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 Bag of
words,Tfidf,word2vec,Average word2vec

-> Applying k-fold cross-validation do determine the best k value ha
```

```
ving accuracy as the check        measure

-> Here we can use both random based splitting of data or time based
splitting of data

-> Since it is the data of reviews they may change overtime due to m
odifications of products

-> The accurancy which we obtained by random based splitting may cha
nge for the future data

-> We can assure about the accurancy obtained in time base splitting
for unseen future data
   also.

-> In this for the first method i am going to do both random based s
plitting and time based
   splitting

-> Random based splitting is possible for every dataset, but for tim
e based splitting there
   should time attribute
```

Importing the required libraries

In [1]:

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as mp
import seaborn as s
from sklearn.feature_extraction.text import
TfidfTransformer,TfidfVectorizer,CountVectorizer
import sqlite3
import nltk
import string
from sklearn.metrics import accuracy_score,roc_curve,auc,confusion_matrix
from sklearn.cross_validation import train_test_split,cross_val_score
from sklearn.neighbors import KNeighborsClassifier
from sklearn import cross_validation
from collections import Counter
```

```
/Users/vthumati/anaconda3/lib/python3.6/site-
packages/sklearn/cross_validation.py:41: DeprecationWarning: This module wa
s deprecated in version 0.18 in favor of the model_selection module into wh
ich all the refactored classes and functions are moved. Also note that the
interface of the new CV iterators are different from that of this module. T
his module will be removed in 0.20.
  "This module will be removed in 0.20.", DeprecationWarning)
```

->loading the data and information about the data

-> Shape of the data

-> Dimensionality 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)
#####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	1	1

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfulness
				"Natalia Corres"		
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
```

```
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]:

```python
sorteddata = data.sort_values('ProductId',axis=0,ascending=True,inplace=False,kind='quicksort',na_position='last')
```

In [6]:

```python
finaldata = sorteddata.drop_duplicates(subset={"UserId","ProfileName","Time","Text"},keep='first',inplace=False)
```

Information about the modified data:

```
-> Shape of the data

-> Dimensionality of the data

-> Attributes if the data

-> Sample of modified data
```

In [7]:

```python
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...
```

Keeping in mind about the performance capability of the box, here i am taking the subset of the data

In [8]:

```python
finaldata1 = finaldata.sample(n=100000)
```

Information about the sampled data:

```
-> Shape of the data

-> Dimensionality of the data

-> Attributes if the data

-> Sample of modified data
```

In [9]:

```python
print(finaldata1.shape)
print(finaldata1.ndim)
print(finaldata1.columns)
print(finaldata1.head(5))
```

```
(100000, 10)
2
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
            Id   ProductId          UserId             ProfileName  \
425529  460208  B005BRHVD6    AAU4SEQOA9NE  Ryan Barton "The Knife"
```

```
494547  534658  B0018Q1G94  A3FITKZSOILAJX            Ursula Nemeth
147114  159580  B000V0H4A8   A5D3JR6T9T53V  Boston Gal "Boston Gal"
441781  477703  B0029TECEA  A3ONWXEVE56C7G                 J. Schick
276015  299126  B004VB0Q9Y  A2Y5OR28P88B49                  Patricia

        HelpfulnessNumerator  HelpfulnessDenominator     Score        Time  
\
425529                     1                       1  positive  1305244800
494547                     0                       0  positive  1346803200
147114                     1                       1  positive  1326672000
441781                     8                       9  positive  1256342400
276015                     0                       0  positive  1346803200

                             Summary  \
425529                      Love it.
494547                The Best Pasta
147114                     Addicted!
441781                Excellent soup
276015  A lot of K-cups - good price

                                                     Text
425529  I think that the roctane Gu is thinner than th...
494547  I love this Pasta... as good as any "normal" p...
147114  Yummy Yummy - love this snack!  slight olive o...
441781  Great tasting soup!  Lots of chicken and veget...
276015  After quite of bit of searching, I found this ...
```

BAG OF WORDS:

```
-> RANDOM BASED SPLITTING:

    ->SIMPLE CROSS-VALIDATION AND K-FOLD CROSS-VALIDATION:

        -> TO FIND THE BEST K-VALUE WITH ACCURANCY AS MEASURE
```

Using Count-Vectorizer to convert the text to vector representation

In [10]:

```
cv   = CountVectorizer()
countvect = cv.fit_transform(finaldata1['Text'].values)
print(type(countvect))
print(countvect.get_shape())
```

```
<class 'scipy.sparse.csr.csr_matrix'>
(100000, 61819)
```

In [11]:

```
score = finaldata1['Score']
print(score.shape)
```

```
(100000,)
```

In [12]:

```
score.head(5)
```

Out[12]:

```
425529    positive
494547    positive
147114    positive
441781    positive
276015    positive
Name: Score, dtype: object
```

RANDOM BASED SPLITTING OF DATA:

```
       -> SIMPLE CROSS-VALIDATION
```

In [13]:

```
x_1,x_test,y_1,y_test = cross_validation.train_test_split(countvect,score,t
est_size=0.3,random_state=9)
```

Shape of Test and Train dataset:

```
     -> The whole data is divided into training data contains 70% perce
   nt of data

     -> 30 % of data for testing
```

In [14]:

```
print(x_1.get_shape())
print(x_test.get_shape())
print(y_1.count())
print(y_test.count())
```

```
(70000, 61819)
(30000, 61819)
70000
30000
```

Splitting the test data into test and cross-validation data:

```
   -> Again the training data is divided into 70 and 30 ratio

   -> This 70 % to train and 30 % for cross validation
```

In [15]:

```
x_train,x_cv,y_train,y_cv = cross_validation.train_test_split(x_1,y_1,test_
size=0.3,random_state=8)
```

In [16]:

```
print(x_train.get_shape())
print(x_cv.get_shape())
print(y_train.count())
print(y_cv.count())
```

```
(49000, 61819)
(21000, 61819)
49000
21000
```

In [18]:

```
for i in range(1,30,2):
    clas = KNeighborsClassifier(n_neighbors=i)
    clas.fit(x_train,y_train)
    pred = clas.predict(x_cv)
    acc = accuracy_score(y_cv,pred,normalize=True)*float(100)
    print('the accurate percentage of k = {} is {}'.format(i,acc))
```

```
the accurate percentage of k = 1 is 81.66190476190476
the accurate percentage of k = 3 is 84.04761904761905
the accurate percentage of k = 5 is 84.64285714285714
the accurate percentage of k = 7 is 84.63333333333334
the accurate percentage of k = 9 is 84.65238095238095
the accurate percentage of k = 11 is 84.67619047619047
the accurate percentage of k = 13 is 84.63809523809523
the accurate percentage of k = 15 is 84.57619047619048
the accurate percentage of k = 17 is 84.54285714285714
the accurate percentage of k = 19 is 84.4952380952381
the accurate percentage of k = 21 is 84.47619047619047
the accurate percentage of k = 23 is 84.46190476190476
the accurate percentage of k = 25 is 84.42380952380952
the accurate percentage of k = 27 is 84.39047619047619
the accurate percentage of k = 29 is 84.39999999999999
```

Note:

-> The highest accurancy 84.67 with cross-validation is occured when k = 11

-> Using the same k-value and testing the accuracy on the test data set

In [22]:

```
clas = KNeighborsClassifier(n_neighbors = 11)
clas.fit(x_train,y_train)
pred = clas.predict(x_test)
acc = accuracy_score(y_test,pred,normalize=True)*float(100)
print("The accuracy on the test data set when k = {} is {}".format(11,acc))
```

```
The accuracy on the test data set when k = 11 is 84.75
```

Observation:

```
By using simple cross validation the highest accuracy achieved is 84
.75 when k = 11
```

RANDOM BASED SPLITTING OF DATA:

```
K-FOLD CROSS VALIDATION
```

In [17]:

```
l = list(np.arange(1,30,2))
print(l)
```

```
[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29]
```

In [24]:

```
cross_validation_scores = []
for k in l:
    classif = KNeighborsClassifier(n_neighbors=k)
    score =
cross_val_score(classif,x_train,y_train,cv=10,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [26]:

```
error = [1 - x for x in cross_validation_scores]
print("Cross Validation Accuracy Scores")
print(cross_validation_scores)
print("errors")
print(error)
```

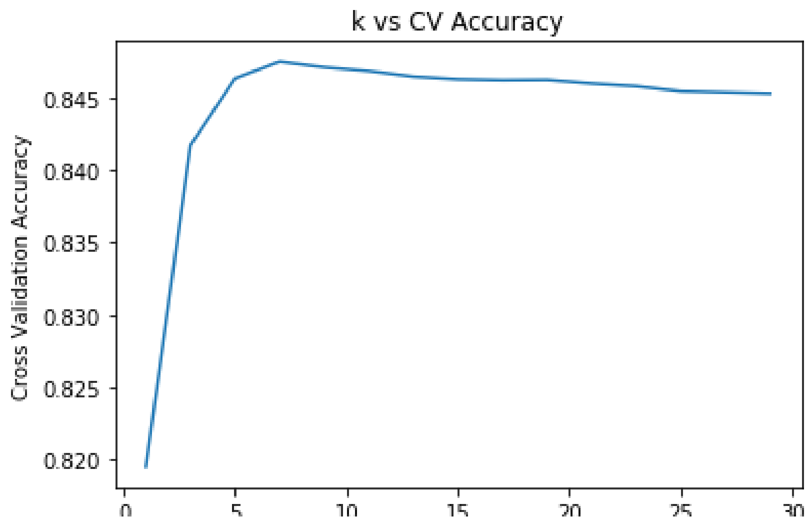
```
Cross Validation Accuracy Scores
[0.8195103131824372, 0.841714120854399, 0.8463265325417131,
0.847489743752176, 0.8471020594378201, 0.8468366491810349,
0.8464489065576387, 0.8462652372455326, 0.8462040502375696,
0.8462244792263423, 0.8459795895868216, 0.8457959452643042,
0.8454489689899611, 0.8453673529932259, 0.8452857286666277]
errors
[0.18048968681756283, 0.158285879145601, 0.15367346745828692,
0.152510256247824, 0.15289794056217987, 0.15316335081896515,
0.15355109344236129, 0.15373476275446 74, 0.15379594976243038,
0.15377552077365775, 0.15402041041317838, 0.15420405473569576,
0.15455103101003886, 0.15463264700677415, 0.15471427133337234]
```

In [27]:

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

Out[27]:

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

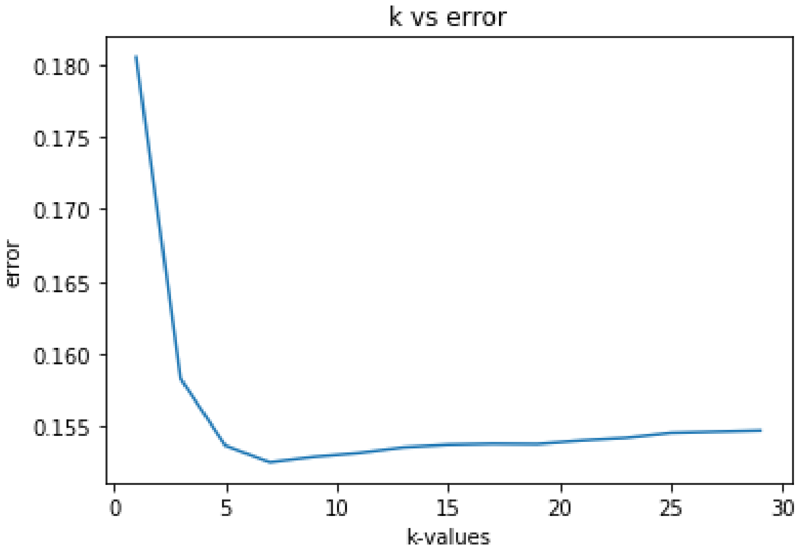


In [28]:

```
mp.plot(l,error)
mp.xlabel('k-values')
mp.ylabel('error')
mp.title("k vs error")
```

Out[28]:

```
Text(0.5,1,'k vs error')
```



In [29]:

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

```
the best value of k is 7
```

Observation:

```
    -> By using k-fold cross validation we got best k value

    -> From the plots we can say that error is less at k = 7 when compar
    ed with all of them

    -> By using k = 7 designing the classifier with the training data
```

In [30]:

```
kclas = KNeighborsClassifier(n_neighbors=best_k)
kclas.fit(x_train,y_train)
predi = kclas.predict(x_test)
accur = accuracy_score(y_test,predi,normalize=True)*float(100)
print(accur)
```

```
84.83333333333334
```

Observation:

```
    -> Using the best k value to design the model with train data
```

-> using the best k value to design the model with train data

-> The accurancy with the test data is 84.83

BAG OF WORDS:

TIME BASED SPLITTING OF DATA:

-> K-FOLD CROSS-VALIDATION:

-> TO FIND THE BEST K-VALUE WITH ACCURANCY AS MEASURE

In order to perform this we have sort the data based on time

In [18]:

```
sorted_count_vect = finaldata1.sort_values("Time",axis=0,ascending=True,kin
d='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 [19]:

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

```
(100000, 10)
2
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
            Id   ProductId          UserId       ProfileName  \
417839  451856  B00004CXX9   AIUWLEQ1ADEG5  Elizabeth Medina
346055  374359  B00004CI84  A344SMIA5JECGM   Vincent P. Ross
70688    76882  B00002N8SM  A32DW342WBJ6BX       Buttersugar
346094  374400  B00004CI84  A2DEE7F9XKP3ZR            jerome
138017  149789  B00004S1C6  A1KXONFPU2XQ5K  Stephanie Manley

        HelpfulnessNumerator  HelpfulnessDenominator     Score       Time  \
417839                     0                       0  positive  944092800
346055                     1                       2  positive  944438400
70688                      0                       0  positive  948672000
346094                     0                       3  positive  959990400
138017                    26                      28  positive  965779200
```

```
                                                  -

                                            Summary  \
417839                             Entertainingl Funny!
346055                          A modern day fairy tale
70688                            A sure death for flies
346094  Research - Beatlejuice video - French version
138017                                      A must have!

                                                   Text
417839  Beetlejuice is a well written movie ..... ever...
346055  A twist of rumplestiskin captured on film, sta...
70688   I bought a few of these after my apartment was...
346094  I'm getting crazy.I'm looking for Beatlejuice ...
138017  These are easy to use, they do not make a mess...
```

In [20]:

```
count_vector = CountVectorizer()
```

In [21]:

```
cvr  = count_vector.fit_transform(sorted_count_vect['Text'].values)
```

In [22]:

```
score = sorted_count_vect["Score"]
```

In [23]:

```
print(cvr.shape)
print(score.shape)
```

```
(100000, 61819)
(100000,)
```

In [24]:

```
x_train = cvr[0:70000]
x_test = cvr[70000:100000]
y_train = score[0:70000]
y_test = score[70000:100000]
```

Splitting the sampled data into test and train:

-> Training data contains 70 percent of data

-> Test data contains 30 percent of data

In [25]:

```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(70000, 61819)
(30000, 61819)
(70000,)
(30000,)
```

TIME BASED SPLITTING :

```
              K-FOLD CROSS VALIDATION
```

In [26]:

```
l = list(np.arange(1,30,2))
print(l)
```

```
[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29]
```

In [54]:

```
cross_validation_scores = []
for k in l:
    classif = KNeighborsClassifier(n_neighbors=k)
    score = 
cross_val_score(classif,x_train,y_train,cv=10,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [55]:

```
error = [1 - x for x in cross_validation_scores]
print("Cross Validation Accuracy Scores")
print(cross_validation_scores)
print("errors")
print(error)
```

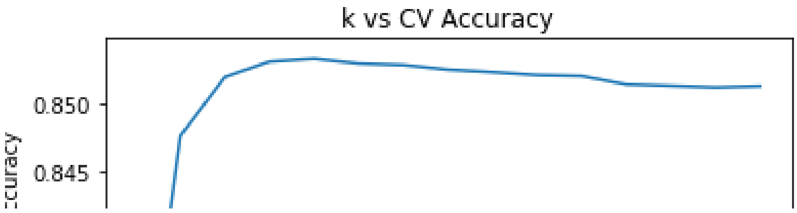
```
Cross Validation Accuracy Scores
[0.8229853780201098, 0.8476284336250701, 0.8520285439189499,
0.853171507207582, 0.8533857908854243, 0.8530286500618093,
0.8529143806717221, 0.8525715153586024, 0.8523857500486887,
0.8521714377994171, 0.8521000235122453, 0.8514714561524788,
0.8513571500276969, 0.8512428520661807, 0.8513285663536442]
errors
[0.17701462197989015, 0.15237156637492988, 0.1479714560810501,
0.14682849279241805, 0.14661420911457568, 0.14697134993819072,
0.1470856193282779, 0.14742848464139757, 0.14761424995131134,
0.14782856220058294, 0.14789997648775466, 0.14852854384752123,
0.14864284997230315, 0.14875714793381933, 0.14867143364635582]
```

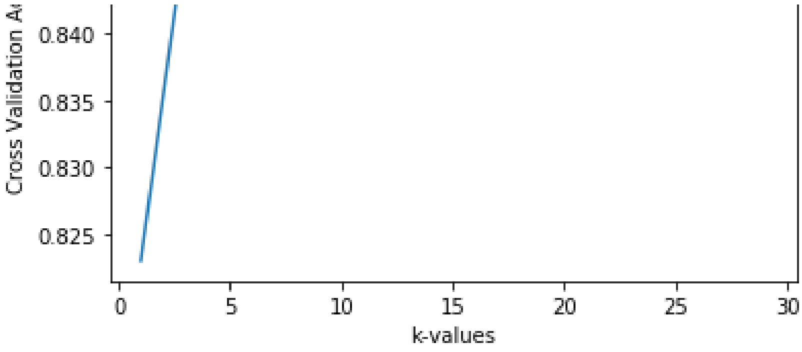
In [56]:

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

Out[56]:

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



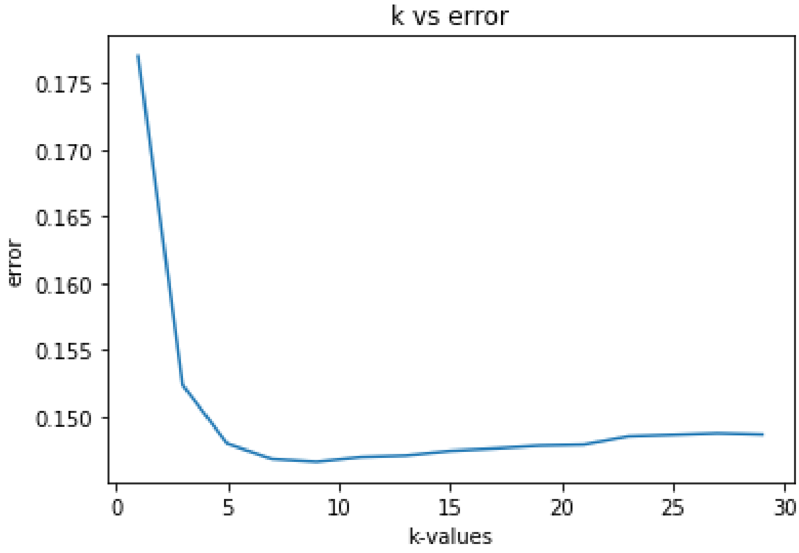


In [57]:

```
mp.plot(l,error)
mp.xlabel('k-values')
mp.ylabel('error')
mp.title("k vs error")
```

Out[57]:

```
Text(0.5,1,'k vs error')
```



In [58]:

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

```
the best value of k is 9
```

Observation:

```
-> By using k-fold cross validation we got best k value as 9

-> From the plots we can say that error is less at k = 9 when compar
ed with all of them

-> By using k = 9 designing the classifier with the training data
```

In [59]:

```
kclas = KNeighborsClassifier(n_neighbors=best_k)
kclas.fit(x_train,y_train)
```

```
predi = kclas.predict(x_test)
accur = accuracy_score(y_test,predi,normalize=True)*float(100)
print(accur)
```

```
83.22666666666667
```

Observation:

```
-> Using the best k value to design the model with train data

-> The accurancy with the test data is 83.2266
```

TFIDF:

TIME BASED SPLITTING OF DATA:

```
 -> K-FOLD CROSS-VALIDATION:

 -> TO FIND THE BEST K-VALUE WITH ACCURANCY AS MEASURE
```

In [27]:

```
tfidf_data = finaldata1.sort_values("Time",axis=0,ascending=True,kind='quic
ksort',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 [28]:

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

```
(100000, 10)
2
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
            Id   ProductId          UserId      ProfileName  \
417839  451856  B00004CXX9   AIUWLEQ1ADEG5  Elizabeth Medina
346055  374359  B00004CI84  A344SMIA5JECGM   Vincent P. Ross
70688    76882  B00002N8SM  A32DW342WBJ6BX      Buttersugar
346094  374400  B00004CI84  A2DEE7F9XKP3ZR           jerome
138017  149789  B00004S1C6  A1KXONFPU2XQ5K  Stephanie Manley
```

```
        HelpfulnessNumerator  HelpfulnessDenominator     Score        Time  \
417839                     0                       0  positive   944092800
346055                     1                       2  positive   944438400
70688                      0                       0  positive   948672000
346094                     0                       3  positive   959990400
138017                    26                      28  positive   965779200

                                          Summary  \
417839                        Entertainingl Funny!
346055                     A modern day fairy tale
70688                       A sure death for flies
346094  Research - Beatlejuice video - French version
138017                                A must have!

                                                     Text
417839  Beetlejuice is a well written movie ..... ever...
346055  A twist of rumplestiskin captured on film, sta...
70688   I bought a few of these after my apartment was...
346094  I'm getting crazy.I'm looking for Beatlejuice ...
138017  These are easy to use, they do not make a mess...
```

In [29]:

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

In [30]:

```
tfid_vect_data = tfid_vect.fit_transform(tfidf_data["Text"].values)
```

In [31]:

```
print(tfid_vect_data.shape)
print(tfidf_data["Score"].shape)
```

```
(100000, 1287433)
(100000,)
```

Splitting the sampled data into test and train:

-> Training data contains 70 percent of data

-> Test data contains 30 percent of data

In [32]:

```
x_train = tfid_vect_data[0:70000]
x_test = tfid_vect_data[70000:100000]
y_train = tfidf_data['Score'][0:70000]
y_test = tfidf_data['Score'][70000:100000]
```

In [33]:

```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(70000, 1287433)
(30000, 1287433)
```

```
(70000,)
(30000,)
```

TIME BASED SPLITTING:

```
    K-FOLD CROSS VALIDATION
```

In [34]:

```
l = list(np.arange(1,30,2))
print(l)
```

```
[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29]
```

In [71]:

```
cross_validation_scores = []
for k in l:
    classif = KNeighborsClassifier(n_neighbors=k)
    score = 
cross_val_score(classif,x_train,y_train,cv=10,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [72]:

```
error = [1 - x for x in cross_validation_scores]
print("Cross Validation Accuracy Scores")
print(cross_validation_scores)
print("errors")
print(error)
```

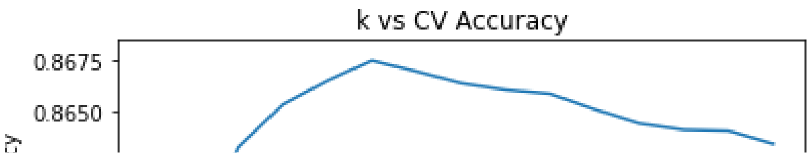
```
Cross Validation Accuracy Scores
[0.8475139805615098, 0.8578856093446042, 0.863228519657725,
0.8653428870478141, 0.8665142789084547, 0.867514401377845,
0.8669716176932983, 0.866400127885717, 0.8660715829810528,
0.8658715625688075, 0.8651001707163302, 0.864414480906418,
0.8641001584510237, 0.864042946204958, 0.8634000992530633]
errors
[0.15248601943849016, 0.14211439065539577, 0.13677148034227504,
0.13465711295218585, 0.13348572109154533, 0.13248559862215503,
0.13302838230670166, 0.13359987211428304, 0.1339284170189472,
0.13412843743119252, 0.13489982928366984, 0.13558551909358196,
0.13589984154897627, 0.13595705379504197, 0.13659990074693673]
```

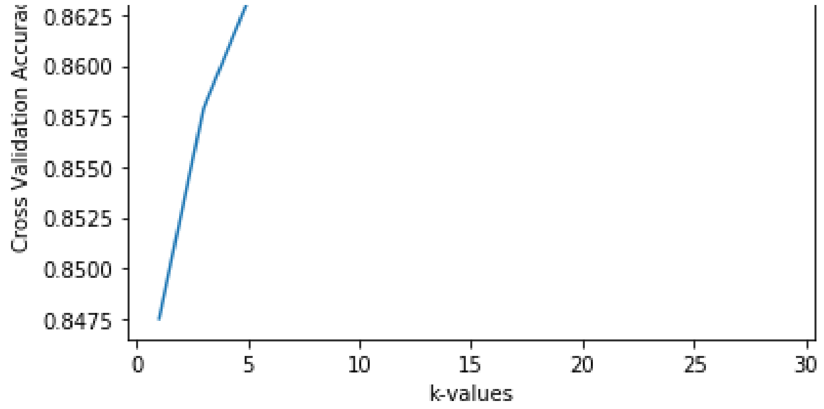
In [73]:

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

Out[73]:

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



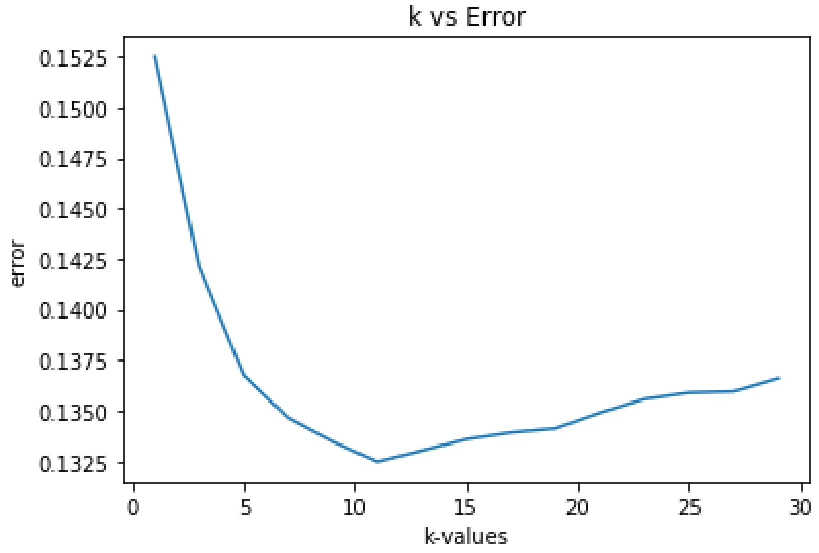


In [77]:

```
mp.plot(l,error)
mp.xlabel('k-values')
mp.ylabel('error')
mp.title("k vs Error")
```

Out[77]:

```
Text(0.5,1,'k vs Error')
```



In [78]:

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

```
the best value of k is 11
```

Observation:

```
-> By using k-fold cross validation we got best k value as 11

-> From the plots we can say that error is less at k = 11 when compa
red with all of them

-> By using k = 11 designing the classifier with the training data
```

In [79]:

```
kclas = KNeighborsClassifier(n_neighbors=best_k)
kclas.fit(x_train,y_train)
predi = kclas.predict(x_test)
accur = accuracy_score(y_test,predi,normalize=True)*float(100)
print(accur)
```

```
84.98333333333333
```

Observation:

```
-> Using the best k value to design the model with train data

-> The accurancy with the test data is 84.9833
```

CONSTRUCTING VECTOR REPRESENTATION OF EACH IN THE DATA BY USING WORD2VEC

In [35]:

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

-> Importing the required libraries

-> Functions to clean the sentences

-> Constructing the word2vec from the sample subset data

In [36]:

```
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 [37]:

```
sorted_w2vec = finaldata1.sort_values("Time",axis=0,ascending=True,kind='qu
icksort',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 [38]:

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

```
(100000, 10)
2
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerator',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
            Id   ProductId          UserId       ProfileName  \
417839  451856  B00004CXX9   AIUWLEQ1ADEG5  Elizabeth Medina
346055  374359  B00004CI84  A344SMIA5JECGM   Vincent P. Ross
70688    76882  B00002N8SM  A32DW342WBJ6BX       Buttersugar
346094  374400  B00004CI84  A2DEE7F9XKP3ZR            jerome
138017  149789  B00004S1C6  A1KXONFPU2XQ5K  Stephanie Manley

        HelpfulnessNumerator  HelpfulnessDenominator     Score       Time  \
417839                     0                       0  positive  944092800
346055                     1                       2  positive  944438400
70688                      0                       0  positive  948672000
346094                     0                       3  positive  959990400
138017                    26                      28  positive  965779200

                                          Summary  \
417839                        Entertainingl Funny!
346055                     A modern day fairy tale
70688                       A sure death for flies
346094  Research - Beatlejuice video - French version
138017                                 A must have!

                                                     Text
417839  Beetlejuice is a well written movie ..... ever...
346055  A twist of rumplestiskin captured on film, sta...
70688   I bought a few of these after my apartment was...
346094  I'm getting crazy.I'm looking for Beatlejuice ...
138017  These are easy to use, they do not make a mess...
```

In [39]:

```
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 [40]:

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

```
100000
<class 'list'>
```

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

In [41]:

```
w2vmodel =
gensim.models.Word2Vec(sentences_list,min_count=4,size=40,workers=4)
```

-> Most similar word

-> Similarity between the words

-> Dimensionality representation of a word

In [42]:

```
print(w2vmodel.most_similar("hello"))
print(w2vmodel.similarity("hello",'hi'))
print(w2vmodel.wv['hello'])
```

```
[('mickey', 0.7368489503860474), ('anyhow', 0.7226568460464478),
('focaccia', 0.709900975227356), ('fern', 0.7098590731620789), ('mike', 0.6
99766993522644), ('boomer', 0.6946572661399841), ('themed',
0.6860719919204712), ('merry', 0.6846867799758911), ('claxton', 0.683440923
6907959), ('samoas', 0.6817569732666016)]
0.5446572411054558
[ 0.29999846 -0.19882171 -0.41949722 -0.4891025  -0.3457285   0.03067495
  0.33179036  0.11951371 -0.3910432  -0.33136272 -0.08102001  0.09156115
  0.2493193   0.2969718   0.23660749 -0.362925   -0.38329345  0.02786745
  0.2396555  -0.12413767  0.32540685 -0.04338589  0.27390665  0.233951
 -0.24852224  0.18082564  0.3852502   0.25250012 -0.04117521  0.1665598
 -0.1021607   0.06984844  0.10276769  0.21571645  0.4212314   0.19228005
  0.01020537  0.06221204 -0.18181211  0.15039672]
```

```
/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

    -> Sorting the data based on the time
```

In [43]:

```
sent_vectors = []
for sent in sentences_list:
    sent_vec = np.zeros(40)
    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[88888]))
```

```
100000
40
```

In [44]:

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

Out[44]:

```
False
```

In [45]:

```
type(sent_vectors)
```

Out[45]:

```
list
```

In [46]:

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

In [47]:

```
type(sent_vectors)
```

Out[47]:

```
numpy.ndarray
```

In [48]:

```
sent_vectors.shape
```

Out[48]:

```
(100000, 40)
```

In [49]:

```
x_train = sent_vectors[0:70000]
x_test = sent_vectors[70000:100000]
y_train = sorted_w2vec['Score'][0:70000]
```

```
y_test = sorted_w2vec['Score'][70000:100000]
```

In [50]:

```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(70000, 40)
(30000, 40)
(70000,)
(30000,)
```

In [51]:

```
print(l)
```

```
[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29]
```

In [52]:

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

In [53]:

```
cross_validation_scores = []
for k in l:
    classif = KNeighborsClassifier(n_neighbors=k)
    score = 
cross_val_score(classif,x_train,y_train,cv=10,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [54]:

```
error = [1 - x for x in cross_validation_scores]
print("Cross Validation Accuracy Scores")
print(cross_validation_scores)
print("errors")
print(error)
```

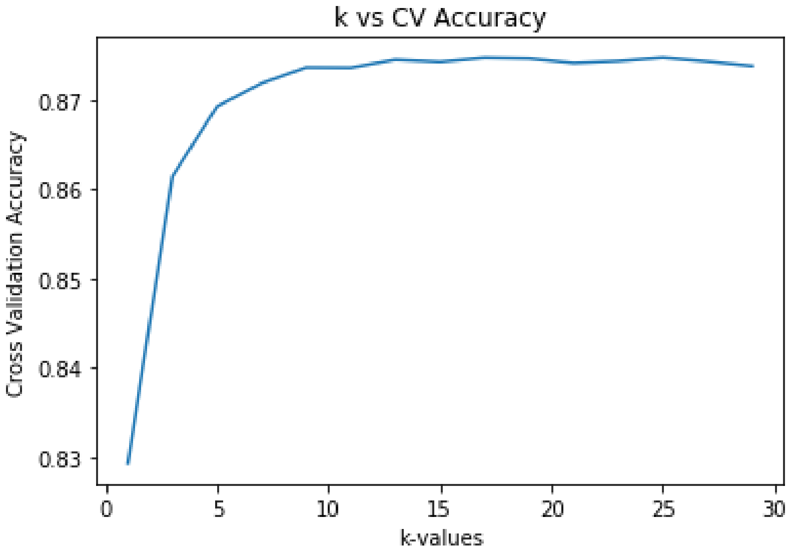
```
Cross Validation Accuracy Scores
[0.8293284544422717, 0.8614428912836741, 0.869257160699417 3,
0.8718571300880464, 0.873614285205831, 0.873585701530612,
0.8744857484731785, 0.8742428852075808, 0.8747000239784262,
0.8746142688775507, 0.8741142811218658, 0.8743285770411079,
0.8747142913268224, 0.8742857015282797, 0.8737857035705536]
errors
[0.17067154555772834, 0.13855710871632587, 0.13074283930058272,
0.12814286991195356, 0.12638571479416905, 0.126414298469388,
0.12551425152 68215, 0.12575711479241924, 0.12529997602157383,
0.12538573112244933, 0.12588571887813416, 0.12567142295 88921,
0.12528570867317756, 0.12571429847172033, 0.12621429642944637]
```

In [55]:

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

Out[55]:

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

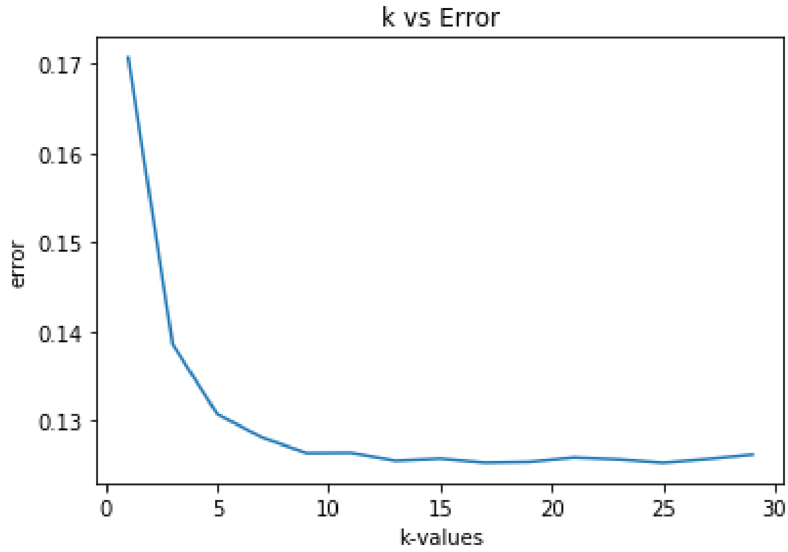


In [56]:

```
mp.plot(l,error)
mp.xlabel('k-values')
mp.ylabel('error')
mp.title("k vs Error")
```

Out[56]:

```
Text(0.5,1,'k vs Error')
```



In [57]:

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

```
the best value of k is 25
```

Observation:

```
-> By using k-fold cross validation we got best k value as 25
-> From the plots we can say that error is less at k = 25 when compared with all of them

-> By using k = 25 designing the classifier with the training data
```

In [58]:

```
kclas = KNeighborsClassifier(n_neighbors=best_k)
kclas.fit(x_train,y_train)
predi = kclas.predict(x_test)
accur = accuracy_score(y_test,predi,normalize=True)*float(100)
print(accur)
```

```
85.71666666666667
```

Observation:

```
-> Using the best k value to design the model with train data

-> The accurancy with the test data is 85.71
```

TFIDF-WORD2VEC:

```
Here i am using the TFIDF-WORD2VEC eith the help of word2vec model to construct vector represenation of each sentence
```

In [53]:

```
tfidf_feat = tfid_vect.get_feature_names()

tfidf_sent_vectors = []

row=0
for sent in sentences_list:
    sent_vec = np.zeros(40)
    sum =0
    for word in sent:
        try:
            vec = w2v_model.wv[word]

            tfidf = tfid_vect_data[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:20: RuntimeWarning: invalid value
encountered in true_divide
```

In [54]:

```
print(len(tfidf_sent_vectors))
print(len(tfidf_sent_vectors[99999]))
```

```
100000
40
```

In [55]:

```
type(tfidf_sent_vectors)
```

Out[55]:

```
list
```

In [56]:

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

Out[56]:

```
True
```

In [57]:

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

In [58]:

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

Out[58]:

```
False
```

In [60]:

```
x_train = tfidf_sent_vectors[0:70000]
x_test = tfidf_sent_vectors[70000:]
y_train = sorted_w2vec['Score'][0:70000]
y_test = sorted_w2vec['Score'][70000:]
```

In [62]:

```
print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(70000, 40)
(30000, 40)
(70000,)
(30000,)
```

In [63]:

```
print(l)
```

```
[1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29]
```

In [64]:

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

In [65]:

```
cross_validation_scores = []
for k in l:
    classif = KNeighborsClassifier(n_neighbors=k)
    score =
cross_val_score(classif,x_train,y_train,cv=10,scoring='accuracy')
    cross_validation_scores.append(score.mean())
```

In [66]:

```
error = [1 - x for x in cross_validation_scores]
print("Cross Validation Accuracy Scores")
print(cross_validation_scores)
print("errors")
print(error)
```

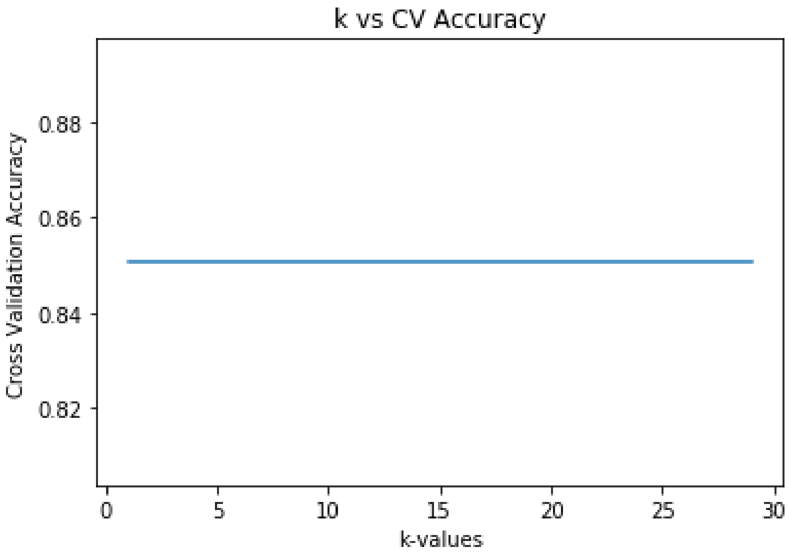
```
Cross Validation Accuracy Scores
[0.8506285771533528, 0.8506285771533528, 0.8506285771533528,
0.8506285771533528, 0.8506285771533528, 0.8506285771533528,
0.8506285771533528, 0.8506285771533528, 0.8506285771533528,
0.8506285771533528, 0.8506285771533528, 0.8506285771533528,
0.8506285771533528, 0.8506285771533528, 0.8506285771533528]
errors
[0.14937142284664717, 0.14937142284664717, 0.14937142284664717,
0.14937142284664717, 0.14937142284664717, 0.14937142284664717,
0.14937142284664717, 0.14937142284664717, 0.14937142284664717,
0.14937142284664717, 0.14937142284664717, 0.14937142284664717,
0.14937142284664717, 0.14937142284664717, 0.14937142284664717]
```

In [67]:

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

Out[67]:

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

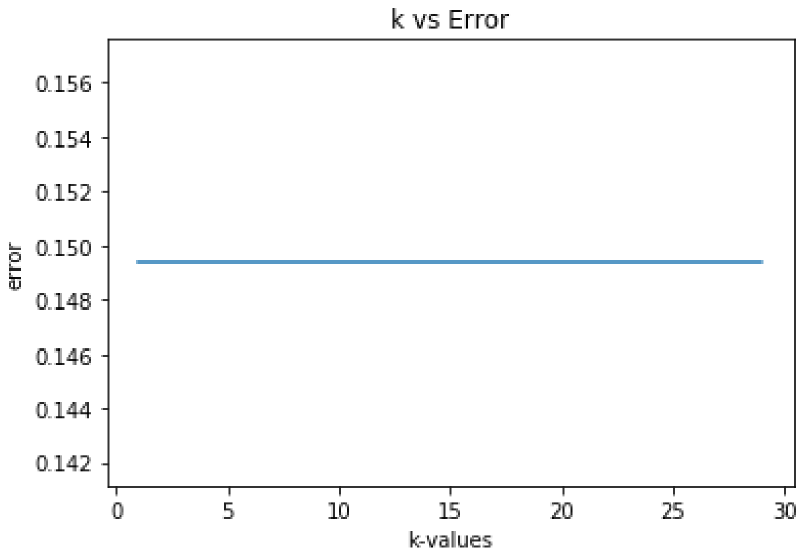


In [68]:

```
mp.plot(l,error)
mp.xlabel('k-values')
mp.ylabel('error')
mp.title("k vs Error")
```

Out[68]:

```
Text(0.5,1,'k vs Error')
```



In [69]:

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

```
the best value of k is 1
```

In [70]:

```
kclas = KNeighborsClassifier(n_neighbors=best_k)
kclas.fit(x_train,y_train)
predi = kclas.predict(x_test)
accur = accuracy_score(y_test,predi,normalize=True)*float(100)
print(accur)
```

```
82.47
```

Observation:

-> Using the best k value which is 1 to design the model with train data

-> The accurancy with the test data is 82.47

CONCLUSION:

RANDOM BASED SPLITTING:

-> THIS IS PERFORMED ONLY ON BAG OF WORDS TECHNIQUE

-> BOTH SIMPLE CROSS VALIDATION AND 10-FOLD CROSS VALIDATION ARE

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    -> BOTH SIMPLE CROSS VALIDATION AND 10 FOLD CROSS VALIDATION ARE
PERFORMED ON THIS
       TECHNIQUE

    -> IN SIMPLE CROSS VALIDATION THE BEST K - VALUE IS 11 AND THE A
CCURACY IS 84.67

    -> IN 10-FOLD CROSS VALIDATION THE BEST K - VALUE IS 7 AND THE A
CCURACY IS 84.83

TIME BASED SPLITTING:

    -> THIS IS PERFORMED ON BAG OF WORDS, TFIDF, AVERAGE WORD2VEC

    USING 10 - FOLD CROSS VALIDATION:

        BAG OF WORDS:

            -> THE BEST K - VALUE IS 9 AND THE ACCURANCY IS 83.22

        TFIDF:

            -> THE BEST K - VALUE IS 11 AND THE ACCURACY IS 84.98

        AVERAGE WORD2VEC:

            -> THE BEST K - VALUE IS 25 AND THE ACCURACY IS 85.71

        TFIDF-WORD2VEC:

            -> THE BEST K - VALUE IS 1 AND ACCURACY IS 82.47
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