In [3]:

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

In [4]:

```
data = pd.read_csv('final_data.csv')
```

In [5]:

```
data.dropna(inplace=True)
```

In [6]:

```
posi_data = data[data['Score'] == 'positive'].sample(1500)
negi_data = data[data['Score'] == 'negative'].sample(1500)
```

In [7]:

```
reduced_data = pd.concat([posi_data, negi_data],axis=0,ignore_index=True)
reduced_data = reduced_data.sample(frac=1).reset_index(drop=True)
reduced_data['Score'].value_counts()
```

Out[7]:

```
negative    1500
positive    1500
Name: Score, dtype: int64
```

In [8]:

```
reduced_data.sort_values(by='Time', axis=0,inplace=True)
```

In [9]:

```
reduced_data.reset_index(inplace=True, drop=True)
```

In [10]:

```
reduced_data.head()
```

Out[10]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Time	Sum
0	241479	B0001E5CJO	A3KZ5XRURPTK8A	Scooze	6	17	negative	1109116800	Ar K
1	319504	B0007LXU9A	A1OJA99YT911TA	Julien R. Fielding "Bodhi Grrl!"	12	12	positive	1127088000	I love
2	451583	B000E4AEOO	A38PUAMKVKDO88	Jasmine Miller "Jasmine Miller"	0	1	negative	1139875200	CAU Co Barle
									Ce Seasc

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Time	Sum
3	14277	B000294AGQ	ACW2VAH8T3E08	Welti Jones	0	0	positive	1141084800	N
4	469194	B000AQFQC6	ACLD6ZHBZC6TP	K. Bowen	3	4	negative	1141171200	thorc disg

In [11]:

```
# BOW
```

In [9]:

```
from sklearn.feature_extraction.text import CountVectorizer
```

In [10]:

```
count_vect = CountVectorizer()
```

In [11]:

```
final_counts = count_vect.fit_transform(reduced_data['CleanedText'].values)
```

In [12]:

```
final_counts.shape
```

Out[12]:

```
(3000, 7743)
```

In [13]:

```
arr_final_counts = (final_counts).toarray()
```

In [15]:

```
X = arr_final_counts
y = reduced_data['Score'].values
```

In [12]:

```
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.model_selection import cross_val_score
```

In [ ]:

```

```

In [ ]:

```
# K-NN basic implementation
# split the data set into train and test
X_1, X_test, y_1, y_test = train_test_split(X, y, test_size=0.3, random_state=0)

# split the train data set into cross validation train and cross validation test
X_tr, X_cv, y_tr, y_cv = train_test_split(X_1, y_1, test_size=0.3)
knn= KNeighborsClassifier(n_neighbors=5)
knn.fit(X_tr, y_tr)
pred = knn.predict(X_cv)
```

In [19]:

```
acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
print(acc)
```

```
63.01587301587301
```

In [ ]:

```

```

In [ ]:

```

```

BOW - 10 fold cross validation

In [17]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=0)
```

In [19]:

```
X_train.shape
```

Out[19]:

```
(2100, 7743)
```

In [20]:

```
neighbours = list(range(1,50,2))
cv_scores = []
# perform 10-fold cross validation
for k in neighbours:
    knn= KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, X_train, y_train, scoring='accuracy', cv=10)
    cv_scores.append(scores.mean())
```

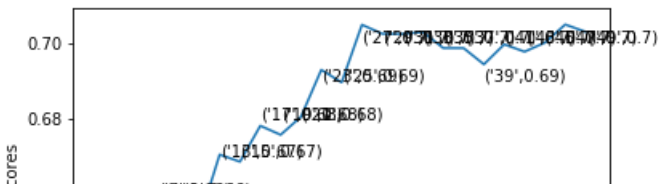
In [26]:

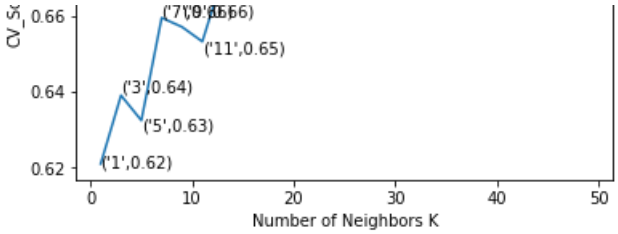
```
optimal_k = neighbours[cv_scores.index(max(cv_scores))]
```

In [34]:

```
plt.plot(neighbours, cv_scores)
for xy in zip(neighbours,np.round(cv_scores,2)):
    plt.annotate("('%s',%s)"% xy, xy=xy, textcoords='data')
plt.xlabel('Number of Neighbors K')
plt.ylabel('CV_Scores')
print("CV_SCORES: ",cv_scores)
```

```
CV_SCORES:  [0.621005940097983, 0.6390743770239904, 0.6324575549170212, 0.6595668404099435,
0.6571472628145114, 0.6532854216540922, 0.6704467221478945, 0.6685600364547734,
0.6780543992467164, 0.6756644843474475, 0.6804354164169579, 0.6928301257236154, 0.689498941235035,
0.7047328467657727, 0.7023541296152921, 0.7023245749012773, 0.702809879070792, 0.6985717309214441,
0.6985604251905075, 0.6942700676724124, 0.6995468313178466, 0.697612644277648, 0.6999980239266843,
0.704796318672597, 0.702866602093342]
```





In [36]:

```
# ============================== KNN with k = optimal_k
==============================================
# instantiate learning model k = optimal_k
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k)

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 23 is 70.000000%
```

In [ ]:

```

```

BOW - 10 fold cross validation (kd-tree)

In [5]:

```
posi_data = data[data['Score'] == 'positive'].sample(2000)
negi_data = data[data['Score'] == 'negative'].sample(2000)
reduced_data = pd.concat([posi_data, negi_data],axis=0,ignore_index=True)
reduced_data = reduced_data.sample(frac=1).reset_index(drop=True)
print(reduced_data['Score'].value_counts())
reduced_data.sort_values(by='Time', axis=0,inplace=True)
reduced_data.reset_index(inplace=True, drop=True)
reduced_data.head()
```

```
positive    2000
negative    2000
Name: Score, dtype: int64
```

Out[5]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Time	Su
0	374408	B00004CI84	A1GB1Q193DNFGR	Bruce Lee Pullen	5	5	positive	970531200	F C D
1	557949	B0000DJDL4	A1Y20KNCR0SZA1	Dessartfamily "grandmasoven"	8	9	positive	1072915200	T I
2	342462	B000084F3O	A3DWUM6SN3N3NR	Author Brian Wallace (Mind Transmission, Inc.)	4	33	negative	1076457600	t u

3	409836	B000HDL1RQ	ALY1O3V3S6HKP	Leslie Wagner "Lesliepd"	0	0	positive	1103760000	Tim	Su
4	390023	B0002268R0	A2OWD8YTOKT5OM	Sean McGahee	6	6	positive	1103932800	ca	

In [6]:

```
from sklearn.feature_extraction.text import CountVectorizer
count_vect = CountVectorizer()
final_counts = count_vect.fit_transform(reduced_data['CleanedText'].values)
print(final_counts.shape)
arr_final_counts = (final_counts).toarray()
```

```
(4000, 8960)
```

In [7]:

```
X = arr_final_counts
y = reduced_data['Score'].values
```

In [8]:

```
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.model_selection import cross_val_score
```

In [9]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=0)
```

In [12]:

```
neighbours = list(range(5,40,2))
cv_scores = []
# perform 10-fold cross validation
for k in neighbours:
    knn= KNeighborsClassifier(n_neighbors=k,algorithm='kd_tree')
    scores = cross_val_score(knn, X_train, y_train, scoring='accuracy', cv=10)
    cv_scores.append(scores.mean())
    print("K: ",k)
    print("Score: ",scores.mean())
```

```
K:  5
Score:  0.6739699121526695
K:  7
Score:  0.6893182402107898
K:  9
Score:  0.6875389263347017
K:  11
Score:  0.6832582321567513
K:  13
Score:  0.6889725452037471
K:  15
Score:  0.6835834731857002
K:  17
Score:  0.6825363023945277
K:  19
Score:  0.6871702627402316
K:  21
Score:  0.6850350314235057
K:  23
Score:  0.6893233787602976
K:  25
Score:  0.6925172560510066
K:  27
Score:  0.6903501502387968
```

```
K:  29
Score:  0.6853934361407672
K:  31
Score:  0.6835796967162482
K:  33
Score:  0.6835682033116312
K:  35
Score:  0.6839317374674968
K:  37
Score:  0.6821345206662621
K:  39
Score:  0.6835631285384471
```

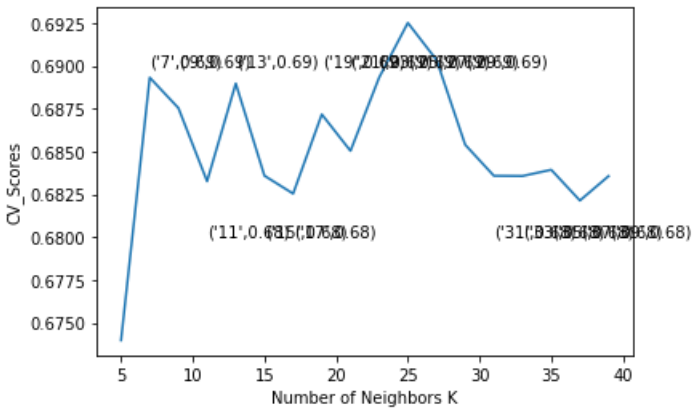
In [17]:

```
optimal_k = neighbours[cv_scores.index(max(cv_scores))]
```

In [18]:

```
plt.plot(neighbours, cv_scores)
for xy in zip(neighbours,np.round(cv_scores,2)):
    plt.annotate("('%s',%s)"% xy, xy=xy, textcoords='data')
plt.xlabel('Number of Neighbors K')
plt.ylabel('CV_Scores')
print("CV_SCORES: ",cv_scores)
```

```
CV_SCORES:  [0.6739699121526695, 0.6893182402107898, 0.6875389263347017, 0.6832582321567513,
0.6889725452037471, 0.6835834731857002, 0.6825363023945277, 0.6871702627402316,
0.6850350314235057, 0.6893233787602976, 0.6925172560510066, 0.6903501502387968,
0.6853934361407672, 0.6835796967162482, 0.6835682033116312, 0.6839317374674968,
0.6821345206662621, 0.6835631285384471]
```



In [20]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='kd_tree')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 25 is 70.666667%
```

In [ ]:

In [ ]:

```
```

TF_IDF - 10 fold cross validation (Brute & Kd-tree)

In [25]:

```
def posi_negi_encoding(s):
    if s == "positive":
        return 1
    return 0
```

In [44]:

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

In [45]:

```
tf_idf_vect = TfidfVectorizer(ngram_range=(1,2))
final_tf_idf = tf_idf_vect.fit_transform(reduced_data['CleanedText'].values)
```

In [26]:

```
X = final_tf_idf.toarray()
```

In [33]:

```
y = reduced_data['Score'].values
```

In [38]:

```
y = list(map(posi_negi_encoding,y))
```

In [43]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=0)
```

In [44]:

```
neighbours = list(range(1,40,2))
cv_scores = []
# perform 10-fold cross validation
for k in neighbours:
    knn= KNeighborsClassifier(n_neighbors=k,algorithm='brute')
    scores = cross_val_score(knn, X_train, y_train, scoring='accuracy', cv=10)
    cv_scores.append(scores.mean())
    print("K: ",k)
    print("Score: ",scores.mean())
```

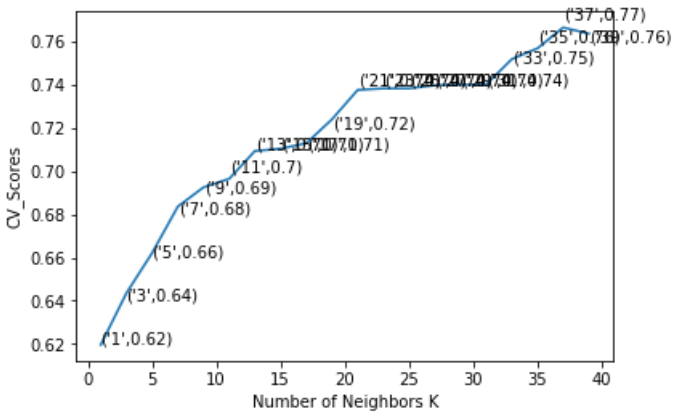
```
K:  1
Score:  0.6196350263213999
K:  3
Score:  0.643571569790431
K:  5
Score:  0.6621303979824815
K:  7
Score:  0.683584671269495
K:  9
Score:  0.6924980457112245
K:  11
Score:  0.6964279974416583
K:  13
Score:  0.7092929118993865
K:  15
```

```
Score:  0.7103656205527402
K:  17
Score:  0.7128644133580421
K:  19
Score:  0.7239359603712147
K:  21
Score:  0.7375240846730916
K:  23
Score:  0.738234584807022
K:  25
Score:  0.7382320519758816
K:  27
Score:  0.7396580541296991
K:  29
Score:  0.7399960413124803
K:  31
Score:  0.7399909483174893
K:  33
Score:  0.7517666041658695
K:  35
Score:  0.7567730319082058
K:  37
Score:  0.7664159528273865
K:  39
Score:  0.7635626228833094
```

In [45]:

```
optimal_k = neighbours[cv_scores.index(max(cv_scores))]
plt.plot(neighbours, cv_scores)
for xy in zip(neighbours,np.round(cv_scores,2)):
    plt.annotate("('%s',%s)"% xy, xy=xy, textcoords='data')
plt.xlabel('Number of Neighbors K')
plt.ylabel('CV_Scores')
print("CV_SCORES: ",cv_scores)
print("Optimal k: ", optimal_k)
```

```
CV_SCORES:  [0.6196350263213999, 0.643571569790431, 0.6621303979824815, 0.683584671269495,
0.6924980457112245, 0.6964279974416583, 0.7092929118993865, 0.7103656205527402,
0.7128644133580421, 0.7239359603712147, 0.7375240846730916, 0.738234584807022, 0.7382320519758816,
0.7396580541296991, 0.7399960413124803, 0.7399909483174893, 0.7517666041658695,
0.7567730319082058, 0.7664159528273865, 0.7635626228833094]
Optimal k:  37
```



In [46]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
# BRUTE FORCE
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='brute')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
```

```
# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 37 is 77.000000%
```

In [47]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
# Kd_tree
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='kd_tree')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 37 is 77.000000%
```

Observation: As the dimensionality of our input matrix is quite high, the kd tree algorithm took lot more time as compared to brute force algorithm

In [ ]:

```

```

Average Word 2 Vec

In [13]:

```
from gensim.models import Word2Vec
```

In [14]:

```
list_of_sent = []
for sentence in data['CleanedText']:
  try:
    list_of_sent.append(sentence.split())
  except:
    print(sentence)
len(list_of_sent)
```

Out[14]:

```
364156
```

In [15]:

```
w2v_model=Word2Vec(list_of_sent,min_count=5,size=50, workers=4)
```

In [17]:

```
w2v_words = list(w2v_model.wv.vocab)
```

In [18]:

```
import pickle
```

In [19]:

```
pickle.dump(w2v_model, open('word2vec_model.sav', 'wb'))
```

In [20]:

```
"""loaded_model = pickle.load(open(filename, 'rb'))
result = loaded_model.score(X_test, Y_test)
print(result)"""
```

Out[20]:

```
"loaded_model = pickle.load(open(filename, 'rb'))\nresult = loaded_model.score(X_test,
Y_test)\nprint(result)"
```

In [21]:

```
len(w2v_words)
```

Out[21]:

```
21842
```

In [22]:

```
reduced_sent_list = []
for sent in reduced_data['CleanedText']:
  reduced_sent_list.append(sent.split())
```

In [23]:

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

```
3000
50
```

In [28]:

```
X = sent_vectors
```

In [29]:

```
y = reduced_data['Score'].values
```

In [30]:

```
y = list(map(posi_negi_encoding,y))
```

In [32]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=0)
```

In [ ]:

```
```

In [36]:

```
neighbours = list(range(1,50,2))
cv_scores = []
# perform 10-fold cross validation
for k in neighbours:
    knn= KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, X_train, y_train, scoring='accuracy', cv=10)
    cv_scores.append(scores.mean())
    print("K: ",k)
    print("Score: ",scores.mean())
```

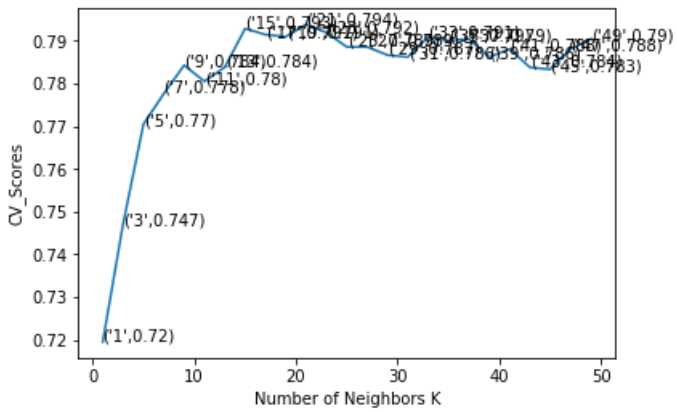
```
K:  1
Score:  0.7195324588938956
K:  3
Score:  0.7471472088234373
K:  5
Score:  0.7704626819094267
K:  7
Score:  0.7776147175348972
K:  9
Score:  0.7842723352975287
K:  11
Score:  0.7804900229893994
K:  13
Score:  0.7838257211317825
K:  15
Score:  0.7928620560448947
K:  17
Score:  0.7914425119239288
K:  19
Score:  0.7909685566782099
K:  21
Score:  0.7938189074582189
K:  23
Score:  0.7919028614189502
K:  25
Score:  0.7885649496425251
K:  27
Score:  0.7885672280658562
K:  29
Score:  0.7866510524480094
K:  31
Score:  0.7861884677225162
K:  33
Score:  0.7909481372539492
K:  35
Score:  0.7899934994746668
K:  37
Score:  0.790483274105125
K:  39
Score:  0.7861748619718187
K:  41
Score:  0.7880955296470388
K:  43
Score:  0.7837870743208734
K:  45
Score:  0.7832972780939855
K:  47
Score:  0.7880638044918414
K:  49
Score:  0.7904469921032655
```

In [40]:

```
optimal_k = neighbours[cv_scores.index(max(cv_scores))]
plt.plot(neighbours, cv_scores)
for xy in zip(neighbours,np.round(cv_scores,3)):
    plt.annotate("('%s',%s)"% xy, xy=xy, textcoords='data')
plt.xlabel('Number of Neighbors K')
```

```
plt.ylabel('CV_Scores')
print("CV_SCORES: ",cv_scores)
print("Optimal k: ", optimal_k)
```

```
CV_SCORES:  [0.7195324588938956, 0.7471472088234373, 0.7704626819094267, 0.7776147175348972,
0.7842723352975287, 0.7804900229893994, 0.7838257211317825, 0.7928620560448947,
0.7914425119239288, 0.7909685566782099, 0.7938189074582189, 0.7919028614189502,
0.7885649496425251, 0.7885672280658562, 0.7866510524480094, 0.7861884677225162,
0.7909481372539492, 0.7899934994746668, 0.790483274105125, 0.7861748619718187, 0.7880955296470388,
0.7837870743208734, 0.7832972780939855, 0.7880638044918414, 0.7904469921032655]
Optimal k:  21
```



In [41]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
# Brute Force
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='brute')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 21 is 79.555556%
```

In [42]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
# KD_TREE
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='kd_tree')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 21 is 79.555556%
```

In [ ]:

```
```

tf_idf Word2Vev

In [46]:

```
# TF-IDF weighted Word2Vec
tfidf_feat = tf_idf_vect.get_feature_names()
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in reduced_sent_list: # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = w2v_model.wv[word]
            # obtain the tf_idfidf of a word in a sentence/review

            tf_idf = final_tf_idf[row, tfidf_feat.index(word)]
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors.append(sent_vec)
    row += 1
```

In [47]:

```
X = tfidf_sent_vectors
y = reduced_data['Score'].values
```

In [53]:

```
y = list(map(posi_negi_encoding,y))
```

In [55]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=0)
```

In [56]:

```
neighbours = list(range(1,50,2))
cv_scores = []
# perform 10-fold cross validation
for k in neighbours:
    knn= KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, X_train, y_train, scoring='accuracy', cv=10)
    cv_scores.append(scores.mean())
    print("K: ",k)
    print("Score: ",scores.mean())
```

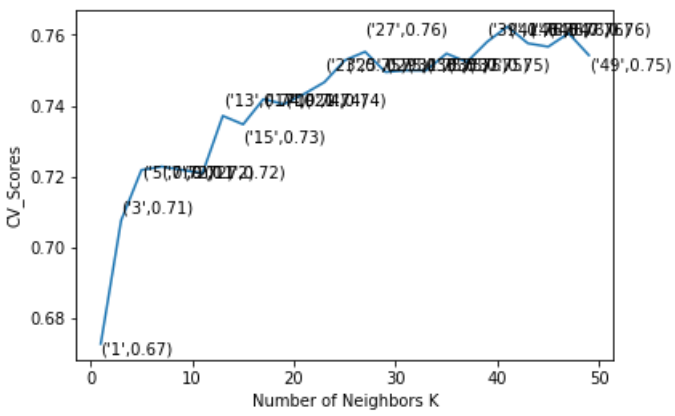
```
K:  1
Score:  0.6728587409929391
K:  3
Score:  0.7076210560870078
K:  5
Score:  0.7218772156587073
K:  7
Score:  0.7228364966703704
K:  9
Score:  0.7218953998524963
K:  11
Score:  0.7209339699960803
K:  13
Score:  0.7371427599589236
K:  15
Score:  0.734734574480147
K:  17
Score:  0.7418774964122932
K:  19
```

```
K:  19
Score:  0.7404466033675312
K:  21
Score:  0.7433197167844212
K:  23
Score:  0.7466462364441909
K:  25
Score:  0.7528254285001603
K:  27
Score:  0.7552200298246693
K:  29
Score:  0.7494851951075449
K:  31
Score:  0.749975034527292
K:  33
Score:  0.7499614287765947
K:  35
Score:  0.7547097709806615
K:  37
Score:  0.7523287970032795
K:  39
Score:  0.7580408906799528
K:  41
Score:  0.762342445946836
K:  43
Score:  0.7575941253391989
K:  45
Score:  0.7566371659437262
K:  47
Score:  0.7604377272349334
K:  49
Score:  0.75424942148564
```

In [58]:

```
optimal_k = neighbours[cv_scores.index(max(cv_scores))]
plt.plot(neighbours, cv_scores)
for xy in zip(neighbours,np.round(cv_scores,2)):
    plt.annotate("('%s',%s)"% xy, xy=xy, textcoords='data')
plt.xlabel('Number of Neighbors K')
plt.ylabel('CV_Scores')
print("CV_SCORES: ",cv_scores)
print("Optimal k: ", optimal_k)
```

```
CV_SCORES:  [0.6728587409929391, 0.7076210560870078, 0.7218772156587073, 0.7228364966703704,
0.7218953998524963, 0.7209339699960803, 0.7371427599589236, 0.734734574480147, 0.7418774964122932,
0.7404466033675312, 0.7433197167844212, 0.7466462364441909, 0.7528254285001603,
0.7552200298246693, 0.7494851951075449, 0.749975034527292, 0.7499614287765947, 0.7547097709806615,
0.7523287970032795, 0.7580408906799528, 0.762342445946836, 0.7575941253391989, 0.7566371659437262,
0.7604377272349334, 0.75424942148564]
Optimal k:  41
```



In [59]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
# Brute Force
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='brute')
```

```
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='brute')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 41 is 76.666667%
```

In [60]:

```
# ============================== KNN with k = optimal_k
================================================
# instantiate learning model k = optimal_k
# kd_tree
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k, algorithm='kd_tree')

# fitting the model
knn_optimal.fit(X_train, y_train)

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier for k = %d is %f%%' % (optimal_k, acc))
```

```
The accuracy of the knn classifier for k = 41 is 76.666667%
```

In [ ]:

```

```

In [ ]:

```

```