COMP 6791 Information Retrieval and Web Search

Project 1 Report

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Abstract

This report outlines the development and testing of an NLTK-based text processing pipeline that includes Tokenization, Lowercasing, Stemming, and Stopword Removal modules. The pipeline is intended to address fundamental text analysis concerns by providing insights into design decisions, encountered obstacles, and novel solutions at each level. Individual module output files, as well as a stopwords list, are supplied, providing a thorough overview of the pipeline's functionality. The following report highlights the NLTK pipeline's capabilities and performances.

Introduction

The NLTK-based text processing pipeline is intended to analyze Reuter's news items by utilizing several critical modules such as Tokenization, Lowercasing, Stemming, and Stopword Removal. This paper looks into the development's design decisions, implementation details, problems, and inventive solutions.

Design Decision

The extensive natural language processing capabilities of NLTK influenced the choice. Each module is critical in converting raw text into a processed format. Custom stopwords were used to customize the pipeline to the unique properties of the Reuter's corpus. The following functions are created:

- **Tokenization**: Dividing the text into separate tokens allows for a more detailed study of word frequencies and trends.
- **Lowercasing**: Case consistency guarantees that words are treated consistently, preventing conflicts in studies that rely on case sensitivity.
- **Stemming**: Reducing words to their root form simplifies word frequency analysis by capturing the core of a term independent of its exact form.
- **Stopword Removal**: Removing frequent terms that do not add significantly to the context improves the analysis's relevance.

Implementation

- I came across unusual characters at the start and the end of the Reuters-21578 files in Reuters's Corpus. To solve this issue, I created a clean_text function that filters out these special characters using regular expressions, ensuring that the text is properly prepared for future processing inside the pipeline.
    - Regex: `r'[\x00-\x1F\x7F-\x9F]'`
- **Tokenization**
    - Tokenization splits text into tokens using the NLTK tokenize function with a custom regex to tokenize terms like “can't”, and ”3:30 AM” etc. These Special characters in tokens can now be handled within the scope of the regex.
    - This strategy was chosen for its effectiveness and precision in dealing with varied language structures.
- **Lowercasing**
    - Lowercasing maintains consistency in the presentation of words. The decision to utilize list comprehensions simplifies the process and improves code readability.
- **Stemming**
    - Using the NLTK's Porter stemmer function to stem words and reduce them to their root form. This strategy was chosen because of its simplicity and extensive application in NLP tasks.
- **Stopword Removal**
    - To improve contextual relevance, custom stopwords are deleted from the text. The usage of a function with custom stopwords as an argument provides better flexibility and customization. Where I receive the generic stopwords for the English language model from NLTK and use them to extend to a custom stopword list.
- **Process Article Function**
    - This method produces a folder for each file read from the corpus and creates five more files to satisfy the project requirement:
        - Tokenizer-output’, ‘Lowercased-output’, ‘Stemmed-output’, ‘No-stopword-output’ and ‘Stopwords-used-for-output’

- **Process Read Corpus Function**
    - This is the primary driver of the Reuters-21578 corpus text processing pipeline. It loops through the corpus files, extracting news items with BeautifulSoup and invoking the process_article function for each one.
    - This function manages the whole pipeline, ensuring that organized output folders are created for the first num_articles articles. Each article is cleaned, tokenized, lowercased, stemmed, and stopword removed, resulting in five output files. The organized output aids additional study and reflects the system's modular design.

Limitation

Module	Limitation	Error	Example Input
Tokenization	Struggles with ambiguous word boundaries in certain contexts.	In cases of complex punctuation, tokens might include special characters or fail to split properly.	"N.A.S.A" might be tokenized as ['N', '.A.S.A'].
Lowercasing	Alters the meaning of words, impacting cases where uppercase vs. lowercase is semantically significant.	Certain non-alphabetic characters might introduce artifacts during lowercasing.	"N.A.S.A" might become 'n.a.s.a'.
Stemming	May produce incorrect stems for irregular words or those from languages other than English.	Overstemming or understemming might occur, affecting the accuracy of the stemmed output.	running' might stem to 'run', but 'better' could stem to 'better'.
Stopword Removal	Stopwords are language-specific, and a predefined list may not cover all domain-specific stopwords.	Essential words might be erroneously removed if they coincide with stopwords.	"The quick brown fox" might become 'quick brown fox'.

Innovative Solutions

- The innovative idea is to use a custom stopwords list that extends to the available stopwords from NLTK.
- To achieve better results for tokenizing value, I used a regex-based tokenizer.
- This method allows for the pipeline to be tailored to the unique characteristics of the Reuter's corpus, resulting in more accuracy.

Output

- For the first five Reuters news items, twenty-five tiny output files are created. To organize and save the output files for each article, the program automatically creates directories (Article_1, Article_2, Article_3, Article_4, Article_5).
- Furthermore, each phase may be carried out separately with the proper input and will provide output acceptable as input for the following module.

Conclusion

- The pipeline, which is built on NLTK, demonstrates good text processing for Reuter's news items. The design choices and implementation details lay the groundwork for future improvements and optimizations.