AFR-DT-Copy1

September 19, 2018

```
In [1]: #main libraries
        import sqlite3
        import pandas as pd
        import numpy as np
        import seaborn as sns
        import matplotlib.pyplot as plt
        import warnings
        warnings.filterwarnings("ignore")
```

```
In [2]: #vectorizors
        from sklearn.feature_extraction.text import TfidfTransformer
        from sklearn.feature_extraction.text import TfidfVectorizer
        from sklearn.feature_extraction.text import CountVectorizer
        import gensim
        from gensim.models import Word2Vec
        from gensim.models import KeyedVectors
        import pickle
```

```
In [3]: #store values in pickles
        from sklearn.externals import joblib
```

```
In [4]: #performence metrics
        from sklearn.metrics import confusion_matrix
        from sklearn import metrics
        from sklearn.metrics import accuracy_score
        from sklearn.metrics import f1_score
        from sklearn.metrics import precision_score
        from sklearn.metrics import recall_score
```

```
In [5]: #modules for building ML model
        from sklearn import preprocessing
        from sklearn.model_selection import train_test_split
        from sklearn.tree import DecisionTreeClassifier
        from sklearn.model_selection import GridSearchCV
        from sklearn.model_selection import RandomizedSearchCV
        from sklearn.model_selection import TimeSeriesSplit
```

0.1 Objective

1. Train, CV, Test split.
2. find right max depth of tree using gridsearchcv().
3. Build Decision tree with featurisation techniques AVGW2V, TFIDFW2V
4. get accuracy, precision scores, confusion matrrix, recall score, f1 score.

0.2 Constraints

1. Decision Tree doesn't work well on BOW, TFIDF, also it takes too much time because of dimensionality problem
2. these are solved in AVGW2V, TFIDFW2V where dimensionallity is small.
3. only 100k points are used.

```
In [6]: #connect sql database
        con = sqlite3.connect('final.sqlite')
```

```
In [7]: #read sql data using pandas
        data = pd.read_sql("SELECT * FROM REVIEWS", con)
```

```
In [8]: def partition(x) :
            if x == 'positive' :
                return 1
            return 0

        actualscore = data['Score']
        positivenegative = actualscore.map(partition)
        data['Score'] = positivenegative
```

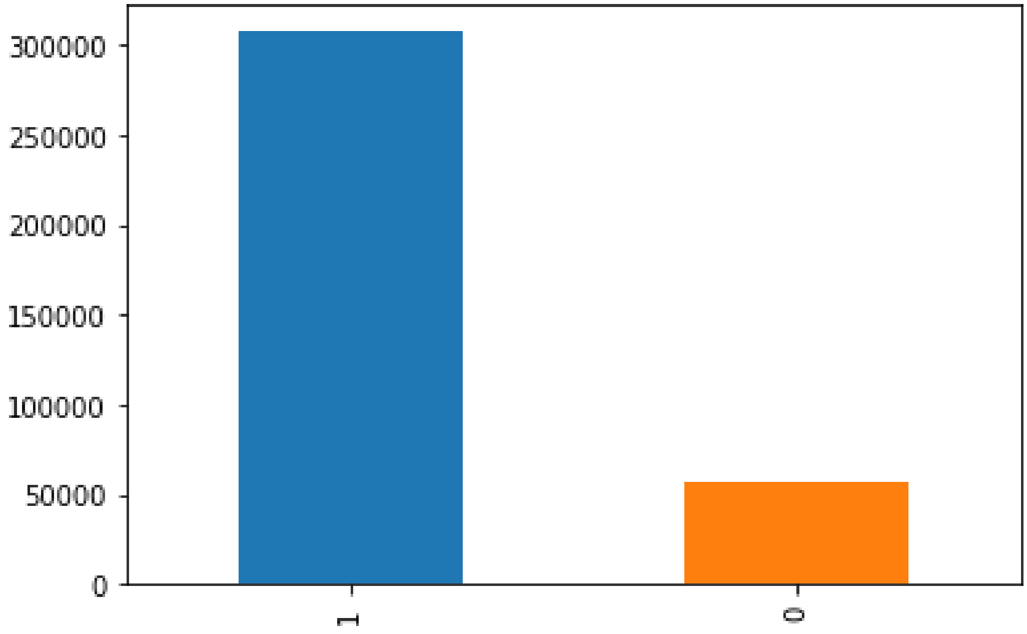
```
In [9]: data.head()
```

```
Out[9]:     index      Id   ProductId          UserId                   ProfileName  \
        0  138706  150524  0006641040   ACITT7DI6IDDL               shari zychinski
        1  138688  150506  0006641040  A2IW4PEEKO2R0U                         Tracy
        2  138689  150507  0006641040  A1S4A3IQ2MU7V4         sally sue "sally sue"
        3  138690  150508  0006641040     AZGXZ2UUK6X  Catherine Hallberg "(Kate)"
        4  138691  150509  0006641040  A3CMRKGE0P909G                        Teresa

           HelpfulnessNumerator  HelpfulnessDenominator  Score        Time  \
        0                     0                       0      1   939340800
        1                     1                       1      1  1194739200
        2                     1                       1      1  1191456000
        3                     1                       1      1  1076025600
        4                     3                       4      1  1018396800

                                            Summary  \
0                   EVERY book is educational
1  Love the book, miss the hard cover version
2                 chicken soup with rice months
3      a good swingy rhythm for reading aloud
4             A great way to learn the months

                                                Text  \
0  this witty little book makes my son laugh at l...
1  I grew up reading these Sendak books, and watc...
2  This is a fun way for children to learn their ...
3  This is a great little book to read aloud- it ...
4  This is a book of poetry about the months of t...

                                         CleanedText
0  witti littl book make son laugh loud recit car...
1  grew read sendak book watch realli rosi movi i...
2  fun way children learn month year learn poem t...
3  great littl book read nice rhythm well good re...
4  book poetri month year goe month cute littl po...
```

```
In [10]: print ('Number of positive & negative data points are \n',data['Score'].value_counts(
         data['Score'].value_counts().plot(kind='bar')
```

```
Number of positive & negative data points are
 1    307061
0     57110
Name: Score, dtype: int64
```

```
Out[10]: <matplotlib.axes._subplots.AxesSubplot at 0x1f797e74748>
```



```
In [11]: #sort data based on time
         df_time_sorted = data.sort_values('Time', kind ='quicksort')

In [12]: df_time_sorted.head()

Out[12]:      index      Id   ProductId          UserId              ProfileName  \
         0    138706  150524  0006641040   ACITT7DI6IDDL           shari zychinski
         30   138683  150501  0006641040   AJ46FKXOVC7NR        Nicholas A Mesiano
         424  417839  451856  B00004CXX9   AIUWLEQ1ADEG5          Elizabeth Medina
         330  346055  374359  B00004CI84  A344SMIA5JECGM          Vincent P. Ross
         423  417838  451855  B00004CXX9   AJH6LUC1UT1ON  The Phantom of the Opera

              HelpfulnessNumerator  HelpfulnessDenominator  Score       Time  \
         0                       0                       0      1  939340800
         30                      2                       2      1  940809600
         424                     0                       0      1  944092800
         330                     1                       2      1  944438400
         423                     0                       0      1  946857600

                                                   Summary  \
         0                            EVERY book is educational
         30   This whole series is great way to spend time w...
         424                               Entertainingl Funny!
         330                            A modern day fairy tale
         423                                         FANTASTIC!

                                                      Text  \
         0    this witty little book makes my son laugh at l...
         30   I can remember seeing the show when it aired o...
         424  Beetlejuice is a well written movie ... ever...
         330  A twist of rumplestiskin captured on film, sta...
         423  Beetlejuice is an excellent and funny movie. K...

                                               CleanedText
         0    witti littl book make son laugh loud recit car...
         30   rememb see show air televis year ago child sis...
         424  beetlejuic well written movi everyth excel act...
         330  twist rumplestiskin captur film star michael k...
         423  beetlejuic excel funni movi keaton hilari wack...
```

The important piece of information from dataset for building ML models are text reviews and their Scores if they are positive or negative so lets seperate only those two columns into a seperate dataframe using pandas

```
In [13]: df = pd.DataFrame(data, columns=['CleanedText', 'Score'])
         df.head()
```

```
Out[13]:                                          CleanedText  Score
         0  witti littl book make son laugh loud recit car...      1
         1  grew read sendak book watch realli rosi movi i...      1
         2  fun way children learn month year learn poem t...      1
         3  great littl book read nice rhythm well good re...      1
         4  book poetri month year goe month cute littl po...      1
```

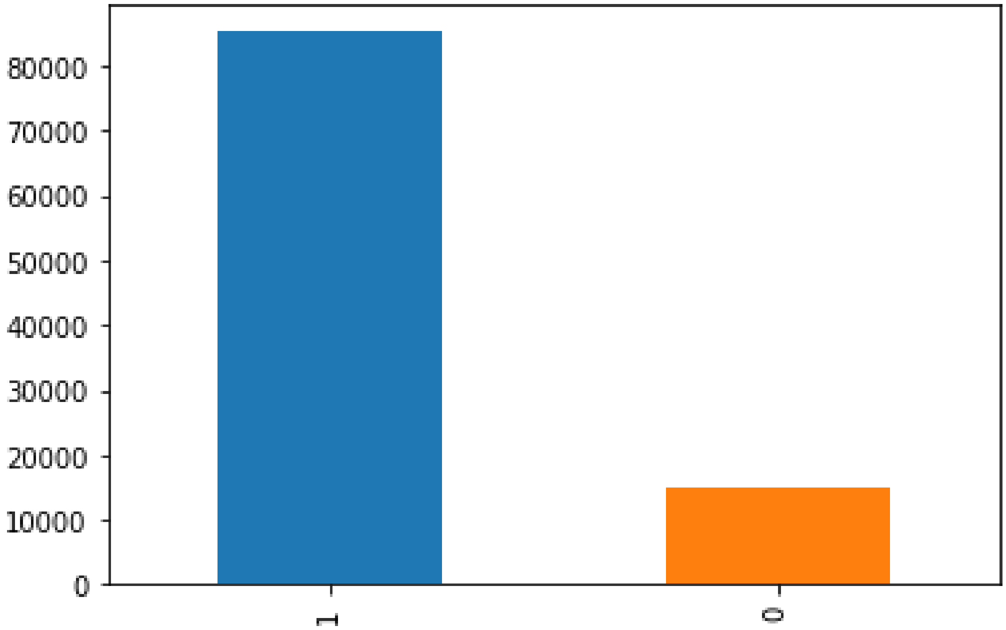
```
In [14]: #lets check the total dataset values
         df.shape
```

```
Out[14]: (364171, 2)
```

```
In [15]: df_sample = df.head(100000)
         print ('Number of +ve & -ve datapoints \n' ,df_sample['Score'].value_counts())
         df_sample['Score'].value_counts().plot(kind='bar')
```

```
Number of +ve & -ve datapoints
 1    85197
0    14803
Name: Score, dtype: int64
```

```
Out[15]: <matplotlib.axes._subplots.AxesSubplot at 0x1f79df32908>
```



```
In [16]: X = df_sample['CleanedText']
         y = df_sample['Score']
         print (X.shape)
         print (y.shape)
```

```
(100000,)
(100000,)
```

```
In [17]: #test-train-split
         X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3,shuffle=False)
         print('X_train shape :' ,X_train.shape)
         print('y_train shape :' ,y_train.shape)
         print('X_test shape :' ,X_test.shape)
         print('y_test shape :' ,y_test.shape)
```

```
X_train shape : (70000,)
y_train shape : (70000,)
X_test shape : (30000,)
y_test shape : (30000,)
```

```
In [18]: joblib.dump(X_train, 'X_train.pkl')
         joblib.dump(X_test, 'X_test.pkl')
         joblib.dump(X_train, 'y_train.pkl')
         joblib.dump(X_test, 'y_test.pkl')
```

```
Out[18]: ['y_test.pkl']
```

```
In [102]: X_train = joblib.load('X_train.pkl')
          X_test = joblib.load('X_test.pkl')
          y_train = joblib.load('y_train.pkl')
          y_test = joblib.load('y_test.pkl')
```

0.2.1 check if rows are not shuffled since its time series data

```
In [18]: X_train.head()
```

```
Out[18]: 0    witti littl book make son laugh loud recit car...
         1    grew read sendak book watch realli rosi movi i...
         2    fun way children learn month year learn poem t...
         3    great littl book read nice rhythm well good re...
         4    book poetri month year goe month cute littl po...
         Name: CleanedText, dtype: object
```

```
In [19]: X_test.head()
```

```
Out[19]: 70000    introduc madhava agav sister back jan diabet r...
         70001    love nectar wish amazon would quit rais price ...
         70002    purchas particular item twice price local heal...
         70003    madhava agav nectar low calori natur kosher sw...
         70004    bought replac honey tendenc crystal winter mon...
         Name: CleanedText, dtype: object
```

```
In [20]: X_train.tail()
```

```
Out[20]: 69995    madhava agav nectar amber bottl pack use agav ...
         69996    forget aspartam artifici sweetner agav nectar ...
         69997    ferment agav nectar realli refresh drink twist...
         69998    love stuff liquid dissolv easier low gci proba...
         69999    start eat healthier one ago biggest step chang...
         Name: CleanedText, dtype: object
```

```
In [21]: X_test.tail()
```

```
Out[21]: 99995    delici sugar pretti light brown color delici a...
         99996    sugar raw flavor profil much better white suga...
         99997    use buy sugar year eat much sugar still sugar ...
         99998    product exact advertis save least half retail ...
         99999    love sugar also get muscavado sugar great use ...
         Name: CleanedText, dtype: object
```

1 Functions to find Hyperparameter & Use Logistic Regression

```
In [22]: def DT_best_params (X_train, y_train) :
             #c=1/lambda, lambda = 0.001,0.002,0.01,0.02,0.1,0.2,1,2,10,20,100,200,1000,2000,1
             #gamma = 1/sigma, sigma = 0.001,0.002,0.01,0.02,0.1,0.2,1,2,10,20,100,200,1000,20
             clf = DecisionTreeClassifier()
             param_grid = {'max_depth' : list(range(1,50))}
             cv = TimeSeriesSplit(n_splits=10)
             grid_cv = GridSearchCV(clf, param_grid, cv=cv, verbose=1, n_jobs=-1)
             grid_cv.fit(X_train, y_train)
             print('best Accuracy:', grid_cv.best_params_)
             print('best Score:', grid_cv.best_score_)
             #plot depth vs CV error
             plt.figure(figsize=(10,6))
             plt.plot(param_grid['max_depth'], grid_cv.cv_results_['mean_test_score'], color='g
             plt.xlabel('MAX-DEPTH')
             plt.ylabel('Accuracy')
```

```
In [23]: def DT(max_depth, X_train, y_train, X_test, y_test) :
             clf = DecisionTreeClassifier(max_depth = max_depth)
             clf.fit(X_train,y_train)
             y_pred = clf.predict(X_test)
             print('accuracy_score =', accuracy_score(y_test, y_pred))
             print('precision_score =', precision_score(y_test, y_pred))
             print('recall_score =', recall_score(y_test, y_pred))
             print('F1_score =', f1_score(y_test, y_pred))
             cm = confusion_matrix(y_test, y_pred)
             sns.heatmap(cm, annot=True, fmt="d")
             return y_pred
```

2 WORD2VECTOR Model

AVGW2V & TFIDFW2V takes lot of time to train so we use only first 25k data

```
In [24]: # Train your own Word2Vec model using your own text corpus
         i=0
         list_of_sent=[]
         for sent in X_train.values:
             list_of_sent.append(sent.split())
```

```
In [25]: print(X_train.values[0])
         print("*****************************************************************")
         print(list_of_sent[0])
```

```
witti littl book make son laugh loud recit car drive along alway sing refrain hes learn whale i
*****************************************************************
['witti', 'littl', 'book', 'make', 'son', 'laugh', 'loud', 'recit', 'car', 'drive', 'along', 'a
```

```
In [26]: # min_count = 5 considers only words that occured atleast 5 times
         w2v_model=Word2Vec(list_of_sent,min_count=5,size=50, workers=4)
```

```
In [29]: joblib.dump(w2v_model, 'w2v.pkl')
```

```
Out[29]: ['w2v.pkl']
```

```
In [30]: w2v_model = joblib.load('w2v.pkl')
```

```
In [27]: w2v_words = list(w2v_model.wv.vocab)
         print("number of words that occured minimum 5 times ",len(w2v_words))
         print("sample words ", w2v_words[0:50])
```

```
number of words that occured minimum 5 times  10848
sample words  ['littl', 'book', 'make', 'son', 'laugh', 'loud', 'recit', 'car', 'drive', 'alon
```

3 AVGW2V

3.0.1 AVGW2V on train data

```
In [28]: # average Word2Vec
         # compute average word2vec for each review.
         %time train_vectors = []; # the avg-w2v for each sentence/review is stored in this li
         for sent in list_of_sent: # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length
             cnt_words =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words:
                     vec = w2v_model.wv[word]
```

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

```
Wall time: 0 ns
70000
50
```

```
In [29]: avgw2v_train = preprocessing.normalize(train_vectors)
```

3.0.2 AVGW2V on test data

```
In [30]: # Train your own Word2Vec model using your own text corpus
         i=0
         list_of_sent_in_test=[]
         for sent in X_test.values:
             list_of_sent_in_test.append(sent.split())
```

```
In [31]: print(X_test.values[0])
         print("*****************************************************************")
         print(list_of_sent_in_test[0])
```

```
introduc madhava agav sister back jan diabet run famili decid use tea coffe cereal cold hot pa
*****************************************************************
['introduc', 'madhava', 'agav', 'sister', 'back', 'jan', 'diabet', 'run', 'famili', 'decid', '
```

```
In [32]: # average Word2Vec
         # compute average word2vec for each review.
         test_vectors = []; # the avg-w2v for each sentence/review is stored in this list

         for sent in list_of_sent_in_test : # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length
             cnt_words =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 if word in w2v_words:
                     vec = w2v_model.wv[word]
                     sent_vec += vec
                     cnt_words += 1
             if cnt_words != 0:
                 sent_vec /= cnt_words
             test_vectors.append(sent_vec)
         print(len(test_vectors))
         print(len(test_vectors[0]))
```

```
30000
50
```

```
In [33]: avgw2v_test = preprocessing.normalize(test_vectors)
```

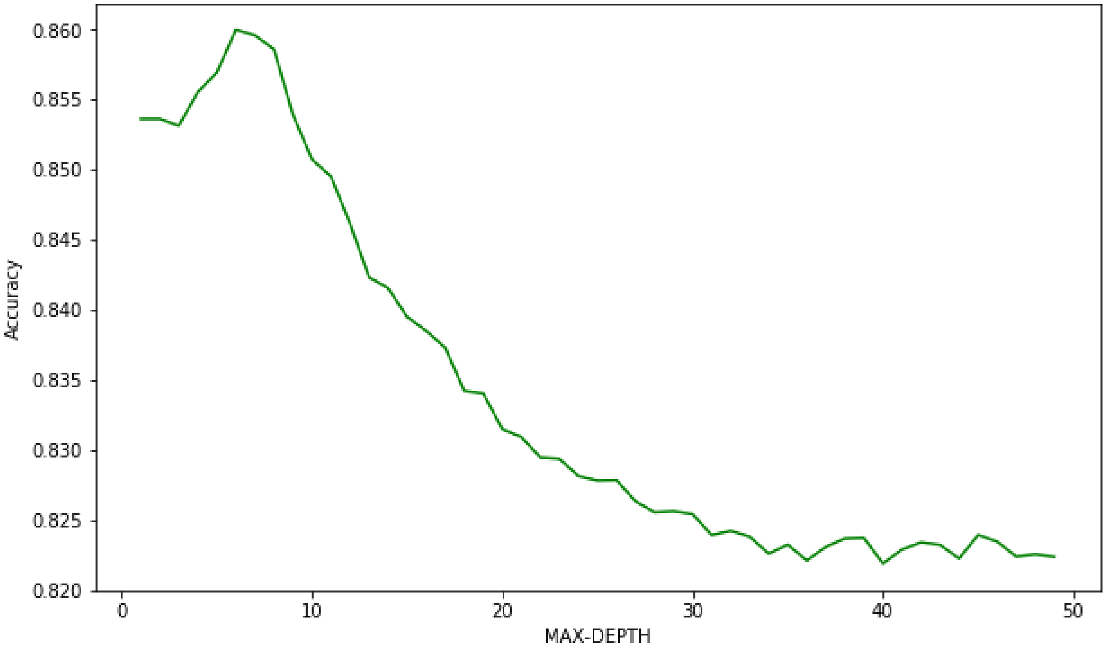
```
In [36]: joblib.dump(avgw2v_train, 'avgw2v_train.pkl')
         joblib.dump(avgw2v_test, 'avgw2v_test.pkl')
```

```
Out[36]: ['avgw2v_test.pkl']
```

```
In [37]: avgw2v_train = joblib.load('avgw2v_train.pkl')
         avgw2v_test = joblib.load('avgw2v_test.pkl')
```

```
In [34]: DT_best_params(avgw2v_train, y_train)
```

```
Fitting 10 folds for each of 49 candidates, totalling 490 fits


[Parallel(n_jobs=-1)]: Done  26 tasks      | elapsed:   11.7s
[Parallel(n_jobs=-1)]: Done 176 tasks      | elapsed:  1.2min
[Parallel(n_jobs=-1)]: Done 426 tasks      | elapsed:  4.2min
[Parallel(n_jobs=-1)]: Done 490 out of 490 | elapsed:  5.1min finished


best Accuracy: {'max_depth': 6}
best Score: 0.860003143171461
```

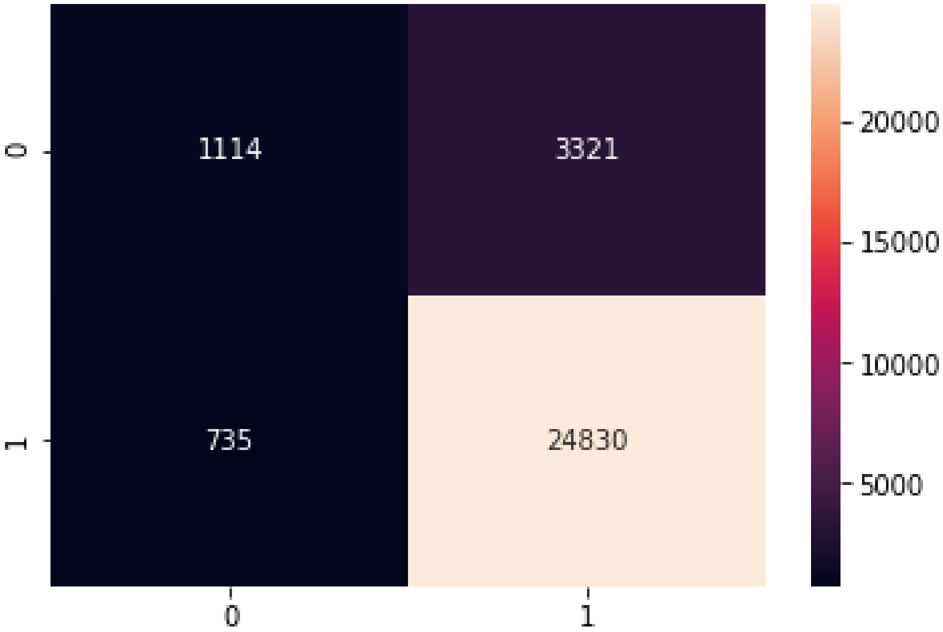


```
In [78]: from sklearn import tree
         tree.export_graphviz(clf,out_file='tree.dot')
```

```
In [35]: DT(6, avgw2v_train, y_train, avgw2v_test, y_test)
```

```
accuracy_score = 0.8648
precision_score = 0.8820290575823239
recall_score = 0.971249755525132
F1_score = 0.9244917715392061
```

```
Out[35]: array([1, 1, 1, ..., 0, 1, 1], dtype=int64)
```



4 TFIDFW2V

4.0.1 TFIDFW2V on Train data

```
In [38]: #calculate TFIDF
         tf_idf_vect = TfidfVectorizer()
         final_tf_idf_train = tf_idf_vect.fit_transform(X_train.values)
         final_tf_idf_test = tf_idf_vect.transform(X_test.values)
```

```
In [39]: # TF-IDF weighted Word2Vec
         tfidf_feat = tf_idf_vect.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf
         np.seterr(divide='ignore', invalid='ignore')
```

```
        tfidf_train_vectors = []; # the tfidf-w2v for each sentence/review is stored in this
        row=0;
        for sent in list_of_sent: # for each review/sentence
            sent_vec = np.zeros(50) # as word vectors are of zero length
            weight_sum =0; # num of words with a valid vector in the sentence/review
            for word in sent: # for each word in a review/sentence
                try:
                    vec = w2v_model.wv[word]
                    # obtain the tf_idfidf of a word in a sentence/review
                    tf_idf = final_tf_idf_train[row, tfidf_feat.index(word)]
                    sent_vec += (vec * tf_idf)
                    weight_sum += tf_idf
                except:
                    pass
            sent_vec /= weight_sum
            tfidf_train_vectors.append(sent_vec)
            row += 1
        print(len(tfidf_train_vectors))
        print(len(tfidf_train_vectors[0]))
```

```
70000
50
```

```
In [40]: tfidfw2v_train = preprocessing.normalize(tfidf_train_vectors)
         #tfidfw2v_train = tfidf_train_vectors
```

4.0.2 TFIDFW2V on Test Data

```
In [41]: # TF-IDF weighted Word2Vec
         tfidf_feat = tf_idf_vect.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf
         np.seterr(divide='ignore', invalid='ignore')
         tfidf_test_vectors = []; # the tfidf-w2v for each sentence/review is stored in this l
         row=0;
         for sent in list_of_sent_in_test: # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero length
             weight_sum =0; # num of words with a valid vector in the sentence/review
             for word in sent: # for each word in a review/sentence
                 try:
                     vec = w2v_model.wv[word]
                     # obtain the tf_idfidf of a word in a sentence/review
                     tf_idf = final_tf_idf_test[row, tfidf_feat.index(word)]
                     sent_vec += (vec * tf_idf)
                     weight_sum += tf_idf
                 except:
                     pass
             sent_vec /= weight_sum
```

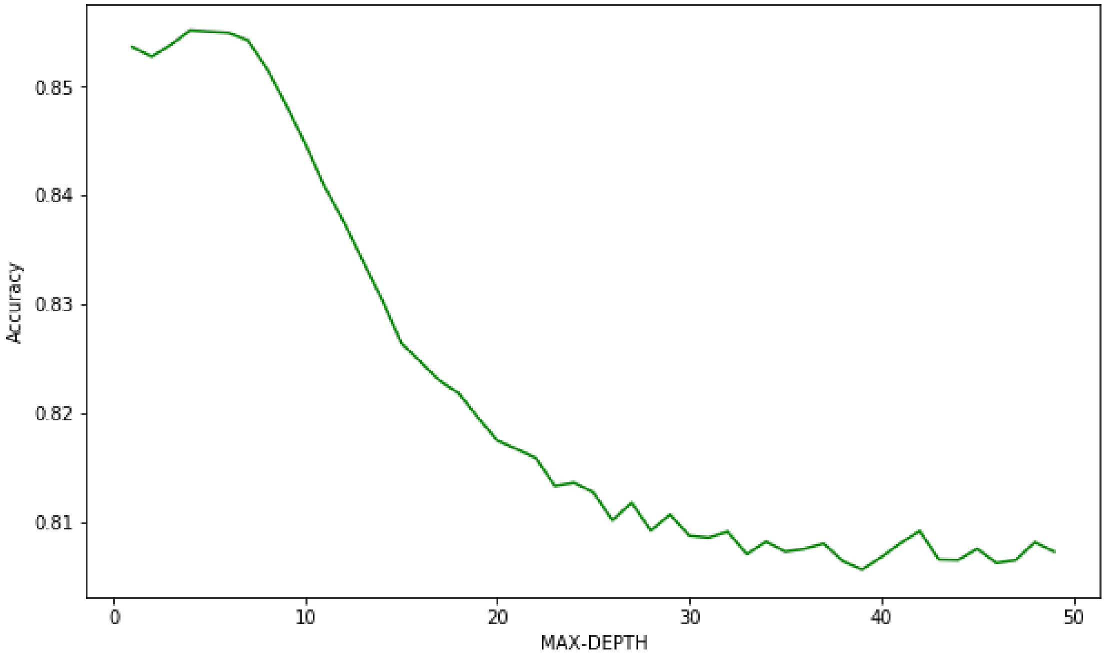
```
                tfidf_test_vectors.append(sent_vec)
                row += 1
            print(len(tfidf_test_vectors))
            print(len(tfidf_test_vectors[0]))

30000
50
```

```
In [42]: tfidfw2v_test = preprocessing.normalize(tfidf_test_vectors)
         tfidfw2v_test.shape

Out[42]: (30000, 50)
```

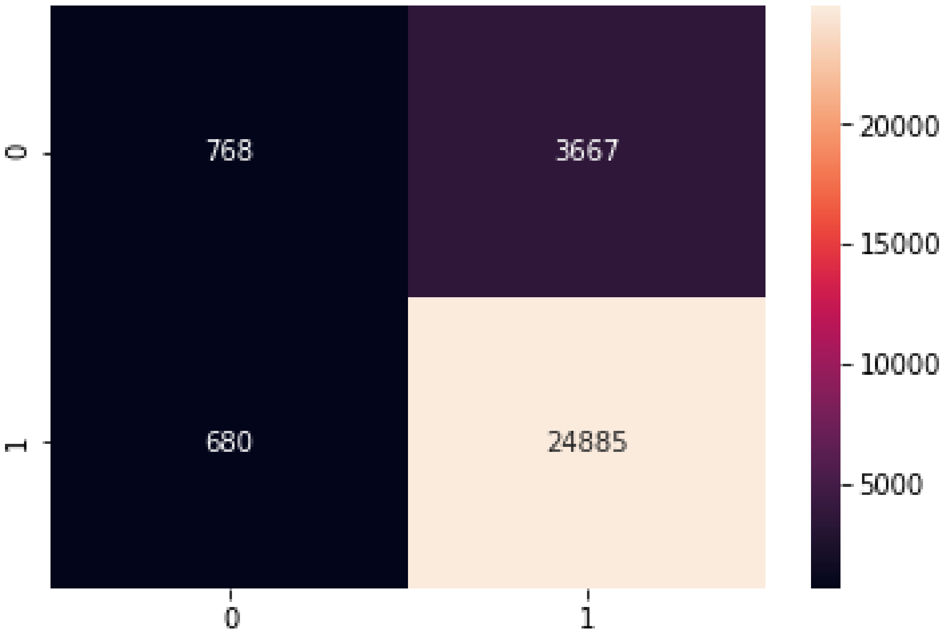
```
In [45]: joblib.dump(tfidfw2v_train, 'tfidfw2v_train.pkl')
         joblib.dump(tfidfw2v_test, 'tfidfw2v_test.pkl')

Out[45]: ['tfidfw2v_test.pkl']
```

```
In [46]: tfidfw2v_train = joblib.load('tfidfw2v_train.pkl')
         tfidfw2v_test = joblib.load('tfidfw2v_test.pkl')
```

```
In [43]: DT_best_params(tfidfw2v_train, y_train)

Fitting 10 folds for each of 49 candidates, totalling 490 fits


[Parallel(n_jobs=-1)]: Done  26 tasks      | elapsed:   11.6s
[Parallel(n_jobs=-1)]: Done 176 tasks      | elapsed:  1.2min
[Parallel(n_jobs=-1)]: Done 426 tasks      | elapsed:  4.0min
[Parallel(n_jobs=-1)]: Done 490 out of 490 | elapsed:  4.9min finished


best Accuracy: {'max_depth': 4}
best Score: 0.8551783749803552
```



```
In [44]: DT(4, tfidfw2v_train, y_train, tfidfw2v_test, y_test)

accuracy_score = 0.8551
precision_score = 0.8715676660128888
recall_score = 0.9734011343633875
F1_score = 0.919674039580908


Out[44]: array([1, 1, 1, ..., 1, 1, 1], dtype=int64)
```



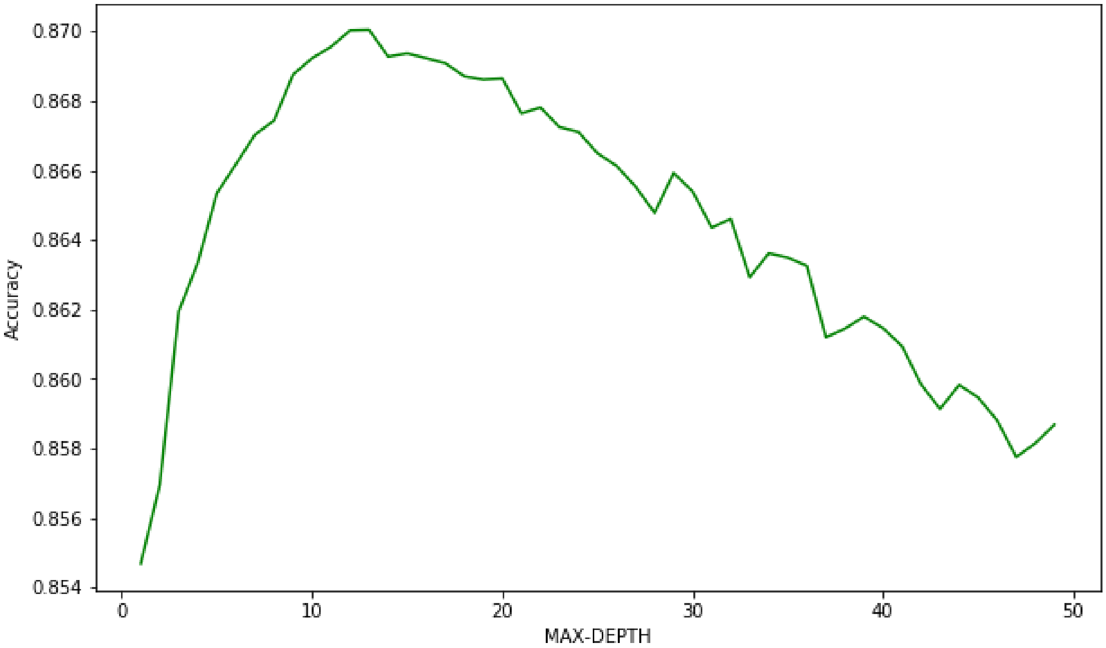
5 BAG of WORDS

```
In [47]: vect = CountVectorizer()

In [48]: bow_X_train = vect.fit_transform(X_train)
         bow_X_train = preprocessing.normalize(bow_X_train)
         bow_X_train

Out[48]: <70000x32149 sparse matrix of type '<class 'numpy.float64'>'
                 with 2162199 stored elements in Compressed Sparse Row format>

In [49]: bow_X_test = vect.transform(X_test)
         bow_X_test = preprocessing.normalize(bow_X_test)
         bow_X_test

Out[49]: <30000x32149 sparse matrix of type '<class 'numpy.float64'>'
                 with 880827 stored elements in Compressed Sparse Row format>

In [ ]: joblib.dump(bow_X_train, 'bow_X_train.pkl')
        joblib.dump(bow_X_test, 'bow_X_test.pkl')

In [ ]: bow_X_train = joblib.load('bow_X_train.pkl')
        bow_X_test = joblib.load('bow_X_test.pkl')

In [50]: DT_best_params(bow_X_train, y_train)
```

```
Fitting 10 folds for each of 49 candidates, totalling 490 fits
```

```
[Parallel(n_jobs=-1)]: Done  26 tasks      | elapsed:   12.5s
[Parallel(n_jobs=-1)]: Done 176 tasks      | elapsed:  1.4min
[Parallel(n_jobs=-1)]: Done 426 tasks      | elapsed:  7.5min
[Parallel(n_jobs=-1)]: Done 490 out of 490 | elapsed: 10.0min finished
```

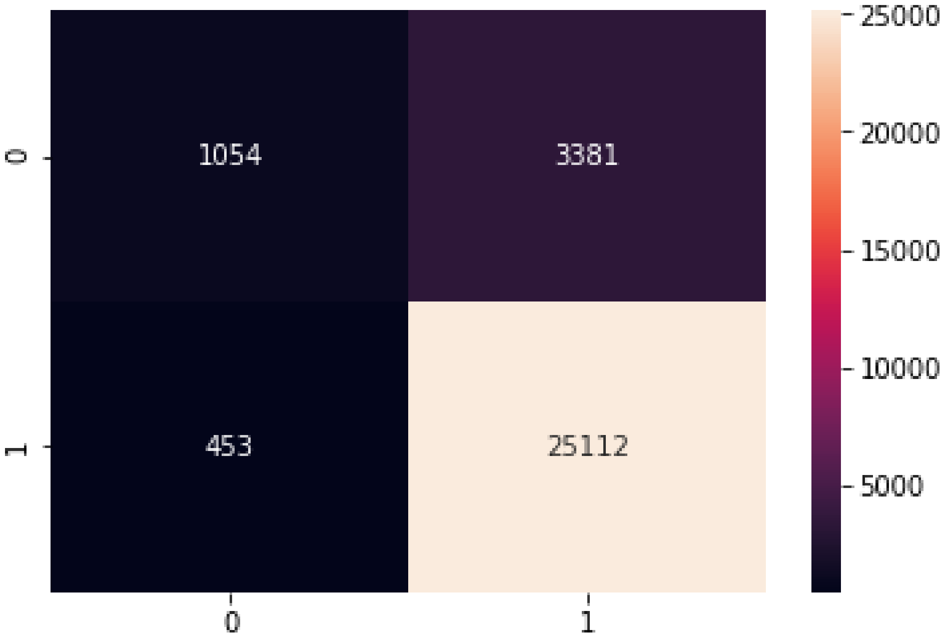
```
best Accuracy: {'max_depth': 13}
best Score: 0.87004557598617
```



```
In [51]: %time DT(13, bow_X_train, y_train, bow_X_test, y_test)
```

```
accuracy_score = 0.8722
precision_score = 0.8813392763134805
recall_score = 0.9822804615685508
F1_score = 0.9290761774390469
Wall time: 6.55 s
```

```
Out[51]: array([1, 1, 1, ..., 1, 1, 1], dtype=int64)
```



6 TFIDF

```
In [20]: vect = TfidfVectorizer()
```

```
In [21]: from sklearn import preprocessing
         tfidf_X_train = vect.fit_transform(X_train)
         tfidf_X_train = preprocessing.normalize(tfidf_X_train)
         tfidf_X_train
```

```
Out[21]: <70000x32149 sparse matrix of type '<class 'numpy.float64'>'
                 with 2162199 stored elements in Compressed Sparse Row format>
```

```
In [22]: tfidf_X_test = vect.transform(X_test)
         tfidf_X_test = preprocessing.normalize(tfidf_X_test)
         tfidf_X_test
```

```
Out[22]: <30000x32149 sparse matrix of type '<class 'numpy.float64'>'
                 with 880827 stored elements in Compressed Sparse Row format>
```

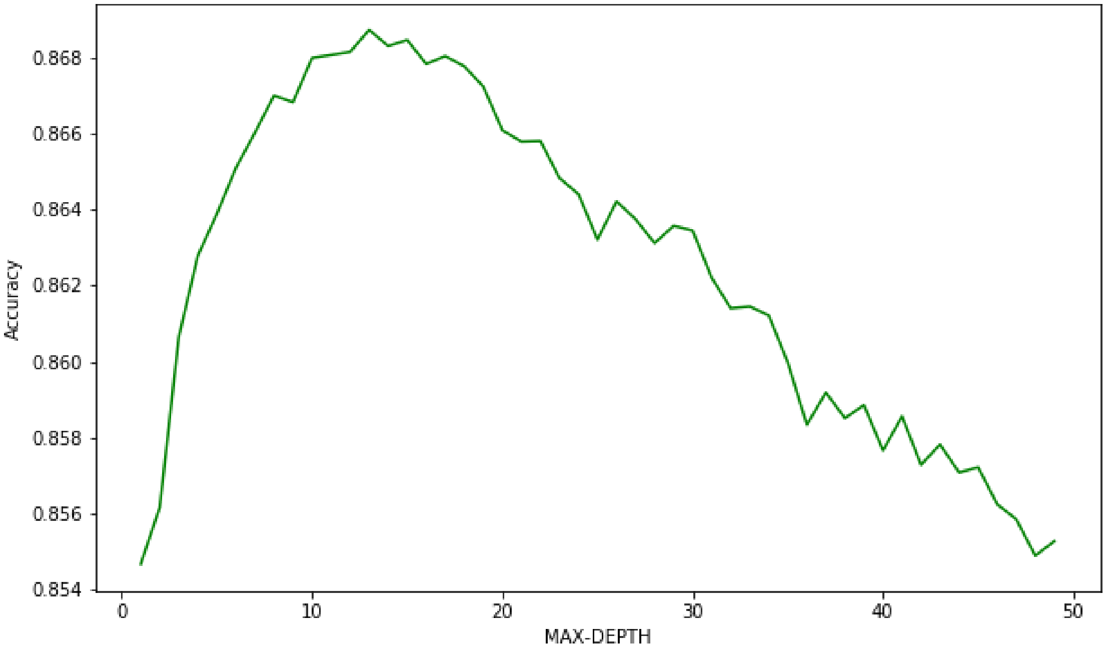
```
In [109]: joblib.dump(tfidf_X_train, 'tfidf_X_train.pkl')
          joblib.dump(tfidf_X_test, 'tfidf_X_test.pkl')
```

```
Out[109]: ['tfidf_X_test.pkl']
```

```
In [111]: tfidf_X_train = joblib.load('tfidf_X_train.pkl')
          tfidf_X_test = joblib.load('tfidf_X_test.pkl')
```

```
In [56]: DT_best_params(tfidf_X_train, y_train)
```

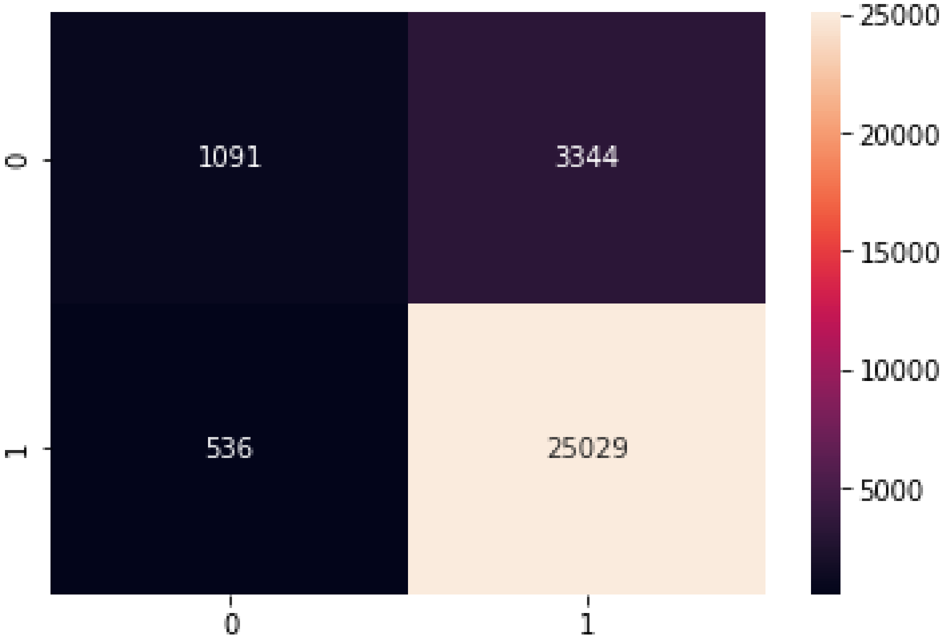
```
Fitting 10 folds for each of 49 candidates, totalling 490 fits


[Parallel(n_jobs=-1)]: Done  26 tasks      | elapsed:    7.8s
[Parallel(n_jobs=-1)]: Done 176 tasks      | elapsed:  1.1min
[Parallel(n_jobs=-1)]: Done 426 tasks      | elapsed:  6.0min
[Parallel(n_jobs=-1)]: Done 490 out of 490 | elapsed:  7.9min finished


best Accuracy: {'max_depth': 13}
best Score: 0.8687254439729687
```



```
In [57]: DT(13, tfidf_X_train, y_train, tfidf_X_test, y_test)
```

```
accuracy_score = 0.8706666666666667
precision_score = 0.882141472526698
recall_score = 0.9790338353217289
F1_score = 0.928065556750343
```

```
Out[57]: array([1, 1, 1, ..., 1, 1, 1], dtype=int64)
```

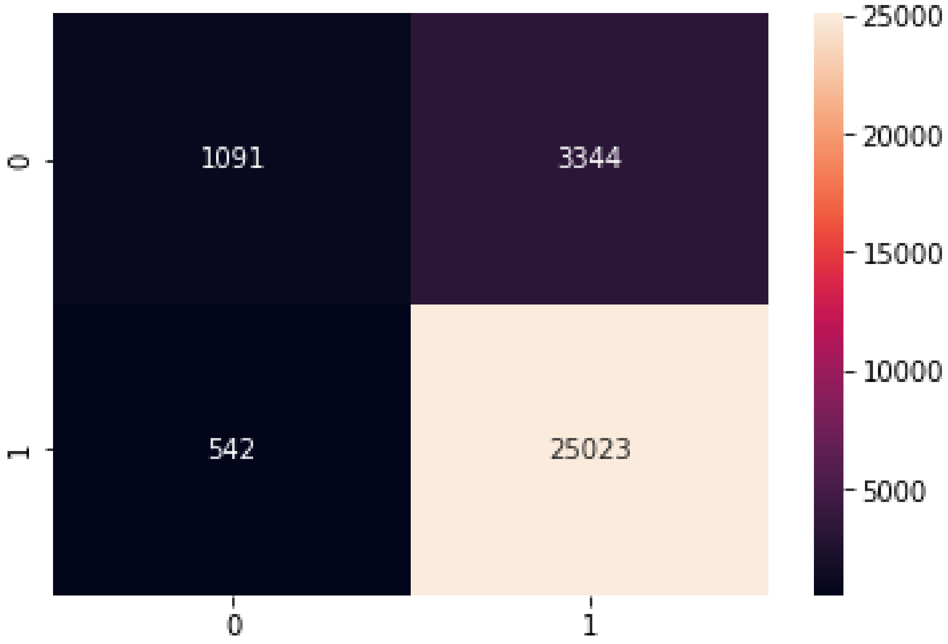


7 Lets see the feature importance and decision tree on our best model TFIDF

```
In [18]: def DT(max_depth, X_train, y_train, X_test, y_test) :
             clf = DecisionTreeClassifier(max_depth = max_depth)
             clf.fit(X_train,y_train)
             y_pred = clf.predict(X_test)
             print('accuracy_score =', accuracy_score(y_test, y_pred))
             print('precision_score =', precision_score(y_test, y_pred))
             print('recall_score =', recall_score(y_test, y_pred))
             print('F1_score =', f1_score(y_test, y_pred))
             cm = confusion_matrix(y_test, y_pred)
             sns.heatmap(cm, annot=True, fmt="d")
             fi = clf.feature_importances_
             return y_pred, fi
```

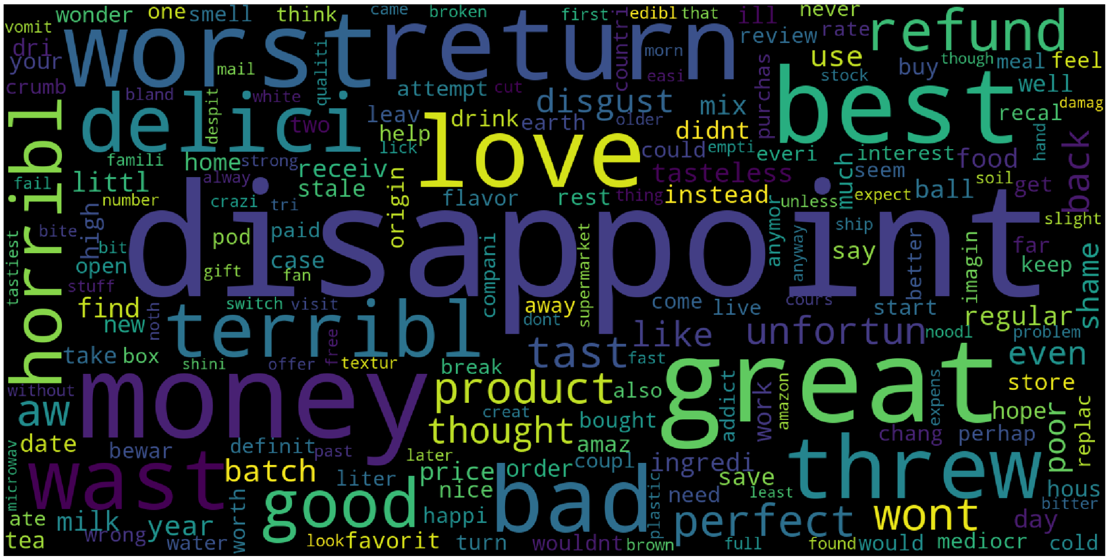
```
In [23]: tfidf_fi = DT(13, tfidf_X_train, y_train, tfidf_X_test, y_test)
```

```
accuracy_score = 0.8704666666666667
precision_score = 0.8821165438713998
recall_score = 0.9787991394484648
F1_score = 0.9279463027516132
```



```
In [24]: features = vect.get_feature_names()

In [29]: tfidf_fi[1]

Out[29]: array([0., 0., 0., ..., 0., 0., 0.])

In [35]: # Ploting word cloud
         from wordcloud import WordCloud

         freq = tfidf_fi[1]
         words = vect.get_feature_names()
         #freqs = tag_dtm.sum(axis=0).A1
         result = dict(zip(words, freq))

         # Lets first convert the 'result' dictionary to 'list of tuples'
         tup = dict(result.items())
         #Initializing WordCloud using frequencies of tags.
         wordcloud = WordCloud(    background_color='black',
                                   width=1600,
                                   height=800,
                             ).generate_from_frequencies(tup)

         fig = plt.figure(figsize=(30,20))
         plt.imshow(wordcloud)
         plt.axis('off')
         plt.tight_layout(pad=0)
```

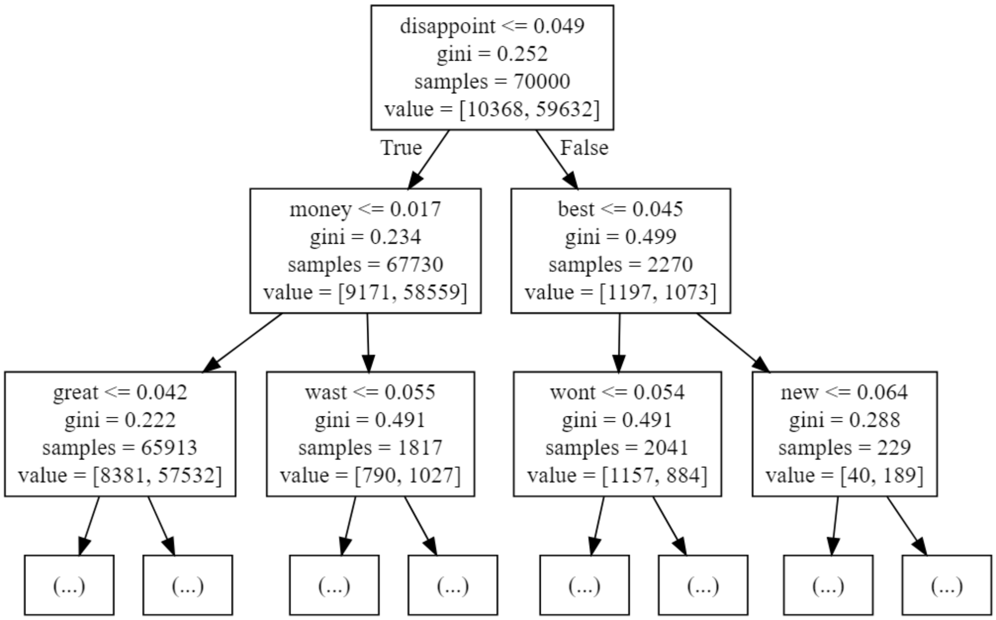
```
fig.savefig("tag.png")
plt.show()
```



```
In [88]: clf = DecisionTreeClassifier(max_depth = 13)
         clf.fit(tfidf_X_train, y_train)

Out[88]: DecisionTreeClassifier(class_weight=None, criterion='gini', max_depth=13,
                     max_features=None, max_leaf_nodes=None,
                     min_impurity_decrease=0.0, min_impurity_split=None,
                     min_samples_leaf=1, min_samples_split=2,
                     min_weight_fraction_leaf=0.0, presort=False, random_state=None,
                     splitter='best')

In [107]: from sklearn import tree
          tree = tree.export_graphviz(clf, out_file='TFIDF_D_tree.dot', max_depth=2, feature_na
```

8 RESULTS

```
In [58]: from prettytable import PrettyTable
         x = PrettyTable()
         x.field_names = ["MODEL", "Tree max-depth", "ACCURACY", "PRECISION", "RECALL", 'F1-SC
         #BOW
         x.add_row(['BOW with DT GridSearch', '13', 0.87, 0.88, 0.98, 0.92])
         x.add_row(['--'*5,'-'*5,'-'*8,'-'*5, '--'*5, '--'*5])
         #TFIDF
         x.add_row(['TFIDF with DT GridSearch', '13', 0.87, 0.88, 0.97, 0.92])
         x.add_row(['--'*5,'-'*8,'-'*8,'-'*5, '--'*5, '--'*5])
```



alt text

```
#AVGW2V
x.add_row(['AVGW2V with DT GridSearch', '6', 0.86, 0.88, 0.97, 0.92])
x.add_row(['--'*5,'-'*8,'-'*8,'-'*5, '--'*5, '--'*5])
#TFIDFW2V
x.add_row(['TFIDFW2V with DT GridSearch', '4', 0.85, 0.87, 0.97, 0.91])
print(x)
```

```
+------------------------------+----------------+----------+------------+-------------+-----------
|            MODEL             | Tree max-depth | ACCURACY | PRECISION  |    RECALL   |  F1-SCORE
+------------------------------+----------------+----------+------------+-------------+-----------
|    BOW with DT GridSearch    |       13       |   0.87   |    0.88    |     0.98    |    0.92
|          ----------          |     ------     | -------- |   -----    |  ---------- | ----------
|   TFIDF with DT GridSearch   |       13       |   0.87   |    0.88    |     0.97    |    0.92
|          ----------          |    --------    | -------- |   -----    |  ---------- | ----------
|  AVGW2V with DT GridSearch   |       6        |   0.86   |    0.88    |     0.97    |    0.92
|          ----------          |    --------    | -------- |   -----    |  ---------- | ----------
| TFIDFW2V with DT GridSearch  |       4        |   0.85   |    0.87    |     0.97    |    0.91
+------------------------------+----------------+----------+------------+-------------+-----------
```

```
In [108]: #number of positive and negative values in test data
          y_test.value_counts()
```

```
Out[108]: 1    25565
          0     4435
          Name: Score, dtype: int64
```

OBSERVATIONS

since AVGW2v and TFIDFW2V took too much time for converting to a vector. the total number of datapoints used are limited to 100K. also, the BOW & TFIDF were trained on all data and the confusion matrix and accuracy score were same in percentages.

1. The best results were obtained from TFIDF with closely 3.8k mis-classifications out of 30k datapoints.
2. DT still lags behind Logistic Regression Model. the maximum misclassification in logistic regression was 2.5k. but this exceeds to atleast 4k misclassification in all models.
3. almost all the model till now has tough in predicting negative reviews.
4. since this data is imbalanced, there are large amount of data for positive reviews. so, the False positive rate is very high on almost all the vectorizers. W2V perfom very bad on this.
5. using SKlearn DT .dot file is generated and sample DT is visualised online graphviz and as we can see in DT. Disappoint is the main word with highest gini impurity