Assignment 8: DT

In [0]:

```
1.Apply Decision Tree Classifier(DecisionTreeClassifier) on these feature sets
Set 1: categorical, numerical features + project_title(TFIDF)+ preprocessed_eassay (TFI
DF)
Set 2: categorical, numerical features + project_title(TFIDF W2V)+ preprocessed_eassay
(TFIDF W2V)
2.The hyper paramter tuning (best depth in range [1, 5, 10, 50], and the best min_sampl
es_split in range [5, 10, 100, 500])
Find the best hyper parameter which will give the maximum AUC value
find the best hyper paramter using k-fold cross validation(use gridsearch cv or randoms
earch cv)/simple cross validation data(you can write your own for loops refer sample so
lution)
3.Representation of results
You need to plot the performance of model both on train data and cross validation data
for each hyper parameter, like shown in the figurewith X-axis as min_sample_split, Y-ax
is as max_depth, and Z-axis as AUC Score , we have given the notebook which explains ho
w to plot this 3d plot, you can find it in the same drive 3d_scatter_plot.ipynb
or


You need to plot the performance of model both on train data and cross validation data
for each hyper parameter, like shown in the figureseaborn heat maps with rows as n_esti
mators, columns as max_depth, and values inside the cell representing AUC Score
You choose either of the plotting techniques out of 3d plot or heat map
Once after you found the best hyper parameter, you need to train your model with it, an
d find the AUC on test data and plot the ROC curve on both train and test.
Along with plotting ROC curve, you need to print the confusion matrix with predicted an
d original labels of test data points
Once after you plot the confusion matrix with the test data, get all the false positive
data points
Plot the WordCloud(https://www.geeksforgeeks.org/generating-word-cloud-python/) with th
e words of essay text of these false positive data points
Plot the box plot with the price of these false positive data points
Plot the pdf with the teacher_number_of_previously_posted_projects of these false posit
ive data points

Task 2: For this task consider set-1 features. Select all the features which are having
non-zero feature importance.You can get the feature importance using 'feature_importanc
es_` (https://scikit-learn.org/stable/modules/generated/sklearn.tree.DecisionTreeClassi
fier.html), discard the all other remaining features and then apply any of the model of
you choice i.e. (Dession tree, Logistic Regression, Linear SVM), you need to do hyperpa
rameter tuning corresponding to the model you selected and procedure in step 2 and step
3
Note: when you want to find the feature importance make sure you don't use max_depth pa
rameter keep it None.

You need to summarize the results at the end of the notebook, summarize it in the table
format
```

In [0]:

```
!pip install -U -q PyDrive
from pydrive.auth import GoogleAuth
from pydrive.drive import GoogleDrive
from google.colab import auth
from oauth2client.client import GoogleCredentials
```

In [0]:

```
auth.authenticate_user()
gauth = GoogleAuth()
gauth.credentials = GoogleCredentials.get_application_default()
drive = GoogleDrive(gauth)
```

In [0]:

```
downloaded = drive.CreateFile({'id':'1OSWChyFHJhFlbFQod8Dn3Rr23CAEd2MR'}) # replace the
id with id of file you want to access
downloaded.GetContentFile('preprocessed_data.csv')
```

In [4]:

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

import pandas as pd
import numpy as np
import nltk
import matplotlib.pyplot as plt
import seaborn as sns
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

import re
# Tutorial about Python regular expressions: https://pymotw.com/2/re/

import pickle
from tqdm import tqdm
import os

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

1. Decision Tree

1.1 Loading Data

In [139]:

```
import pandas
data = pandas.read_csv('preprocessed_data.csv')
data.head(1)
```

Out[139]:

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previous
0	ca	mrs	grades_prek_2	53
1	ut	ms	grades_3_5	4
2	ca	mrs	grades_prek_2	10
3	ga	mrs	grades_prek_2	2
4	wa	mrs	grades_3_5	2

In [6]:

```
import pandas as pd
#data = pandas.read_csv('preprocessed_data.csv')
#data.head(5)
data  = pd.read_csv('preprocessed_data.csv',nrows=60000)
# data  = pd.read_csv('preprocessed_data.csv', nrows=60000) # you can take less number
 of rows like this
#data.head(5)
print(len(data))
```

```
60000
```

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

In [8]:

```
y = data['project_is_approved'].values
X = data.drop(['project_is_approved'], axis=1)
X.head(1)
#y.head()
```

Out[8]:

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previous
0	ca	mrs	grades_prek_2	53

In [9]:

```
# train test split
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.33, stratify=y)
X_train, X_cv, y_train, y_cv = train_test_split(X_train, y_train, test_size=0.33, strat
ify=y_train)
print(len(X_train))
print(len(X_test))
print(len(X_cv))
```

```
26934
19800
13266
```

In [10]:

```
data.columns.values
```

Out[10]:

```
array(['school_state', 'teacher_prefix', 'project_grade_category',
       'teacher_number_of_previously_posted_projects',
       'project_is_approved', 'clean_categories', 'clean_subcategories',
       'essay', 'price'], dtype=object)
```

one hot vector for clean_categories

In [11]:

```
#one hot vector for clean_categories
vectorizer_clean_cat = CountVectorizer()
vectorizer_clean_cat.fit(X_train['clean_categories'].values) # fit has to happen only o
n train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_clean_category_ohe = vectorizer_clean_cat.transform(X_train['clean_categories']
.values)
X_cv_clean_category_ohe = vectorizer_clean_cat.transform(X_cv['clean_categories'].value
s)
X_test_clean_category_ohe = vectorizer_clean_cat.transform(X_test['clean_categories'].v
alues)

print("After vectorizations")
print(X_train_clean_category_ohe.shape, y_train.shape)
print(X_cv_clean_category_ohe.shape, y_cv.shape)
print(X_test_clean_category_ohe.shape, y_test.shape)
print(vectorizer_clean_cat.get_feature_names())
print("="*100)
```

```
After vectorizations
(26934, 9) (26934,)
(13266, 9) (13266,)
(19800, 9) (19800,)
['appliedlearning', 'care_hunger', 'health_sports', 'history_civics', 'lit
eracy_language', 'math_science', 'music_arts', 'specialneeds', 'warmth']
==========================================================================
==========================
```

one hot vector for clean_subcategories

In [12]:

```
#one hot vector for clean_subcategories
vectorizer_clean_subcat = CountVectorizer()
vectorizer_clean_subcat.fit(X_train['clean_subcategories'].values) # fit has to happen
 only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_clean_subcategory_ohe = vectorizer_clean_subcat.transform(X_train['clean_subcat
egories'].values)
X_cv_clean_subcategory_ohe = vectorizer_clean_subcat.transform(X_cv['clean_subcategorie
s'].values)
X_test_clean_subcategory_ohe = vectorizer_clean_subcat.transform(X_test['clean_subcateg
ories'].values)

print("After vectorizations")
print(X_train_clean_subcategory_ohe.shape, y_train.shape)
print(X_cv_clean_subcategory_ohe.shape, y_cv.shape)
print(X_test_clean_subcategory_ohe.shape, y_test.shape)
print(vectorizer_clean_subcat.get_feature_names())
print("="*100)
```

```
After vectorizations
(26934, 30) (26934,)
(13266, 30) (13266,)
(19800, 30) (19800,)
['appliedsciences', 'care_hunger', 'charactereducation', 'civics_governmen
t', 'college_careerprep', 'communityservice', 'earlydevelopment', 'economi
cs', 'environmentalscience', 'esl', 'extracurricular', 'financialliterac
y', 'foreignlanguages', 'gym_fitness', 'health_lifescience', 'health_welln
ess', 'history_geography', 'literacy', 'literature_writing', 'mathematic
s', 'music', 'nutritioneducation', 'other', 'parentinvolvement', 'performi
ngarts', 'socialsciences', 'specialneeds', 'teamsports', 'visualarts', 'wa
rmth']
===========================================================================
=========================
```

one hot vector for school_state

In [13]:

```
#one hot vector for school_state
vectorizer_school_state = CountVectorizer()
vectorizer_school_state.fit(X_train['school_state'].values) # fit has to happen only on
train data

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

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

```
After vectorizations
(26934, 51) (26934,)
(13266, 51) (13266,)
(19800, 51) (19800,)
['ak', 'al', 'ar', 'az', 'ca', 'co', 'ct', 'dc', 'de', 'fl', 'ga', 'hi',
'ia', 'id', 'il', 'in', 'ks', 'ky', 'la', 'ma', 'md', 'me', 'mi', 'mn', 'm
o', 'ms', 'mt', 'nc', 'nd', 'ne', 'nh', 'nj', 'nm', 'nv', 'ny', 'oh', 'o
k', 'or', 'pa', 'ri', 'sc', 'sd', 'tn', 'tx', 'ut', 'va', 'vt', 'wa', 'w
i', 'wv', 'wy']
==========================================================================
==========================
```

one hot vector for vectorizer_project_grade

In [14]:

```
#one hot vector for vectorizer_project_grade
vectorizer_project_grade = CountVectorizer()
vectorizer_project_grade.fit(X_train['project_grade_category'].values) # fit has to happen only on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_project_grade_category_ohe = vectorizer_project_grade.transform(X_train['project_grade_category'].values)
X_cv_project_grade_category_ohe = vectorizer_project_grade.transform(X_cv['project_grade_category'].values)
X_test_project_grade_category_ohe = vectorizer_project_grade.transform(X_test['project_grade_category'].values)

print("After vectorizations")
print(X_train_project_grade_category_ohe.shape, y_train.shape)
print(X_cv_project_grade_category_ohe.shape, y_cv.shape)
print(X_test_project_grade_category_ohe.shape, y_test.shape)
print(vectorizer_project_grade.get_feature_names())
print("="*100)
```

```
After vectorizations
(26934, 4) (26934,)
(13266, 4) (13266,)
(19800, 4) (19800,)
['grades_3_5', 'grades_6_8', 'grades_9_12', 'grades_prek_2']
====================================================================================================
```

one hot vector for teacher_prefixs¶

In [15]:

```
#one hot vector for teacher_prefixs
vectorizer_teacher_prefixs = CountVectorizer()
vectorizer_teacher_prefixs.fit(X_train['teacher_prefix'].values) # fit has to happen on
ly on train data

# we use the fitted CountVectorizer to convert the text to vector
X_train_teacher_prefix_ohe = vectorizer_teacher_prefixs.transform(X_train['teacher_pref
ix'].values)
X_cv_teacher_prefix_ohe = vectorizer_teacher_prefixs.transform(X_cv['teacher_prefix'].v
alues)
X_test_teacher_prefix_ohe =vectorizer_teacher_prefixs.transform(X_test['teacher_prefix'
].values)

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

```
After vectorizations
(26934, 5) (26934,)
(13266, 5) (13266,)
(19800, 5) (19800,)
['dr', 'mr', 'mrs', 'ms', 'teacher']
==========================================================================
==========================
```

vectorizing numerical data (previously_posted_projects)

In [16]:

```
from sklearn.preprocessing import Normalizer##http://localhost:8888/notebooks/Desktop/M
achine%20Learning/module-4/assignment-10/assignment-09/9_Assignment_DT_Instructions.ipy
nb#vectorizing-numerical-data-(previously_posted_projects)
normalizer_teacher_projects = Normalizer()
normalizer_teacher_projects.fit(X_train['teacher_number_of_previously_posted_projects']
.values.reshape(1,-1))

X_train_teacher_previously_posted_projects_norm = normalizer_teacher_projects.transform
(X_train['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
X_cv_teacher_previously_posted_projects_norm = normalizer_teacher_projects.transform(X_
cv['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))
X_test_teacher_previously_posted_projects_norm = normalizer_teacher_projects.transform(
X_test['teacher_number_of_previously_posted_projects'].values.reshape(-1,1))



print("After vectorizations")
print(X_train_teacher_previously_posted_projects_norm.shape, y_train.shape)
print(X_cv_teacher_previously_posted_projects_norm.shape, y_cv.shape)
print(X_test_teacher_previously_posted_projects_norm.shape, y_test.shape)
print("="*100)
```

```
After vectorizations
(26934, 1) (26934,)
(13266, 1) (13266,)
(19800, 1) (19800,)
===========================================================================
=========================
```

Reshaping a numerical data

In [0]:

```
price_train = (X_train['price'].values.reshape(-1,1))
price_cv = (X_cv['price'].values.reshape(-1,1))
price_test = (X_test['price'].values.reshape(-1,1))


previous_projects_train = (X_train['teacher_number_of_previously_posted_projects'].valu
es.reshape(-1,1))
previous_projects_cv = (X_cv['teacher_number_of_previously_posted_projects'].values.res
hape(-1,1))
previous_projects_test = (X_test['teacher_number_of_previously_posted_projects'].values
.reshape(-1,1))
```

vectorizing text data

1.vectorizing preprocessed_essay (tfidf)

In [18]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
print(X_train.shape, y_train.shape)
print(X_cv.shape, y_cv.shape)
print(X_test.shape, y_test.shape)

print("="*100)



vectorizer_tfidf_essay =TfidfVectorizer(min_df=10,ngram_range=(1,4), max_features=5000)
vectorizer_tfidf_essay.fit(X_train['essay'].values) # fit has to happen only on train d
ata

# we use the fitted CountVectorizer to convert the text to vector
X_train_essay_tfidf = vectorizer_tfidf_essay.transform(X_train['essay'].values)
X_cv_essay_tfidf = vectorizer_tfidf_essay.transform(X_cv['essay'].values)
X_test_essay_tfidf = vectorizer_tfidf_essay.transform(X_test['essay'].values)

print("After vectorizations")
print(X_train_essay_tfidf.shape, y_train.shape)
print(X_cv_essay_tfidf.shape, y_cv.shape)
print(X_test_essay_tfidf.shape, y_test.shape)
print("="*100)



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

```
(26934, 8) (26934,)
(13266, 8) (13266,)
(19800, 8) (19800,)
==========================================================================
==========================
After vectorizations
(26934, 5000) (26934,)
(13266, 5000) (13266,)
(19800, 5000) (19800,)
==========================================================================
==========================
NOTE: THE NUMBER OF COLUMNS IN EACH OF THE VECTOR WONT BE SAME
```

Creating(set 1)

Combining all the features using hstack

In [19]:

```
# merge two sparse matrices: https://stackoverflow.com/a/19710648/4084039
from scipy.sparse import hstack
X_tr_tfidf = hstack((X_train_clean_category_ohe, X_train_clean_subcategory_ohe,X_train_
school_state_ohe, X_train_project_grade_category_ohe, X_train_teacher_prefix_ohe,X_trai
n_essay_tfidf,price_train,previous_projects_train)).tocsr()
X_cv_tfidf = hstack((X_cv_clean_category_ohe, X_cv_clean_subcategory_ohe,X_cv_school_st
ate_ohe, X_cv_project_grade_category_ohe, X_cv_teacher_prefix_ohe,X_cv_essay_tfidf,pric
e_cv,previous_projects_cv)).tocsr()
X_te_tfidf = hstack((X_test_clean_category_ohe, X_test_clean_subcategory_ohe,X_test_sch
ool_state_ohe, X_test_project_grade_category_ohe,X_test_teacher_prefix_ohe,X_test_essay
_tfidf,price_test,previous_projects_test)).tocsr()

print("Final Data matrix")
print(X_tr_tfidf.shape, y_train.shape)
print(X_cv_tfidf.shape, y_cv.shape)
print(X_te_tfidf.shape, y_test.shape)
print("="*100)
```

```
Final Data matrix
(26934, 5101) (26934,)
(13266, 5101) (13266,)
(19800, 5101) (19800,)
==========================================================================
==========================
```

In [0]:

```
# Necessary Package imports
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import roc_auc_score
from sklearn.model_selection import GridSearchCV
```

Hyperparameter tuning

In [0]:

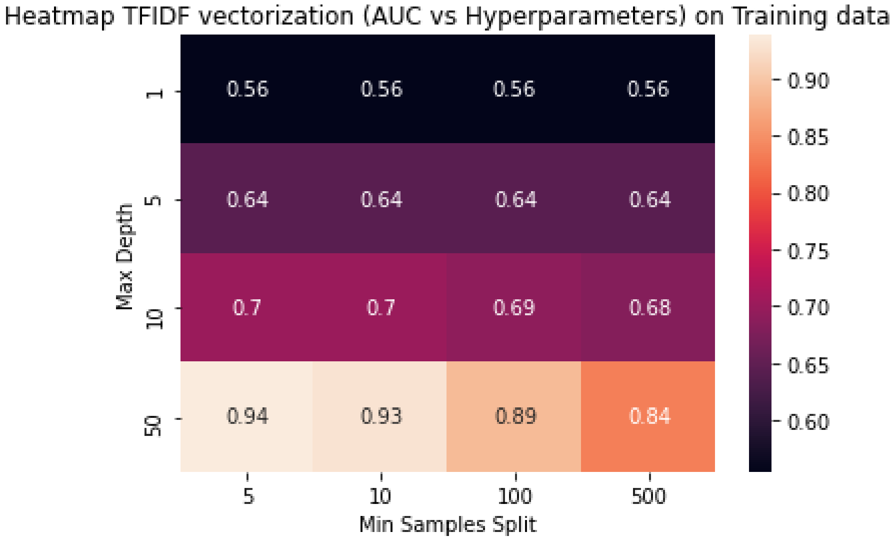
```
def batch_predict(clf, data):
    # roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates
 of the positive class
    # not the predicted outputs

    y_data_pred = []
    tr_loop = data.shape[0] - data.shape[0]%1000
    # consider you X_tr shape is 49041, then your tr_loop will be 49041 - 49041%1000 =
 49000
    # in this for loop we will iterate unti the last 1000 multiplier
    for i in range(0, tr_loop, 1000):
        y_data_pred.extend(clf.predict_proba(data[i:i+1000])[:,1])
    # we will be predicting for the last data points
    if data.shape[0]%1000 !=0:
        y_data_pred.extend(clf.predict_proba(data[tr_loop:])[:,1])

    return y_data_pred
```

In [0]:

```
from sklearn.tree import DecisionTreeClassifier
from tqdm import tqdm
from sklearn.metrics import roc_auc_score
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
#parameters = {'max_depth':[1, 5, 10, 50],'min_samples_split':[5, 10, 100, 500]}
depth=[1, 5, 10, 50]
min_samples_split=[5, 10, 100, 500]
train_auc = [[0 for samples in min_samples_split]for max_depth in depth]
cv_auc = [[0 for samples in min_samples_split]for max_depth in depth]
i=0
for max_depth in depth:
    j = 0
    for samples in min_samples_split:
        clf_tfidf = DecisionTreeClassifier(max_depth = max_depth,min_samples_split=samp
les)
        clf_tfidf.fit(X_tr_tfidf, y_train)

        y_train_pred = batch_predict(clf_tfidf, X_tr_tfidf)
        y_cv_pred = batch_predict(clf_tfidf, X_cv_tfidf)

        train_auc[i][j] = roc_auc_score(y_train,y_train_pred)
        cv_auc[i][j] = roc_auc_score(y_cv, y_cv_pred)
        j += 1
    i += 1
```

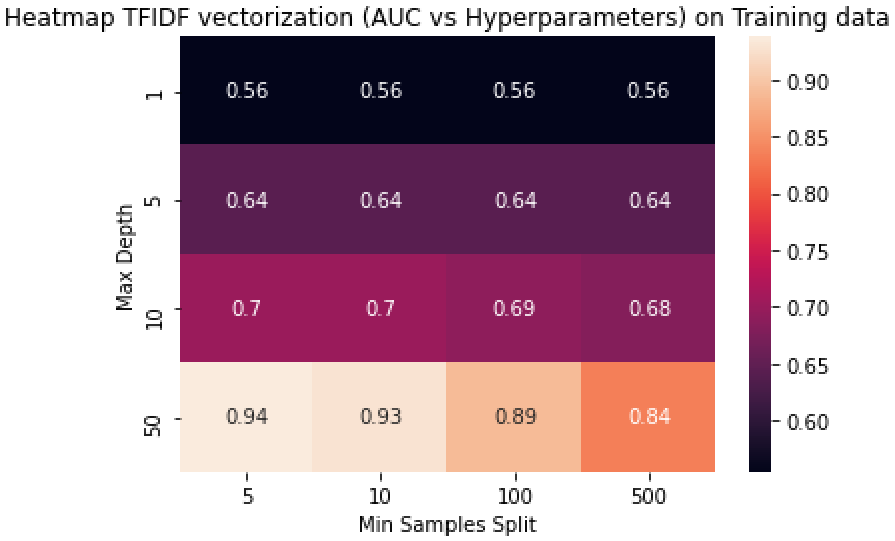
In [37]:

```
sns.heatmap(train_auc,annot=True,xticklabels=min_samples_split,yticklabels=depth)
plt.title('Heatmap TFIDF vectorization (AUC vs Hyperparameters) on Training data')
plt.ylabel('Max Depth')
plt.xlabel('Min Samples Split')A
plt.show()
```



In [38]:

```
sns.heatmap(train_auc,annot=True,xticklabels=min_samples_split,yticklabels=depth)
plt.title('Heatmap TFIDF vectorization (AUC vs Hyperparameters) on Training data')
plt.ylabel('Max Depth')
plt.xlabel('Min Samples Split')
plt.show()
```



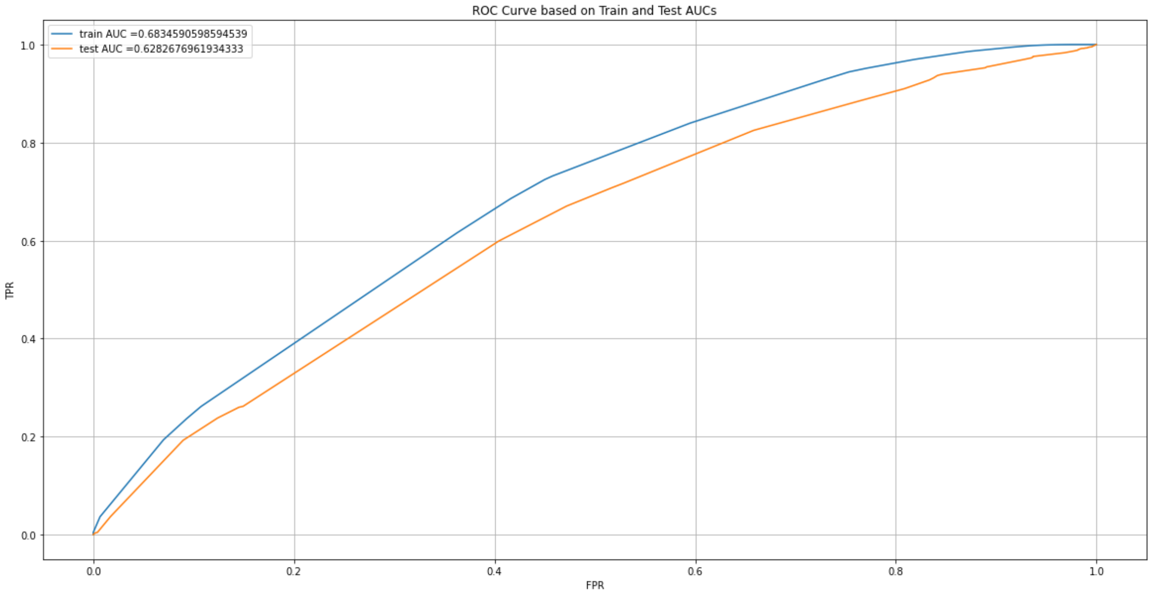
Training the model on best hyperparamets and testing in Test set

In [0]:

```
from sklearn.metrics import roc_curve, auc, confusion_matrix, accuracy_score

clf1 = DecisionTreeClassifier(max_depth = 10,min_samples_split=500)
clf1.fit(X_tr_tfidf, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of t
he positive class
# not the predicted outputs

y_train_pred = batch_predict(clf1, X_tr_tfidf)
y_test_pred = batch_predict(clf1, X_te_tfidf)

train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)

#y_test_class = list(map(lambda x:1 if x>=0.5 else 0, y_test_pred))
#tn, fp, fn, tp = confusion_matrix(y_test, y_test_class).ravel()
#print('Confusion Matrix')
##print('================')
#print(np.array([[tn, tp],[fn, fp]]))
#print('Accuracy Score: ',accuracy_score(y_test, y_test_class))
```

In [43]:

```
plt.figure(figsize=(20,10))
plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("FPR")
plt.ylabel("TPR")
plt.title("ROC Curve based on Train and Test AUCs")
plt.grid()
plt.show()
```



Confusion matrix for both train and test set data

In [0]:

```
# we are writing our own function for predict, with defined thresould
# we will pick a threshold that will give the least fpr
def find_best_threshold(threshould, fpr, tpr):
    t = threshould[np.argmax(tpr*(1-fpr))]
    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high
    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.rou
nd(t,3))
    return t

def predict_with_best_t(proba, threshould):
    predictions = []
    global _predictions
    for i in proba:
        if i>=threshould:
            predictions.append(1)
        else:
            predictions.append(0)
    _predictions = predictions
    return predictions
```

In [45]:

```
best_t = find_best_threshold(tr_thresholds, train_fpr, train_tpr)
Train_CM = confusion_matrix(y_train, predict_with_best_t(y_train_pred, best_t))
Test_CM = confusion_matrix(y_test, predict_with_best_t(y_test_pred, best_t))
print("Train confusion matrix")
print(Train_CM)
print("Test confusion matrix")
print(Test_CM)
```

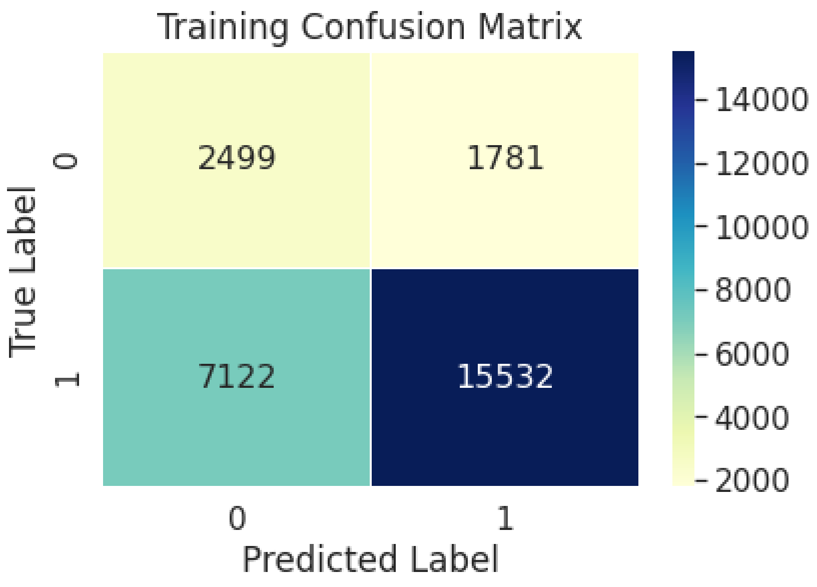
```
the maximum value of tpr*(1-fpr) 0.40031786592122537 for threshold 0.874
Train confusion matrix
[[ 2499  1781]
 [ 7122 15532]]
Test confusion matrix
[[ 1662  1485]
 [ 5489 11164]]
```

In [46]:

```
sns.set(font_scale=1.4)
sns.heatmap(Train_CM,annot=True,cbar=True,fmt="g", annot_kws = {"size":16},linewidths=.
5,cmap="YlGnBu")
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Training Confusion Matrix')
```

Out[46]:

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

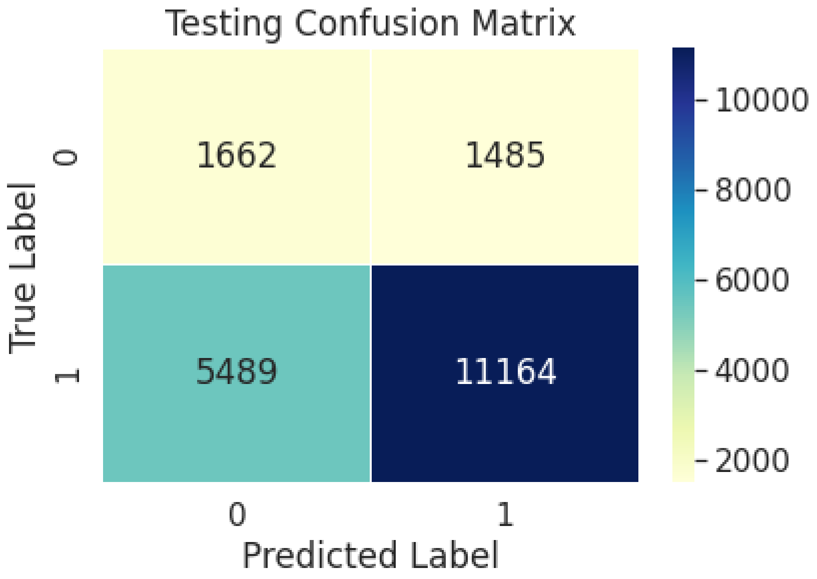


In [47]:

```
sns.heatmap(Test_CM,annot=True,cbar=True,fmt="d", linewidths=.5,cmap="YlGnBu")
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Testing Confusion Matrix')
```

Out[47]:

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



Extracting features to draw decision tree

In [50]:

```
feature_names_tfidf =[]
feature_names_tfidf.extend(vectorizer_clean_cat.get_feature_names())
feature_names_tfidf.extend(vectorizer_clean_subcat.get_feature_names())
feature_names_tfidf.extend(vectorizer_school_state.get_feature_names())
feature_names_tfidf.extend(vectorizer_project_grade.get_feature_names())
feature_names_tfidf.extend(vectorizer_teacher_prefixs.get_feature_names())
print(len(feature_names_tfidf))
```

```
99
```

In [51]:

```
feature_names_tfidf.extend(["price","teacher_previously_posted_projects",
                           ])
print(len(feature_names_tfidf))
```

```
101
```

In [52]:

```
k = (vectorizer_tfidf_essay.get_feature_names())
feature_names_tfidf.extend(k)
print(len(feature_names_tfidf))
```

```
5101
```

Drawing decision tree

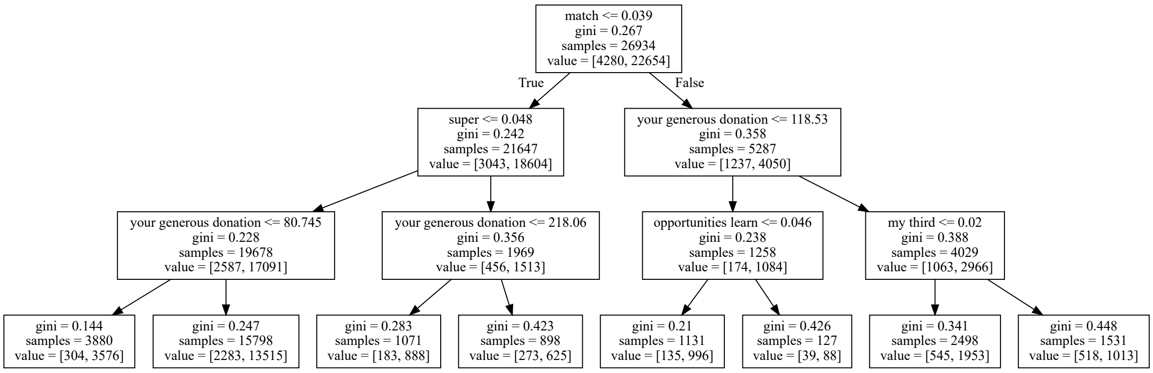
In [0]:

```
#Please write all the code with proper documentation
dtree = DecisionTreeClassifier(max_depth=3)
clf = dtree.fit(X_tr_tfidf,y_train)
import graphviz
from sklearn import tree
from graphviz import Source
from sklearn.tree import export_graphviz
import pydot
```

In [59]:

```
_dot_data = tree.export_graphviz(dtree, feature_names=feature_names_tfidf)
graph = graphviz.Source(_dot_data)
graph
#graph = Source(_dot_data)
#graph.render("tfidf of Words Tree", view=True)
```

Out[59]:



plotting word cloud

In [60]:

```
X_test['essay'].values[2]
```

Out[60]:

```
'today ell kindergartners stem school tomorrow scientists technologists en
gineers mathematicians to become future professionals need develop practic
e strong academic skills need supplies build skills my kindergartners dive
rse energetic group 5 6 year olds southern arizona title i stem school 99
free lunch 1 2 refugees africa asia middle east all come low income househ
olds living neighborhood apartments trailer parks a lot parents want help
children learn not always know these games activities give starting point
the activities students make also supports common core standards gives stu
dents support need prepare become grade level ready i requesting laminatin
g pouches ink paper play doh sheet protectors make activities students tak
e home practice kindergarten skills they help make various math alphabet s
ight word games play maintain remediate skills working school practicing s
kills home serves strong enrichment tool ell students the play doh used pr
actice letters numbers sight words batteries used various electronic devic
es classroom these materials also give chance time together parents play h
ome it incredible potential right tools i know bringing resources ell stud
ents spark lifetime love reading learning nannan'
```

In [0]:

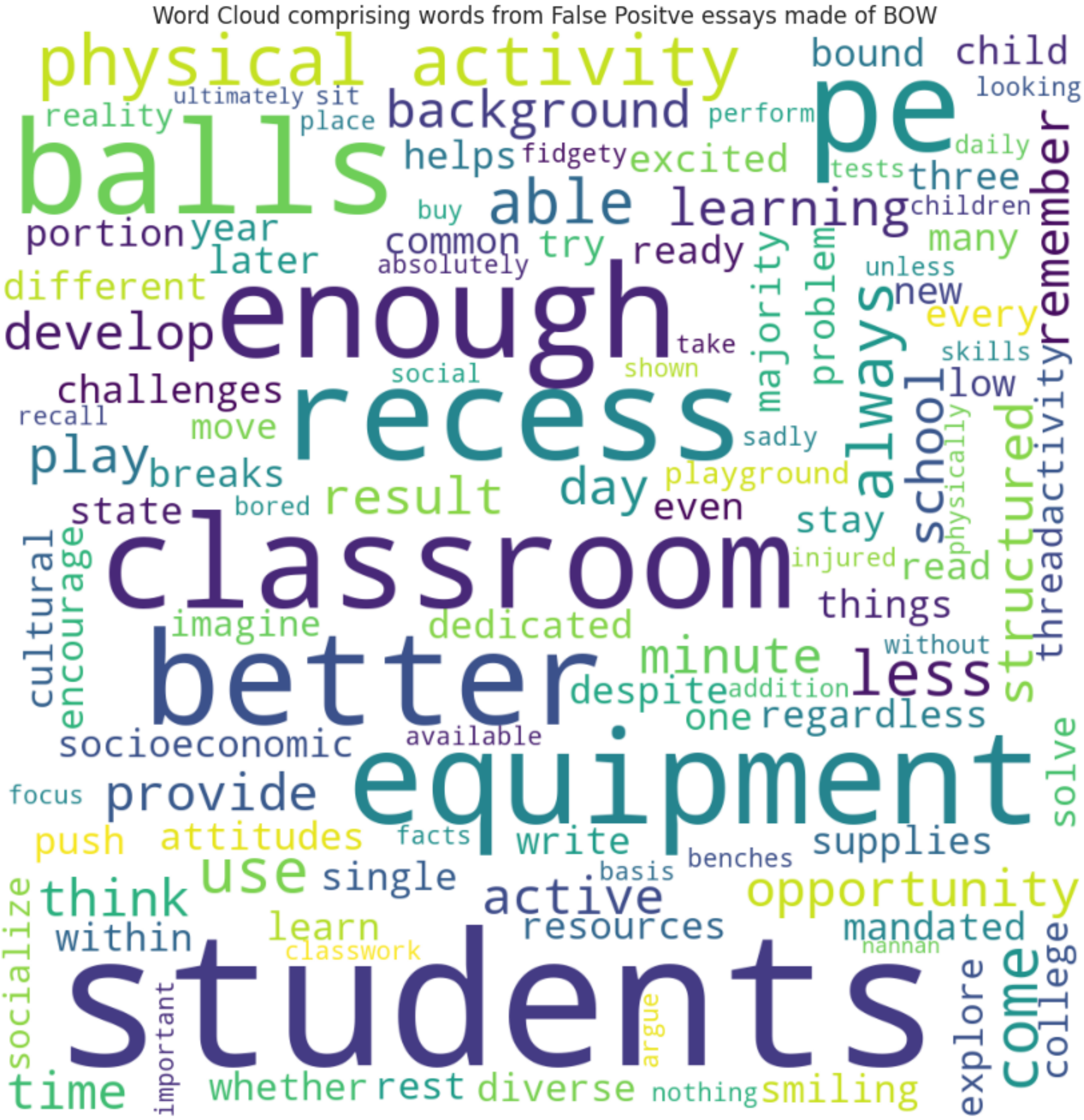
```
false_pos_indices = []
for i in range(len(y_test)):
    if(y_test[i]==0 and _predictions[i] == 1):
        false_pos_indices.append(i)
#In [180]:
false_pos_essay = []
for i in false_pos_indices :
    false_pos_essay.append(X_test['essay'].values[i])
```

In [0]:

```
from wordcloud import WordCloud, STOPWORDS
comments = " "
stopwords = set(STOPWORDS)
for _essay in false_pos_essay:
    tokens = str(_essay).lower().split()

for words in tokens:
    comments += words + " "

wordcloud = WordCloud(width=1000, height=1000, background_color="white",stopwords=stopw
ords, min_font_size=12).generate(comments)
```

In [63]:

```
plt.figure(figsize=(15,15))
plt.imshow(wordcloud)
plt.axis("off")
plt.title("Word Cloud comprising words from False Positve essays made of BOW")
plt.show()
```



box plot with the price of these false positive data points

In [64]:

```
cols = X_test.columns
X_test_falsePos = pd.DataFrame(columns=cols)
for i in false_pos_indices:
    X_test_falsePos = X_test_falsePos.append(X_test.filter(items=[i],axis=0))

X_test_falsePos.head(1)
```

Out[64]:

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previou
23	va	mrs	grades_3_5	0

In [65]:

```
len(X_test_falsePos)
```

Out[65]:

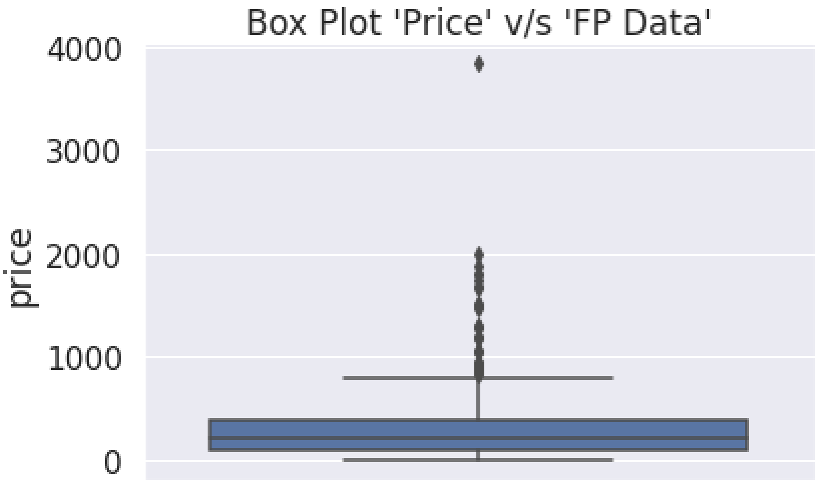
```
514
```

In [66]:

```
sns.boxplot(y="price",data=X_test_falsePos).set_title("Box Plot 'Price' v/s 'FP Data'")
```

Out[66]:

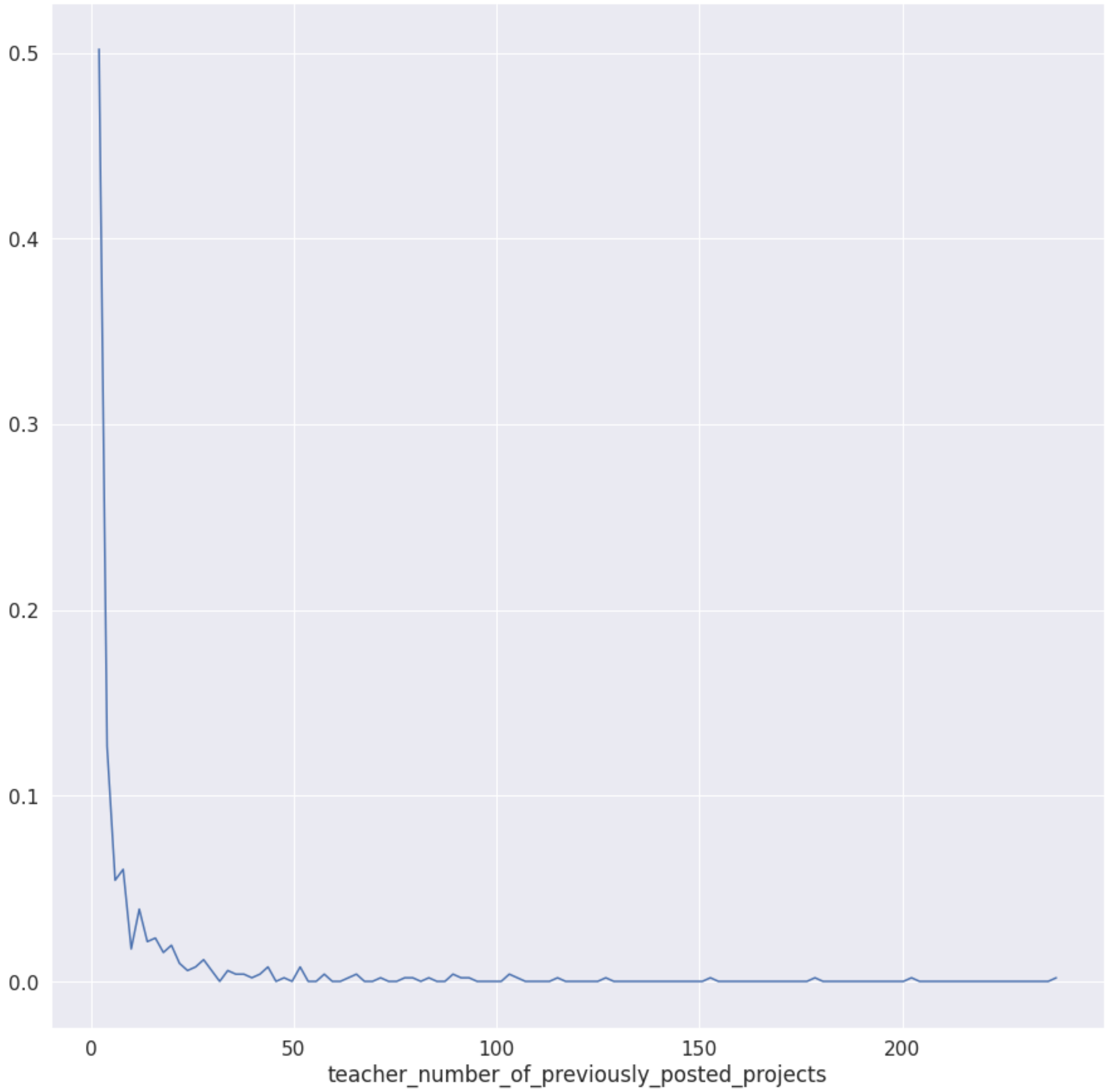
```
Text(0.5, 1.0, "Box Plot 'Price' v/s 'FP Data'")
```



Drawing pdf with the teacher_number_of_previously_posted_projects of these false positive data points

In [67]:

```
# Plot the pdf with the `teacher_number_of_previously_posted_projects` of these `false
 positive data points`
plt.figure(figsize=(15,15))
counts, bin_edges = np.histogram(X_test_falsePos["teacher_number_of_previously_posted_p
rojects"], bins="auto",density=True)
pdf = counts/sum(counts)
pdfPoints = plt.plot(bin_edges[1:],pdf)
plt.xlabel("teacher_number_of_previously_posted_projects")
plt.show()
```



Creating (set-2)

Applying tfidf w2vec

In [72]:

```
#tfidf_w2v train
from tqdm import tqdm
tfidf_w2v_vectors_train = [];# the avg-w2v for each sentence/review is stored in this l
ist
glove_vectors = []
for sentence in tqdm(X_train["essay"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_vectors) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(Asentence.count(word)/len(sentence.split())) # g
etting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_train.append(vector)

print(len(tfidf_w2v_vectors_train))
#(len(tfidf_w2v_vectors_train[0]))
#k = list('tfidf_w2v_vectors_train[0]')
#print(len(k))
#print(type(k))
```

```
100%|██████████| 26934/26934 [00:00<00:00, 41452.17it/s]

26934
```

In [73]:

```
#tfidf w2v
from tqdm import tqdm
tfidf_w2v_vectors_cv = []; # the avg-w2v for each sentence/review is stored in this lis
t
glove_vectors = []
for sentence in tqdm(X_cv["essay"]): # for each review/sentence
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_vectors) and (word in tfidf_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_cv.append(vector)

print(len(tfidf_w2v_vectors_cv))
```

```
100%|██████████| 13266/13266 [00:00<00:00, 39302.13it/s]

13266
```

In [74]:

```
tfidf_w2v_vectors_test = [];

for sentence in tqdm(X_test["essay"]): # for each review/sentence
    glove_vectors = []
    vector = np.zeros(300) # as word vectors are of zero length
    tf_idf_weight =0; # num of words with a valid vector in the sentence/review
    for word in sentence.split(): # for each word in a review/sentence
        if (word in glove_vectors) and (word in tfidf_title_words):
            vec = model[word] # getting the vector for each word
            # here we are multiplying idf value(dictionary[word]) and the tf value((sen
tence.count(word)/len(sentence.split())))
            tf_idf = dictionary[word]*(sentence.count(word)/len(sentence.split())) # ge
tting the tfidf value for each word
            vector += (vec * tf_idf) # calculating tfidf weighted w2v
            tf_idf_weight += tf_idf
    if tf_idf_weight != 0:
        vector /= tf_idf_weight
    tfidf_w2v_vectors_test.append(vector)

#print(len(tfidf_w2v_vectors_titles_test))
```

```
100%|██████████| 19800/19800 [00:00<00:00, 42131.18it/s]
```

In [76]:

```
from scipy.sparse import hstack
X_tr_tfidf_w2v = hstack((X_train_clean_category_ohe, X_train_clean_subcategory_ohe,X_tr
ain_school_state_ohe, X_train_project_grade_category_ohe, X_train_teacher_prefix_ohe,tf
idf_w2v_vectors_train,price_train,previous_projects_train)).tocsr()
X_cv_tfidf_w2v = hstack((X_cv_clean_category_ohe, X_cv_clean_subcategory_ohe,X_cv_schoo
l_state_ohe, X_cv_project_grade_category_ohe, X_cv_teacher_prefix_ohe,tfidf_w2v_vectors
_cv,price_cv,previous_projects_cv)).tocsr()
X_te_tfidf_w2v = hstack((X_test_clean_category_ohe, X_test_clean_subcategory_ohe,X_test
_school_state_ohe, X_test_project_grade_category_ohe,X_test_teacher_prefix_ohe,tfidf_w2
v_vectors_test,price_test,previous_projects_test)).tocsr()

print("Final Data matrix")
print(X_tr_tfidf_w2v.shape, y_train.shape)
print(X_cv_tfidf_w2v.shape, y_cv.shape)
print(X_te_tfidf_w2v.shape, y_test.shape)
print("="*100)
```

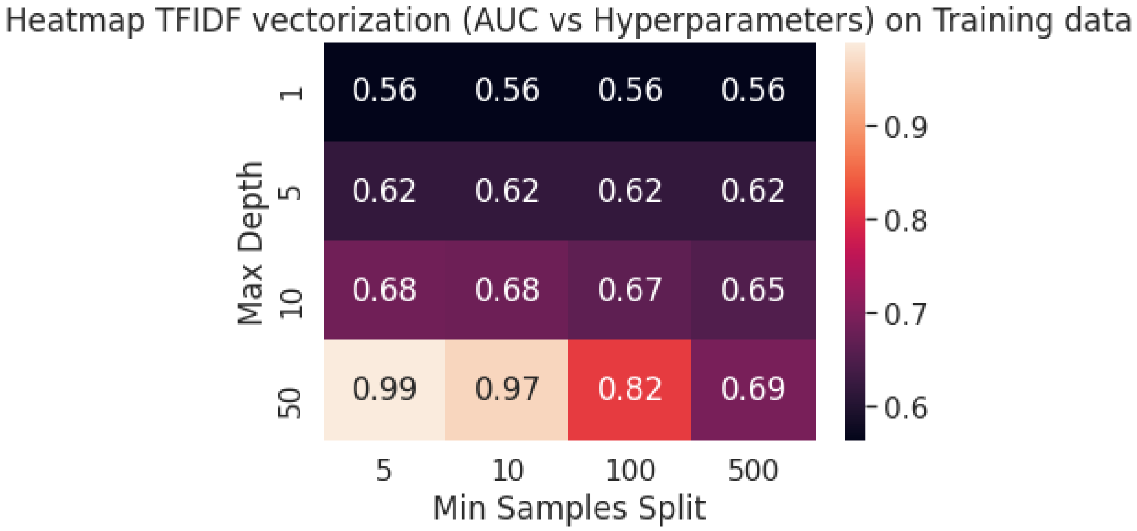
```
Final Data matrix
(26934, 401) (26934,)
(13266, 401) (13266,)
(19800, 401) (19800,)
===========================================================================
=========================
```

In [0]:

```
from sklearn.tree import DecisionTreeClassifier
from tqdm import tqdm
from sklearn.metrics import roc_auc_score
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
#parameters = {'max_depth':[1, 5, 10, 50],'min_samples_split':[5, 10, 100, 500]}
depth=[1, 5, 10, 50]
min_samples_split=[5, 10, 100, 500]
train_auc = [[0 for samples in min_samples_split]for max_depth in depth]
cv_auc = [[0 for samples in min_samples_split]for max_depth in depth]
i=0
for max_depth in depth:
    j = 0
    for samples in min_samples_split:
        clf_tfidf = DecisionTreeClassifier(max_depth = max_depth,min_samples_split=samp
les)
        clf_tfidf.fit(X_tr_tfidf_w2v, y_train)

        y_train_pred = batch_predict(clf_tfidf, X_tr_tfidf_w2v)
        y_cv_pred = batch_predict(clf_tfidf, X_cv_tfidf_w2v)

        train_auc[i][j] = roc_auc_score(y_train,y_train_pred)
        cv_auc[i][j] = roc_auc_score(y_cv, y_cv_pred)
        j += 1
    i += 1
```

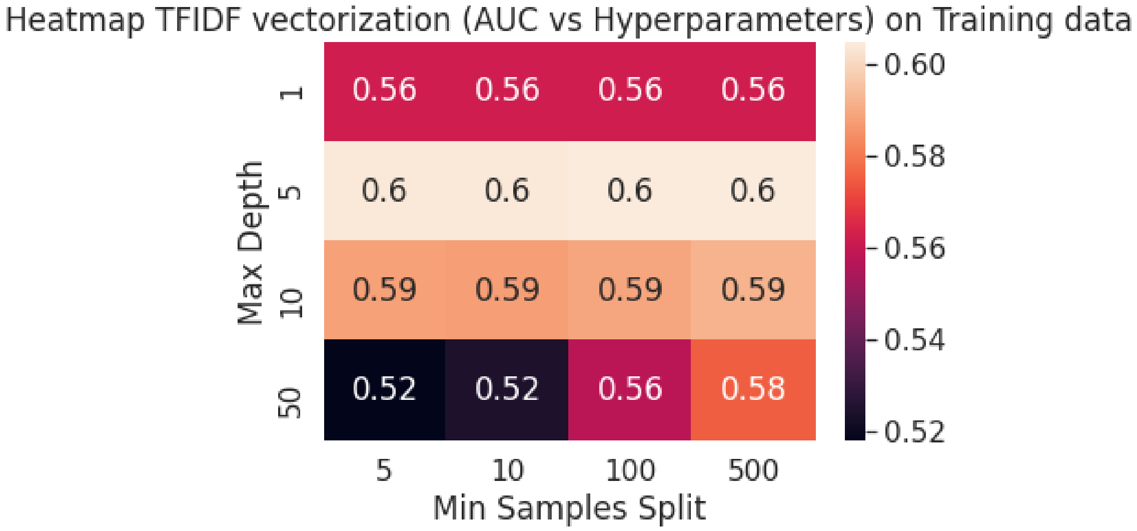
In [80]:

```
sns.heatmap(train_auc,annot=True,xticklabels=min_samples_split,yticklabels=depth)
plt.title('Heatmap TFIDF vectorization (AUC vs Hyperparameters) on Training data')
plt.ylabel('Max Depth')
plt.xlabel('Min Samples Split')
plt.show()
```



In [81]:

```
sns.heatmap(cv_auc,annot=True,xticklabels=min_samples_split,yticklabels=depth)
plt.title('Heatmap TFIDF vectorization (AUC vs Hyperparameters) on Training data')
plt.ylabel('Max Depth')
plt.xlabel('Min Samples Split')
plt.show()
```

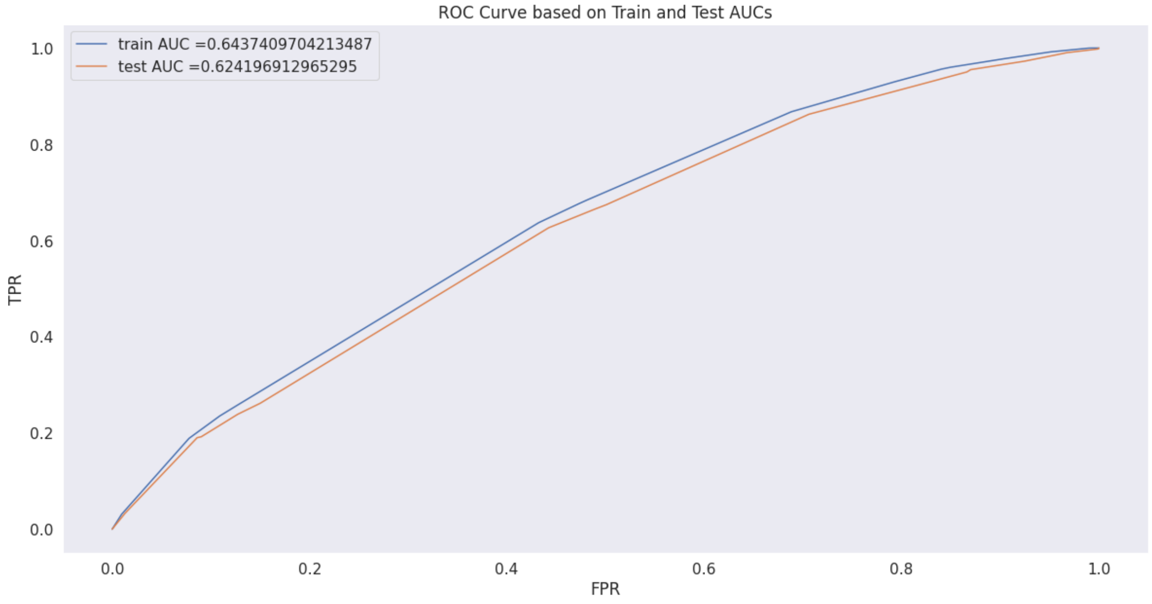


In [0]:

```
from sklearn.metrics import roc_curve, auc, confusion_matrix, accuracy_score

clf1 = DecisionTreeClassifier(max_depth = 5,min_samples_split=500)
clf1.fit(X_tr_tfidf, y_train)
# roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of t
he positive class
# not the predicted outputs

y_train_pred = batch_predict(clf1, X_tr_tfidf)
y_test_pred = batch_predict(clf1, X_te_tfidf)

train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
```

In [98]:

```
plt.figure(figsize=(20,10))
plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("FPR")
plt.ylabel("TPR")
plt.title("ROC Curve based on Train and Test AUCs")
plt.grid()
plt.show()
```



In [85]:

```
best_t = find_best_threshold(tr_thresholds, train_fpr, train_tpr)
Train_CM = confusion_matrix(y_train, predict_with_best_t(y_train_pred, best_t))
Test_CM = confusion_matrix(y_test, predict_with_best_t(y_test_pred, best_t))
print("Train confusion matrix")
print(Train_CM)
print("Test confusion matrix")
print(Test_CM)
```

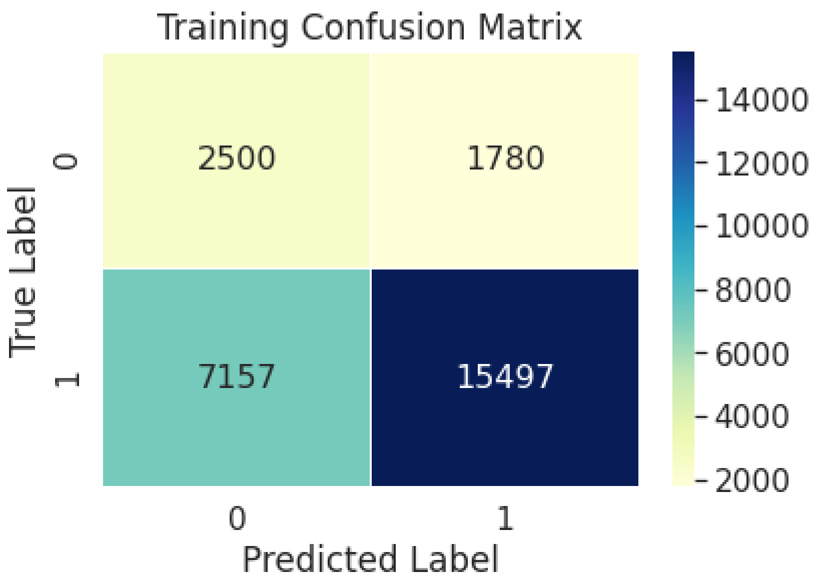
```
the maximum value of tpr*(1-fpr) 0.39957561496020183 for threshold 0.874
Train confusion matrix
[[ 2500  1780]
 [ 7157 15497]]
Test confusion matrix
[[ 1670  1477]
 [ 5500 11153]]
```

In [86]:

```
sns.set(font_scale=1.4)
sns.heatmap(Train_CM,annot=True,cbar=True,fmt="g", annot_kws = {"size":16},linewidths=.
5,cmap="YlGnBu")
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Training Confusion Matrix')
```

Out[86]:

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

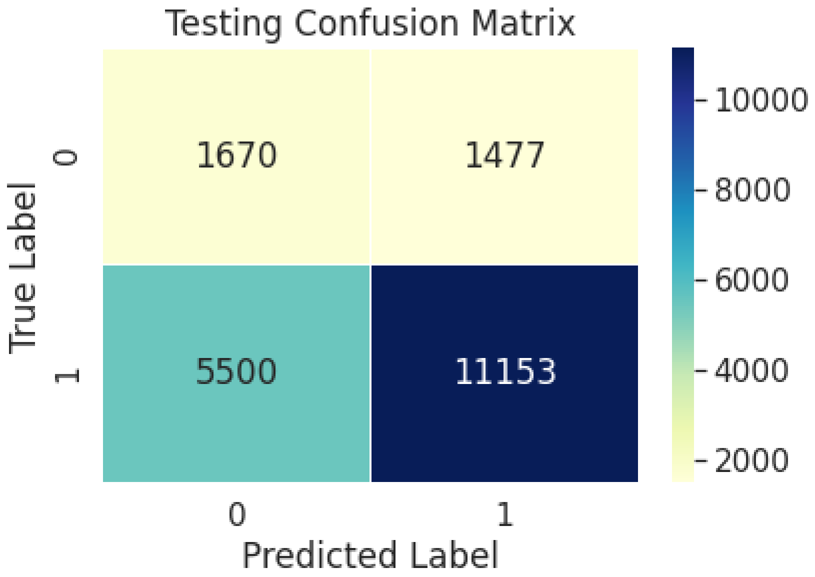


In [87]:

```
sns.heatmap(Test_CM,annot=True,cbar=True,fmt="d", linewidths=.5,cmap="YlGnBu")
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Testing Confusion Matrix')
```

Out[87]:

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



In [145]:

```
X_test['essay'].values[3]
```

Out[145]:

```
'if not struggling not learning quote past student our school title 1 scho
ol many students not opportunities many students in spite financial challe
nges face many community children amazing work hard accomplish goals avail
able they continuously prove no limit achievements reach given support nee
d i made switch desks tables classroom loving it enabling much group discu
ssions collaborative projects in order students get experience typing comp
uters research i wanting chromebook table group our school provides two i
wanting add four technological competence skill students today absolutely
need by giving students opportunities utilize technology available chromeb
ooks help keep skills need become successful citizens nannan'
```

In [0]:

```
false_pos_indices = []
for i in range(len(y_test)):
    if(y_test[i]==0 and _predictions[i] == 1):
        false_pos_indices.append(i)
#In [180]:
false_pos_essay = []
for i in false_pos_indices :
    false_pos_essay.append(X_test['essay'].values[i])
```

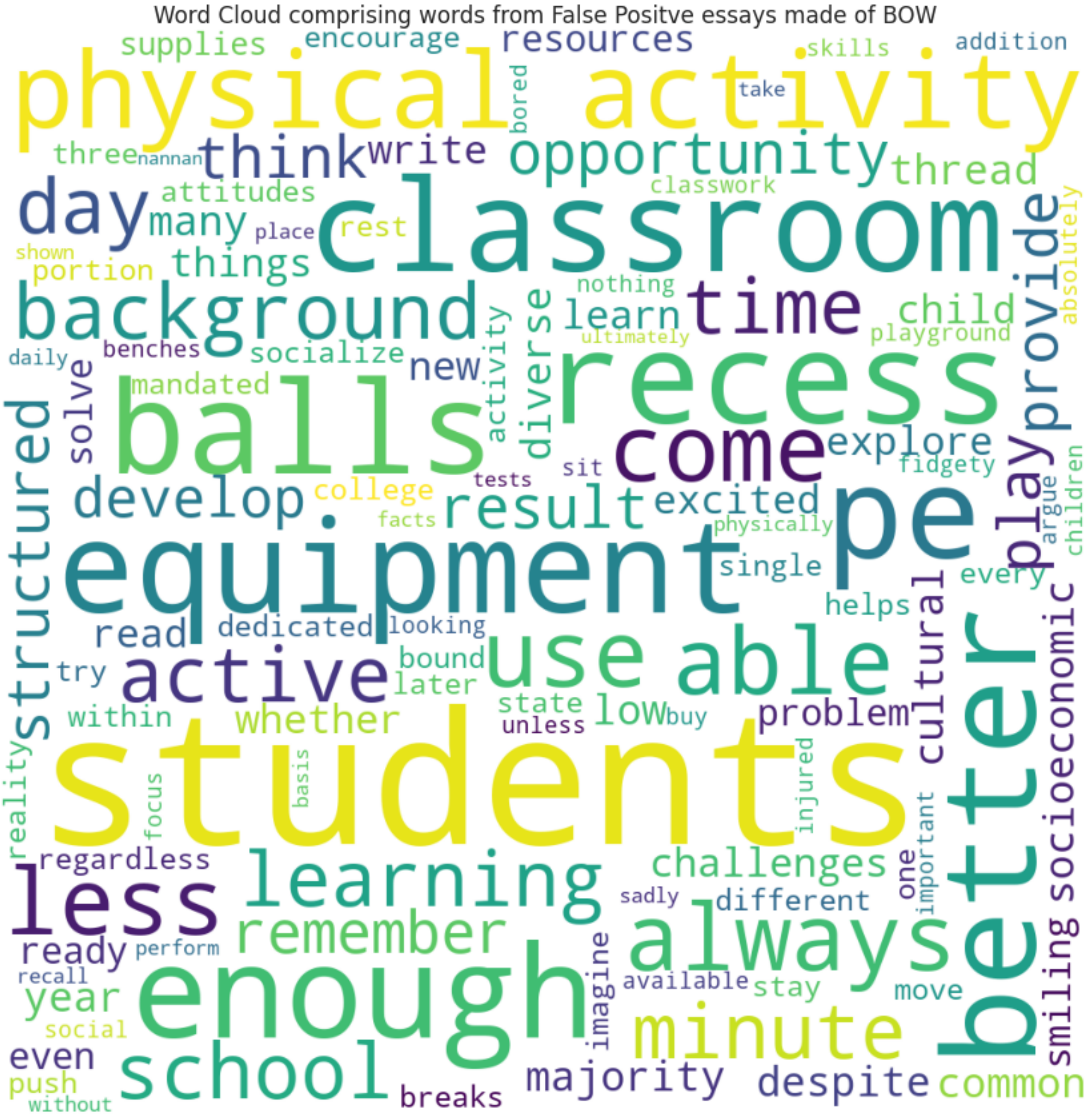
In [0]:

```
from wordcloud import WordCloud, STOPWORDS
comments = " "
stopwords = set(STOPWORDS)
for _essay in false_pos_essay:
    tokens = str(_essay).lower().split()

for words in tokens:
    comments += words + " "

wordcloud = WordCloud(width=1000, height=1000, background_color="white",stopwords=stopw
ords, min_font_size=12).generate(comments)
```

In [91]:

```
plt.figure(figsize=(15,15))
plt.imshow(wordcloud)
plt.axis("off")
plt.title("Word Cloud comprising words from False Positve essays made of BOW")
plt.show()
```

Word Cloud comprising words from False Positve essays made of BOW



In [92]:

```
cols = X_test.columns
X_test_falsePos = pd.DataFrame(columns=cols)
for i in false_pos_indices:
    X_test_falsePos = X_test_falsePos.append(X_test.filter(items=[i],axis=0))

X_test_falsePos.head(1)
```

Out[92]:

	school_state	teacher_prefix	project_grade_category	teacher_number_of_previou
23	va	mrs	grades_3_5	0

In [93]:

```
len(X_test_falsePos)
```

Out[93]:

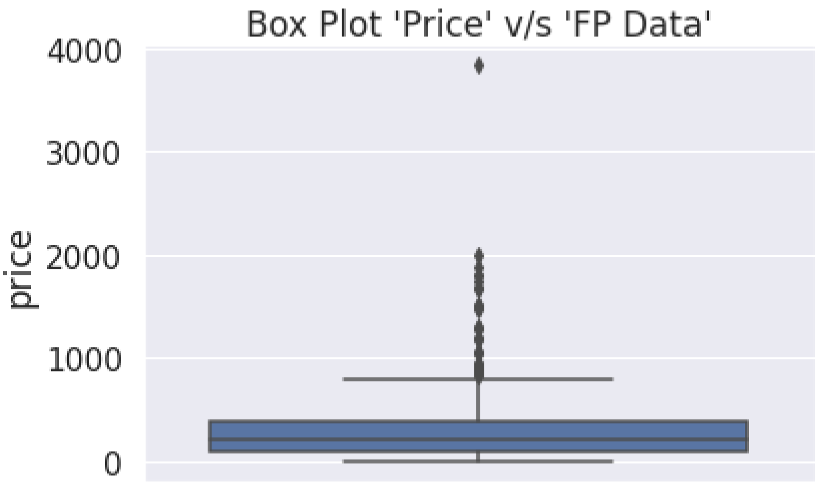
```
508
```

In [94]:

```
sns.boxplot(y="price",data=X_test_falsePos).set_title("Box Plot 'Price' v/s 'FP Data'")
```

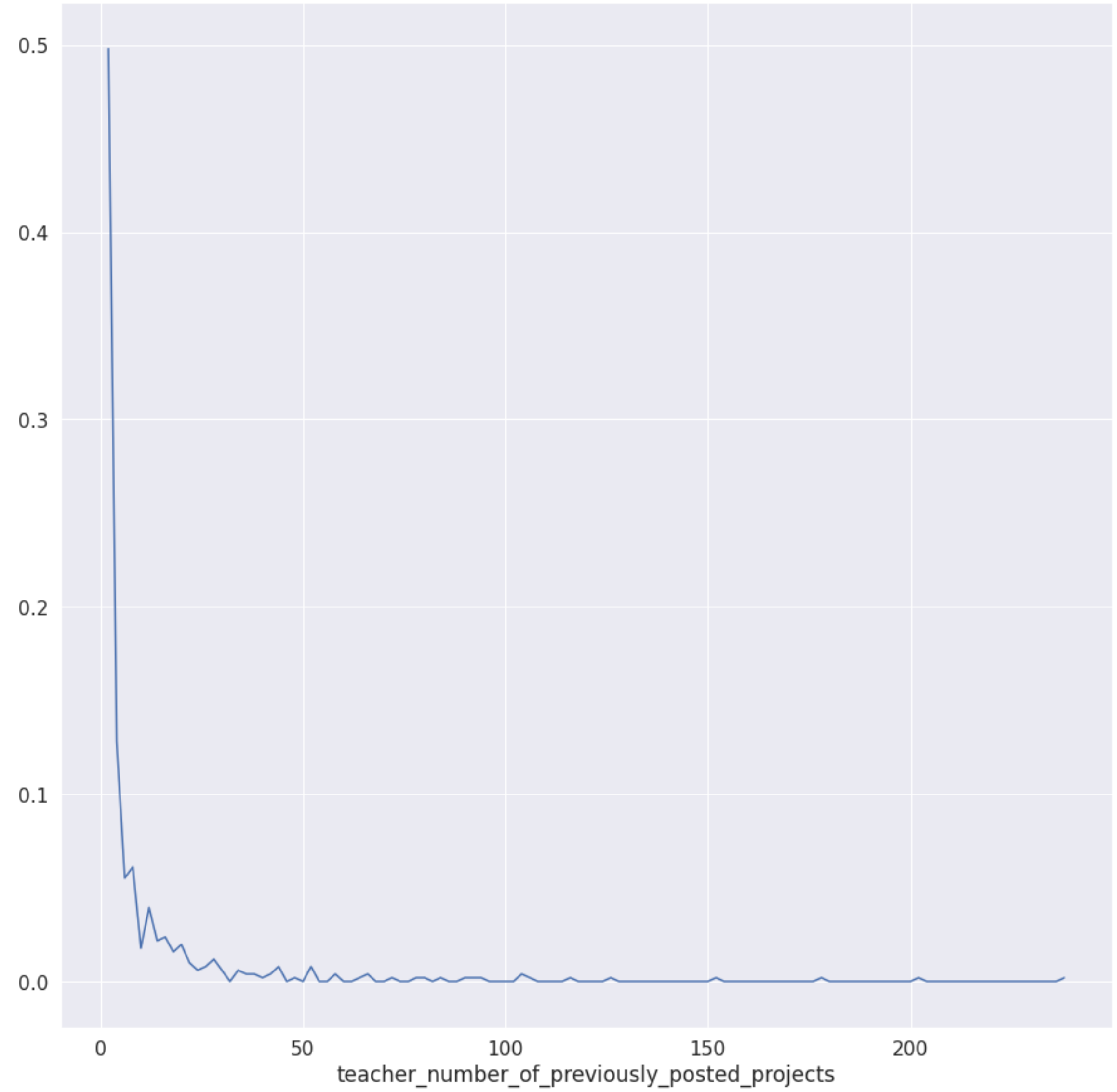
Out[94]:

```
Text(0.5, 1.0, "Box Plot 'Price' v/s 'FP Data'")
```



In [95]:

```
#Plot the pdf with the `teacher_number_of_previously_posted_projects` of these `false positive data points`
plt.figure(figsize=(15,15))
counts, bin_edges = np.histogram(X_test_falsePos["teacher_number_of_previously_posted_projects"], bins="auto",density=True)
pdf = counts/sum(counts)
pdfPoints = plt.plot(bin_edges[1:],pdf)
plt.xlabel("teacher_number_of_previously_posted_projects")
plt.show()
```



Task - 2 (selecting top features)

selcting top 5k data features from tfidf

In [104]:

```
task2_clf_set1 = DecisionTreeClassifier(min_samples_split= 500)

task2_clf_set1.fit(X_tr_tfidf, y_train)
```

Out[104]:

```
DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, criterion='gini',
                       max_depth=None, max_features=None, max_leaf_nodes=N
one,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=500,
                       min_weight_fraction_leaf=0.0, presort='deprecated',
                       random_state=None, splitter='best')
```

In [109]:

```
nonzero_features = np.nonzero(task2_clf_set1.feature_importances_)[0]
#print(nonzero_features)
print(len(nonzero_features))
```

```
942
```

In [111]:

```
from sklearn.linear_model import LogisticRegression

X_tr_nonzero_set1 = X_tr_tfidf[:, nonzero_features]
X_te_nonzero_set1 = X_te_tfidf[:, nonzero_features]
print(X_tr_nonzero_set1.shape,y_train.shape)
print(X_te_nonzero_set1.shape,y_train.shape)
param = {'C': [0.001, 1, 100]}

clf_LR = LogisticRegression()

grid_search = GridSearchCV(clf_LR, param_grid = param)
grid_search.fit(X_tr_nonzero_set1, y_train)
```

```
(26934, 942) (26934,)
(19800, 942) (26934,)
```

Out[111]:

```
GridSearchCV(cv=None, error_score=nan,
             estimator=LogisticRegression(C=1.0, class_weight=None, dual=F
alse,
                                          fit_intercept=True,
                                          intercept_scaling=1, l1_ratio=No
ne,
                                          max_iter=100, multi_class='aut
o',
                                          n_jobs=None, penalty='l2',
                                          random_state=None, solver='lbfg
s',
                                          tol=0.0001, verbose=0,
                                          warm_start=False),
             iid='deprecated', n_jobs=None, param_grid={'C': [0.001, 1, 10
0]},
             pre_dispatch='2*n_jobs', refit=True, return_train_score=Fals
e,
             scoring=None, verbose=0)
```

In [112]:

```
grid_search.best_params_
```

Out[112]:

```
{'C': 1}
```

In [113]:

```
LR_clf_set1 = LogisticRegression(C= grid_search.best_params_['C'])

LR_clf_set1.fit(X_tr_nonzero_set1, y_train)
```

Out[113]:

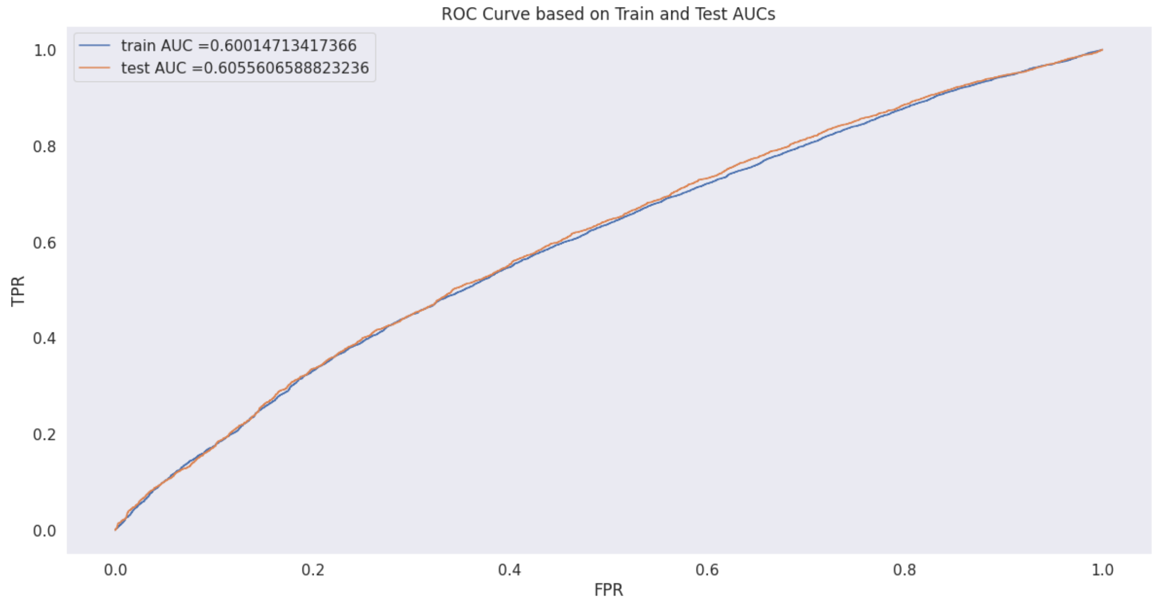
```
LogisticRegression(C=1, class_weight=None, dual=False, fit_intercept=True,
                   intercept_scaling=1, l1_ratio=None, max_iter=100,
                   multi_class='auto', n_jobs=None, penalty='l2',
                   random_state=None, solver='lbfgs', tol=0.0001, verbose=
0,
                   warm_start=False)
```

In [0]:

```
y_train_pred = LR_clf_set1.predict_proba(X_tr_nonzero_set1)[:,1]
y_test_pred = LR_clf_set1.predict_proba(X_te_nonzero_set1)[:,1]

train_fpr, train_tpr, tr_thresholds = roc_curve(y_train, y_train_pred)
test_fpr, test_tpr, te_thresholds = roc_curve(y_test, y_test_pred)
```

In [121]:

```
plt.figure(figsize=(20,10))
plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("FPR")
plt.ylabel("TPR")
plt.title("ROC Curve based on Train and Test AUCs")
plt.grid()
plt.show()
```



In [0]:

```
# we are writing our own function for predict, with defined thresould
# we will pick a threshold that will give the least fpr
def find_best_threshold(threshould, fpr, tpr):
    t = threshould[np.argmax(tpr*(1-fpr))]
    # (tpr*(1-fpr)) will be maximum if your fpr is very low and tpr is very high
    print("the maximum value of tpr*(1-fpr)", max(tpr*(1-fpr)), "for threshold", np.rou
nd(t,3))
    return t

def predict_with_best_t(proba, threshould):
    predictions = []
    global _predictions
    for i in proba:
        if i>=threshould:
            predictions.append(1)
        else:
            predictions.append(0)
    _predictions = predictions
    return predictions
```

In [126]:

```
best_t = find_best_threshold(tr_thresholds, train_fpr, train_tpr)
Train_CM = confusion_matrix(y_train, predict_with_best_t(y_train_pred, best_t))
Test_CM = confusion_matrix(y_test, predict_with_best_t(y_test_pred, best_t))
print("Train confusion matrix")
print(Train_CM)
print("Test confusion matrix")
print(Test_CM)
```

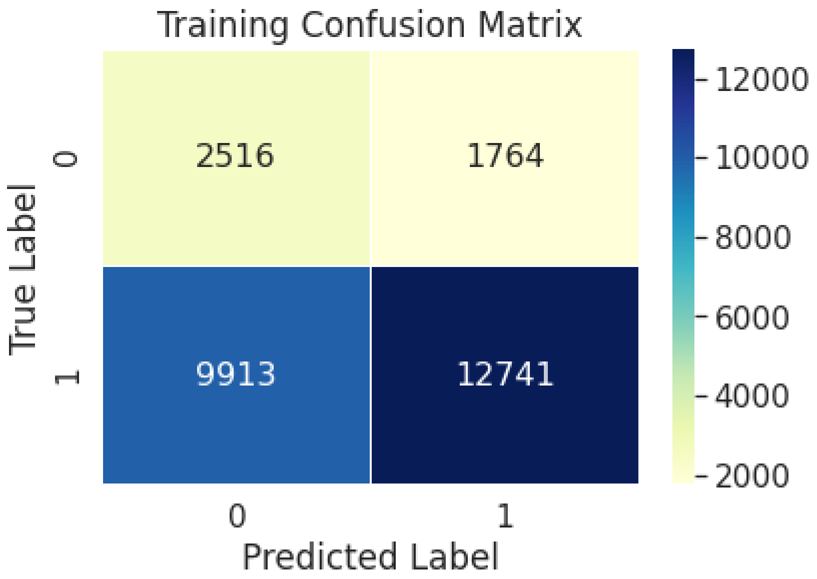
```
the maximum value of tpr*(1-fpr) 0.33061723332472487 for threshold 0.841
Train confusion matrix
[[ 2516  1764]
 [ 9913 12741]]
Test confusion matrix
[[1867 1280]
 [7284 9369]]
```

In [128]:

```
sns.set(font_scale=1.4)
sns.heatmap(Train_CM,annot=True,cbar=True,fmt="g", annot_kws = {"size":16},linewidths=.
5,cmap="YlGnBu")
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Training Confusion Matrix')
```

Out[128]:

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

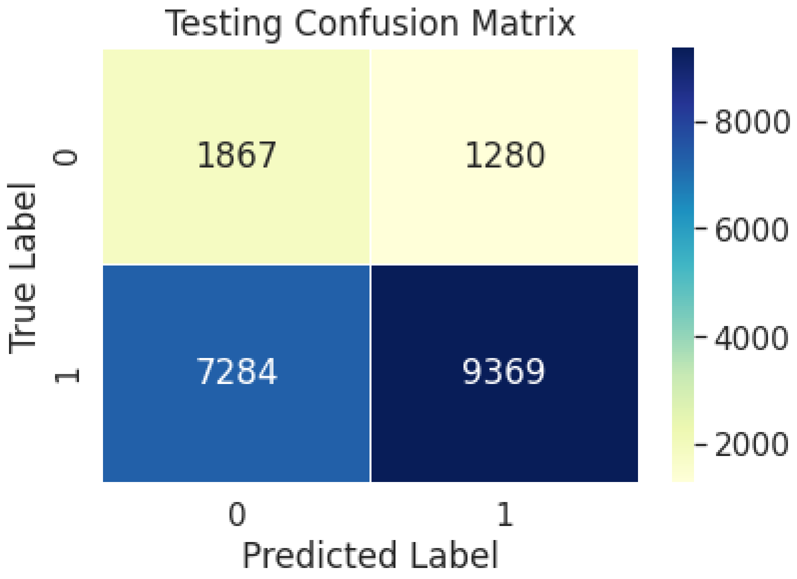


In [129]:

```
sns.heatmap(Test_CM,annot=True,cbar=True,fmt="d", linewidths=.5,cmap="YlGnBu")
plt.ylabel('True Label')
plt.xlabel('Predicted Label')
plt.title('Testing Confusion Matrix')
```

Out[129]:

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



In [0]:

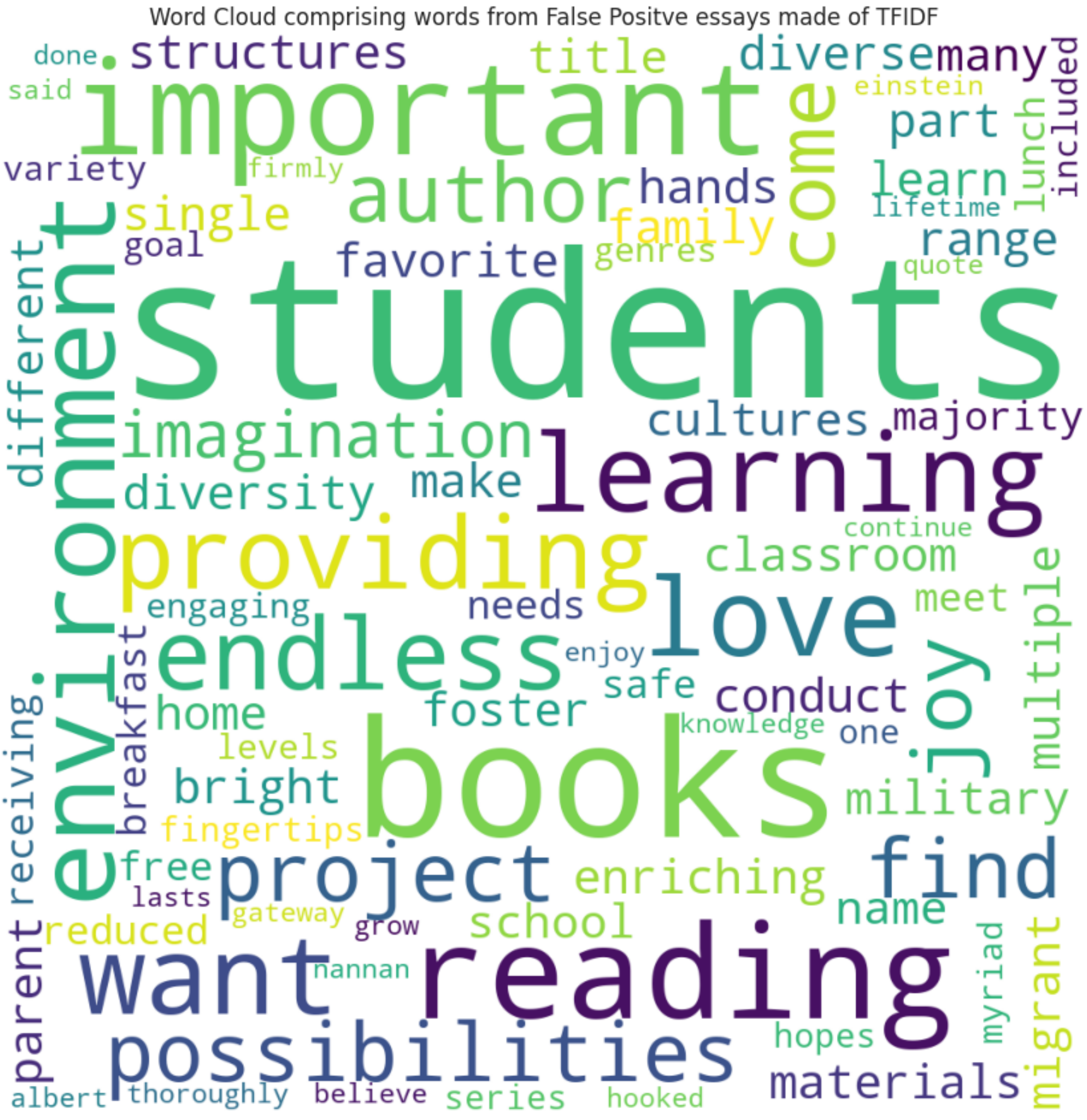
```
false_pos_indices = []
for i in range(len(y_test)):
    if(y_test[i]==0 and _predictions[i] == 1):
        false_pos_indices.append(i)
#In [180]:
false_pos_essay = []
for i in false_pos_indices :
    false_pos_essay.append(X_test['essay'].values[i])
```

In [0]:

```
from wordcloud import WordCloud, STOPWORDS
comments = " "
stopwords = set(STOPWORDS)
for _essay in false_pos_essay:
    tokens = str(_essay).lower().split()

for words in tokens:
    comments += words + " "

wordcloud = WordCloud(width=1000, height=1000, background_color="white",stopwords=stopw
ords, min_font_size=12).generate(comments)
```

In [136]:

```
plt.figure(figsize=(15,15))
plt.imshow(wordcloud)
plt.axis("off")
plt.title("Word Cloud comprising words from False Positve essays made of TFIDF")
plt.show()
```



In [137]:

```
cols = X_test.columns
X_test_falsePos = pd.DataFrame(columns=cols)
for i in false_pos_indices:
    X_test_falsePos = X_test_falsePos.append(X_test.filter(items=[i],axis=0))

X_test_falsePos.head(1)
```

Out[137]:

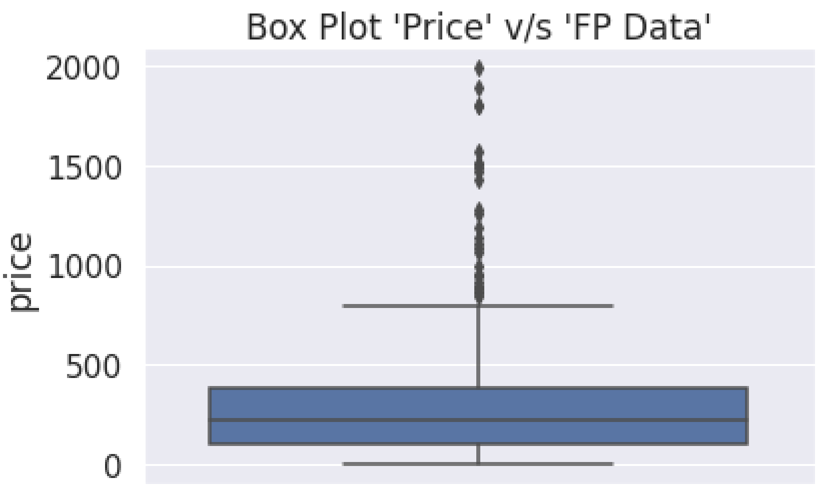
	school_state	teacher_prefix	project_grade_category	teacher_number_of_previou
23	va	mrs	grades_3_5	0

In [138]:

```
sns.boxplot(y="price",data=X_test_falsePos).set_title("Box Plot 'Price' v/s 'FP Data'")
```

Out[138]:

```
Text(0.5, 1.0, "Box Plot 'Price' v/s 'FP Data'")
```



summary

In [5]:

```
 #Please compare all your models using Prettytable library
# http://zetcode.com/python/prettytable/
from prettytable import PrettyTable
TB = PrettyTable()
TB.field_names = ["Model", "Hyperparameter", "Train_AUC", "Test_Auc"]
TB.title = "Decision Tree"
TB.add_row(["TFIDF-Model", "Depth:10 | Samp_Split:500", 0.68, 0.62])
TB.add_row(["tfidf_W2v-Model", "Depth:5 | Samp_Split:500", 0.64, 0.62])

TB.add_row(["Logistic Reg on Best 5K","C:1.0  | Reg: L1", 0.60, 0.60])
print(TB)
```

```
+-------------------------+---------------------------+-----------+-------
---+
|          Model          |       Hyperparameter      | Train_AUC | Test_A
uc |
+-------------------------+---------------------------+-----------+-------
---+
|       TFIDF-Model       | Depth:10 | Samp_Split:500 |    0.68   |   0.62
|
|     tfidf_W2v-Model     |  Depth:5 | Samp_Split:500 |    0.64   |   0.62
|
| Logistic Reg on Best 5K |      C:1.0  | Reg: L1     |    0.6    |   0.6
|
+-------------------------+---------------------------+-----------+-------
---+
```