```
#ML1010_Week_2
#https://towardsdatascience.com/understanding-feature-engineering-part-3-traditional-methods-
```

```
import pandas as pd
import numpy as np
import re
import nltk
import matplotlib.pyplot as plt
pd.options.display.max_colwidth = 200
%matplotlib inline
```

```
corpus = ['The sky is blue and beautiful.',
          'Love this blue and beautiful sky!',
          'The quick brown fox jumps over the lazy dog.',
          "A king's breakfast has sausages, ham, bacon, eggs, toast and beans",
          'I love green eggs, ham, sausages and bacon!',
          'The brown fox is quick and the blue dog is lazy!',
          'The sky is very blue and the sky is very beautiful today',
          'The dog is lazy but the brown fox is quick!'
]
labels = ['weather', 'weather', 'animals', 'food', 'food', 'animals', 'weather', 'animals']

corpus = np.array(corpus)
corpus_df = pd.DataFrame({'Document': corpus,
                          'Category': labels})
corpus_df = corpus_df[['Document', 'Category']]
corpus_df
```

	Document	Category
0	The sky is blue and beautiful.	weather
1	Love this blue and beautiful sky!	weather
2	The quick brown fox jumps over the lazy dog.	animals
3	A king's breakfast has sausages, ham, bacon, eggs, toast and beans	food
4	I love green eggs, ham, sausages and bacon!	food
5	The brown fox is quick and the blue dog is lazy!	animals
6	The sky is very blue and the sky is very beautiful today	weather
7	The dog is lazy but the brown fox is quick!	animals

```
wpt = nltk.WordPunctTokenizer()
nltk.download('stopwords')
stop_words = nltk.corpus.stopwords.words('english')
```

```
def normalize_document(doc):
    # lower case and remove special characters\whitespaces
    doc = re.sub(r'[^a-zA-Z\s]', '', doc, re.I|re.A)
    doc = doc.lower()
    doc = doc.strip()
    # tokenize document
    tokens = wpt.tokenize(doc)
    # filter stopwords out of document
    filtered_tokens = [token for token in tokens if token not in stop_words]
    # re-create document from filtered tokens
    doc = ' '.join(filtered_tokens)
    return doc

normalize_corpus = np.vectorize(normalize_document)
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
```

```
norm_corpus = normalize_corpus(corpus)
norm_corpus
```

```
array(['sky blue beautiful', 'love blue beautiful sky',
       'quick brown fox jumps lazy dog',
       'kings breakfast sausages ham bacon eggs toast beans',
       'love green eggs ham sausages bacon',
       'brown fox quick blue dog lazy', 'sky blue sky beautiful today',
       'dog lazy brown fox quick'], dtype='<U51')
```

```
#Create the bag of words
from sklearn.feature_extraction.text import CountVectorizer

cv = CountVectorizer(min_df=0., max_df=1.)
cv_matrix = cv.fit_transform(norm_corpus)
cv_matrix = cv_matrix.toarray()
cv_matrix
```

```
array([[0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0],
       [0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 1, 0, 0],
       [0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0],
       [1, 1, 0, 0, 1, 0, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1, 0, 1, 0],
       [1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0],
       [0, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0],
       [0, 0, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2, 0, 1],
       [0, 0, 0, 0, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0]])
```

```
# get all unique words in the corpus
vocab = cv.get_feature_names()
# show document feature vectors
pd.DataFrame(cv_matrix, columns=vocab)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarning: F
  warnings.warn(msg, category=FutureWarning)
```

	bacon	beans	beautiful	blue	breakfast	brown	dog	eggs	fox	green	ham	jumps	k
0	0	0	1	1	0	0	0	0	0	0	0	0	
1	0	0	1	1	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	1	1	0	1	0	0	1	
3	1	1	0	0	1	0	0	1	0	0	1	0	
4	1	0	0	0	0	0	0	1	0	1	1	0	
5	0	0	0	1	0	1	1	0	1	0	0	0	
6	0	0	1	1	0	0	0	0	0	0	0	0	
7	0	0	0	0	0	1	1	0	1	0	0	0	

```
# you can set the n-gram range to 1,2 to get unigrams as well as bigrams
bv = CountVectorizer(ngram_range=(2,2))
bv_matrix = bv.fit_transform(norm_corpus)

bv_matrix = bv_matrix.toarray()
vocab = bv.get_feature_names()
pd.DataFrame(bv_matrix, columns=vocab)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/utils/deprecation.py:87: FutureWarning: F
  warnings.warn(msg, category=FutureWarning)
```

	bacon eggs	beautiful sky	beautiful today	blue beautiful	blue dog	blue sky	breakfast sausages	brown fox	dog lazy	eggs ham	eg toa
0	0	0	0	1	0	0	0	0	0	0	
1	0	1	0	1	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	1	0	0	
3	1	0	0	0	0	0	1	0	0	0	
4	0	0	0	0	0	0	0	0	0	1	
5	0	0	0	0	1	0	0	1	1	0	
6	0	0	1	0	0	1	0	0	0	0	
7	0	0	0	0	0	0	0	1	1	0	

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

tv = TfidfVectorizer(min_df=0., max_df=1., use_idf=True)
```

```
tv_matrix = tv.fit_transform(norm_corpus)
tv_matrix = tv_matrix.toarray()

vocab = tv.get_feature_names_out()
pd.DataFrame(np.round(tv_matrix, 2), columns=vocab)
```

	bacon	beans	beautiful	blue	breakfast	brown	dog	eggs	fox	green	ham	jumps
0	0.00	0.00	0.60	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.49	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.38	0.38	0.00	0.38	0.00	0.00	0.53
3	0.32	0.38	0.00	0.00	0.38	0.00	0.00	0.32	0.00	0.00	0.32	0.00
4	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.00	0.47	0.39	0.00
5	0.00	0.00	0.00	0.37	0.00	0.42	0.42	0.00	0.42	0.00	0.00	0.00
6	0.00	0.00	0.36	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.45	0.45	0.00	0.45	0.00	0.00	0.00

```
#Pairwise document similarity

from sklearn.metrics.pairwise import cosine_similarity

similarity_matrix = cosine_similarity(tv_matrix)
similarity_df = pd.DataFrame(similarity_matrix)
similarity_df
```

	0	1	2	3	4	5	6	7
0	1.000000	0.820599	0.000000	0.000000	0.000000	0.192353	0.817246	0.000000
1	0.820599	1.000000	0.000000	0.000000	0.225489	0.157845	0.670631	0.000000
2	0.000000	0.000000	1.000000	0.000000	0.000000	0.791821	0.000000	0.850516
3	0.000000	0.000000	0.000000	1.000000	0.506866	0.000000	0.000000	0.000000
4	0.000000	0.225489	0.000000	0.506866	1.000000	0.000000	0.000000	0.000000
5	0.192353	0.157845	0.791821	0.000000	0.000000	1.000000	0.115488	0.930989
6	0.817246	0.670631	0.000000	0.000000	0.000000	0.115488	1.000000	0.000000
7	0.000000	0.000000	0.850516	0.000000	0.000000	0.930989	0.000000	1.000000

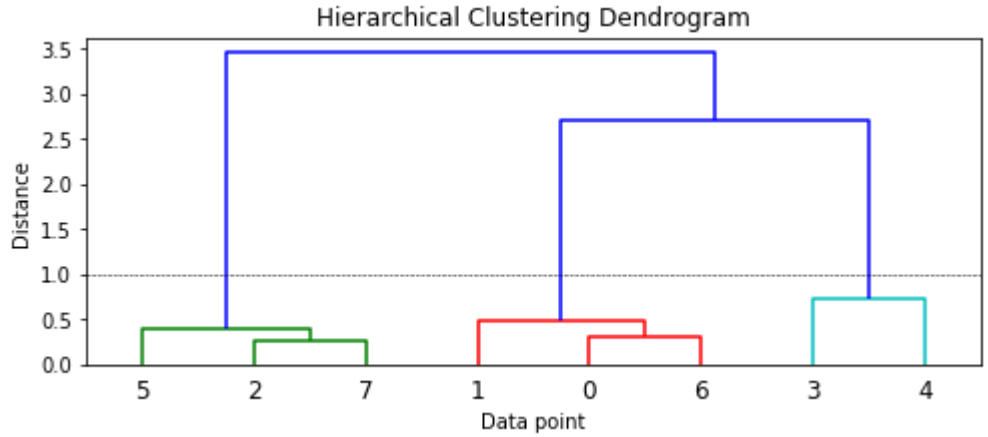
```
#reread this. needs deeper understanding
from scipy.cluster.hierarchy import dendrogram, linkage

Z = linkage(similarity_matrix, 'ward')
```

```
pd.DataFrame(Z, columns=['Document\Cluster 1', 'Document\Cluster 2',
                         'Distance', 'Cluster Size'], dtype='object')
```

	Document\Cluster 1	Document\Cluster 2	Distance	Cluster Size
0	2	7	0.253098	2
1	0	6	0.308539	2
2	5	8	0.386952	3
3	1	9	0.489845	3
4	3	4	0.732945	2
5	11	12	2.69565	5
6	10	13	3.45108	8

```
plt.figure(figsize=(8, 3))
plt.title('Hierarchical Clustering Dendrogram')
plt.xlabel('Data point')
plt.ylabel('Distance')
dendrogram(Z)
plt.axhline(y=1.0, c='k', ls='--', lw=0.5)
```

```
<matplotlib.lines.Line2D at 0x7fc88dc8c450>
```




```
from scipy.cluster.hierarchy import fcluster
max_dist = 1.0

cluster_labels = fcluster(Z, max_dist, criterion='distance')
cluster_labels = pd.DataFrame(cluster_labels, columns=['ClusterLabel'])
pd.concat([corpus_df, cluster_labels], axis=1)
```

	Document	Category	ClusterLabel
0	The sky is blue and beautiful.	weather	2
1	Love this blue and beautiful sky!	weather	2
2	The quick brown fox jumps over the lazy dog.	animals	1
3	A king's breakfast has sausages, ham, bacon, eggs, toast and beans	food	3
4	I love green eggs, ham, sausages and bacon!	food	3
5	The brown fox is quick and the blue dog is lazy!	animals	1

```
from sklearn.decomposition import LatentDirichletAllocation

lda = LatentDirichletAllocation(n_components=3, max_iter=10000, random_state=0)
dt_matrix = lda.fit_transform(cv_matrix)
features = pd.DataFrame(dt_matrix, columns=['T1', 'T2', 'T3'])
features
```

	T1	T2	T3
0	0.832191	0.083480	0.084329
1	0.863554	0.069100	0.067346
2	0.047794	0.047776	0.904430
3	0.037243	0.925559	0.037198
4	0.049121	0.903076	0.047802
5	0.054902	0.047778	0.897321
6	0.888287	0.055697	0.056016
7	0.055704	0.055689	0.888607

```
tt_matrix = lda.components_
for topic_weights in tt_matrix:
    topic = [(token, weight) for token, weight in zip(vocab, topic_weights)]
    topic = sorted(topic, key=lambda x: -x[1])
    topic = [item for item in topic if item[1] > 0.6]
    print(topic)
    print()
```

```
[('sky', 4.332439442470133), ('blue', 3.373774254787669), ('beautiful', 3.3323650509884

[('bacon', 2.33269586574902), ('eggs', 2.33269586574902), ('ham', 2.33269586574902), ('s

[('brown', 3.3323473548404405), ('dog', 3.3323473548404405), ('fox', 3.3323473548404405)
```

```
from sklearn.cluster import KMeans

km = KMeans(n_clusters=3, random_state=0)
km.fit_transform(features)
cluster_labels = km.labels_
cluster_labels = pd.DataFrame(cluster_labels, columns=['ClusterLabel'])
pd.concat([corpus_df, cluster_labels], axis=1)
```

	Document	Category	ClusterLabel
0	The sky is blue and beautiful.	weather	2
1	Love this blue and beautiful sky!	weather	2
2	The quick brown fox jumps over the lazy dog.	animals	1
3	A king's breakfast has sausages, ham, bacon, eggs, toast and beans	food	0
4	I love green eggs, ham, sausages and bacon!	food	0
5	The brown fox is quick and the blue dog is lazy!	animals	1
6	The sky is very blue and the sky is very beautiful today	weather	2
7	The dog is lazy but the brown fox is quick!	animals	1