Information about data:

```
                    ->We have the amazon reviews dataset from kaggle

                    ->Reviews are given for the product

                    ->The features of the data were:

                          Id

                          ProductId- unique identifier for the product

                          UserId- unqiue identifier for the user

                          ProfileName

                          HelpfullnessNumerator- number of users who fou
nd the review helpful

                          HelpfulnessDenominator- number of users who in
dicated whether they found the review
                                                  helpful or not

                          Score-rating between 1 and 5

                          Time-timestamp for the review

                          Summary- brief summary of the review

                          Text- text of the review

                    -> Based on the score of the review we review we cla
ssify them into positive and negative

                    Number of reviews: 568,454
```

objective:

```
-> Cleaning the dataset by classifying them into positive and negati
ve reviews based on the
  rating provided and removing the duplicates

-> Converting the text data to vectors by using word2vec,Average wor
d2vec

-> Applying the following Ensemble Models:
```

-> Random Forests

-> Gradient Boost Decision Trees

-> stacking

Importing the required libraries

In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as mp
import seaborn as s
import sqlite3
import nltk
import string
from sklearn.metrics import accuracy_score
from sklearn.ensemble import
RandomForestClassifier,GradientBoostingClassifier
from mlxtend.classifier import StackingClassifier
```

->loading the data and information about the data

-> Shape of the data

-> Dimensionality of the data

-> Attributes if the data

In [2]:

```
con = sqlite3.connect("database.sqlite")
data = pd.read_sql_query("SELECT * FROM Reviews WHERE Score != 3",con)
print(data.shape)
print(data.ndim)
print(data.columns)
```

```
(525814, 10)
2
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
```

Removing the Duplicates from the data

In [3]:

```
####function to categorise rating into positive and negatives
def change(n):
    if n>3:
        return 'positive'
    return 'negative'

rating = data['Score']
####take the ratings
rating = rating.map(change)
```

```
rating = rating.map(change)
#####apply function change on ratings column
data['Score'] = rating
####updating the column with positive and negatives
data.head(6)
##### head with first 6 elements in data
```

Out[3]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfulness
0	1	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1	1
1	2	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0	0
2	3	B000LQOCH0	ABXLMWJIXXAIN	Natalia Corres "Natalia Corres"	1	1
3	4	B000UA0QIQ	A395BORC6FGVXV	Karl	3	3
4	5	B006K2ZZ7K	A1UQRSCLF8GW1T	Michael D. Bigham "M. Wassir"	0	0
5	6	B006K2ZZ7K	ADT0SRK1MGOEU	Twoapennything	0	0

Data Cleaning:Removing Duplicates

In [4]:

```
user = pd.read_sql_query("""SELECT * FROM Reviews WHERE UserId= "AR5J8UI46C
URR" ORDER BY ProductId """,con)
print(user)
```

```
       Id   ProductId          UserId      ProfileName  HelpfulnessNumerator
\
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


   HelpfulnessDenominator  Score        Time  \
0                       2      5  1199577600
1                       2      5  1199577600
2                       2      5  1199577600
3                       2      5  1199577600
4                       2      5  1199577600

                           Summary  \
0  LOACKER QUADRATINI VANILLA WAFERS
1  LOACKER QUADRATINI VANILLA WAFERS
2  LOACKER QUADRATINI VANILLA WAFERS
3  LOACKER QUADRATINI VANILLA WAFERS
4  LOACKER QUADRATINI VANILLA WAFERS

                                                Text
0  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
1  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
2  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
3  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
4  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
```

Observation:

-> Here we can see that for the same time span we got five reviews, practically which is not possible

->This happened because when the user given review for a product it is applied to all the flavors of the product

In [5]:

```
sorteddata = data.sort_values('ProductId',axis=0,ascending=True,inplace=Fal
se,kind='quicksort',na_position='last')
finaldata = sorteddata.drop_duplicates(subset={"UserId","ProfileName","Time
","Text"},keep='first',inplace=False)
```

Information about the modified data:

-> Shape of the data

-> Shape of the data

-> Dimensionality of the data

-> Attributes if the data

-> Sample of modified data

In [6]:

```
print(finaldata.shape)
print(finaldata.ndim)
print(finaldata.columns)
print(finaldata.head(5))
```

```
(364173, 10)
2
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
            Id   ProductId          UserId                ProfileName  \
138706  150524  0006641040   ACITT7DI6IDDL             shari zychinski
138688  150506  0006641040  A2IW4PEEKO2R0U                       Tracy
138689  150507  0006641040  A1S4A3IQ2MU7V4       sally sue "sally sue"
138690  150508  0006641040     AZGXZ2UUK6X  Catherine Hallberg "(Kate)"
138691  150509  0006641040  A3CMRKGE0P909G                      Teresa

        HelpfulnessNumerator  HelpfulnessDenominator     Score        Time
\
138706                     0                       0  positive   939340800
138688                     1                       1  positive  1194739200
138689                     1                       1  positive  1191456000
138690                     1                       1  positive  1076025600
138691                     3                       4  positive  1018396800

                                        Summary  \
138706                   EVERY book is educational
138688  Love the book, miss the hard cover version
138689               chicken soup with rice months
138690      a good swingy rhythm for reading aloud
138691             A great way to learn the months

                                                     Text
138706  this witty little book makes my son laugh at l...
138688  I grew up reading these Sendak books, and watc...
138689  This is a fun way for children to learn their ...
138690  This is a great little book to read aloud- it ...
138691  This is a book of poetry about the months of t...
```

CONSTRUCTING VECTOR REPRESENTATION OF EACH IN THE DATA BY USING WORD2VEC

In [7]:

```
import gensim
from gensim.models import word2vec
```

-> Importing the required libraries

-> Importing the required libraries

-> Functions to clean the sentences

-> Constructing the word2vec from the sample subset data

In [8]:

```
import re
def cleanhtml(sentence):
    clean = re.compile("<.*?>")
    cleantext = re.sub(clean," ",sentence)
    return cleantext
def cleanpunct(sentence):
    cleanr = re.sub(r"[?|!|\|'|#|.|,|)|(|/]",r' ',sentence)
    return cleanr
```

In [9]:

```
sorted_w2vec = finaldata.sort_values("Time",axis=0,ascending=True,kind='quicksort',na_position='last',inplace=False)
```

Information about the sorted data:

-> Shape of the data

-> Dimensionality of the data

-> Attributes if the data

-> Sample of modified data

In [10]:

```
print(sorted_w2vec.shape)
print(sorted_w2vec.ndim)
print(sorted_w2vec.columns)
print(sorted_w2vec.head(5))
```

```
(364173, 10)
2
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
            Id   ProductId          UserId               ProfileName  \
138706  150524  0006641040   ACITT7DI6IDDL          shari zychinski
138683  150501  0006641040   AJ46FKXOVC7NR        Nicholas A Mesiano
417839  451856  B00004CXX9   AIUWLEQ1ADEG5          Elizabeth Medina
346055  374359  B00004CI84  A344SMIA5JECGM           Vincent P. Ross
417838  451855  B00004CXX9   AJH6LUC1UT1ON  The Phantom of the Opera

        HelpfulnessNumerator  HelpfulnessDenominator     Score       Time  `
138706                     0                       0  positive  939340800
138683                     2                       2  positive  940809600
417839                     0                       0  positive  944092800
346055                     1                       2  positive  944438400
417838                     0                       0  positive  946857600
```

```
                                                    Summary  \
138706                          EVERY book is educational
138683  This whole series is great way to spend time w...
417839                               Entertainingl Funny!
346055                            A modern day fairy tale
417838                                         FANTASTIC!

                                                     Text
138706  this witty little book makes my son laugh at l...
138683  I can remember seeing the show when it aired o...
417839  Beetlejuice is a well written movie ..... ever...
346055  A twist of rumplestiskin captured on film, sta...
417838  Beetlejuice is an excellent and funny movie. K...
```

In [11]:

```
i=0
sentences_list=[]
for sent in sorted_w2vec['Text'].values:
    filtered_sentences = []
    sent = cleanhtml(sent)
    for w in sent.split():
        for cleanedwords in cleanpunct(w).split():
            if(cleanedwords.isalpha()):
                filtered_sentences.append(cleanedwords.lower())
    sentences_list.append(filtered_sentences)
```

In [12]:

```
print(len(sentences_list))
print(type(sentences_list))
```

```
364173
<class 'list'>
```

In [13]:

```
w2vmodel =
gensim.models.Word2Vec(sentences_list,min_count=4,size=200,workers=4)
```

-> Most similar word

-> Similarity between the words

-> Dimensionality representation of a word

In [14]:

```
print(w2vmodel.most_similar("where"))
print(w2vmodel.similarity("where",'when'))
print(w2vmodel.wv['what'])
```

```
[('wherever', 0.46529310941696167), ('what', 0.4458898901939392), ('everywh
ere', 0.43889546394348145), ('when', 0.4215936064720154), ('anywhere', 0.41
7721152305603), ('somewhere', 0.41519832611083984), ('florida', 0.402750521
89826965), ('tx', 0.39854639768600464), ('why', 0.3969125747680664), ('soca
l', 0.3944746255874634)]
0.42159361544755236
[ 0.7996897   3.085431    1.340987   -2.8525755   2.5451179  -1.5701782
```

```
 2.9685671  -2.174922    2.0419028  -1.5547013   0.5668547  -1.4338609
 0.78857225  1.9789118   0.3574971   0.0636769   0.35909358  0.69823474
 2.6059813  -0.9402875  -0.5818643   0.7744852   0.72097564 -2.0476422
 0.27967906  2.9229062  -0.97952425 -1.5813259   0.30517542 -2.1099699
 0.47375268  1.0395159   0.22731662 -2.1210387   1.2303616  -1.834373
-0.97481966  1.1496507  -3.404694    2.0946565   3.0210366  -2.050492
 1.0970054  -0.47758338  0.5858939  -1.2708788   2.4784617   0.93791187
-0.7387846  -0.9668217   1.1821761   1.0469359  -3.9322011  -2.7136335
-1.7385392  -1.6255865   0.8993696   0.1553515   2.447226   -1.9305716
 1.9676238   1.8910409   1.9982429   0.1086377  -1.0972705  -0.74526596
-1.6416489  -0.8614319   1.7360628  -0.3634593  -2.319029   -0.65476465
-0.32638937 -1.2970817  -1.4328616  -0.2941087  -1.546655   -0.63256735
-1.6564442  -0.169883   -4.90044     0.5828991   0.9893994  -0.14594601
 3.3804927  -0.91457057 -0.46898943  0.59321076  2.395959    2.3215127
-1.0949532   0.20803766  1.0500869   2.367571    2.299582    0.41732547
 0.26027352 -0.45078978 -1.88151    -1.0135818  -0.9517791  -1.0697248
 0.02675325 -2.0144515   1.1063651   0.85391486  0.4794889  -0.81614196
-0.30623537 -0.2284333  -0.5333915  -0.11328614 -1.5450444  -0.5077817
-1.3774561   0.41217175  0.11516482  1.5560768  -0.7469817  -1.4765854
 0.7093949  -0.114291    2.1057208  -2.6741965   0.72566754  0.55012083
 2.3451302  -1.2510659   0.3140531   1.4746969   0.4024581  -2.3046188
 1.2659645   2.278225    0.08678623 -1.471766    2.15753     0.34023762
 0.17808026 -1.1826618  -0.16569561 -0.10871834  2.3015096   0.19112433
-1.1756605  -0.96922463  0.06874546  0.36971325 -0.04724248  1.880946
-1.7491736  -1.3938425  -0.43538195 -0.5430063   1.9600484  -2.5801857
-2.3907616  -0.38354483  1.182356   -3.9656587  -0.8018017  -0.29514363
-1.8328854  -0.08165321 -0.64735687  0.5654924  -1.7028366  -0.17562585
 0.55491775 -0.05971068 -0.38406396  1.5891556   4.154112   -0.9290452
-1.3967556   2.7509627  -0.4634398  -2.4117336   1.4015831  -1.3671825
 0.80604464  2.378248    0.7243261   3.1934304  -1.391462   -1.4871521
 1.4887595   1.0651935   3.69667    -0.7252996  -0.87798625 -1.7895714
 0.17647578  1.9107432   0.73745984  2.9707737  -0.44027588 -0.49605256
 0.16137503 -1.351188  ]
```

```
/Users/vthumati/anaconda3/lib/python3.6/site-
packages/ipykernel_launcher.py:1: DeprecationWarning: Call to deprecated `m
ost_similar` (Method will be removed in 4.0.0, use self.wv.most_similar() i
nstead).
  """Entry point for launching an IPython kernel.
/Users/vthumati/anaconda3/lib/python3.6/site-
packages/ipykernel_launcher.py:2: DeprecationWarning: Call to deprecated `s
imilarity` (Method will be removed in 4.0.0, use self.wv.similarity() inste
ad).
```

Observation:

-> We have constructed the vector representation of each word

-> Using this model to construct vector representation of each sente
nce in average word2vec and tfidf-word2vec

AVERAGE WORD2VEC

-> Here i am using the word2vec model to construct vector
representation of each sentence

In [15]:

```
sent_vectors = []
for sent in sentences_list:
    sent_vec = np.zeros(200)
    cnt=0
    for word in sent:
        try:
            vec = w2vmodel.wv[word]
            sent_vec += vec
            cnt += 1
        except:
            pass
    sent_vec /= cnt
    sent_vectors.append(sent_vec)
print(len(sent_vectors))
print(len(sent_vectors[364000]))
```

```
/Users/vthumati/anaconda3/lib/python3.6/site-
packages/ipykernel_launcher.py:12: RuntimeWarning: invalid value
encountered in true_divide
  if sys.path[0] == '':
```

```
364173
200
```

In [16]:

```
np.isnan(sent_vectors).any()
```

Out[16]:

```
True
```

In [17]:

```
sent_vectors = np.nan_to_num(sent_vectors)
```

In [18]:

```
np.isnan(sent_vectors).any()
```

Out[18]:

```
False
```

In [19]:

```
sent_vectors.shape
```

Out[19]:

```
(364173, 200)
```

In [20]:

```
xtrain = sent_vectors[0:250000]
xtest = sent_vectors[250000:]
ytrain = sorted_w2vec['Score'][0:250000]
ytest = sorted_w2vec['Score'][250000:]
```

In [41]:

```
print(xtrain.shape)
print(xtest.shape)
print(ytrain.shape)
print(ytest.shape)
```

```
(250000, 200)
(114173, 200)
(250000,)
(114173,)
```

In [42]:

```
ytest.head(2)
```

Out[42]:

```
457707    positive
114937    positive
Name: Score, dtype: object
```

In [22]:

```
l = np.arange(1,20,1)
l
```

Out[22]:

```
array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15, 16, 17,
       18, 19])
```

RANDOM FOREST ON AVERAGE WORD2VEC:

In [116]:

```
from sklearn.cross_validation import cross_val_score
```

In [110]:

```
cross_validation_scores = []
for d in l:
    model = RandomForestClassifier(n_estimators=d,n_jobs=-1,criterion='gini
',max_depth=None)
    score = cross_val_score(model,xtrain,ytrain,cv=3,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [111]:

```
error = [1 - x for x in cross_validation_scores]
print(error)
print(cross_validation_scores)
```

```
[0.1952400012730009, 0.2443400086073444, 0.15175600497946462,
0.16532401019724308, 0.13709198932946232, 0.14107600104206608,
0.13147599105675745, 0.13233998769684108, 0.12684398606412461,
0.12647600321621466, 0.1248919869918822, 0.12309199889574696,
0.12333998683168224, 0.12128399348747221, 0.12196398651150353,
0.11992398660724302, 0.12085198830337551, 0.11905998535912266,
0.12070798609533939]
[0.8047599987269991, 0.7556599913926556, 0.8482439950205354,
0.8346759898027569, 0.8629080106705377, 0.8589239989579339,
0.8685240089432426, 0.8676600123031589, 0.8731560139358754,
0.8735239967837853, 0.8751080130081178, 0.876908001104253
```

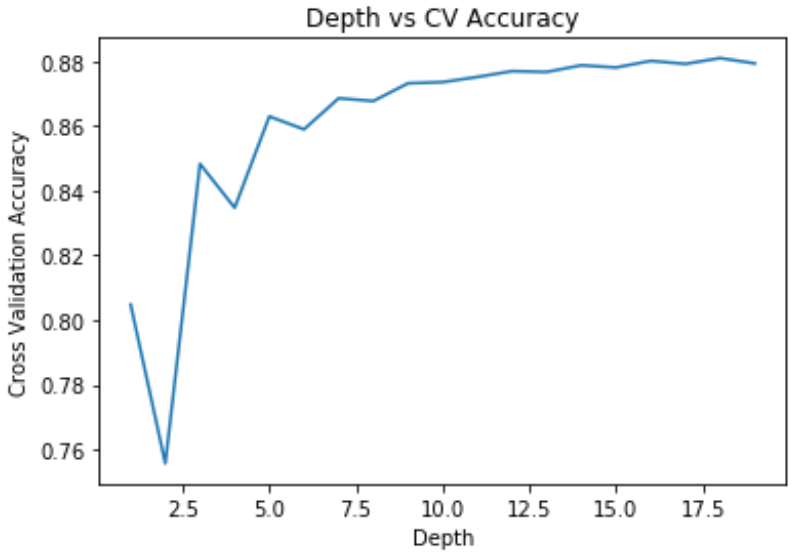
0.8766600131683178, 0.8787160065125278, 0.8780360134884965,
0.880076013392757, 0.8791480116966245, 0.8809400146408773,
0.8792920139046606]

In [112]:

```
mp.plot(l,cross_validation_scores)
mp.xlabel('Depth')
mp.ylabel('Cross Validation Accuracy')
mp.title("Depth vs CV Accuracy")
```

Out[112]:

```
Text(0.5,1,'Depth vs CV Accuracy')
```

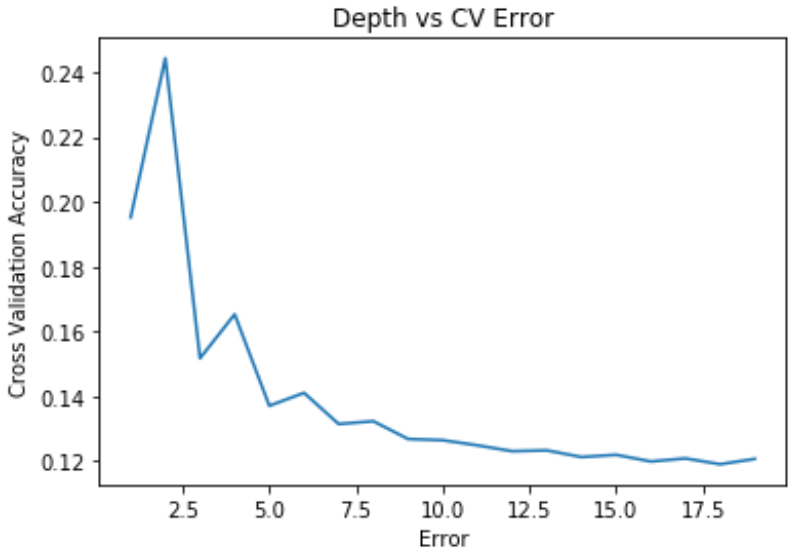


In [113]:

```
mp.plot(l,error)
mp.xlabel('Error')
mp.ylabel('Cross Validation Accuracy')
mp.title("Depth vs CV Error")
```

Out[113]:

```
Text(0.5,1,'Depth vs CV Error')
```



In [114]:

```
best_d = l[error.index(min(error))]
print("the best value of d is {}".format(best_d))
```

```
the best value of d is 18
```

In [115]:

```
model = RandomForestClassifier(criterion='gini',n_estimators=best_d)
model.fit(xtrain,ytrain)
pred = model.predict(xtest)
score = accuracy_score(ytest,pred)
print(score)
```

```
0.8667898715107775
```

Observation:

```
    Random Forest on Average Word2vec:

        -> The best Number of base learning model is achieved with the h
    elp of cross-validation when it is 18

        -> The accuracy with 18 base learning models is 86.67
```

GBDT ON AVERAGE WORD2VEC:

In [117]:

```
parameters = { 'n_estimators':[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,
19,20],'learning_rate':[0.1,0.2,0.3,0.4,0.5]}
```

In [118]:

```
classifier = GradientBoostingClassifier()
```

In [25]:

```
from sklearn.model_selection import GridSearchCV
```

In [120]:

```
model = GridSearchCV(classifier,param_grid=parameters,n_jobs=-1,cv=3,scorin
g='accuracy')
model.fit(xtrain,ytrain)
print(model.best_estimator_)
```

```
GradientBoostingClassifier(criterion='friedman_mse', init=None,
              learning_rate=0.5, loss='deviance', max_depth=3,
              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, n_estimators=20,
              presort='auto', random_state=None, subsample=1.0, verbose=0,
              warm_start=False)
```

In [122]:

```
classifier = GradientBoostingClassifier(learning_rate=0.5,n_estimators=20)
classifier.fit(xtrain,ytrain)
pred = classifier.predict(xtest)
score  = accuracy_score(ytest,pred)
print(score)
```

```
0.8739894721168753
```

Observation:

GBDT on Average Word2vec:

-> By performing grid search the best parameters were:

-> Number of baseline models = 20

-> Learning rate = 0.5

-> Model with the best hyper parameters has given an accurancy of 87.39

STACKING ON AVERAGE WORD2VEC:

In [33]:

```
cross_validation_scores = []
for d in l:
    model = DecisionTreeClassifier(criterion='gini',max_depth=d,
min_samples_split=10)
    score = cross_val_score(model,xtrain,ytrain,cv=3,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [34]:

```
error = [1 - x for x in cross_validation_scores]
print(error)
print(cross_validation_scores)
```

```
[0.14885599995505316, 0.14885599995505316, 0.14885599995505316,
0.1420880048502261, 0.1402120039219784, 0.13879200846583306,
0.13720401608169075, 0.1369680067375857, 0.13882399131369993,
0.14072399281795522, 0.1450480132346721, 0.14893999976306238,
0.15308800123560518, 0.15749999982815865, 0.1613440081487173,
0.16448001771719511, 0.1667120169494748, 0.16950801157378959,
0.17139201935009307]
[0.8511440000449468, 0.8511440000449468, 0.8511440000449468,
0.8579119951497739, 0.8597879960780216, 0.8612079915341669,
0.8627959839183093, 0.8630319932624143, 0.8611760086863001,
0.8592760071820448, 0.8549519867653279, 0.8510600002369376,
0.8469119987643948, 0.8425000001718413, 0.8386559918512827,
0.8355199822828049, 0.8332879830505252, 0.8304919884262104,
0.8286079806499069]
```

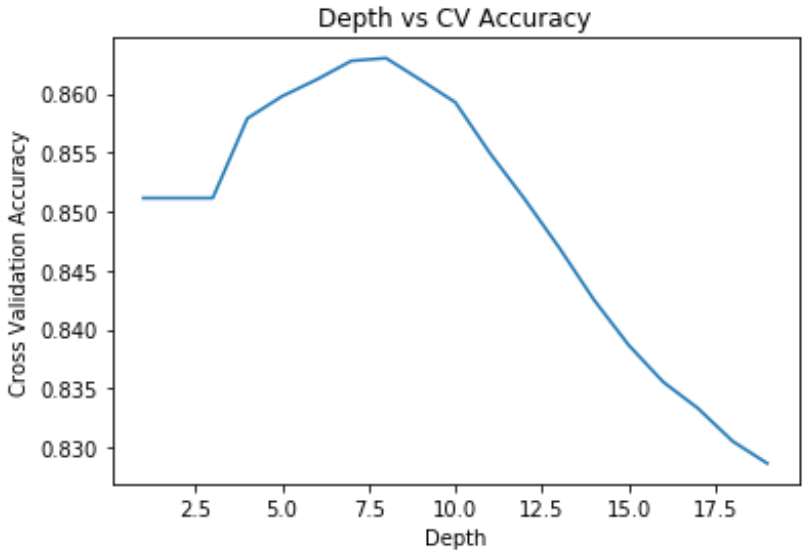
In [35]:

```
mp.plot(l,cross_validation_scores)
mp.xlabel('Depth')
```

```
mp.ylabel('Cross Validation Accuracy')
mp.title("Depth vs CV Accuracy")
```

Out[35]:

```
Text(0.5,1,'Depth vs CV Accuracy')
```

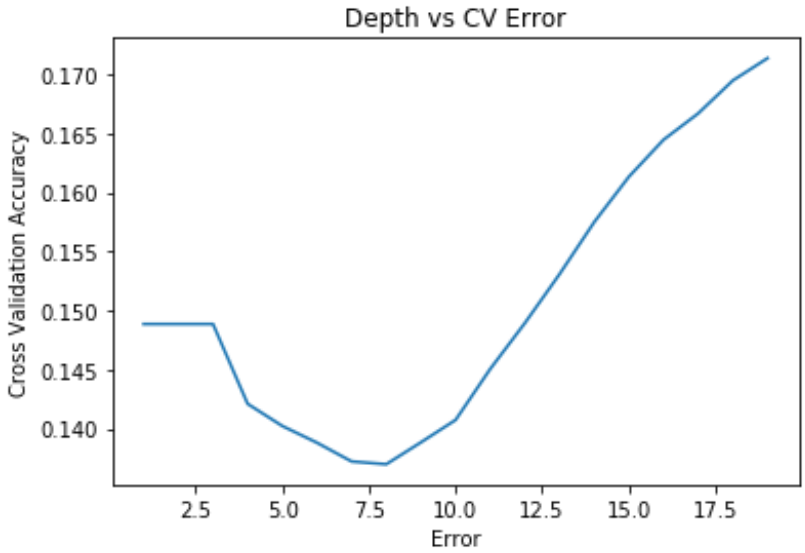


In [36]:

```
mp.plot(l,error)
mp.xlabel('Error')
mp.ylabel('Cross Validation Accuracy')
mp.title("Depth vs CV Error")
```

Out[36]:

```
Text(0.5,1,'Depth vs CV Error')
```



In [37]:

```
best_d = l[error.index(min(error))]
print("the best value of d is {}".format(best_d))
```

```
the best value of d is 8
```

Note:

-> In stacking all the models are perfect models which means they do

not overfit or underfit

-> The decision tree with depth 8 is the perfect model

-> From above we have the best models hyper parameters for Random forest and GBDT

In [38]:

```
moedl1 = DecisionTreeClassifier(max_depth=8,criterion='gini')
model2 = RandomForestClassifier(criterion='gini',n_estimators=18)
model3 = GradientBoostingClassifier(learning_rate=0.5,n_estimators=20)
```

In [39]:

```
clf = StackingClassifier(classifiers=[moedl1,model2],meta_classifier=model3
)
```

In [43]:

```
clf.fit(xtrain,ytrain)
pred = clf.predict(xtest)
score = accuracy_score(ytest,pred)
print(score)
```

Out[43]:

```
91.37
```

TFIDF WORD2VEC:

-> Here i am using the word2vec model to construct vector representation of each sentence

In [45]:

```
data = finaldata.sort_values("Time",axis=0,ascending=True,kind='quicksort',
na_position='last',inplace=False)
```

In [46]:

```
data.shape
```

Out[46]:

```
(364173, 10)
```

In [47]:

```
from sklearn.feature_extraction.text import TfidfVectorizer
```

In [48]:

```
tfid = TfidfVectorizer(ngram_range=(1,2))
```

In [49]:

```
tfid_vect = tfid.fit_transform(data['Text'].values)
```

In [50]:

```
tfid_vect.shape
```

Out[50]:

```
(364173, 2910206)
```

In [51]:

```
tfidf_feat = tfid.get_feature_names()
print(len(tfidf_feat))
```

```
2910206
```

In [52]:

```
tfidf_feat = tfid.get_feature_names()
tfidf_sent_vectors = [];
row=0;
for sent in sentences_list:
    sent_vec = np.zeros(200)
    sum =0;
    for word in sent:
        try:
            vec = w2v_model.wv[word]
            tfidf = tfid_vect[row, tfidf_feat.index(word)]
            sent_vec += (vec * tf_idf)
            sum += tf_idf
        except:
            pass
    sent_vec /= sum
    tfidf_sent_vectors.append(sent_vec)
    row += 1
```

```
/Users/vthumati/anaconda3/lib/python3.6/site-
packages/ipykernel_launcher.py:15: RuntimeWarning: invalid value
encountered in true_divide
  from ipykernel import kernelapp as app
```

In [53]:

```
print(len(tfidf_sent_vectors))
print(len(tfidf_sent_vectors[300000]))
```

```
364173
200
```

In [54]:

```
type(tfidf_sent_vectors)
```

Out[54]:

```
list
```

In [55]:

```
tfidf_sent_vectors = np.nan_to_num(tfidf_sent_vectors)
```

In [56]:

In [56]:

```
np.isnan(tfidf_sent_vectors).any()
```

Out[56]:

False

In [57]:

```
xtrain = tfidf_sent_vectors[0:250000]
xtest = tfidf_sent_vectors[250000:]
ytrain = data['Score'][0:250000]
ytest = data['Score'][250000:]
```

In [58]:

```
print(xtrain.shape)
print(xtest.shape)
print(ytrain.shape)
print(ytest.shape)
```

```
(250000, 200)
(114173, 200)
(250000,)
(114173,)
```

RANDOM FOREST ON TFIDF WORD2VEC:

In [59]:

```
from sklearn.cross_validation import cross_val_score
```

In [61]:

```
cross_validation_scores = []
for d in l:
    model = RandomForestClassifier(n_estimators=d,n_jobs=-1,criterion='gini
',max_depth=None)
    score = cross_val_score(model,xtrain,ytrain,cv=3,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [62]:

```
error = [1 - x for x in cross_validation_scores]
print(error)
print(cross_validation_scores)
```

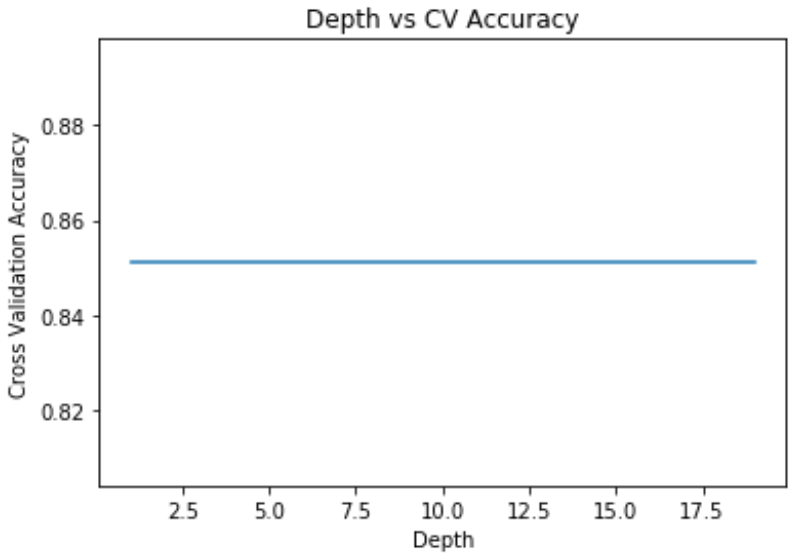
```
[0.14885599995505316, 0.14885599995505316, 0.14885599995505316,
0.14885599995505316, 0.14885599995505316, 0.14885599995505316,
0.14885599995505316, 0.14885599995505316, 0.14885599995505316,
0.14885599995505316, 0.14885599995505316, 0.14885599995505316,
0.14885599995505316, 0.14885599995505316, 0.14885599995505316,
0.14885599995505316, 0.14885599995505316, 0.14885599995505316,
0.14885599995505316]
[0.8511440000449468, 0.8511440000449468, 0.8511440000449468,
0.8511440000449468, 0.8511440000449468, 0.8511440000449468,
0.8511440000449468, 0.8511440000449468, 0.8511440000449468,
0.8511440000449468, 0.8511440000449468, 0.8511440000449468,
0.8511440000449468, 0.8511440000449468, 0.8511440000449468,
0.8511440000449468, 0.8511440000449468, 0.8511440000449468,
0.8511440000449468]
```

In [63]:

```
mp.plot(l,cross_validation_scores)
mp.xlabel('Depth')
mp.ylabel('Cross Validation Accuracy')
mp.title("Depth vs CV Accuracy")
```

Out[63]:

```
Text(0.5,1,'Depth vs CV Accuracy')
```

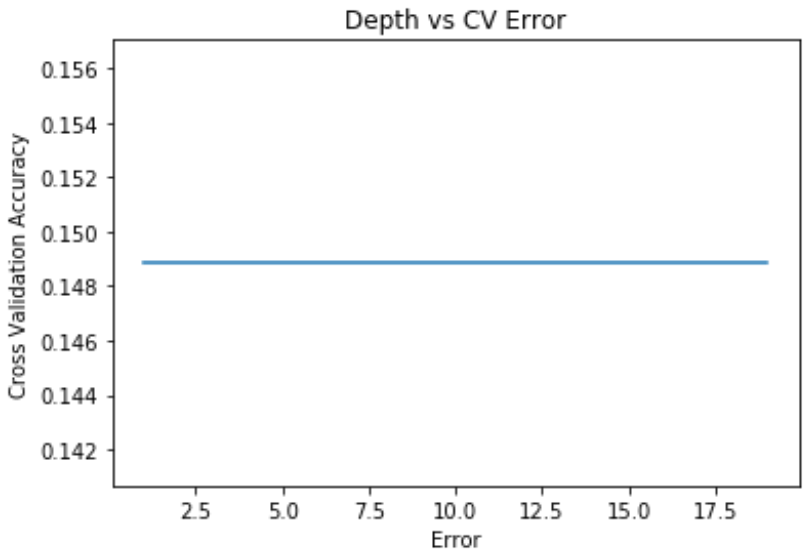


In [64]:

```
mp.plot(l,error)
mp.xlabel('Error')
mp.ylabel('Cross Validation Accuracy')
mp.title("Depth vs CV Error")
```

Out[64]:

```
Text(0.5,1,'Depth vs CV Error')
```



In [65]:

```
best_d = l[error.index(min(error))]
print("the best value of d is {}".format(best_d))
```

```
the best value of d is 1
```

In [66]:

```
model = RandomForestClassifier(criterion='gini',n_estimators=best_d)
model.fit(xtrain,ytrain)
pred = model.predict(xtest)
score = accuracy_score(ytest,pred)
print(score)
```

```
0.8257381342348892
```

Observation:

```
    Random Forest on TFIDF Word2vec:

        -> The best Number of base learning model is achieved with the h
    elp of cross-validation when 1

        -> The accuracy with 18 base learning models is 82.57
```

GBDT ON TFIDF WORD2VEC:

In [68]:

```
parameters = { 'n_estimators':[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,
19,20],'learning_rate':[0.1,0.2,0.3,0.4,0.5]}
```

In [70]:

```
from sklearn.model_selection import GridSearchCV
classifier = GradientBoostingClassifier()
model = GridSearchCV(classifier,param_grid=parameters,n_jobs=-1,cv=3,scorin
g='accuracy')
model.fit(xtrain,ytrain)
print(model.best_estimator_)
```

```
GradientBoostingClassifier(criterion='friedman_mse', init=None,
              learning_rate=0.1, loss='deviance', max_depth=3,
              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, n_estimators=1, presort='auto',
              random_state=None, subsample=1.0, verbose=0,
              warm_start=False)
```

In [74]:

```
classifier = GradientBoostingClassifier(learning_rate=0.1,n_estimators=1)
classifier.fit(xtrain,ytrain)
pred = classifier.predict(xtest)
score  = accuracy_score(ytest,pred)
print(score)
```

```
0.8257381342348892
```

Observation:

GBDT on TFIDF Word2vec:

-> By performing grid search the best parameters were:

-> Number of baseline models = 1

-> Learning rate = 0.1

-> Model with the best hyper parameters has given an accurancy of 82.57

CONCLUSION:

AVERAGE WORD2VEC:

RANDOM FOREST:

-> IN RANDOM FOREST THE BASE MODELS WERE HAVING LOW BIAS AND HIGH VARIANCE, DUE TO ITS DEPTH

-> THIS IS CONTROLLED BY ROW SAMPLING, COLUMN SAMPLING AND BOOTSTRAP AGGREGATION

-> THE BEST NUMBER OF BASE LEARNING MODEL IS ACHIEVED WITH THE HELP OF CROSS-VALIDATION WHEN IT IS 18

-> THE ACCURACY WITH 18 BASE LEARNING MODELS IS 86.67

GBDT:

-> IN GBDT THE BASE MODELS WERE HAVING HIGH BIAS AND LOW VARIANCE, DUE TO LESS DEPTH OF TREES

-> THIS IS CONTROLLED BY PSEDUO RESIDUAL ERRORS

-> BY PERFORMING GRID SEARCH THE BEST PARAMETERS WERE:

-> NUMBER OF BASELINE MODELS = 20

-> LEARNING RATE = 0.5

-> MODEL WITH THE BEST HYPER PARAMETERS HAS GIVEN AN ACCURACY OF 87.39

STACKING:

-> IN STACKING ALL THE MODELS ARE PERFECT MODELS WHICH MEANS THEY DO NOT OVERFIT OR UNDERFIT

-> THE DECISION TREE WITH DEPTH 8 IS THE PERFECT MODEL

-> RANDOM FOREST WITH NUMBER OF BASE LEARNERS = 18 IS THE BEST MODEL

-> GBDT WITH NUMBER OF BASELINE MODELS = 20 AND LEARNING RATE = 0.5 IS THE BEST MODEL

-> USING GBDT AS META-CLASSIFIER AND RANDOM FOREST, DECISION TREES AS CLASSIFIER THE ACCURANCY IS 91.37

TFIDF WORD2VEC:

RANDOM FOREST:

-> THE BEST NUMBER OF BASE LEARNING MODEL IS ACHIEVED WITH THE HELP OF CROSS-VALIDATION WHEN 1

-> THE ACCURACY WITH 18 BASE LEARNING MODELS IS 82.57

GBDT:

-> BY PERFORMING GRID SEARCH THE BEST PARAMETERS WERE:

-> NUMBER OF BASELINE MODELS = 1

-> LEARNING RATE = 0.1

-> MODEL WITH THE BEST HYPER PARAMETERS HAS GIVEN AN ACCURACY OF 82.57