EX.NO.: 11

DATE: 07.01.2025

PROBABILITY N-GRAM

To analyze text data from two distinct corpora (Brown and Inaugural) by performing n-gram frequency analysis, generating random sentences based on unigram frequencies, and computing perplexity to evaluate the predictive power of bigram models.

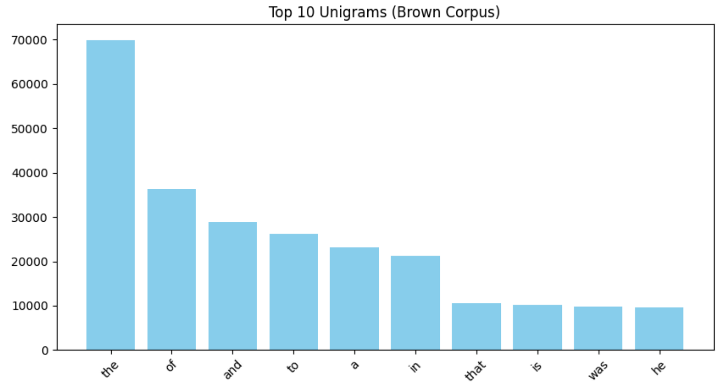
PROCEDURE:

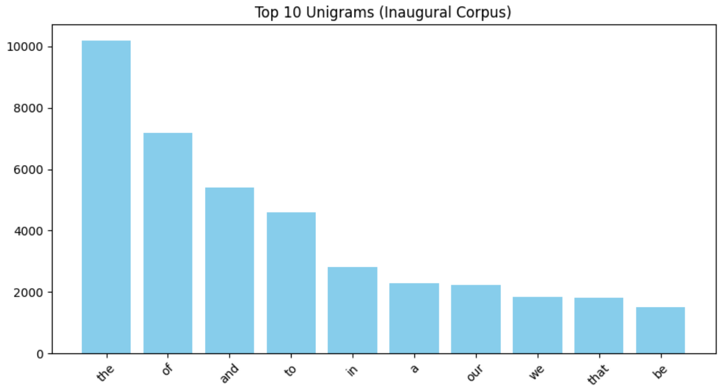
1. Import essential Python libraries like nltk, numpy, random, and matplotlib for text processing, random sampling, and visualization.
2. Download and Load Corpora:
   a. Use the nltk.corpus module to download and access the Brown and Inaugural corpora.
   b. Extract words from each corpus while preprocessing to remove punctuation by keeping only alphabetic characters.
3. Preprocessing:
   a. Convert words to lowercase to ensure case-insensitive analysis.
   b. Filter out non-alphabetic tokens to remove punctuation and special characters.
4. Generate N-grams:
   a. Define a function to compute n-grams using the ngrams() function from nltk.util.
   b. Count the frequencies of unigrams and bigrams using collections.Counter.
5. Frequency Analysis:
   a. Plot bar graphs for the top 10 most common unigrams and bigrams for both corpora.
6. Generate Random Sentences:
   a. Define a function to generate random sentences based on unigram frequencies.
   b. Use random.choices() with unigram probabilities to construct sentences of a given length.
7. Compute Perplexity:
   a. Define a function to compute the perplexity of a given test set using n-gram frequencies.
   b. Apply smoothing by adding a small constant (1e-10) to avoid log(0) errors.
   c. Calculate perplexity using the formula: Perplexity=2−1N∑i=1Nlog2(P(ngrami))\text{Perplexity} = 2^{-\frac{1}{N} \sum_{i=1}^{N} \log_2(P(ngram_i))}Perplexity=2−N1∑i=1Nlog2(P(ngrami)) where NNN is the total number of n-grams.

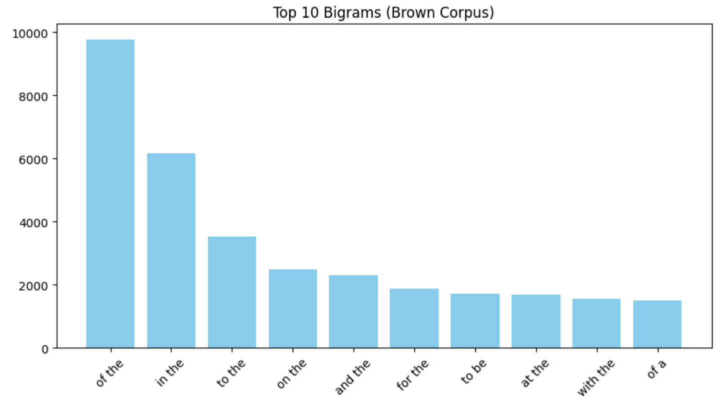
CODE AND OUTPUT

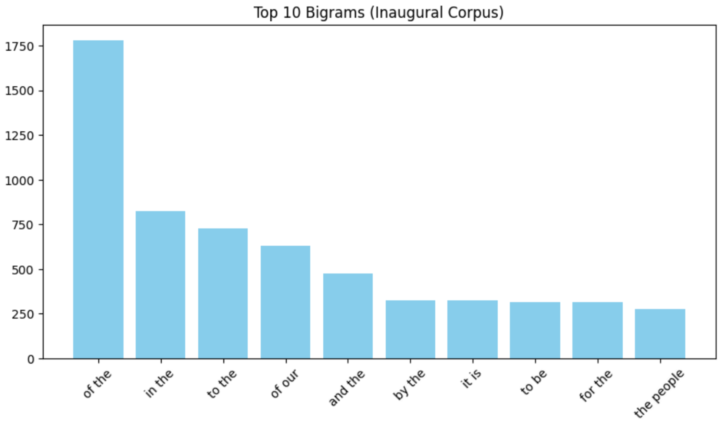
```
import nltk
from nltk.util import ngrams
from nltk.corpus import brown, inaugural
from collections import Counter
import random
import numpy as np
import matplotlib.pyplot as plt
import string

nltk.download("brown")
nltk.download("inaugural")

# Helper function to extract and preprocess words from a corpus
def extract_words(corpus):
    return [word.lower() for fileid in corpus.fileids() for word in corpus.words(fileid)
            if word.isalpha()]  # Keep only alphabetic words and remove punctuation
```

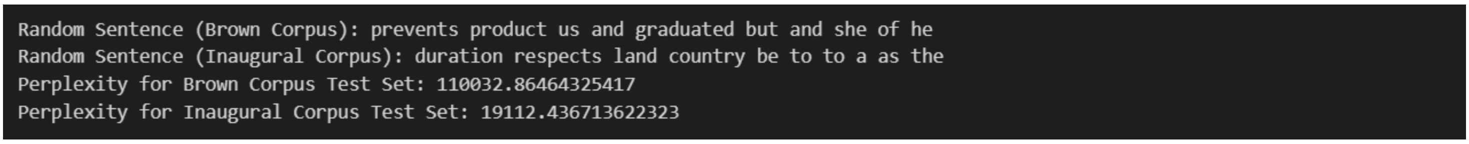
```
# Load two different corpora
corpus1_words = extract_words(brown)
corpus2_words = extract_words(inaugural)

# Function to get n-grams and their frequency counts
def get_ngram_frequencies(words, n):
    ngrams_list = list(ngrams(words, n))
    return Counter(ngrams_list)

# Analyze unigrams and bigrams for both corpora
unigram_freq1 = get_ngram_frequencies(corpus1_words, 1)
unigram_freq2 = get_ngram_frequencies(corpus2_words, 1)
bigram_freq1 = get_ngram_frequencies(corpus1_words, 2)
bigram_freq2 = get_ngram_frequencies(corpus2_words, 2)

# Plot the top 10 most common unigrams and bigrams
def plot_ngram_frequencies(ngram_freq, title):
    most_common = ngram_freq.most_common(10)
    labels, values = zip(*most_common)
    labels = [' '.join(ngram) for ngram in labels]

    plt.figure(figsize=(10, 5))
    plt.bar(labels, values, color='skyblue')
    plt.title(title)
    plt.xticks(rotation=45)
    plt.show()

plot_ngram_frequencies(unigram_freq1, "Top 10 Unigrams (Brown Corpus)")
plot_ngram_frequencies(unigram_freq2, "Top 10 Unigrams (Inaugural Corpus)")
plot_ngram_frequencies(bigram_freq1, "Top 10 Bigrams (Brown Corpus)")
plot_ngram_frequencies(bigram_freq2, "Top 10 Bigrams (Inaugural Corpus)")

# Generate random sentences based on unigram frequencies
def generate_random_sentence(unigram_freq, length=10):
    unigrams, counts = zip(*unigram_freq.items())
    unigrams = [unigram[0] for unigram in unigrams]  # Extract single word from tuple
    probabilities = np.array(counts) / sum(counts)
    sentence = ' '.join(random.choices(unigrams, probabilities, k=length))
    return sentence

print("Random Sentence (Brown Corpus):", generate_random_sentence(unigram_freq1))
print("Random Sentence (Inaugural Corpus):", generate_random_sentence(unigram_freq2))

# Perplexity calculation
def compute_perplexity(test_set, ngram_freq, n):
    test_ngrams = list(ngrams(test_set, n))
    N = len(test_ngrams)
    total_prob = 0

    for ngram in test_ngrams:
        count = ngram_freq.get(ngram, 1e-10)  # Smoothing by adding a small value to avoid log(0)
        total_prob += np.log2(count / sum(ngram_freq.values()))

    perplexity = 2 ** (-total_prob / N)
    return perplexity

# Example test sets for perplexity computation
test_set1 = corpus1_words[:50]
test_set2 = corpus2_words[:50]

perplexity1 = compute_perplexity(test_set1, bigram_freq1, 2)
perplexity2 = compute_perplexity(test_set2, bigram_freq2, 2)

print("Perplexity for Brown Corpus Test Set:", perplexity1)
print("Perplexity for Inaugural Corpus Test Set:", perplexity2)
```


Top 10 Unigrams (Brown Corpus)


Top 10 Unigrams (Inaugural Corpus)


Top 10 Bigrams (Brown Corpus)


Top 10 Bigrams (Inaugural Corpus)



```
Random Sentence (Brown Corpus): prevents product us and graduated but and she of he
Random Sentence (Inaugural Corpus): duration respects land country be to to a as the
Perplexity for Brown Corpus Test Set: 110032.86464325417
Perplexity for Inaugural Corpus Test Set: 19112.436713622323
```