In [ ]:
```
import os
import datetime
import pandas as pd
from pandas import json_normalize
import numpy as np
import re
import json
import requests
import time
from bs4 import BeautifulSoup
from collections import defaultdict, Counter
import random
import pprint
from string import punctuation
from wordcloud import WordCloud
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer
from sklearn.decomposition import NMF, TruncatedSVD, LatentDirichletAllocation


from nltk.corpus import stopwords
```

```
/Users/viviando/.local/lib/python3.10/site-packages/pandas/core/computation/ex
pressions.py:21: UserWarning: Pandas requires version '2.8.4' or newer of 'num
expr' (version '2.8.3' currently installed).
  from pandas.core.computation.check import NUMEXPR_INSTALLED
/Users/viviando/.local/lib/python3.10/site-packages/pandas/core/arrays/masked.
py:60: UserWarning: Pandas requires version '1.3.6' or newer of 'bottleneck'
(version '1.3.5' currently installed).
  from pandas.core import (
/var/folders/b8/4ntn3_wd1wg59r0lmbfgfmwc0000gn/T/ipykernel_6734/4282336640.py:
3: DeprecationWarning:
Pyarrow will become a required dependency of pandas in the next major release
of pandas (pandas 3.0),
(to allow more performant data types, such as the Arrow string type, and bette
r interoperability with other libraries)
but was not found to be installed on your system.
If this would cause problems for you,
please provide us feedback at https://github.com/pandas-dev/pandas/issues/5446
6

  import pandas as pd
/opt/miniconda3/envs/ADS500B/lib/python3.10/site-packages/scipy/__init__.py:14
6: UserWarning: A NumPy version >=1.16.5 and <1.23.0 is required for this vers
ion of SciPy (detected version 1.24.4
  warnings.warn(f"A NumPy version >={np_minversion} and <{np_maxversion}"
```

In [ ]:
```
sw = stopwords.words("english")

recipe_based_stopwords = ['teaspoon', 'tablespoon', 'fluid ounce',
                          'cup', 'pint', 'quart', 'gallon', 'milliliter',
                          'liter', 'gram', 'kilogram', 'ounce', 'pound',
                          'pinch', 'dash', 'recipe', 'recipes', 'tin', 'tbsp',
                          'tablespoons', 'chopped', 'cups','oz.','teaspoons','
                          'minced','taste','cut','tsp','&']

#len(recipe_based_stopwords)
#recipe_based_stopwords[10]
```

```
for rbs in recipe_based_stopwords:
    sw.append(rbs)
```

In [ ]:
```
# define functions

punctuation = set(punctuation) # speeds up comparison
tw_punct = punctuation


def descriptive_stats(tokens, verbose=True) :
    """
        Given a list of tokens, print number of tokens, number of unique tokens
        number of characters, lexical diversity, and num_tokens most common
        tokens. Return a list of
    """


    num_tokens=len(tokens)
    num_unique_tokens = len(set(tokens))
    lexical_diversity = num_unique_tokens/num_tokens
    num_characters = sum(len(token) for token in tokens)

    if verbose :
        print(f"There are {num_tokens} tokens in the data.")
        print(f"There are {num_unique_tokens} unique tokens in the data.")
        print(f"There are {num_characters} characters in the data.")
        print(f"The lexical diversity is {lexical_diversity:.3f} in the data."

        # print the five most common tokens
        counter = Counter(tokens)
        top_5_tokens = counter.most_common(5)
        print("Top 5 most common tokens:")
        for token, count in top_5_tokens:
            print(f"{token}: {count} occurrences")

    return([num_tokens, num_unique_tokens,
            lexical_diversity,
            num_characters])


def remove_stopwords(tokens) :
    return [token for token in tokens if token not in sw]
    return(tokens)

def remove_punctuation(text, punct_set=tw_punct) :
    """
        Function takes two arguments: (1) text, which is the input string, and
        Returns all characters not found in the punctuation set and concatenate
        string "" as the separator.
    """
    return("".join([ch for ch in text if ch not in punct_set]))

def tokenize(text) :
    """
        Splitting on whitespace rather than the book's tokenize function. That
        function will drop tokens like '#hashtag' or '2A', which we need for Tw
    """
    tokens = text.split()
    return(tokens)
```

```
def prepare(text, pipeline) :
    tokens = str(text)

    for transform in pipeline :
        tokens = transform(tokens)

    return(tokens)
def display_topics(model, features, no_top_words=5):
    for topic, words in enumerate(model.components_):
        total = words.sum()
        largest = words.argsort()[::-1] # invert sort order
        print("\nTopic %02d" % topic)
        for i in range(0, no_top_words):
            print("  %s (%2.2f)" % (features[largest[i]], abs(words[largest[i]
```

In [ ]:

```
from matplotlib import pyplot as plt

def wordcloud(word_freq, title=None, max_words=200, stopwords=sw):

    wc = WordCloud(width=800, height=400,
                   background_color= "black", colormap="Paired",
                   max_font_size=150, max_words=max_words)

    # convert data frame into dict
    if type(word_freq) == pd.Series:
        counter = Counter(word_freq.fillna(0).to_dict())
    else:
        counter = word_freq

    # filter stop words in frequency counter
    if stopwords is not None:
        counter = {token:freq for (token, freq) in counter.items()
                              if token not in stopwords}
    wc.generate_from_frequencies(counter)

    plt.title(title)

    plt.imshow(wc, interpolation='bilinear')
    plt.axis("off")


def count_words_ingredients(df, column='Ingredients_tokens', preprocess=None, 

# process tokens and update counter
    def update(doc):
        tokens = doc if preprocess is None else preprocess(doc)
        counter.update(tokens)

    # create counter and run through all data
    counter = Counter()
    df[column].map(update)

    # transform counter into data frame
    freq_df = pd.DataFrame.from_dict(counter, orient='index', columns=['freq']
    freq_df = freq_df.query('freq >= @min_freq')
    freq_df.index.name = 'token'

    return freq_df.sort_values('freq', ascending=False)

def count_words_title(df, column='Recipe_tokens', preprocess=None, min_freq=2)
```

```
    # process tokens and update counter
    def update(doc):
        tokens = doc if preprocess is None else preprocess(doc)
        counter.update(tokens)

    # create counter and run through all data
    counter = Counter()
    df[column].map(update)

    # transform counter into data frame
    freq_df = pd.DataFrame.from_dict(counter, orient='index', columns=['freq']
    freq_df = freq_df.query('freq >= @min_freq')
    freq_df.index.name = 'token'

    return freq_df.sort_values('freq', ascending=False)
```

In [ ]:

```
# data import
recipes = pd.read_csv("all_recipes.csv")
recipes.head(5)
```

Out[ ]:

| | Recipe | URL | Ingredients |
|---|---|---|---|
| **0** | Michela's tuna with cannellini beans (no cook) | http://www.jamieoliver.com/recipes/fish-recipe... | 1 x 400 g tin of cannellini beans\n1 x 80 g ti... |
| **1** | Haddock with cannellini beans & artichokes | https://www.bbcgoodfood.com/recipes/haddock-ca... | 400g can cannellini beans , drained and rinsed... |
| **2** | Grilled Bruschetta - Cannellini Beans with Fet... | https://food52.com/recipes/10069-grilled-brusc... | 1 loaf bread\n1 15 oz. can cannellini beans\n8... |
| **3** | Escarole with Cannellini Beans | https://www.epicurious.com/recipes/food/views/... | 1 sweet onion, halved\n1 head of garlic, halve... |
| **4** | Broccoli Rabe with Cannellini Beans | http://www.eatingwell.com/recipe/255758/brocco... | 1 bunch broccoli rabe (1-1¼ pounds), trimmed a... |

In [ ]:

```
#regex = For all numbers, single letters, numbers + single letters
import re

# Function to remove numbers, single letters, and numbers + single letters
def remove_patterns(text):
    pattern = r'(\b(?:\d+|\b\w\b|\d+\s*\w)\b)|[/\n%()]'
    #(\b(?:\d+|\b\w\b|\d+\s*\w)\b)|\n'
    return re.sub(pattern, '', text)

# Apply the function to the DataFrame column
recipes['Ingredients'] = recipes['Ingredients'].apply(remove_patterns)

# Remove line separators
#recipes['Ingredients'] = recipes['Ingredients'].replace('\n', '')

recipes.head(5)
```

Out[ ]:

| | Recipe | URL | Ingredients |
|---|---|---|---|
| **0** | Michela's tuna with cannellini beans (no cook) | http://www.jamieoliver.com/recipes/fish-recipe... | tin of cannellini beans tin of tuna in ... |
| **1** | Haddock with cannellini beans & artichokes | https://www.bbcgoodfood.com/recipes/haddock-ca... | can cannellini beans , drained and rinsed sma... |
| **2** | Grilled Bruschetta - Cannellini Beans with Fet... | https://food52.com/recipes/10069-grilled-brusc... | loaf bread oz. can cannellini beans ounces f... |
| **3** | Escarole with Cannellini Beans | https://www.epicurious.com/recipes/food/views/... | sweet onion, halved head of garlic, halved cr... |
| **4** | Broccoli Rabe with Cannellini Beans | http://www.eatingwell.com/recipe/255758/brocco... | bunch broccoli rabe - pounds, trimmed and coa... |

In [ ]:
```
# store tokens in new dataframe 'df'
df=pd.DataFrame()

# fold to lowercase
df['Recipe_tokens']=recipes['Recipe'].str.lower()
df['Ingredients_tokens']=recipes['Ingredients'].str.lower()
#df['URL_tokens']=recipes['URL'].str.lower()

# remove punctuation
#df['Ingredients_tokens']=df['Ingredients_tokens'].apply(remove_punctuation)
#df['URL_tokens']=df['URL_tokens'].apply(remove_punctuation)
#df['Recipe_tokens']=df['Recipe_tokens'].apply(remove_punctuation)

# tokenize
df['Recipe_tokens']=tokenize(df['Recipe_tokens'].str)
df['Ingredients_tokens']=tokenize(df['Ingredients_tokens'].str)
#df['URL_tokens']=tokenize(df['URL_tokens'].str)

# remove stopwords
df['Ingredients_tokens']=df['Ingredients_tokens'].apply(remove_stopwords)
#df['URL_tokens']=df['URL_tokens'].apply(remove_stopwords)
df['Recipe_tokens']=df['Recipe_tokens'].apply(remove_stopwords)

df
```

Out[ ]:

| | Recipe_tokens | Ingredients_tokens |
|---|---|---|
| **0** | [michela's, tuna, cannellini, beans, (no, cook)] | [cannellini, beans, tuna, spring, water, added... |
| **1** | [haddock, cannellini, beans, artichokes] | [cannellini, beans, ,, drained, rinsed, small,... |
| **2** | [grilled, bruschetta, -, cannellini, beans, fe... | [loaf, bread, cannellini, beans, ounces, feta,... |
| **3** | [escarole, cannellini, beans] | [sweet, onion,, halved, head, garlic,, halved,... |
| **4** | [broccoli, rabe, cannellini, beans] | [bunch, broccoli, rabe, -, pounds,, trimmed, c... |
| **...** | ... | ... |
| **1059** | [creamy, yogurt, porridge] | [porridge, oat, pot, fat, probiotic, yogurt] |
| **1060** | [twice-baked, truffled, potatoes-, appetizer] | [uniformly, sized, fingerling, potatoes, asiag... |
| **1061** | [frozen, strawberry, yogurt] | [strawberries, light, condensed, milk, tub, -f... |
| **1062** | [blueberry, honey, yogurt, parfait] | [plain, greek, yogurt, blueberries, sliced, al... |
| **1063** | [twice, baked, truffled, potato, boats, (my, v... | [uniformly, sized, fingerling, potatoes, asiag... |

1064 rows × 2 columns

In [ ]:
```
Recipe_combined_tokens = [token for sublist in df['Ingredients_tokens'] for tol
#descriptive_stats(sza_combined_tokens)
#tokens_without_stopwords = Recipe_combined_tokens

#tokens_with_punctuation = remove_punctuation(tokens_without_stopwords)

descriptive_stats(Recipe_combined_tokens)
```

```
There are 19169 tokens in the data.
There are 2799 unique tokens in the data.
There are 116342 characters in the data.
The lexical diversity is 0.146 in the data.
Top 5 most common tokens:
salt: 440 occurrences
oil: 396 occurrences
pepper: 347 occurrences
fresh: 332 occurrences
olive: 315 occurrences
```

Out[ ]:
```
[19169, 2799, 0.1460170066252804, 116342]
```

In [ ]:
```
# Count Vectorizer
count_ingredient_vectorizer = CountVectorizer(stop_words='english', min_df=5, 
count_ingredient_vectors = count_ingredient_vectorizer.fit_transform(Recipe_co
count_ingredient_vectors.shape
```

Out[ ]:
```
(19169, 521)
```

In [ ]:
```
# TF-IDF Vectorizer
tfidf_ingredient_vectorizer = TfidfVectorizer(stop_words='english', min_df=5, 
tfidf_ingredient_vectors = tfidf_ingredient_vectorizer.fit_transform(Recipe_co
tfidf_ingredient_vectors.shape
```

Out[ ]:
```
(19169, 521)
```

In [ ]:
```
# NFM Model
nmf_ingredient_model = NMF(n_components=5, random_state=314)
W_ingredient_matrix = nmf_ingredient_model.fit_transform(tfidf_ingredient_vect
H_ingredient_matrix = nmf_ingredient_model.components_

# Display NMF Model
display_topics(nmf_ingredient_model, tfidf_ingredient_vectorizer.get_feature_na
```

```
Topic 00
  salt (98.80)
  low (0.58)
  added (0.51)
  free (0.09)
  sodium (0.01)

Topic 01
  oil (99.89)
  packed (0.11)
  garlic (0.00)
  black (0.00)
  butter (0.00)

Topic 02
  pepper (98.34)
  red (1.47)
  lemon (0.19)
  wine (0.00)
  lime (0.00)

Topic 03
  fresh (98.97)
  ground (1.03)
  garlic (0.00)
  large (0.00)
  black (0.00)

Topic 04
  olive (99.94)
  ground (0.04)
  garlic (0.01)
  sliced (0.01)
  sugar (0.00)
```

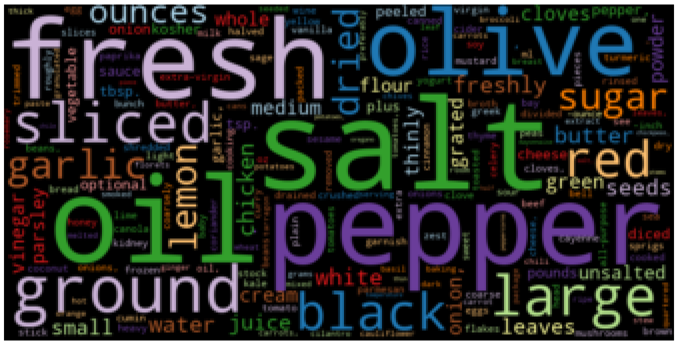
In [ ]:
```
# Fitting LDA Model
lda_ingredient_model = LatentDirichletAllocation(n_components=5, random_state=
W_lda_ingredient_matrix = lda_ingredient_model.fit_transform(count_ingredient_
H_lda_ingredient_matrix = lda_ingredient_model.components_

# Display LDA Model
display_topics(lda_ingredient_model, count_ingredient_vectorizer.get_feature_na
Topic 00
  salt (12.08)
  red (4.89)
  sugar (4.45)
  lemon (4.20)
  ounces (3.98)

Topic 01
  ground (8.90)
  cloves (4.61)
  leaves (4.42)
  water (4.33)
  white (4.20)

Topic 02
  fresh (10.60)
  onion (5.30)
  grated (3.46)
  medium (3.37)
  vinegar (3.30)

Topic 03
  pepper (14.70)
  sliced (7.56)
  large (7.25)
  dried (5.45)
  cream (3.58)

Topic 04
  oil (12.70)
  olive (8.95)
  garlic (7.48)
  black (5.65)
  butter (5.42)
```

In [ ]:

```
# Fitting LSA Model
svd_ingredient_model = TruncatedSVD(n_components=5, random_state=314)
W_svd_ingredient_matrix = svd_ingredient_model.fit_transform(tfidf_ingredient_v
H_svd_ingredient_matrix = svd_ingredient_model.components_
# Display LSA Model
display_topics(svd_ingredient_model, tfidf_ingredient_vectorizer.get_feature_na
Topic 00
  salt (98.95)
  low (0.58)
  added (0.52)
  free (0.09)
  cloves (0.06)

Topic 01
  oil (99.06)
  olive (0.74)
  packed (0.11)
  water (0.05)
  red (0.05)

Topic 02
  pepper (98.54)
  red (1.55)
  lemon (0.21)
  ounces (0.06)
  powder (0.03)

Topic 03
  fresh (100.78)
  ground (1.13)
  cloves (0.31)
  freshly (0.19)
  black (0.15)

Topic 04
  olive (99.28)
  sugar (1.80)
  lemon (1.67)
  ground (0.97)
  sliced (0.75)
```

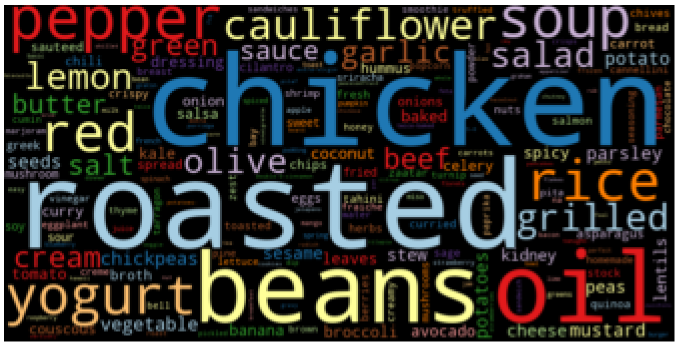
In [ ]:
```
ingredient_count= count_words_ingredients(df)
print('Wordcloud for Ingredients')
wordcloud(ingredient_count['freq'])
```

```
Wordcloud for Ingredients
```



In [ ]:
```
title_count=count_words_title(df)
print('Wordcloud for Recipe Titles')
wordcloud(title_count['freq'])
```

```
Wordcloud for Recipe Titles
```


pepper
cauliflower
soup
green
sauce
garlic
salad
lemon
potato
chicken
butter
red
roasted
olive
salt
beef
rice
grilled
cream
chickpeas
yogurt
beans
oil
tomato
broth
vegetable
couscous
banana
broccoli
avocado
cheese
mustard
lentils
peas
quinoa
kidney
stew
sesame
leaves
coconut
spicy
parsley
asparagus
seeds
kale
onion
salsa
baked
onions
salmon
nuts
dressing
hummus
cilantro
crispy
chili
sauteed
carrot
bread
chives