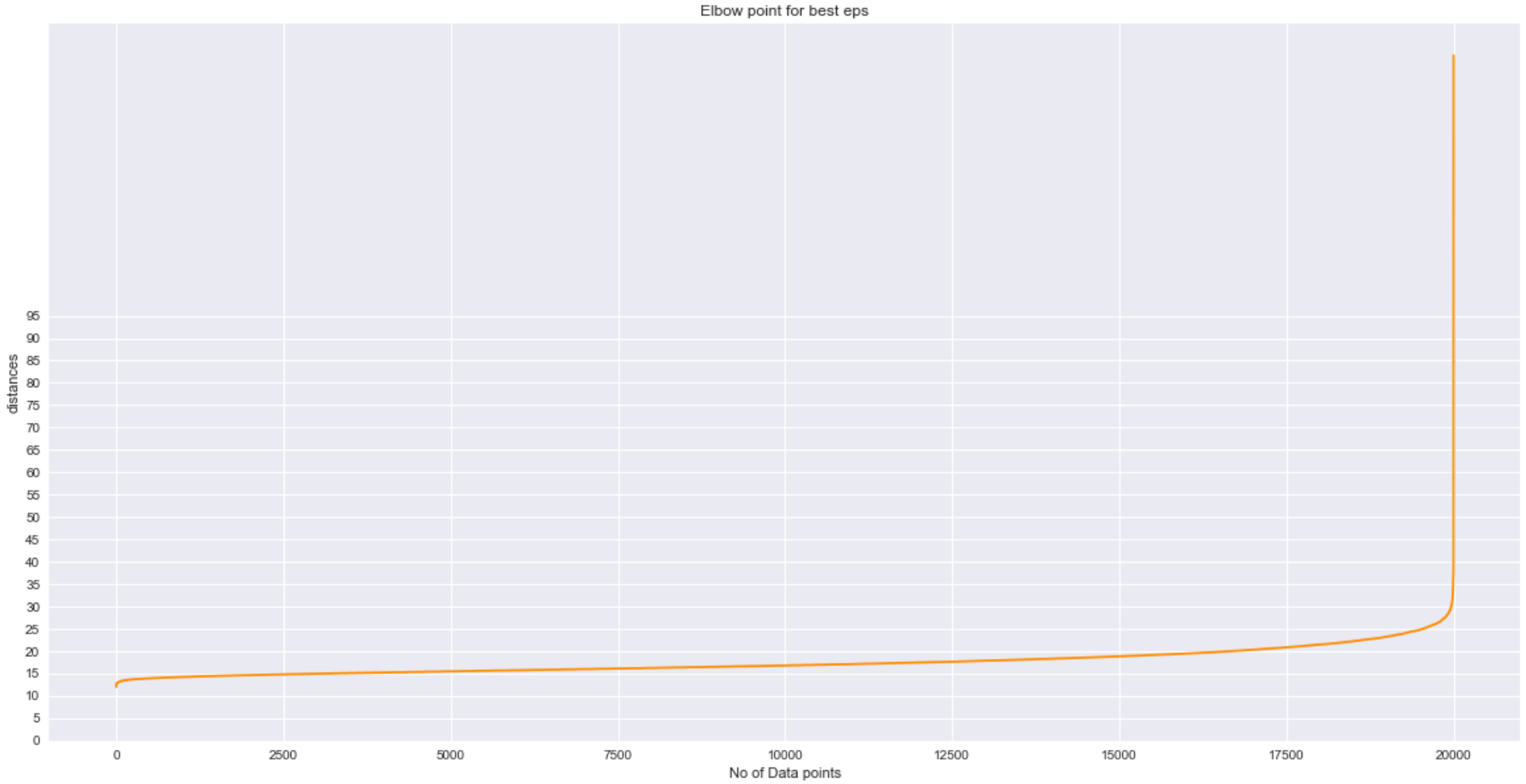
```
100%|██████████████████████████████████████████████████████████████████████████████| 20000/20000 [1:38:38<00:00,  3.44it/s]
```

In [383…

```
sorted_epi=sorted(epi)
#sorted_epi
```

In [384…

```
plt.figure(figsize=(20,10))
plt.plot(sorted_epi,color='darkorange')
#plt.legend()
plt.xlabel("No of Data points")
plt.ylabel("distances")
plt.title("Elbow point for best eps")
plt.yticks([x for x in range(0,100,5)])
plt.grid(True)
plt.show()
```



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
```

In [101…
```
#from sklearn.feature_selection import SelectKBest
#from sklearn.feature_selection import chi2
```

```
#print(X_tr_bow.shape)
#
#bow_Feature= SelectKBest(chi2,k=50)
#X_tr_bow_50=bow_Feature.fit_transform(X_tr_bow,y)
#
#print("Final Data matrix ")#
#print(X_tr_bow_50.shape, y.shape)
```

```
(20000, 14116)
Final Data matrix
(20000, 50) (20000,)
```

In [297…
```
# https://scikit-learn.org/stable/modules/generated/sklearn.cluster.KMeans.html
# https://stackoverflow.com/questions/51514158/how-to-run-gridsearchcv-for-k-means-using-spark-sklearn
from sklearn.cluster import DBSCAN
import numpy as np

dbs=DBSCAN(eps=28, min_samples=100).fit(X_tr_bow_2K)
```

In [298…
```
DBlabels=dbs.labels_
```

In [353…
```
print(DBlabels)
print(np.unique(DBlabels))
```

```
[0 0 0 ... 0 0 0]
[-1  0]
```

In [355…
```
X_working = X.copy(deep=True)
X_working["DBLabels"]=DBlabels
X_working.columns
```

Out[355…
```
Index(['Unnamed: 0', 'id', 'teacher_id', 'school_state',
       'project_submitted_datetime', 'project_title', 'project_essay_1',
       'project_essay_2', 'project_essay_3', 'project_essay_4',
       'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'clean_categories', 'clean_subcategories', 'clean_grade',
       'clean_tea_pfx', 'essay', 'price', 'quantity', 'DBLabels'],
      dtype='object')
```

In [359…
```
X_working_noise=X_working[X_working.DBLabels==-1]
X_working_clus0=X_working[X_working.DBLabels==0]
```

step 4: Summarize each cluster by manually observing few points from each cluster.

In [388…
```
print(X_working_clus0.head(3))
print(X_working_noise.head(3))
```

```
   Unnamed: 0       id                         teacher_id school_state  \
0      160221  p253737  c90749f5d961ff158d4b4d1e7dc665fc           IN
1      140945  p258326  897464ce9ddc600bced1151f324dd63a           FL
2       21895  p182444  3465aaf82da834c0582ebd0ef8040ca0           AZ

  project_submitted_datetime  \
0        2016-12-05 13:43:57
1        2016-10-25 09:22:10
2        2016-08-31 12:03:56

                                    project_title  \
0   Educational Support for English Learners at Home
1              Wanted: Projector for Hungry Learners
2  Soccer Equipment for AWESOME Middle School Stu...

                                    project_essay_1  \
0  My students are English learners that are work...
1  Our students arrive to our school eager to lea...
2  \r\n\"True champions aren't always the ones th...

                                    project_essay_2 project_essay_3  \
0  \"The limits of your language are the limits o...             NaN
1  The projector we need for our school is very c...             NaN
2  The students on the campus come to school know...             NaN

  project_essay_4    ...    teacher_number_of_previously_posted_projects  \
0             NaN    ...                                               0
1             NaN    ...                                               7
2             NaN    ...                                               1

   project_is_approved             clean_categories  \
0                    0            Literacy_Language
1                    1  History_Civics Health_Sports
2                    0               Health_Sports

           clean_subcategories clean_grade clean_tea_pfx  \
0                 ESL Literacy      PreK-2           Mrs
1  Civics_Government TeamSports         6-8            Mr
2    Health_Wellness TeamSports         6-8            Ms

                                           essay   price  quantity  \
0  My students are English learners that are work...  154.60        23
1  Our students arrive to our school eager to lea...  299.00         1
```

```
2  \r\n\"True champions aren't always the ones th...  516.85        22

   DBLabels
0         0
1         0
2         0

[3 rows x 21 columns]
      Unnamed: 0       id                         teacher_id school_state  \
3441      117467  p064802  4ceddad7ccc70d29e40a4e06a6616674           VA
4195       94544  p091272  68d1135a7f04d5ad727f9015bffaa9ab           NY
5132       82686  p114039  536aa1fd06ca90ccec54bee2212b3642           UT

     project_submitted_datetime  \
3441        2016-05-03 15:21:42
4195        2016-09-25 10:55:20
5132        2016-09-29 23:16:45

                                      project_title  \
3441                 Sing It Read It ! Play It Say It!
4195  Creativity Through Dance Education & Dance Tec...
5132                         \"Wrapping Up Math Facts\"

                                     project_essay_1  \
3441  \"The more that you read, the more things you ...
4195  Lets change the world through dance. \r\nI tea...
5132  It's the start of a brand-new school day and m...

                                     project_essay_2  \
3441  My students come from diverse cultures includi...
4195  My students whom I refer to as dancers are in ...
5132  My 25 third grade students would greatly benef...

                                     project_essay_3  \
3441  My students will learn letters and sight words...
4195                                              NaN
5132                                              NaN

                                     project_essay_4    ...     \
3441  These music books, singing games, and  music v...    ...
4195                                              NaN    ...
5132                                              NaN    ...

     teacher_number_of_previously_posted_projects  project_is_approved  \
3441                                            4                   1
4195                                            0                   1
5132                                            0                   1
```

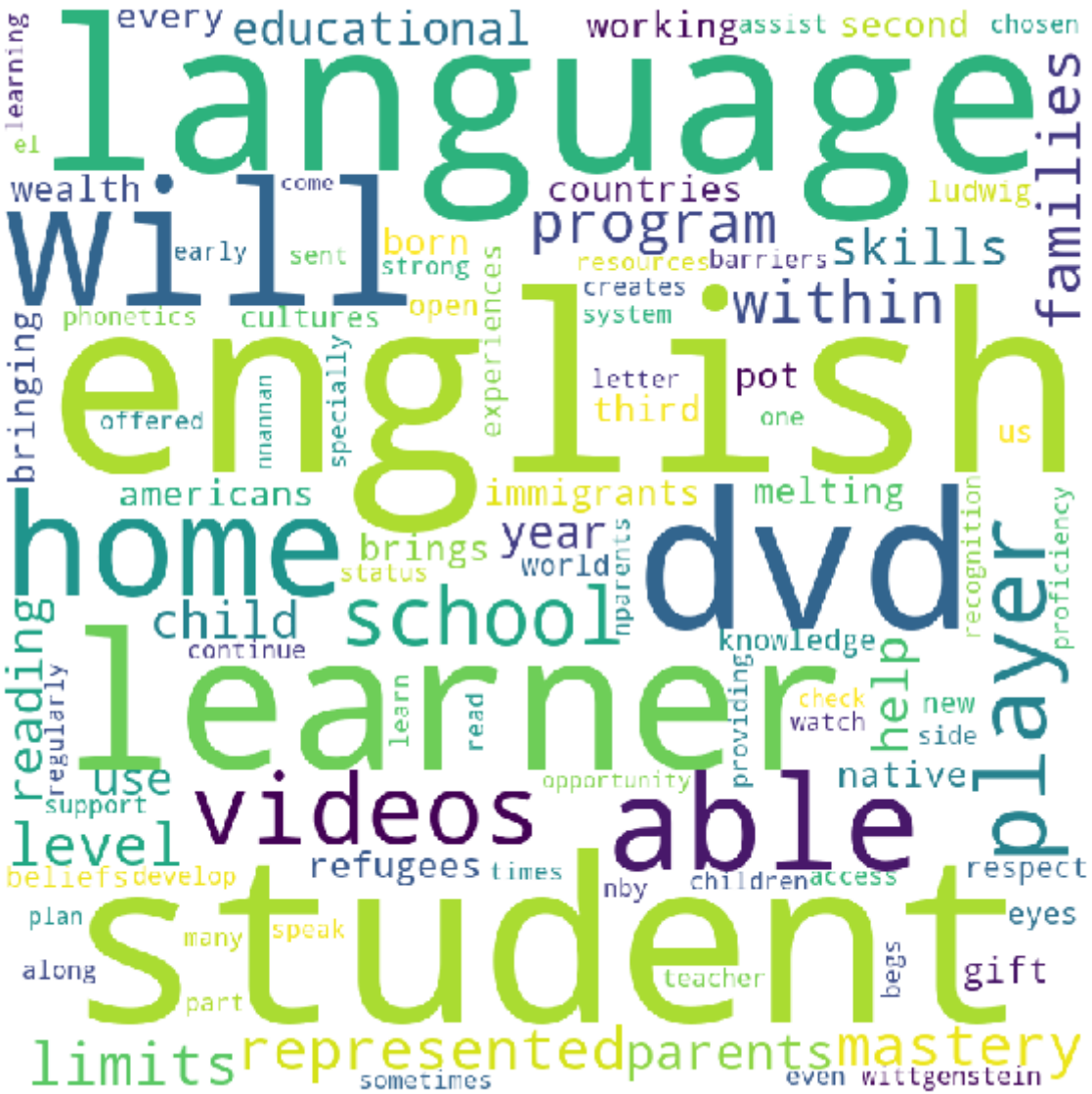
```
                clean_categories       clean_subcategories clean_grade  \
3441  Literacy_Language Music_Arts  Literature_Writing Music      PreK-2
4195                   Music_Arts            PerformingArts      PreK-2
5132     Math_Science SpecialNeeds  Mathematics SpecialNeeds         3-5

     clean_tea_pfx                                              essay   price  \
3441           Mrs  \"The more that you read, the more things you ...  325.89
4195            Ms  Lets change the world through dance. \r\nI tea...   91.67
5132           Mrs  It's the start of a brand-new school day and m...   19.26

      quantity  DBLabels
3441        14        -1
4195        17        -1
5132        52        -1

[3 rows x 21 columns]
```

step 5: You need to plot the word cloud with essay text for each cluster for each of algorithms mentioned in step 3.

In [360…

```
# https://www.geeksforgeeks.org/generating-word-cloud-python/
# Python program to generate WordCloud

# importing all necessery modules
from wordcloud import WordCloud, STOPWORDS
import matplotlib.pyplot as plt
import pandas as pd

# Reads 'Youtube04-Eminem.csv' file
#df = pd.read_csv(r"Youtube04-Eminem.csv", encoding ="latin-1")

comment_words = ' '
stopwords = set(STOPWORDS)

# iterate through the csv file
for val in X_working_clus0["essay"][:1]:

    # typecaste each val to string
    val = str(val)

    # split the value
    tokens = val.split()
```

```
    # Converts each token into lowercase
    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,
                min_font_size = 10).generate(comment_words)

# plot the WordCloud image
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



3. Conclusions

- Logistic regression, without splitting the data give AUC of 0.92111529754
- K-Mean algorithm, give best_k as 10

- Run AgglomerativeClustering algorithm on two cluster[2,5], and draw word count on cluster 2.
- DBSCAN algorithm, give best_epi as 28, and draw word count on cluster 0.