CWordTM Toolkit Usage on BBC News

This Jupyter notebook demonstrates how to use the package "CWordTM" on the BBC News:

1. Meta Information Features
2. Utility Features
3. Text Visualization - Word Cloud
4. Text Summarization
5. Topic Modeling - LDA, BERTopic and NMF

In [1]:
```
import warnings
warnings.filterwarnings('ignore')
```

1. Meta Information Features

In [2]:
```
import cwordtm
from cwordtm import *
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\User\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to
[nltk_data]     C:\Users\User\AppData\Roaming\nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package punkt to
[nltk_data]     C:\Users\User\AppData\Roaming\nltk_data...
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package averaged_perceptron_tagger to
[nltk_data]     C:\Users\User\AppData\Roaming\nltk_data...
[nltk_data]   Package averaged_perceptron_tagger is already up-to-
[nltk_data]       date!
```

In [3]:
```
cwordtm.__version__
```

Out[3]:
```
'0.6.3'
```

In [4]:
```
# Show brief module information
print(meta.get_module_info())
```

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```
The member information of the module 'cwordtm'
1. Submodule meta:
   addin (func)
   addin_all (modname='cwordtm')
   addin_all_functions (submod)
   get_function (mod_name, submodules, func_name)
   get_module_info (detailed=False)
   get_submodule_info (submodname, detailed=False)
   import_module (name, package=None)
   wraps (wrapped, assigned=('__module__', '__name__', '__qualname__', '__doc__', '__annotations_
_'), updated=('__dict__',))
2. Submodule pivot:
   stat (df, chi=False, *, timing=False, code=0)
3. Submodule quot:
   extract_quotation (text, quot_marks, *, timing=False, code=0)
   match_text (target, sent_tokens, lang, threshold, n=5, *, timing=False, code=0)
   match_verse (i, ot_list, otdf, df, book, chap, verse, lang, threshold, *, timing=False, code=
0)
   show_quot (target, source='ot', lang='en', threshold=0.5, *, timing=False, code=0)
   tokenize (sentence, *, timing=False, code=0)
4. Submodule ta:
   get_sent_scores (sentences, diction, sent_len, *, timing=False, code=0) -> dict
   get_sentences (docs, lang='en', *, timing=False, code=0)
   get_summary (sentences, sent_weight, threshold, sent_len, *, timing=False, code=0)
   pos_tag (tokens, tagset=None, lang='eng', *, timing=False, code=0)
   preprocess_sent (text, *, timing=False, code=0)
   sent_tokenize (text, language='english', *, timing=False, code=0)
   summary_chi (docs, weight=1.5, sent_len=8, *, timing=False, code=0)
   summary_en (docs, sent_len=8, *, timing=False, code=0)
   word_tokenize (text, language='english', preserve_line=False, *, timing=False, code=0)
5. Submodule tm:
   BTM (textfile, num_topics, chi=False, embed=True)
   LDA (textfile, num_topics, chi=False)
   NMF (textfile, num_topics, chi=False)
   btm_process (doc_file, num_topics=10, source=0, text_col='text', cat=0, chi=False, group=True,
eval=False, *, timing=False, code=0)
   lda_process (doc_file, num_topics=10, source=0, text_col='text', cat=0, chi=False, group=True,
eval=False, *, timing=False, code=0)
   load_bible (textfile, cat=0, group=True, *, timing=False, code=0)
   load_text (textfile, text_col='text', *, timing=False, code=0)
   ngrams (sequence, n, *, timing=False, code=0, **kwargs)
   nmf_process (doc_file, num_topics=10, source=0, text_col='text', cat=0, chi=False, group=True,
eval=False, *, timing=False, code=0)
   pprint (object, stream=None, indent=1, width=80, depth=None, *, compact=False, sort_dicts=Tru
e, underscore_numbers=False, timing=False, code=0)
   process_text (doc, *, timing=False, code=0)
6. Submodule util:
   add_chi_vocab (*, timing=False, code=0)
   bible_cat_info (lang='en', *, timing=False, code=0)
   chi_sent_terms (text, *, timing=False, code=0)
   chi_stops (*, timing=False, code=0)
   clean_sentences (sentences, *, timing=False, code=0)
   clean_text (df, text_col='text', *, timing=False, code=0)
   extract (df, testament=-1, category='', book=0, chapter=0, verse=0, *, timing=False, code=0)
   extract2 (df, filter='', *, timing=False, code=0)
   get_diction (docs, *, timing=False, code=0)
   get_diction_chi (docs, *, timing=False, code=0)
   get_diction_en (docs, *, timing=False, code=0)
   get_list (df, column='book', *, timing=False, code=0)
   get_sent_terms (text, *, timing=False, code=0)
   get_text (df, text_col='text', *, timing=False, code=0)
   get_text_list (df, text_col='text', *, timing=False, code=0)
   group_text (df, column='chapter', *, timing=False, code=0)
   is_chi (*, timing=False, code=0)
   load_text (filepath, nr=0, info=False, *, timing=False, code=0)
   load_word (ver='web.csv', nr=0, info=False, *, timing=False, code=0)
   preprocess_text (text, *, timing=False, code=0)
   remove_noise (text, noise_list, *, timing=False, code=0)
   set_lang (lang='en', *, timing=False, code=0)
   word_tokenize (text, language='english', preserve_line=False, *, timing=False, code=0)
7. Submodule version:
8. Submodule viz:
Loading [MathJax]/extensions/Safe.js d (docs, figsize=(15, 10), bg='white', image=0, *, timing=False, code=0)
   plot_cloud (wordcloud, figsize, *, timing=False, code=0)
   show_wordcloud (docs, clean=False, figsize=(12, 8), bg='white', image=0, *, timing=False, code
=0)
```

In [5]:
```
# Show detailed module information of a submodule
print(meta.get_submodule_info("viz", detailed=True))
```

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```
The function(s) of the submodule 'cwordtm.viz':

def chi_wordcloud(docs, figsize=(15, 10), bg='white', image=0):
    """Prepare and show a Chinese wordcloud

    :param docs: The collection of Chinese documents for preparing a wordcloud,
        default to None
    :type docs: pandas.DataFrame
    :param figsize: Size (width, height) of word cloud, default to (15, 10)
    :type figsize: tuple, optional
    :param bg: The background color (name) of the wordcloud, default to 'white'
    :type bg: str, optional
    :param image: The filename of the presribed image as the mask of the wordcloud,
        or 1/2/3/4 for using an internal image (heart / disc / triangle / arrow),
        default to 0 (No image mask)
    :type image: int or str, optional
    """

    util.set_lang('chi')
    diction = util.get_diction(docs)

    masks = ['heart.jpg', 'disc.jpg', 'triangle.jpg', 'arrow.jpg']

    if image == 0:
        mask = None
    elif image in [1, 2, 3, 4]:  # Internal image file
        img_file = files('cwordtm.images').joinpath(masks[image-1])
        mask = np.array(Image.open(img_file))
    elif isinstance(image, str) and len(image) > 0:
        mask = np.array(Image.open(image))
    else:
        mask = None

    font_file = files('cwordtm.data').joinpath('msyh.ttc')
    wordcloud = WordCloud(background_color=bg, colormap='Set2',
                          mask=mask, font_path=str(font_file)) \
                    .generate_from_frequencies(frequencies=diction)

    plot_cloud(wordcloud, figsize=figsize)

def plot_cloud(wordcloud, figsize):
    """Plot the prepared 'wordcloud'
    :param wordcloud: The WordCloud object for plotting, default to None
    :type wordcloud: WordCloud object
    :param figsize: Size (width, height) of word cloud, default to None
    :type figsize: tuple
    """

    plt.figure(figsize=figsize)
    plt.imshow(wordcloud)
    plt.axis("off");

def show_wordcloud(docs, clean=False, figsize=(12, 8), bg='white', image=0):
    """Prepare and show a wordcloud

    :param docs: The collection of documents for preparing a wordcloud,
        default to None
    :type docs: pandas.DataFrame
    :param clean: The flag whether text preprocessing is needed,
        default to False
    :type clean: bool, optional
    :param figsize: Size (width, height) of word cloud, default to (12, 8)
    :type figsize: tuple, optional
    :param bg: The background color (name) of the wordcloud, default to 'white'
    :type bg: str, optional
    :param image: The filename of the presribed image as the mask of the wordcloud,
        or 1/2/3/4 for using an internal image (heart / disc / triangle / arrow),
        default to 0 (No image mask)
    :type image: int or str, optional
    """

    masks = ['heart.jpg', 'disc.jpg', 'triangle.jpg', 'arrow.jpg']

    if image == 0:
```

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```
            mask = None
        elif image in [1, 2, 3, 4]:  # Internal image file
            img_file = files('cwordtm.images').joinpath(masks[image-1])
            mask = np.array(Image.open(img_file))
        elif isinstance(image, str) and len(image) > 0:
            mask = np.array(Image.open(image))
        else:
            mask = None

        if isinstance(docs, pd.DataFrame):
            docs = ' '.join(list(docs.text.astype(str)))
        elif isinstance(docs, pd.Series):
            docs = ' '.join(list(docs.astype(str)))
        elif isinstance(docs, list) or isinstance(docs, np.ndarray):
            docs = ' '.join(str(doc) for doc in docs)

        if clean:
            docs = util.preprocess_text(docs)

        wordcloud = WordCloud(background_color=bg, colormap='Set2', mask=mask) \
                        .generate(docs)

        plot_cloud(wordcloud, figsize=figsize)
```

In [6]:
```
# Show execution time
df = util.load_text("BBC/BBC News Train.csv", timing=True)
```

```
Finished 'load_text' in 0.0360 secs
```

In [7]:
```
# Execute and show code
df = util.load_text("BBC/BBC News Train.csv", code=1)
```

```
def load_text(filepath, nr=0, info=False):
    """Loads and returns the text from the prescribed file path ('filepath').

    :param filepath: The prescribed filepath from which the text is loaded,
        default to None
    :type filepath: str
    :param nr: The number of rows of text to be loaded; 0 represents all rows,
        default to 0
    :type nr: int, optional
    :param info: The flag whether the dataset information is shown,
        default to False
    :type info: bool, optional
    :return: The collection of text with the prescribed number of rows loaded
    :rtype: pandas.DataFrame
    """

    # print("Loading file '%s' ..." %filepath)
    if filepath.lower().endswith('csv'):
        nrows = None
        if nr > 0: nrows = nr
        df = pd.read_csv(filepath, nrows=nrows, encoding='utf-8')
    else:
        noise_list = ['\u3000', '- ', '•']
        tf =  open(filepath, encoding='utf-8')
        lines = [remove_noise(line, noise_list) for line in tf.readlines()]
        lines = list(filter(None, lines))

        df = pd.DataFrame({'text': lines})
        if nr > 0: df = df.iloc[:nr]

    if info:
        print("\nDataset Information:")
        df.info()

    return df

>> cwordtm.util.remove_noise
def remove_noise(text, noise_list):
    """Removes a list of substrings in noise_list from the input text.

    :param text: The input text, default to None
    :type text: str
    :param noise_list: The list of substrings to be removed, default to ""
    :type noise_list: list, optional
    :return: The text with the prescribed substrings removed
    :rtype: str
    """

    text = text.rstrip()
    for noise in noise_list:
        text = text.replace(noise, '')
    return text
```

In [8]:
```
# Show code without execution
df = util.load_text("BBC/BBC News Train.csv", code=2)
```

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```
def load_text(filepath, nr=0, info=False):
    """Loads and returns the text from the prescribed file path ('filepath').

    :param filepath: The prescribed filepath from which the text is loaded,
        default to None
    :type filepath: str
    :param nr: The number of rows of text to be loaded; 0 represents all rows,
        default to 0
    :type nr: int, optional
    :param info: The flag whether the dataset information is shown,
        default to False
    :type info: bool, optional
    :return: The collection of text with the prescribed number of rows loaded
    :rtype: pandas.DataFrame
    """

    # print("Loading file '%s' ..." %filepath)
    if filepath.lower().endswith('csv'):
        nrows = None
        if nr > 0: nrows = nr
        df = pd.read_csv(filepath, nrows=nrows, encoding='utf-8')
    else:
        noise_list = ['\u3000', '- ', '•']
        tf =  open(filepath, encoding='utf-8')
        lines = [remove_noise(line, noise_list) for line in tf.readlines()]
        lines = list(filter(None, lines))

        df = pd.DataFrame({'text': lines})
        if nr > 0: df = df.iloc[:nr]

    if info:
        print("\nDataset Information:")
        df.info()

    return df


>> cwordtm.util.remove_noise
def remove_noise(text, noise_list):
    """Removes a list of substrings in noise_list from the input text.

    :param text: The input text, default to None
    :type text: str
    :param noise_list: The list of substrings to be removed, default to ""
    :type noise_list: list, optional
    :return: The text with the prescribed substrings removed
    :rtype: str
    """

    text = text.rstrip()
    for noise in noise_list:
        text = text.replace(noise, '')
    return text
```

In [9]:
```
# Add timing and code reveal features to some other function
from importlib_resources import files
files = meta.addin(files)
files(code=2)
```

```
@package_to_anchor
def files(anchor: Optional[Anchor] = None) -> Traversable:
    """
    Get a Traversable resource for an anchor.
    """
    return from_package(resolve(anchor))
```

2. Utility Features

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Load BBC News

```
In [10]: bbc_file = "BBC/BBC News Train.csv"
         df = util.load_text(bbc_file, info=True)
```

```
Dataset Information:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1490 entries, 0 to 1489
Data columns (total 3 columns):
 #   Column     Non-Null Count  Dtype
---  ------     --------------  -----
 0   ArticleId  1490 non-null   int64
 1   Text       1490 non-null   object
 2   Category   1490 non-null   object
dtypes: int64(1), object(2)
memory usage: 35.0+ KB
```

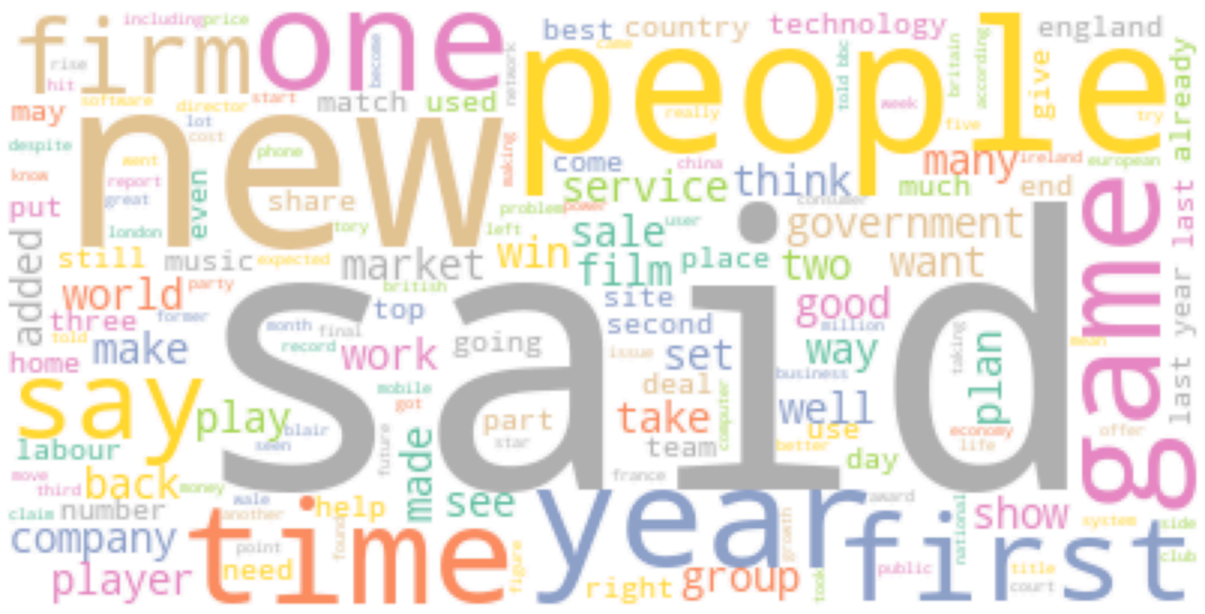
Preprocessing Text

```
In [11]: text_list = util.get_text_list(df.iloc[:500], text_col='Text')
         text = util.preprocess_text(text_list)
```

3. Text Visualization - Word Cloud

```
In [12]: # White background with no image mask
         viz.show_wordcloud(text)
```

```
C:\Dev\Anaconda3\envs\aiml\lib\site-packages\wordcloud\wordcloud.py:106: MatplotlibDeprecationWar
ning: The get_cmap function was deprecated in Matplotlib 3.7 and will be removed two minor releas
es later. Use ``matplotlib.colormaps[name]`` or ``matplotlib.colormaps.get_cmap(obj)`` instead.
  self.colormap = plt.cm.get_cmap(colormap)
```



```
In [13]: # Black background with the prescribed image as the mask
         viz.show_wordcloud(text, bg='black', image='images/disc.png')
```

```
C:\Dev\Anaconda3\envs\aiml\lib\site-packages\wordcloud\wordcloud.py:106: MatplotlibDeprecationWar
ning: The get_cmap function was deprecated in Matplotlib 3.7 and will be removed two minor releas
es later. Use ``matplotlib.colormaps[name]`` or ``matplotlib.colormaps.get_cmap(obj)`` instead.
  self.colormap = plt.cm.get_cmap(colormap)
```

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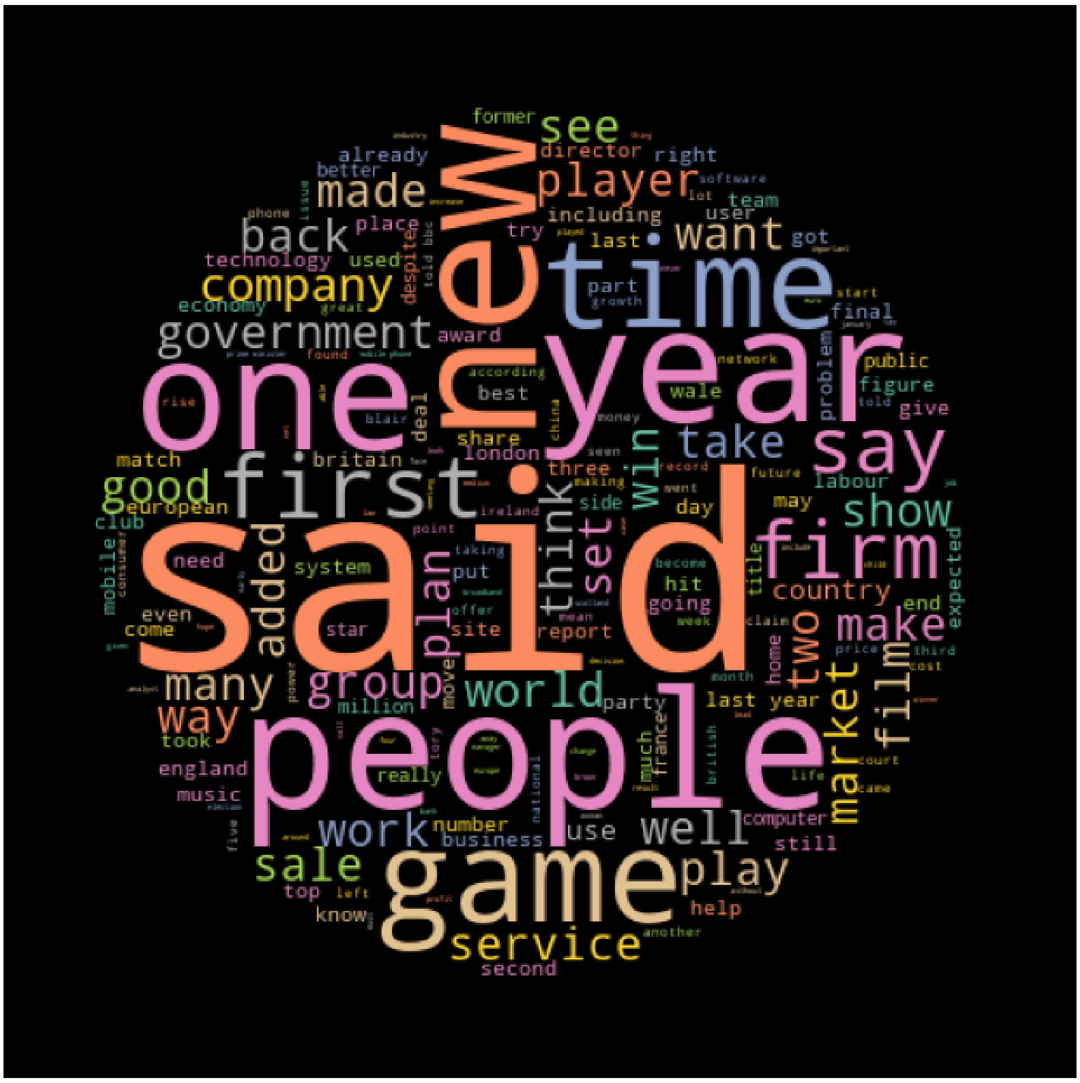

4. Text Summarization

In [14]:
```
news = df.iloc[:5]['Text']  # "df" stores previously loaded text
ta.summary_en(news, sent_len=5)
```

Out[14]:
```
['but ms cooper  who now runs her own consulting business  told a jury in new york on wednesday t
hat external auditors arthur andersen had approved worldcom s accounting in early 2001 and 2002.
she said andersen had given a  green light  to the procedures and practices used by worldcom.',
 'cynthia cooper  worldcom s ex-head of internal accounting  alerted directors to irregular accou
nting practices at the us telecoms giant in 2002. her warnings led to the collapse of the firm fo
llowing the discovery of an $11bn (£5.7bn) accounting fraud.',
 'prosecution lawyers have argued that mr ebbers orchestrated a series of accounting tricks at wo
rldcom  ordering employees to hide expenses and inflate revenues to meet wall street earnings est
imates.',
 'the university of california said the trial in the case is scheduled to begin in october 2006.
it joined the lawsuit in december 2001alleging  massive insider trading  and fraud  claiming it h
ad lost $145m on its investments in the company.',
 'the bbc s david willey in rome says one reason for that result is the changeover from the lira
to the euro in 2001  which is widely viewed as the biggest reason why their wages and salaries ar
e worth less than they used to be.']
```

5. Topic Modeling

In [15]:
```
import warnings
warnings.filterwarnings('ignore')
```

LDA Modeling

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In [16]:
```
doc_file = "BBC/BBC News Train.csv"
lda = tm.lda_process(doc_file, source=1, text_col='Text', eval=True, timing=True)
```

```
Corpus loaded!
Text preprocessed!
Text trained!
If no visualization is shown,
  you may execute the following commands to show the visualization:
    > import pyLDAvis
    > pyLDAvis.display(lda.vis_data)
Visualization prepared!

Topics from LDA Model:
[(0,
  '0.006*"said" + 0.006*"wa" + 0.004*"ha" + 0.003*"film" + 0.003*"best" + '
  '0.002*"year" + 0.002*"award" + 0.002*"sale" + 0.002*"mr" + 0.002*"new"'),
 (1,
  '0.006*"wa" + 0.004*"said" + 0.004*"ha" + 0.003*"mr" + 0.002*"year" + '
  '0.002*"new" + 0.002*"people" + 0.001*"say" + 0.001*"world" + 0.001*"game"'),
 (2,
  '0.005*"said" + 0.003*"ha" + 0.003*"wa" + 0.002*"mr" + 0.002*"new" + '
  '0.002*"year" + 0.001*"people" + 0.001*"world" + 0.001*"government" + '
  '0.001*"blair"'),
 (3,
  '0.008*"said" + 0.005*"wa" + 0.005*"mr" + 0.004*"ha" + 0.002*"people" + '
  '0.002*"labour" + 0.002*"election" + 0.002*"year" + 0.002*"new" + '
  '0.002*"brown"'),
 (4,
  '0.006*"wa" + 0.005*"said" + 0.004*"ha" + 0.003*"year" + 0.002*"game" + '
  '0.002*"film" + 0.001*"new" + 0.001*"win" + 0.001*"time" + 0.001*"england"'),
 (5,
  '0.005*"said" + 0.004*"wa" + 0.004*"ha" + 0.003*"year" + 0.002*"mr" + '
  '0.002*"bn" + 0.002*"government" + 0.001*"new" + 0.001*"world" + '
  '0.001*"number"'),
 (6,
  '0.004*"ha" + 0.004*"said" + 0.004*"wa" + 0.002*"year" + 0.002*"mr" + '
  '0.001*"dollar" + 0.001*"game" + 0.001*"film" + 0.001*"time" + 0.001*"say"'),
 (7,
  '0.007*"said" + 0.006*"wa" + 0.004*"ha" + 0.003*"mr" + 0.002*"year" + '
  '0.002*"people" + 0.002*"new" + 0.001*"world" + 0.001*"game" + 0.001*"time"'),
 (8,
  '0.006*"ha" + 0.006*"said" + 0.004*"wa" + 0.003*"year" + 0.002*"mr" + '
  '0.002*"people" + 0.002*"new" + 0.002*"time" + 0.002*"game" + '
  '0.001*"company"'),
 (9,
  '0.007*"said" + 0.005*"wa" + 0.004*"ha" + 0.002*"year" + 0.002*"people" + '
  '0.002*"new" + 0.001*"mobile" + 0.001*"uk" + 0.001*"game" + 0.001*"mr"')]

Model Evaluation Scores:
  Coherence: 0.6684181983634158
  Perplexity: -11.226267428136477
  Topic diversity: 0.0007368078040197184
  Topic size distribution: 0.0017825311942959

Finished 'lda_process' in 63.5579 secs
```

In [17]:
```
# LDA Model Visualization
import pyLDAvis
pyLDAvis.display(lda.vis_data)
```

Out[17]:

BERTopic Modeling

In [18]:
```
btm = tm.btm_process(doc_file, source=1, text_col='Text', eval=True, timing=True)
```

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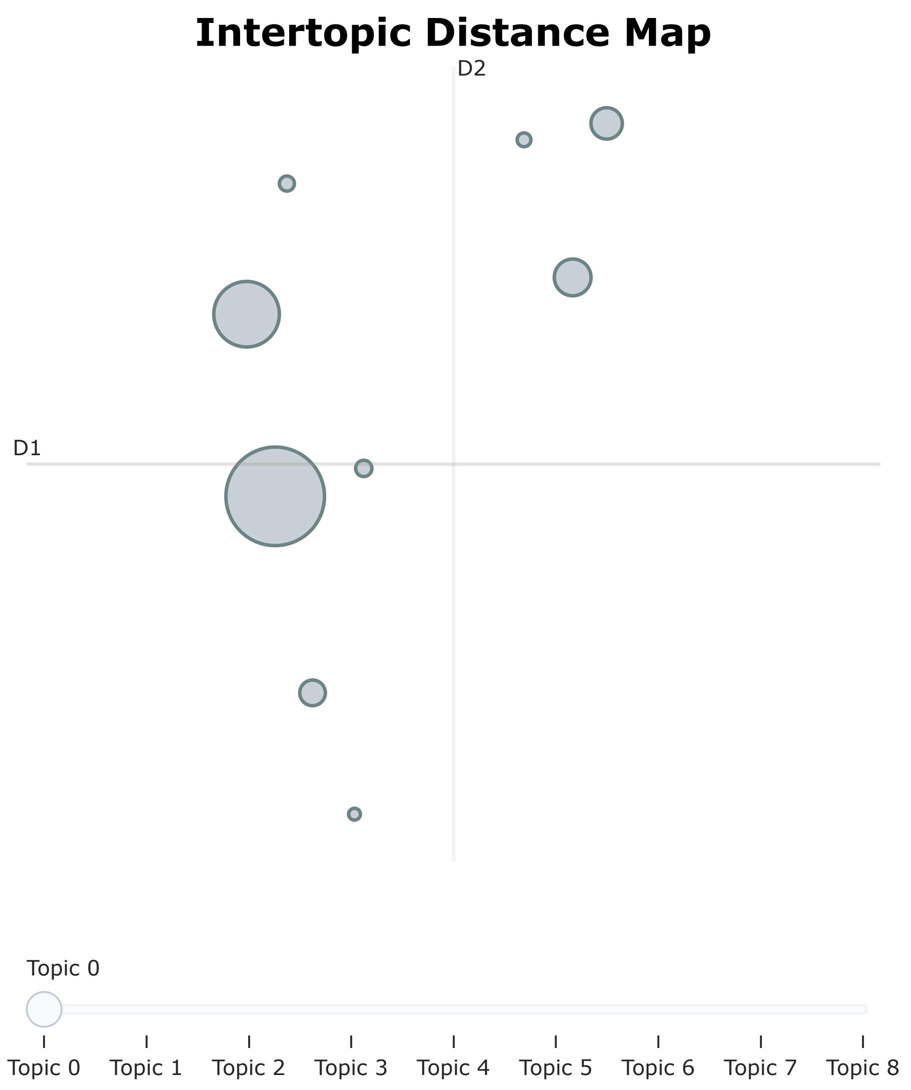
```
Corpus loaded!
Text preprocessed!
Text trained!

Topics from BERTopic Model:
Topic 0: said | mr | wa | ha | year | people | government | new | election | say
Topic 1: wa | game | year | ha | england | said | win | time | half | player
Topic 2: music | band | album | wa | chart | song | year | single | said | singer
Topic 3: film | best | award | oscar | actor | wa | star | director | actress | aviator
Topic 4: mail | virus | spam | anti | security | site | said | user | spyware | attack
Topic 5: yukos | russian | russia | tax | gazprom | oil | company | ha | bn | court
Topic 6: doping | test | kenteris | iaaf | conte | greek | drug | thanou | sprinter | athens
Topic 7: tv | bbc | series | channel | audience | rating | television | drama | said | wa
Topic 8: file | peer | sharing | pp | to | network | said | firm | apple | piracy

Model Evaluation Scores:
  Coherence: 0.6400456129165745

BERTopic Model Visualization:
```



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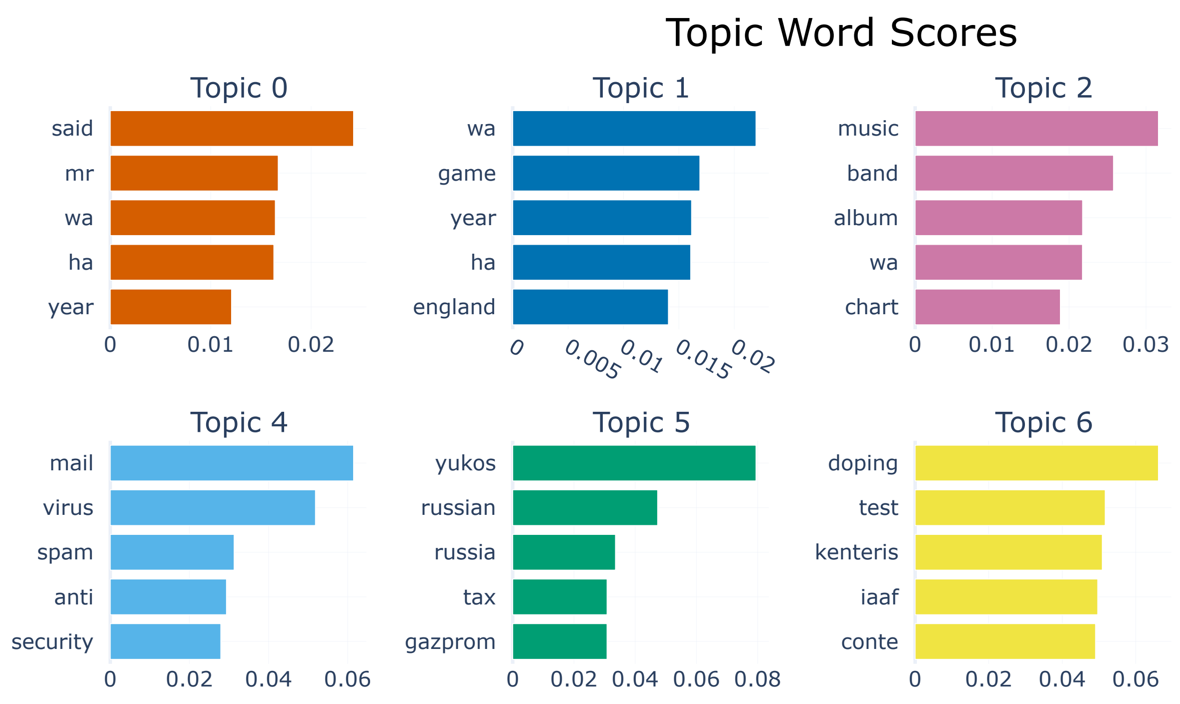
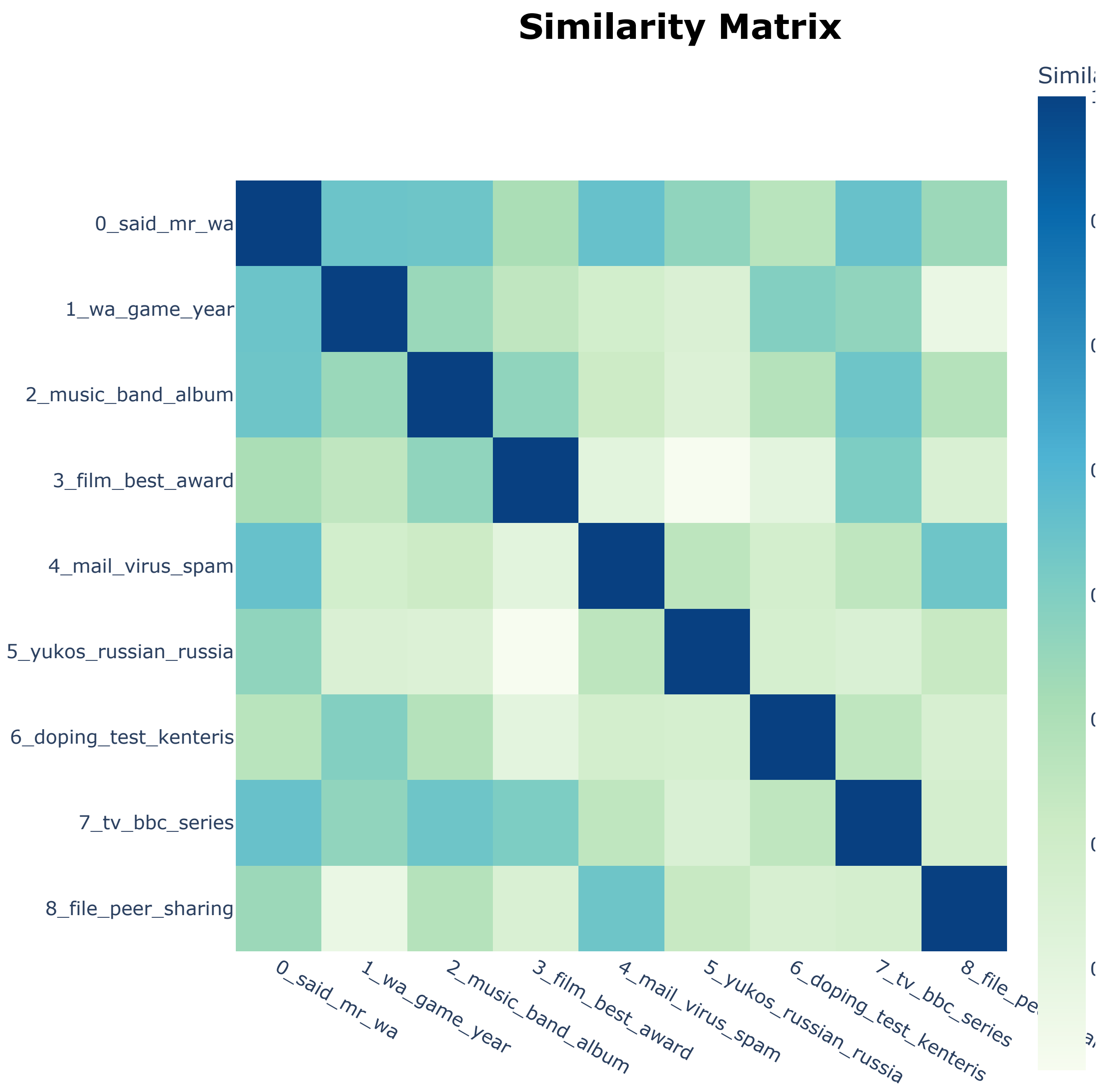


Loading [MathJax]/extensions/Safe.js



```
  If no visualization is shown,
    you may execute the following commands one-by-one:
      btm.model.visualize_topics()
      btm.model.visualize_barchart()
      btm.model.visualize_heatmap()

Finished 'btm_process' in 169.5788 secs
```

NMF Modeling

In [19]:
```
nmf = tm.nmf_process(doc_file, num_topics=8, source=1, text_col='Text', eval=True, timing=True, c
```

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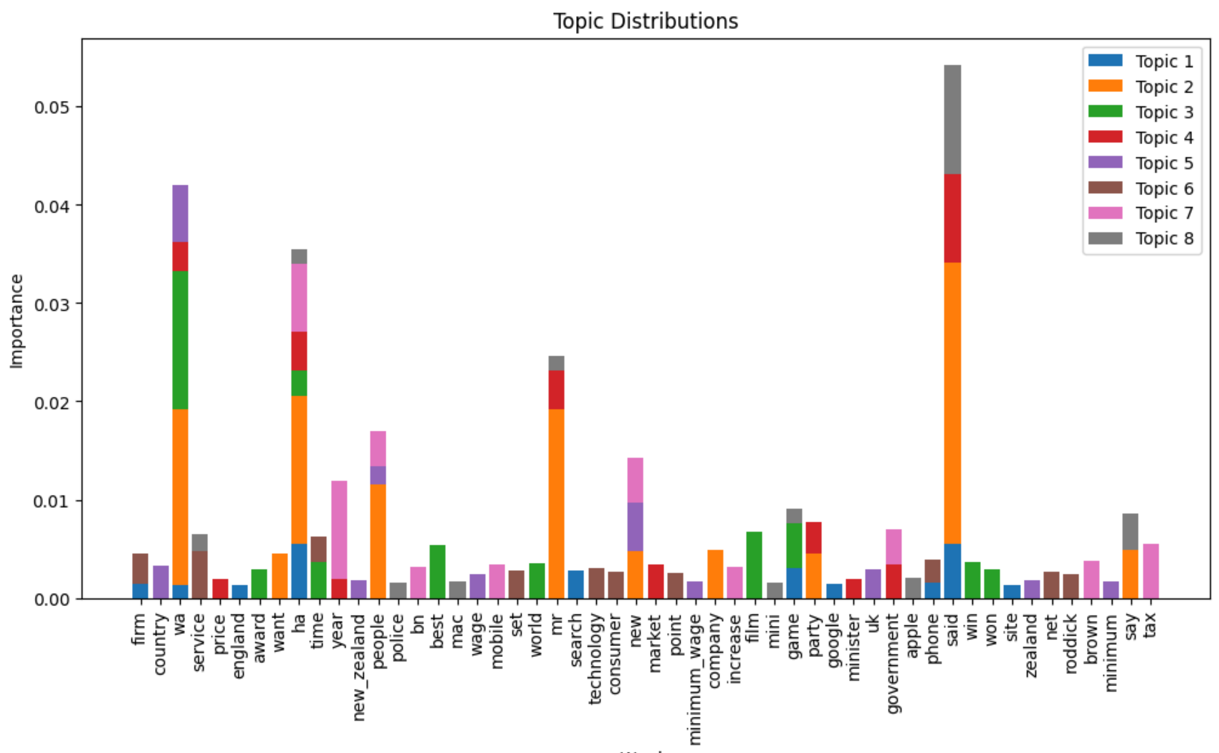
```
Corpus loaded!
Text preprocessed!
Text trained!

Topics-Words from NMF Model:
Topic 1:
ha (0.005502)
said (0.005488)
game (0.003028)
search (0.002788)
phone (0.001550)
firm (0.001429)
google (0.001412)
wa (0.001345)
england (0.001339)
site (0.001289)

Topic 2:
said (0.028586)
mr (0.019235)
wa (0.017877)
ha (0.015009)
people (0.011592)
say (0.004923)
company (0.004858)
new (0.004716)
want (0.004489)
party (0.004476)

Topic 3:
wa (0.014089)
film (0.006790)
best (0.005350)
game (0.004527)
time (0.003683)
win (0.003658)
world (0.003584)
award (0.002960)
won (0.002953)
ha (0.002610)

Topic 4:
said (0.009010)
ha (0.003972)
mr (0.003871)
government (0.003408)
market (0.003403)
party (0.003221)
wa (0.002955)
minister (0.001978)
price (0.001934)
year (0.001903)

Topic 5:
wa (0.005697)
new (0.004982)
country (0.003291)
uk (0.002917)
wage (0.002376)
zealand (0.001834)
new_zealand (0.001834)
people (0.001753)
minimum (0.001704)
minimum_wage (0.001660)

Topic 6:
service (0.004724)
technology (0.003066)
firm (0.003040)
set (0.002814)
net (0.002721)
consumer (0.002667)
[illegible])
time (0.002501)
```

```
roddick (0.002433)
phone (0.002372)

Topic 7:
year (0.010072)
ha (0.006910)
tax (0.005475)
new (0.004573)
brown (0.003770)
people (0.003628)
government (0.003540)
mobile (0.003380)
increase (0.003180)
bn (0.003099)

Topic 8:
said (0.011184)
say (0.003642)
apple (0.002075)
service (0.001739)
mac (0.001658)
mini (0.001602)
game (0.001500)
police (0.001495)
mr (0.001495)
ha (0.001485)
```



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```
Model Evaluation Scores:
  Coherence: 0.5600512699799133
  Topic diversity: 0.0007071142751343485
  Topic size distribution: 0.0010509721492380452

Finished 'nmf_process' in 36.3509 secs
```

```
def nmf_process(doc_file, num_topics=10, source=0, text_col='text', cat=0, chi=False, group=True,
eval=False):
    """Pipelines the NMF modeling.

    :param doc_file: The filename of the prescribed text file to be loaded,
        default to None
    :type doc_file: str
    :param num_topics: The number of topics to be modeled, default to 10
    :type num_topics: int, optional
    :param source: The source of the prescribed document file ('doc_file'),
        where 0 refers to internal store of the package and 1 to external file,
        default to 0
    :type source: int, optional
    :param text_col: The name of the text column to be extracted, default to 'text'
    :type text_col: str, optional
    :param cat: The category indicating a subset of the Scripture to be loaded, where
        0 stands for the whole Bible, 1 for OT, 2 for NT, or one of the ten categories
        ['tor', 'oth', 'ket', 'map', 'mip', 'gos', 'nth', 'pau', 'epi', 'apo'] (See
        the package's internal file 'data/book_cat.csv'), default to 0
    :type cat: int or str, optional
    :param chi: The flag indicating whether the text is processed as Chinese (True)
        or English (False), default to False
    :type chi: bool, optional
    :param group: The flag indicating whether the loaded text is grouped by chapter,
        default to True
    :type group: bool, optional
    :param eval: The flag indicating whether the model evaluation results will be shown,
        default to False
    :type eval: bool, optional
    :return: The pipelined NMF
    :rtype: cwordtm.tm.NMF object
    """

    nmf = NMF(doc_file, num_topics, chi)
    if source == 0:
        nmf.docs = load_bible(nmf.textfile, cat=cat, group=group)
    else:
        nmf.docs = load_text(nmf.textfile, text_col=text_col)

    print("Corpus loaded!")

    if chi:
        nmf.preprocess_chi()
    else:
        nmf.preprocess()
    print("Text preprocessed!")

    nmf.fit()
    print("Text trained!")
    nmf.show_topics_words()
    nmf.viz()

    if eval:
        print("\nModel Evaluation Scores:")
        nmf.evaluate()

    return nmf
```

```
>> cwordtm.tm.NMF
class NMF:
    """The NMF object for Non-negative Matrix Factorization (NMF) modeling.

    :cvar num_topics: The number of topics to be modeled, default to 10
    :vartype num_topics: int
    :ivar textfile: The filename of the text file to be processed
Loading [MathJax]/extensions/Safe.js xtfile: str
    :ivar chi: The flag indicating whether the processed text is in Chinese or not,
        True stands for Traditional Chinese or False for English
    :vartype chi: bool
    :ivar num_topics: The number of topics set for the topic model
    :vartype num_topics: int
    :ivar docs: The collection of the original documents to be processed
    :vartype docs: pandas.DataFrame or list
    :ivar pro_docs: The collection of documents, in form of list of lists of words
        after text preprocessing
    :vartype pro_docs: list
    :ivar dictionary: The dictionary of word ids with their tokenized words
        from preprocessed documents ('pro_docs')
    :vartype dictionary: gensim.corpora.Dictionary
    :ivar corpus: The list of documents, where each document is a list of tuples
        (word id, word frequency in the particular document)
    :vartype corpus: list
    :ivar model: The NMF model object
    :vartype model: gensim.models.Nmf
    """

    def __init__(self, textfile, num_topics, chi=False):
        """Constructor method.
        """

        self.textfile = textfile
        self.num_topics = num_topics
        self.chi = chi
        self.docs = None
        self.pro_docs = None
        self.dictionary = None
        self.corpus = None
        self.model = None


    def preprocess(self):
        """Process the original English documents (cwordtm.tm.NMF.docs)
        by invoking cwordtm.tm.process_text, and build a dictionary
        and a corpus from the preprocessed documents for the NMF model.
        """

        self.pro_docs = [process_text(doc) for doc in self.docs]

        for i, doc in enumerate(self.pro_docs):
            self.pro_docs[i] += ["_".join(w) for w in ngrams(doc, 2)]
            # self.pro_docs[i] += ["_".join(w) for w in ngrams(doc, 3)]

        # Create a dictionary and corpus for the NMF model
        self.dictionary = corpora.Dictionary(self.pro_docs)
        self.corpus = [self.dictionary.doc2bow(doc) for doc in self.pro_docs]


    def preprocess_chi(self):
        """Process the original Chinese documents (cwordtm.tm.NMF.docs)
        by tokenizing text, removing stopwords, and building a dictionary
        and a corpus from the preprocessed documents for the NMF model.
        """

        # Build stop words
        stop_file = files('cwordtm.data').joinpath("tc_stopwords_2.txt")
        stopwords = [k[:-1] for k in open(stop_file, encoding='utf-8')\
                     .readlines() if k != '']

        # Tokenize"the text using Jieba
        dict_file = files('cwordtm.data').joinpath("user_dict_4.txt")
        jieba.load_userdict(str(dict_file))
        docs = [jieba.cut(doc) for doc in self.docs]

        # Replace special characters
        docs = [[word.replace('\u3000', ' ') for word in doc] \
                                     for doc in docs]

        # Remove stop words
        self.pro_docs = [' '.join([word for word in doc if word not in stopwords]) \
                                        for doc in docs]
```

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```
        self.pro_docs = [doc.split() for doc in self.pro_docs]

        # Create a dictionary and corpus
        self.dictionary = corpora.Dictionary(self.pro_docs)
        self.corpus = [self.dictionary.doc2bow(doc) for doc in self.pro_docs]


    def fit(self):
        """Build the NMF model with the created corpus and dictionary.
        """

        self.model = models.Nmf(self.corpus,
                                num_topics=self.num_topics)


    def show_topics_words(self):
        """Shows the topics with their keywords from the built NMF model.
        """

        print("\nTopics-Words from NMF Model:")
        for topic_id in range(self.num_topics):
            topic_words = self.model.show_topic(topic_id, topn=10)
            print(f"Topic {topic_id+1}:")
            for word_id, prob in topic_words:
                word = self.dictionary[int(word_id)]
                print("%s (%.6f)" %(word, prob))
            print()


    def viz(self):
        """Plot the topic distributions as a stacked bar chart for the built NMF model.
        """

        # Build a list of word ids from the built topics
        word_ids = []
        for topic_id in range(self.num_topics):
            topic_words = self.model.show_topic(topic_id, topn=10)
            for word_id, _ in topic_words:
                word_ids.append(int(word_id))

        word_ids = list(set(word_ids))

        # Create a topic distribution table
        topic_dist = np.zeros((self.num_topics, len(word_ids)))
        for topic_id in range(self.num_topics):
            topic_words = self.model.show_topic(topic_id, topn=10)
            for word_id, prob in topic_words:
                topic_dist[topic_id, word_ids.index(int(word_id))] = prob

        # Build a list of distinct words from the word id list
        word_list = []
        for i in range(len(word_ids)):
            word_list.append(self.dictionary[word_ids[i]])

        # Plot the topic distributions
        plt.figure(figsize=(12, 6))

        bottom = np.zeros(len(word_list))
        for i, topic in enumerate(topic_dist):
            plt.bar(word_list, topic, width=0.8, bottom=bottom, label=f"Topic {i+1}")
            bottom += topic

        plt.xticks(range(len(word_list)), word_list, rotation=90)
        plt.title("Topic Distributions")
        plt.xlabel("Words")
        plt.ylabel("Importance")
        plt.legend(loc="upper right")

        plt.show()


    def evaluate(self):
Loading [MathJax]/extensions/Safe.js utes and outputs the coherence score, topic diversity,
        and topic size distribution.
        """

        # Compute coherence score
        coherence_model = CoherenceModel(model=self.model,
                                         texts=self.pro_docs,
                                         dictionary=self.dictionary,
                                         coherence='c_v')
        print(f"  Coherence: {coherence_model.get_coherence()}")

        # Compute topic diversity
        topic_sizes = [len(self.model[self.corpus[i]]) for i in range(len(self.corpus))]
        total_docs = sum(topic_sizes)
        topic_diversity = sum([(size/total_docs)**2 for size in topic_sizes])
        print(f"  Topic diversity: {topic_diversity}")

        # Compute topic size distribution
        # topic_sizes = [len(self.model[self.corpus[i]]) for i in range(len(self.corpus))]
        topic_size_distribution = max(topic_sizes) / sum(topic_sizes)
        print(f"  Topic size distribution: {topic_size_distribution}\n")

>> cwordtm.tm.load_bible
def load_bible(textfile, cat=0, group=True):
    """Loads and returns the Bible Scripture from the prescribed internal
    file ('textfile').

    :param textfile: The package's internal Bible text from which the text is loaded,
        either World English Bible ('web.csv') or Chinese Union Version (Traditional)
        ('cuv.csv'), default to None
    :type textfile: str
    :param cat: The category indicating a subset of the Scripture to be loaded, where
        0 stands for the whole Bible, 1 for OT, 2 for NT, or one of the ten categories
        ['tor', 'oth', 'ket', 'map', 'mip', 'gos', 'nth', 'pau', 'epi', 'apo'] (See
        the package's internal file 'data/book_cat.csv'), default to 0
    :type cat: int or str, optional
    :param group: The flag indicating whether the loaded text is grouped by chapter,
        default to True
    :type group: bool, optional
    :return: The collection of Scripture loaded
    :rtype: pandas.DataFrame
    """

    # textfile = "web.csv"
    scfile = files('cwordtm.data').joinpath(textfile)
    print("Loading Bible '%s' ..." %scfile)
    df = pd.read_csv(scfile)

    cat_list = ['tor', 'oth', 'ket', 'map', 'mip',\
                'gos', 'nth', 'pau', 'epi', 'apo']
    cat = str(cat)
    if cat == '1' or cat == 'ot':
        df = util.extract(df, testament=0)
    elif cat == '2' or cat == 'nt':
        df = util.extract(df, testament=1)
    elif cat in cat_list:
        df = util.extract(df, category=cat)

    if group:
        # Group verses into chapters
        df = df.groupby(['book_no', 'chapter'])\
                        .agg({'text': lambda x: ' '.join(x)})\
                .reset_index()

    df.text = df.text.str.replace('  ', '')
    return list(df.text)

>> cwordtm.tm.load_text
def load_text(textfile, text_col='text'):
    """Loads and returns the list of documents from the prescribed file ('textfile').

    :param textfile: The prescribed text file from which the text is loaded,
        default to None
    :type textfile: str
Loading [MathJax]/extensions/Safe.js _col: The name of the text column to be extracted, default to 'text'
    :type text_col: str, optional
```

```
        :return: The list of documents loaded
        :rtype: list
        """

        # docs = pd.read_csv(textfile)
        docs = util.load_text(textfile)
        return list(docs[text_col])
```

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