ex2

July 24, 2024

1 Practical Question 4

1.1 4.a. Name of chosen book:

We've chosen the book "Alice in Wonderland" by Lewis Carroll.

1.2 4.b. Tokenization and Counting Words:

1.2.1 4.b.1. Read Document

We've downloaded the book "Alice in Wonderland" from Project Gutenberg and saved it as a utf-8 encoded text file, so we can read the content of the book using open().

[199]:

```
def read_document(file_path: str) -> str:
    """
    Read document from given file path.
    :param file_path: The path to the document, including the file's name and␣
 ↪extension.
    :return: The content of the document.
    """
    with open(file_path, 'r', encoding='utf-8') as file:
        return file.read()
```

[200]:

```
FILE_PATH = 'alice_in_wonderland.txt'
print(f"Reading document from file path: {FILE_PATH}")
document = read_document(FILE_PATH)
print(f"Read document with {len(document)} characters!")

CHAR_COUNT = 1000
print(f"First {CHAR_COUNT} characters of the document: {document[:CHAR_COUNT]}..
 ↪.")
```

```
Reading document from file path: alice_in_wonderland.txt
Read document with 163918 characters!
First 1000 characters of the document: The Project Gutenberg eBook of Alice's
Adventures in Wonderland

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Title: Alice's Adventures in Wonderland

Author: Lewis Carroll

Release date: June 27, 2008 [eBook #11]
                Most recently updated: February 4, 2024

Language: English

Credits: Arthur DiBianca and David Widger


*** START OF THE PROJECT GUTENBERG EBOOK ALICE'S ADVENTURES IN WONDERLAND ***
[Illustration]




Alice’s Adventures in Wonderland

by Lewis Carroll

THE MILLENNIUM FULCRUM EDITION 3.0

Contents

 CHAPTER I.     Down the Rabbit-Hole
 CHAPTER II.    The Pool of Te…
```

1.2.2 4.b.2. Clean Document

We’ve noticed that the document contains a header and a footer that we don’t need for our analysis, so we’ll remove them using regular expressions.
Also, The document contains a lot of special characters and new lines that we don’t need for our analysis, so we’ll remove them using regular expressions as well.

[201]:

```python
import re

def remove_header_and_footer(document: str, header: str=None, footer: str=None) -> str:
    """
    Remove header and footer from the document.
    :param document: The content of the document.
    :param header: A regex pattern to identify the header.
    :param footer: A regex pattern to identify the footer.
    :return: The content of the document without header and footer.
    """
    if header is not None:
        header_end = re.search(header, document)
        if header_end is not None:
            document = document[header_end.end():]

    if footer is not None:
        footer_start = re.search(footer, document)
        if footer_start is not None:
            document = document[:footer_start.start()]

    return document
```

[202]:

```
print(f"Removing header and footer from the document...")
# HEADER = r'\*\*\* START OF THE PROJECT GUTENBERG [^\*]+\*\*\*'
HEADER = r'Alice's Evidence'
FOOTER = r'\*\*\* END OF THE PROJECT GUTENBERG [^\*]+\*\*\*'
document_body = remove_header_and_footer(document, HEADER, FOOTER)
print(f"Removed {len(document) - len(document_body)} characters from the␣
  ↪document!")

print(f"First {CHAR_COUNT} characters without header and footer:␣
  ↪{document_body[:CHAR_COUNT]}...")
```

```
Removing header and footer from the document…
Removed 19894 characters from the document!
First 1000 characters without header and footer:




CHAPTER I.
Down the Rabbit-Hole


Alice was beginning to get very tired of sitting by her sister on the
bank, and of having nothing to do: once or twice she had peeped into
the book her sister was reading, but it had no pictures or
conversations in it, "and what is the use of a book," thought Alice
"without pictures or conversations?"

So she was considering in her own mind (as well as she could, for the
hot day made her feel very sleepy and stupid), whether the pleasure of
making a daisy-chain would be worth the trouble of getting up and
picking the daisies, when suddenly a White Rabbit with pink eyes ran
```

```
close by her.

There was nothing so _very_ remarkable in that; nor did Alice think it
so _very_ much out of the way to hear the Rabbit say to itself, "Oh
dear! Oh dear! I shall be late!" (when she thought it over afterwards,
it occurred to her that she ought to have wondered at this, but at the
time it all seemed quite natural); but when the Rabbit actually _took a
watch out of …
```

[203]:

```python
def clean_document(document: str) -> str:
    """
    Clean document by removing special characters and new lines.
    Punctuation is kept for nltk's sentence tokenizer.
    :param document: The content of the document.
    :return: The cleaned content of the document.
    """
    document = re.sub(r'\s+', ' ', document)              # Replace extra spaces
    document = re.sub(r'-', ' ', document)                # Separate hyphenated␣
 ↪words
    document = re.sub(r'[^\w\s.,!?;]', '', document)      # Remove special␣
 ↪characters except punctuation
    return document
```

[204]:

```python
print(f"Cleaning document...")
cleaned_document_body = clean_document(document_body)
print(f"Cleaned {len(document_body) - len(cleaned_document_body)} characters␣
 ↪from the document!")
print(f"Document now has {len(cleaned_document_body)} characters left!")

print(f"First {CHAR_COUNT} characters: {cleaned_document_body[:CHAR_COUNT]}...")
```

```
Cleaning document…
Cleaned 5072 characters from the document!
Document now has 138952 characters left!
First 1000 characters:  CHAPTER I. Down the Rabbit Hole Alice was beginning to
get very tired of sitting by her sister on the bank, and of having nothing to do
once or twice she had peeped into the book her sister was reading, but it had no
pictures or conversations in it, and what is the use of a book, thought Alice
without pictures or conversations? So she was considering in her own mind as
well as she could, for the hot day made her feel very sleepy and stupid, whether
the pleasure of making a daisy chain would be worth the trouble of getting up
and picking the daisies, when suddenly a White Rabbit with pink eyes ran close
by her. There was nothing so _very_ remarkable in that; nor did Alice think it
so _very_ much out of the way to hear the Rabbit say to itself, Oh dear! Oh
dear! I shall be late! when she thought it over afterwards, it occurred to her
that she ought to have wondered at this, but at the time it all seemed quite
natural; but when the Rabbit actually _took a watch out of its waistcoat
pocke…
```

1.2.3 4.b.3 Tokenize Document

We'll tokenize the document into sentences using nltk's sent_tokenize(), and into words using nltk's word_tokenize().

[205]:

```
import nltk
from nltk.tokenize import word_tokenize, sent_tokenize
nltk.download('punkt')

def tokenize_document(document: str) -> [[str]]:
    """
    Tokenize document into a list of tokenized sentences.
    :param document: The content of the document.
    :return: A list of tokenized sentences.
    """
    sentences = sent_tokenize(document)
    tokenized_sentences = []
    for sentence in sentences:
        words = word_tokenize(sentence)
        words = [word for word in words if word.isalnum()]      # Remove␣
 ↪punctuation
        if len(words) > 0:
            tokenized_sentences.append(words)
    return tokenized_sentences
```

```
[nltk_data] Downloading package punkt to
[nltk_data]     C:\Users\idobb\AppData\Roaming\nltk_data…
[nltk_data]   Package punkt is already up-to-date!
```

[206]:

```
print(f"Tokenizing document...")
tokenized_document_body = tokenize_document(cleaned_document_body)
print(f"Tokenized document into {len(tokenized_document_body)} sentences!")

SENTENCE_COUNT = 10
print(f"First {SENTENCE_COUNT} tokenized sentences:")
for index, sentence in enumerate(tokenized_document_body[:SENTENCE_COUNT]):
    print(f"\t{index + 1}: {sentence}")
```

```
Tokenizing document…
Tokenized document into 1612 sentences!
First 10 tokenized sentences:
        1: ['CHAPTER', 'I']
        2: ['Down', 'the', 'Rabbit', 'Hole', 'Alice', 'was', 'beginning', 'to',
'get', 'very', 'tired', 'of', 'sitting', 'by', 'her', 'sister', 'on', 'the',
'bank', 'and', 'of', 'having', 'nothing', 'to', 'do', 'once', 'or', 'twice',
'she', 'had', 'peeped', 'into', 'the', 'book', 'her', 'sister', 'was',
'reading', 'but', 'it', 'had', 'no', 'pictures', 'or', 'conversations', 'in',
'it', 'and', 'what', 'is', 'the', 'use', 'of', 'a', 'book', 'thought', 'Alice',
'without', 'pictures', 'or', 'conversations']
```

```
        3: ['So', 'she', 'was', 'considering', 'in', 'her', 'own', 'mind', 'as',
'well', 'as', 'she', 'could', 'for', 'the', 'hot', 'day', 'made', 'her', 'feel',
'very', 'sleepy', 'and', 'stupid', 'whether', 'the', 'pleasure', 'of', 'making',
'a', 'daisy', 'chain', 'would', 'be', 'worth', 'the', 'trouble', 'of',
'getting', 'up', 'and', 'picking', 'the', 'daisies', 'when', 'suddenly', 'a',
'White', 'Rabbit', 'with', 'pink', 'eyes', 'ran', 'close', 'by', 'her']
        4: ['There', 'was', 'nothing', 'so', 'remarkable', 'in', 'that', 'nor',
'did', 'Alice', 'think', 'it', 'so', 'much', 'out', 'of', 'the', 'way', 'to',
'hear', 'the', 'Rabbit', 'say', 'to', 'itself', 'Oh', 'dear']
        5: ['Oh', 'dear']
        6: ['I', 'shall', 'be', 'late']
        7: ['when', 'she', 'thought', 'it', 'over', 'afterwards', 'it',
'occurred', 'to', 'her', 'that', 'she', 'ought', 'to', 'have', 'wondered', 'at',
'this', 'but', 'at', 'the', 'time', 'it', 'all', 'seemed', 'quite', 'natural',
'but', 'when', 'the', 'Rabbit', 'actually', 'a', 'watch', 'out', 'of', 'its',
'waistcoat', 'and', 'looked', 'at', 'it', 'and', 'then', 'hurried', 'on',
'Alice', 'started', 'to', 'her', 'feet', 'for', 'it', 'flashed', 'across',
'her', 'mind', 'that', 'she', 'had', 'never', 'before', 'seen', 'a', 'rabbit',
'with', 'either', 'a', 'waistcoat', 'pocket', 'or', 'a', 'watch', 'to', 'take',
'out', 'of', 'it', 'and', 'burning', 'with', 'curiosity', 'she', 'ran',
'across', 'the', 'field', 'after', 'it', 'and', 'fortunately', 'was', 'just',
'in', 'time', 'to', 'see', 'it', 'pop', 'down', 'a', 'large', 'rabbit', 'hole',
'under', 'the', 'hedge']
        8: ['In', 'another', 'moment', 'down', 'went', 'Alice', 'after', 'it',
'never', 'once', 'considering', 'how', 'in', 'the', 'world', 'she', 'was', 'to',
'get', 'out', 'again']
        9: ['The', 'rabbit', 'hole', 'went', 'straight', 'on', 'like', 'a',
'tunnel', 'for', 'some', 'way', 'and', 'then', 'dipped', 'suddenly', 'down',
'so', 'suddenly', 'that', 'Alice', 'had', 'not', 'a', 'moment', 'to', 'think',
'about', 'stopping', 'herself', 'before', 'she', 'found', 'herself', 'falling',
'down', 'a', 'very', 'deep', 'well']
        10: ['Either', 'the', 'well', 'was', 'very', 'deep', 'or', 'she',
'fell', 'very', 'slowly', 'for', 'she', 'had', 'plenty', 'of', 'time', 'as',
'she', 'went', 'down', 'to', 'look', 'about', 'her', 'and', 'to', 'wonder',
'what', 'was', 'going', 'to', 'happen', 'next']
```

1.2.4 4.b.4 Count Words

We can count the frequency of words in the tokenized sentences using Python's Counter.

[207]:

```python
from collections import Counter

def count_words(tokenized_sentences: [[str]]) -> Counter:
    """
    Count the frequency of words in tokenized sentences.
    :param tokenized_sentences: A list of tokenized sentences.
    :return: A Counter of words.
    """
    word_counts = Counter()

    for sentence in tokenized_sentences:
        word_counts.update(sentence)

    return word_counts
```

[208]:
```
print(f"Counting words for tokenized document...")
tokenized_body_word_counts = count_words(tokenized_document_body)
print(f"Counted {len(tokenized_body_word_counts)} words in tokenized document!
 ↪\n")

WORD_COUNT = 20
base_step_most_common = tokenized_body_word_counts.most_common(WORD_COUNT)

print(f"Top {WORD_COUNT} words in tokenized document:")
print(f"\t   {'Word'.ljust(7)} | Count")
for index, (word, count) in enumerate(base_step_most_common):
    print(f"\t{index + 1}: {word.ljust(7)} | {count}")
```

```
Counting words for tokenized document…
Counted 2988 words in tokenized document!

Top 20 words in tokenized document:
           Word    | Count
        1: the     | 1526
        2: and     | 781
        3: to      | 724
        4: a       | 613
        5: of      | 499
        6: she     | 499
        7: it      | 484
        8: said    | 456
        9: Alice   | 385
        10: I       | 384
        11: in      | 355
        12: was     | 351
        13: you     | 308
        14: that    | 257
        15: as      | 246
        16: her     | 244
        17: at      | 199
        18: on      | 189
        19: had     | 178
        20: with    | 176
```

1.2.5 4.b.5 Plot Word Counts

We can plot the frequency of words in the tokenized sentences using matplotlib and numpy.

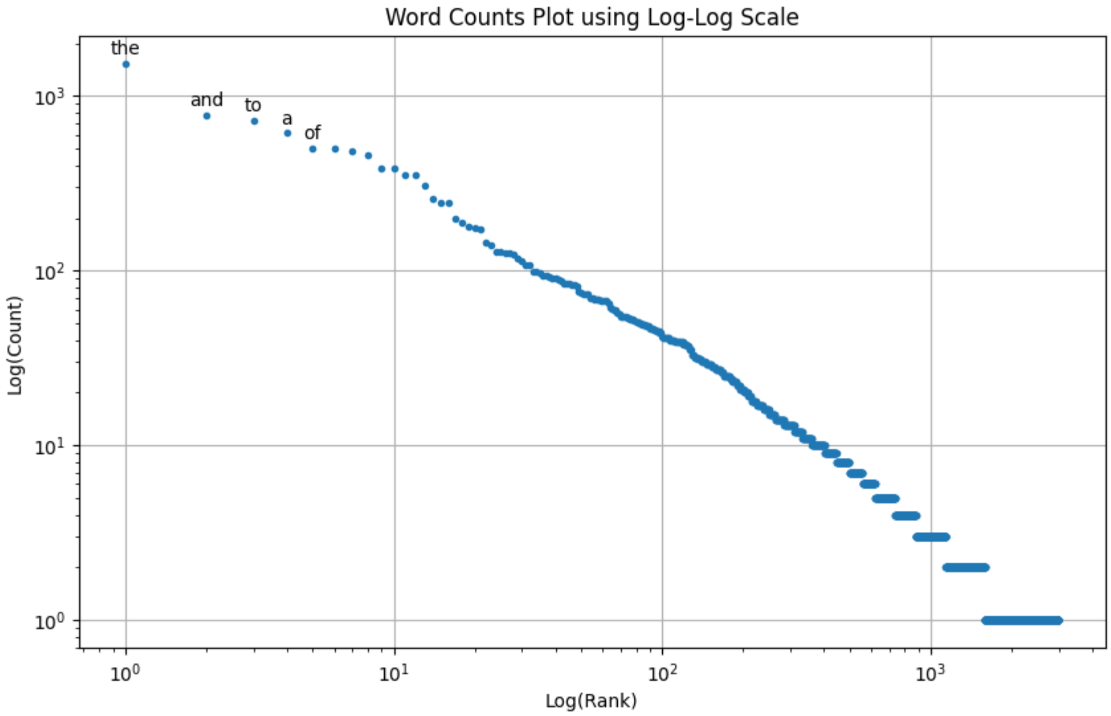
[209]:

```
import matplotlib.pyplot as plt
import numpy as np

def plot_word_counts(word_counts: Counter, top_n: int=5):
    """
    Plot the frequency of words.
    :param word_counts: A Counter of all words.
    :param top_n: The number of top words to annotate.
    :return: None. The plot will be displayed.
    """

    sorted_word_counts = word_counts.most_common()
    ranks = np.arange(1, len(sorted_word_counts) + 1)
    counts = np.array([count for _, count in sorted_word_counts])
    words = []
    for i, (word, _) in enumerate(sorted_word_counts):
        if i >= top_n:
            break

        words.append(word)

    plt.figure(figsize=(10, 6))
    plt.loglog(ranks, counts, marker='.', linestyle='None')
    for (rank, count, word) in zip(ranks, counts, words):
        plt.annotate(word, (rank, count), textcoords="offset points",␣
 ↪xytext=(0, 5), ha='center')
    plt.title('Word Counts Plot using Log-Log Scale')
    plt.xlabel('Log(Rank)')
    plt.ylabel('Log(Count)')
    plt.grid(True)
    plt.show()
```

[210]:

```
print(f"Plotting word counts for tokenized document...")
plot_word_counts(tokenized_body_word_counts)
```

```
Plotting word counts for tokenized document…
```



1.3 4.c. A List of Top 20 Words:

[211]:
```
WORD_COUNT = 20
print(f"Top {WORD_COUNT} words in tokenized document:")
print(f"\t    {'Word'.ljust(7)} | Count")
for index, (word, count) in enumerate(base_step_most_common):
    print(f"\t{index + 1}: {word.ljust(7)} | {count}")
```

```
Top 20 words in tokenized document:
           Word    | Count
        1: the     | 1526
        2: and     | 781
        3: to      | 724
        4: a       | 613
        5: of      | 499
        6: she     | 499
        7: it      | 484
        8: said    | 456
        9: Alice   | 385
        10: I       | 384
        11: in      | 355
        12: was     | 351
        13: you     | 308
        14: that    | 257
```

```
15: as       | 246
16: her      | 244
17: at       | 199
18: on       | 189
19: had      | 178
20: with     | 176
```

1.4 4.d. Most Common Words Excluding Stopwords:

1.4.1 4.d.1 Remove Stopwords

We'll remove stopwords from the tokenized sentences using nltk's stopwords.

[212]:

```
from nltk.corpus import stopwords
nltk.download('stopwords')

def remove_stopwords(tokenized_sentences: [[str]]) -> [[str]]:
    """
    Remove stopwords from tokenized sentences.
    :param tokenized_sentences: A list of tokenized sentences.
    :return: A list of tokenized sentences without stopwords.
    """
    stop_words = set(stopwords.words('english'))
    clean_sentences = []

    for sentence in tokenized_sentences:
        clean_sentence = [word for word in sentence if word not in stop_words]
        if len(clean_sentence) > 0:
            clean_sentences.append(clean_sentence)

    return clean_sentences
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\idobb\AppData\Roaming\nltk_data…
[nltk_data]   Package stopwords is already up-to-date!
```

[213]:

```
print(f"Removing stopwords...")
count_with_stopwords = sum([len(sentence) for sentence in␣
 ↪tokenized_document_body])
stopword_free_tokenized_body = remove_stopwords(tokenized_document_body)
count_without_stopwords = sum([len(sentence) for sentence in␣
 ↪stopword_free_tokenized_body])
print(f"Removed {count_with_stopwords - count_without_stopwords} stopwords from␣
 ↪tokenized document!")
print(f"Tokenized document now has {count_without_stopwords} words left!")

print(f"First {SENTENCE_COUNT} tokenized sentences without stopwords:")
for sentence in stopword_free_tokenized_body[:SENTENCE_COUNT]:
    print(f"\t{sentence}")
```

```
Removing stopwords…
Removed 12363 stopwords from tokenized document!
Tokenized document now has 13924 words left!
First 10 tokenized sentences without stopwords:
        ['CHAPTER', 'I']
        ['Down', 'Rabbit', 'Hole', 'Alice', 'beginning', 'get', 'tired',
'sitting', 'sister', 'bank', 'nothing', 'twice', 'peeped', 'book', 'sister',
'reading', 'pictures', 'conversations', 'use', 'book', 'thought', 'Alice',
'without', 'pictures', 'conversations']
        ['So', 'considering', 'mind', 'well', 'could', 'hot', 'day', 'made',
'feel', 'sleepy', 'stupid', 'whether', 'pleasure', 'making', 'daisy', 'chain',
'would', 'worth', 'trouble', 'getting', 'picking', 'daisies', 'suddenly',
'White', 'Rabbit', 'pink', 'eyes', 'ran', 'close']
        ['There', 'nothing', 'remarkable', 'Alice', 'think', 'much', 'way',
'hear', 'Rabbit', 'say', 'Oh', 'dear']
        ['Oh', 'dear']
        ['I', 'shall', 'late']
        ['thought', 'afterwards', 'occurred', 'ought', 'wondered', 'time',
'seemed', 'quite', 'natural', 'Rabbit', 'actually', 'watch', 'waistcoat',
'looked', 'hurried', 'Alice', 'started', 'feet', 'flashed', 'across', 'mind',
'never', 'seen', 'rabbit', 'either', 'waistcoat', 'pocket', 'watch', 'take',
'burning', 'curiosity', 'ran', 'across', 'field', 'fortunately', 'time', 'see',
'pop', 'large', 'rabbit', 'hole', 'hedge']
        ['In', 'another', 'moment', 'went', 'Alice', 'never', 'considering',
'world', 'get']
        ['The', 'rabbit', 'hole', 'went', 'straight', 'like', 'tunnel', 'way',
'dipped', 'suddenly', 'suddenly', 'Alice', 'moment', 'think', 'stopping',
'found', 'falling', 'deep', 'well']
        ['Either', 'well', 'deep', 'fell', 'slowly', 'plenty', 'time', 'went',
'look', 'wonder', 'going', 'happen', 'next']
```

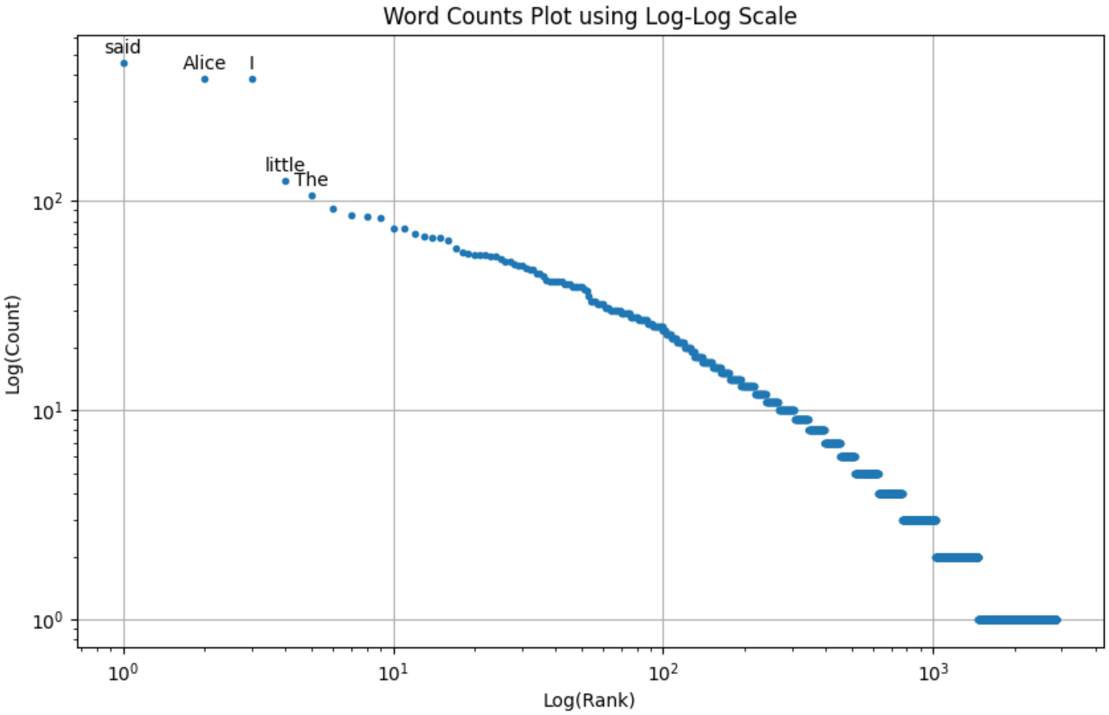
1.4.2 4.d.2 Print Most Common Words and Plot Word Counts

[214]:

```
print(f"Counting words without stopwords...")
stopword_free_word_counts = count_words(stopword_free_tokenized_body)
print(f"Counted {len(stopword_free_word_counts)} words in tokenized document!
 ↪\n")

stopword_step_most_common = stopword_free_word_counts.most_common(WORD_COUNT)

print(f"Top {WORD_COUNT} words after removing stopwords:")
print(f"\t    {'Word'.ljust(7)} | Count")
for index, (word, count) in enumerate(stopword_step_most_common):
    print(f"\t{index + 1}: {word.ljust(7)} | {count}")

plot_word_counts(stopword_free_word_counts)
```

```
Counting words without stopwords…
```

```
Counted 2865 words in tokenized document!

Top 20 words after removing stopwords:
          Word     | Count
        1: said     | 456
        2: Alice    | 385
        3: I        | 384
        4: little   | 125
        5: The      | 107
        6: one      | 92
        7: know     | 85
        8: like     | 84
        9: went     | 83
        10: thought | 74
        11: could   | 74
        12: would   | 70
        13: time    | 68
        14: And     | 67
        15: Queen   | 67
        16: see     | 65
        17: King    | 59
        18: began   | 57
        19: Mock    | 56
        20: way     | 55
```



1.5 4.e. Most Common Words after Stemming:

1.5.1 4.e.1. Stem Words

We'll stem the words using nltk's PorterStemmer.

[215]:

```python
from nltk.stem import PorterStemmer
# note: nltk's stemming doesn't need to be downloaded, unlike stopwords and␣
 ↪punkt.

def stem_words(tokenized_sentences: [[str]]) -> [[str]]:
    """
    Stem words in tokenized sentences.
    :param tokenized_sentences: A list of tokenized sentences.
    :return: A list of tokenized sentences with stemmed words.
    """
    stemmer = PorterStemmer()
    stemmed_sentences = []

    for sentence in tokenized_sentences:
        stemmed_sentence = [stemmer.stem(word) for word in sentence]
        stemmed_sentences.append(stemmed_sentence)

    return stemmed_sentences
```

[216]:

```python
print(f"Stemming words...")
stemmed_tokenized_body = stem_words(stopword_free_tokenized_body)
print(f"Stemmed {count_without_stopwords} words in tokenized document!")

print(f"First {SENTENCE_COUNT} tokenized sentences with stemmed words:")
for index, sentence in enumerate(stemmed_tokenized_body[:SENTENCE_COUNT]):
    print(f"\t{index + 1}: {sentence}")
```

```
Stemming words…
Stemmed 13924 words in tokenized document!
First 10 tokenized sentences with stemmed words:
        1: ['chapter', 'i']
        2: ['down', 'rabbit', 'hole', 'alic', 'begin', 'get', 'tire', 'sit',
'sister', 'bank', 'noth', 'twice', 'peep', 'book', 'sister', 'read', 'pictur',
'convers', 'use', 'book', 'thought', 'alic', 'without', 'pictur', 'convers']
        3: ['so', 'consid', 'mind', 'well', 'could', 'hot', 'day', 'made',
'feel', 'sleepi', 'stupid', 'whether', 'pleasur', 'make', 'daisi', 'chain',
'would', 'worth', 'troubl', 'get', 'pick', 'daisi', 'suddenli', 'white',
'rabbit', 'pink', 'eye', 'ran', 'close']
        4: ['there', 'noth', 'remark', 'alic', 'think', 'much', 'way', 'hear',
'rabbit', 'say', 'oh', 'dear']
        5: ['oh', 'dear']
        6: ['i', 'shall', 'late']
        7: ['thought', 'afterward', 'occur', 'ought', 'wonder', 'time', 'seem',
'quit', 'natur', 'rabbit', 'actual', 'watch', 'waistcoat', 'look', 'hurri',
'alic', 'start', 'feet', 'flash', 'across', 'mind', 'never', 'seen', 'rabbit',
'either', 'waistcoat', 'pocket', 'watch', 'take', 'burn', 'curios', 'ran',
'across', 'field', 'fortun', 'time', 'see', 'pop', 'larg', 'rabbit', 'hole',
'hedg']
        8: ['in', 'anoth', 'moment', 'went', 'alic', 'never', 'consid', 'world',
'get']
        9: ['the', 'rabbit', 'hole', 'went', 'straight', 'like', 'tunnel',
'way', 'dip', 'suddenli', 'suddenli', 'alic', 'moment', 'think', 'stop',
'found', 'fall', 'deep', 'well']
        10: ['either', 'well', 'deep', 'fell', 'slowli', 'plenti', 'time',
'went', 'look', 'wonder', 'go', 'happen', 'next']
```

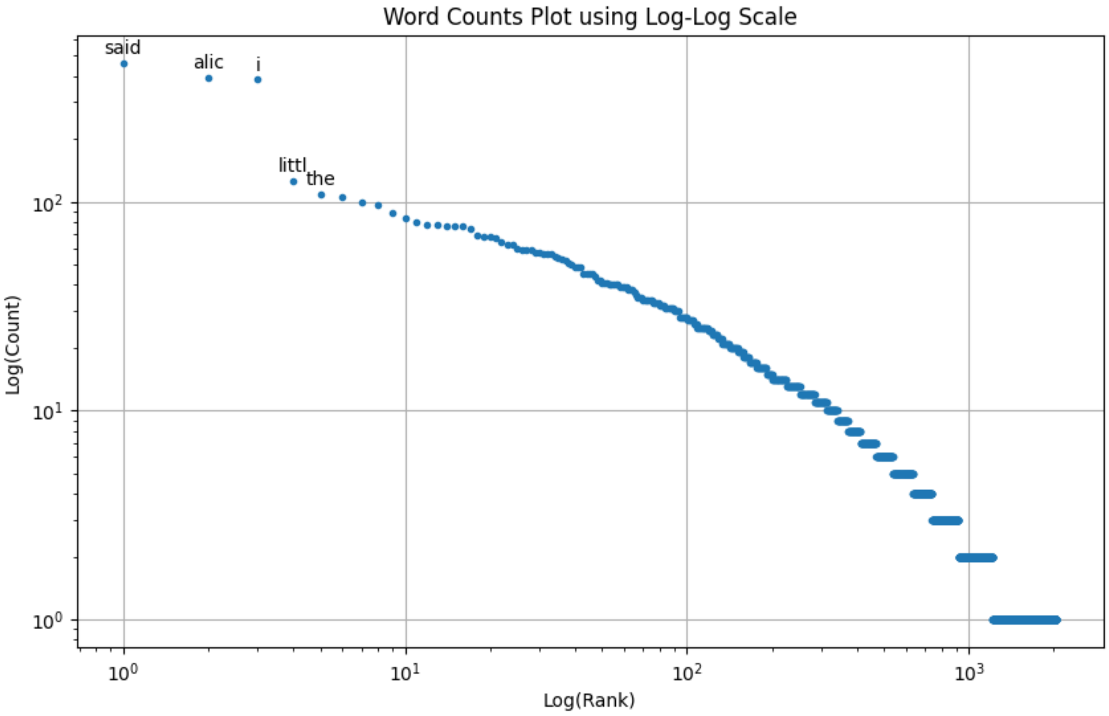
1.5.2 4.e.2. Print Most Common Words and Plot Word Counts

[217]:

```python
print(f"Counting words after stemming...")
stemmed_word_counts = count_words(stemmed_tokenized_body)
print(f"Counted {len(stemmed_word_counts)} words after stemming!\n")

stemming_step_most_common = stemmed_word_counts.most_common(WORD_COUNT)

print(f"Top {WORD_COUNT} words after stemming:")
print(f"\t   {'Word'.ljust(7)} | Count")
for index, (word, count) in enumerate(stemming_step_most_common):
    print(f"\t{index + 1}: {word.ljust(7)} | {count}")

plot_word_counts(stemmed_word_counts)
```

```
Counting words after stemming…
Counted 2044 words after stemming!

Top 20 words after stemming:
           Word    | Count
        1: said    | 460
        2: alic    | 395
        3: i       | 384
        4: littl   | 126
        5: the     | 109
        6: look    | 106
        7: one     | 100
        8: like    | 97
        9: know    | 89
        10: went    | 83
        11: thought | 80
        12: would   | 78
        13: thing   | 78
        14: time    | 77
        15: go      | 77
```

```
16: queen    | 76
17: could    | 74
18: say      | 69
19: get      | 68
20: and      | 68
```



1.6 4.e.3. Explanation for the Differences in the Plots:

- Base tokenized document: Stopwords dominate the frequency of words, causing a steep curve in the plot and a long tail.
- Stopword-free tokenized document: The frequency of words is more evenly distributed, with a shallower curve and a shorter tail.
- Stemmed tokenized document: The frequency of words is further reduced, with a shallower curve and a shorter tail. Overall, stopword-removal and Stemming allowed us to even out the frequency of words and reduce the noise in the data.

1.7 4.f. Example of Incorrect POS Tagging:

1.7.1 4.f.1. Part-of-Speech Tagging

We can perform Part-of-Speech (POS) tagging on the tokenized sentences using nltk's pos_tag().

[218]:
```
from nltk import pos_tag
nltk.download('punkt')
nltk.download('averaged_perceptron_tagger')
```

```python
def pos_tag_sentences(tokenized_sentences: [[str]]) -> [[(str, str)]]:
    """
    Perform Part-of-Speech tagging on the tokenized sentences.
    :param tokenized_sentences: A list of tokenized sentences.
    :return: A list of POS-tagged sentences.
    """
    return [pos_tag(sentence) for sentence in tokenized_sentences]
```

```
[nltk_data] Downloading package punkt to
[nltk_data]     C:\Users\idobb\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\idobb\AppData\Roaming\nltk_data…
[nltk_data]   Package averaged_perceptron_tagger is already up-to-
[nltk_data]       date!
```

[219]:

```python
print(f"POS tagging tokenized sentences...")
tagged_sentences = pos_tag_sentences(tokenized_document_body)
print(f"POS tagged {len(tagged_sentences)} sentences!\n")

SENTENCE_COUNT = 20
print(f"First {SENTENCE_COUNT} tagged sentences:")
for index, sentence in enumerate(tagged_sentences[:SENTENCE_COUNT]):
    print(f"{index + 1} : {sentence}\n")
```

```
POS tagging tokenized sentences…
POS tagged 1612 sentences!

First 20 tagged sentences:
1 : [('CHAPTER', 'NN'), ('I', 'PRP')]

2 : [('Down', 'IN'), ('the', 'DT'), ('Rabbit', 'NNP'), ('Hole', 'NNP'),
('Alice', 'NNP'), ('was', 'VBD'), ('beginning', 'VBG'), ('to', 'TO'), ('get',
'VB'), ('very', 'RB'), ('tired', 'JJ'), ('of', 'IN'), ('sitting', 'VBG'), ('by',
'IN'), ('her', 'PRP$'), ('sister', 'NN'), ('on', 'IN'), ('the', 'DT'), ('bank',
'NN'), ('and', 'CC'), ('of', 'IN'), ('having', 'VBG'), ('nothing', 'NN'), ('to',
'TO'), ('do', 'VB'), ('once', 'RB'), ('or', 'CC'), ('twice', 'VB'), ('she',
'PRP'), ('had', 'VBD'), ('peeped', 'VBN'), ('into', 'IN'), ('the', 'DT'),
('book', 'NN'), ('her', 'PRP$'), ('sister', 'NN'), ('was', 'VBD'), ('reading',
'VBG'), ('but', 'CC'), ('it', 'PRP'), ('had', 'VBD'), ('no', 'DT'), ('pictures',
'NNS'), ('or', 'CC'), ('conversations', 'NNS'), ('in', 'IN'), ('it', 'PRP'),
('and', 'CC'), ('what', 'WP'), ('is', 'VBZ'), ('the', 'DT'), ('use', 'NN'),
('of', 'IN'), ('a', 'DT'), ('book', 'NN'), ('thought', 'NN'), ('Alice', 'NNP'),
('without', 'IN'), ('pictures', 'NNS'), ('or', 'CC'), ('conversations', 'NNS')]

3 : [('So', 'IN'), ('she', 'PRP'), ('was', 'VBD'), ('considering', 'VBG'),
('in', 'IN'), ('her', 'PRP$'), ('own', 'JJ'), ('mind', 'NN'), ('as', 'RB'),
('well', 'RB'), ('as', 'IN'), ('she', 'PRP'), ('could', 'MD'), ('for', 'IN'),
('the', 'DT'), ('hot', 'JJ'), ('day', 'NN'), ('made', 'VBD'), ('her', 'PRP$'),
('feel', 'JJ'), ('very', 'RB'), ('sleepy', 'JJ'), ('and', 'CC'), ('stupid',
'JJ'), ('whether', 'IN'), ('the', 'DT'), ('pleasure', 'NN'), ('of', 'IN'),
('making', 'VBG'), ('a', 'DT'), ('daisy', 'NN'), ('chain', 'NN'), ('would',
'MD'), ('be', 'VB'), ('worth', 'IN'), ('the', 'DT'), ('trouble', 'NN'), ('of',
'IN'), ('getting', 'VBG'), ('up', 'RP'), ('and', 'CC'), ('picking', 'VBG'),
('the', 'DT'), ('daisies', 'NNS'), ('when', 'WRB'), ('suddenly', 'RB'), ('a',
'DT'), ('White', 'NNP'), ('Rabbit', 'NN'), ('with', 'IN'), ('pink', 'JJ'),
('eyes', 'NNS'), ('ran', 'VBD'), ('close', 'RB'), ('by', 'IN'), ('her', 'PRP$')]

4 : [('There', 'EX'), ('was', 'VBD'), ('nothing', 'NN'), ('so', 'RB'),
('remarkable', 'JJ'), ('in', 'IN'), ('that', 'DT'), ('nor', 'CC'), ('did',
'VBD'), ('Alice', 'NNP'), ('think', 'VB'), ('it', 'PRP'), ('so', 'RB'), ('much',
'JJ'), ('out', 'IN'), ('of', 'IN'), ('the', 'DT'), ('way', 'NN'), ('to', 'TO'),
('hear', 'VB'), ('the', 'DT'), ('Rabbit', 'NNP'), ('say', 'VBP'), ('to', 'TO'),
('itself', 'PRP'), ('Oh', 'UH'), ('dear', 'VB')]

5 : [('Oh', 'UH'), ('dear', 'NN')]

6 : [('I', 'PRP'), ('shall', 'MD'), ('be', 'VB'), ('late', 'JJ')]

7 : [('when', 'WRB'), ('she', 'PRP'), ('thought', 'VBD'), ('it', 'PRP'),
('over', 'IN'), ('afterwards', 'NNS'), ('it', 'PRP'), ('occurred', 'VBD'),
('to', 'TO'), ('her', 'PRP$'), ('that', 'IN'), ('she', 'PRP'), ('ought', 'MD'),
('to', 'TO'), ('have', 'VB'), ('wondered', 'VBN'), ('at', 'IN'), ('this', 'DT'),
('but', 'CC'), ('at', 'IN'), ('the', 'DT'), ('time', 'NN'), ('it', 'PRP'),
('all', 'DT'), ('seemed', 'VBD'), ('quite', 'JJ'), ('natural', 'JJ'), ('but',
'CC'), ('when', 'WRB'), ('the', 'DT'), ('Rabbit', 'NNP'), ('actually', 'RB'),
('a', 'DT'), ('watch', 'NN'), ('out', 'IN'), ('of', 'IN'), ('its', 'PRP$'),
('waistcoat', 'NN'), ('and', 'CC'), ('looked', 'VBD'), ('at', 'IN'), ('it',
'PRP'), ('and', 'CC'), ('then', 'RB'), ('hurried', 'VBD'), ('on', 'IN'),
('Alice', 'NNP'), ('started', 'VBD'), ('to', 'TO'), ('her', 'PRP$'), ('feet',
'NNS'), ('for', 'IN'), ('it', 'PRP'), ('flashed', 'VBD'), ('across', 'IN'),
('her', 'PRP$'), ('mind', 'NN'), ('that', 'IN'), ('she', 'PRP'), ('had', 'VBD'),
('never', 'RB'), ('before', 'RB'), ('seen', 'VBN'), ('a', 'DT'), ('rabbit',
'NN'), ('with', 'IN'), ('either', 'CC'), ('a', 'DT'), ('waistcoat', 'NN'),
('pocket', 'NN'), ('or', 'CC'), ('a', 'DT'), ('watch', 'NN'), ('to', 'TO'),
('take', 'VB'), ('out', 'IN'), ('of', 'IN'), ('it', 'PRP'), ('and', 'CC'),
('burning', 'VBG'), ('with', 'IN'), ('curiosity', 'NN'), ('she', 'PRP'), ('ran',
'VBD'), ('across', 'IN'), ('the', 'DT'), ('field', 'NN'), ('after', 'IN'),
('it', 'PRP'), ('and', 'CC'), ('fortunately', 'RB'), ('was', 'VBD'), ('just',
'RB'), ('in', 'IN'), ('time', 'NN'), ('to', 'TO'), ('see', 'VB'), ('it', 'PRP'),
('pop', 'VB'), ('down', 'RP'), ('a', 'DT'), ('large', 'JJ'), ('rabbit', 'NN'),
('hole', 'NN'), ('under', 'IN'), ('the', 'DT'), ('hedge', 'NN')]

8 : [('In', 'IN'), ('another', 'DT'), ('moment', 'NN'), ('down', 'RP'), ('went',
'VBD'), ('Alice', 'NNP'), ('after', 'IN'), ('it', 'PRP'), ('never', 'RB'),
('once', 'RB'), ('considering', 'VBG'), ('how', 'WRB'), ('in', 'IN'), ('the',
'DT'), ('world', 'NN'), ('she', 'PRP'), ('was', 'VBD'), ('to', 'TO'), ('get',
'VB'), ('out', 'RP'), ('again', 'RB')]

9 : [('The', 'DT'), ('rabbit', 'NN'), ('hole', 'JJ'), ('went', 'VBD'),
('straight', 'RB'), ('on', 'IN'), ('like', 'IN'), ('a', 'DT'), ('tunnel', 'NN'),
('for', 'IN'), ('some', 'DT'), ('way', 'NN'), ('and', 'CC'), ('then', 'RB'),
('dipped', 'VBD'), ('suddenly', 'RB'), ('down', 'RB'), ('so', 'RB'),
('suddenly', 'RB'), ('that', 'IN'), ('Alice', 'NNP'), ('had', 'VBD'), ('not',
'RB'), ('a', 'DT'), ('moment', 'NN'), ('to', 'TO'), ('think', 'VB'), ('about',
'IN'), ('stopping', 'VBG'), ('herself', 'PRP'), ('before', 'IN'), ('she',
'PRP'), ('found', 'VBD'), ('herself', 'PRP'), ('falling', 'VBG'), ('down',
'RP'), ('a', 'DT'), ('very', 'RB'), ('deep', 'JJ'), ('well', 'NN')]

10 : [('Either', 'CC'), ('the', 'DT'), ('well', 'NN'), ('was', 'VBD'), ('very',
'RB'), ('deep', 'JJ'), ('or', 'CC'), ('she', 'PRP'), ('fell', 'VBD'), ('very',
'RB'), ('slowly', 'RB'), ('for', 'IN'), ('she', 'PRP'), ('had', 'VBD'),
('plenty', 'NN'), ('of', 'IN'), ('time', 'NN'), ('as', 'IN'), ('she', 'PRP'),
('went', 'VBD'), ('down', 'RB'), ('to', 'TO'), ('look', 'VB'), ('about', 'IN'),
('her', 'PRP$'), ('and', 'CC'), ('to', 'TO'), ('wonder', 'VB'), ('what', 'WP'),
('was', 'VBD'), ('going', 'VBG'), ('to', 'TO'), ('happen', 'VB'), ('next',
'JJ')]

11 : [('First', 'RB'), ('she', 'PRP'), ('tried', 'VBD'), ('to', 'TO'), ('look',
'VB'), ('down', 'RP'), ('and', 'CC'), ('make', 'VB'), ('out', 'RP'), ('what',
'WP'), ('she', 'PRP'), ('was', 'VBD'), ('coming', 'VBG'), ('to', 'TO'), ('but',
'CC'), ('it', 'PRP'), ('was', 'VBD'), ('too', 'RB'), ('dark', 'JJ'), ('to',
'TO'), ('see', 'VB'), ('anything', 'NN'), ('then', 'RB'), ('she', 'PRP'),
('looked', 'VBD'), ('at', 'IN'), ('the', 'DT'), ('sides', 'NNS'), ('of', 'IN'),
('the', 'DT'), ('well', 'NN'), ('and', 'CC'), ('noticed', 'VBD'), ('that',
'IN'), ('they', 'PRP'), ('were', 'VBD'), ('filled', 'VBN'), ('with', 'IN'),
('cupboards', 'NNS'), ('and', 'CC'), ('book', 'NN'), ('shelves', 'NNS'),
('here', 'RB'), ('and', 'CC'), ('there', 'RB'), ('she', 'PRP'), ('saw', 'VBD'),
('maps', 'NNS'), ('and', 'CC'), ('pictures', 'NNS'), ('hung', 'VBP'), ('upon',
'IN'), ('pegs', 'NNS')]

12 : [('She', 'PRP'), ('took', 'VBD'), ('down', 'RP'), ('a', 'DT'), ('jar',
'NN'), ('from', 'IN'), ('one', 'CD'), ('of', 'IN'), ('the', 'DT'), ('shelves',
'NNS'), ('as', 'IN'), ('she', 'PRP'), ('passed', 'VBD'), ('it', 'PRP'), ('was',
'VBD'), ('labelled', 'VBN'), ('ORANGE', 'NNP'), ('MARMALADE', 'NNP'), ('but',
'CC'), ('to', 'TO'), ('her', 'PRP$'), ('great', 'JJ'), ('disappointment', 'NN'),
('it', 'PRP'), ('was', 'VBD'), ('empty', 'JJ'), ('she', 'PRP'), ('did', 'VBD'),
('not', 'RB'), ('like', 'IN'), ('to', 'TO'), ('drop', 'VB'), ('the', 'DT'),
('jar', 'NN'), ('for', 'IN'), ('fear', 'NN'), ('of', 'IN'), ('killing', 'VBG'),
('somebody', 'NN'), ('underneath', 'IN'), ('so', 'RB'), ('managed', 'VBN'),
('to', 'TO'), ('put', 'VB'), ('it', 'PRP'), ('into', 'IN'), ('one', 'CD'),
('of', 'IN'), ('the', 'DT'), ('cupboards', 'NNS'), ('as', 'IN'), ('she', 'PRP'),
('fell', 'VBD'), ('past', 'IN'), ('it', 'PRP')]
```

```
13 : [('Well', 'RB')]

14 : [('thought', 'VBN'), ('Alice', 'NNP'), ('to', 'TO'), ('herself', 'VB'),
('after', 'IN'), ('such', 'PDT'), ('a', 'DT'), ('fall', 'NN'), ('as', 'IN'),
('this', 'DT'), ('I', 'PRP'), ('shall', 'MD'), ('think', 'VB'), ('nothing',
'NN'), ('of', 'IN'), ('tumbling', 'VBG'), ('down', 'RP'), ('stairs', 'NNS')]

15 : [('How', 'WRB'), ('brave', 'JJ'), ('theyll', 'VBP'), ('all', 'DT'),
('think', 'VBP'), ('me', 'PRP'), ('at', 'IN'), ('home', 'NN')]

16 : [('Why', 'WRB'), ('I', 'PRP'), ('wouldnt', 'VBP'), ('say', 'VB'),
('anything', 'NN'), ('about', 'IN'), ('it', 'PRP'), ('even', 'RB'), ('if',
'IN'), ('I', 'PRP'), ('fell', 'VBD'), ('off', 'RP'), ('the', 'DT'), ('top',
'NN'), ('of', 'IN'), ('the', 'DT'), ('house', 'NN')]

17 : [('Which', 'WDT'), ('was', 'VBD'), ('very', 'RB'), ('likely', 'JJ'),
('true', 'JJ')]

18 : [('Down', 'IN'), ('down', 'RB'), ('down', 'RB')]

19 : [('Would', 'MD'), ('the', 'DT'), ('fall', 'NN'), ('come', 'NN'), ('to',
'TO'), ('an', 'DT'), ('end', 'NN')]

20 : [('I', 'PRP'), ('wonder', 'VBP'), ('how', 'WRB'), ('many', 'JJ'), ('miles',
'NNS'), ('Ive', 'NNP'), ('fallen', 'VBN'), ('by', 'IN'), ('this', 'DT'),
('time', 'NN')]
```

1.8 4.f.2. Incorrect POS Tagging Example:

Tokenized Sentence: [‘Oh’, ‘dear’] (Fourth sentence)
Tags: [‘UH’, ‘NN’]
Expected Tags: [‘UH’, ‘UH’]
Explanation: “Oh dear!” is an interjection, a word used to express emotion, and therefore both “Oh” and “dear” should be tagged as UH(Corresponding Penn’s Treebank-tag for interjection). However, the word “dear” is incorrectly tagged as NN (Noun, singular or mass).

2 4.g. Plot Word Cloud of Proper Nouns

2.0.1 4.g.1. Extract Proper Nouns

We’ll extract proper noun by filtering the tagged sentences for words with the tags ‘NNP’ (Proper noun, singular) and ‘NNPS’ (Proper noun, plural).

[220]:

```
def extract_proper_nouns(tagged_sentences):
    """
    Extract proper nouns from tagged sentences.
    :param tagged_sentences: A list of POS-tagged sentences.
    :return: A list of proper nouns.
    """
    proper_nouns = []
    for sentence in tagged_sentences:
        for word, tag in sentence:
            if tag in ('NNP', 'NNPS'):
                proper_nouns.append(word)
    return proper_nouns
```

[221]:

```
print(f"Extracting proper nouns from tagged sentences...")
proper_nouns = extract_proper_nouns(tagged_sentences)
print(f"Extracted {len(proper_nouns)} proper nouns!")

PROPER_NOUN_COUNT = 20
print(f"First {PROPER_NOUN_COUNT} proper nouns:")
for index, noun in enumerate(proper_nouns[:PROPER_NOUN_COUNT]):
    print(f"\t{index + 1}: {noun}")
```

```
Extracting proper nouns from tagged sentences…
Extracted 1637 proper nouns!
First 20 proper nouns:
        1: Rabbit
        2: Hole
        3: Alice
        4: Alice
        5: White
        6: Alice
        7: Rabbit
        8: Rabbit
        9: Alice
        10: Alice
        11: Alice
        12: ORANGE
        13: MARMALADE
        14: Alice
        15: Ive
        16: Alice
        17: Latitude
        18: Longitude
        19: Ive
        20: Alice
```

2.0.2 4.g.2. Plot Word Cloud

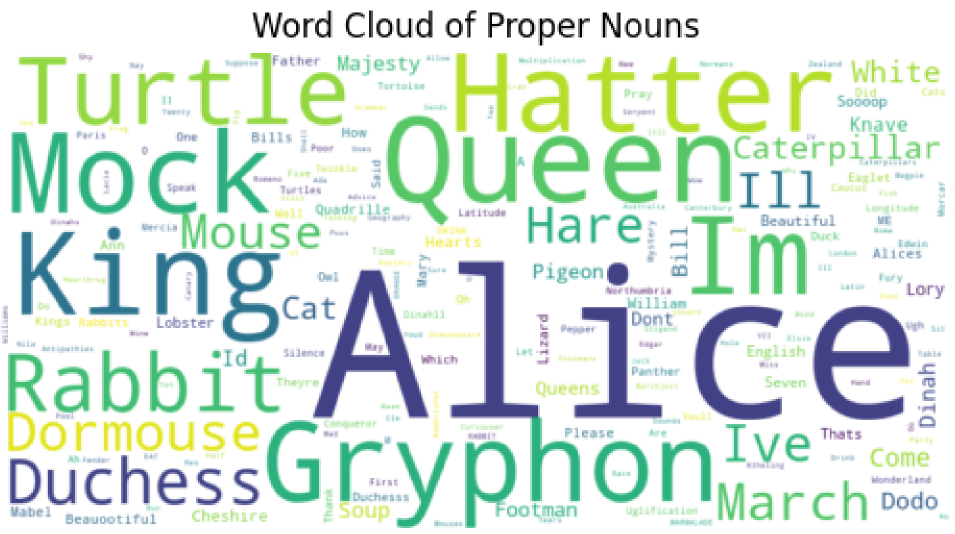
We can plot a word cloud of the most frequent proper nouns using the wordcloud library.

[222]:

```
from wordcloud import WordCloud

def plot_word_cloud(proper_nouns: [str]):
    """
    Plot a word cloud of the most frequent proper nouns.
    :param proper_nouns: A list of proper nouns.
    :return: None. The plot will be displayed.
    """
    proper_nouns_counts = Counter(proper_nouns)

    wordcloud = WordCloud(width=800, height=400, background_color='white').
 ↪generate_from_frequencies(proper_nouns_counts)

    plt.imshow(wordcloud, interpolation='bilinear')
    plt.axis('off')
    plt.title('Word Cloud of Proper Nouns')
    plt.show()
```

[223]:

```
plot_word_cloud(proper_nouns)

TOP_PROPER_NOUNS_COUNT = 5
proper_nouns_counts = Counter(proper_nouns)
print(f"Top {TOP_PROPER_NOUNS_COUNT} most frequent proper nouns:")
for noun, count in proper_nouns_counts.most_common(TOP_PROPER_NOUNS_COUNT):
    print(f"\t'{noun}' appears {count} times.")
```



```
Top 5 most frequent proper nouns:
        'Alice' appears 376 times.
        'Queen' appears 63 times.
```

```
'King' appears 58 times.
'Mock' appears 56 times.
'Gryphon' appears 55 times.
```

2.1 4.g.3. Explanation - Top Proper Nouns relevance to the book's narrative:

Answer: The top proper nouns and their frequencies do correspond well with what is known about the book.
Explanation: The main character is Alice, therefore it is the most prevalent Proper Noun. Following Alice, the Queen and the King are Key characters in the story. At last, the presence of "Mock" and "Gryphon" aligns with their roles in the narrative.

2.2 4.h. Find Repeated Words

2.2.1 4.h.1. Choosing the pattern:

[224]:

```
# We'll use the pattern \b([a-zA-Z]+)\b[\s,.;!?]*\b\1\b:
# - \b([a-zA-Z]+)\b: Match a word and capture it in a group.
# - [\s,.;!?]*: Match any number of optional spaces or punctuation characters␣
 ↪between the words.
# - \b\1\b: Match the same word as the first group.
```

2.3 4.h.2. Get Overlapping Matches

We can find repeated words in the document using re.

[225]:

```
def find_overlapping_matches(document: str, pattern: re.Pattern) -> [str]:
    """
    Find overlapping matches in the document using the pattern.
    :param document: The content of the document.
    :param pattern: The regex pattern to match.
    :return: A list of matches.
    """
    matches: [re.Match] = []
    search_start = 0

    # Using a while loop for "jumping" index:
    while search_start < len(document):
        match = pattern.search(document, search_start)
        if match is None:
            break

        matches.append(match)
        search_start = match.start() + 1

    return matches
```

2.3.1 4.h.3. Print Matches with Context

[226]:

```
pattern = re.compile(r'\b([a-zA-Z]+)\b[\s.,!?]*\b\1\b', re.IGNORECASE)
matches = find_overlapping_matches(document, pattern)

# Print matches with context
print(f"Found: {len(matches)} repeated word matches!")
for match in matches:
    start, end = match.span()
    highlighted_match = f"\033[1;31m{match.group()}\033[0m"  # Highlight the␣
 ↪match in red
    context = document[max(start - 30, 0):start] + highlighted_match +␣
 ↪document[end:end + 30] # Get 30*2 characters around the match
    context = re.sub(r'\s+', ' ', context)  # Remove extra spaces
    print(f"Match: '{match.group()}'")
    print(f"Start: {start}")
    print(f"Context: {context}")
    print("-" * 50)
```

```
Found: 29 repeated word matches!
Match: 'Down, down'
Start: 4080
Context: Which was very likely true.) Down, down, down. Would the
fall _never_
--------------------------------------------------
Match: 'down, down'
Start: 4086
Context: was very likely true.) Down, down, down. Would the fall
_never_ come
--------------------------------------------------
Match: 'Down, down'
Start: 5474
Context: ee it written up somewhere." Down, down, down. There was
nothing else
--------------------------------------------------
Match: 'down, down'
Start: 5480
Context: written up somewhere." Down, down, down. There was nothing
else to do
--------------------------------------------------
Match: 'thump! thump'
Start: 6366
Context: er eat a bat?" when suddenly, thump! thump! down she came
upon a heap of
--------------------------------------------------
Match: 'Dear, dear'
Start: 15562
Context: he time she went on talking: "Dear, dear! How queer
```

```
everything is to-d
--------------------------------------------------
Match: 'there. There'
Start: 27494
Context: ed along the course, here and there. There was no "One, two,
three, and
--------------------------------------------------
Match: 'Prizes! Prizes'
Start: 28418
Context: lling out in a confused way, "Prizes! Prizes!" Alice had no
idea what to
--------------------------------------------------
Match: 'Pat! Pat'
Start: 39252
Context:  an angry voice-the Rabbit's-"Pat! Pat! Where are you?" And
then a v
--------------------------------------------------
Match: 'you, you'
Start: 39990
Context: t all, at all!" "Do as I tell you, you coward!" and at last
she spre
--------------------------------------------------
Match: 'it, it'
Start: 46692
Context:  both sides of it, and behind it, it occurred to her that
she migh
--------------------------------------------------
Match: 'No, no'
Start: 56880
Context: ne_ with such a neck as that! No, no! You're a serpent; and
there'
--------------------------------------------------
Match: 'Wow! wow'
Start: 65860
Context: cook and the baby joined): "Wow! wow! wow!" While the
Duchess sa
--------------------------------------------------
Match: 'wow! wow'
Start: 65865
Context: and the baby joined): "Wow! wow! wow!" While the Duchess
sang th
--------------------------------------------------
Match: 'Wow! wow'
Start: 66194
Context: hen he pleases!" CHORUS. "Wow! wow! wow!" "Here! you may
nurse
--------------------------------------------------
Match: 'wow! wow'
```

```
Start: 66199
Context: e pleases!" CHORUS. "Wow! wow! wow!" "Here! you may nurse it
a
--------------------------------------------------
Match: 'Twinkle, twinkle'
Start: 78873
Context: f Hearts, and I had to sing ‘Twinkle, twinkle, little bat!
How I wonder wha
--------------------------------------------------
Match: 'Twinkle, twinkle'
Start: 79149
Context:  the sky. Twinkle, twinkle-’" Here the Dormouse shook
--------------------------------------------------
Match: 'twinkle, twinkle'
Start: 79245
Context: nging in its sleep "_Twinkle, twinkle, twinkle, twinkle_-"
and went on so lo
--------------------------------------------------
Match: 'Sh! sh'
Start: 82170
Context: tter and the March Hare went "Sh! sh!" and the Dormouse
sulkily re
--------------------------------------------------
Match: 'Two. Two'
Start: 86911
Context: n said nothing, but looked at Two. Two began in a low voice,
"Why th
--------------------------------------------------
Match: 'Hush! Hush'
Start: 91501
Context: ce: "-where’s the Duchess?" "Hush! Hush!" said the Rabbit in
a low, h
--------------------------------------------------
Match: 'you! You'
Start: 92048
Context: ed tone. "The Queen will hear you! You see, she came rather
late, an
--------------------------------------------------
Match: 'Tut, tut'
Start: 100558
Context: " Alice ventured to remark. "Tut, tut, child!" said the
Duchess. "E
--------------------------------------------------
Match: 'No, no'
Start: 118464
Context: hat," said the Mock Turtle. "No, no! The adventures first,"
said
--------------------------------------------------
```

```
Match: 'Soup!
Soup'
Start: 122390
Context: oup of the evening, beautiful Soup! Soup of the evening,
beautiful Sou
--------------------------------------------------
Match: 'Beautiful, beautiful'
Start: 122517
Context: o-oop of the e-e-evening, Beautiful, beautiful Soup!
"Beautiful Soup! Who c
--------------------------------------------------
Match: 'Beautiful, beautiful'
Start: 123338
Context: o-oop of the e-e-evening, Beautiful, beautiful Soup!"
CHAPTER XI. Who St
--------------------------------------------------
Match: 'No, no'
Start: 141604
Context: he twentieth time that day. "No, no!" said the Queen.
"Sentence f
--------------------------------------------------
```

2.4 Bonus: Convert to PDF

```
[ ]: !jupyter nbconvert --to pdf ex2.ipynb
```