Amazon Fine Food Reviews Analysis

Data Source: https://www.kaggle.com/snap/amazon-fine-food-reviews (https://www.kaggle.com/snap/amazon-fine-food-reviews)

EDA: https://nycdatascience.com/blog/student-works/amazon-fine-foods-visualization/ (https://nycdatascience.com/blog/student-works/amazon-fine-foods-visualization/)

The Amazon Fine Food Reviews dataset consists of reviews of fine foods from Amazon.

Number of reviews: 568,454
Number of users: 256,059
Number of products: 74,258
Timespan: Oct 1999 - Oct 2012
Number of Attributes/Columns in data: 10

Attribute Information:

1. Id
2. ProductId - unique identifier for the product
3. UserId - unqiue identifier for the user
4. ProfileName
5. HelpfulnessNumerator - number of users who found the review helpful
6. HelpfulnessDenominator - number of users who indicated whether they found the review helpful or not
7. Score - rating between 1 and 5
8. Time - timestamp for the review
9. Summary - brief summary of the review
10. Text - text of the review

Objective:

Given a review, determine whether the review is positive (rating of 4 or 5) or negative (rating of 1 or 2).

[Q] How to determine if a review is positive or negative?

[Ans] We could use Score/Rating. A rating of 4 or 5 can be cosnidered as a positive review. A rating of 1 or 2 can be considered as negative one. A review of rating 3 is considered nuetral and such reviews are ignored from our analysis. This is an approximate and proxy way of determining the polarity (positivity/negativity) of a review.

[1]. Reading Data

[1.1] Loading the data

The dataset is available in two forms

1. .csv file
2. SQLite Database

In order to load the data, We have used the SQLITE dataset as it is easier to query the data and visualise the data efficiently.

Here as we only want to get the global sentiment of the recommendations (positive or negative), we will purposefully ignore all Scores equal to 3. If the score is above 3, then the recommendation wil be set to "positive". Otherwise, it will be set to "negative".

In [0]:
```
%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
```

```
/usr/local/lib/python3.6/dist-packages/smart_open/ssh.py:34: UserWarning: param
iko missing, opening SSH/SCP/SFTP paths will be disabled.  `pip install paramik
o` to suppress
  warnings.warn('paramiko missing, opening SSH/SCP/SFTP paths will be disabled.
`pip install paramiko` to suppress')
```

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
# Authenticate and create the PyDrive client.
auth.authenticate_user()
gauth = GoogleAuth()
gauth.credentials = GoogleCredentials.get_application_default()
drive = GoogleDrive(gauth)
```

In [0]:
```
link = 'https://drive.google.com/open?id=16lXcQBv5WlRaLUKNcjHqqyX2I-pXL7pH' # Th
```

In [0]:
```
fluff, id = link.split('=')
print (id) # Verify that you have everything after '='
```

```
16lXcQBv5WlRaLUKNcjHqqyX2I-pXL7pH
```

In [0]:
```
import pandas as pd
downloaded = drive.CreateFile({'id':id})
downloaded.GetContentFile('realdata.csv')
df3 = pd.read_csv('realdata.csv')
```

In [0]:
```
filtered_data=df3
```

In [0]:
```
# using SQLite Table to read data.
con = sqlite3.connect('database.sqlite')

# filtering only positive and negative reviews i.e.
# not taking into consideration those reviews with Score=3
# SELECT * FROM Reviews WHERE Score != 3 LIMIT 500000, will give top 500000 data
# you can change the number to any other number based on your computing power

# filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3 LI
# for tsne assignment you can take 5k data points

filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3 LIMI

# Give reviews with Score>3 a positive rating(1), and reviews with a score<3 a ne
def partition(x):
    if x < 3:
        return 0
    return 1

#changing reviews with score less than 3 to be positive and vice-versa
actualScore = filtered_data['Score']
positiveNegative = actualScore.map(partition)
filtered_data['Score'] = positiveNegative
print("Number of data points in our data", filtered_data.shape)
filtered_data.head(3)
```

In [0]:
```
display = pd.read_sql_query("""
SELECT UserId, ProductId, ProfileName, Time, Score, Text, COUNT(*)
FROM Reviews
GROUP BY UserId
HAVING COUNT(*)>1
""", con)
```

In [0]:
```
print(display.shape)
display.head()
```

In [0]:
```
display[display['UserId']=='AZY10LLTJ71NX']
```

In [0]:
```
display['COUNT(*)'].sum()
```

[2] Exploratory Data Analysis

[2.1] Data Cleaning: Deduplication

It is observed (as shown in the table below) that the reviews data had many duplicate entries. Hence it was necessary to remove duplicates in order to get unbiased results for the analysis of the data. Following is an example:

In [0]:
```
display= pd.read_sql_query("""
SELECT *
FROM Reviews
WHERE Score != 3 AND UserId="AR5J8UI46CURR"
ORDER BY ProductID
""", con)
display.head()
```

Out[7]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenomi
0	78445	B000HDL1RQ	AR5J8UI46CURR	Geetha Krishnan	2	
1	138317	B000HDOPYC	AR5J8UI46CURR	Geetha Krishnan	2	
2	138277	B000HDOPYM	AR5J8UI46CURR	Geetha Krishnan	2	
3	73791	B000HDOPZG	AR5J8UI46CURR	Geetha Krishnan	2	
4	155049	B000PAQ75C	AR5J8UI46CURR	Geetha Krishnan	2	

As it can be seen above that same user has multiple reviews with same values for HelpfulnessNumerator, HelpfulnessDenominator, Score, Time, Summary and Text and on doing analysis it was found that

ProductId=B000HDOPZG was Loacker Quadratini Vanilla Wafer Cookies, 8.82-Ounce Packages (Pack of 8)

ProductId=B000HDL1RQ was Loacker Quadratini Lemon Wafer Cookies, 8.82-Ounce Packages (Pack of 8) and so on

It was inferred after analysis that reviews with same parameters other than ProductId belonged to the same product just having different flavour or quantity. Hence in order to reduce redundancy it was decided to eliminate the rows having same parameters.

The method used for the same was that we first sort the data according to ProductId and then just keep the first similar product review and delelte the others. for eg. in the above just the review for ProductId=B000HDL1RQ remains. This method ensures that there is only one representative for

each product and deduplication without sorting would lead to possibility of different representatives still existing for the same product.

In [0]:
```
#Sorting data according to ProductId in ascending order
sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inpla
```

In [0]:
```
#Deduplication of entries
final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"},
final.shape
```

Out[9]:
```
(101945, 11)
```

In [0]:
```
#Checking to see how much % of data still remains
(final['Id'].size*1.0)/(filtered_data['Id'].size*1.0)*100
```

Out[10]:
```
100.0
```

Observation:- It was also seen that in two rows given below the value of HelpfulnessNumerator is greater than HelpfulnessDenominator which is not practically possible hence these two rows too are removed from calcualtions

In [0]:
```
display= pd.read_sql_query("""
SELECT *
FROM Reviews
WHERE Score != 3 AND Id=44737 OR Id=64422
ORDER BY ProductID
""", con)

display.head()
```

In [0]:
```
final=final[final.HelpfulnessNumerator<=final.HelpfulnessDenominator]
```

In [0]:
```
#Before starting the next phase of preprocessing lets see the number of entries
print(final.shape)

#How many positive and negative reviews are present in our dataset?
final['Score'].value_counts()
```

```
(101945, 11)
```

Out[12]:
```
positive    60650
negative    41295
Name: Score, dtype: int64
```

[3] Preprocessing

[3.1]. Preprocessing Review Text

Now that we have finished deduplication our data requires some preprocessing before we go on further with analysis and making the prediction model.

Hence in the Preprocessing phase we do the following in the order below:-

1. Begin by removing the html tags
2. Remove any punctuations or limited set of special characters like , or . or # etc.
3. Check if the word is made up of english letters and is not alpha-numeric
4. Check to see if the length of the word is greater than 2 (as it was researched that there is no adjective in 2-letters)
5. Convert the word to lowercase
6. Remove Stopwords
7. Finally Snowball Stemming the word (it was obsereved to be better than Porter Stemming)

After which we collect the words used to describe positive and negative reviews

In [0]:
```
# printing some random reviews
sent_0 = final['Text'].values[0]
print(sent_0)
print("="*50)

sent_1000 = final['Text'].values[1000]
print(sent_1000)
print("="*50)

sent_1500 = final['Text'].values[1500]
print(sent_1500)
print("="*50)

sent_4900 = final['Text'].values[4900]
print(sent_4900)
print("="*50)
```

```
In June<br />I saw a charming group<br />of roses all begin<br />to droop<br />
I pepped them up<br />with chicken soup!<br />Sprinkle once<br />sprinkle twice
<br />sprinkle chicken soup<br />with rice<br /><br />This is a great book to t
each children the months of the year. The repetition of the phrases and the fun
ny little stories with accompanying pictures make for an ideal bedtime read. Th
is isn't nearly as good as some of Sendak's other books (like Where the Wild Th
ings are or Pierre: The Boy Who Didn't Care), but it still carries his unique b
rand of charm.
==================================================
This was a gift to a friend who shared it during entertaining.  She was delight
ed with the quality and selection.
==================================================
I liked the lemon better than the almond ones. They bag is bigger than I expect
ed.  Great munchies, lots of cookies.
==================================================
We originally had the Purina One hairball for my rescued cat (per their recomme
ndation), but he does have a sensitive tummy and would have really loose stool
s, and have them at least 4x's a day.  So I switched to Sensitive Systems, and
I LOVE it.  My cat had no problem with the change, he chows down on this, and a
fter a couple weeks of using this, I have noticed that his coat is very sleek,
soft and healthy.  He hasn't shed in a while now, and he used to be pretty bad.
Over the last two weeks since being on it (it did take him a good week for his
system to "firm up") he is now only going roughly 2x's a day, and they are all
normal, not wet or loose.  Very happy with this purchase, it did exactly what I
hoped it would with the benefit of helping his fur too!  No complaints with the
shipping or packaging either.
==================================================
```

In [0]:
```
# remove urls from text python: https://stackoverflow.com/a/40823105/4084039
sent_0 = re.sub(r"http\S+", "", sent_0)
sent_1000 = re.sub(r"http\S+", "", sent_1000)
sent_150 = re.sub(r"http\S+", "", sent_1500)
sent_4900 = re.sub(r"http\S+", "", sent_4900)

print(sent_0)
```

```
In June<br />I saw a charming group<br />of roses all begin<br />to droop<br />
I pepped them up<br />with chicken soup!<br />Sprinkle once<br />sprinkle twice
<br />sprinkle chicken soup<br />with rice<br /><br />This is a great book to t
each children the months of the year. The repetition of the phrases and the fun
ny little stories with accompanying pictures make for an ideal bedtime read. Th
is isn't nearly as good as some of Sendak's other books (like Where the Wild Th
ings are or Pierre: The Boy Who Didn't Care), but it still carries his unique b
rand of charm.
```

In [0]:
```
# https://stackoverflow.com/questions/16206380/python-beautifulsoup-how-to-remove
from bs4 import BeautifulSoup

soup = BeautifulSoup(sent_0, 'lxml')
text = soup.get_text()
print(text)
print("="*50)

soup = BeautifulSoup(sent_1000, 'lxml')
text = soup.get_text()
print(text)
print("="*50)

soup = BeautifulSoup(sent_1500, 'lxml')
text = soup.get_text()
print(text)
print("="*50)

soup = BeautifulSoup(sent_4900, 'lxml')
text = soup.get_text()
print(text)
```

```
In JuneI saw a charming groupof roses all beginto droopI pepped them upwith chi
cken soup!Sprinkle oncesprinkle twicesprinkle chicken soupwith riceThis is a gr
eat book to teach children the months of the year. The repetition of the phrase
s and the funny little stories with accompanying pictures make for an ideal bed
time read. This isn't nearly as good as some of Sendak's other books (like Wher
e the Wild Things are or Pierre: The Boy Who Didn't Care), but it still carries
his unique brand of charm.
==================================================
This was a gift to a friend who shared it during entertaining.  She was delight
ed with the quality and selection.
==================================================
I liked the lemon better than the almond ones. They bag is bigger than I expect
ed.  Great munchies, lots of cookies.
==================================================
We originally had the Purina One hairball for my rescued cat (per their recomme
ndation), but he does have a sensitive tummy and would have really loose stool
s, and have them at least 4x's a day.  So I switched to Sensitive Systems, and
I LOVE it.  My cat had no problem with the change, he chows down on this, and a
fter a couple weeks of using this, I have noticed that his coat is very sleek,
soft and healthy.  He hasn't shed in a while now, and he used to be pretty bad.
Over the last two weeks since being on it (it did take him a good week for his
system to "firm up") he is now only going roughly 2x's a day, and they are all
normal, not wet or loose.  Very happy with this purchase, it did exactly what I
hoped it would with the benefit of helping his fur too!  No complaints with the
shipping or packaging either.
```

In [0]:
```
# https://stackoverflow.com/a/47091490/4084039
import re

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

    # general
    phrase = re.sub(r"n\'t", " not", phrase)
    phrase = re.sub(r"\'re", " are", phrase)
    phrase = re.sub(r"\'s", " is", phrase)
    phrase = re.sub(r"\'d", " would", phrase)
    phrase = re.sub(r"\'ll", " will", phrase)
    phrase = re.sub(r"\'t", " not", phrase)
    phrase = re.sub(r"\'ve", " have", phrase)
    phrase = re.sub(r"\'m", " am", phrase)
    return phrase
```

In [0]:
```
sent_1500 = decontracted(sent_1500)
print(sent_1500)
print("="*50)
```

```
I liked the lemon better than the almond ones. They bag is bigger than I expect
ed.  Great munchies, lots of cookies.
==================================================
```

In [0]:
```
#remove words with numbers python: https://stackoverflow.com/a/18082370/4084039
sent_0 = re.sub("\S*\d\S*", "", sent_0).strip()
print(sent_0)
```

```
In June<br />I saw a charming group<br />of roses all begin<br />to droop<br />
I pepped them up<br />with chicken soup!<br />Sprinkle once<br />sprinkle twice
<br />sprinkle chicken soup<br />with rice<br /><br />This is a great book to t
each children the months of the year. The repetition of the phrases and the fun
ny little stories with accompanying pictures make for an ideal bedtime read. Th
is isn't nearly as good as some of Sendak's other books (like Where the Wild Th
ings are or Pierre: The Boy Who Didn't Care), but it still carries his unique b
rand of charm.
```

In [0]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent_1500 = re.sub('[^A-Za-z0-9]+', ' ', sent_1500)
print(sent_1500)
```

```
I liked the lemon better than the almond ones They bag is bigger than I expecte
d Great munchies lots of cookies
```

In [0]:
```
# https://gist.github.com/sebleier/554280
# we are removing the words from the stop words list: 'no', 'nor', 'not'
# <br /><br /> ==> after the above steps, we are getting "br br"
# we are including them into stop words list
# instead of <br /> if we have <br/> these tags would have revmoved in the 1st st

stopwords= set(['br', 'the', 'i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ou
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he',
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itse
            'theirs', 'themselves', 'what', 'which', 'who','not','no', 'whom', '
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'ha
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 't
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'of
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than'
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "di
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma',
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn
            'won', "won't", 'wouldn', "wouldn't"])
```

In [0]:
```
# Combining all the above stundents
from tqdm import tqdm
preprocessed_reviews = []
# tqdm is for printing the status bar
for sentance in tqdm(final['Text'].values):
    sentance = re.sub(r"http\S+", "", sentance)
    sentance = BeautifulSoup(sentance, 'lxml').get_text()
    sentance = decontracted(sentance)
    sentance = re.sub("\S*\d\S*", "", sentance).strip()
    sentance = re.sub('[^A-Za-z]+', ' ', sentance)
    # https://gist.github.com/sebleier/554280
    sentance = ' '.join(e.lower() for e in sentance.split() if e.lower() not in
    preprocessed_reviews.append(sentance.strip())
```

```
100%|██████████| 101945/101945 [01:02<00:00, 1630.17it/s]
```

[3.2] Preprocessing Review Summary

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

In [0]:
```
x=preprocessed_reviews
y=final['Score'].apply(func)
```

In [0]:
```
from sklearn.model_selection import train_test_split
x1,xtest,y1,ytest=train_test_split(x,y,test_size=0.3,random_state=1,stratify=y)
```

In [0]:
```
xtrain,xcv,ytrain,ycv=train_test_split(x1,y1,test_size=0.2,random_state=1)
```

In [0]:
```
print(len(xtrain))
print(ytrain.shape)
print(len(xtest))
print(ytest.shape)
print(len(xcv))
print(ycv.shape)
```

```
57088
(57088,)
30584
(30584,)
14273
(14273,)
```

[4] Featurization

[4.1] BAG OF WORDS

In [0]:
```
from sklearn.feature_extraction.text import CountVectorizer
count_vect=CountVectorizer()
xtrainonehotencoding=count_vect.fit_transform(xtrain)
xtestonehotencoding=count_vect.transform(xtest)
xcvonehotencoding=count_vect.transform(xcv)
print(xtrainonehotencoding.shape)
print(xtestonehotencoding.shape)
print(xcvonehotencoding.shape)
```

```
(57088, 45065)
(30584, 45065)
(14273, 45065)
```

[4.2] Bi-Grams and n-Grams.

In [0]:
```
#bi-gram, tri-gram and n-gram

#removing stop words like "not" should be avoided before building n-grams
# count_vect = CountVectorizer(ngram_range=(1,2))
# please do read the CountVectorizer documentation http://scikit-learn.org/stable

# you can choose these numebrs min_df=10, max_features=5000, of your choice

from sklearn.feature_extraction.text import CountVectorizer
count_vect1=CountVectorizer(ngram_range=(1,2), min_df=10, max_features=5000)
xtrainonehotencoding=count_vect1.fit_transform(xtrain)
xtestonehotencoding=count_vect1.transform(xtest)
xcvonehotencoding=count_vect1.transform(xcv)
print(xtrainonehotencoding.shape)
print(xtestonehotencoding.shape)
print(xcvonehotencoding.shape)
```

In [0]:
```
```

[4.3] TF-IDF

In [0]:
```
from sklearn.feature_extraction.text import TfidfVectorizer
tfidf= TfidfVectorizer(min_df=2)
xtraintfidfencoding=tfidf.fit_transform(xtrain)
xtesttfidfencoding=tfidf.transform(xtest)
xcvtfidfencoding=tfidf.transform(xcv)
print(xtraintfidfencoding.shape)
print(xtesttfidfencoding.shape)
print(xcvtfidfencoding.shape)
```

```
(57088, 23142)
(30584, 23142)
(14273, 23142)
```

[4.4] Word2Vec

In [0]:
```
# Train your own Word2Vec model using your own text corpus
i=0
list_of_sentance=[]
for sentance in xtrain:
    list_of_sentance.append(sentance.split())
```

In [0]:

```
# Using Google News Word2Vectors

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


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

is_your_ram_gt_16g=False
want_to_use_google_w2v = False
want_to_train_w2v = True

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

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

```
[('fantastic', 0.849480926990509), ('terrific', 0.818476676940918), ('good', 0.
8132082223892212), ('wonderful', 0.812318742275238), ('awesome', 0.805288314819
3359), ('amazing', 0.787868082523346), ('perfect', 0.7628589272499084), ('excel
lent', 0.7627221345901489), ('incredible', 0.685796320438385), ('nice', 0.67650
19297599792)]
==================================================
[('nastiest', 0.8064655065536499), ('greatest', 0.8033692836761475), ('best',
0.7524702548980713), ('tastiest', 0.6948477625846863), ('disgusting', 0.6498489
379882812), ('surpass', 0.6444903612136841), ('closest', 0.6229448318481445),
('terrible', 0.618537962436676), ('smoothest', 0.6092801690101624), ('superio
r', 0.6031782627105713)]
```

In [0]:
```
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  14224
sample words  ['went', 'online', 'research', 'dry', 'dog', 'foods', 'thought',
'course', 'star', 'food', 'know', 'tons', 'protein', 'always', 'best', 'every',
'breed', 'started', 'three', 'little', 'dogs', 'lbs', 'lb', 'yorkie', 'wellnes
s', 'core', 'sure', 'wonderful', 'rated', 'turned', 'far', 'rich', 'talking',
'breeder', 'explained', 'much', 'breeds', 'liver', 'kidneys', 'saw', 'right',
'away', 'knew', 'make', 'quick', 'change', 'definately', 'wanted', 'eliminate',
'gas']
```

[4.4.1] Converting text into vectors using Avg W2V, TFIDF-W2V

[4.4.1.1] Avg W2v

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

```
100%|██████████| 57088/57088 [02:52<00:00, 331.36it/s]

57088
50
```

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

```
100%|██████████| 30584/30584 [01:34<00:00, 324.42it/s]

30584
30584
```

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

```
100%|██████████| 14273/14273 [00:44<00:00, 321.05it/s]

14273
14273
```

[4.4.1.2] TFIDF weighted W2v

In [0]:
```
model = TfidfVectorizer()
xtraintfidfw2v = model.fit_transform(xtrain)
#xtesttfidfw2v=model.transform(xtest)
#xcvtfidfw2v=model.transform(xcv)
tfidf_feat = model.get_feature_names()
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))
```

In [0]:
```
xcvtfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored i
row=0;
for sent in tqdm(xcv): # for each review/sentence
    sent_vec = np.zeros(50)
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent.split(' '): # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    xcvtfidf_sent_vectors.append(sent_vec)
    row += 1
```

100%|██████████| 14273/14273 [08:31<00:00, 21.49it/s]

In [0]:
```
xtraintfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is store
row=0;
for sent in tqdm(xtrain): # for each review/sentence
    sent_vec = np.zeros(50)
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent.split(' '): # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    xtraintfidf_sent_vectors.append(sent_vec)
    row += 1
```

100%|██████████| 57088/57088 [36:39<00:00, 25.95it/s]

In [0]:
```
xtesttfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored
row=0;
for sent in tqdm(xtest): # for each review/sentence
    sent_vec = np.zeros(50)
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent.split(' '): # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    xtesttfidf_sent_vectors.append(sent_vec)
    row += 1
```

```
100%|██████████| 30584/30584 [15:32<00:00, 32.81it/s]
```

[5] Assignment 9: Random Forests

1. **Apply Random Forests & GBDT on these feature sets**
   - SET 1:Review text, preprocessed one converted into vectors using (BOW)
   - SET 2:Review text, preprocessed one converted into vectors using (TFIDF)
   - SET 3:Review text, preprocessed one converted into vectors using (AVG W2v)
   - SET 4:Review text, preprocessed one converted into vectors using (TFIDF W2v)
2. **The hyper paramter tuning (Consider two hyperparameters: n_estimators & max_depth)**
   - Find the best hyper parameter which will give the maximum AUC (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/receiver-operating-characteristic-curve-roc-curve-and-auc-1/) value
   - Find the best hyper paramter using k-fold cross validation or simple cross validation data
   - Use gridsearch cv or randomsearch cv or you can also write your own for loops to do this task of hyperparameter tuning
3. **Feature importance**
   - Get top 20 important features and represent them in a word cloud. Do this for BOW & TFIDF.
4. **Feature engineering**
   - To increase the performance of your model, you can also experiment with with feature engineering like :
     - Taking length of reviews as another feature.
     - Considering some features from review summary as well.
5. **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 figure
  with X-axis as **n_estimators**, Y-axis as **max_depth**, and Z-axis as **AUC Score** , we have given the notebook which explains how 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 figure
  seaborn heat maps (https://seaborn.pydata.org/generated/seaborn.heatmap.html) with rows as **n_estimators**, 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, and 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 (https://www.appliedaicourse.com/course/applied-ai-course-online/lessons/confusion-matrix-tpr-fpr-fnr-tnr-1/) with predicted and original labels of test data points. Please visualize your confusion matrices using seaborn heatmaps. (https://seaborn.pydata.org/generated/seaborn.heatmap.html)

6. **Conclusion**

- You need to summarize the results at the end of the notebook, summarize it in the table format. To print out a table please refer to this prettytable library link (http://zetcode.com/python/prettytable/)

Note: Data Leakage

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

[5.1] Applying RF

[5.1.1] Applying Random Forests on BOW, SET 1

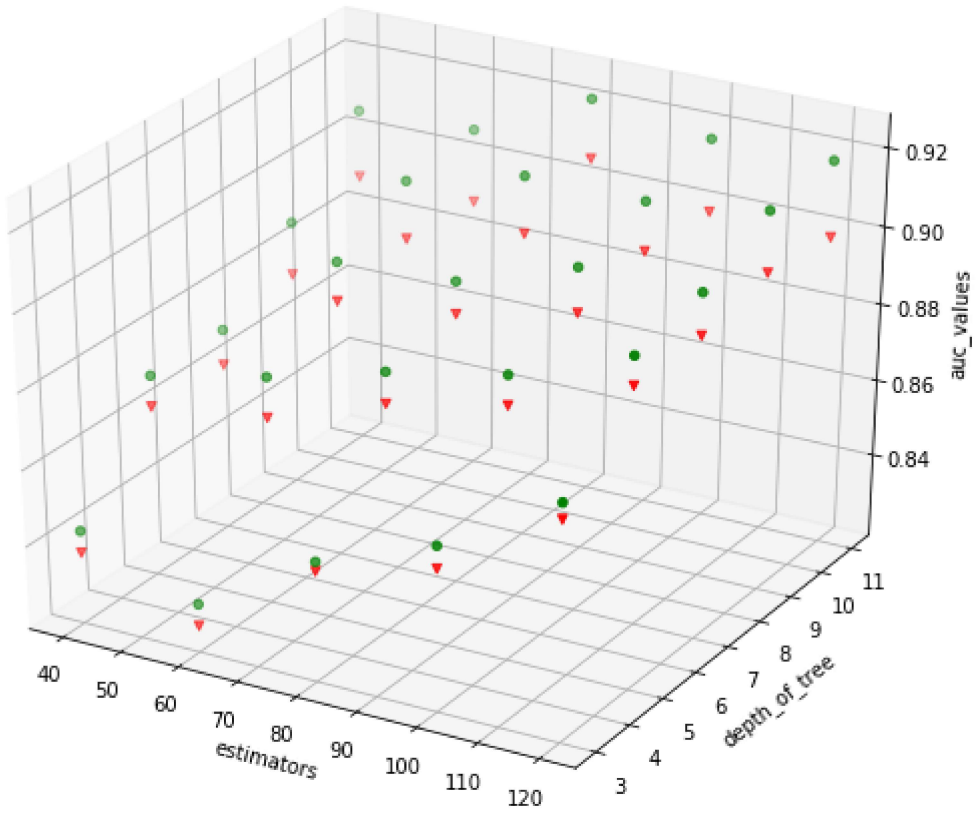
In [0]:
```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from sklearn.ensemble import RandomForestClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx=RandomForestClassifier(n_estimators=i,max_depth=j)
    knnx.fit(xtrainonehotencoding,ytrain)
    predict1=knnx.predict_proba(xtrainonehotencoding)[:,1]
    predix=knnx.predict(xtrainonehotencoding)
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba(xcvonehotencoding)[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
optimal_k=np.argmax(cvscores1)
print(cvscores)
print(cvscores1)
```

```
[0.8427277081479072, 0.8710617908821205, 0.871073283773396, 0.8878137844271216,
0.9062463390221396, 0.8309444154445427, 0.8776201451423241, 0.8954566964216089,
0.905001008657202, 0.9074310971623238, 0.8497652502697448, 0.8859152419844827,
0.8971081528327975, 0.9125811743883961, 0.9214590115118713, 0.8614705663549764,
0.8920919767902749, 0.9072660884004015, 0.9125625296863118, 0.9174178618599373,
0.8798350566246085, 0.903784031113201, 0.9076396191338899, 0.9166084936441875,
0.9181251297712735]
[0.8370043109423139, 0.8629270062618003, 0.8618476453090718, 0.874148416337550
6, 0.8889419390146495, 0.825220807603693, 0.8671001291058282, 0.885331226330359
7, 0.8900965783070969, 0.8886550246799279, 0.8473025697759878, 0.87776653009706
54, 0.8887440011423006, 0.897904712669406, 0.9061332669499138, 0.85562389305879
74, 0.8843942134059559, 0.8957998223414827, 0.8999026860832716, 0.8987735927673
258, 0.8756282838182319, 0.8963587977480777, 0.896885787016028, 0.9010453344071
571, 0.8986950841240557]
```

In [0]:
```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

In [0]:

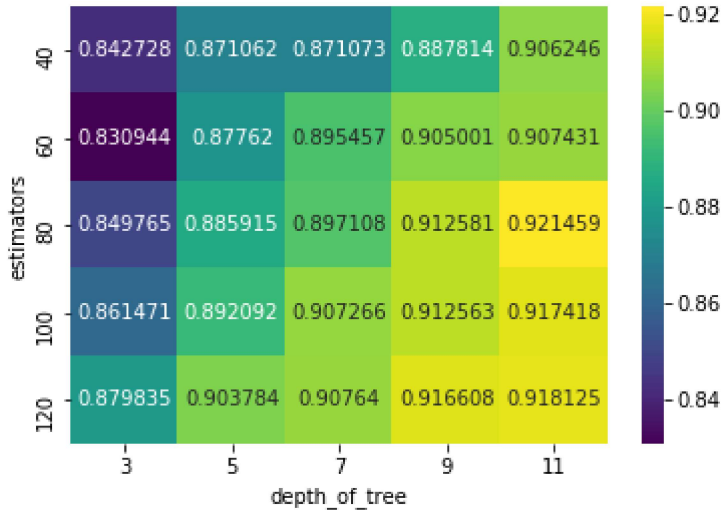
```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt



fig = plt.figure(figsize=(10,8))
ax = fig.add_subplot(111, projection='3d')
ax.scatter(estimatorsy, depthsy,cvscores, marker='o',color='g')
ax.scatter(estimatorsy, depthsy,cvscores1, marker='v',color='r')

ax.set_xlabel('estimators')
ax.set_ylabel('depth_of_tree')
ax.set_zlabel('auc_values')

plt.show()
```



In [0]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

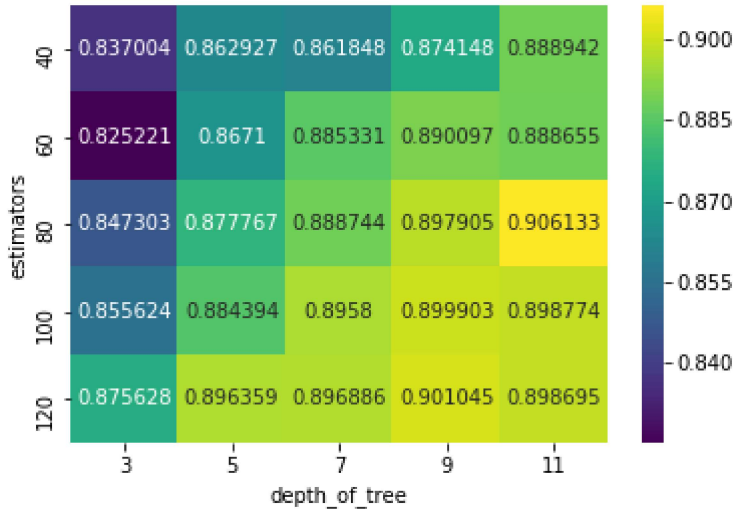
Out[42]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a06001b70>
```



In [0]:
```
print('for cv data')
dat['a']=pd.DataFrame(cvscores1)
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for cv data
```

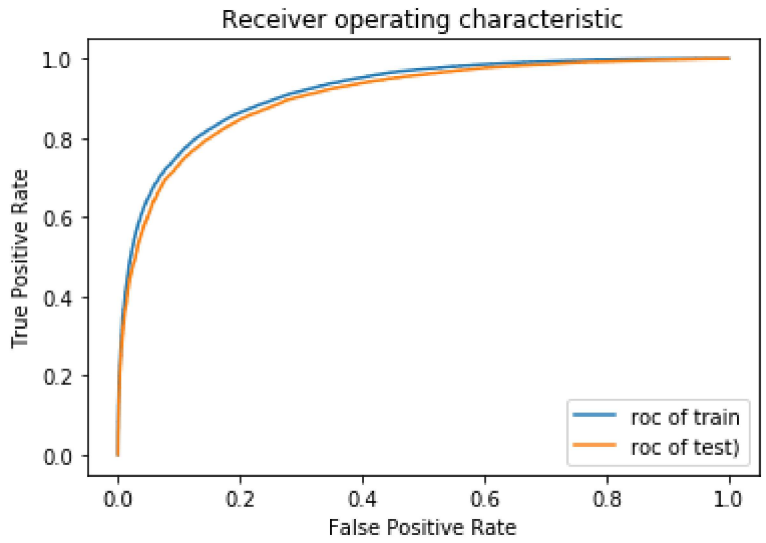
Out[43]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a0559c240>
```



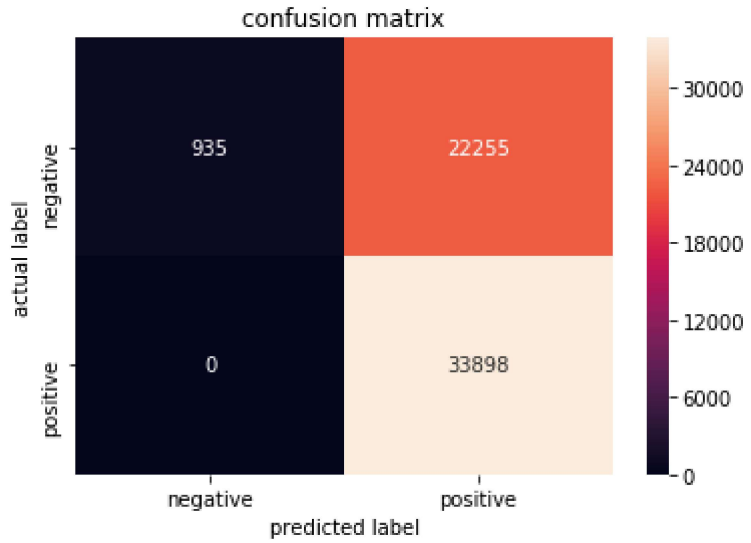
In [0]:

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne=RandomForestClassifier(n_estimators=100,max_depth=9)
knne.fit(xtrainonehotencoding,ytrain)
predictrain=knne.predict_proba(xtrainonehotencoding)[:,1]
predictra=knne.predict(xtrainonehotencoding)
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(xtestonehotencoding)[:,1]
predictra1=knne.predict(xtestonehotencoding)
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

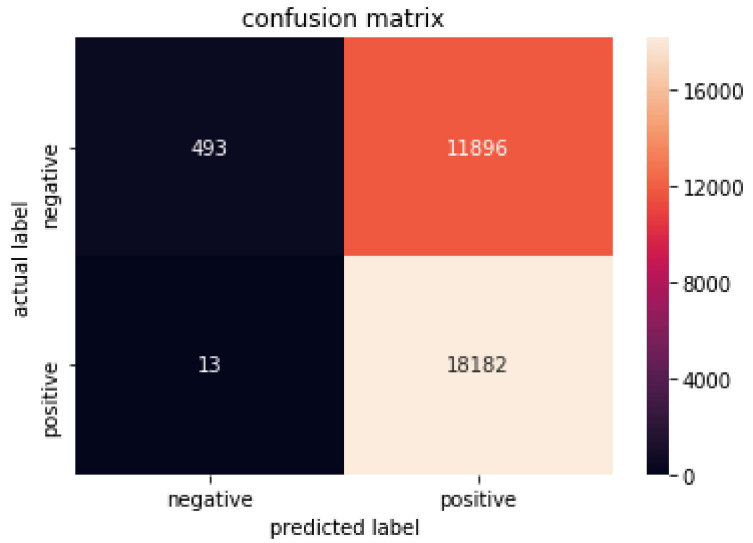
```
0.9042088258714023
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



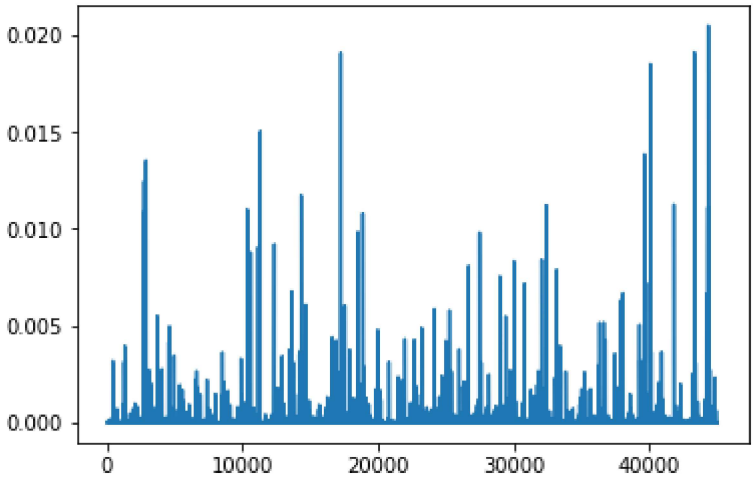
In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



[5.1.2] Wordcloud of top 20 important features from SET 1

In [0]:
```
plt.plot(knnx.feature_importances_)
```

Out[53]:
```
[<matplotlib.lines.Line2D at 0x7f6a0514f358>]
```



In [ ]:
```
p=knnx.feature_importances_
s=count_vect.get_feature_names()
print(s)
x=np.argsort(p)
print(x[:3])
```

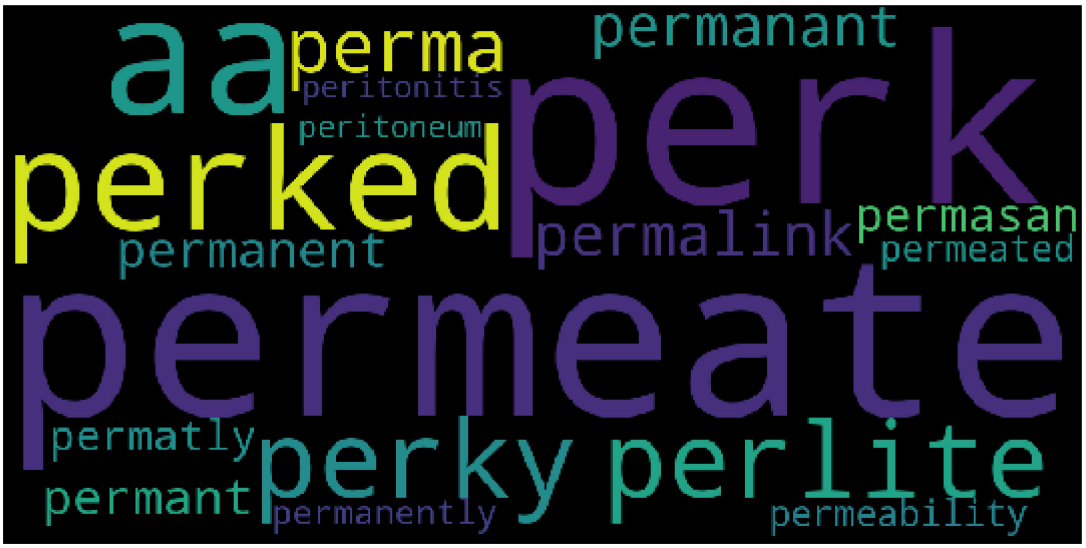
In [0]:
```
c=[s[i] for i in x[:10]]
print(c)
y=np.argsort(p)
y=y[::-1]
d=[s[i] for i in y[:10]]
```

```
['aa', 'perked', 'perks', 'perky', 'perlite', 'perma', 'permalink', 'permanan
t', 'perk', 'permanent']
```

In [0]:
```
print(d)
```

```
['would', 'waste', 'great', 'thought', 'disgusting', 'terrible', 'bad', 'awfu
l', 'favorite', 'unfortunately']
```

In [0]:
```
from wordcloud import WordCloud
wordcloud = WordCloud(width = 1000, height = 500).generate(" ".join(c))
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```



In [0]:
```
from wordcloud import WordCloud
wordcloud = WordCloud(width = 1000, height = 500).generate(" ".join(d))
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```

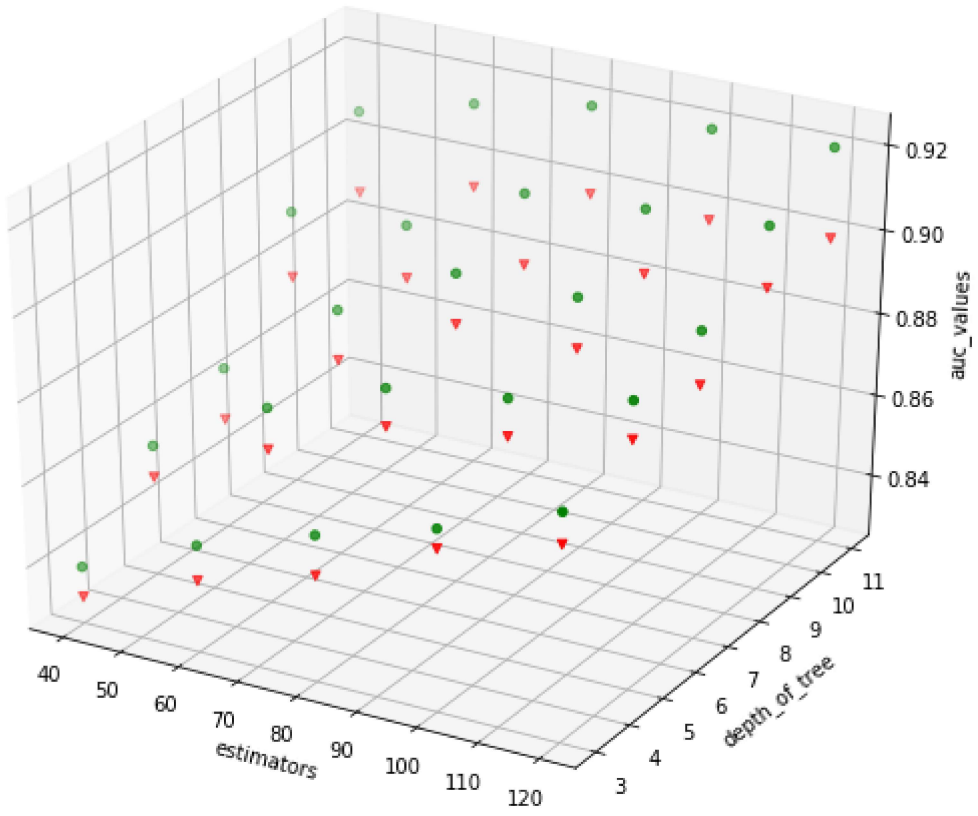
[5.1.3] Applying Random Forests on TFIDF, SET 2

In [0]:
```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from sklearn.ensemble import RandomForestClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx=RandomForestClassifier(n_estimators=i,max_depth=j)
    knnx.fit(xtraintfidfencoding,ytrain)
    predict1=knnx.predict_proba(xtraintfidfencoding)[:,1]
    predix=knnx.predict(xtraintfidfencoding)
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba(xcvtfidfencoding)[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
optimal_k=np.argmax(cvscores1)
print(cvscores)
print(cvscores1)
```

```
[0.8388691866381174, 0.8568156095509216, 0.8645396472755404, 0.892086300628797,
0.9064092430755981, 0.8511056487067675, 0.8726631267365752, 0.8850524781609623,
0.894810935100917, 0.9138949786986202, 0.860561705027316, 0.883864078601632, 0.
8999783798291355, 0.9083666938211586, 0.9190435414759612, 0.8690892484418733,
0.8880052346624634, 0.9005659229673904, 0.9106322976742927, 0.9192601120969381,
0.8799469744494626, 0.8940479398014453, 0.8990213131085923, 0.9126994006141399,
0.9207055646812593]
[0.8314051930850569, 0.849048272838471, 0.8518802881398055, 0.8761618870304784,
0.8866101300847329, 0.8425107415771061, 0.8625724395571359, 0.8729686706352241,
0.8820564652153962, 0.8938366258031905, 0.850854329420468, 0.8747419743926068,
0.8879189345919141, 0.891418028021534, 0.8980099019844121, 0.8643625695159279,
0.8790164020093959, 0.8884665119337636, 0.8953527421965065, 0.8976608860861669,
0.8724121997361292, 0.8849375688637338, 0.8863399806165432, 0.8981982409484236,
0.8993122049945725]
```

In [0]:
```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

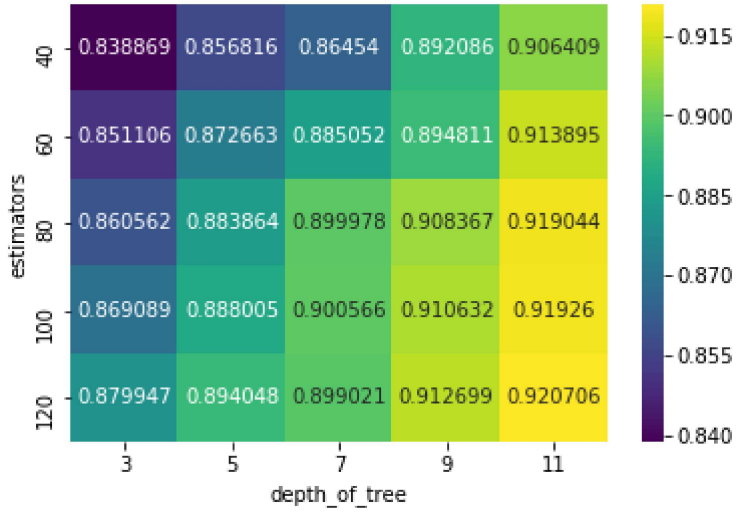
In [0]:
```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt



fig = plt.figure(figsize=(10,8))
ax = fig.add_subplot(111, projection='3d')
ax.scatter(estimatorsy, depthsy,cvscores, marker='o',color='g')
ax.scatter(estimatorsy, depthsy,cvscores1, marker='v',color='r')

ax.set_xlabel('estimators')
ax.set_ylabel('depth_of_tree')
ax.set_zlabel('auc_values')

plt.show()
```



In [0]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

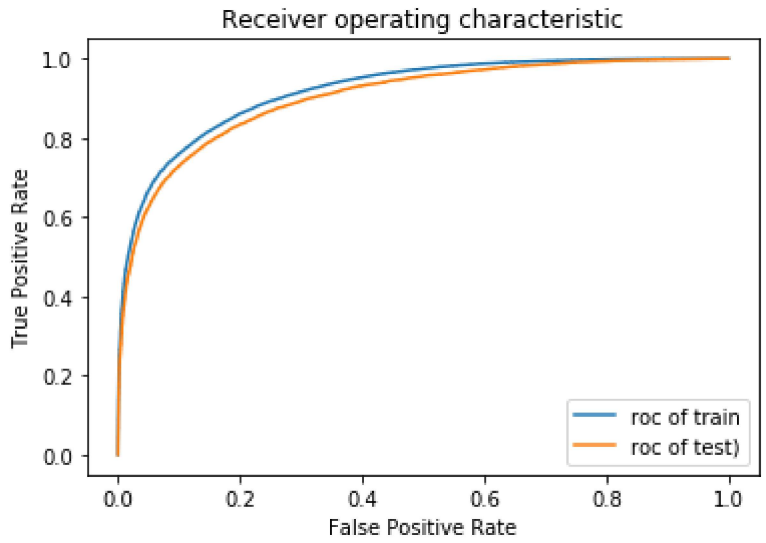
Out[98]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a14492198>
```



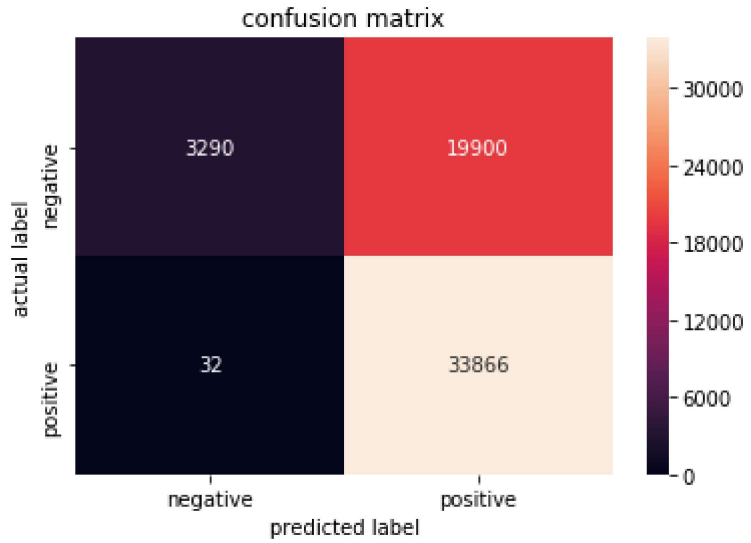
In [0]:

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne=RandomForestClassifier(n_estimators=120,max_depth=11)
knne.fit(xtraintfidfencoding,ytrain)
predictrain=knne.predict_proba(xtraintfidfencoding)[:,1]
predictra=knne.predict(xtraintfidfencoding)
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(xtesttfidfencoding)[:,1]
predictra1=knne.predict(xtesttfidfencoding)
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

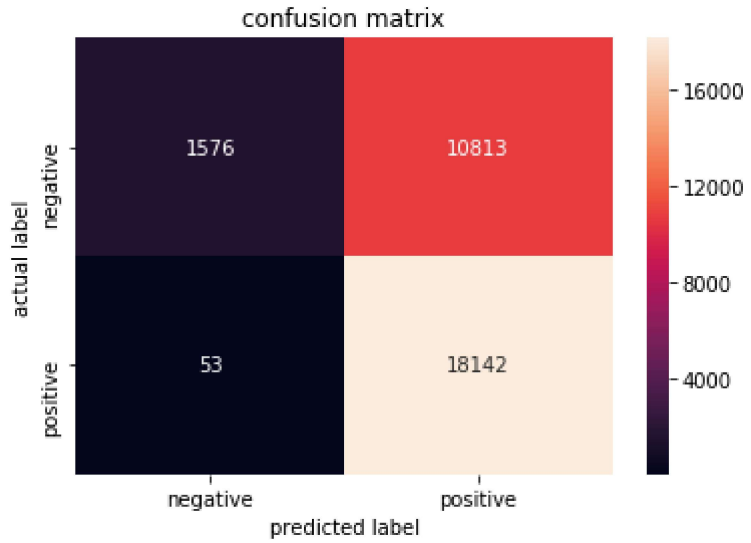
```
0.9018026788516819
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



[5.1.4] Wordcloud of top 20 important features from SET 2

In [ ]:
```
p=knnx.feature_importances_
s=tfidf.get_feature_names()
print(s)
x=np.argsort(p)
print(x[:3])
```

In [0]:
```
print(p)
```

```
[0. 0. 0. ... 0. 0. 0.]
```

In [0]:
```
print(x[:20])
```

```
[    0 14679 14678 14677 14676 14675 14672 14671 14680 14670 14668 14667
 14666 14665 14664 14663 14662 14669 14661 14681]
```

In [0]:
```
print(s[0])
```

```
aa
```

In [0]:
```
c=[s[i] for i in x[:20]]
print(c)
y=np.argsort(p)
y=y[::-1]
d=[s[i] for i in y[:10]]
print(d)
```

```
['aa', 'peer', 'peeps', 'peep', 'peels', 'peeling', 'peeking', 'peek', 'peers',
'peeing', 'pee', 'pedigree', 'pediatricians', 'pediatrician', 'pediatric', 'ped
ialyte', 'pedestrian', 'peed', 'peddling', 'pees']
['best', 'disappointed', 'love', 'would', 'stale', 'great', 'find', 'money', 'b
ad', 'loves']
```

In [0]:
```
from wordcloud import WordCloud
wordcloud = WordCloud(width = 1000, height = 500).generate(" ".join(c))
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```

In [0]:
```
from wordcloud import WordCloud
wordcloud = WordCloud(width = 1000, height = 500).generate(" ".join(d))
plt.figure(figsize = (8, 8), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)

plt.show()
```

[5.1.5] Applying Random Forests on AVG W2V, SET 3

In [0]:

```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from sklearn.ensemble import RandomForestClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx=RandomForestClassifier(n_estimators=i,max_depth=j)
    knnx.fit(sent_vectors,ytrain)
    predict1=knnx.predict_proba(sent_vectors)[:,1]
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba(sent_vectorscv)[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
    optimal_k=np.argmax(cvscores1)
print(cvscores)
print(cvscores1)
```

```
[0.863307449553592, 0.8868685248093925, 0.9067331271138837, 0.9356062238410943,
0.9683388203318323, 0.8638284459954706, 0.8870056889589195, 0.908040525706689,
0.9369414498727902, 0.9698392898300208, 0.8710286135783504, 0.8871293051210551,
0.9094769291259109, 0.9371128567194621, 0.9697385525930708, 0.8673256763924934,
0.8887949201331514, 0.9099108590769899, 0.9376168660205307, 0.9700202400571066,
0.8695071039921377, 0.8895823787726724, 0.9088344924686038, 0.9386022524871115,
0.9701865304713573]
[0.8601859199164407, 0.8797932900134634, 0.8907766696519033, 0.900526011998901
4, 0.9063162084447005, 0.8610335679242471, 0.8801697430469351, 0.89327167024603
38, 0.9022589880742917, 0.9077554313465221, 0.8669146626585823, 0.8813303011550
666, 0.894963695068177, 0.901857653525492, 0.9078644438688961, 0.86532058963589
42, 0.8818505640314449, 0.8951029456851853, 0.9027650212590776, 0.9078282154012
204, 0.865478363385924, 0.8827332751442536, 0.8943781514371211, 0.9040833326722
797, 0.9088146846818923]
```

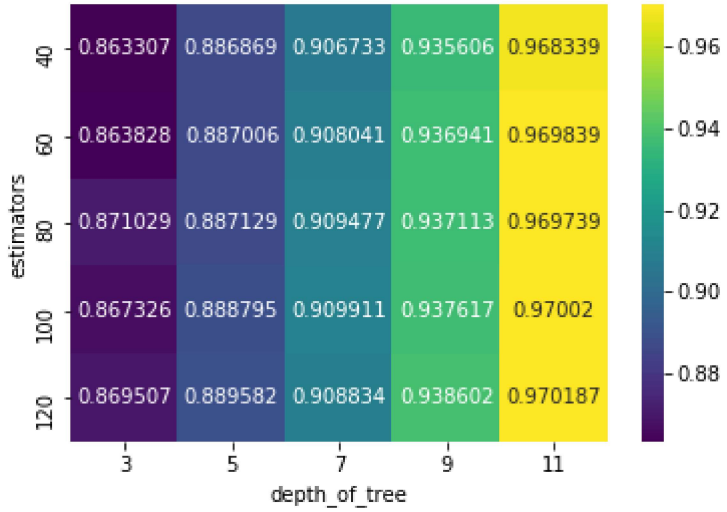
In [0]:

```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

In [0]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

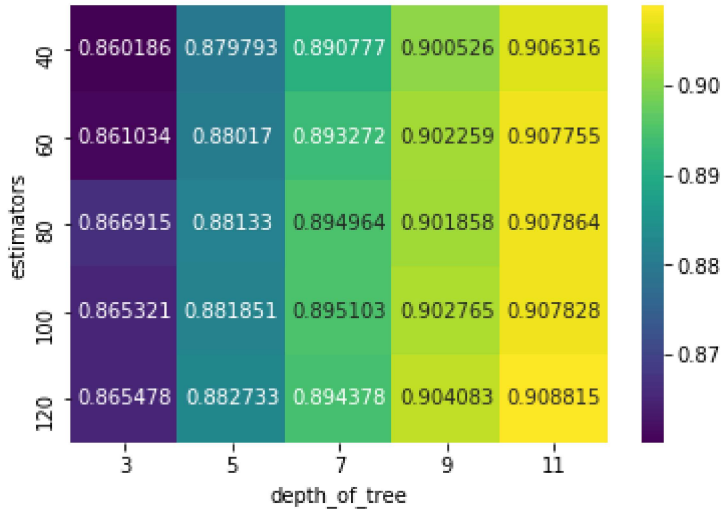
Out[111]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a182e49e8>
```



In [0]:
```
print('for cv data')
dat['a']=pd.DataFrame(cvscores1)
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for cv data
```

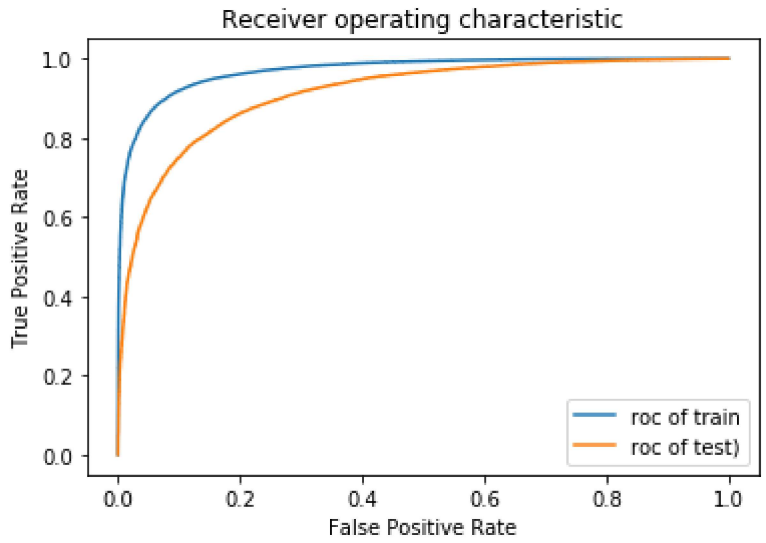
Out[112]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a18730b38>
```



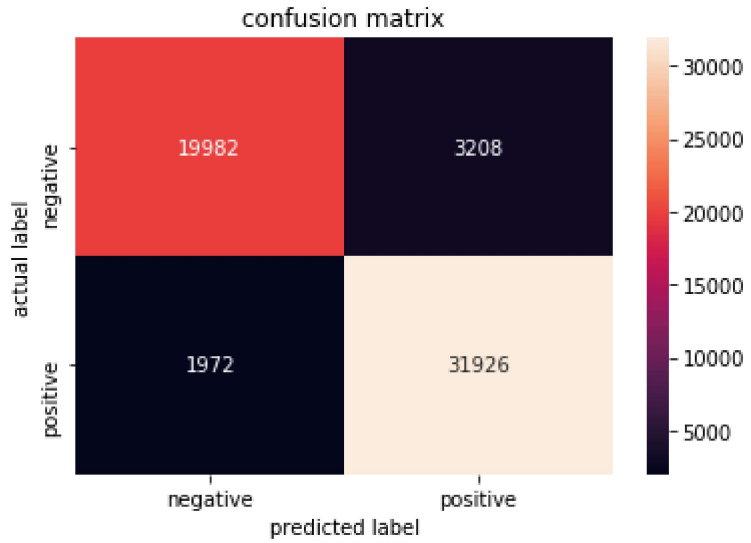
In [0]:

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne=RandomForestClassifier(n_estimators=120,max_depth=11)
knne.fit(sent_vectors,ytrain)
predictrain=knne.predict_proba(sent_vectors)[:,1]
predictra=knne.predict(sent_vectors)
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(sent_vectorstest)[:,1]
predictra1=knne.predict(sent_vectorstest)
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

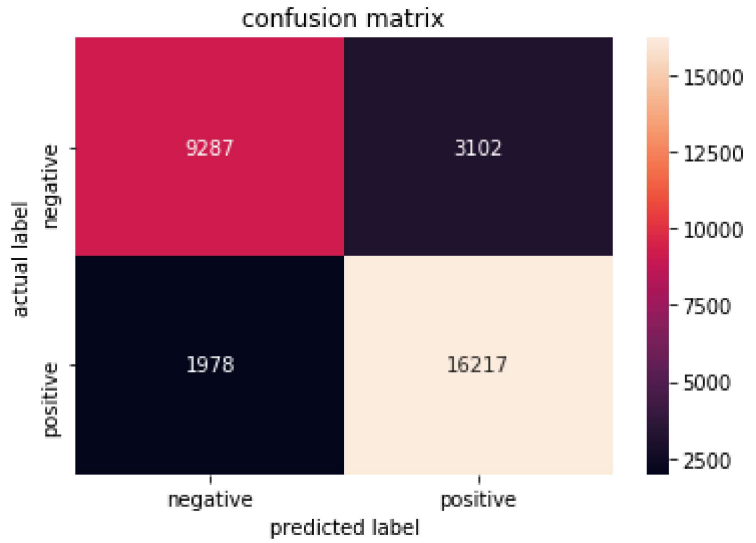
```
0.9123049458526699
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



[5.1.6] Applying Random Forests on TFIDF W2V, SET 4

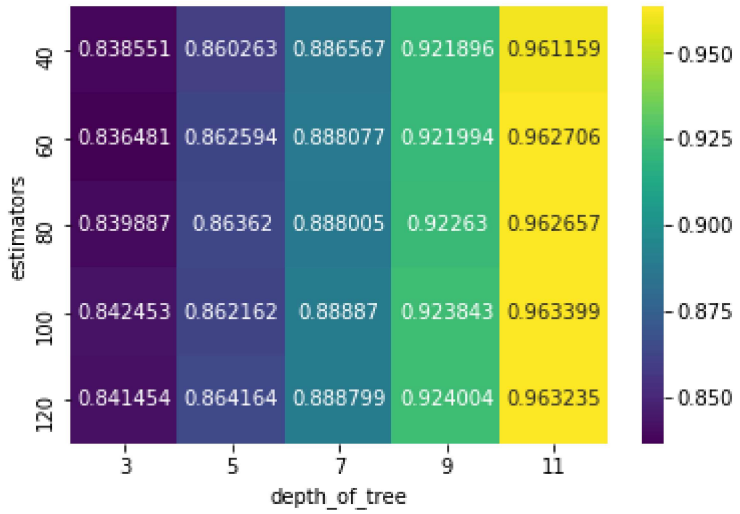
In [0]:
```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from sklearn.ensemble import RandomForestClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx=RandomForestClassifier(n_estimators=i,max_depth=j)
    knnx.fit( xtraintfidf_sent_vectors,ytrain)
    predict1=knnx.predict_proba( xtraintfidf_sent_vectors)[:,1]
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba( xcvtfidf_sent_vectors)[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
    optimal_k=np.argmax(cvscores1)
```

In [0]:
```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

In [0]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

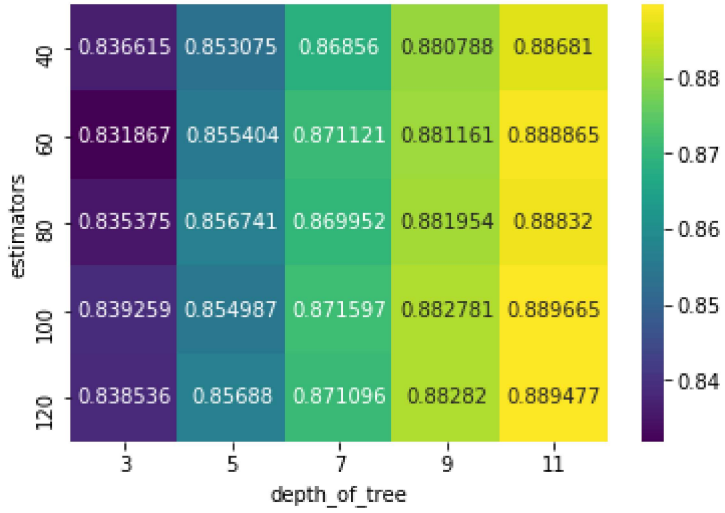
Out[121]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a0545b3c8>
```



In [0]:
```
print('for cv data')
dat['a']=pd.DataFrame(cvscores1)
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

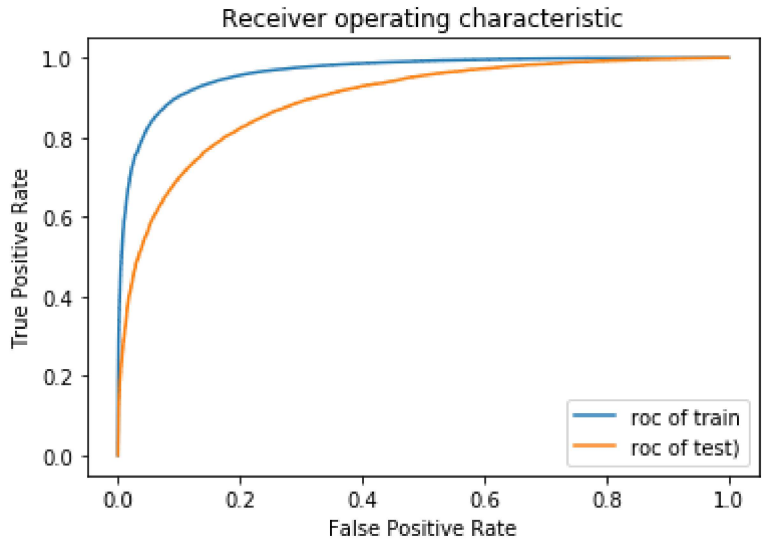
```
for cv data
```

Out[122]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a052eef98>
```

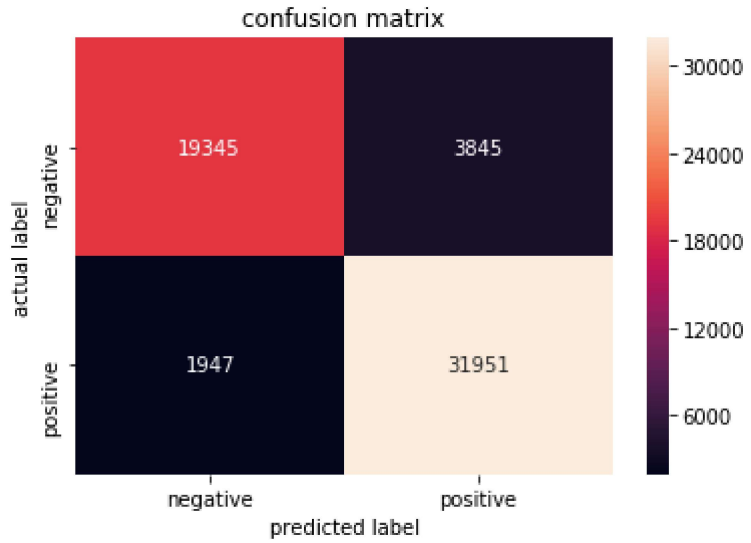


In [147]:
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne=RandomForestClassifier(n_estimators=120,max_depth=11)
knne.fit( xtraintfidf_sent_vectors,ytrain)
predictrain=knne.predict_proba( xtraintfidf_sent_vectors)[:,1]
predictra=knne.predict( xtraintfidf_sent_vectors)
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(xtesttfidf_sent_vectors)[:,1]
predictra1=knne.predict(xtesttfidf_sent_vectors)
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

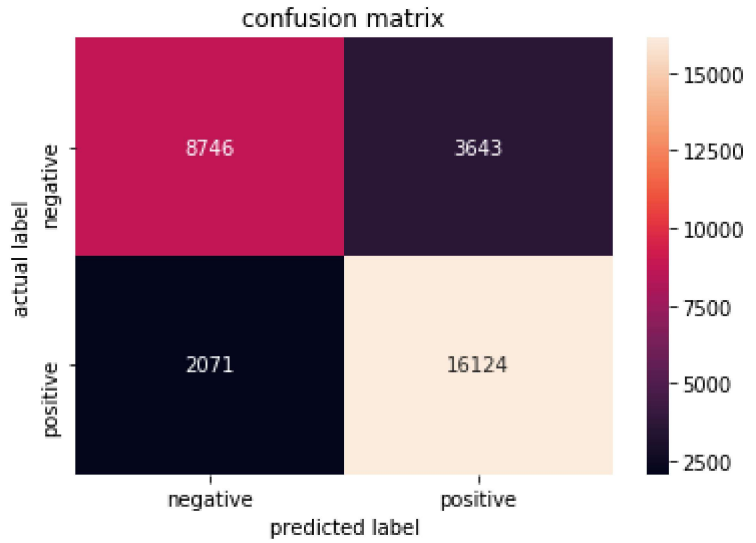
```
0.8933686907809498
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



[5.2] Applying GBDT using XGBOOST

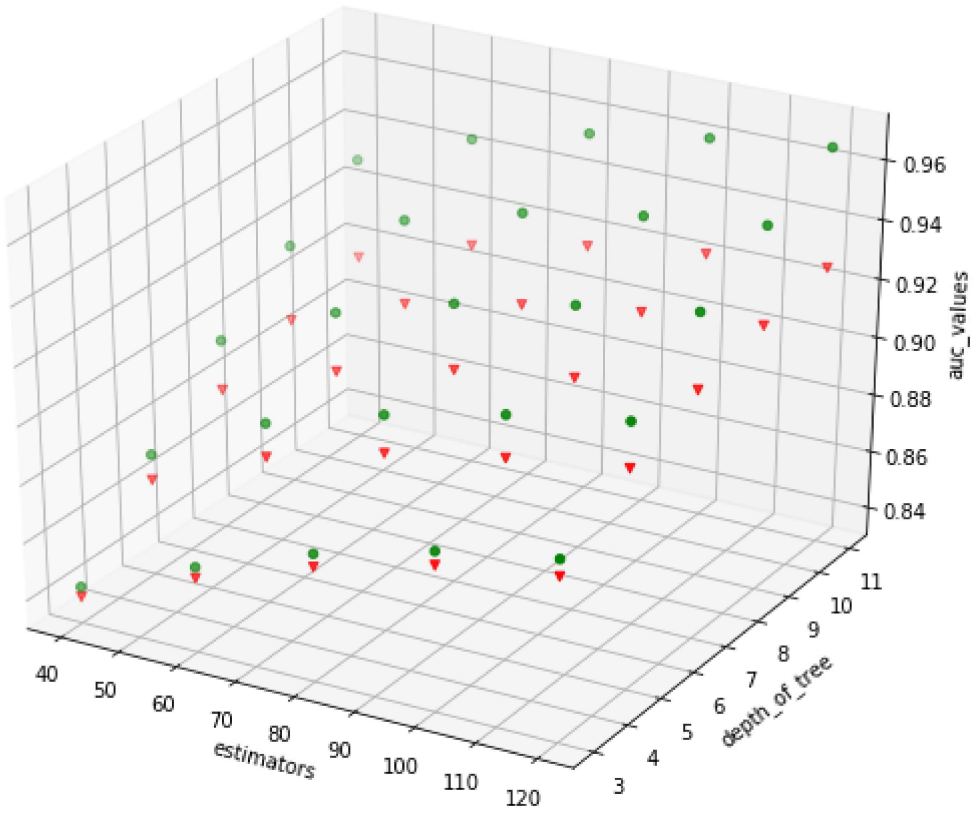
[5.2.1] Applying XGBOOST on BOW, SET 1

In [0]:
```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from sklearn.ensemble import RandomForestClassifier
from xgboost import XGBClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx= XGBClassifier(n_estimators=i,max_depth=j)
    knnx.fit(xtrainonehotencoding,ytrain)
    predict1=knnx.predict_proba(xtrainonehotencoding)[:,1]
    predix=knnx.predict(xtrainonehotencoding)
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba(xcvonehotencoding)[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
optimal_k=np.argmax(cvscores1)
print(cvscores)
print(cvscores1)
```

```
[0.8428542628875898, 0.8722762496453671, 0.8959712190881042, 0.913619136586890
9, 0.9289007778732794, 0.8598249648369303, 0.8925530936721078, 0.91451465918950
06, 0.9309120503839602, 0.9442358554750063, 0.874400264309149, 0.90475596754497
57, 0.9264412533442858, 0.9418517563445479, 0.9542123529607669, 0.8852810746879
3, 0.9141132469523834, 0.9347317674047941, 0.9492680760237233, 0.96081914541025
61, 0.8925977435133698, 0.9212840332121851, 0.9413953017513337, 0.9546730672193
126, 0.9659066652815916]
[0.8394036189049794, 0.8634790814946705, 0.8787497588517064, 0.887645554820173,
0.8947645918331547, 0.8560436382933432, 0.880966360436616, 0.8943501827329561,
0.9022172292451566, 0.9075191387307425, 0.869953335607358, 0.8917453415956047,
0.9040196977368166, 0.9108374067188516, 0.9158523303123589, 0.8805327228523041,
0.8996498841629502, 0.9104853956340853, 0.9170942184681279, 0.9217681201424309,
0.8868209993937661, 0.905734845807798, 0.9156019408972211, 0.9214158739406342,
0.925684893865719]
```

In [0]:
```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

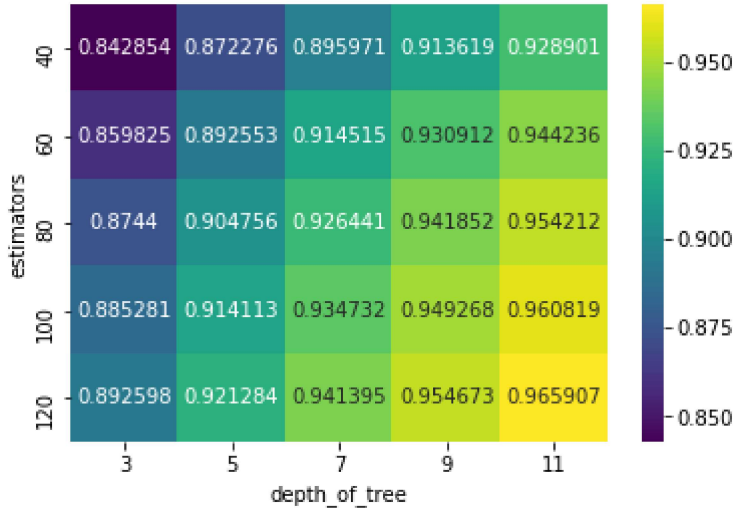
In [0]:
```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt



fig = plt.figure(figsize=(10,8))
ax = fig.add_subplot(111, projection='3d')
ax.scatter(estimatorsy, depthsy,cvscores, marker='o',color='g')
ax.scatter(estimatorsy, depthsy,cvscores1, marker='v',color='r')

ax.set_xlabel('estimators')
ax.set_ylabel('depth_of_tree')
ax.set_zlabel('auc_values')

plt.show()
```



In [0]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

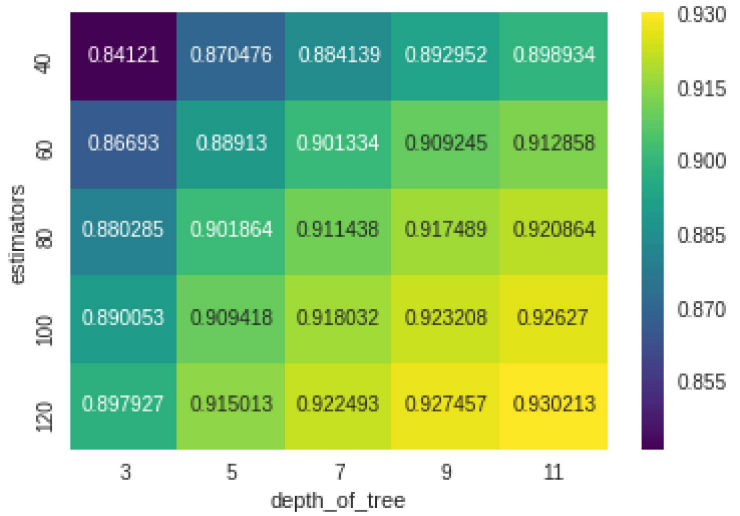
Out[129]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a14c58438>
```



In [0]:
```
print('for cv data')
dat['a']=pd.DataFrame(cvscores1)
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for cv data
```

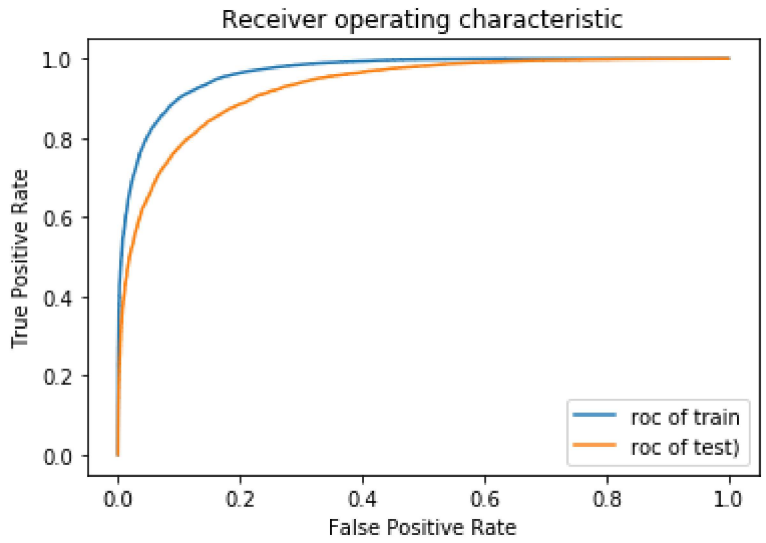
Out[166]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7fea37158a58>
```



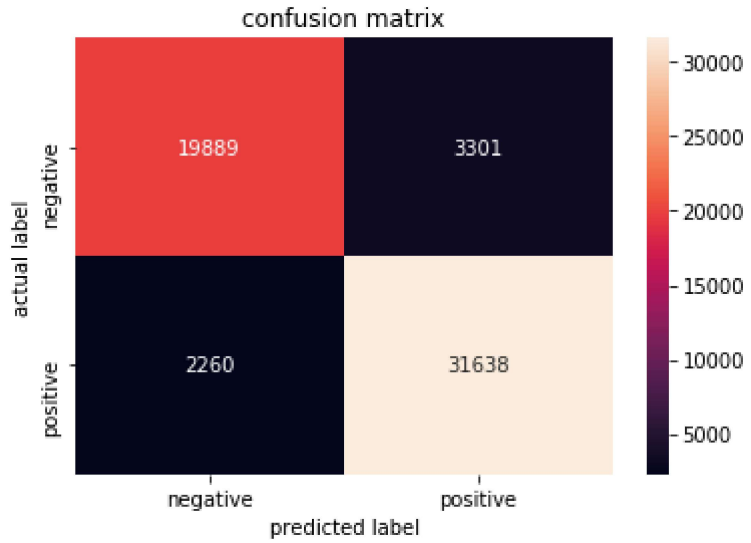
In [0]:

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne= XGBClassifier(n_estimators=120,max_depth=11)
knne.fit(xtrainonehotencoding,ytrain)
predictrain=knne.predict_proba(xtrainonehotencoding)[:,1]
predictra=knne.predict(xtrainonehotencoding)
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(xtestonehotencoding)[:,1]
predictra1=knne.predict(xtestonehotencoding)
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

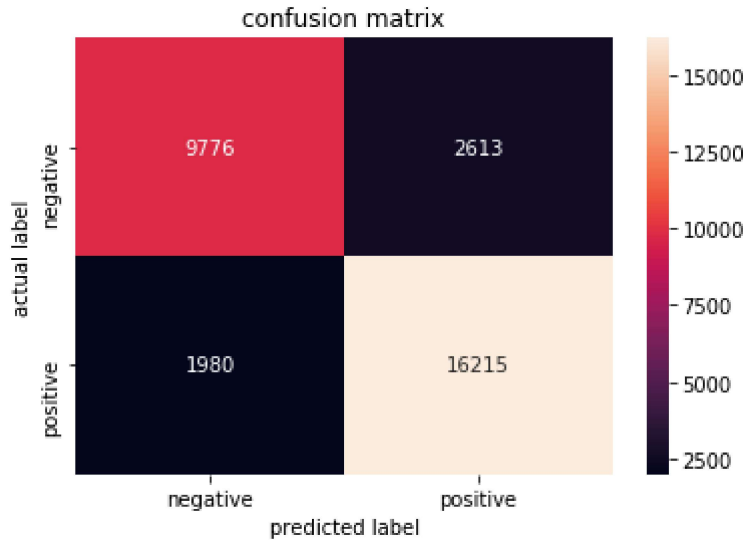
```
0.9271105321271023
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



In [0]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



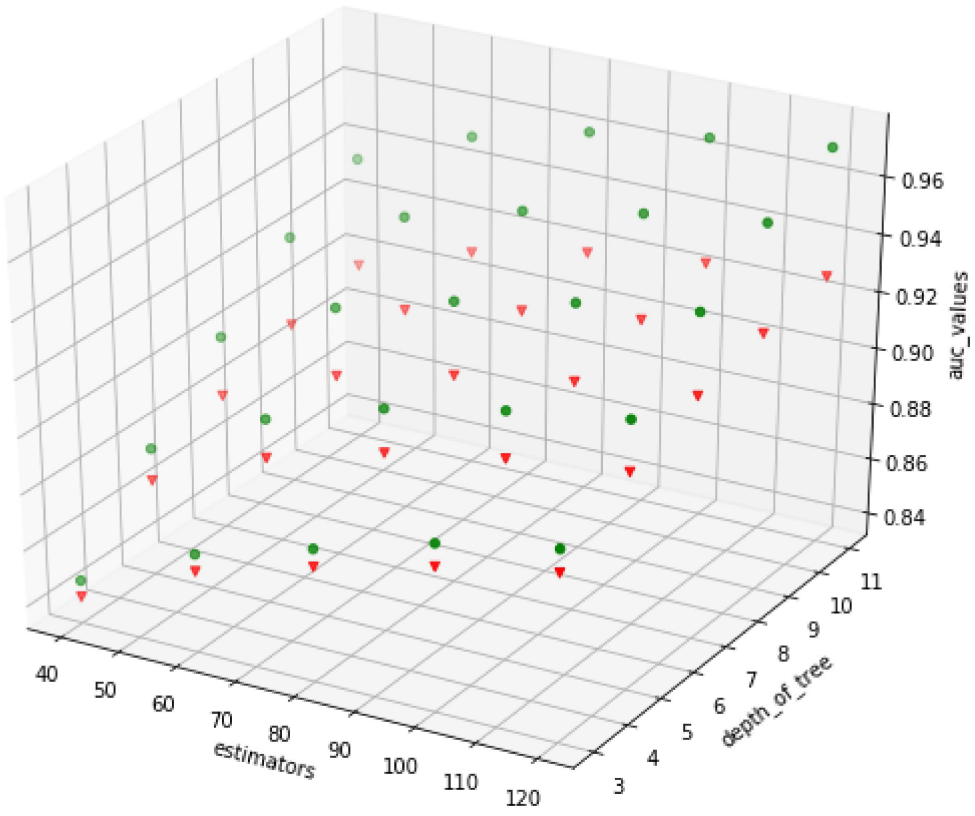
[5.2.2] Applying XGBOOST on TFIDF, SET 2

In [133]:
```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from sklearn.ensemble import RandomForestClassifier
from xgboost import XGBClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx=XGBClassifier(n_estimators=i,max_depth=j)
    knnx.fit(xtraintfidfencoding,ytrain)
    predict1=knnx.predict_proba(xtraintfidfencoding)[:,1]
    predix=knnx.predict(xtraintfidfencoding)
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba(xcvtfidfencoding)[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
optimal_k=np.argmax(cvscores1)
print(cvscores)
print(cvscores1)
```

```
[0.8473498273019602, 0.8774697306794951, 0.9010243219830203, 0.920905496719975,
0.9339284156403462, 0.867024485551116, 0.8976083947756823, 0.9204875743838572,
0.9368845629550295, 0.9502982974237884, 0.8792168053509893, 0.9109359036193377,
0.9318691800740221, 0.947648541978318, 0.9602191215861521, 0.8914167489150352,
0.9197324521824104, 0.940416262485043, 0.9554179928110944, 0.9666287272135254,
0.8996948630687742, 0.9263983176732592, 0.946475235385786, 0.9610234388832224,
0.9717229867315464]
[0.8414557510157261, 0.8660270652005287, 0.8798783921560707, 0.889455179047547
9, 0.8955151467297919, 0.8609739913131822, 0.8839268927513868, 0.89646451863202
28, 0.9039135475087287, 0.9090495359280496, 0.8729422966378756, 0.8954675713097
686, 0.906055708997246, 0.9127742701497135, 0.9178266284634885, 0.8833315559848
816, 0.9032900478109459, 0.9132590712443859, 0.9187540731469935, 0.923031444837
9054, 0.8915172167410195, 0.9085093494389453, 0.9178359820323155, 0.92319791791
80686, 0.9272654221029473]
```

In [0]:
```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

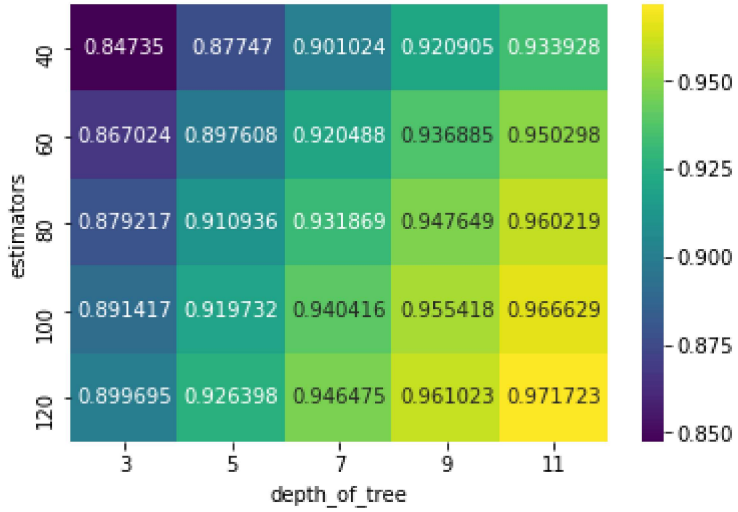
In [135]:
```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt



fig = plt.figure(figsize=(10,8))
ax = fig.add_subplot(111, projection='3d')
ax.scatter(estimatorsy, depthsy,cvscores, marker='o',color='g')
ax.scatter(estimatorsy, depthsy,cvscores1, marker='v',color='r')

ax.set_xlabel('estimators')
ax.set_ylabel('depth_of_tree')
ax.set_zlabel('auc_values')

plt.show()
```



In [136]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

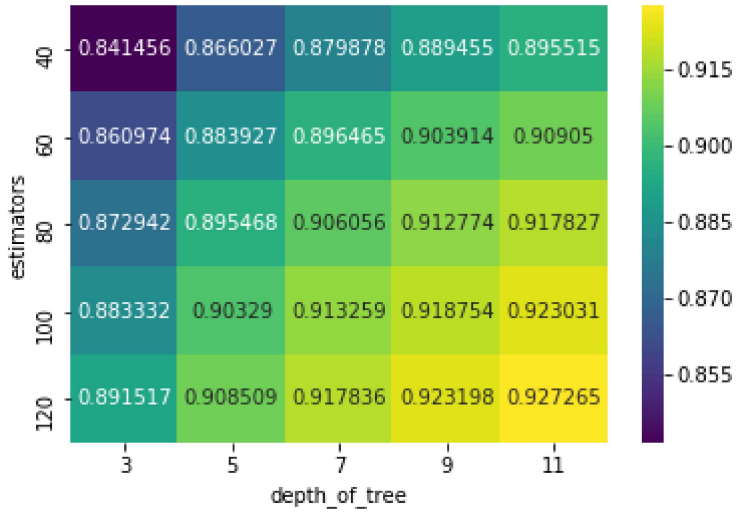
Out[136]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a148be1d0>
```



In [137]:
```
print('for cv data')
dat['a']=pd.DataFrame(cvscores1)
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for cv data
```

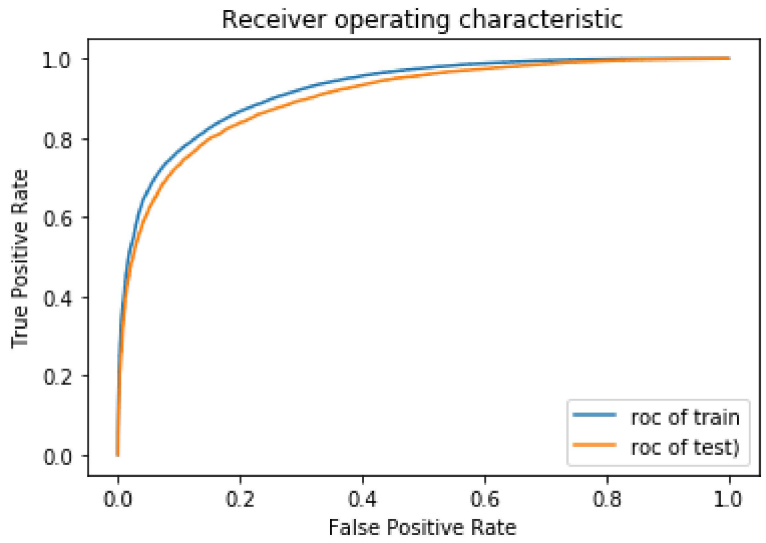
Out[137]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f6a05379048>
```



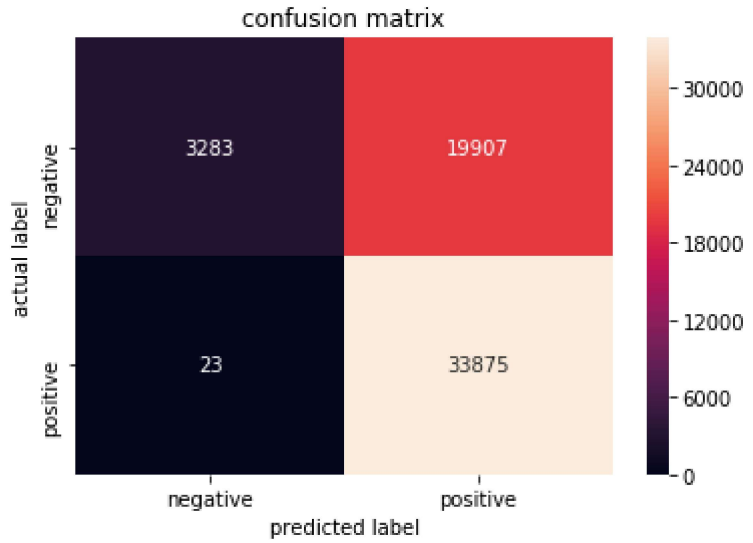
In [141]:

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne=RandomForestClassifier(n_estimators=120,max_depth=11)
knne.fit(xtraintfidfencoding,ytrain)
predictrain=knne.predict_proba(xtraintfidfencoding)[:,1]
predictra=knne.predict(xtraintfidfencoding)
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(xtesttfidfencoding)[:,1]
predictra1=knne.predict(xtesttfidfencoding)
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

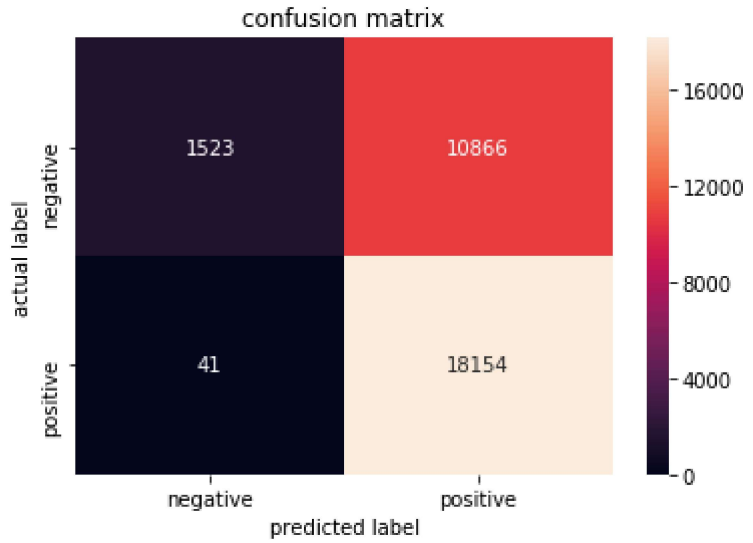
```
0.9028231148770358
```



In [142]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



In [143]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



[5.2.3] Applying XGBOOST on AVG W2V, SET 3

In [0]:

```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from xgboost import XGBClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx=XGBClassifier(n_estimators=i,max_depth=j)
    knnx.fit(np.array(sent_vectors),ytrain)
    predict1=knnx.predict_proba(np.array(sent_vectors))[:,1]
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba(np.array(sent_vectorscv))[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
    optimal_k=np.argmax(cvscores1)
print(cvscores)
print(cvscores1)
```

```
[0.6329211730262192, 0.6957073405489024, 0.7947580209873464, 0.913565059763416
4, 0.9860824807578507, 0.6483588820389077, 0.7170388025299042, 0.82326751263098
59, 0.9393808769483756, 0.9919004972963688, 0.6598344675097764, 0.7332874972481
048, 0.8436515803911748, 0.9572849251913211, 0.9960040166665942, 0.667665712430
3942, 0.7452874019160696, 0.8617659271093854, 0.9662948895388701, 0.99779731796
15451, 0.674174486145192, 0.7566907193691264, 0.8786625177513618, 0.97456027240
07958, 0.9987104777539376]
[0.610029771540666, 0.620498612891299, 0.6222674187576612, 0.6175968291667461,
0.6087299117031281, 0.6175823643581227, 0.6262783312955161, 0.6259959046293357,
0.6222645769083345, 0.6106880072241037, 0.6240213406937367, 0.6280808917894924,
0.6267019201823887, 0.6215111494949319, 0.6100491022495751, 0.6275721905375331,
0.6307723582189104, 0.6269780293561809, 0.6210138258627589, 0.610250474875067,
0.6294381508499419, 0.6331299175749203, 0.6270526943471242, 0.620943014746622,
0.6100007396986233]
```

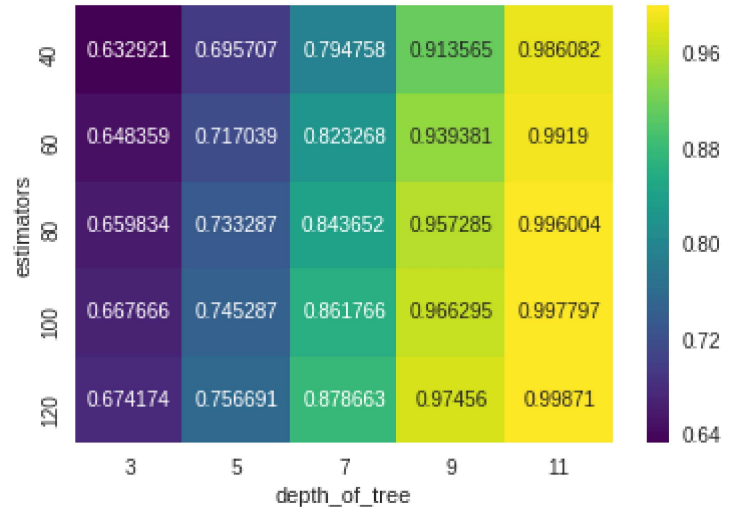
In [0]:

```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

In [0]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

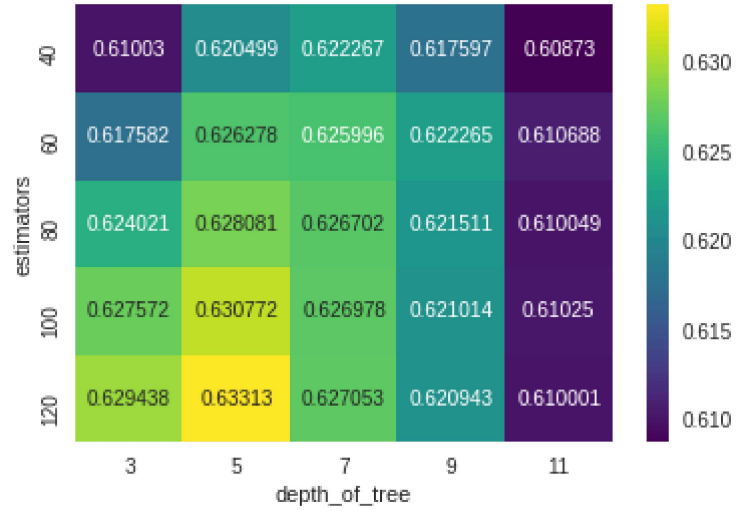
Out[37]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ffa2038bf60>
```



In [0]:
```
print('for cv data')
dat['a']=pd.DataFrame(cvscores1)
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']d.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for cv data
```

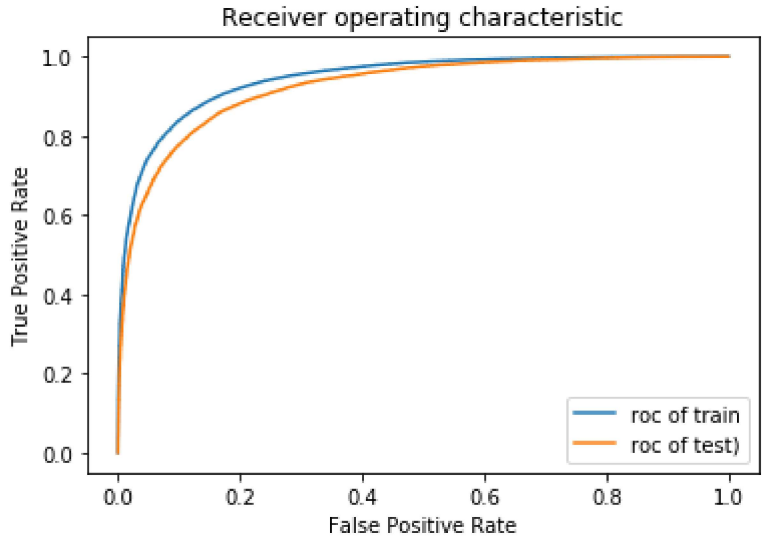
Out[38]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ffa200b3b38>
```



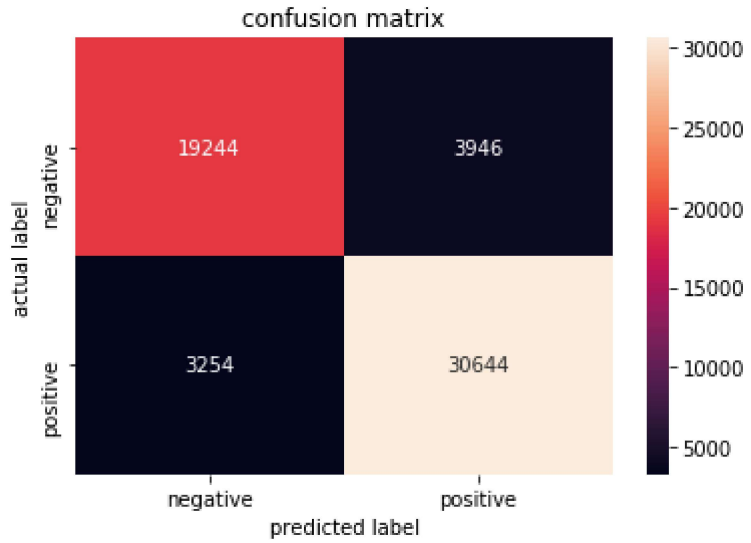
In [138]:

```
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne=XGBClassifier(n_estimators=120,max_depth=5)
knne.fit(np.array(sent_vectors),ytrain)
predictrain=knne.predict_proba(np.array(sent_vectors))[:,1]
predictra=knne.predict(np.array(sent_vectors))
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(np.array(sent_vectorstest))[:,1]
predictra1=knne.predict(np.array(sent_vectorstest))
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

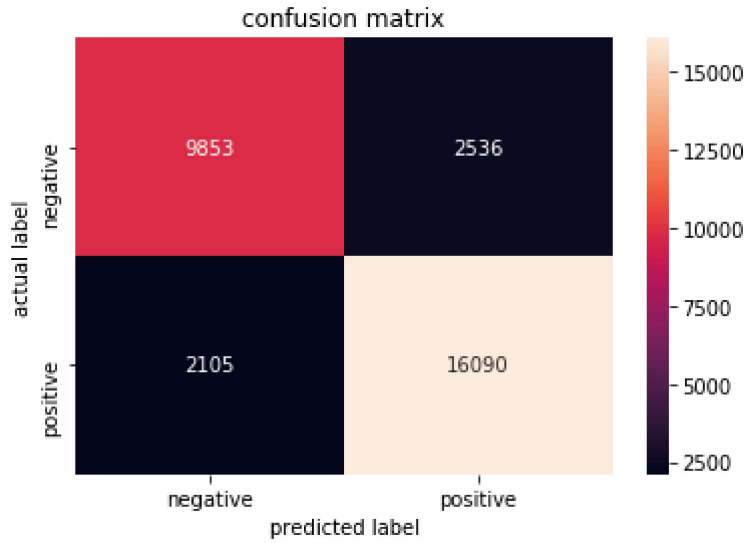
```
0.9232385739807523
```



In [139]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



In [140]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



[5.2.4] Applying XGBOOST on TFIDF W2V, SET 4

In [0]:

```
#with hyper parameter tuning
from sklearn.metrics import auc
from sklearn.metrics import roc_auc_score
from sklearn.neighbors import KNeighborsClassifier
from sklearn.ensemble import RandomForestClassifier
from xgboost import XGBClassifier
cvscores=[]
cvscores1=[]
estimators=[i for i in [40,60,80,100,120]]
depth=[i for i in [3,5,7,9,11]]
for i in estimators:
  for j in depth:
    knnx=XGBClassifier(n_estimators=i,max_depth=j)
    knnx.fit(np.array(xtraintfidf_sent_vectors),ytrain)
    predict1=knnx.predict_proba(np.array(xtraintfidf_sent_vectors))[:,1]
    cvscores.append(roc_auc_score(ytrain,predict1))
    predict2=knnx.predict_proba(np.array(xcvtfidf_sent_vectors))[:,1]
    cvscores1.append(roc_auc_score(ycv,predict2))
    optimal_k=np.argmax(cvscores1)
print(cvscores)
print(cvscores1)
```

```
[0.8740390819619145, 0.9023736862618396, 0.9358828801041787, 0.975737374337964
6, 0.9973391243919212, 0.8852154947962881, 0.9136927282367101, 0.94878276866975
63, 0.9853692593647315, 0.9993068550704494, 0.892580685770372, 0.92126851790437
14, 0.9577594730262877, 0.9899116184003397, 0.999769911286252, 0.89792070895994
68, 0.9272850684310752, 0.9644419001366529, 0.9933901614795428, 0.9999266386023
606, 0.9019306600775362, 0.9322073664618136, 0.9692304928890113, 0.995863441350
1012, 0.9999707757826913]
[0.8669897365487094, 0.8857365476462005, 0.8953435215199144, 0.899951529090764
3, 0.9006127804056818, 0.8779589784978729, 0.8941136754451051, 0.90144654628620
17, 0.9045649852432374, 0.9053377842554677, 0.8851237815519899, 0.8985677120283
337, 0.9049685585150679, 0.9067707612222585, 0.9078355858090066, 0.889294062546
6912, 0.9018894556595041, 0.9071095341959525, 0.9083567584860688, 0.90906359183
7489, 0.8927109979078265, 0.904052399449033, 0.9082133166524274, 0.909530053803
7723, 0.9101205553374306]
```

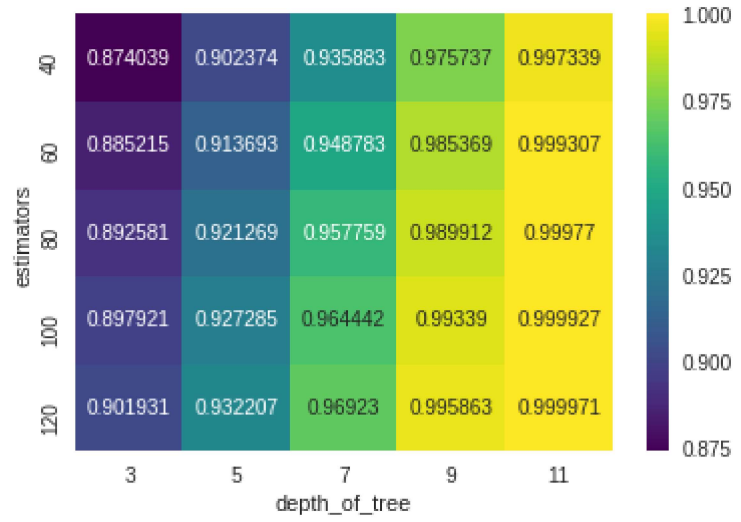
In [0]:

```
depthsy=depth*5
estimators2=[[i]*5 for i in estimators]
estimatorsy=np.array(estimators2).flatten()
```

In [0]:
```
print('for training data')
dat=pd.DataFrame(cvscores,columns=['a'])
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

```
for training data
```

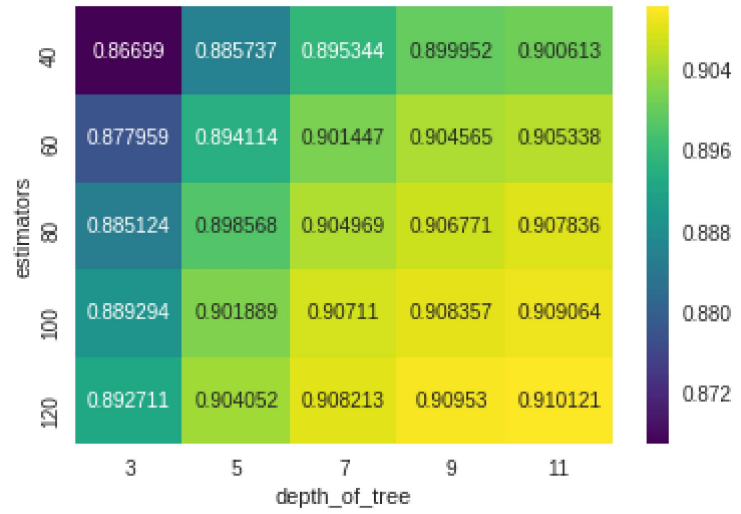
Out[47]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f4324aab9b0>
```



In [0]:
```
print('for cv data')
dat['a']=pd.DataFrame(cvscores1)
dat['depth_of_tree']=pd.DataFrame(depthsy)
dat['estimators']=pd.DataFrame(estimatorsy)
result = dat.pivot(index='estimators', columns='depth_of_tree', values='a')
sns.heatmap(result, annot=True, fmt="g", cmap='viridis')
```

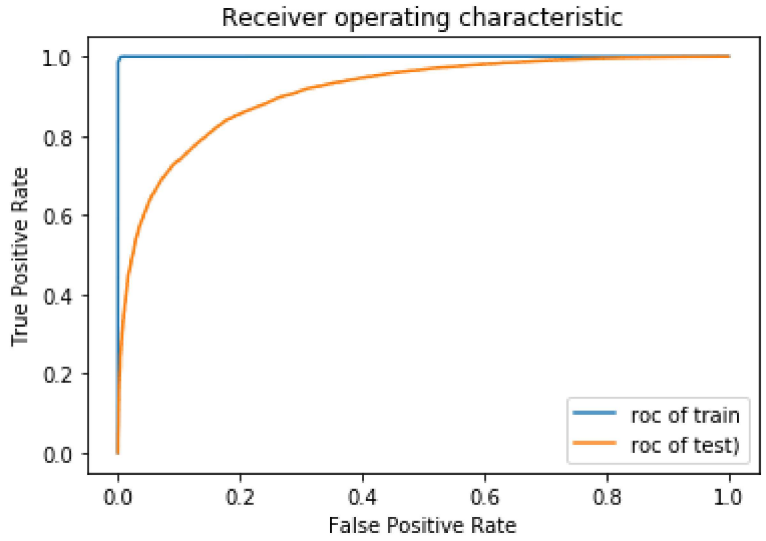
```
for cv data
```

Out[48]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7f4324044eb8>
```

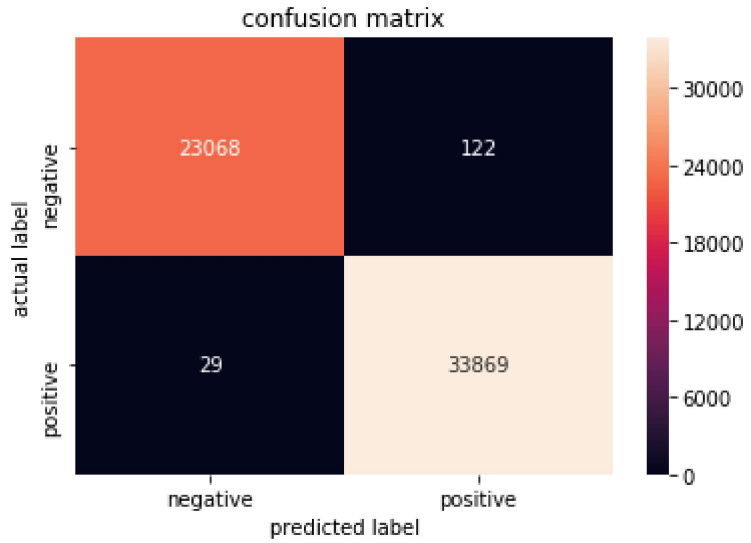


In [144]:
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
knne=XGBClassifier(n_estimators=120,max_depth=11)
knne.fit(np.array(xtraintfidf_sent_vectors),ytrain)
predictrain=knne.predict_proba(np.array(xtraintfidf_sent_vectors))[:,1]
predictra=knne.predict(np.array(xtraintfidf_sent_vectors))
fpr, tpr, thresh = metrics.roc_curve(ytrain, predictrain)
auc = metrics.roc_auc_score(ytrain, predictrain)
plt.plot(fpr,tpr,label="roc of train")
plt.legend()
predic=knne.predict_proba(np.array(xtesttfidf_sent_vectors))[:,1]
predictra1=knne.predict(np.array(xtesttfidf_sent_vectors))
fpr, tpr, thresh = metrics.roc_curve(ytest, predic)
auc = metrics.roc_auc_score(ytest, predic)
plt.plot(fpr,tpr,label="roc of test)")
plt.legend()
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
plt.title('Receiver operating characteristic')
print(roc_auc_score(ytest, predic))
```

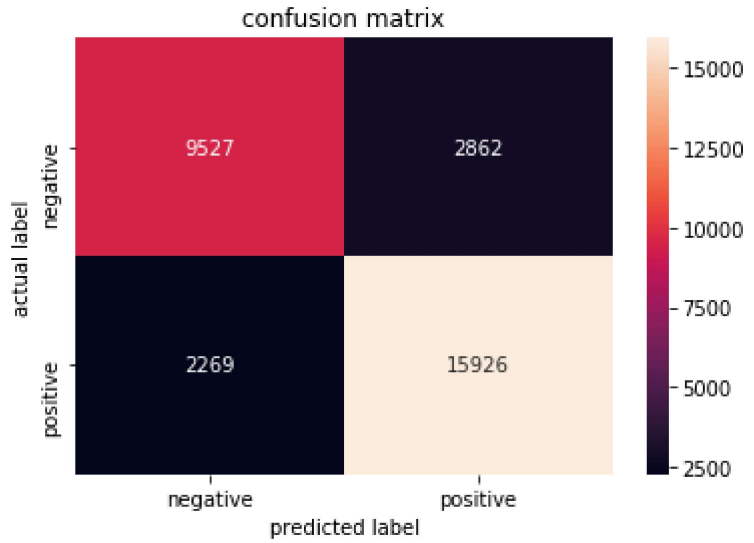
```
0.9110021497631586
```



In [145]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest=confusion_matrix(ytrain,predictra)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



In [146]:
```
#plotting confusion matrix aftyer performing knn on top of svd data
from sklearn.metrics import confusion_matrix

rest1=confusion_matrix(ytest,predictra1)
import seaborn as sns

classlabel=['negative','positive']

frame=pd.DataFrame(rest1,index=classlabel,columns=classlabel)
sns.heatmap(frame,annot=True,fmt="d")
plt.title("confusion matrix")
plt.xlabel("predicted label")
plt.ylabel("actual label")
plt.show()
```



[6] Conclusions

In [148]:
```
import pandas as pd
print('for random forest')
data = [[100,9,0.9], [120,11, 0.9],[120,11, 0.91],[120,11,0.89]]
pd.DataFrame(data, columns=["numberof_estimators", "depth_of_tree",'auc'],index=
```

```
for random forest
```

Out[148]:

	numberof_estimators	depth_of_tree	auc
bow	100	9	0.90
tfidf	120	11	0.90
word2vec	120	11	0.91
averageword2vec	120	11	0.89

In [149]:
```
print('xgboost algorithm')
data = [[120,11, 0.92], [120,11, 0.9],[120,5, 0.92],[120,11,0.91]]
pd.DataFrame(data, columns=["numberof_estimators", "depth_of_tree",'auc'],index=
```

xgboost algorithm

Out[149]:

	numberof_estimators	depth_of_tree	auc
bow	120	11	0.92
tfidf	120	11	0.90
word2vec	120	5	0.92
averageword2vec	120	11	0.91

#DOCUMENTATION,CONCLUSIONS AND KEYTAKE AWAYS

##IN THIS RANDOM FOREST AND XG BOOST ASSIGNMENT WE HAVE EXPLORED MORE THINGS COMAPRED TO THE OTHER ASSIGNMENTS. THE DIFFERENCE BETWEEN THE RANDOM FOREST AND XGBOOST IS IN RANDOM FOREST WE WILL USE THE MULTIPLE TREES TO TRAIN THE MODEL BUT WE TAKE THE RANDOM FEATURES IN DOING IT SO. BUT IN CASE OF XG BOOST WHAT WE DO IS WE TAKE THE TREES AND REDUCE THE LOSS BUILD THE SEQUENTIAL MODELS AND TRAIN THE WEAK LEARNERS.

IN RANDOM FOREST ANALYSIS

- WE HAVE TRAINED THE MODELS WITH ONEHOT ENCODING, TFIDF CODING,AVERAGE WORD2VEC MODEL AND APPLIED WEIGHTED WORD2VEC MODEL.

  FOR THE MODELS OF ONEHOT ENCODING AND TFIDF CODING WE HAVE PLOTTED THE SCATTERED PLOTS WITH CROSS VALIDATION DATA AND TRAIN DATA ROC SCORES.WE HAVE PLOTTED THE HEATMAP FOR THE ROC SCORES OF TRAIN AND CROSS VALIDATION DATA, WE HAVE PLOTTED HOW THE MODEL IS PERFORMING AND AUC FOR THE TEST DATA FOT THE GIVEN BEST HYPER PARAMETERS FOR CROSS VALIDATION . WE HAVE PLOTTED THE CONFUSION MATRIX FOR THE DATA AND DISPLAYED THE FEATURE IMPORTANCES AND IMPORTANT FEATURES WE HAVE PLOTTED IN THE WORD CLOUD.WE DISPLAYED THE POSITIVE FEATURES IN THE WORD CLOUD.

  THE MODELS OF RANDOM FOREST BOW,TFIDF,AVFW2VEC,TFIDFWORD2VEC PERFORMED EXTREEMELY WELL COMPARE TO ALL OTHER MODELS WE HAVE DONE WE WERE ABLE TO ACHIEVE AUC VALUE OF 0.9.

  MODELS OF XGBOOST BOW,TFIDF,WORD2VEC,TFIDFWORD2VEC PERFORMED EXTREELEY GOOD WE ARE ABLE TOA CHIEVE AUC VALUE OF 0.92FOR ALL THE ENCODING TECHNIQUES.

##IN XG BOOST ANALYSIS

- WE HAVE TRAINED THE MODELS WITH ONEHOT ENCODING, TFIDF CODING,AVERAGE WORD2VEC MODEL AND APPLIED WEIGHTED WORD2VEC MODEL.

  WE ALSO PLOTTED THE CVSCORES OF TRAIN DATA AND CROSS VALIDATION DATA AND OBTAINED BEST HYPERPARAMETERS AND APPLIED FOR TEST DATA . WE HAVE PLOTTED THE ROC CURVES AND OBTAINED CONFUSION MATRIXES FOR THE TEST DATA.WE ARE ABLE TO ACHIN=VE ALL MODELS HAVING AUC OF 0.9 WHICH IS VERY NICE COMPARING TO THE OTHER MODELS.

In [0]: