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`
`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

Feature	Description
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`
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."

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
```

```
C:\ProgramData\Anaconda3\lib\site-packages\gensim\utils.py:1197: UserWarning: detected Windows; al
iasing chunkize to chunkize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_serial")
```

1.1 Reading Data

In [2]:

```
project_data = pd.read_csv('train_data.csv',nrows=50000)
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 (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 [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

In [5]:

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

Out[5]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	proje
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Grade

In [6]:

```
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')
project_data.head(5)
```

Out[6]:

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	pro
0	160221	p253737	c90749f5d961ff158d4b4d1e7dc665fc	Mrs.	IN	2016-12-05 13:43:57	Gra
1	140945	p258326	897464ce9ddc600bced1151f324dd63a	Mr.	FL	2016-10-25 09:22:10	Gra
2	21895	p182444	3465aaf82da834c0582ebd0ef8040ca0	Ms.	AZ	2016-08-31 12:03:56	Gra

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	pro
3	45	p246581	f3cb9bffbba169bef1a77b243e620b60	Mrs.	KY	2016-10-06 21:16:17	Gra
4	172407	p104768	be1f7507a41f8479dc06f047086a39ec	Mrs.	TX	2016-07-11 01:10:09	Gra

1.2 preprocessing of `project_subject_categories`

In [7]:

```
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 & H
unger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "Math & Scienc
e"=> "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 [8]:

```
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 & H
unger"]
        if 'The' in j.split(): # this will split each of the catogory based on space "Math & Scienc
e"=> "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 [9]:

```
catogories = 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
cat_list = []
for j in catogories:
    temp = ""
    j=j.replace(' ','_')
    j = j.replace('-','To')
    temp+=j
    cat_list.append(temp)

project_data['project_grade_category'] = cat_list
```

1.5 Text preprocessing

In [10]:

```
# 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 [11]:

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

Out[11]:

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

	Unnamed: 0	id	teacher_id	teacher_prefix	school_state	project_submitted_datetime	pro

In [12]:

```
#### 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)
```

```
My students are English learners that are working on English as their second or third languages. W
e are a melting pot of refugees, immigrants, and native-born Americans bringing the gift of langua
ge to our school. \r\n\r\n We have over 24 languages represented in our English Learner program wi
th students at every level of mastery.  We also have over 40 countries represented with the
families within our school.  Each student brings a wealth of knowledge and experiences to us that
open our eyes to new cultures, beliefs, and respect.\"The limits of your language are the limits o
f your world.\"-Ludwig Wittgenstein  Our English learner's have a strong support system at home th
at begs for more resources.  Many times our parents are learning to read and speak English along s
ide of their children.  Sometimes this creates barriers for parents to be able to help their child
learn phonetics, letter recognition, and other reading skills.\r\n\r\nBy providing these dvd's and
players, students are able to continue their mastery of the English language even if no one at hom
e 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 En
glish Learner Teacher and will be sent home regularly to watch.  The videos are to help the child
develop early reading skills.\r\n\r\nParents that do not have access 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 ed
ucational 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 l
east most of the time. At our school, 97.3% of the students receive free or reduced price lunch. O
f 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 bea
utiful costumes that students wear. On Cinco de Mayo we put on a big festival with crafts made by
the students, dances, and games. At the end of the year the school hosts a carnival to celebrate t
he hard work put in during the school year, with a dunk tank being the most popular activity.My st
udents will use these five brightly colored Hokki stools in place of regular, stationary, 4-legged
chairs. As I will only have a total of ten in the classroom and not enough for each student to hav
e 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 occasion. I will utilize them in place of
chairs at my small group tables during math and reading times. The rest of the day they will be us
ed by the students who need the highest amount of movement in their life in order to stay focused
on school.\r\n\r\nWhenever asked what the classroom is missing, my students always say more Hokki
Stools. They can't get their fill of the 5 stools we already have. When the students are sitting i
n 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 ta
ken. There are always students 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 ask 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 move at th
e 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 for 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 of 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\nThey attend a Title I school, which means there is a high enough percentage of free a
nd reduced-price lunch to qualify. Our school is an \"open classroom\" concept, which is very uniq
ue as there are no walls separating the classrooms. These 9 and 10 year-old students are very eage
r learners; they are like sponges, absorbing all the information and experiences and keep on wanti
ng more.With these resources such as the comfy red throw pillows and the whimsical nautical hangin
g decor and the blue fish nets, I will be able 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 step foot into our classroom for the first time on Meet the Teacher evening. I'll take pic
tures 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 cards to their team groups.\r\n\r\nYour generous donations will help me to help make our
classroom a fun, inviting, learning environment 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 helping with this project t
o make our new school year a very successful one. Thank you!nannan
==================================================
My kindergarten students have varied disabilities ranging from speech and language delays, cogniti
ve delays, gross/fine motor delays, to autism. They are eager beavers and always strive to work th
eir hardest working past their limitations. \r\n\r\nThe 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 pr
ice 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 gr
oove 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 dev
elop their core, which enhances gross motor and in Turn fine motor skills. \r\nThey also want to l
earn through games, my kids don't want to sit and do worksheets. They want to learn to count by ju
mping and playing. Physical engagement is the key to our success. The number toss and color and sh
ape 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 [13]:

```python
# 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]:

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

```
My kindergarten students have varied disabilities ranging from speech and language delays, cogniti
ve delays, gross/fine motor delays, to autism. They are eager beavers and always strive to work th
eir hardest working past their limitations. \r\n\r\nThe 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 pr
ice 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 gr
oove 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 dev
elop their core, which enhances gross motor and in Turn fine motor skills. \r\nThey also want to l
earn through games, my kids do not want to sit and do worksheets. They want to learn to count by j
umping and playing. Physical engagement is the key to our success. The number toss and color and s
hape 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]:

```python
# \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, cogniti
ve delays, gross/fine motor delays, to autism. They are eager beavers and always strive to work th
eir 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 eag
er to learn and explore.Have you ever felt like you had ants in your pants and you needed to groov
e 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 develo
p their core, which enhances gross motor and in Turn fine motor skills.   They also want to learn t
hrough 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 color and shape ma
ts can make that happen. My students will forget they are doing work and just have the fun a 6 yea
r 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 cognitiv
e 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 studen
ts 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 lea
rn and explore Have you ever felt like you had ants in your pants and you needed to groove and mov
e as you were in a meeting This is how my kids feel all the time The want to be able to move as th
ey learn or so they say Wobble chairs are the answer and I love then because they develop their co
re 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 Ph
ysical 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 nan
nan
```

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', 'e
ach', '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', "do
esn'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%|██████████████████████████████████████████████████████████████████████████████| 50000/50000
[00:42<00:00, 1173.46it/s]
```

In [19]:

```
# after preprocesing
preprocessed_essays[20000]
```

Out[19]:

```
'my kindergarten students varied disabilities ranging speech language delays cognitive delays gros
s 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 students receive free reduced price lunc
h despite disabilities limitations students love coming school come eager learn explore have ever
felt like ants pants needed groove move meeting this kids feel time the want able move learn say w
obble chairs answer i love develop core enhances gross motor turn fine motor skills they also want
learn games kids not want sit worksheets they want learn count jumping playing physical engagement
key success the number toss color shape mats make happen my students forget work fun 6 year old de
serves nannan'
```

1.6 Preprocessing of `project_title`

In [20]:

```
# Displaying first two datasets
project_data.head(2)
```

Out[20]:

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

In [21]:

```
# printing some random project titles.
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)
```

```
Educational Support for English Learners at Home
==================================================
More Movement with Hokki Stools
==================================================
Sailing Into a Super 4th Grade Year
==================================================
```

In [22]:

```
# https://stackoverflow.com/a/47091490/4084039
import re

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

    # 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 [23]:

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

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

In [24]:

```
# \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)
```

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

In [25]:

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

```
we need to move it while we input it
```

In [26]:

```
# 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', '
            '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', 'e
ach', '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', "do
esn'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 [27]:

```
sent = ' '.join(e for e in sent.split() if e not in stopwords)
print(sent)
```

```
need move input
```

In [28]:

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

```
100%|████████████████████████████████████████████████████████████| 50000/50000
[00:02<00:00, 24147.85it/s]
```

In [29]:

```
# after preprocesing
preprocessed_project_titles[20000]
```

Out[29]:

```
'need move input'
```

2.1 Preparing data for models

In [30]:

```
project_data.columns
```

Out[30]:

```
Index(['Unnamed: 0', 'id', 'teacher_id', 'teacher_prefix', 'school_state',
       'project_submitted_datetime', 'project_grade_category', 'project_title',
       'project_essay_1', 'project_essay_2', 'project_essay_3',
       'project_essay_4', 'project_resource_summary',
       'teacher_number_of_previously_posted_projects', 'project_is_approved',
       'price', 'quantity', '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
```

2.2 Vectorizing Categorical data

- https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/handling-categorical-and-numerical-features/

In [31]:

```
# we use count vectorizer to convert the values into one hot encoded features
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_cat_dict.keys()), lowercase=False, binary=True
)
vectorizer.fit(project_data['clean_categories'].values)
print(vectorizer.get_feature_names())


categories_one_hot = vectorizer.transform(project_data['clean_categories'].values)
print("Shape of matrix after one hot encodig ",categories_one_hot.shape)
```

```
['Warmth', 'Care_Hunger', 'History_Civics', 'Music_Arts', 'AppliedLearning', 'SpecialNeeds',
'Health_Sports', 'Math_Science', 'Literacy_Language']
Shape of matrix after one hot encodig  (50000, 9)
```

In [32]:

```
# we use count vectorizer to convert the values into one hot encoded features
vectorizer = CountVectorizer(vocabulary=list(sorted_sub_cat_dict.keys()), lowercase=False, binary=
True)
vectorizer.fit(project_data['clean_subcategories'].values)
print(vectorizer.get_feature_names())


sub_categories_one_hot = vectorizer.transform(project_data['clean_subcategories'].values)
print("Shape of matrix after one hot encodig ",sub_categories_one_hot.shape)
```

```
['Economics', 'CommunityService', 'FinancialLiteracy', 'ParentInvolvement', 'Extracurricular',
'Civics_Government', 'ForeignLanguages', 'NutritionEducation', 'Warmth', 'Care_Hunger',
'SocialSciences', 'PerformingArts', 'CharacterEducation', 'TeamSports', 'Other',
'College_CareerPrep', 'Music', 'History_Geography', 'Health_LifeScience', 'EarlyDevelopment', 'ESL
', 'Gym_Fitness', 'EnvironmentalScience', 'VisualArts', 'Health_Wellness', 'AppliedSciences',
'SpecialNeeds', 'Literature_Writing', 'Mathematics', 'Literacy']
Shape of matrix after one hot encodig  (50000, 30)
```

In [33]:

```
# we use count vectorizer to convert the values into one hot encoded features
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer('school_state', lowercase=False)
vectorizer.fit(project_data['school_state'].values)
print(vectorizer.get_feature_names())


school_state_one_hot = vectorizer.transform(project_data['school_state'].values)
school_state_one_hot = vectorizer.transform(project_data['school_state'].values)
print("Shape of matrix after one hot encodig ", school_state_one_hot.shape)
```

```
['AK', 'AL', 'AR', 'AZ', 'CA', 'CO', 'CT', 'DC', 'DE', 'FL', 'GA', 'HI', 'IA', 'ID', 'IL', 'IN', 'K
S', 'KY', 'LA', 'MA', 'MD', 'ME', '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']
Shape of matrix after one hot encodig  (50000, 51)
```

In [34]:

```
from collections import Counter
my_counter = Counter()
for word in project_data['project_grade_category'].values:
    my_counter.update(word.split())
project_grade_cat_dict = dict(my_counter)
sorted_project_grade_dict = dict(sorted(project_grade_cat_dict.items(), key=lambda kv: kv[1]))
# we use count vectorizer to convert the values into one hot encoded features
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer(vocabulary=list(sorted_project_grade_dict.keys()), lowercase=False)
vectorizer.fit(project_data['project_grade_category'].values)
print(vectorizer.get_feature_names())


project_grade_category_one_hot =
vectorizer.transform(project_data['project_grade_category'].values)
print("Shape of matrix after one hot encodig ",project_grade_category_one_hot.shape)
```

```
['Grades_9To12', 'Grades_6To8', 'Grades_3To5', 'Grades_PreKTo2']
Shape of matrix after one hot encodig  (50000, 4)
```

In [35]:

```
# we use count vectorizer to convert the values into one hot encoded features
project_data['teacher_prefix'].fillna(value='Teacher',inplace=True)
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer('teacher_prefix', lowercase=False)
vectorizer.fit(project_data['teacher_prefix'].values)
print(vectorizer.get_feature_names())


teacher_prefix_one_hot = vectorizer.transform(project_data['teacher_prefix'].values)
print("Shape of matrix after one hot encodig ",teacher_prefix_one_hot.shape)
```

```
['Dr', 'Mr', 'Mrs', 'Ms', 'Teacher']
Shape of matrix after one hot encodig  (50000, 5)
```

2.3 Vectorizing Text data

Bag of words

Vectorizing Essay Text

In [36]:

```
# We are considering only the words which appeared in at least 10 documents(rows or projects).
vectorizer = CountVectorizer(min_df=10,max_features=5000)
text_bow = vectorizer.fit_transform(preprocessed_essays)
print("Shape of matrix after one hot encodig ",text_bow.shape)
```

```
Shape of matrix after one hot encodig  (50000, 5000)
```

Vectorizing Title Text

In [37]:

```
# We are considering only the words which appeared in at least 10 documents(rows or projects).
vectorizer = CountVectorizer(min_df=10)
title_bow = vectorizer.fit_transform(preprocessed_project_titles)
print("Shape of matrix after one hot encodig ",title_bow.shape)
```

```
Shape of matrix after one hot encodig  (50000, 2039)
```

2.4 Vectorizing Numerical features

In [38]:

```
# 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 = (project_data['price'].values.reshape(-1, 1))
price_standardized.shape
```

Out[38]:

```
(50000, 1)
```

In [39]:

```
# 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

teacher_number_of_previously_posted_projects_standardized
=(project_data['teacher_number_of_previously_posted_projects'].values.reshape(-1, 1))
teacher_number_of_previously_posted_projects_standardized.shape
```

Out[39]:

```
(50000, 1)
```

In [40]:

```
# 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

quantity_standardized = (project_data['quantity'].values.reshape(-1, 1))
quantity_standardized.shape
```

Out[40]:

```
(50000, 1)
```

2.5 Merging all the above features

In [42]:

```
# Stacking for BOW
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
# with the same hstack function we are concatinating a sparse matrix and a dense matirx :)
X = hstack((text_bow,title_bow,categories_one_hot,
sub_categories_one_hot,school_state_one_hot,project_grade_category_one_hot,teacher_prefix_one_hot,
title_bow,
price_standardized,teacher_number_of_previously_posted_projects_standardized,quantity_standardized
))
X.shape
```

Out[42]:

```
(50000, 9180)
```

2.6 Dimensionality Reduction on the selected features

In [43]:

```
from sklearn.feature_selection import SelectKBest, chi2

X_new = SelectKBest(chi2,k=5000).fit_transform(X,y)
print(X_new.shape)
```

```
(50000, 5000)
```

2.7 Apply Kmeans

In [48]:

```
#https://scikit-learn.org/stable/modules/generated/sklearn.cluster.KMeans.html
from sklearn.cluster import KMeans
cluster_range = range( 1, 11 )
score=[]
for i in cluster_range:
    kmeans=KMeans(n_clusters=i,random_state=0).fit(X_new)
    score.append(kmeans.inertia_)
```

In [49]:

```
clusters_df = pd.DataFrame( { "num_clusters":cluster_range, "cluster_errors": score } )
```

In [50]:

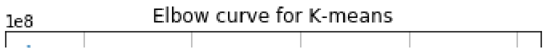
```
clusters_df[0:10]
```

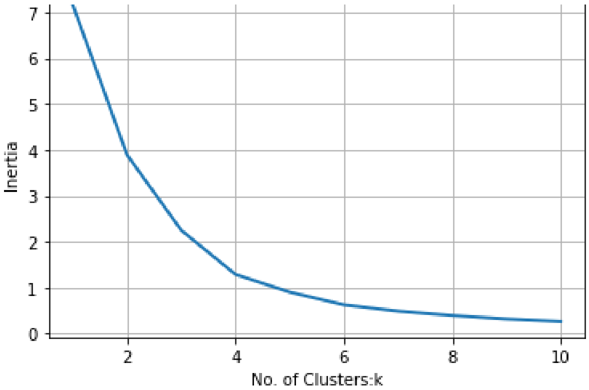
Out[50]:

	num_clusters	cluster_errors
0	1	7.161112e+08
1	2	3.893656e+08
2	3	2.250990e+08
3	4	1.289226e+08
4	5	9.021249e+07
5	6	6.271691e+07
6	7	4.895610e+07
7	8	3.949321e+07
8	9	3.171190e+07
9	10	2.642686e+07

In [51]:

```
# Plotting Elbow Curve
plt.plot(clusters_df.num_clusters,clusters_df.cluster_errors,linewidth=2)
plt.grid()
plt.xlabel("No. of Clusters:k")
plt.ylabel("Inertia")
plt.title("Elbow curve for K-means")
plt.show()
```





In [52]:

```
# Applying k-means on n_clusters=2 and fitting
kmeans=KMeans(n_clusters=2,random_state=0).fit(X_new)
```

In [53]:

```
count=0;
project_title=[]
school_state=[]
price=[]
project_grade_category=[]
teacher_prefix=[]
clean_categories=[]
i=0
for i in range(5000):
    if(kmeans.predict(X_new[i])==0):
        project_title.append(project_data['project_title'][i])
        school_state.append(project_data['school_state'][i])
        price.append(project_data['price'][i])
        project_grade_category.append(project_data['project_grade_category'][i])
        teacher_prefix.append(project_data['teacher_prefix'][i])
        clean_categories.append(project_data['clean_categories'][i])
        count=count+1;
        if(count==5):
            break;
```

In [54]:

```
from pandas import DataFrame
cluster1={'Title':project_title,'State':school_state,'Price':price,'Project
Grade':project_grade_category,'Teacher Prefix':teacher_prefix,'Subject category':clean_categories}
df_project_not_approved=DataFrame(cluster1,columns=['Title','State','Price','Project
Grade','Teacher Prefix','Subject category'])
```

In [55]:

```
#printing cluster1
df_project_not_approved
```

Out[55]:

	Title	State	Price	Project Grade	Teacher Prefix	Subject category
0	Educational Support for English Learners at Home	IN	154.60	Grades_PreKTo2	Mrs.	Literacy_Language
1	Wanted: Projector for Hungry Learners	FL	299.00	Grades_6To8	Mr.	History_Civics Health_Sports
2	Soccer Equipment for AWESOME Middle School Stu...	AZ	516.85	Grades_6To8	Ms.	Health_Sports
3	Techie Kindergarteners	KY	232.90	Grades_PreKTo2	Mrs.	Literacy_Language Math_Science

	Title	State	Price	Project Grade	Teacher Prefix	Subject category
4	Interactive Math Tools	TX	67.98	Grades_PreKTo2	Mrs.	Math_Science

In [56]:

```
count=0;
project_title=[]
school_state=[]
price=[]
project_grade_category=[]
teacher_prefix=[]
clean_categories=[]
i=0
for i in range(5000):
    if(kmeans.predict(X_new[i])==1):
        project_title.append(project_data['project_title'][i])
        school_state.append(project_data['school_state'][i])
        price.append(project_data['price'][i])
        project_grade_category.append(project_data['project_grade_category'][i])
        teacher_prefix.append(project_data['teacher_prefix'][i])
        clean_categories.append(project_data['clean_categories'][i])
        count=count+1;
        if(count==5):
            break;
```

In [67]:

```
from pandas import DataFrame
cluster2={'Title':project_title,'State':school_state,'Price':price,'Project
Grade':project_grade_category,'Teacher Prefix':teacher_prefix,'Subject category':clean_categories}
df_project_approved=DataFrame(cluster2,columns=['Title','State','Price','Project Grade','Teacher P
refix','Subject category'])
```

In [68]:

```
#printing cluster2
df_project_approved
```

Out[68]:

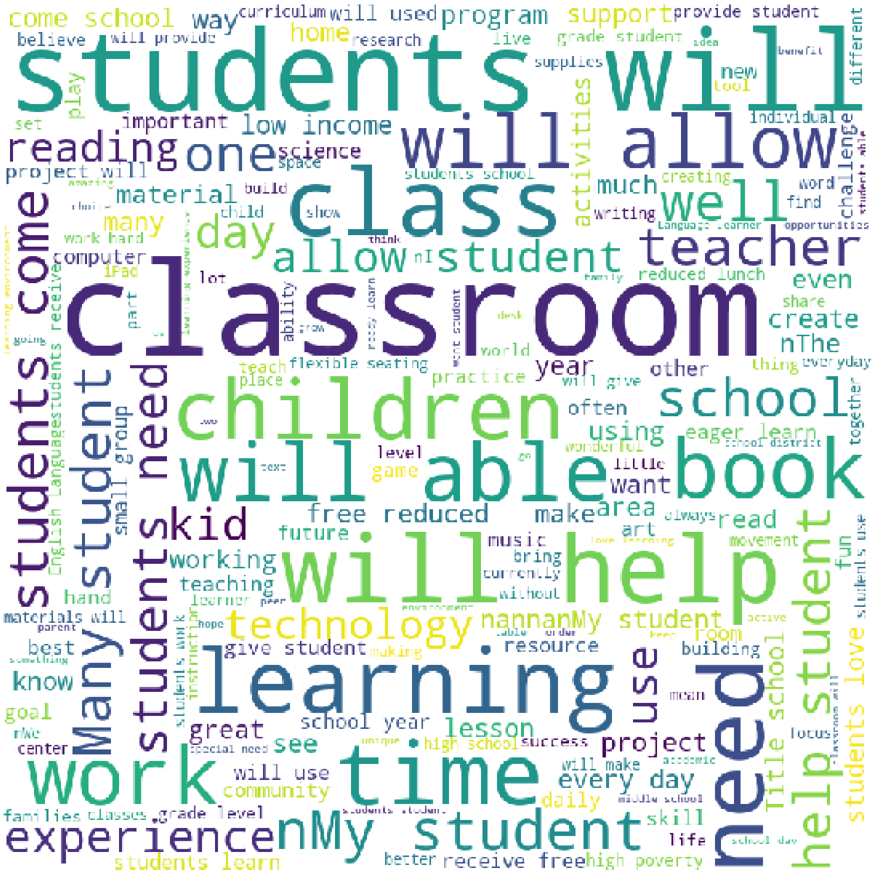
	Title	State	Price	Project Grade	Teacher Prefix	Subject category
0	Wiggling Our Way to Success	OH	749.42	Grades_3To5	Ms.	Health_Sports
1	Pressing on to Mastery After the Flood	LA	1366.91	Grades_PreKTo2	Mrs.	Math_Science
2	Stand and Learn	NY	869.00	Grades_6To8	Mr.	Math_Science History_Civics
3	Picnic Table To Make Us ABLE To Do More!	CT	748.97	Grades_6To8	Ms.	Health_Sports
4	Make Music, Make Our Year!	TX	4102.47	Grades_3To5	Ms.	Music_Arts

In [201]:

```
#Reference:https://stackoverflow.com/questions/36184432/is-it-possible-to-retrieve-false-positives
-false-negatives-identified-by-a-conf
from scipy.sparse import csr_matrix
words_P=[]

words_F=[]

for i in range(5000):
    if(kmeans.predict(X_new[i])==0):
        words_P.append(project_data['essay'][i])
    else:
        words_F.append(project_data['essay'][i])

#converting array to string as word cloud accepts string as a parameter
string1=''.join(str(e) for e in words_P)
string2=''.join(str(e) for e in words_F)
```

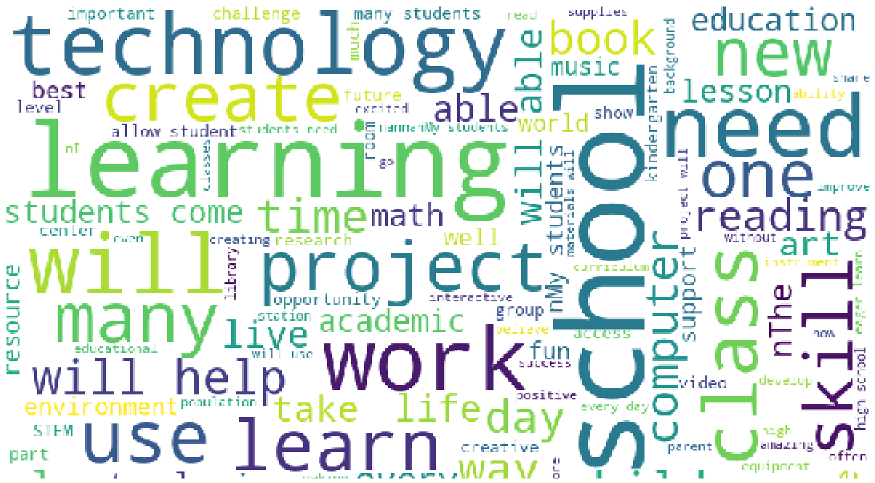
In [202]:

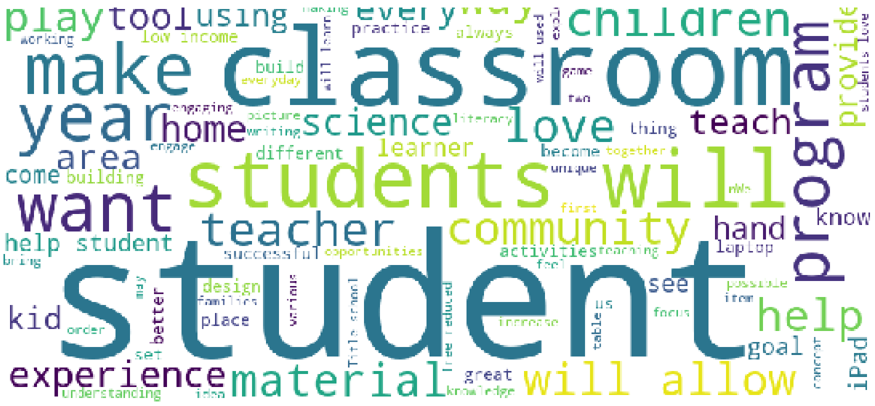
```
# Code for generating word Cloud
#Reference:https://www.geeksforgeeks.org/generating-word-cloud-python/
from wordcloud import WordCloud
wordcloud=WordCloud(width=800,height=800,background_color='white',min_font_size=10).generate(string
1)
plt.figure(figsize=(10,10),facecolor=None)
plt.imshow(wordcloud)
plt.axis("off")
plt.show()
```



In [203]:

```
#Reference:https://www.geeksforgeeks.org/generating-word-cloud-python/
from wordcloud import WordCloud
wordcloud=WordCloud(width=800,height=800,background_color='white',min_font_size=10).generate(string
2)
plt.figure(figsize=(10,10),facecolor=None)
plt.imshow(wordcloud)
plt.axis("off")
plt.show()
```





2.8 Apply Agglomerative Clustering

In [95]:

```
#https://scikit-learn.org/stable/modules/generated/sklearn.cluster.AgglomerativeClustering.html
#https://stackabuse.com/hierarchical-clustering-with-python-and-scikit-learn/
from sklearn.cluster import AgglomerativeClustering
clf = AgglomerativeClustering(n_clusters=2, compute_full_tree=True)
clf.fit(X_new.toarray())
```

Out[95]:

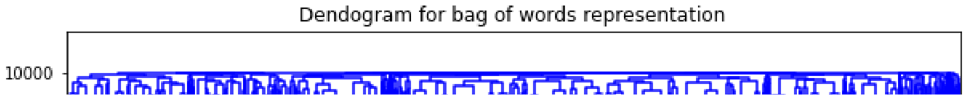
```
AgglomerativeClustering(affinity='euclidean', compute_full_tree=True,
            connectivity=None, linkage='ward', memory=None, n_clusters=2,
            pooling_func='deprecated')
```

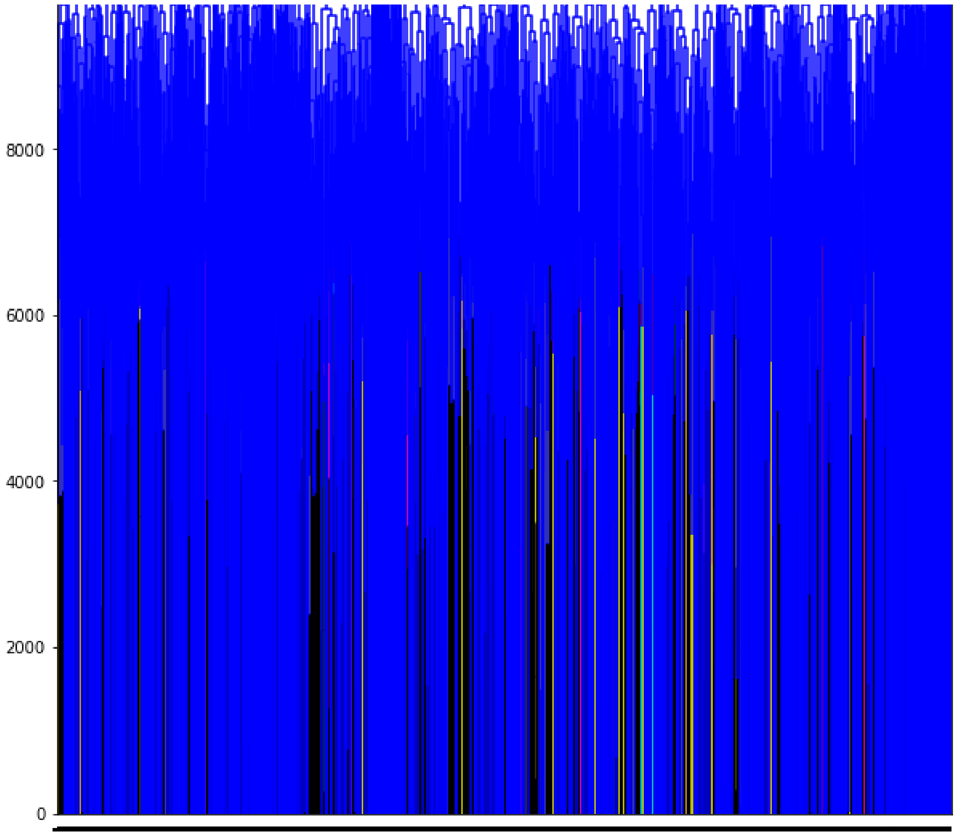
In [96]:

```
# code borrowed from https://github.com/scikit-learn/scikit-
learn/blob/70cf4a676caa2d2dad2e3f6e4478d64bcb0506f7/examples/cluster/plot_hierarchical_clustering_d
ogram.py

from scipy.cluster.hierarchy import dendrogram
def plot_dendrogram(model, **kwargs):

    # Children of hierarchical clustering
    children = model.children_

    # Distances between each pair of children
    # Since we don't have this information, we can use a uniform one for plotting
    distance = np.arange(children.shape[0])

    # The number of observations contained in each cluster level
    no_of_observations = np.arange(2, children.shape[0]+2)

    # Create linkage matrix and then plot the dendrogram
    linkage_matrix = np.column_stack([children, distance, no_of_observations]).astype(float)

    # Plot the corresponding dendrogram
    dendrogram(linkage_matrix, **kwargs)
    return linkage_matrix
```

In [97]:

```
import matplotlib.pyplot as plt
%matplotlib inline
plt.figure(figsize=(10,10))
linkage_matrix=plot_dendrogram(clf, labels=clf.labels_)
plt.title('Dendogram for bag of words representation')
plt.show()
```





Taking 2 clusters for BOW representation

In [98]:

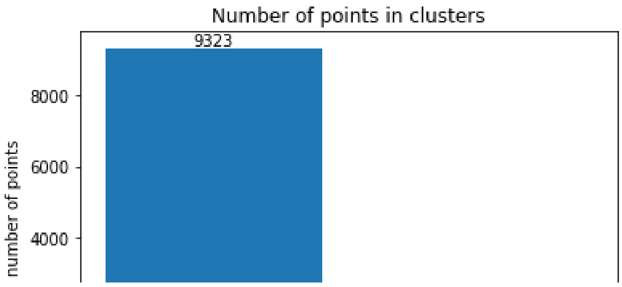
```
#https://docs.scipy.org/doc/scipy-0.15.1/reference/generated/scipy.cluster.hierarchy.fcluster.html
from scipy.cluster.hierarchy import fcluster
max_depth = 2
clusters = fcluster(linkage_matrix, max_depth, criterion='maxclust')
```

In [105]:

```
project_data['project_is_approved']=clusters
label=project_data.groupby(['project_is_approved'])['project_is_approved'].count()
```

In [106]:

```
# Plotting bar plots
fig, ax = plt.subplots()
cluster1 = ax.bar(list(range(1,len(label)+1)), label)

for i in cluster1:
    height = i.get_height()
    ax.text(i.get_x() + i.get_width()/2, height,'%d' % int(height))

plt.xticks(list(range(1,len(label)+1)))
plt.xlabel('cluster label')
plt.ylabel('number of points')
plt.title('Number of points in clusters')
plt.show()
```



2000
0
677
1
2
cluster label

Taking 5 clusters for BOW representation

In [107]:

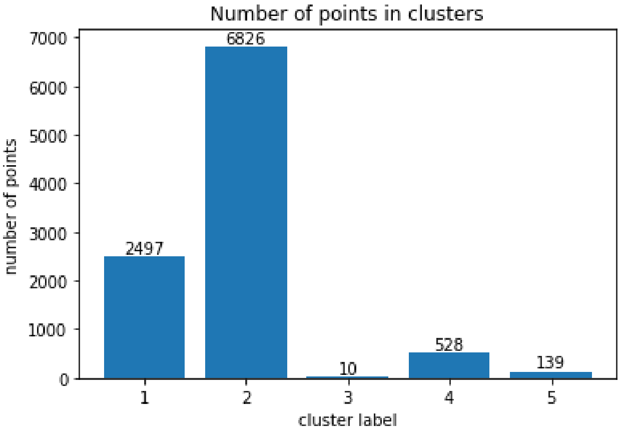
```
#https://docs.scipy.org/doc/scipy-0.15.1/reference/generated/scipy.cluster.hierarchy.fcluster.html
from scipy.cluster.hierarchy import fcluster
max_depth = 5
clusters = fcluster(linkage_matrix, max_depth, criterion='maxclust')
```

In [108]:

```
project_data['project_is_approved']=clusters
label=project_data.groupby(['project_is_approved'])['project_is_approved'].count()
```

In [109]:

```
# Plotting bar plots
fig, ax = plt.subplots()
cluster1 = ax.bar(list(range(1,len(label)+1)), label)

for i in cluster1:
    height = i.get_height()
    ax.text(i.get_x() + i.get_width()/2, height,'%d' % int(height))

plt.xticks(list(range(1,len(label)+1)))
plt.xlabel('cluster label')
plt.ylabel('number of points')
plt.title('Number of points in clusters')
plt.show()
```



2.9 Apply DBSCAN

In [43]:

```
from sklearn.feature_selection import SelectKBest, chi2
X_new = SelectKBest(chi2,k=5000).fit_transform(X,y)
print(X_new.shape)
```

```
(50000, 5000)
```

In [44]:

```
# Reducing number of rows to 30000
X_new=X_new[0:30000]
```

```
X_new.shape
```

Out[44]:

```
(30000, 5000)
```

In [46]:

```
#https://scikit-learn.org/stable/modules/generated/sklearn.cluster.DBSCAN.html
from sklearn.cluster import DBSCAN
from sklearn.neighbors import NearestNeighbors
neigh = NearestNeighbors(n_neighbors=5000).fit(X_new)
distances, indices = neigh.kneighbors(X_new,n_neighbors=5000)
```

In [48]:

```
min_pts_dist = {'distance': distances[:,5000],'Indices': indices[:,5000] }

MinPts_Distance = pd.DataFrame(min_pts_dist,columns= ['distance','Indices' ])
MinPts_Distance.head()
```

Out[48]:

	distance	Indices
0	46.508538	10102
1	67.639610	930
2	147.204484	25883
3	54.823215	11792
4	49.945980	15042

In [49]:

```
# Sorting in ascending order according to Distance
MinPts_Distance.sort_values(by='distance',inplace=True)
MinPts_Distance.head()
```

Out[49]:

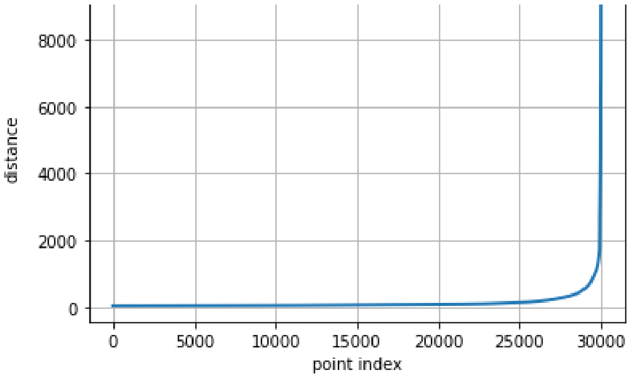
	distance	Indices
29931	42.213468	10401
19265	42.328630	13849
23856	42.409623	503
15848	42.442342	21297
4733	42.442716	3541

In [50]:

```
d=MinPts_Distance['distance'].values
i=MinPts_Distance['Indices'].values
```

In [51]:

```
# Taking indices along X-axis and distances along Y-axis
plt.plot(np.sort(i),d,scalex='True', scaley='False',linewidth=2)
plt.grid()
plt.xlabel('point index')
plt.ylabel('distance')
plt.show()
```



In [52]:

```
#https://scikit-learn.org/stable/modules/generated/sklearn.cluster.DBSCAN.html
db = DBSCAN(eps=500, min_samples=5000).fit(X_new)
```

In [53]:

```
count=0;
project_title=[]
school_state=[]
price=[]
project_grade_category=[]
teacher_prefix=[]
clean_categories=[]
i=0
for i in range(5000):
    if(kmeans.predict(X_new[i])==0):
        project_title.append(project_data['project_title'][i])
        school_state.append(project_data['school_state'][i])
        price.append(project_data['price'][i])
        project_grade_category.append(project_data['project_grade_category'][i])
        teacher_prefix.append(project_data['teacher_prefix'][i])
        clean_categories.append(project_data['clean_categories'][i])
        count=count+1;
        if(count==5):
            break;
```

In [54]:

```
from pandas import DataFrame
cluster1={'Title':project_title,'State':school_state,'Price':price,'Project
Grade':project_grade_category,'Teacher Prefix':teacher_prefix,'Subject category':clean_categories}
df_project_not_approved=DataFrame(cluster1,columns=['Title','State','Price','Project
Grade','Teacher Prefix','Subject category'])
```

In [55]:

```
#printing cluster1
df_project_not_approved
```

Out[55]:

	Title	State	Price	Project Grade	Teacher Prefix	Subject category
0	Educational Support for English Learners at Home	IN	154.60	Grades_PreKTo2	Mrs.	Literacy_Language
1	Wanted: Projector for Hungry Learners	FL	299.00	Grades_6To8	Mr.	History_Civics Health_Sports
2	Soccer Equipment for AWESOME Middle School Stu...	AZ	516.85	Grades_6To8	Ms.	Health_Sports
3	Techie Kindergarteners	KY	232.90	Grades_PreKTo2	Mrs.	Literacy_Language Math_Science

4	Interactive Math Tools	TX	67.98	Grades_PreKTo2	Mrs.	Math_Science

In [61]:

```
count=0;
project_title=[]
school_state=[]
price=[]
project_grade_category=[]
teacher_prefix=[]
clean_categories=[]
i=0
for i in range(5000):
    if(kmeans.predict(X_new[i])==1):
        project_title.append(project_data['project_title'][i])
        school_state.append(project_data['school_state'][i])
        price.append(project_data['price'][i])
        project_grade_category.append(project_data['project_grade_category'][i])
        teacher_prefix.append(project_data['teacher_prefix'][i])
        clean_categories.append(project_data['clean_categories'][i])
        count=count+1;
        if(count==5):
            break;
```

In [62]:

```
from pandas import DataFrame
cluster2={'Title':project_title,'State':school_state,'Price':price,'Project
Grade':project_grade_category,'Teacher Prefix':teacher_prefix,'Subject category':clean_categories}
df_project_approved=DataFrame(cluster2,columns=['Title','State','Price','Project Grade','Teacher P
refix','Subject category'])
```

In [63]:

```
#printing cluster2
df_project_approved
```

Out[63]:

	Title	State	Price	Project Grade	Teacher Prefix	Subject category
0	Make Music, Make Our Year!	TX	4102.47	Grades_3To5	Ms.	Music_Arts
1	Project Some Light Over Here!	CA	1521.97	Grades_3To5	Ms.	Literacy_Language Math_Science
2	Behavior and Technology (A match made in Heaven)	FL	1526.33	Grades_9To12	Mr.	Health_Sports AppliedLearning
3	What do ya make of this? 3D Objects	DE	1599.00	Grades_3To5	Mr.	Math_Science SpecialNeeds
4	RECORDING LIVE MUSIC WITH A MACBOOK PRO	NY	1849.99	Grades_6To8	Mr.	Music_Arts

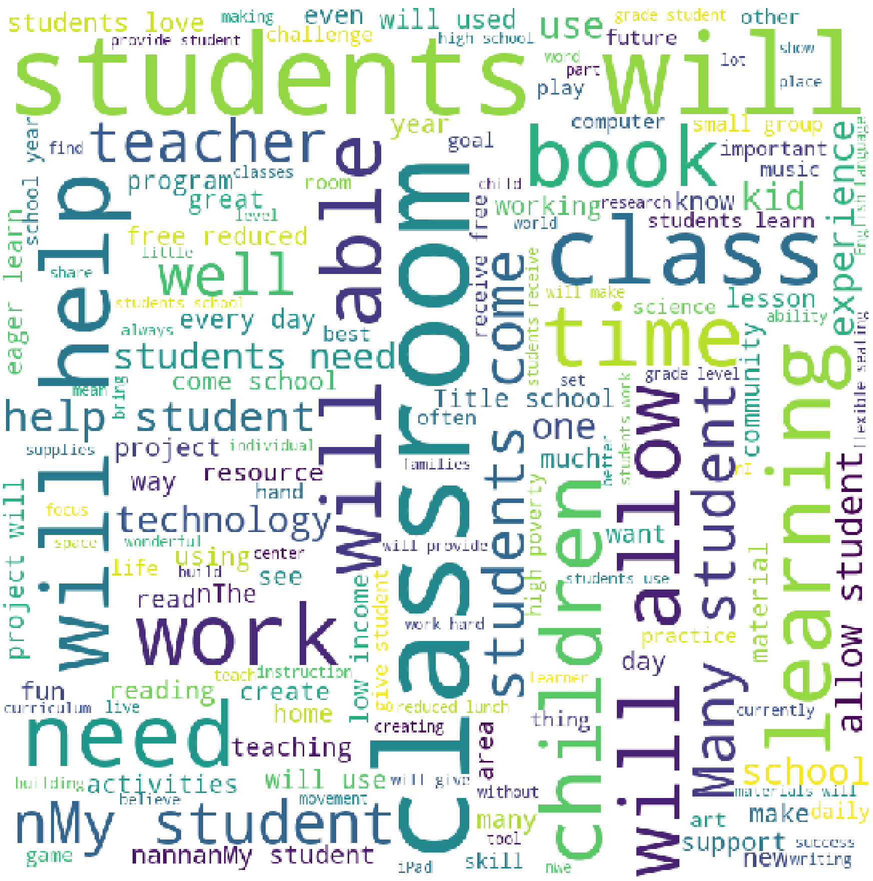
In [66]:

```
#Reference:https://stackoverflow.com/questions/36184432/is-it-possible-to-retrieve-false-positives
-false-negatives-identified-by-a-conf
from scipy.sparse import csr_matrix
words_P=[]

words_F=[]

for i in range(5000):
    if(db.labels_[i]==0):
        words_P.append(project_data['essay'][i])
    else:
        words_F.append(project_data['essay'][i])

#converting array to string as word cloud accepts string as a parameter
string1=''.join(str(e) for e in words_P)
```

```
string2=''.join(str(e) for e in words_F)
```

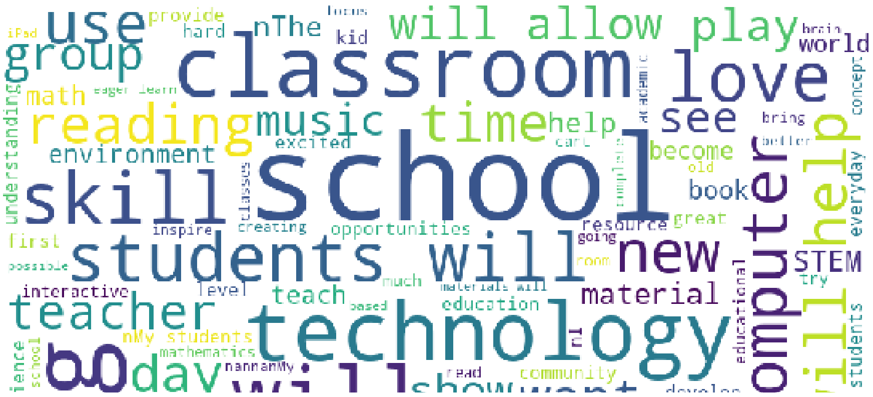
In [67]:

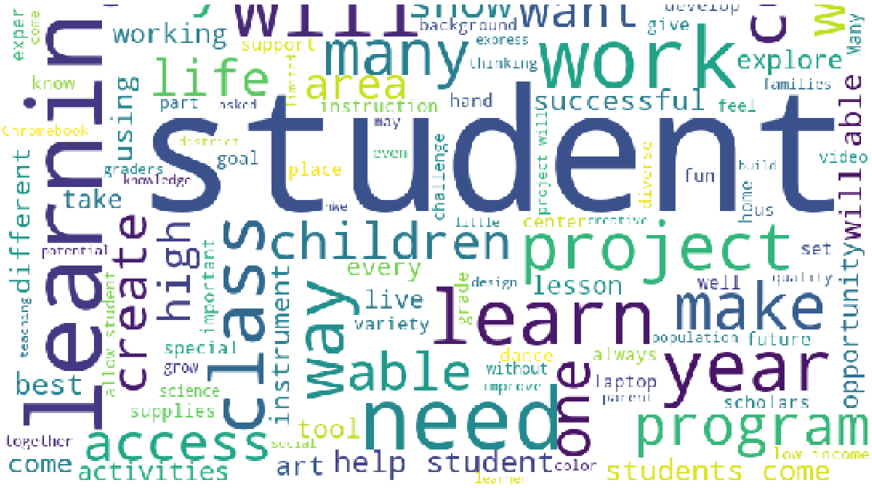
```
#Reference:https://www.geeksforgeeks.org/generating-word-cloud-python/
from wordcloud import WordCloud
wordcloud=WordCloud(width=800,height=800,background_color='white',min_font_size=10).generate(string1)
plt.figure(figsize=(10,10),facecolor=None)
plt.imshow(wordcloud)
plt.axis("off")
plt.show()
```



In [68]:

```
#Reference:https://www.geeksforgeeks.org/generating-word-cloud-python/
from wordcloud import WordCloud
wordcloud=WordCloud(width=800,height=800,background_color='white',min_font_size=10).generate(string2)
plt.figure(figsize=(10,10),facecolor=None)
plt.imshow(wordcloud)
plt.axis("off")
plt.show()
```





3. Conclusions

- All the clustering algorithms like K-Means,Agglomerative and DBSCAN clustering results in two clusters ie. One cluster having value as 0(Project Not Approved) and other as 1(Project Approved).
- In K-Means cluster2 seems to have much higher price than the cluster1.
- In Agglomerative Clustering, many point belong to Cluster 1 rather than Cluster 2.
- In DBSCAN cluster2 seems to have much higher price than the cluster1.
- All the clustering algorithms gives the similar set of clusters.