In [1]:

```
# Importing libraries
import warnings
warnings.filterwarnings("ignore")

import sqlite3
import pandas as pd
import numpy as np
import nltk
import string
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer

from sklearn.feature_extraction.text import CountVectorizer
from nltk.stem.porter import PorterStemmer

import re

import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle
```

```
C:\Users\Sai charan\Anaconda3\lib\site-packages\ipykernel\parentpoller.py:116: U
serWarning: Parent poll failed.  If the frontend dies,
                the kernel may be left running.  Please let us know
                about your system (bitness, Python, etc.) at
                ipython-dev@scipy.org
  ipython-dev@scipy.org""")
C:\Users\Sai charan\Anaconda3\lib\site-packages\gensim\utils.py:1197: UserWarnin
g: detected Windows; aliasing chunkize to chunkize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_serial")
```

In [2]:

```
con1 = sqlite3.connect('final.sqlite')

# Eliminating neutral reviews i.e. those reviews with Score = 3
filtered_data = pd.read_sql_query(" SELECT * FROM Reviews ", con1)
print(filtered_data.shape)
filtered_data.head()
```

```
(364171, 12)
```

Out[2]:

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

In [3]:

```
#Sorting data according to ProductId in ascending order
sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inplace=
False, kind='quicksort', na_position='last')

#Deduplication of entries
final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, ke
ep='first', inplace=False)
print(final.shape)

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

```
(364171, 12)
```

Out[3]:

```
100.0
```

In [4]:

```
final = final[final.HelpfulnessNumerator <= final.HelpfulnessDenominator]

print(final.shape)
final[30:50]
```

```
(364171, 12)
```

Out[4]:

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenomir
12	138700	150518	0006641040	AK1L4EJBA23JF	L. M. Kraus	0	
13	138701	150519	0006641040	A12HY5OZ2QNK4N	Elizabeth H. Roessner	0	
14	138702	150520	0006641040	ADBFSA9KTQANE	James L. Hammock "Pucks Buddy"	0	
8	138696	150514	0006641040	A2ONB6ZA292PA	Rosalind Matzner	0	
34	476617	515426	141278509X	AB1A5EGHHVA9M	CHelmic	1	
36	22620	24750	2734888454	A13ISQV0U9GZIC	Sandikaye	1	
35	22621	24751	2734888454	A1C298ITT645B6	Hugh G. Pritchard	0	
37	284375	308077	2841233731	A3QD68O22M2XHQ	LABRNTH	0	
142	157910	171225	7310172001	A314APAWYQFKBJ	Diana Hersholt "dog lover"	1	
143	157909	171224	7310172001	AK0CENM3LUM28	Ana Mardoll	1	
144	157924	171240	7310172001	A2JCG7KT8HRSUJ	B. Le	0	
145	157925	171241	7310172001	ACBK6OXAMOHTE	Andrew Fox	0	
146	157926	171242	7310172001	A12L1NY994GXSF	Dawn Rene	0	
147	157907	171222	7310172001	A1CV6GLAPUIP80	Reader Rabbit	1	

In [5]:

```
final = final[final['ProductId'] != '2841233731']
final = final[final['ProductId'] != '0006641040']
final.shape
```

Out[5]:

```
(364136, 12)
```

Text Preprocessing: Stemming, stop-word removal and Lemmatization

In [6]:

```
from nltk.corpus import stopwords
stop = set(stopwords.words('english'))
words_to_keep = set(('not'))
stop -= words_to_keep
#initialising the snowball stemmer
sno = nltk.stem.SnowballStemmer('english')

 #function to clean the word of any html-tags
def cleanhtml(sentence):
    cleanr = re.compile('<.*?>')
    cleantext = re.sub(cleanr, ' ', sentence)
    return cleantext

#function to clean the word of any punctuation or special characters
def cleanpunc(sentence):
    cleaned = re.sub(r'[?|!|\'|"|#]',r'',sentence)
    cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
    return  cleaned
```

In [7]:

```
i=0
str1=' '
final_string=[]
all_positive_words=[] # store words from +ve reviews here
all_negative_words=[] # store words from -ve reviews here.
s=''
for sent in final['Text'].values:
    filtered_sentence=[]
    #print(sent);
    sent=cleanhtml(sent) # remove HTMl tags
    for w in sent.split():
        for cleaned_words in cleanpunc(w).split():
            if((cleaned_words.isalpha()) & (len(cleaned_words)>2)):
                if(cleaned_words.lower() not in stop):
                    s=(sno.stem(cleaned_words.lower())).encode('utf8')
                    filtered_sentence.append(s)
                    if (final['Score'].values)[i] == 'positive':
                        all_positive_words.append(s) #list of all words used to describe positive reviews
                    if(final['Score'].values)[i] == 'negative':
                        all_negative_words.append(s) #list of all words used to describe negative reviews reviews
                else:
                    continue
            else:
                continue

    str1 = b" ".join(filtered_sentence) #final string of cleaned words


    final_string.append(str1)
    i+=1
```

In [8]:

```
final['CleanedText']=final_string
final['CleanedText']=final['CleanedText'].str.decode("utf-8")
#below the processed review can be seen in the CleanedText Column
print('Shape of final',final.shape)
final.head()
```

```
Shape of final (364136, 12)
```

Out[8]:

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenomina
34	476617	515426	141278509X	AB1A5EGHHVA9M	CHelmic	1	
36	22620	24750	2734888454	A13ISQV0U9GZIC	Sandikaye	1	
35	22621	24751	2734888454	A1C298ITT645B6	Hugh G. Pritchard	0	
142	157910	171225	7310172001	A314APAWYQFKBJ	Diana Hersholt "dog lover"	1	
143	157909	171224	7310172001	AK0CENM3LUM28	Ana Mardoll	1	

In [9]:

```
time_sorted_data = final.sort_values('Time', axis=0, ascending=True, inplace=False,
kind='quicksort', na_position='last')

# We will collect different 20K rows without repetition from time_sorted_data dataf
rame
my_final = time_sorted_data.take(np.random.permutation(len(final))[:20000])

x = my_final['CleanedText'].values
```

Bag of Words (BoW)

In [10]:

```
count_vect = CountVectorizer(min_df = 10)
data_vec = count_vect.fit_transform(x)
print("the type of count vectorizer :",type(data_vec))
print("the shape of out text BOW vectorizer : ",data_vec.get_shape())
print("the number of unique words :", data_vec.get_shape()[1])

# Converting sparse matrix to dense matrix
data_dense = data_vec.toarray()

# Standardising the data
import warnings
warnings.filterwarnings('ignore')
from sklearn.preprocessing import StandardScaler
data = StandardScaler().fit_transform(data_dense)
from sklearn.decomposition import TruncatedSVD
svd = TruncatedSVD(n_components=100)
data = svd.fit_transform(data)
```

```
the type of count vectorizer : <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer :  (20000, 4066)
the number of unique words : 4066
```

Function To Compute Distance of nth-nearesr neighbour

In [11]:

```
def n_neighbour(vectors , n):
    distance = []
    for point in vectors:
        temp = np.sort(np.sum((vectors-point)**2,axis=1),axis=None)
        distance.append(temp[n])
    return np.sqrt(np.array(distance))
```

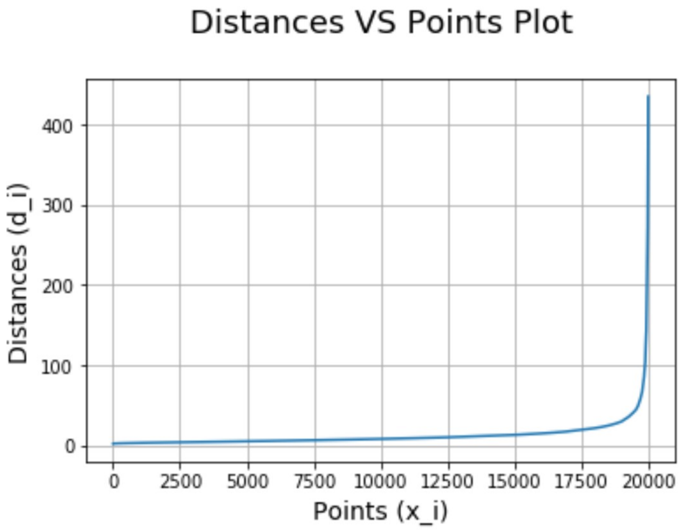
Function to call DBSCAN

In [12]:

```
def dbscan(epsilon, samples, Data):
    from sklearn.cluster import DBSCAN
    db = DBSCAN(eps=epsilon, min_samples=samples, n_jobs=-1).fit(Data)

    # Number of clusters in labels, ignoring noise(-1) if present.
    n_clusters = len(set(db.labels_))
    print("Number of clusters for MinPts = %d and Epsilon = %f is : %d "%(samples,e
psilon,n_clusters))
    print("Labels(-1 is for Noise) : ",set(db.labels_))
    print()
    return db
```

In [13]:

```
min_points = 2*data.shape[1]

# Computing distances of nth-nearest neighbours
distances = n_neighbour(data,min_points)
sorted_distance = np.sort(distances)
points = [i for i in range(data.shape[0])]

# Draw distances(d_i) VS points(x_i) plot
plt.plot(points, sorted_distance)
plt.xlabel('Points (x_i)',size=14)
plt.ylabel('Distances (d_i)',size=14)
plt.title('Distances VS Points Plot\n',size=18)
plt.grid()
plt.show()
```



DBSCAN Implementation

In [15]:

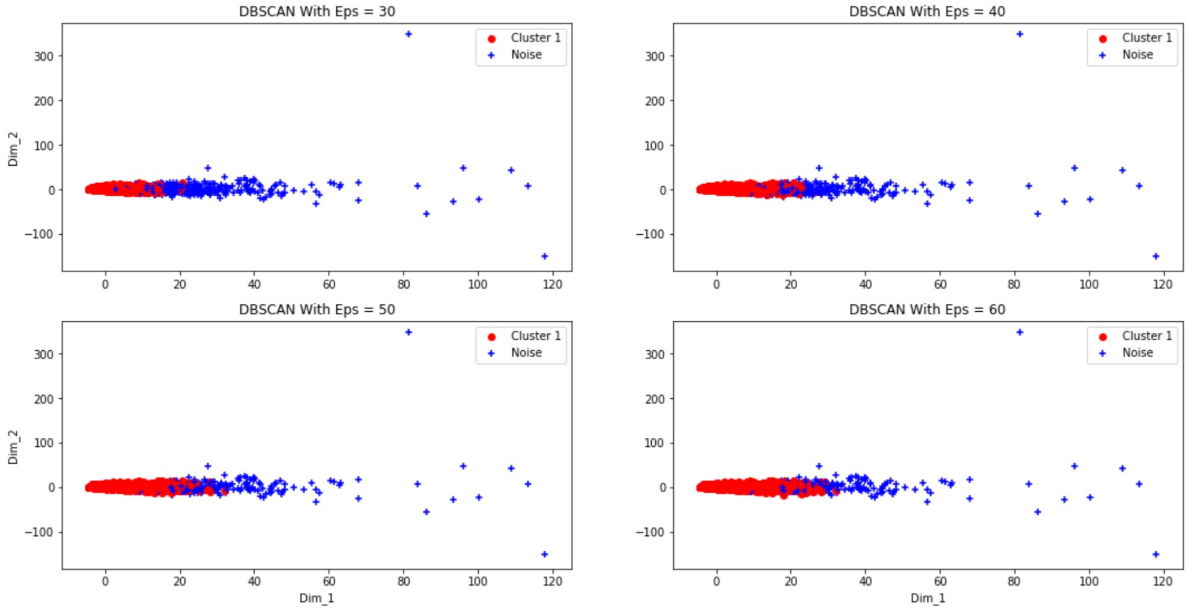
```
optimal_eps = 30
# Clustering with right epsilon
db1 = dbscan(optimal_eps, min_points, data)


# Clustering with  epsilon = 40
db2 = dbscan(40, min_points, data)


# Clustering with epsilon = 50
db3 = dbscan(50, min_points, data)


# Clustering with epsilon = 60
db4 = dbscan(60, min_points, data)
```

```
Number of clusters for MinPts = 200 and Epsilon = 30.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 200 and Epsilon = 40.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 200 and Epsilon = 50.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 200 and Epsilon = 60.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}
```

Visualizing The Clusters

In [17]:

```
from sklearn.decomposition import PCA
pca_2d = PCA(n_components=2).fit_transform(data)

# Scatter plot for DBSCAN with Eps = 30
plt.figure(figsize=(18,9))
plt.subplot(221)
for i in range(0, pca_2d.shape[0]):
    if db1.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db1.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 30')
plt.ylabel('Dim_2')

# Scatter plot for DBSCAN with Eps = 18
plt.subplot(222)
for i in range(0, pca_2d.shape[0]):
    if db2.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db2.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 40')

# Scatter plot for DBSCAN with Eps = 20
plt.subplot(223)
for i in range(0, pca_2d.shape[0]):
    if db3.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db3.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 50')
plt.ylabel('Dim_2')
plt.xlabel('Dim_1')

# Scatter plot for DBSCAN with Eps = 22
plt.subplot(224)
for i in range(0, pca_2d.shape[0]):
    if db4.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db4.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 60')
plt.xlabel('Dim_1')

plt.show()
```



TFIDF

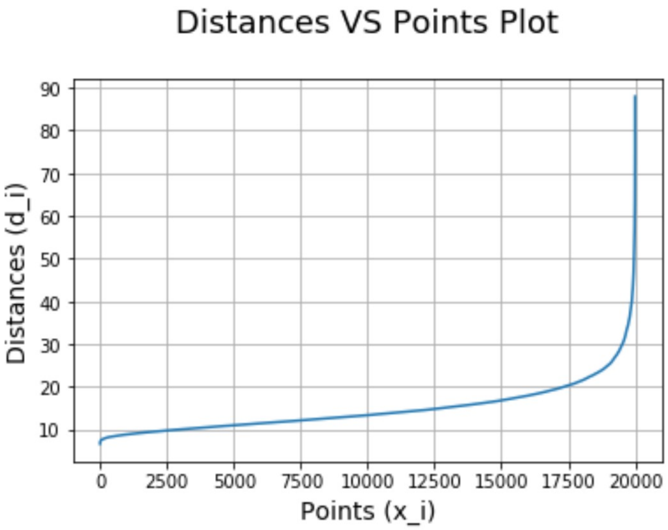
In [18]:

```
tf_idf_vect = TfidfVectorizer(min_df=10)
data_vec = tf_idf_vect.fit_transform(x)
print("the type of count vectorizer :",type(data_vec))
print("the shape of out text BOW vectorizer : ",data_vec.get_shape())
print("the number of unique words :", data_vec.get_shape()[1])

# Converting sparse matrix to dense matrix
data_dense = data_vec.toarray()

# Standardising the data
data = StandardScaler().fit_transform(data_dense)
svd = TruncatedSVD(n_components=100)
data = svd.fit_transform(data)
```

```
the type of count vectorizer : <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer :  (20000, 4066)
the number of unique words : 4066
```

In [19]:

```
min_points = 2*data.shape[1]

# Computing distances of nth-nearest neighbours
distances = n_neighbour(data,min_points)
sorted_distance = np.sort(distances)
points = [i for i in range(data.shape[0])]

# Draw distances(d_i) VS points(x_i) plot
plt.plot(points, sorted_distance)
plt.xlabel('Points (x_i)',size=14)
plt.ylabel('Distances (d_i)',size=14)
plt.title('Distances VS Points Plot\n',size=18)
plt.grid()
plt.show()
```



DBSCAN Implementation

In [22]:

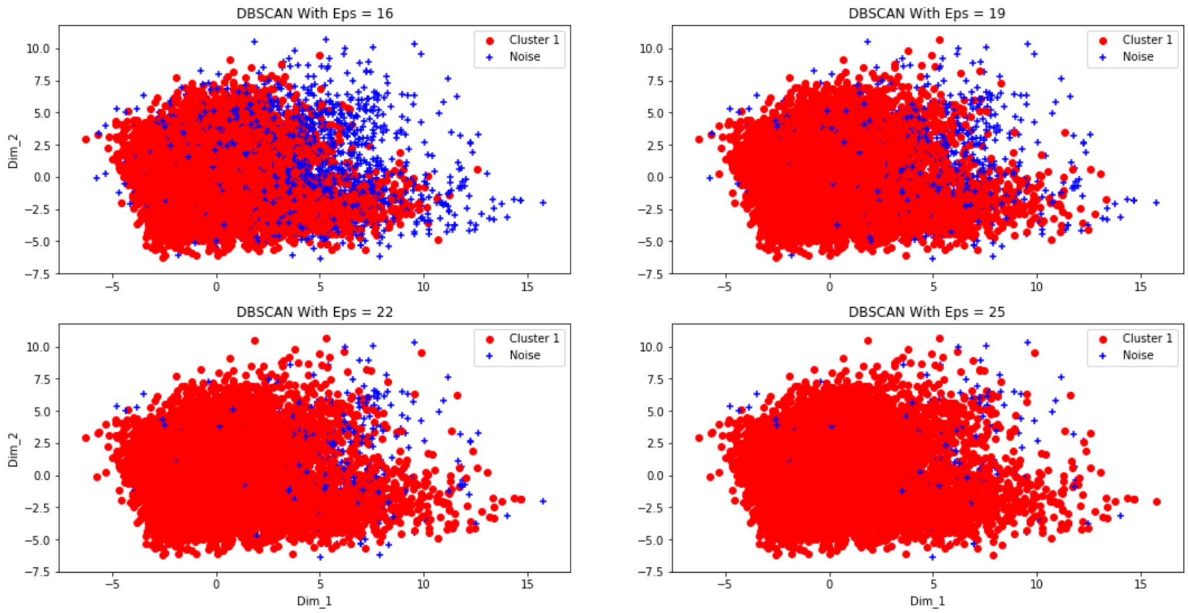
```
optimal_eps = 16
# Clustering with right epsilon
db1 = dbscan(optimal_eps, min_points, data)


# Clustering with  epsilon = 19
db2 = dbscan(19, min_points, data)


# Clustering with epsilon = 22
db3 = dbscan(22, min_points, data)


# Clustering with epsilon = 25
db4 = dbscan(25, min_points, data)
```

```
Number of clusters for MinPts = 200 and Epsilon = 16.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 200 and Epsilon = 19.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 200 and Epsilon = 22.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 200 and Epsilon = 25.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}
```

Visualizing The Clusters :

In [23]:

```
pca_2d = PCA(n_components=2).fit_transform(data)

# Scatter plot for DBSCAN with Eps = 16
plt.figure(figsize=(18,9))
plt.subplot(221)
for i in range(0, pca_2d.shape[0]):
    if db1.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db1.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 16')
plt.ylabel('Dim_2')

# Scatter plot for DBSCAN with Eps = 19
plt.subplot(222)
for i in range(0, pca_2d.shape[0]):
    if db2.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db2.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 19')

# Scatter plot for DBSCAN with Eps = 22
plt.subplot(223)
for i in range(0, pca_2d.shape[0]):
    if db3.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db3.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 22')
plt.ylabel('Dim_2')
plt.xlabel('Dim_1')

# Scatter plot for DBSCAN with Eps = 25
plt.subplot(224)
for i in range(0, pca_2d.shape[0]):
    if db4.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db4.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1,c2], ['Cluster 1','Noise'])
plt.title('DBSCAN With Eps = 25')
plt.xlabel('Dim_1')

plt.show()
```



Word2Vec

In [24]:
```
sent_x = []
for sent in x :
    sent_x.append(sent.split())


# Train your own Word2Vec model using your own train text corpus
# min_count = 5 considers only words that occured atleast 5 times
w2v_model=Word2Vec(sent_x,min_count=5,size=100, workers=4)

w2v_words = list(w2v_model.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words))
```

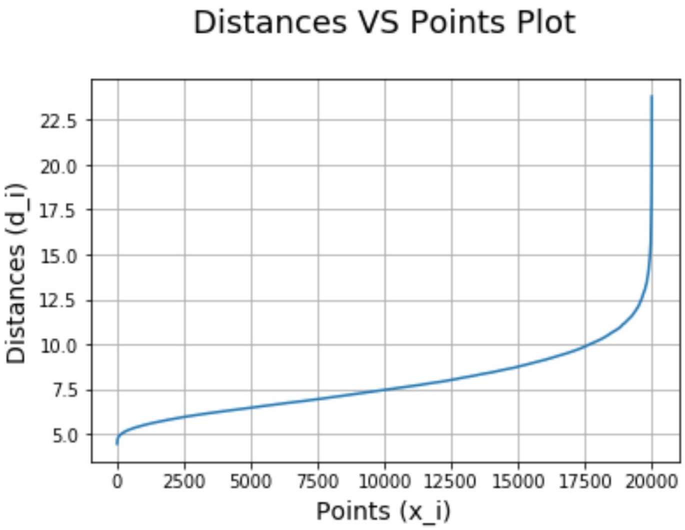
```
number of words that occured minimum 5 times  6275
```

Avg Word2Vec

In [26]:
```
# compute average word2vec for each review for sent_x .
train_vectors = [];
for sent in sent_x:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    train_vectors.append(sent_vec)

#Standardising the data
data = StandardScaler().fit_transform(train_vectors)
svd = TruncatedSVD(n_components=90)
data = svd.fit_transform(data)
```

In [27]:

```
min_points = 2*data.shape[1]

# Computing distances of nth-nearest neighbours
distances = n_neighbour(data,min_points)
sorted_distance = np.sort(distances)
points = [i for i in range(data.shape[0])]

# Draw distances(d_i) VS points(x_i) plot
plt.plot(points, sorted_distance)
plt.xlabel('Points (x_i)',size=14)
plt.ylabel('Distances (d_i)',size=14)
plt.title('Distances VS Points Plot\n',size=18)
plt.grid()
plt.show()
```



DBSCAN Implementation

In [28]:

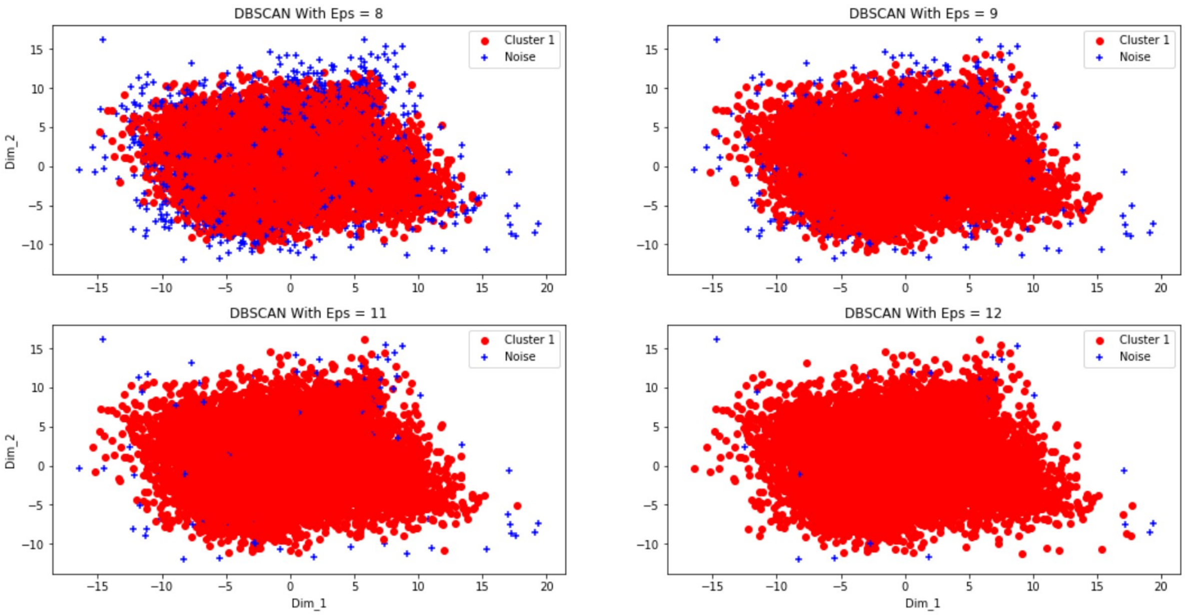
```
optimal_eps = 8
# Clustering with right epsilon
db1 = dbscan(optimal_eps, min_points, data)


# Clustering with  epsilon = 9
db2 = dbscan(9, min_points, data)


# Clustering with epsilon = 11
db3 = dbscan(10, min_points, data)


# Clustering with epsilon = 12
db4 = dbscan(11, min_points, data)
```

```
Number of clusters for MinPts = 180 and Epsilon = 8.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 180 and Epsilon = 9.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 180 and Epsilon = 10.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 180 and Epsilon = 11.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}
```

Visualizing The Clusters

In [29]:

```
pca_2d = PCA(n_components=2).fit_transform(data)

# Scatter plot for DBSCAN with Eps = 8
plt.figure(figsize=(18,9))
plt.subplot(221)
for i in range(0, pca_2d.shape[0]):
    if db1.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db1.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 8')
plt.ylabel('Dim_2')

# Scatter plot for DBSCAN with Eps = 9
plt.subplot(222)
for i in range(0, pca_2d.shape[0]):
    if db2.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db2.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 9')

# Scatter plot for DBSCAN with Eps = 10
plt.subplot(223)
for i in range(0, pca_2d.shape[0]):
    if db3.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db3.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 11')
plt.ylabel('Dim_2')
plt.xlabel('Dim_1')

# Scatter plot for DBSCAN with Eps = 11
plt.subplot(224)
for i in range(0, pca_2d.shape[0]):
    if db4.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db4.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1,c2], ['Cluster 1','Noise'])
plt.title('DBSCAN With Eps = 12')
plt.xlabel('Dim_1')

plt.show()
```

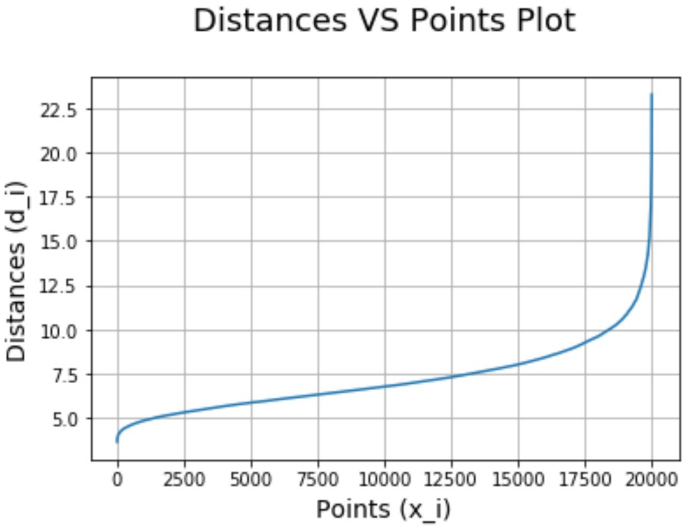


TFIDF-Word2Vec

```
In [31]: tf_idf_vect = TfidfVectorizer()

         # final_tf_idf1 is the sparse matrix with row= sentence, col=word and cell_val = tf
         idf
         final_tf_idf1 = tf_idf_vect.fit_transform(x)

         # tfidf words/col-names
         tfidf_feat = tf_idf_vect.get_feature_names()

         # compute TFIDF Weighted Word2Vec for each review for sent_x .
         tfidf_vectors = [];
         row=0;
         for sent in sent_x:
             sent_vec = np.zeros(100)
             weight_sum =0;
             for word in sent:
                 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_idf1[row, tfidf_feat.index(word)]
                     sent_vec += (vec * tf_idf)
                     weight_sum += tf_idf
             if weight_sum != 0:
                 sent_vec /= weight_sum
             tfidf_vectors.append(sent_vec)
             row += 1

         #Standardising the data
         data = StandardScaler().fit_transform(tfidf_vectors)
         svd = TruncatedSVD(n_components=90)
         data = svd.fit_transform(data)
```

In [32]:

```
min_points = 2*data.shape[1]

# Computing distances of nth-nearest neighbours
distances = n_neighbour(data,min_points)
sorted_distance = np.sort(distances)
points = [i for i in range(data.shape[0])]

# Draw distances(d_i) VS points(x_i) plot
plt.plot(points, sorted_distance)
plt.xlabel('Points (x_i)',size=14)
plt.ylabel('Distances (d_i)',size=14)
plt.title('Distances VS Points Plot\n',size=18)
plt.grid()
plt.show()
```



DBSCAN Implementation

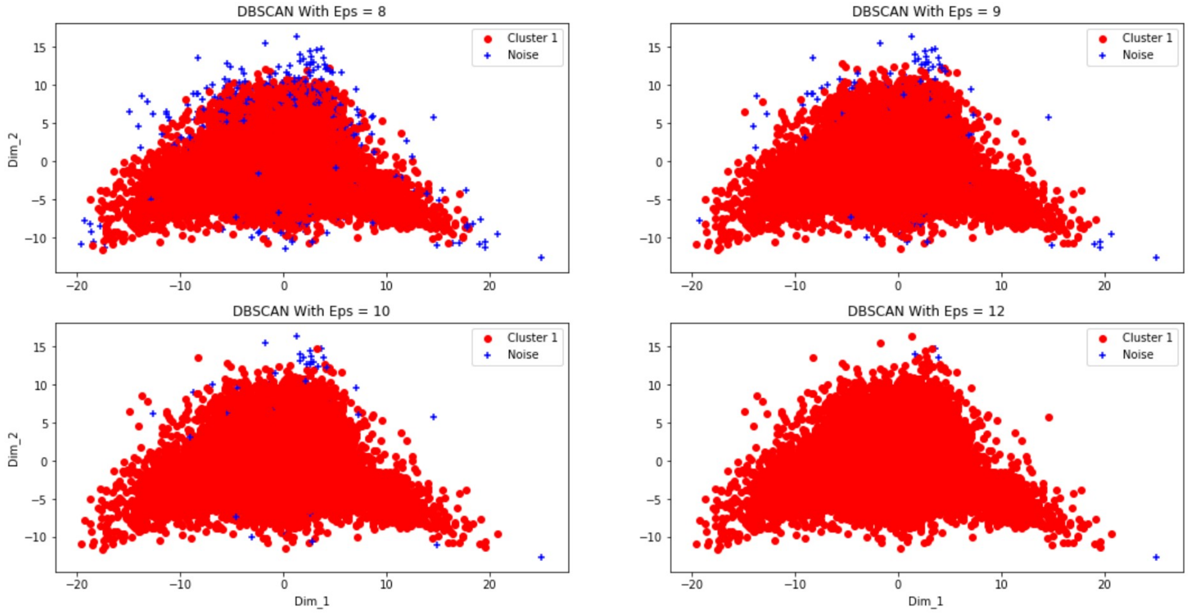
```
In [33]: optimal_eps = 8
         # Clustering with right epsilon
         db1 = dbscan(optimal_eps, min_points, data)


         # Clustering with  epsilon = 9
         db2 = dbscan(9, min_points, data)


         # Clustering with epsilon = 10
         db3 = dbscan(10, min_points, data)


         # Clustering with epsilon = 11
         db4 = dbscan(12, min_points, data)
```

```
Number of clusters for MinPts = 180 and Epsilon = 8.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 180 and Epsilon = 9.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 180 and Epsilon = 10.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}

Number of clusters for MinPts = 180 and Epsilon = 12.000000 is : 2
Labels(-1 is for Noise) :  {0, -1}
```

Visualizing The Clusters

In [35]:

```
pca_2d = PCA(n_components=2).fit_transform(data)

# Scatter plot for DBSCAN with Eps = 8
plt.figure(figsize=(18,9))
plt.subplot(221)
for i in range(0, pca_2d.shape[0]):
    if db1.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db1.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 8')
plt.ylabel('Dim_2')

# Scatter plot for DBSCAN with Eps = 9
plt.subplot(222)
for i in range(0, pca_2d.shape[0]):
    if db2.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db2.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 9')

# Scatter plot for DBSCAN with Eps = 10
plt.subplot(223)
for i in range(0, pca_2d.shape[0]):
    if db3.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db3.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1, c2], ['Cluster 1', 'Noise'])
plt.title('DBSCAN With Eps = 10')
plt.ylabel('Dim_2')
plt.xlabel('Dim_1')

# Scatter plot for DBSCAN with Eps = 12
plt.subplot(224)
for i in range(0, pca_2d.shape[0]):
    if db4.labels_[i] == 0:
        c1 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='r',marker='o')
    elif db4.labels_[i] == -1:
        c2 = plt.scatter(pca_2d[i,0],pca_2d[i,1],c='b',marker='+')
plt.legend([c1,c2], ['Cluster 1','Noise'])
plt.title('DBSCAN With Eps = 12')
plt.xlabel('Dim_1')

plt.show()
```


DBSCAN With Eps = 8
DBSCAN With Eps = 9
DBSCAN With Eps = 10
DBSCAN With Eps = 12
Cluster 1
Noise
Dim_2
Dim_1
15
10
5
0
−5
−10
−20
−10
0
10
20

In [ ]: