```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
!pip install sentence-transformers
```

```
Collecting sentence-transformers
  Downloading https://files.pythonhosted.org/packages/f5/5a/6e41e8383913dd2ba923cdcd
     |████████████████████████████████| 71kB 5.3MB/s
Collecting transformers<3.6.0,>=3.1.0
  Downloading https://files.pythonhosted.org/packages/3a/83/e74092e7f24a08d751aa59b3
     |████████████████████████████████| 1.3MB 10.5MB/s
Requirement already satisfied: tqdm in /usr/local/lib/python3.6/dist-packages (from
Requirement already satisfied: torch>=1.6.0 in /usr/local/lib/python3.6/dist-package
Requirement already satisfied: numpy in /usr/local/lib/python3.6/dist-packages (from
Requirement already satisfied: scikit-learn in /usr/local/lib/python3.6/dist-package
Requirement already satisfied: scipy in /usr/local/lib/python3.6/dist-packages (from
Requirement already satisfied: nltk in /usr/local/lib/python3.6/dist-packages (from
Requirement already satisfied: filelock in /usr/local/lib/python3.6/dist-packages (f
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.6/dist-pa
Collecting sentencepiece==0.1.91
  Downloading https://files.pythonhosted.org/packages/d4/a4/d0a884c4300004a78cca907a
     |████████████████████████████████| 1.1MB 29.1MB/s
Collecting sacremoses
  Downloading https://files.pythonhosted.org/packages/7d/34/09d19aff26edcc8eb2a01bed
     |████████████████████████████████| 890kB 50.1MB/s
Requirement already satisfied: packaging in /usr/local/lib/python3.6/dist-packages (
Requirement already satisfied: dataclasses; python_version < "3.7" in /usr/local/lib
Collecting tokenizers==0.9.3
  Downloading https://files.pythonhosted.org/packages/4c/34/b39eb9994bc3c999270b69c9
     |████████████████████████████████| 2.9MB 51.0MB/s
Requirement already satisfied: requests in /usr/local/lib/python3.6/dist-packages (f
Requirement already satisfied: protobuf in /usr/local/lib/python3.6/dist-packages (f
Requirement already satisfied: future in /usr/local/lib/python3.6/dist-packages (fro
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.6/dist-pa
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.6/dist-package
Requirement already satisfied: six in /usr/local/lib/python3.6/dist-packages (from n
Requirement already satisfied: click in /usr/local/lib/python3.6/dist-packages (from
Requirement already satisfied: pyparsing>=2.0.2 in /usr/local/lib/python3.6/dist-pac
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.6/dist-package
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in /usr/local
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.6/dist-p
Requirement already satisfied: chardet<4,>=3.0.2 in /usr/local/lib/python3.6/dist-pa
Requirement already satisfied: setuptools in /usr/local/lib/python3.6/dist-packages
Building wheels for collected packages: sentence-transformers, sacremoses
  Building wheel for sentence-transformers (setup.py) ... done
  Created wheel for sentence-transformers: filename=sentence_transformers-0.3.9-cp36
  Stored in directory: /root/.cache/pip/wheels/fc/89/43/f2f5bc00b03ef9724b0f6254a97e
  Building wheel for sacremoses (setup.py) ... done
  Created wheel for sacremoses: filename=sacremoses-0.0.43-cp36-none-any.whl size=89
  Stored in directory: /root/.cache/pip/wheels/29/3c/fd/7ce5c3f0666dab31a50123635e6f
Successfully built sentence-transformers sacremoses
Installing collected packages: sentencepiece, sacremoses, tokenizers, transformers,
Successfully installed sacremoses-0.0.43 sentence-transformers-0.3.9 sentencepiece-0
```

```
# import all the necessary libraries
# import all the necessary libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import re
from sklearn.cluster import DBSCAN
import string
import unicodedata
# from sklearn.feature_extraction.text import TfidfVectorizer
from gensim.models.doc2vec import Doc2Vec, TaggedDocument
import spacy
from sentence_transformers import SentenceTransformer
from sklearn.manifold import TSNE
```

```
# loading the dataset
train=pd.read_csv("/content/drive/My Drive/3rd Sem/Code v0.2/excel_data/summarydata-xlnet-
```

```
train.head()
```

	News_ID	GPT-2	XLNET
0	1	Abu Dhabi [UAE], October 7 (ANI): USA pacer Al...	Abu Dhabi [UAE], October 7 (ANI): USA pacer Al...
1	2	Abu Dhabi [UAE], October 6 (ANI): England and ...	Abu Dhabi [UAE], October 6 (ANI): England and ...
2	3	Sydney [Australia], October 7 (ANI): Arjun Nai...	Sydney [Australia], October 7 (ANI): Arjun Nai...

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

```
train.isnull().sum()
```

```
News_ID    0
GPT-2      0
XLNET      0
dtype: int64
```

```
#convert each question to a list of string
data = pd.Series(train["GPT-2"].tolist()).astype(str)
```

```
data.head()
```

```
0    Abu Dhabi [UAE], October 7 (ANI): USA pacer Al...
1    Abu Dhabi [UAE], October 6 (ANI): England and ...
2    Sydney [Australia], October 7 (ANI): Arjun Nai...
3    Sydney [Australia], October 7 (ANI): Sydney Th...
4    Abu Dhabi [UAE], October 6 (ANI): Mumbai India...
dtype: object
```

```
data1 = data[:100]
```

```
sentences_list = data
```

Text Preprocessing

```
nlp = spacy.load('en_core_web_sm')
# stop_list = ['best','different',"won\'t", "couldn\'t", "mustn\'t", "didn\'t", "dtype obj
# for word in stop_list:
#     spacy.lang.en.stop_words.STOP_WORDS.add(word)
#     nlp.vocab[word].is_stop = True


def normalize(data):
    """Run all the functions for preprocessing in a pipeline"""
    clean_data = re.sub(re.compile('<.*?>'), '', data)
    cleaned_list = [ unicodedata.normalize('NFKD', word.text).encode('ascii', 'ignore').de
    cleaned_list = " ".join(cleaned_list)
    cleaned_list = [word.text.rstrip('0123456789').lower() for word in nlp(cleaned_list) i
    return cleaned_list


# Preprocess the text data
normalized_data = []
for i, batch in data.groupby(np.arange(len(data)) // 10):
    for batch_data in batch:
        normalized_data.append(normalize(batch_data))

    print(i)
```

```
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
```

```
26
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55
56
57
58
```

```
# Data after prerocessing
print(normalized_data[0])
len(normalized_data)
```

```
['abu', 'dhabi', 'uae', 'october', 'ani', 'usa', 'pacer', 'ali', 'khan', 'ruled', 'i
9048
```

```
# function to form sentences from token
sentence = []
sentences = []


def token_2_sentence(normalized_data):
    """Join the tokens in each list with space to form a sentence"""
    for i in normalized_data:
      sentence = " ".join(i)
      sentences.append(sentence)
      sentence = []
    return sentences

sentences_list = token_2_sentence(normalized_data)


sentences_list[:10]
```

```
sentences_list[:10]
```

```
['abu dhabi uae october ani usa pacer ali khan ruled indian premier league ipl injur
 'abu dhabi uae october ani england rajasthan royals rounder ben stokes reckons kart
 'sydney australia october ani arjun nair signed big bash league bbl season sydney t
 'sydney australia october ani sydney thunder completed squad women big bash league 
 'abu dhabi uae october ani mumbai indians brigade continued impress edition indian 
 'abu dhabi uae october ani reminiscing catch dismiss rajasthan royals mahipal lomro
 'adelaide australia october ani west indies captain stafanie taylor rejoin adelaide
 'abu dhabi uae october ani rajasthan royals skipper steve smith fined maintaining r
 'abu dhabi uae october ani registering win rajasthan royals mumbai indians bowling 
 'new delhi india october ani india head coach ravi shastri rounder yuvraj singh pra
```

```
import csv
with open('./normalized.csv', 'w', newline='') as file:
    writer = csv.writer(file)
    writer.writerow("Normalized")
```

```
for item in sentences_list:
  with open('./normalized.csv', 'a', newline='') as file:
      writer = csv.writer(file)
      writer.writerow([item])
```

```
# sentences_list = pd.read_csv("./normalized.csv")
# sentences_list = sentences_list.values.tolist()
# sentences_list[0]
```

```
# sentences_list[0][0]
```

Clustering with Embedding

```
model = SentenceTransformer('distilbert-base-nli-mean-tokens')
```

```
100%|██████████| 245M/245M [00:16<00:00, 15.2MB/s]
```

```
def data_gen(data):
    for sen in data:
      yield sen
```

```
a = data_gen(sentences_list)
```

```
encoding_arr = list()
current = 1
for item in a:
  embeddings = model.encode(item)
  encoding_arr.append(embeddings)
  print("Current:",current)
  current += 1
```

```
Streaming output truncated to the last 5000 lines.
Current: 4049
Current: 4050
Current: 4051
Current: 4052
Current: 4053
Current: 4054
Current: 4055
Current: 4056
Current: 4057
Current: 4058
Current: 4059
Current: 4060
Current: 4061
Current: 4062
Current: 4063
Current: 4064
Current: 4065
Current: 4066
Current: 4067
Current: 4068
Current: 4069
Current: 4070
Current: 4071
Current: 4072
Current: 4073
Current: 4074
Current: 4075
Current: 4076
Current: 4077
Current: 4078
Current: 4079
Current: 4080
Current: 4081
Current: 4082
Current: 4083
Current: 4084
Current: 4085
Current: 4086
Current: 4087
Current: 4088
Current: 4089
Current: 4090
Current: 4091
Current: 4092
Current: 4093
Current: 4094
Current: 4095
Current: 4096
Current: 4097
Current: 4098
Current: 4099
Current: 4100
Current: 4101
Current: 4102
Current: 4103
Current: 4104
Current: 4105
Current: 4106
Current: 4107
```

```
encoded_arr = np.array(encoding_arr)
encoded_arr_gpt2 = encoded_arr
encoded_arr_gpt2.shape
```

```
(9048, 768)
```

```
# from gensim.models.doc2vec import Doc2Vec, TaggedDocument
```

```
def tagged_document(normalized_data):
    tagged_corpus = []
    tagged_corpus = [TaggedDocument(words = d, tags=[str(i)]) for i,d in enumerate(normali
    return tagged_corpus
```

```
tagged_corpus =  tagged_document(normalized_data)
```

```
tagged_corpus
```

```
[TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'usa', 'pacer', '
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'england', 'rajas
 TaggedDocument(words=['sydney', 'australia', 'october', 'ani', 'arjun', 'nair', 
 TaggedDocument(words=['sydney', 'australia', 'october', 'ani', 'sydney', 'thunde
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'mumbai', 'indian
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'reminiscing', 'c
 TaggedDocument(words=['adelaide', 'australia', 'october', 'ani', 'west', 'indies
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'rajasthan', 'roy
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'registering', 'w
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'india', 'head'
 TaggedDocument(words=['paris', 'france', 'october', 'ani', 'argentina', 'diego',
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'mumbai', 'indian
 TaggedDocument(words=['london', 'uk', 'october', 'ani', 'expressing', 'sadness',
 TaggedDocument(words=['mumbai', 'maharashtra', 'india', 'october', 'ani', 'west'
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'onslaught', 'sur
 TaggedDocument(words=['bhubaneswar', 'odisha', 'india', 'october', 'ani', 'odish
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'kolkata', 'knigh
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'playing', 'match
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'facing', 'defeat
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'mumbai', 'indian
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'stumbling', 'def
 TaggedDocument(words=['paris', 'france', 'october', 'ani', 'rafael', 'nadal', 't
 TaggedDocument(words=['dubai', 'uae', 'october', 'ani', 'delhi', 'capitals', 'si
 TaggedDocument(words=['los', 'angeles', 'october', 'ani', 'facing', 'loss', 'gam
 TaggedDocument(words=['baidurjo', 'bhosedubai', 'uae', 'october', 'ani', 'wins',
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'kiren', 'rijij
 TaggedDocument(words=['brisbane', 'australia', 'october', 'ani', 'women', 'team'
 TaggedDocument(words=['mumbai', 'maharashtra', 'india', 'october', 'ani', 'onlin
 TaggedDocument(words=['uk', 'october', 'ani', 'celtic', 'football', 'club', 'wed
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'india', 'royal
 TaggedDocument(words=['dhaka', 'bangladesh', 'october', 'ani', 'bangladesh', 'cr
 TaggedDocument(words=['mumbai', 'maharashtra', 'india', 'october', 'ani', 'nba',
 TaggedDocument(words=['bristol', 'uk', 'october', 'ani', 'gloucestershire', 'cri
 TaggedDocument(words=['bengaluru', 'karnataka', 'india', 'october', 'ani', 'men'
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'scalping', 'wick
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'skipper', 'vir
 TaggedDocument(words=['uk', 'october', 'ani', 'england', 'county', 'cricket', 'c
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'india', 'men',
 TaggedDocument(words=['liverpool', 'uk', 'october', 'ani', 'liverpool', 'midfiel
 TaggedDocument(words=['dubai', 'uae', 'october', 'ani', 'delhi', 'capitals', 'sp
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'batsman', 'cri
 TaggedDocument(words=['melbourne', 'australia', 'october', 'ani', 'batsman', 'de
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'kolkata', 'knigh
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'rajasthan', 'r
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'testing', 'cor
 TaggedDocument(words=['rome', 'italy', 'october', 'ani', 'expressing', 'elation'
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'registering', 'w
 TaggedDocument(words=['uk', 'october', 'ani', 'stuart', 'armstrong', 'tested', '
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'stumbling', 'los
 TaggedDocument(words=['london', 'uk', 'october', 'ani', 'arsenal', 'kieran', 'ti
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'playing', 'match
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'started', 'injur
 TaggedDocument(words=['paris', 'france', 'october', 'ani', 'world', 'number', 'n
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'kolkata', 'knigh
 TaggedDocument(words=['al', 'khor', 'qatar', 'october', 'ani', 'fifa', 'presiden
 TaggedDocument(words=['abu', 'dhabi', 'uae', 'october', 'ani', 'suffering', 'def
 TaggedDocument(words=['new', 'delhi', 'india', 'october', 'ani', 'boxer', 'mary'
```

```
def build_model(tagged_corpus,max_epochs,vec_size, alpha):
    model = Doc2Vec(size=vec_size, alpha=alpha,min_alpha=0.001, min_count=1,dm =1)
    model.build_vocab(tagged_corpus)

    for epoch in range(max_epochs):
        model.train(tagged_corpus,total_examples=model.corpus_count, epochs=model.iter)
        # decrease the learning rate
        model.alpha -= 0.002
        # fix the learning rate, no decay
        model.min_alpha = model.alpha


    model.save("d2v.model")
    print("Model Saved")
    model_name = "d2v.model"
    return model_name



# from gensim.models.doc2vec import Doc2Vec

def load_model(model_name, data):
    corpus_vector = []
    model= Doc2Vec.load(model_name)
    for doc in data:
        corpus_vector.append(model.infer_vector(doc.split()))
    return corpus_vector


max_epochs = 100
vec_size = 100
alpha = 0.001
model_name = build_model(tagged_corpus,max_epochs,vec_size, alpha)
```

```
/usr/local/lib/python3.6/dist-packages/gensim/models/doc2vec.py:570: UserWarning: Th
  warnings.warn("The parameter `size` is deprecated, will be removed in 4.0.0, use `
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:7: DeprecationWarning:
  import sys
Model Saved
```

```
corpus_vector = load_model("d2v.model",data)
```

```
corpus_vector = np.array(corpus_vector)
```

```
corpus_vector.shape
```

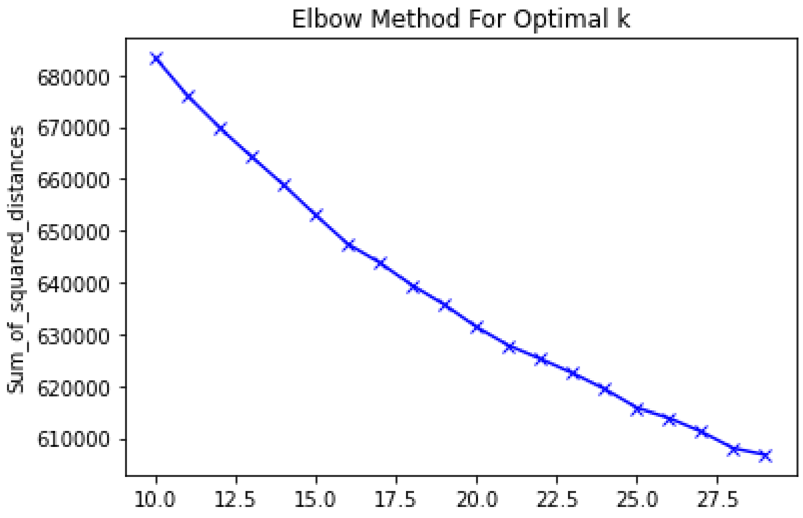
```
(9048, 100)
```

```
#KMeans (WITHOUT Dimensionality Reduction)

from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans

def kmeans(corpus_vector):
    """Function to form dbscan clusters and display them"""
#     eps = 0.005# how close points should be to each other to be considered a part of a c
#     min_samples = 3# the minimum number of points to form a dense region
#     dbscan = DBSCAN( eps=eps, min_samples=min_samples,metric = "cosine" )
#     dbscan_model = dbscan.fit(corpus_vector)

    # pca = PCA(n_components=2)
    # result = pca.fit_transform(corpus_vector)
    # print(result.shape)

    Sum_of_squared_distances = []
    K = range(10,30)
    for k in K:
      km = KMeans(n_clusters=k, max_iter=200, n_init=10)
      km = km.fit(corpus_vector)
      Sum_of_squared_distances.append(km.inertia_)
      print(Sum_of_squared_distances[-1])
    plt.plot(K, Sum_of_squared_distances, 'bx-')
    plt.xlabel('k')
    plt.ylabel('Sum_of_squared_distances')
    plt.title('Elbow Method For Optimal k')
    plt.show()
```

```
#K-Means on BERT Embedding
```

```
kmeans(encoded_arr_gpt2)
```

```
683313.2831422676
675995.5040660618
669879.2074353832
664319.0162487404
658843.4172706455
653015.7827639786
647446.9855148335
643829.5133821758
639439.9103127285
635725.6093027759
631399.6169552275
627834.9215213703
625230.3221832777
622484.4828826431
619413.6241234245
615817.2593456473
613883.7381366036
611255.9008192695
608047.206561707
606779.1408204187
```

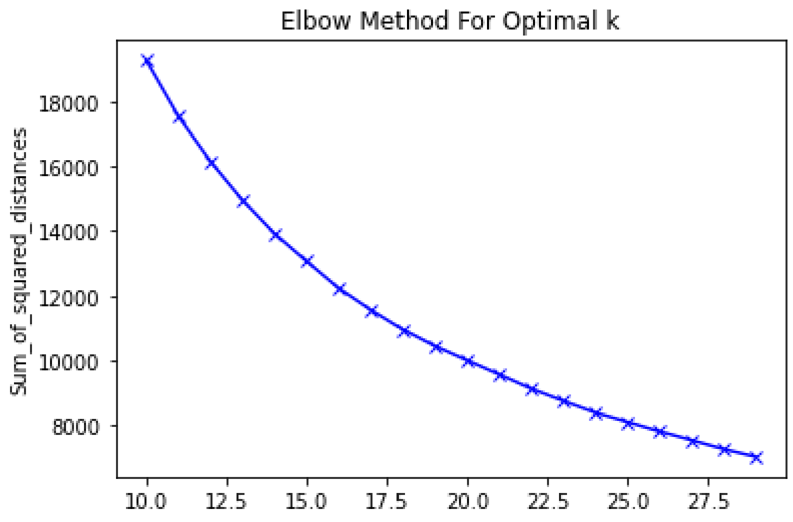


```
#K-Means on Doc2Vec Embedding


kmeans(corpus_vector)
```

```
     528.0408767728637
     442.40464116368275
     376.56779485725644
     318.798725220188
     273.9617173810412
     240.89527249770984
     209.10726805624765
     179.15801703245376
     155.6759900405035
     137.77390846390094
     121.45138988902337
     109.22416777128151
     100.81308926354839
     92.02973480111245
     84.2615519260186
     77.0922000827196
     70.82392250553292
     66.15833113451728
```

```
#KMeans (WITH Dimensionality Reduction PCA)

from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans

def kmeans_pca(corpus_vector):
    """Function to form dbscan clusters and display them"""
#     eps = 0.005# how close points should be to each other to be considered a part of a c
#     min_samples = 3# the minimum number of points to form a dense region
#     dbscan = DBSCAN( eps=eps, min_samples=min_samples,metric = "cosine" )
#     dbscan_model = dbscan.fit(corpus_vector)

    pca = PCA(n_components=2)
    result = pca.fit_transform(corpus_vector)
    print(result.shape)

    Sum_of_squared_distances = []
    K = range(10,30)
    for k in K:
      km = KMeans(n_clusters=k, max_iter=200, n_init=10)
      km = km.fit(result)
      Sum_of_squared_distances.append(km.inertia_)
      print(k,":",Sum_of_squared_distances[-1])
    plt.plot(K, Sum_of_squared_distances, 'bx-')
    plt.xlabel('k')
    plt.ylabel('Sum_of_squared_distances')
    plt.title('Elbow Method For Optimal k')
    plt.show()




##K-Means on BERT Embedding + PCA
kmeans_pca(encoded_arr_gpt2)
```

```
(9048, 2)
10 : 19280.71987833191
11 : 17555.277282753555
12 : 16164.989398038932
13 : 14965.748471437415
14 : 13929.463485653894
15 : 13074.052795726577
16 : 12240.229530085773
17 : 11568.826638069417
18 : 10957.722838625497
19 : 10444.74095973643
20 : 10002.503107378863
21 : 9566.590360941302
22 : 9127.62436586601
23 : 8752.056662772333
24 : 8391.403769668075
25 : 8107.229596817202
26 : 7815.2917626682265
27 : 7540.490259494871
28 : 7266.006271275218
29 : 7029.340011955454
```

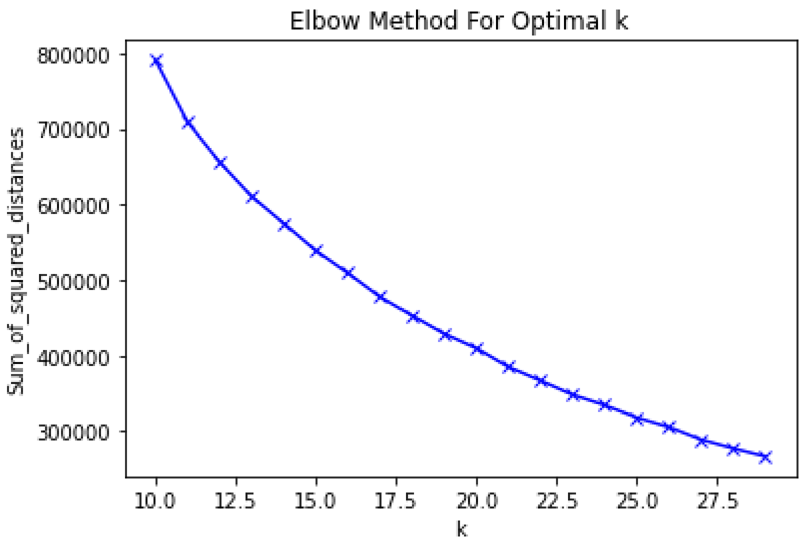


```
##K-Means on Doc2Vec Embedding + PCA
kmeans_pca(corpus_vector)
```

```
     (9048, 2)
     10 : 521.0135397273966
     11 : 435.8899148720983
     12 : 370.64550402790695
     13 : 311.66890647546506
     14 : 267.19024720440433
     15 : 235.8179351081292
     16 : 202.3394927912526
     17 : 174.9796786603735
     18 : 148.85193307084998
     19 : 131.37209937286914
     20 : 114.6535260151957
     21 : 102.67736979419017
     22 : 92.49198770694991
     23 : 85.08450877802146
     24 : 77.6744159059567
     25 : 70.12139994756886
     26 : 65.21609024478688
```

```
#KMeans (WITH Dimensionality Reduction T-SNE)

from sklearn.manifold import TSNE
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans

def kmeans_tsne(corpus_vector):
    """Function to form dbscan clusters and display them"""
#     eps = 0.005# how close points should be to each other to be considered a part of a c
#     min_samples = 3# the minimum number of points to form a dense region
#     dbscan = DBSCAN( eps=eps, min_samples=min_samples,metric = "cosine" )
#     dbscan_model = dbscan.fit(corpus_vector)

   # Initialize t-SNE
    tsne = TSNE(n_components = 2, init = 'random', random_state = 10, perplexity = 100)
    # Use only 400 rows to shorten processing time
    result = tsne.fit_transform(corpus_vector)
    print(result.shape)

    Sum_of_squared_distances = []
    K = range(10,30)
    for k in K:
      km = KMeans(n_clusters=k, max_iter=200, n_init=10)
      km = km.fit(result)
      Sum_of_squared_distances.append(km.inertia_)
      print(k,":",Sum_of_squared_distances[-1])
    plt.plot(K, Sum_of_squared_distances, 'bx-')
    plt.xlabel('k')
    plt.ylabel('Sum_of_squared_distances')
    plt.title('Elbow Method For Optimal k')
    plt.show()



##K-Means on BERT Embedding + t-SNE
kmeans_tsne(encoded_arr_gpt2)
```

```
(9048, 2)
10 : 791281.8465603164
11 : 709313.898410255
12 : 656655.2995625981
13 : 611218.0160936668
14 : 575549.6028959483
15 : 539339.1962662236
16 : 509547.42386999185
17 : 477986.1943781696
18 : 452990.56288240314
19 : 428926.72484807234
20 : 409780.19056690414
21 : 384988.97359318
22 : 366935.28715970536
23 : 348280.50878353196
24 : 334568.9186679296
25 : 318299.8585364376
26 : 305717.1114356258
27 : 289084.0003650729
28 : 277506.1075561704
29 : 266953.00630279497
```



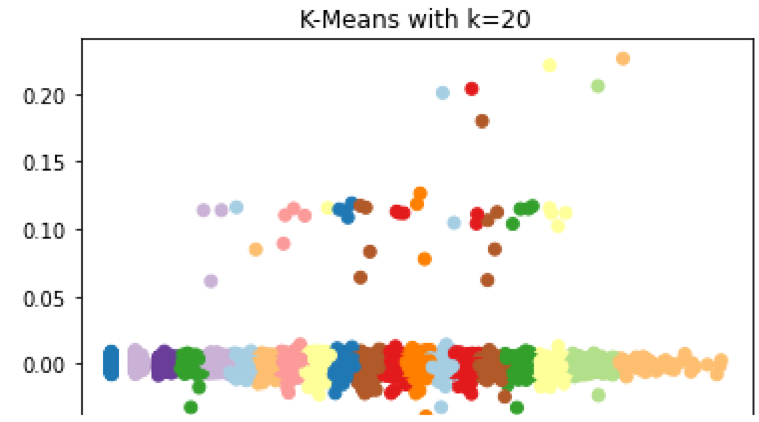
```
##K-Means on Doc2Vec Embedding + t-SNE
kmeans_tsne(corpus_vector)
```

```
(9048, 2)
10 : 1220357.9892761556
11 : 1053860.0563983603
12 : 916547.5049931834
13 : 797334.9394883943
14 : 715020.4927019074
15 : 643164.1155920003
16 : 568017.9217405145
17 : 503598.4721238964
18 : 448224.84572185104
19 : 407419.52570022095
20 : 371629.7800549106
21 : 342649.9238644669
22 : 313045.36722527724
23 : 288957.1895142778
24 : 268016.35222846
25 : 249055.27511303476
26 : 231821.3770147308
27 : 216879.31816006117
```

```
def plot_kmeans_pca(true_k, corpus_vector):
  pca = PCA(n_components=2)
  result_pca = pca.fit_transform(corpus_vector)
  print(result_pca.shape)

  model = KMeans(n_clusters=true_k, init='k-means++', max_iter=200, n_init=10)
  model.fit(result_pca)
  print("SSD:",model.inertia_)
  labels=model.labels_
  print("Labels:",labels)
  y_pred = model.fit_predict(result_pca)
  plt.scatter(result_pca[:,0], result_pca[:,1],c=y_pred, cmap='Paired')
  plt.title("K-Means with k="+str(true_k))
  return labels
```

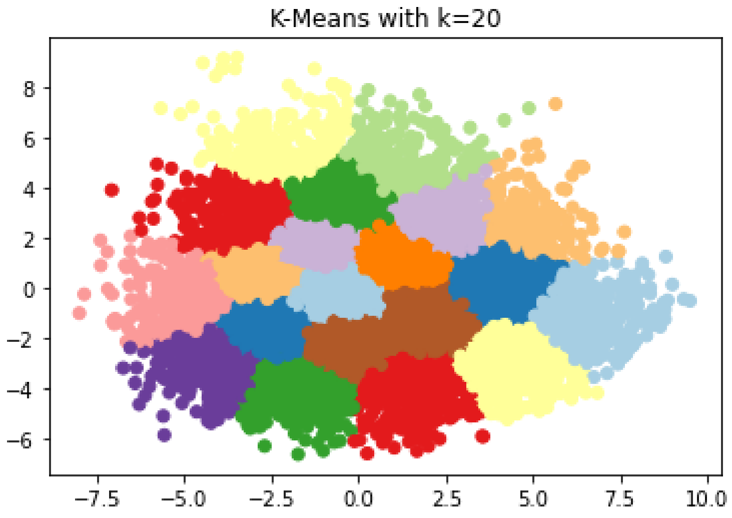
```
from sklearn.decomposition import PCA
import matplotlib.pyplot as plt
from sklearn.cluster import KMeans
def plot_kmeans(true_k, result_pca):

  model = KMeans(n_clusters=true_k, init='k-means++', max_iter=200, n_init=10)
  model.fit(result_pca)
  print("SSD:",model.inertia_)
  labels=model.labels_
  print("Labels:",labels)
  y_pred = model.fit_predict(result_pca)
  plt.scatter(result_pca[:,0], result_pca[:,1],c=y_pred, cmap='Paired')
  plt.title("K-Means with k="+str(true_k))
  return labels


 labels_kmeans_pca = plot_kmeans_pca(20, corpus_vector)
```

```
(9048, 2)
SSD: 114.1691115747464
Labels: [10 17 16 ...  2 15  8]
```



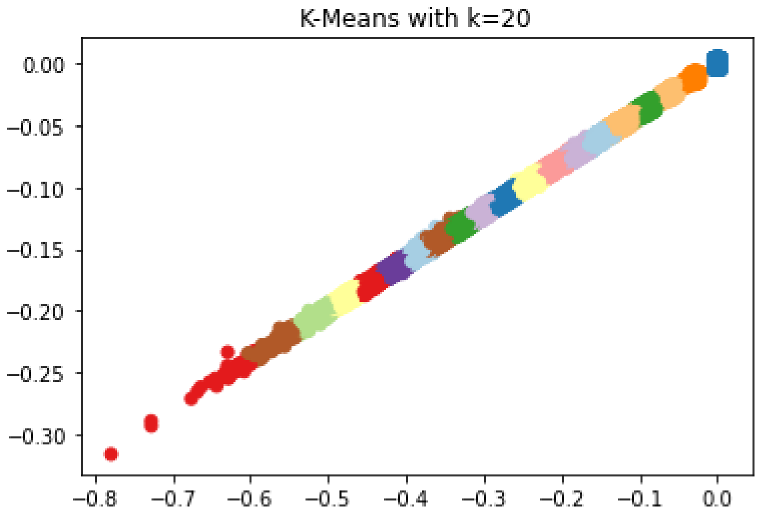
```
plot_kmeans_pca(20, encoded_arr_gpt2)
```

```
(9048, 2)
SSD: 10001.23722568379
Labels: [ 1 11  7 ...  0 17 13]
array([ 1, 11,  7, ...,  0, 17, 13], dtype=int32)
```

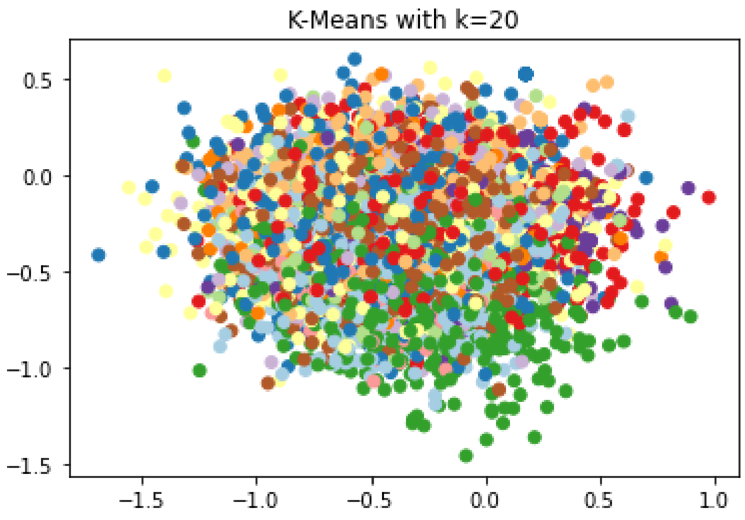


```
plot_kmeans(20, corpus_vector)
```

```
SSD: 125.06148301365438
Labels: [ 0  7 10 ...  7  8  4]
array([ 0,  7, 10, ...,  7,  8,  4], dtype=int32)
```



```
plot_kmeans(20, encoded_arr_gpt2)

     SSD: 631419.9000870567
     Labels: [10 10 12 ...  8 11  7]
     array([10, 10, 12, ...,  8, 11,  7], dtype=int32)
```

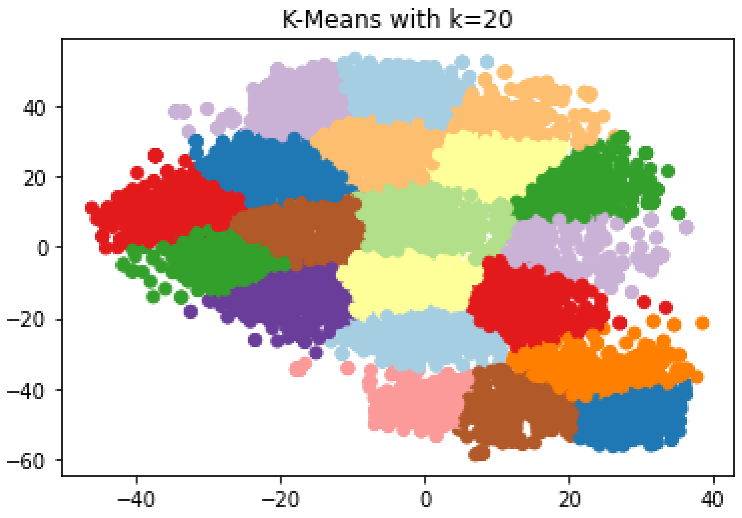


```
def plot_kmeans_tsne(true_k, corpus_vector):
  tsne = TSNE(n_components = 2, init = 'random', random_state = 10, perplexity = 100)
  # Use only 400 rows to shorten processing time
  result_tsne = tsne.fit_transform(corpus_vector)
  print(result_tsne.shape)

  model = KMeans(n_clusters=true_k, init='k-means++', max_iter=200, n_init=10)
  model.fit(result_tsne)
  print("SSD:",model.inertia_)
  labels=model.labels_
  print(labels)
  y_pred = model.fit_predict(result_tsne)
  plt.scatter(result_tsne[:,0], result_tsne[:,1],c=y_pred, cmap='Paired')
  plt.title("K-Means with k="+str(true_k))


plot_kmeans_tsne(20, corpus_vector)
```

```
    (9048, 2)
    SSD: 374543.4737039017
```

```
plot_kmeans_tsne(20, encoded_arr_gpt2)
```

```
    (9048, 2)
    SSD: 405936.37767738954
    [14 14  1 ...  0  6 13]
```



```
labels1 = labels_kmeans_pca.tolist()


total = 0
for each in range(-1, 21):
  print(each, ":", labels1.count(each))
  total += labels1.count(each)

print(total)
```

```
    -1 : 0
    0 : 414
    1 : 543
    2 : 1188
    3 : 492
    4 : 468
    5 : 182
    6 : 487
    7 : 296
    8 : 320
    9 : 537
    10 : 486
    11 : 394
    12 : 491
    13 : 555
    14 : 286
    15 : 17
    16 : 420
    17 : 458
    18 : 536
    19 : 462
    20 : 0
    9032
```

```
list2 = [i for i, e in enumerate(labels1) if e == 2]
```

```
list3 = [i for i, e in enumerate(labels1) if e == 2]


combined_sent = ""
for each in list3:
  print(sentences_list[each])
  print()
  combined_sent += sentences_list[each]
```

```
    sydney australia october ani arjun nair signed big bash league bbl season sydney

    abu dhabi uae october ani registering win rajasthan royals mumbai indians bowling

    london uk october ani expressing sadness gunnersaurus years midfielder mesut ozil

    abu dhabi uae october ani playing match winning knock runs rajasthan royals mumba

    abu dhabi uae october ani facing defeat indian premier league ipl rajasthan royal

    abu dhabi uae october ani mumbai indians performance trounce rajasthan royals run

    uk october ani celtic football club wednesday said odsonne edouard tested coronav

    new delhi india october ani skipper virat kohli childhood coach rajkumar sharma s

    uk october ani stuart armstrong tested coronavirus scottish football association

    london uk october ani arsenal kieran tierney expressed disappointment frustration

    abu dhabi uae october ani suffering defeat mumbai indians indian premier league i

    abu dhabi uae october ani chennai super kings csk failed chase target kolkata kni

    abu dhabi uae october ani kolkata knight riders kkr skipper dinesh karthik praise

    brisbane australia october ani women team wednesday equalled world record odi vic

    dubai uae october ani order provide fans scenes updates multimedia messaging app

    uk october ani arsenal confirmed club closed hale end academy staff member tested

    new delhi india october ani completion ahf education workshops hockey india coach

    bern switzerland october ani switzerland xherdan shaqiri set fly spain testing co

    liverpool uk october ani liverpool thursday announced signing goalkeeper marcelo

    meerut uttar pradesh india october ani boxer sunil chauhan thursday thanked union

    new delhi india october ani defender sandesh jhingan feels sporting action resume

    london uk october ani edouard mendy set miss senegal match morocco injury returne

    london uk october ani ollie pope replaced wicket keeper batsman jonny bairstow re

    dubai uae october ani kings xi punjab kxip cricketer nicholas pooran said team ch

    sharjah uae october ani spinner shane warne hailed rajasthan royals bowling perfo

    canterbury uk october ani rounder calum haggett left club following conclusion se
```

```
birmingham uk october ani aston villa women team member tested coronavirus club a

brussels belgium october ani substituted ivory coast match belgium manchester uni

dubai uae october ani match chennai super kings csk royal challengers bangalore r
```

```
wordlist = combined_sent.split()
wordfreq = {}
for w in wordlist:
  if w not in wordfreq:
    wordfreq[w] = 0
  wordfreq[w] += 1
```

```
sorted_words = dict(sorted(wordfreq.items(), key=lambda item: item[1],reverse=True))
print(sorted_words)
```

```
{'said': 452, 'october': 367, 'ani': 283, 'india': 280, 'oct': 177, 'delhi': 168, 'm
```

```
# kmeans_pca(encoded_arr)
```

```
# kmeans(encoded_arr)
```

```
from sklearn.decomposition import PCA

def dbscan(corpus_vector, eps= 0.005, min_samples = 3):
    """Function to form dbscan clusters and display them"""
#     eps = 0.005# how close points should be to each other to be considered a part of a c
#     min_samples = 3# the minimum number of points to form a dense region
#     dbscan = DBSCAN( eps=eps, min_samples=min_samples,metric = "cosine" )
#     dbscan_model = dbscan.fit(corpus_vector)

    pca = PCA(n_components=2)
    result = pca.fit_transform(corpus_vector)
    print(result.shape)
    db = DBSCAN(eps=eps, min_samples=min_samples)
    dbscan_model = db.fit(result)
    #Forming the clusters

    core_samples_mask = np.zeros_like(dbscan_model.labels_, dtype=bool)
    core_samples_mask[dbscan_model.core_sample_indices_] = True
    labels1 = dbscan_model.labels_
    n_clusters_ = len(set(labels1)) - (1 if -1 in labels1 else 0) # Number of clusters in
    print(labels1)
    print(len(labels1))
    print(n_clusters_) # number of clusters

    clusters1 = {} # a dictionary for different cluster
    for c, i in enumerate(labels1):
        if i == -1:
            continue
        elif i in clusters1:
            clusters1[i].append( data[c] )
        else:
            clusters1[i] = [data[c]]

    for c in clusters1: # print the different clusters
        # print("Cluster No."+" "+str(c)+" "+str(clusters1[c]))
        # print()
        pass

    return labels1, clusters1


labels1, clusters1 = dbscan(corpus_vector,0.005,3)
```

```
(9048, 2)
[ 0  1 -1 ...  6 29 45]
9048
170
```

```
labels1, clusters1 = dbscan(corpus_vector,0.01,3)
```

```
(9048, 2)
[ 0  1 -1 ...  3  5  0]
9048
34
```

```
labels1, clusters1 = dbscan(encoded_arr_gpt2,0.01,3)
```

```
(9048, 2)
[-1 -1 -1 ... -1 -1 -1]
9048
15
```

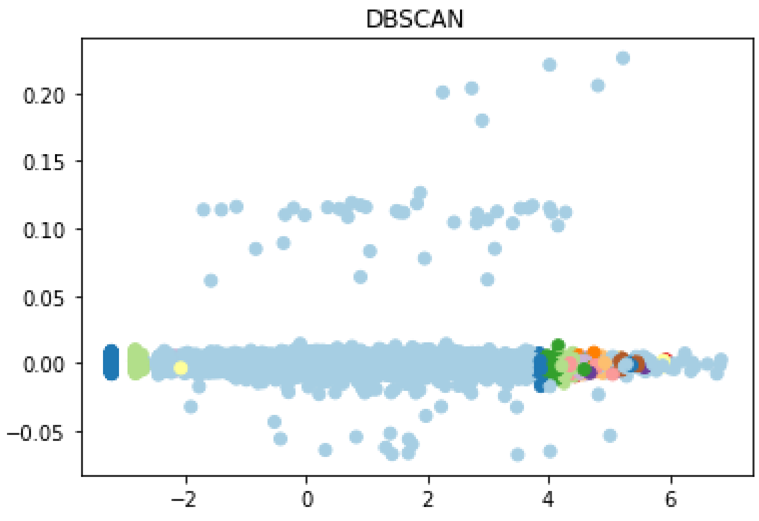
```
labels1, clusters1 = dbscan(encoded_arr_gpt2,0.04,3)
```

```
(9048, 2)
[-1 -1 -1 ... -1 -1 -1]
9048
359
```

```
from sklearn.decomposition import PCA

def plot_dbscan(X , eps, min_samples):
    """Function to plot clusters"""
    pca = PCA(n_components=2)
    result = pca.fit_transform(X)
    print(result.shape)
    db = DBSCAN(eps=eps, min_samples=min_samples)
    db.fit(result)
    y_pred = db.fit_predict(result)
    plt.scatter(result[:,0], result[:,1],c=y_pred, cmap='Paired')
    plt.title("DBSCAN")
```

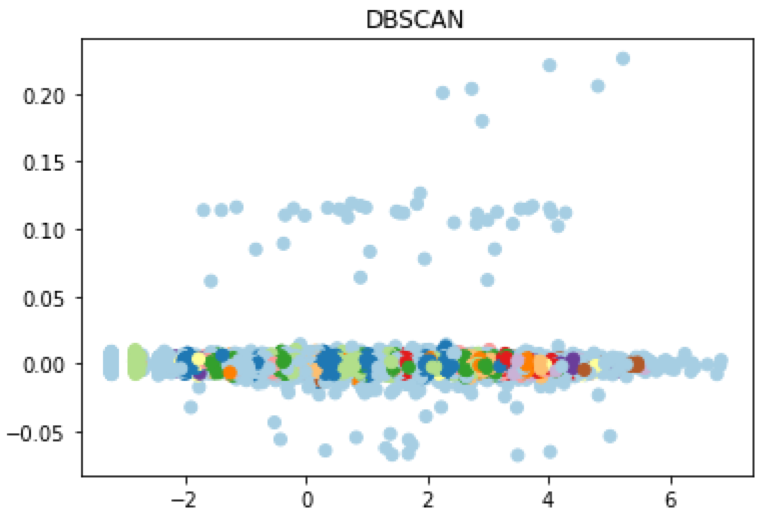
```
plot_dbscan(corpus_vector,0.01,3)
```

```
(9048, 2)
```



```
plot_dbscan(corpus_vector,0.005,3)
```

```
(9048, 2)
```

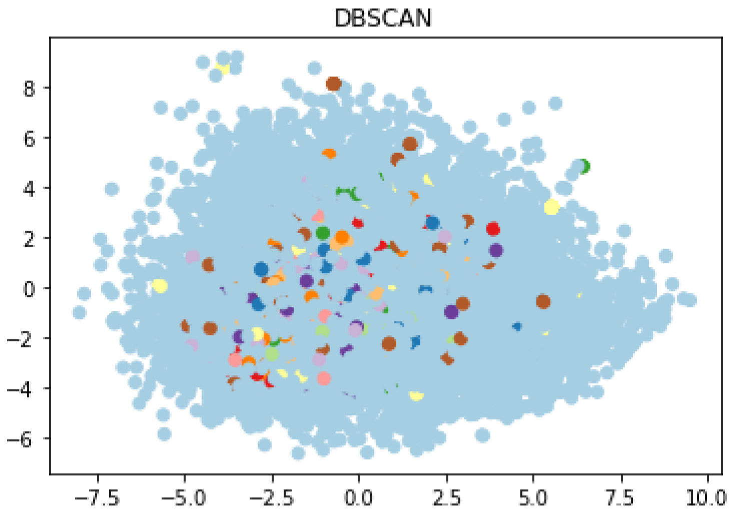


```
plot_dbscan(encoded_arr_gpt2,0.01,3)
```

```
(9048, 2)
```

```
plot_dbscan(encoded_arr_gpt2,0.04,3)
```

```
(9048, 2)
```



```
labels1 = labels1.tolist()
```

```
total = 0
for each in range(-1, 150):
  print(each, ":", labels1.count(each))
  total += labels1.count(each)

print(total)
```

```
-1 : 177
0 : 301
1 : 33
2 : 1188
3 : 5252
4 : 420
5 : 472
6 : 48
7 : 371
8 : 281
9 : 5
10 : 73
11 : 44
12 : 96
13 : 3
14 : 6
15 : 36
16 : 9
17 : 10
18 : 14
19 : 5
20 : 12
21 : 3
22 : 4
23 : 15
24 : 5
```

```
25 : 8
26 : 23
27 : 5
28 : 4
29 : 11
30 : 18
31 : 7
32 : 7
33 : 7
34 : 7
35 : 5
36 : 12
37 : 3
38 : 4
39 : 4
40 : 8
41 : 4
42 : 3
43 : 3
44 : 3
45 : 3
46 : 0
47 : 0
48 : 0
49 : 0
50 : 0
51 : 0
52 : 0
53 : 0
54 : 0
55 : 0
56 : 0
57 : 0
```

```
[i for i, e in enumerate(labels1) if e == 3]
```

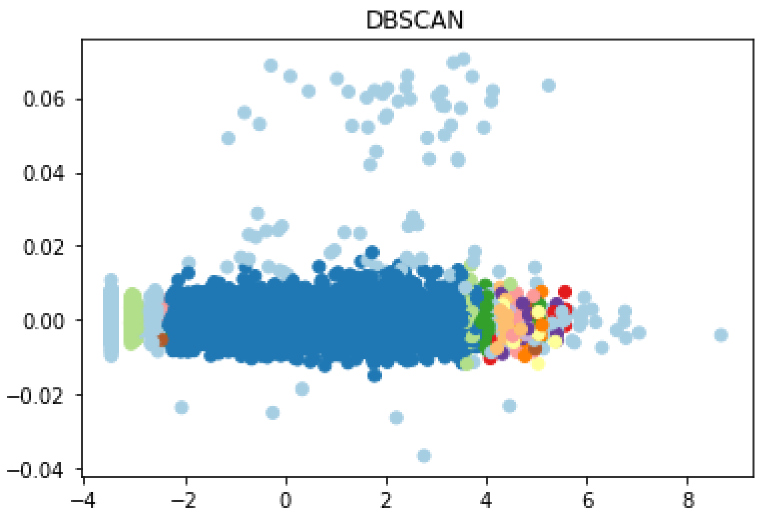
```
[3,
 5,
 7,
 10,
 11,
 13,
 14,
 15,
 23,
 24,
 26,
 27,
 29,
 30,
 31,
 32,
 34,
 36,
 37,
 39,
 40,
 41,
 42,
 45,
 48,
      50,
      52,
      54,
      61,
      63,
      67,
      72,
      73,
      74,
      75,
      76,
      78,
      80,
      84,
      85,
      87,
      88,
      92,
      93,
      97,
      99,
      102,
      103,
      104,
      111,
      112,
      114,
      116,
      117,
      119,
      120,
      127,
      128,
      129,
```

```
print(sentences_list[20])
print()
print(sentences_list[1468])
print()
print(sentences_list[1523])
```

```
abu dhabi uae october ani stumbling defeat hands mumbai indians rajasthan royals wic

new york usa october ani newsvoir support expansion testing contact tracing india ro

new delhi india october ani newsvoir arjun anand author art photographer launched bo
```

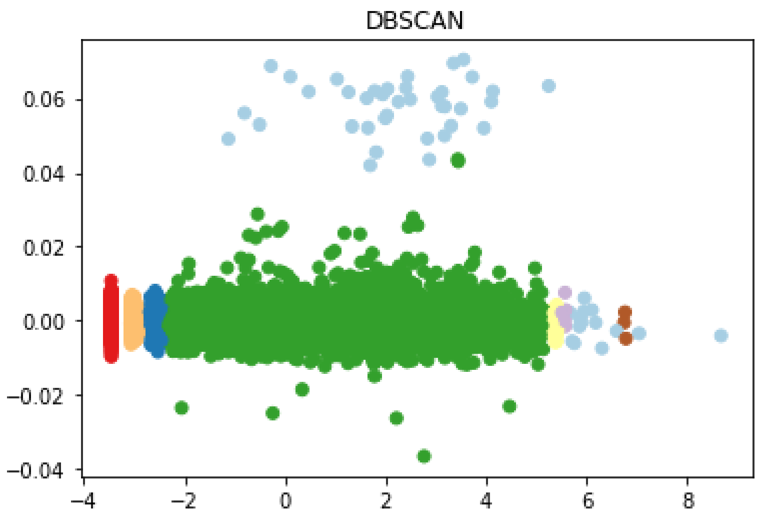
```
from sklearn.decomposition import PCA

def plot_dbscan(X , eps, min_samples):
    """Function to plot clusters"""
    pca = PCA(n_components=2)
    result = pca.fit_transform(X)
    print(result.shape)
    db = DBSCAN(eps=eps, min_samples=min_samples)
    db.fit(result)
    y_pred = db.fit_predict(result)
    plt.scatter(result[:,0], result[:,1],c=y_pred, cmap='Paired')
    plt.title("DBSCAN")

plot_dbscan(corpus_vector,0.01,3)
```

```
     (9032, 2)
```



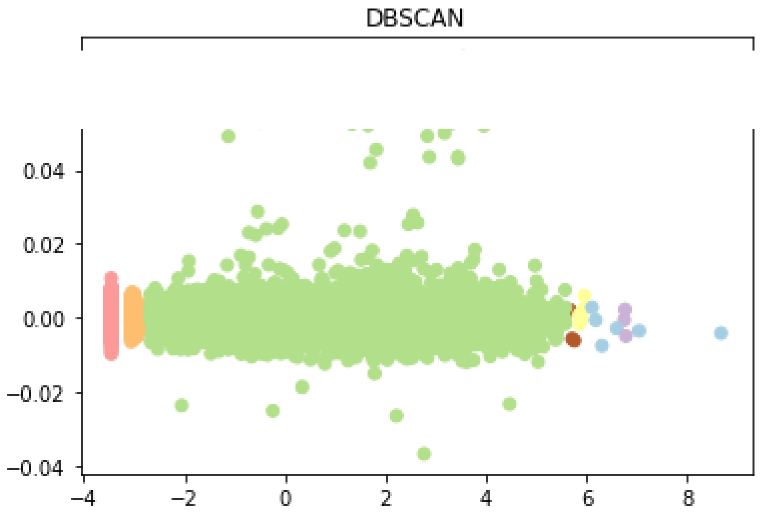
```
plot_dbscan(corpus_vector,0.03, 3)
```

```
     (9032, 2)
```



```
plot_dbscan(corpus_vector,0.05, 3)
```

```
(9032, 2)
```


DBSCAN