# M06 Homework

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In [ ]:

```python
import pandas as pd
import numpy as np
from glob import glob
import re
import nltk
import plotly_express as px
from lib.textparser import TextParser
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer, TfidfTransformer

from numpy.linalg import norm
from scipy.spatial.distance import pdist
import scipy.cluster.hierarchy as sch
import matplotlib.pyplot as plt
```

In [ ]:

```python
import configparser
config = configparser.ConfigParser()
config.read("../env.ini")
data_home = config['DEFAULT']['data_home']
output_dir = config['DEFAULT']['output_dir']
data_prefix = 'austen-melville'
```

In [ ]:

```python
OHCO = ['book_id', 'chap_id', 'para_num', 'sent_num', 'token_num']
bags = dict(
    SENTS = OHCO[:4],
    PARAS = OHCO[:3],
    CHAPS = OHCO[:2],
    BOOKS = OHCO[:1]
)
```

In [ ]:

```python
LIB = pd.read_csv(f"{output_dir}/{data_prefix}-LIB.csv").set_index('book_id')
CORPUS = pd.read_csv(f"{output_dir}/{data_prefix}-CORPUS.csv").set_index(OHCO)
VOCAB = pd.read_csv(f'{output_dir}/{data_prefix}-VOCAB.csv').set_index('term_str').dropna()
```

In [ ]:

```python
austen_dates = {
    "EMMA": 1815,
    "LADY SUSAN": 1794,
    "LOVE AND FREINDSHIP SIC": 1790,
    "MANSFIELD PARK": 1814,
    "NORTHANGER ABBEY": 1803,
    "PERSUASION": 1818,
    "PRIDE AND PREJUDICE": 1813,
    "SENSE AND SENSIBILITY": 1811
}

LIB['year'] = LIB['title'].map(austen_dates)
LIB['label'] = LIB['year'].astype(str) + '_' + LIB['title']
LIB = LIB.query("author == 'AUSTEN, JANE'")

LIB
```

Out[ ]:

| book_id | source_file_path | author | title | chap_regex | book_len | n_chaps | year | label |
|---|---|---|---|---|---|---|---|---|
| 105 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | PERSUASION | ^Chapter\s+\d+$ | 83624 | 24 | 1818.0 | 1818.0_PERSUASION |
| 121 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | NORTHANGER ABBEY | ^CHAPTER\s+\d+$ | 77601 | 31 | 1803.0 | 1803.0_NORTHANGER ABBEY |
| 141 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | MANSFIELD PARK | ^CHAPTER\s+[IVXLCM]+$ | 160378 | 48 | 1814.0 | 1814.0_MANSFIELD PARK |
| 158 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | EMMA | ^\s*CHAPTER\s+[IVXLCM]+\s*$ | 160926 | 55 | 1815.0 | 1815.0_EMMA |
| 161 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | SENSE AND SENSIBILITY | ^CHAPTER\s+\d+$ | 119873 | 50 | 1811.0 | 1811.0_SENSE AND SENSIBILITY |
| 946 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | LADY SUSAN | ^\s*[IVXLCM]+\s*$ | 23116 | 41 | 1794.0 | 1794.0_LADY SUSAN |
| 1212 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | LOVE AND FREINDSHIP SIC | ^\s*LETTER .* to .*$ | 33265 | 24 | 1790.0 | 1790.0_LOVE AND FREINDSHIP SIC |
| 1342 | /Users/michaelvaden/GithubRepos/DS5001-Workpla... | AUSTEN, JANE | PRIDE AND PREJUDICE | ^Chapter\s+\d+$ | 122126 | 61 | 1813.0 | 1813.0_PRIDE AND PREJUDICE |

In [ ]:

```python
def create_bag_of_words(CORPUS, bag):
    BOW = CORPUS.groupby(bag+['term_str']).term_str.count().to_frame('n')
    return BOW

idf_method = 'standard'

def get_TFIDF(BOW, tf_method):
    DTCM = BOW.n.unstack(fill_value=0)

    DF = DTCM.astype('bool').sum()
    N = len(DTCM)

    if tf_method == 'sum':
        TF = DTCM.T / DTCM.T.sum()
    elif tf_method == 'max':
        TF = DTCM.T / DTCM.T.max()

    elif tf_method == 'log':
        TF = np.log2(1 + DTCM.T)

    elif tf_method == 'raw':
        TF = DTCM.T

    elif tf_method == 'double_norm':
        TF = DTCM.T / DTCM.T.max()

    elif tf_method == 'binary':
        TF = DTCM.T.astype('bool').astype('int')

    TF = TF.T

    if idf_method == 'standard':
        IDF = np.log2(N / DF)

    elif idf_method == 'max':
        IDF = np.log2(DF.max() / DF)

    elif idf_method == 'smooth':
        IDF = np.log2((1 + N) / (1 + DF)) + 1

    return TF * IDF, DF * IDF
```

In [ ]:

```
CORPUS = CORPUS.loc[LIB.index]
```

In [ ]:

```
TFIDF = get_TFIDF(create_bag_of_words(CORPUS, bags['CHAPS']), 'max')[0]

TFIDF
```

Out[ ]:

| | term_str | 0 | 1 | 10 | 10000 | 10th | 11th | 12 | 12th | 1399 | 13th | ... | youthful | youths | yrs | z | zeal | zealous | zealously | zephyr | zigzags | ł20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **book_id** | **chap_id** | | | | | | | | | | | | | | | | | | | | |
| **105** | **1** | 0.0 | 0.119092 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.043417 | 0.0 | 0.0 | 0.067611 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| | **2** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.061689 | 0.0 | 0.0 | 0.0 | |
| | **3** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.036998 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| | **4** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| | **5** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| **...** | **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | |
| **1342** | **57** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| | **58** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| | **59** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| | **60** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |
| | **61** | 0.0 | 0.000000 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | ... | 0.000000 | 0.0 | 0.0 | 0.000000 | 0.000000 | 0.000000 | 0.0 | 0.0 | 0.0 | |

334 rows × 14745 columns

In [ ]:

```
DFIDF = get_TFIDF(create_bag_of_words(CORPUS, bags['CHAPS']), 'max')[1].to_frame('DFIDF')

DFIDF
```

Out[ ]:

| | DFIDF |
|---|---|
| **term_str** | |
| **0** | 8.383704 |
| **1** | 14.767409 |
| **10** | 20.396225 |
| **10000** | 8.383704 |
| **10th** | 14.767409 |
| **...** | ... |
| **zealous** | 34.792451 |
| **zealously** | 14.767409 |
| **zephyr** | 8.383704 |
| **zigzags** | 8.383704 |
| **ł20000** | 8.383704 |

14745 rows × 1 columns

In [ ]:

```
part_of_speech = ['NN', 'NNS', 'VB', 'VBD', 'VBG', 'VBN', 'VBP', 'VBZ', 'JJ', 'JJR', 'JJS', 'RB', 'RBR', 'RBS']

Collapsed_TFIDF = TFIDF.loc[:, VOCAB.query("max_pos in @part_of_speech").join(DFIDF).sort_values('DFIDF', ascending=False)\
          .head(1000).reset_index()['term_str'].to_list()].reset_index().groupby(['book_id']).mean().drop('chap_id', axis=1)

Collapsed_TFIDF
```

Out[ ]:

| term_str | respect | forward | greatest | stay | thinking | assure | marriage | fortune | believed | new | ... | impression | unable | deep | sensations | fort |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **book_id** | | | | | | | | | | | | | | | | |
| **105** | 0.006140 | 0.009262 | 0.003233 | 0.010584 | 0.011340 | 0.010205 | 0.011468 | 0.013589 | 0.008962 | 0.010591 | ... | 0.006734 | 0.004557 | 0.004729 | 0.007360 | 0.00272 |
| **121** | 0.004111 | 0.006748 | 0.007326 | 0.008810 | 0.008241 | 0.008954 | 0.005660 | 0.010054 | 0.009190 | 0.016896 | ... | 0.002037 | 0.001299 | 0.006226 | 0.002145 | 0.01087 |
| **141** | 0.009049 | 0.009500 | 0.010356 | 0.009412 | 0.010821 | 0.004308 | 0.007412 | 0.006946 | 0.008376 | 0.009582 | ... | 0.006074 | 0.003468 | 0.005070 | 0.007835 | 0.00260 |
| **158** | 0.011402 | 0.008882 | 0.007157 | 0.011392 | 0.014596 | 0.014604 | 0.009475 | 0.010334 | 0.011059 | 0.009415 | ... | 0.003549 | 0.000696 | 0.006773 | 0.006615 | 0.00237 |
| **161** | 0.006497 | 0.006474 | 0.009488 | 0.008128 | 0.005347 | 0.009847 | 0.013288 | 0.012934 | 0.008158 | 0.010615 | ... | 0.003638 | 0.011270 | 0.002284 | 0.001596 | 0.00786 |
| **946** | 0.010156 | 0.010188 | 0.015570 | 0.005638 | 0.001255 | 0.005513 | 0.021950 | 0.005375 | 0.009788 | 0.000000 | ... | 0.004818 | 0.001120 | 0.001906 | 0.005358 | 0.01026 |
| **1212** | 0.003126 | 0.001501 | 0.010051 | 0.000884 | 0.003517 | 0.011138 | 0.016403 | 0.011411 | 0.000000 | 0.005096 | ... | 0.010533 | 0.002869 | 0.000339 | 0.002735 | 0.00497 |
| **1342** | 0.009518 | 0.006757 | 0.005553 | 0.012313 | 0.007312 | 0.013715 | 0.020465 | 0.014328 | 0.010656 | 0.007232 | ... | 0.003633 | 0.008668 | 0.005856 | 0.001252 | 0.00250 |

8 rows × 1000 columns

In [ ]:

```
L0 = Collapsed_TFIDF.astype('bool').astype('int') # Binary (Pseudo L)
L1 = Collapsed_TFIDF.apply(lambda x: x / x.sum(), 1) # Probabilistic
L2 = Collapsed_TFIDF.apply(lambda x: x / norm(x), 1) # Pythagorean, AKA Euclidean

PAIRS = pd.DataFrame(index=pd.MultiIndex.from_product([LIB.index.tolist(), LIB.index.tolist()])).reset_index()

# Keep only unique pairs of different books
PAIRS = PAIRS[PAIRS.level_0 < PAIRS.level_1].set_index(['level_0','level_1'])

# Name index cols
PAIRS.index.names = ['doc_a', 'doc_b']
```

In [ ]:

```
PAIRS['cityblock'] = pdist(Collapsed_TFIDF, 'cityblock')
PAIRS['euclidean'] = pdist(Collapsed_TFIDF, 'euclidean')
PAIRS['cosine'] = pdist(Collapsed_TFIDF, 'cosine')
PAIRS['jaccard'] = pdist(L0, 'jaccard')
PAIRS['dice'] = pdist(L0, 'dice')
PAIRS['js'] = pdist(L1, 'jensenshannon')
```

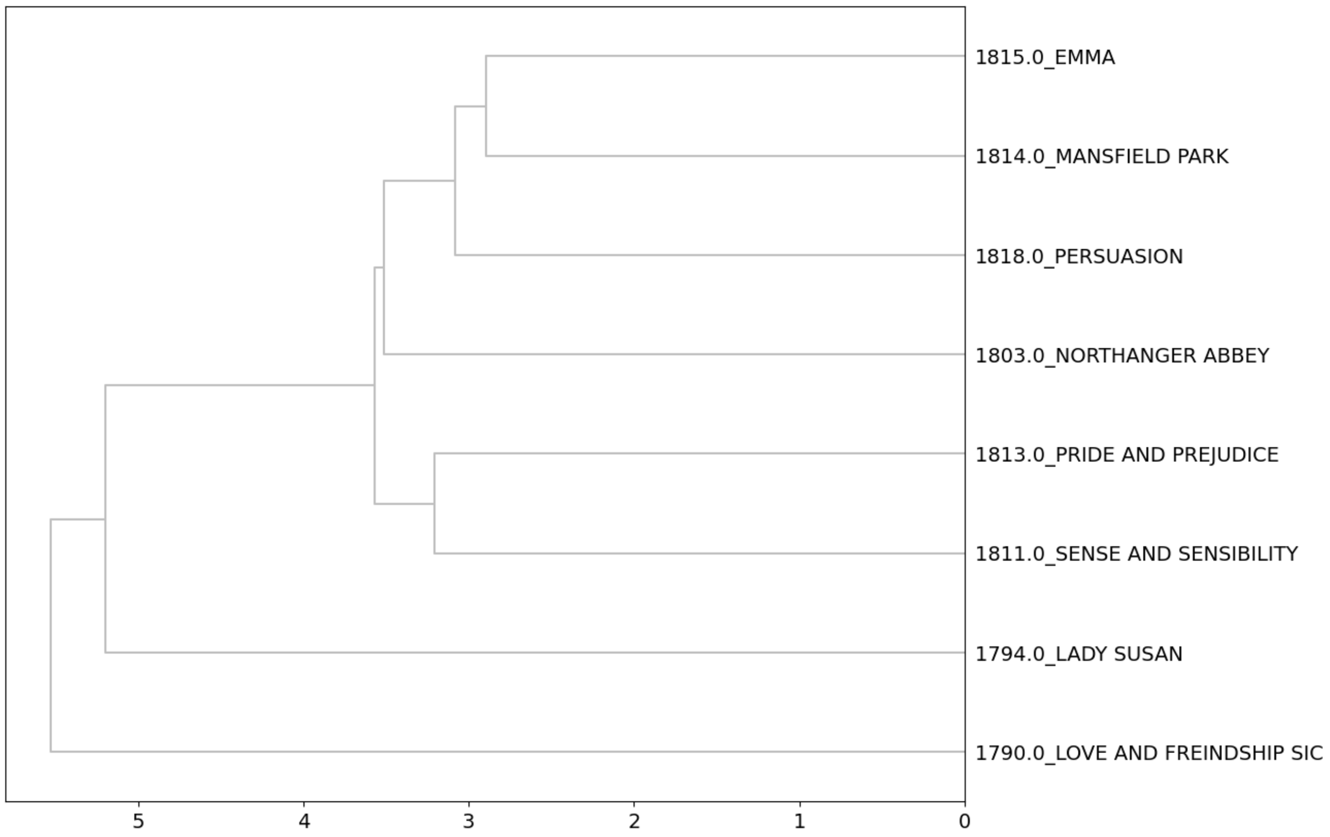
In [ ]:

```
def hac(sims, linkage_method='complete', color_thresh=.3, figsize=(10, 10)):

    # Generate the clustering
    tree = sch.linkage(sims, method=linkage_method)

    # Get labels for the leaves
    labels = LIB.label.values

    # Create a figure
    plt.figure()
    fig, axes = plt.subplots(figsize=(figsize))

    # Create a dendrogram with the tree
    dendrogram = sch.dendrogram(tree,
                                labels=labels,
                                orientation="left",
                                count_sort=True,
                                distance_sort=True,
                                above_threshold_color='.75',
                                color_threshold=color_thresh
                               )

    # Change the appearance of ticks, tick labels, and gridlines
    plt.tick_params(axis='both', which='major', labelsize=14)
```

In [ ]:

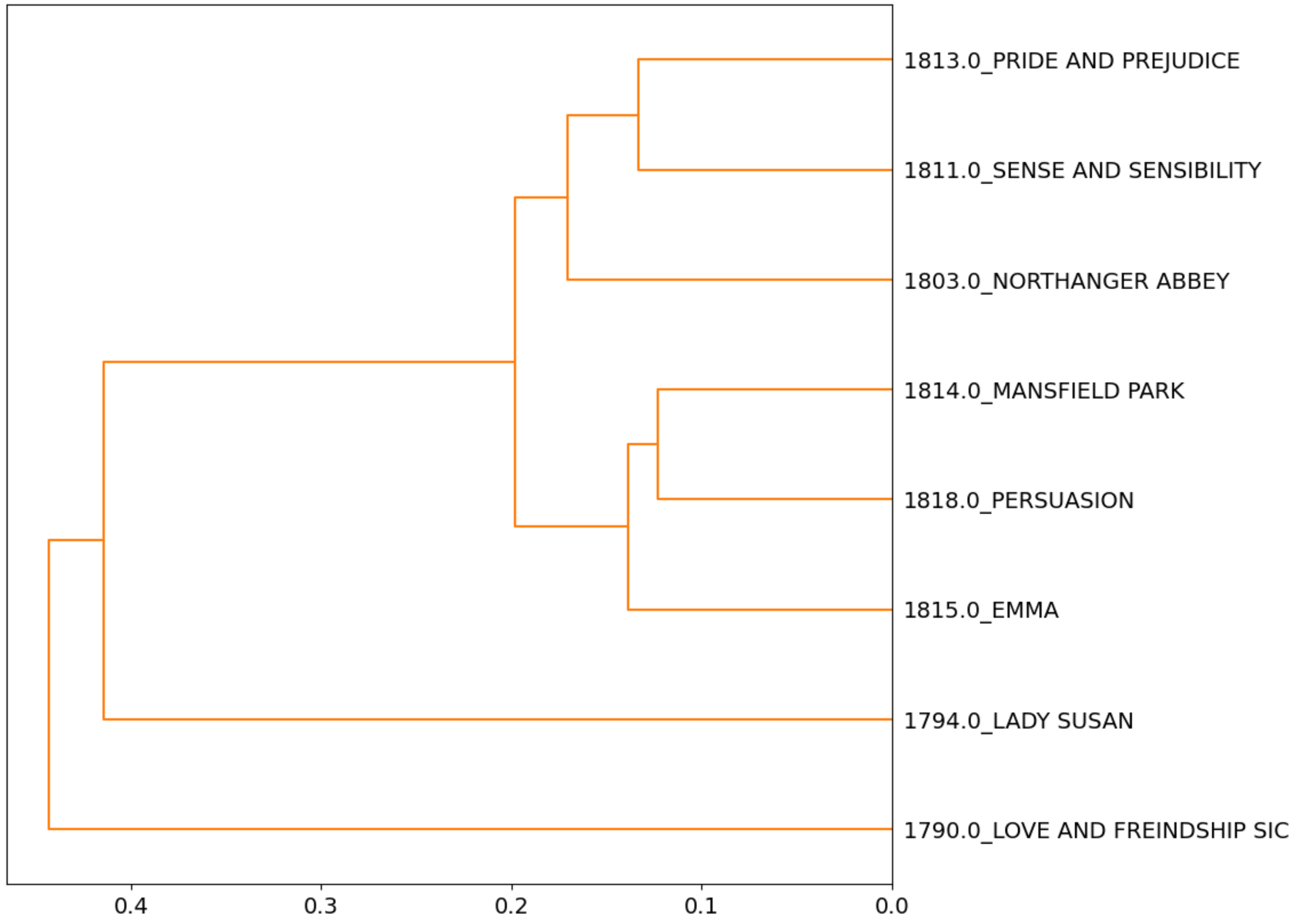
```
hac(PAIRS.cityblock, linkage_method='weighted', color_thresh=1.2)
```

```
<Figure size 640x480 with 0 Axes>
```



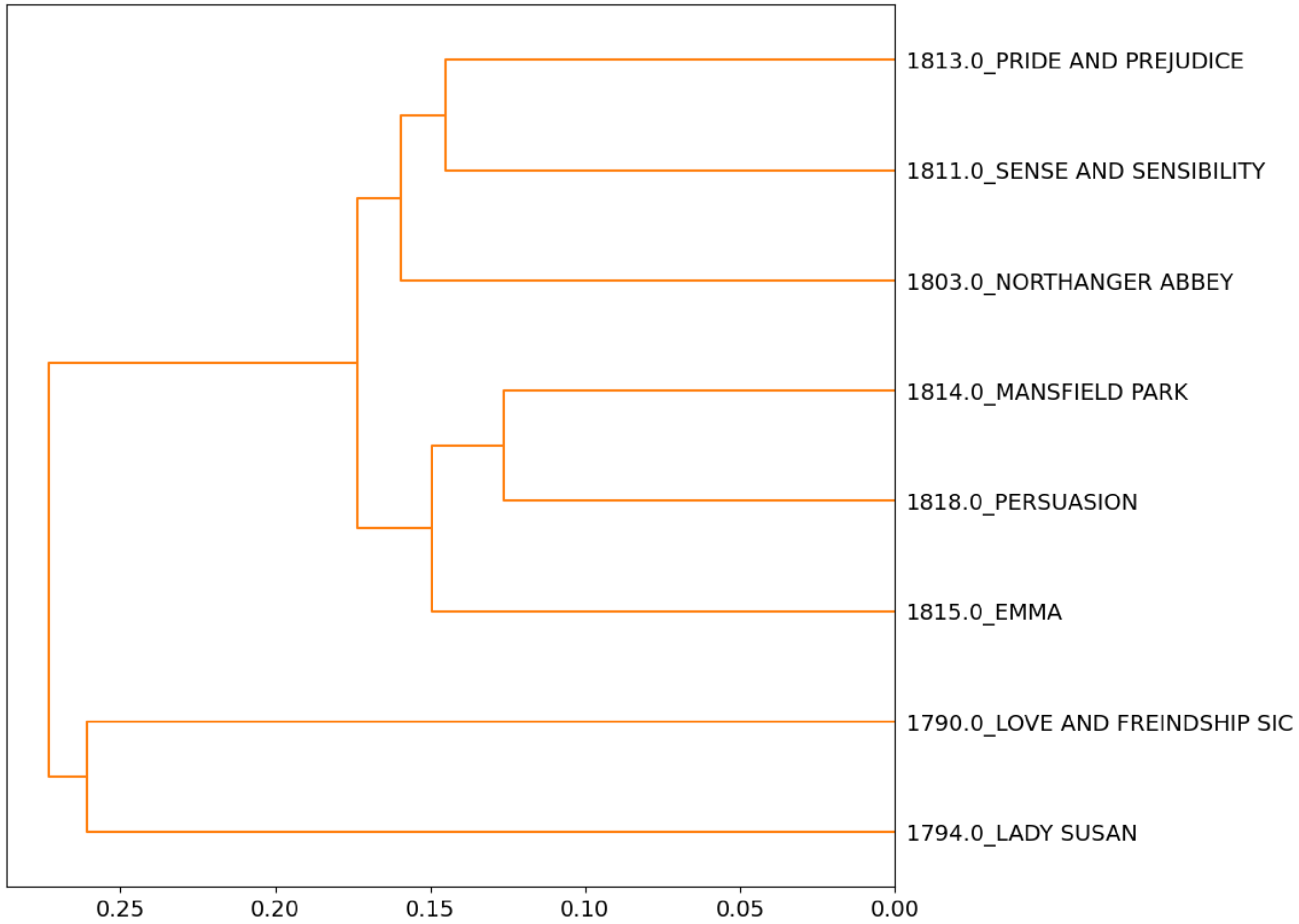
```
In [ ]: hac(PAIRS.cosine, linkage_method='ward', color_thresh=.85);
```

```
<Figure size 640x480 with 0 Axes>
```



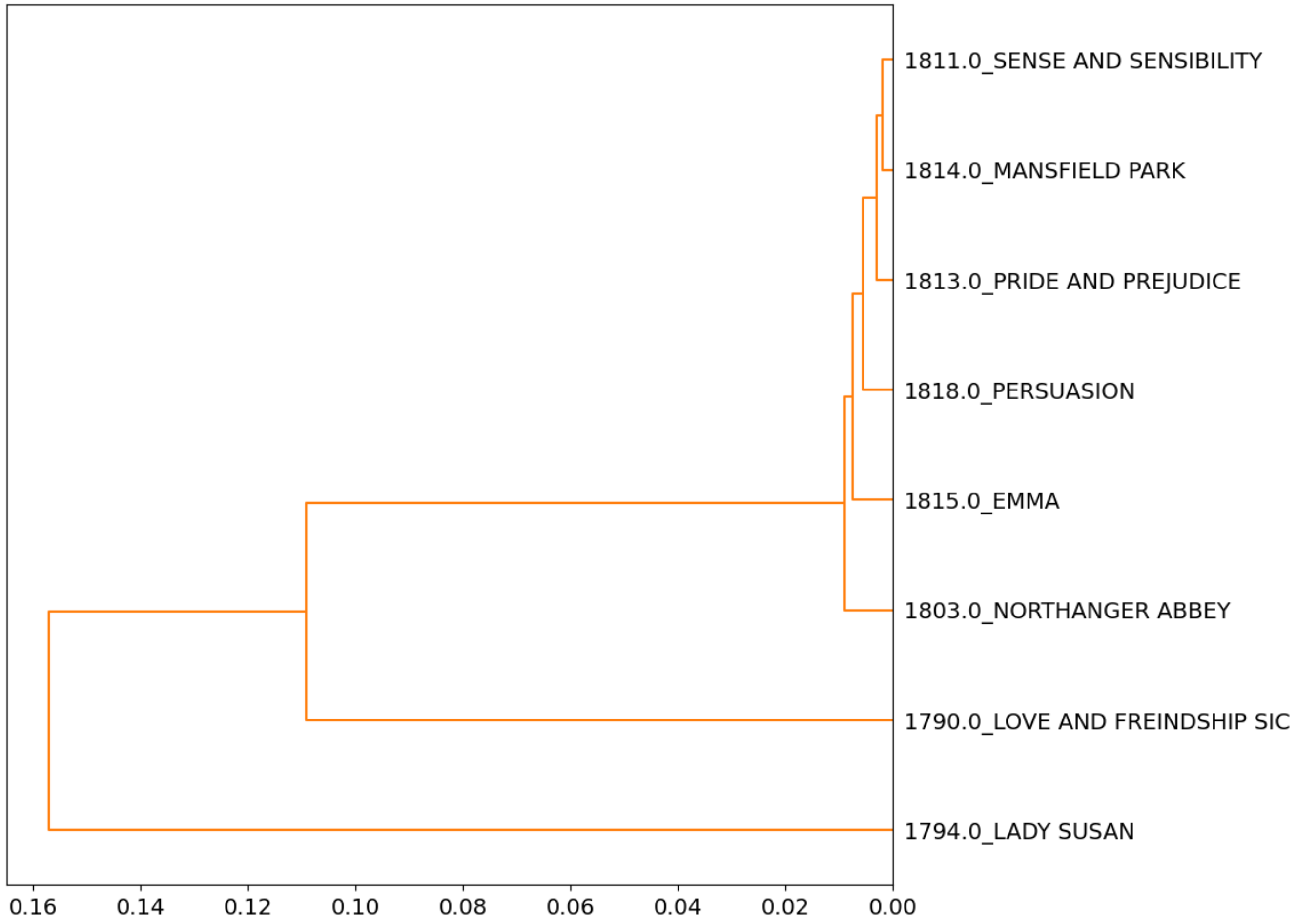
```
In [ ]: hac(PAIRS.euclidean, linkage_method='ward', color_thresh=.85);
```

```
<Figure size 640x480 with 0 Axes>
```



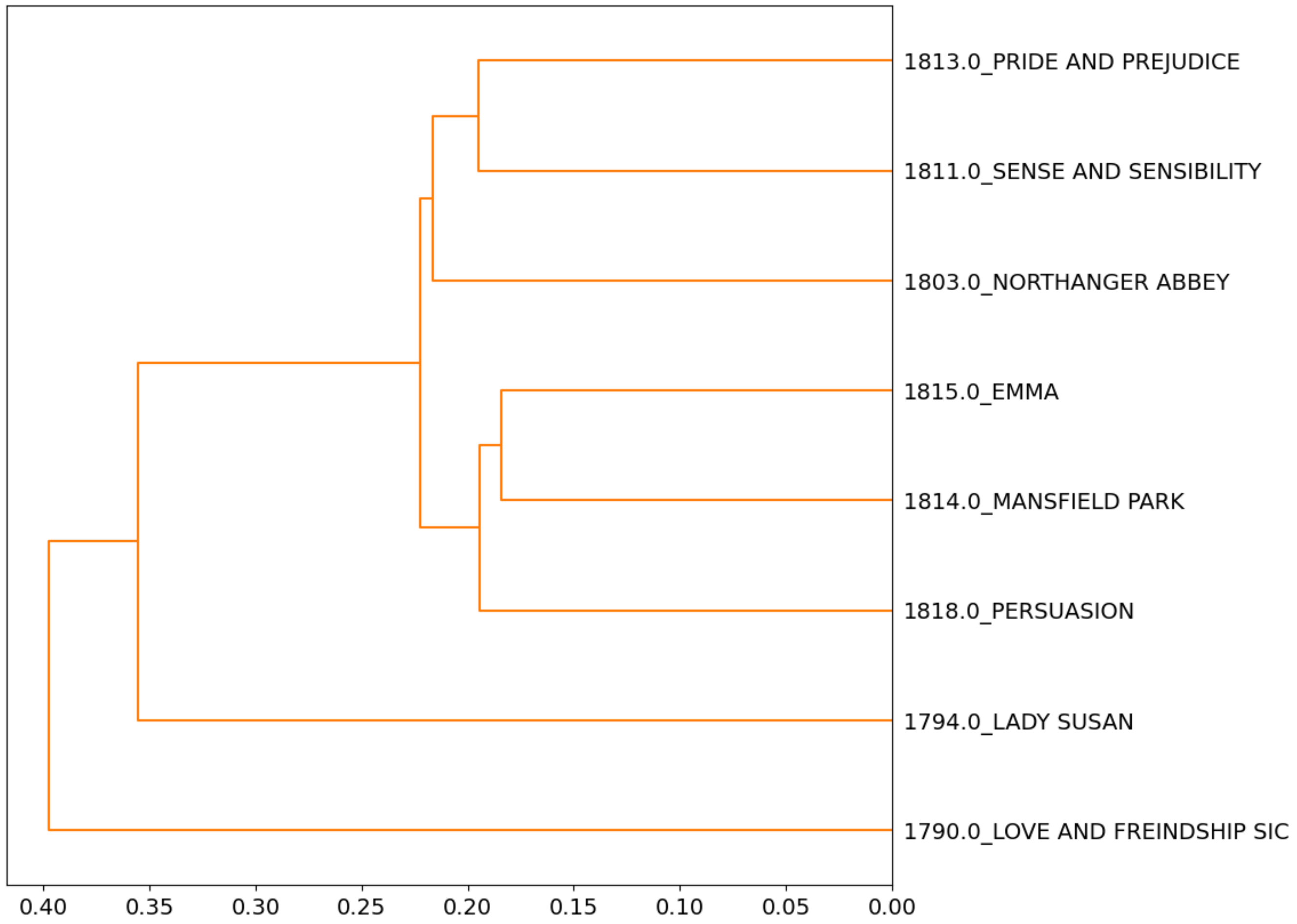
```
In [ ]: hac(PAIRS.jaccard, linkage_method='weighted', color_thresh=.85);
```

```
<Figure size 640x480 with 0 Axes>
```



```
In [ ]: hac(PAIRS.js, linkage_method='weighted', color_thresh=.85);
```

```
<Figure size 640x480 with 0 Axes>
```



1. What are the top 10 nouns by DFIDF, sorted in descending order? Include plural nouns, but don't include proper nouns.

In [ ]:

```
VOCAB.query("max_pos == 'NN' or max_pos == 'NNS'").join(DFIDF).sort_values('DFIDF', ascending=False).head(10)['DFIDF'].to_frame()
```

Out[ ]:

| term_str | DFIDF |
|---|---|
| respect | 177.266344 |
| marriage | 177.261968 |
| fortune | 177.261968 |
| question | 177.258990 |
| ladies | 177.258990 |
| behaviour | 177.240001 |
| farther | 177.240001 |
| advantage | 177.217644 |
| girl | 177.209470 |
| voice | 177.209470 |

2. Grouping your TFIDF results by book, and taking the mean TFIDF of all terms per book, what is Austen's most "significant" book? This value is computed from the TFIDF matrix your function returned.

In [ ]:

```
TFIDF_means = TFIDF.loc[:, VOCAB.join(DFIDF, how='right').reset_index()['term_str'].to_list()]\
    .reset_index().groupby(['book_id']).mean().drop('chap_id', axis=1)

TFIDF_means.T.mean().to_frame('TFIDF').join(LIB, how='left').sort_values(by='TFIDF', ascending=False).head(1)[['title', 'TFIDF']]
```

Out[ ]:

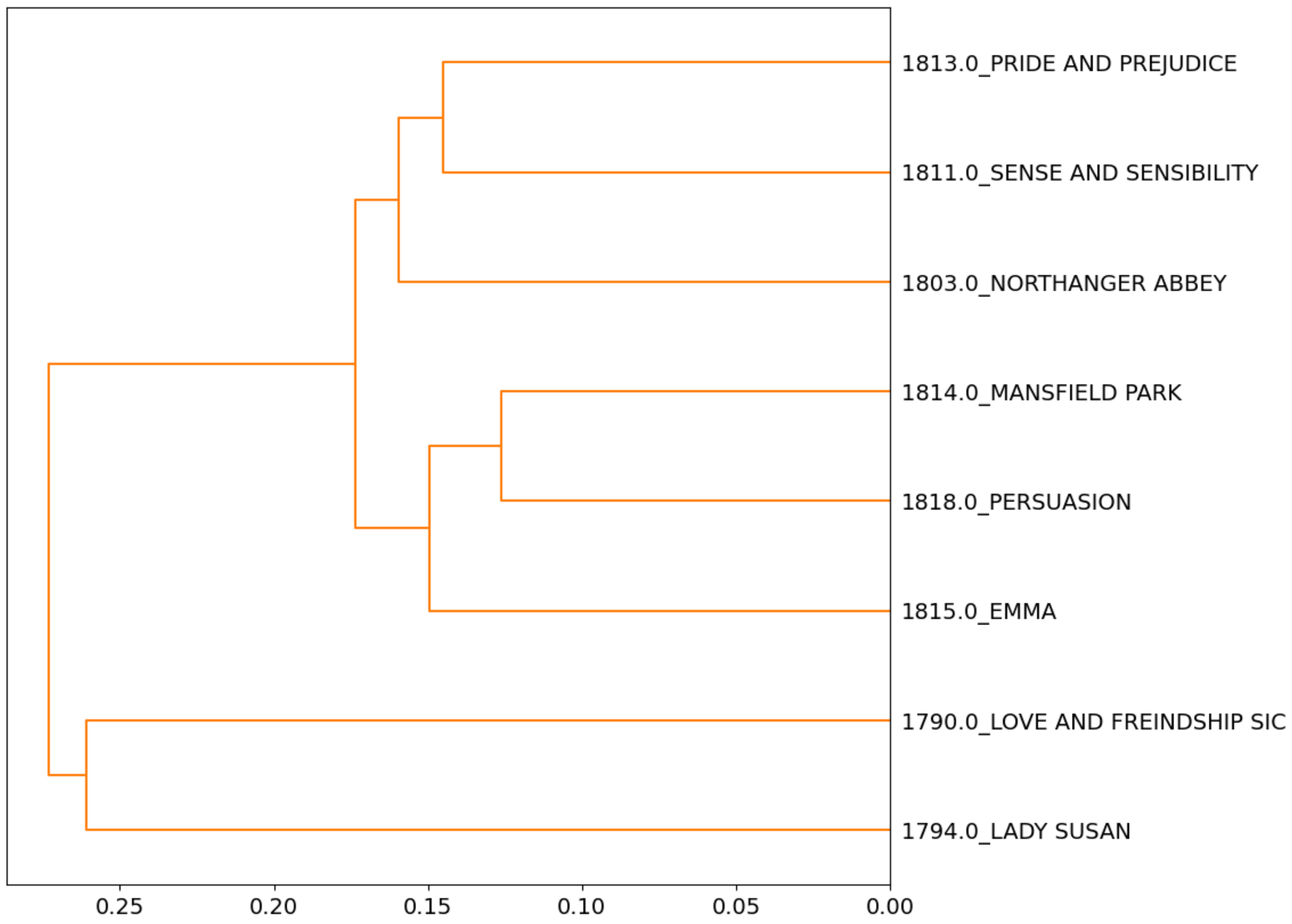
| book_id | title | TFIDF |
|---|---|---|
| 121 | NORTHANGER ABBEY | 0.001851 |

3. Using the dendograms you generated, which distance measure most clearly distinguishes Austen's two youthful works from her later works? That is, which measure show the greatest separation between the first two work and the rest? Note that the two youthful works were published before 1800.

In [ ]:

```
hac(PAIRS.euclidean, linkage_method='ward', color_thresh=.85);
```

```
<Figure size 640x480 with 0 Axes>
```



As we can see from the dendrograms created, Austen's earliest works Lady Susan (946) and Love and Friendship (1212) are most clearly distinguished from her later works through **Euclidean** distance. Shown above, we can see the first split separates the two earliest works from the rest of Austen's works.

### 4. Do any of the distance measures produce dendrograms with works sorted in the exact order of their publication years?

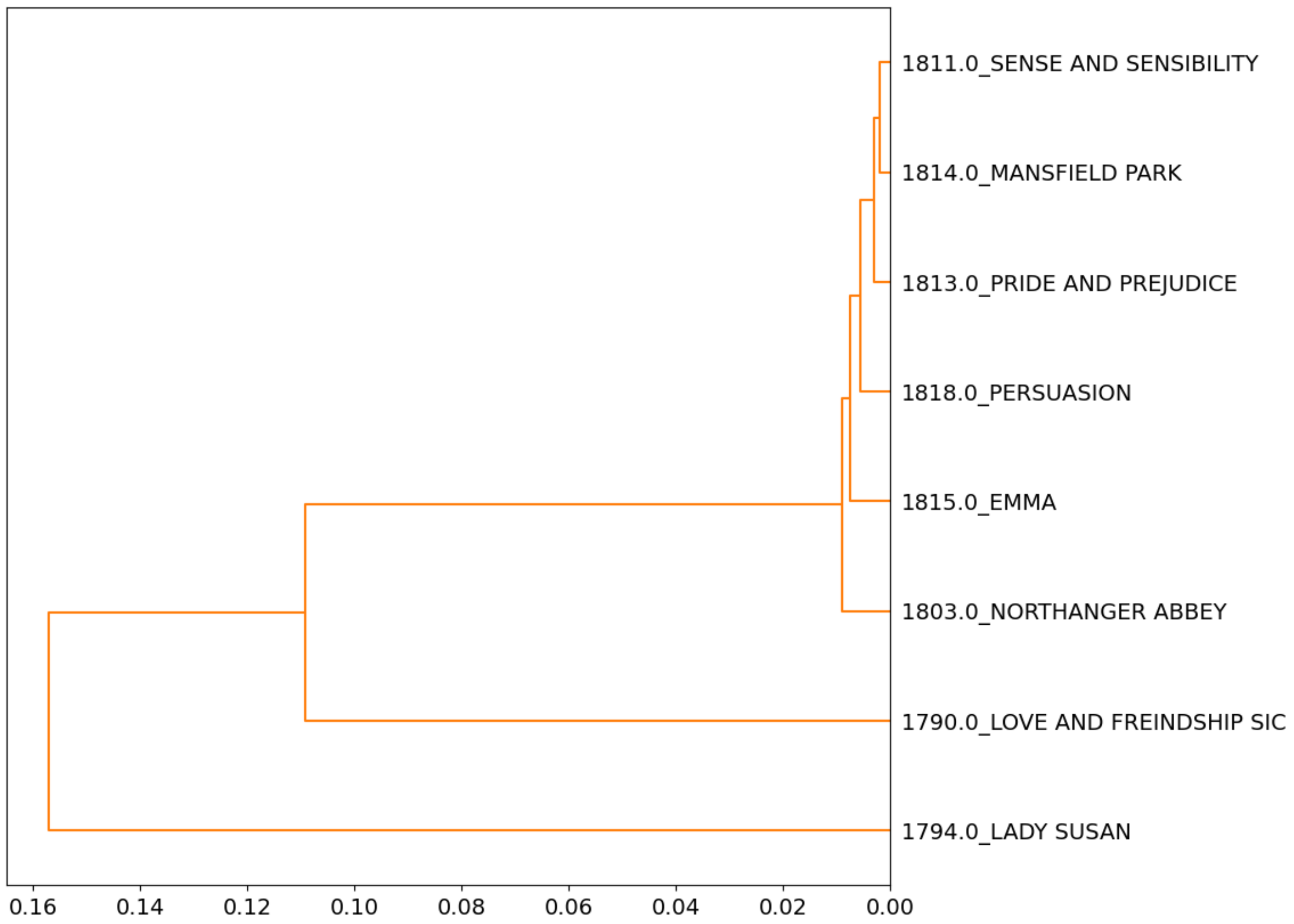
No, none of the dendrograms with the given distance and linkage measure combinations produce the works exactly sorted. However, **cityblock** comes the closest to doing so.

### 5. Some literary critics believe that Northanger Abbey is, among Austen's mature works, the one that most resembles her juvenalia, i.e. her two works written as a young adult. Which distance measure dendrograms appear to corroborate this thesis? In other words, do any of them show that Northanger Abbey is closer to her juvenalia than the her other adult works?

In [ ]:

```
hac(PAIRS.jaccard, linkage_method='weighted', color_thresh=.85);
```

```
<Figure size 640x480 with 0 Axes>
```



yes, the **jaccard** distance measure dendrogram shows that Northanger Abbey is closest to Austen's two earliest works!