Vidyavardhini's College of Engineering and Technology

Department of Artificial Intelligence & Data Science

AY:2024-25

Class:	**BE**	**Semester:**	**VII**
Course Code:	**CSDOL7011**	**Course Name:**	**Natural Language Processing**

Name of Student:	**Parth Raut**
Roll No.:	**40**
Experiment No.:	**4**
Title of the Experiment:	**Morphological Analysis & Word Generation**
Date of Performance:	
Date of Submission:	

Evaluation

Performance Indicator	Max. Marks	Marks Obtained
Performance	5	
Understanding	5	
Journal work and timely submission	10	
Total	20	

Performance Indicator	Exceed Expectations (EE)	Meet Expectations (ME)	Below Expectations (BE)
Performance	4-5	2-3	1
Understanding	4-5	2-3	1
Journal work and timely submission	8-10	5-8	1-4

Checked by

Name of Faculty :

Signature :

Date :

Experiment 4

Aim: Perform morphological analysis and word generation for any given text.

Objective: Understand the working of stemming algorithms and apply stemming on the given input text.

Theory:

Stemming is a process of linguistic normalization, which reduces words to their word root word or chops off the derivational affixes. For example, connection, connected, connecting word reduce to a common word "conect".

Stemming is the process of producing morphological variants of a root/base word. Stemming programs are commonly referred to as stemming algorithms or stemmers. A stemming algorithm reduces the words “chocolates”, “chocolatey”, “choco” to the root word, “chocolate” and “retrieval”, “retrieved”, “retrieves” and reduces to the stem “retrieve”. Stemming is an important part of the pipelining process in Natural language processing. The input to the stemmer is tokenized words.

Applications of stemming :

1. Stemming is used in information retrieval systems like search engines.
2. It is used to determine domain vocabularies in domain analysis.

Porter’s Stemmer Algorithm:

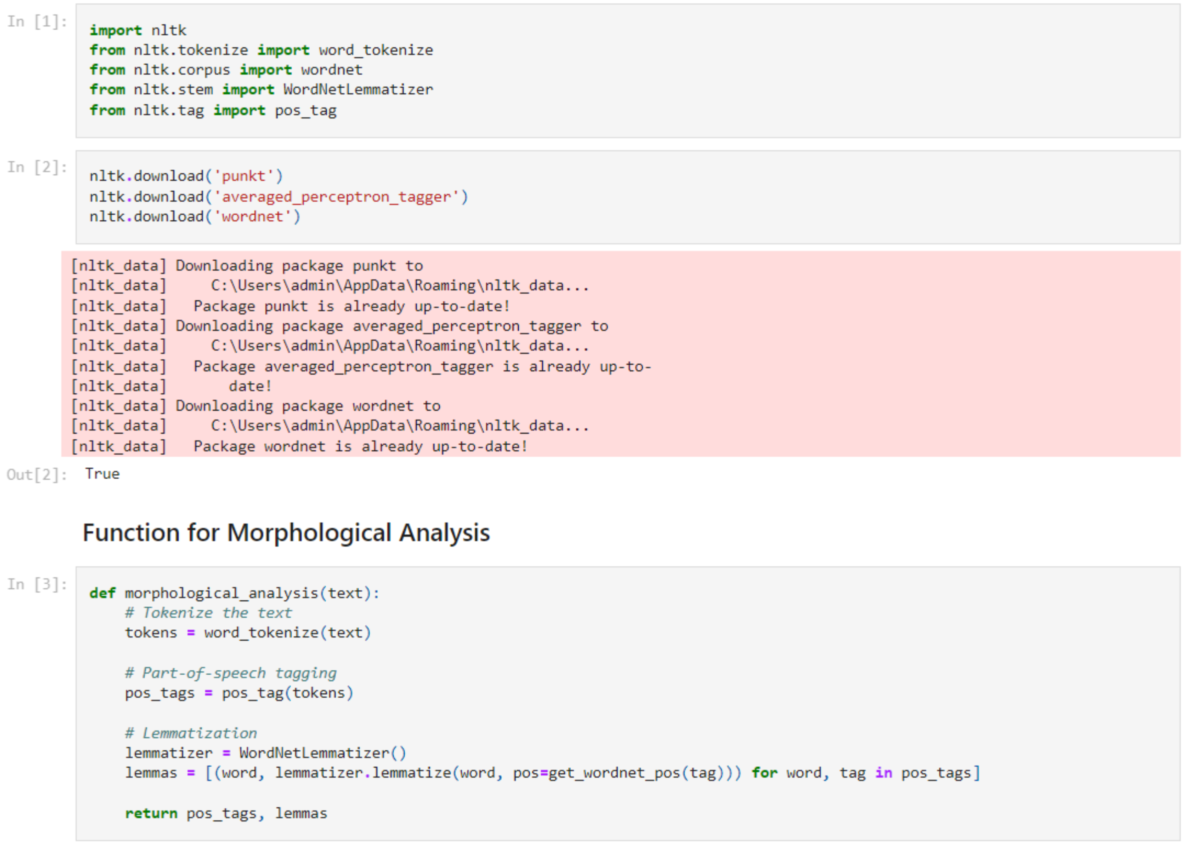
It is one of the most popular stemming methods proposed in 1980. It is based on the idea that the suffixes in the English language are made up of a combination of smaller and simpler suffixes. This stemmer is known for its speed and simplicity. The main applications of Porter Stemmer include data mining and Information retrieval. However, its applications are only limited to English words. Also, the group of stems is mapped on to the same stem and the output stem is not necessarily a meaningful word. The algorithms are fairly lengthy in nature and are known to be the oldest stemmer.

Example: EED -> EE means “if the word has at least one vowel and consonant plus EED ending, change the ending to EE” as ‘agreed’ becomes ‘agree’.

Advantage: It produces the best output as compared to other stemmers and it has less error rate.

Limitation: Morphological variants produced are not always real words.

Code:



In [1]:
```
import nltk
from nltk.tokenize import word_tokenize
from nltk.corpus import wordnet
from nltk.stem import WordNetLemmatizer
from nltk.tag import pos_tag
```

In [2]:
```
nltk.download('punkt')
nltk.download('averaged_perceptron_tagger')
nltk.download('wordnet')
```

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

Out[2]:
```
True
```

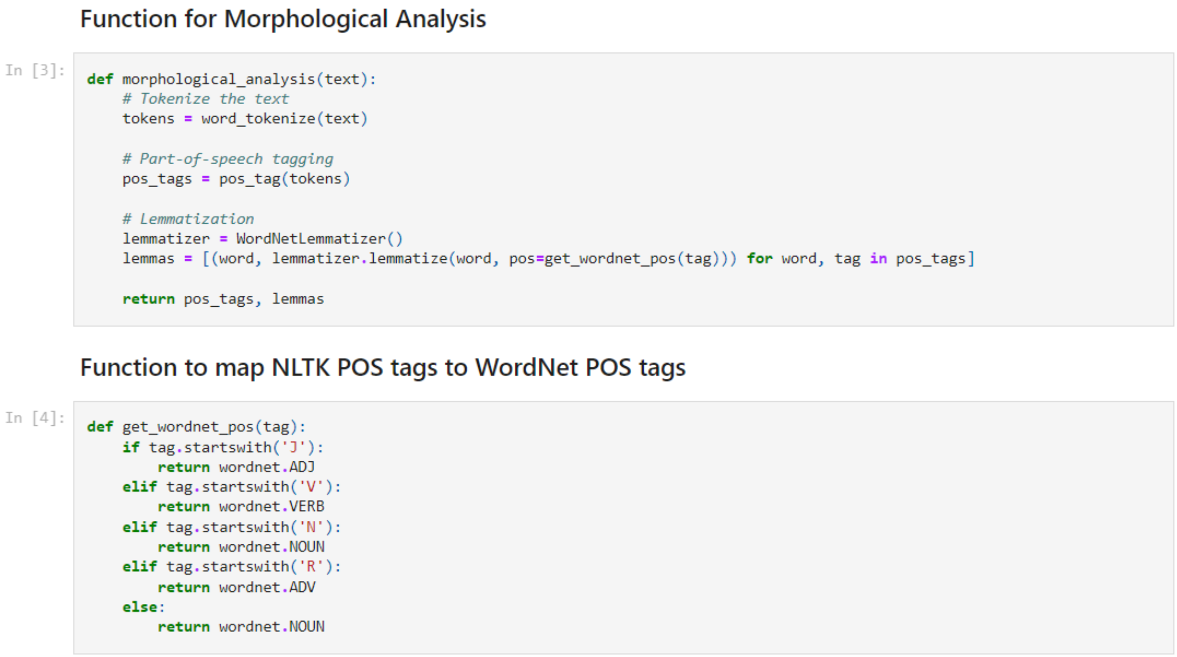
Function for Morphological Analysis

In [3]:
```
def morphological_analysis(text):
    # Tokenize the text
    tokens = word_tokenize(text)

    # Part-of-speech tagging
    pos_tags = pos_tag(tokens)

    # Lemmatization
    lemmatizer = WordNetLemmatizer()
    lemmas = [(word, lemmatizer.lemmatize(word, pos=get_wordnet_pos(tag))) for word, tag in pos_tags]

    return pos_tags, lemmas
```



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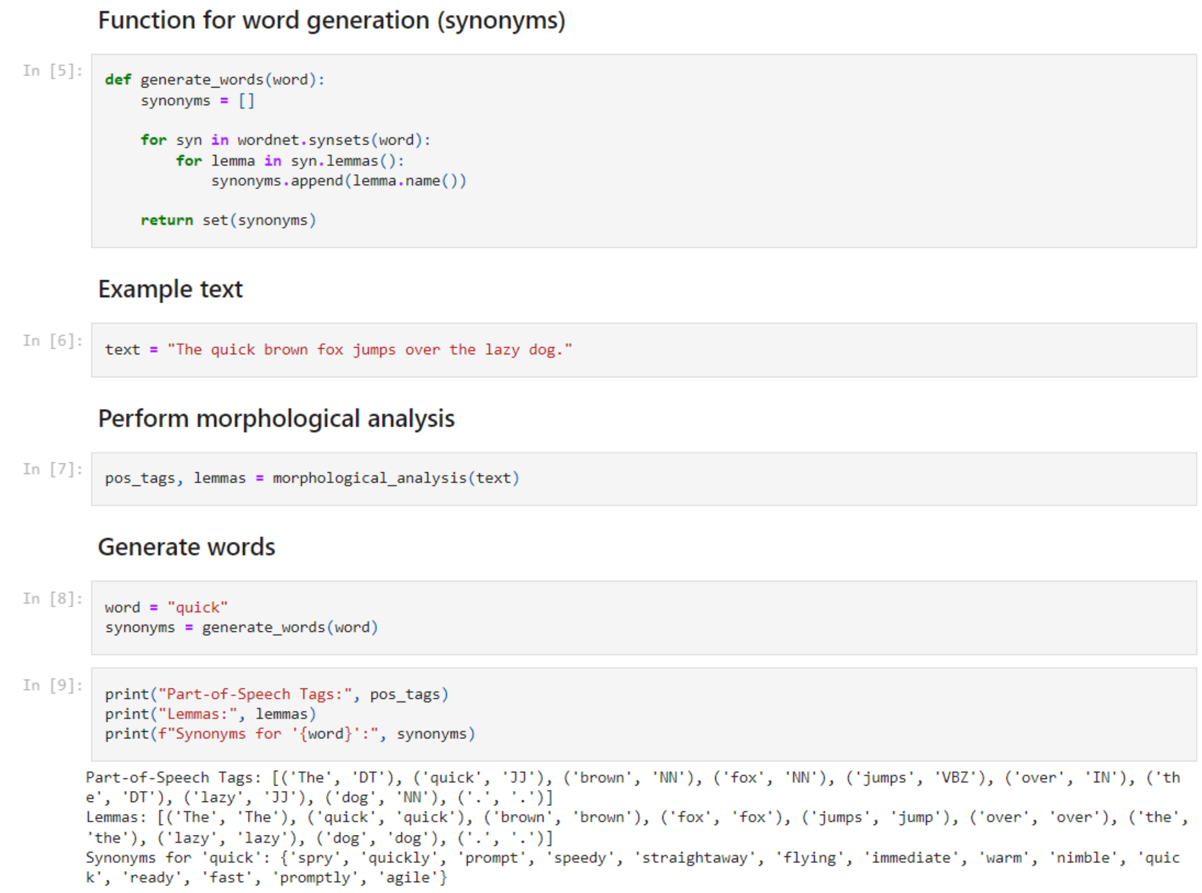
    return pos_tags, lemmas
```

Function to map NLTK POS tags to WordNet POS tags

In [4]:
```
def get_wordnet_pos(tag):
    if tag.startswith('J'):
        return wordnet.ADJ
    elif tag.startswith('V'):
        return wordnet.VERB
    elif tag.startswith('N'):
        return wordnet.NOUN
    elif tag.startswith('R'):
        return wordnet.ADV
    else:
        return wordnet.NOUN
```



Function for word generation (synonyms)

In [5]:
```
def generate_words(word):
    synonyms = []

    for syn in wordnet.synsets(word):
        for lemma in syn.lemmas():
            synonyms.append(lemma.name())

    return set(synonyms)
```

Example text

In [6]:
```
text = "The quick brown fox jumps over the lazy dog."
```

Perform morphological analysis

In [7]:
```
pos_tags, lemmas = morphological_analysis(text)
```

Generate words

In [8]:
```
word = "quick"
synonyms = generate_words(word)
```

In [9]:
```
print("Part-of-Speech Tags:", pos_tags)
print("Lemmas:", lemmas)
print(f"Synonyms for '{word}':", synonyms)
```

```
Part-of-Speech Tags: [('The', 'DT'), ('quick', 'JJ'), ('brown', 'NN'), ('fox', 'NN'), ('jumps', 'VBZ'), ('over', 'IN'), ('th
e', 'DT'), ('lazy', 'JJ'), ('dog', 'NN'), ('.', '.')]
Lemmas: [('The', 'The'), ('quick', 'quick'), ('brown', 'brown'), ('fox', 'fox'), ('jumps', 'jump'), ('over', 'over'), ('the',
'the'), ('lazy', 'lazy'), ('dog', 'dog'), ('.', '.')]
Synonyms for 'quick': {'spry', 'quickly', 'prompt', 'speedy', 'straightaway', 'flying', 'immediate', 'warm', 'nimble', 'quic
k', 'ready', 'fast', 'promptly', 'agile'}
```

Conclusion:

Implementation of Stemming for Indian Languages

Stemming in Indian languages can be complex due to rich morphological structures, including inflections and derivations. Here's how stemming can be implemented:

1. Tools: Libraries like the Indic NLP Library provide specific stemming algorithms for various Indian languages (e.g., Hindi, Tamil). Custom algorithms may also be developed to handle language-specific morphological rules.
2. Approach:
   - Tokenization: Break down the text into individual words.
   - Suffix Removal: Identify and remove common suffixes based on linguistic rules. For example, in Hindi, suffixes like "-ता" or "-ने" can indicate verb forms.
   - Root Extraction: Reduce words to their base or root form (e.g., "खेलना" becomes "खेल").

3. Challenges: The high morphological richness and variations among Indian languages necessitate tailored stemming approaches, often requiring substantial linguistic knowledge.

Implementation of Stemming for English

Stemming in English is often performed using established algorithms like the Porter Stemmer, which follows specific rules to reduce words to their base forms:

1. Common Rules:

   Suffix Removal

2. Step-wise Reduction: The process is iterative, applying multiple steps to refine the stem further until no more rules can be applied (e.g., "consigning" → "consign").