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Mini Project Report On

Malayalam Parser for Dataset Creation

Submitted in partial fulfillment of the requirements for the award of the degree of

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CERTIFICATE

This is to certify that the mini project report entitled ***"Malayalam Parser for Dataset Creation"*** *is a bonafide record of the work done by* ***Fathima Jennath N K (U2103089)***, ***Gautham C Sudheer (U2103092)***, ***Godwin Gino (U2103096)***, ***Mohammed Basil (U2103139)***, *submitted to the APJ Abdul Kalam Technological University in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology (B. Tech.) in Computer Science and Engineering during the academic year 2023-2024.*

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Abstract

The "Malayalam Parser for Dataset Creation" project aims to address the scarcity of annotated datasets in the Malayalam language for Natural Language Processing (NLP) applications. The primary objective is to develop a robust Malayalam parser capable of analyzing the syntactic and semantic structures of Malayalam sentences. The creation of this parser involves several key steps, including data collection from diverse sources, preprocessing to ensure data quality, and man-ual annotation of a representative subset of the data with grammatical and syntactic information. The parser development process encompasses the selection of an appropriate parsing approach,whether rule-based, statistical, or machine learning-based. The model is trained using the annotated Malayalam dataset, focusing on capturing the unique linguistic nuances of the Malayalam language. Evaluation metrics are employed to assess the parser's performance on a separate test set, guiding iterative refinement and enhancement. The resulting Malayalam parser serves as a valuable tool for the analysis of grammatical structures in new Malayalam text data. Its application contributes to the creation of high-quality Malayalam datasets, crucial for advancing NLP research and applications in the Malayalam language. This project encourages collaboration with linguists,researchers, and the Malayalam-speaking community to ensure linguistic accuracy and relevance in the development of the parser. The "Malayalam Parser for Dataset Creation" project aligns with the broader goal of promoting linguistic diversity in NLP, addressing the challenges posed by the scarcity of resources for underrepresented languages. Through the development of this parser, the project aims to facilitate further research and innovation in Malayalam NLP, opening avenues for the exploration of various language-related tasks and applications.

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NLP - Natural Language Processing

NER - Named Entity Recognition

POS - Part-of-Speech

Chapter 1

Introduction

1.1 Background

Malayalam is spoken widely in Kerala and neighboring areas but has not received as much attention in the tech world as bigger languages like English. This lack of attention has led to a scarcity of tools for analyzing Malayalam text, despite its complex grammar and word forms.

Our project aims to address this issue by creating a specialized system for Malayalam that can understand and process Malayalam text more effectively than current tools. This system will facilitate tasks such as sentiment analysis, translation, and summarization, benefiting areas such as education and business.

We are designing our system to be adaptable and scalable, ensuring that it can evolve to meet diverse needs. Our ultimate goal is to establish a strong foundation for Malayalam language technology, paving the way for future improvements and innovations.

In short, our project focuses on using technology to make working with Malayalam text more efficient, enabling individuals to achieve more in various fields.

1.2 Problem Definition

The aim of the project is to create a Malayalam Parser for Dataset Creation, involving data collection, preprocessing, manual annotation, and training using various parsing approaches to address the scarcity of annotated datasets in Malayalam for NLP applications.

1.3 Scope and Motivation

Scope:

The Malayalam Parser project aims to develop an advanced tool capable of understanding

and processing Malayalam text efficiently. It encompasses essential tasks such as tokenization, part-of-speech tagging, parsing, and semantic analysis, providing a comprehensive breakdown of Malayalam sentences. The system's scope extends to facilitating tasks such as identifying different parts of speech and extracting meaningful insights from text. Additionally, the parser's design includes provisions for future expansion, allowing for the incorporation of domain-specific or specialized parsing tasks. This flexibility ensures that the parser can adapt to evolving needs and requirements, making it applicable across various domains and applications.

Motivation:

The motivation behind the Malayalam Parser project stems from the necessity for effective tools to process Malayalam text, essential for informed decision-making and strategic planning. By implementing parsing tasks such as tokenization, part-of- speech tagging, parsing, and semantic analysis, the system enables data-driven decision-making processes, enhancing strategic planning and execution.Furthermore, the project's innovation lies in the creation of annotated datasets,crucial for training and evaluating models for sentiment analysis, machine translation,question answering, and domain-specific parsing. Through these efforts, the project aims to advance natural language processing capabilities in Malayalam, contributing to the improvement of Malayalam language processing technologies and fostering innovation in linguistic research and technology development.

Parsing Tasks	**Description**
Tokenization	Breaking down sentences into individual words or tokens.
Part-of-Speech Tagging	Assigning grammatical tags to each word in a sentence.
Parsing	Analyzing the structure of sentences to understand their grammatical relationships.
Semantic Analysis	Extracting the meaning and context from sentences.

Table 1.1: Description of parsing tasks

1.4 Objectives

- Develop parsing algorithms to accurately identify linguistic components such as words, phrases, and sentences in Malayalam text, laying the foundation for compre-

hensive analysis.

- Implement functionalities to determine the grammatical structure, syntax, and semantics of Malayalam sentences, facilitating precise linguistic analysis and comprehension.

- Incorporate part-of-speech tagging, syntactic parsing, and semantic analysis capabilities tailored specifically for the Malayalam language, enabling detailed linguistic processing.

- Enhance the Malayalam Parser system to effectively handle compound words, inflections, and variations in word forms commonly encountered in Malayalam text, ensuring robust parsing capabilities.

- Ensure compatibility and interoperability with existing linguistic analysis frameworks, facilitating seamless integration and utilization of the Malayalam Parser within broader NLP applications.

- Continuously refine and optimize the Malayalam Parser system to improve efficiency, accuracy, and adaptability in analyzing and processing Malayalam text data.

1.5 Challenges

1. Morphological Complexity: Malayalam words can change a lot by adding suffixes, making it hard for the parser to figure out their basic forms and parts of speech. This makes it tough to understand the meaning and grammar of sentences.

2. Limited Resources: The scarcity of Malayalam-specific NLP tools and datasets complicates the development and training process. Adapting existing tools from other languages or creating new ones becomes necessary, potentially slowing down progress and hindering the effectiveness of the parser.

3. Syntactic Freedom: Malayalam's relatively flexible sentence structure allows for varied word orders, challenging parsing algorithms in determining precise word relationships. This freedom introduces complexity in identifying grammatical elements like subjects, objects, and verbs, especially when word order isn't a definitive indicator.

4. Data Annotation: The process of manually annotating data for parts of speech (POS), named entities, and intents is meticulous and time-consuming, requiring expertise in Malayalam grammar. It's crucial to ensure the quality and comprehensiveness of annotated training data for the parser's success, although this can be resource-intensive.

5. Model Selection and Training: Optimal performance of POS tagging, named entity recognition, and intent recognition tasks relies on choosing suitable algorithms and training them effectively. However, training on potentially limited or imbalanced datasets necessitates careful optimization, such as data augmentation and hyperparameter tuning, to mitigate any shortcomings.

1.6 Assumptions

1. Availability of Training Data: The project assumes a certain amount of high-quality Malayalam text data will be available for annotation and training the parser for POS tagging, NER, and intent recognition.

2. Effectiveness of Algorithms: The project assumes that the selected algorithms for POS tagging, NER, and intent recognition will be capable of accurately handling the linguistic complexities inherent in the Malayalam language.

3. Computational Resources: Adequate computational resources are assumed to be accessible for training the parser models, as this process can be computationally demanding.

4. Annotation Quality: The project assumes the quality of the annotations in the training data, including accuracy and consistency, as these factors greatly influence the performance of the parser models.

1.7 Societal / Industrial Relevance

The project aims to preserve and promote Malayalam, enhancing understanding and analysis of Malayalam text, providing datasets for parts-of-speech tagging, named entity recognition, and intent recognition. It supports research and learning in NLP and

Malayalam linguistics, improving access to information for Malayalam speakers online. The project also supports the development of local language technologies for industries in Malayalam-speaking regions, expanding market opportunities in e-commerce and social media.

1.8 Organization of the Report

The organization of the report are as follows:

- **Chapter 1-Introduction:**The introduction covers the background of the project, the problem definition, the scope and motivation, the objectives,the societal and industrial relevance, the assumptions and the challenges faced by the project.
- **Chapter 2-Software Requirements Specification:** This chapter outlines the functional and nonfunctional requirements of the NLP tools for Malayalam. It defines the overall description of the software, external interface requirements, system features, and other nonfunctional requirements necessary for the development and deployment of the tools.
- **Chapter 3-System Architecture and Design:** The system architecture and design chapter provides an overview of the project's technical framework. It includes discussions on the system overview, architectural design, identified datasets, proposed algorithms, implementation strategies, module division, and a work schedule presented as a Gantt chart for project planning and management.
- **Chapter 4-Results and Discussions:** This chapter presents an overview of the testing process, including graphical analysis and discussion.
- **Chapter 5-Conclusion:** This chapter comprises the conclusion of the study along with suggestions for future research directions.

Chapter 2

Software Requirements Specification

2.1 Introduction

2.1.1 Purpose

The system aims to enhance the understanding and analysis of Malayalam text data, enabling more accurate and efficient processing of information, including but not limited to retrieval, sentiment analysis, machine translation, and text summarization. By focusing on the unique linguistic characteristics of Malayalam, the project seeks to overcome the challenges posed by the language's morphology, syntax, and semantics. Through the development of innovative algorithms, data structures, and linguistic resources, the project aims to contribute to the advancement of NLP research and technology in the context of the Malayalam language.

- The primary focus of the Malayalam Parser system is to analyze and parse written text in the Malayalam language. This involves tasks such as tokenization, part-of-speech tagging, parsing, and semantic analysis.
- Initially, the system will target general-purpose parsing tasks, which are applicable to a wide range of text data. These tasks form the foundation of the parsing capabilities of the system.
- The system is designed to be extensible, allowing for the inclusion of domain-specific or specialized parsing tasks in the future. This flexibility ensures that the system can adapt to different needs and requirements over time.
- In addition to algorithms and data structures, the project also involves the development of linguistic resources that are crucial for parsing Malayalam text. These resources may include lexicons, grammars, and annotated corpora.

2.1.2 Product Scope

The Malayalam Parser is a smart tool that understands Malayalam text. It breaks down sentences to figure out their grammar, structure, and meaning using advanced language processing techniques. It helps with tasks like identifying different parts of speech, understanding how sentences are put together, and analyzing the overall meaning of text.

1. **Informed Decision-Making:** Implementation of parsing tasks including tokenization, part-of-speech tagging, parsing, and semantic analysis for Malayalam text. Extracting insights from Malayalam text aids in data-driven decision-making, enhancing strategic planning and execution.

2. **Innovation:** Developing a Malayalam parser for dataset creation is significant as it encompasses crucial linguistic tasks such as tokenization, part-of-speech tagging, and named entity recognition. This effort is essential for advancing natural language processing capabilities in Malayalam, enabling the development of robust models for sentiment analysis, machine translation, question answering, and domain-specific parsing. The creation of annotated datasets is vital to train and evaluate these models, contributing to the overall improvement of Malayalam language processing technologies.

2.2 Overall Description

2.2.1 Product Perspective

This software represents a new, standalone product developed to fulfill the crucial task of parsing and analyzing Malayalam language text. Unlike existing systems or components, this software is designed from the ground up to specialize in the intricacies of Malayalam language parsing, catering to the specific needs of users requiring accurate linguistic analysis in Malayalam. The Malayalam Parser software does not belong to a product family but serves as an independent solution, tailored specifically for parsing Malayalam text. It is not intended as a replacement for existing systems but rather as a complementary tool to enhance language processing capabilities in Malayalam. While it operates autonomously, it may interface with other systems or applications, such as text

input sources or linguistic databases, to facilitate seamless integration within broader linguistic analysis frameworks.

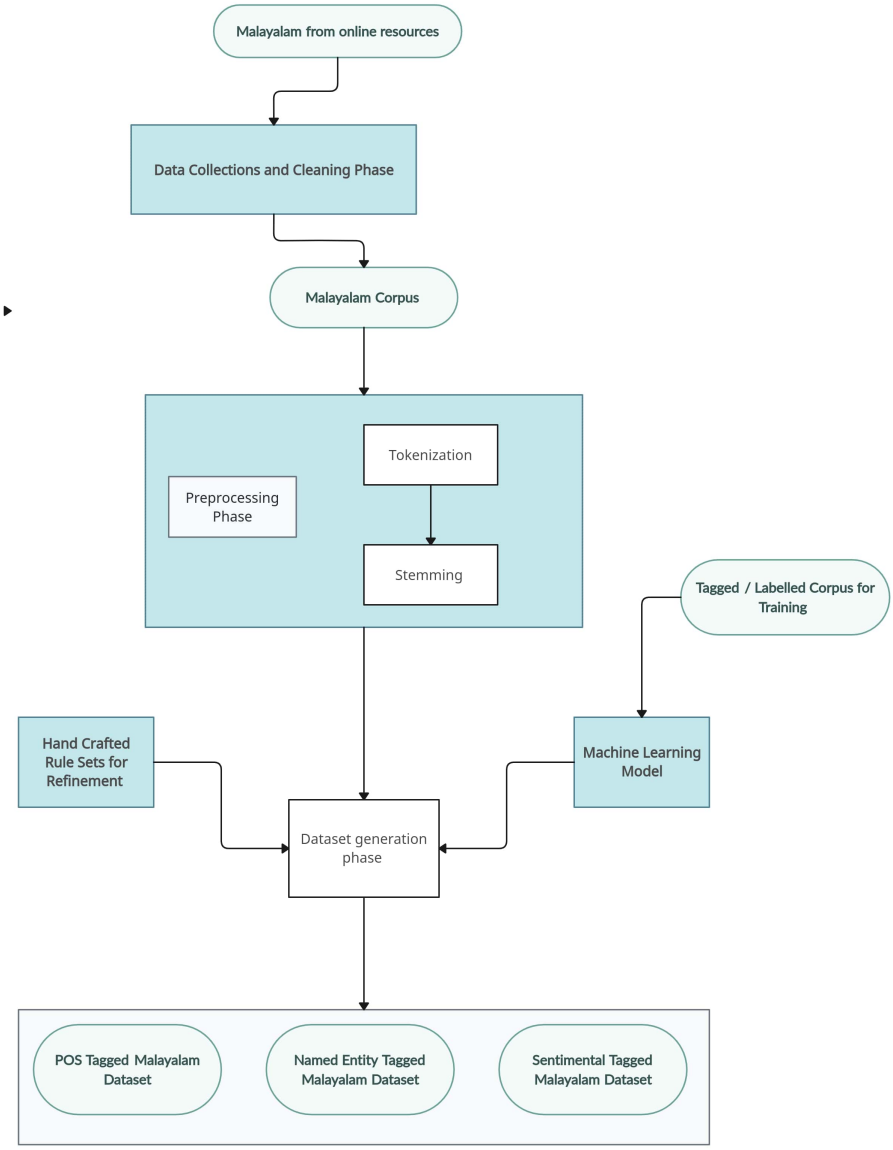


Figure 2.1: System design

2.2.2 Product Functions

Major Functions of the Malayalam Parser:

- Parse and analyze Malayalam language text to identify linguistic components such as words, phrases, and sentences.
- Determine grammatical structure, syntax, and semantics of Malayalam sentences to facilitate accurate linguistic analysis.

- Provide functionality for part-of-speech tagging, syntactic parsing, and semantic analysis tailored for the Malayalam language.
- Support for handling compound words, inflections, and variations in word forms commonly found in Malayalam text.
- Generation of a part-of-speech tagged dataset, named entity dataset, and sentimental tagged dataset, contributing to the advancement of language processing technologies in Malayalam

2.2.3 Operating Environment

For creating the Malayalam Parser, the operating environment encompasses the following specifications:

Hardware Platform

- The software should be compatible with standard computing hardware commonly used for software development and deployment.
- Minimum hardware requirements include a modern processor (e.g., Intel Core i5 or equivalent), sufficient RAM (at least 4GB), and available storage space for software installation and data processing.

Operating System and Versions

- The software should be compatible with popular operating systems used for software development and deployment, including Windows, MacOS, and Linux distributions.
- Specific operating system versions supported include:
  Windows 10 or later
  MacOS 10.13 High Sierra or later
  Ubuntu 18.04 LTS or later

Software Components and Applications

- The Malayalam Parser may require integration with various software components and applications for development, testing, and deployment purposes.

- Development tools such as Python (version 3.6 or later), Java Development Kit (JDK), or other programming languages and frameworks suitable for NLP development may be necessary.
- Libraries and frameworks for natural language processing, such as NLTK (Natural Language Toolkit), spacey or TensorFlow, may be utilized.
- Database systems such as SQLite, PostgreSQL, or MongoDB may be employed for data storage and retrieval if necessary.

2.2.4 Design and Implementation Constraints

The development of the Malayalam Parser is subject to various constraints and limitations, including:

- **Hardware Limitations:** The software must be optimized to operate within hardware limitations, including timing and memory constraints. Performance optimizations are crucial to ensure efficient operation across different hardware configuration.
- **Integration with External Systems:** The parser must support standard interfaces and data formats for interoperability with other language processing tools or databases. Ensuring smooth integration is a technical requirement.
- **Language Requirements:** The Malayalam Parser must be designed and implemented to meet the linguistic complexities of the Malayalam language. This includes handling unique grammar rules, character encoding, and text processing requirements inherent to Malayalam.
- **Character Encoding and Localization:** Proper handling of character encoding specific to Malayalam and localization considerations are crucial. The parser should accurately interpret and process Malayalam characters.
- **Security Considerations:** Security measures such as encryption, access control, and data integrity must be incorporated into the design and implementation of the Malayalam Parser to safeguard against security threats and vulnerabilities.

- **Design Conventions and Programming Standards:** Adherence to design conventions, programming standards, and coding guidelines is paramount. Developers must follow established best practices and organizational standards to ensure maintainability, readability, and consistency of the codebase.

2.2.5 Assumptions and Dependencies

1. **Third-Party or Commercial Components:** It is assumed that the development of the Malayalam Parser will rely on third-party or commercial components. The project is intended to be developed from existing models, without significant dependencies on pre-existing software solutions or proprietary libraries.

2. **Development Environment:** The assumption is made that the development environment for the Malayalam Parser will be properly configured and equipped with necessary tools, including programming languages, development frameworks, and version control systems.

3. **Operating Environment:** It is assumed that the operating environment for testing and deployment of the Malayalam Parser will meet the specified requirements, including compatibility with supported operating systems and hardware configurations.

4. **Constraints and Limitations:** The project assumes that constraints and limitations identified in the SRS, such as corporate policies, regulatory requirements, and hardware limitations, will be properly addressed and accounted for during the development process.

5. **External Dependencies:** The project does anticipate reliance on external dependencies or reused software components from other projects. Any dependencies arising during development will be clearly documented and managed accordingly.

6. **Availability of Resources:** It is assumed that the necessary resources, including human resources, budget allocation, and development timelines, will be available and allocated appropriately to support the successful development and completion of the Malayalam Parser project.

2.3 External Interface Requirements

2.3.1 User Interfaces

The project has the potential to be utilized in various future applications, particularly in educational tools designed for teaching purposes. Additionally, it can serve as a foundation for developing apps focused on language learning, text analysis, and speech recognition. This versatility opens up opportunities for creating interactive and innovative tools that cater to different learning styles and linguistic analysis needs. By leveraging the project's capabilities, we can create user-friendly applications that enhance the learning and analysis experience for users. These applications can play a significant role in promoting the Malayalam language and its usage in various contexts.

2.3.2 Hardware Interfaces

The software interacts with the hardware components of the system through various interfaces, each with specific communication protocols. It communicates with the CPU to execute algorithms, process data, and manage computational tasks, utilizing the CPU's instruction set architecture. The software uses RAM for temporary storage of linguistic data, parsing results, and intermediate processing steps, managing memory efficiently for complex linguistic analyses. For long-term storage, the software reads and writes data to the storage device, employing file systems for dataset management and data integrity. Optionally, the software can access external datasets, online resources, or collaboration tools through a network interface, using standard networking protocols such as HTTP or FTP for data exchange. User interaction and data visualization are facilitated through input/output devices such as keyboards, mouse, and monitors, utilizing standard interfaces for user input and output display.

2.3.3 Software Interfaces

The Malayalam parser integrates with various software components, including databases such as SQLite, PostgreSQL, and MongoDB for data storage and retrieval. It is designed to run on popular operating systems like Windows 10 or later, MacOS 10.13 High Sierra or later, and Ubuntu 18.04 LTS or later. Development and NLP tasks are facilitated by Python (version 3.6 or later) along with libraries like NLTK, Spacy, and TensorFlow.

These tools aid in implementing NLP algorithms and processing linguistic data. The system may also include integrated commercial components for specific functionalities, each with its own data formats, configurations, and communication protocols. To ensure consistent data sharing, the system may implement global data areas or standardized data formats, depending on the software components involved. Detailed application programming interface (API) protocols should be referenced for precise communication details.

2.3.4 Communication Interfaces

The software requires communication functions for fetching inputs from websites, email, and network server communications. It needs to support standard email protocols like SMTP for sending emails, following MIME standards for message formatting. For web scraping, it should interact with web servers using HTTP or HTTPS for secure communication, and handle HTML parsing for extracting data from web pages. Network server communication may require protocols like FTP or SFTP for file transfers, adhering to communication standards for compatibility and security. Secure protocols such as SMTPS, SFTP, or TLS should be used for data transmission, with defined data transfer rates and synchronization mechanisms for efficiency.

2.4 System Features

The system features for the Malayalam Parser are organized to highlight the major services provided by the product:

1. **Text Parsing:** The parser breaks down Malayalam language text into its constituent components such as words, phrases, and sentences.

2. **Grammatical Analysis:** It identifies the parts of speech, syntactic structure, and grammatical relationships within Malayalam sentences.

3. **Semantic Analysis:** The system determines the meaning and interpretation of Malayalam text, capturing semantic relationships between words and phrases.

4. **Part-of-Speech Tagging:** Each word in a Malayalam sentence is assigned appropriate part-of-speech tags, indicating its grammatical function.

5. **Syntactic Parsing:** It analyzes the syntactic structure of Malayalam sentences, identifying constituents and their hierarchical relationships.

6. **Error Handling:** Mechanisms are in place to detect and handle errors or inconsistencies in input Malayalam text, ensuring parsing reliability.

7. **Customization and Extension:** Users can customize and extend the parser with custom linguistic rules, dictionaries, or algorithms for domain-specific parsing tasks.

2.4.1 Parsing Malayalam Text

Description and Priority

This feature involves analyzing and understanding the linguistic structure of Malayalam text, including sentence segmentation, word tokenization, and part-of-speech tagging. It is of high priority as it forms the core functionality of the system.

Stimulus/Response Sequences

Stimulus: User inputs a Malayalam text.
Response: The system parses the text, segments sentences, tokenizes words, and tags parts of speech.

Functional Requirements

1. The system shall be able to segment sentences in Malayalam text based on punctuation marks and grammatical rules.

2. The system shall tokenize words in Malayalam text, considering compound words and affixes.

3. The system shall tag each word in Malayalam text with its respective part of speech (e.g., noun, verb, adjective).

4. The system shall handle variations in spelling and word forms commonly found in Malayalam text.

5. The system shall provide error messages for invalid inputs or unsupported characters.

6. The system shall process text efficiently, aiming for a parsing speed of at least X characters per second.

7. The system shall be able to handle text inputs of up to Y characters in length.

2.4.2 Lemmatization and Morphological Analysis

Description and Priority

This feature involves performing lemmatization to identify the base form of words and morphological analysis to understand the grammatical properties of words. It is of high priority as it enhances the accuracy of language analysis.

Stimulus/Response Sequences

Stimulus: User inputs a Malayalam word
Response: The system lemmatizes the word and performs morphological analysis to determine its grammatical properties.

Functional Requirements

1. The system shall lemmatize Malayalam words to identify their base forms.

2. The system shall analyze the morphology of Malayalam words to determine their grammatical properties.

3. The system shall handle variations in word forms and inflections commonly found in Malayalam.

4. The system shall provide error messages for invalid inputs or unsupported characters.

5. The system shall process words efficiently, aiming for a lemmatization speed of at least X words per second.

6. The system shall be able to handle word inputs of up to Y characters in length.

2.4.3 Dependency Parsing

Description and Priority

Dependency parsing involves identifying the syntactic dependencies between words in a sentence, which is crucial for understanding the relationships within the sentence. It is of high priority as it provides valuable linguistic information for further analysis.

Stimulus/Response Sequences

Stimulus: User inputs a Malayalam sentence.
Response:The system parses the sentence to identify syntactic dependencies between words.

Functional Requirements

1. The system shall parse Malayalam sentences to identify syntactic dependencies between words.
2. The system shall generate dependency trees that represent the syntactic structure of parsed sentences.
3. The system shall handle complex sentence structures and dependencies between words.
4. The system shall provide error messages for invalid inputs or unsupported characters.
5. The system shall process sentences efficiently, aiming for a parsing speed of at least X sentences per second.
6. The system shall be able to handle sentence inputs of up to Y characters in length.

2.4.4 Syntax Tree Generation

Description and Priority

Syntax tree generation involves creating syntax trees that represent the grammatical structure of sentences. It is of high priority as it provides a visual representation of the

sentence's structure, aiding in linguistic analysis.

Stimulus/Response Sequences

Stimulus: User inputs a Malayalam sentence.
Response: The system analyzes the sentence's grammatical structure and generates a syntax tree.

Functional Requirements

1. The system shall generate syntax trees for Malayalam sentences based on their grammatical structure.
2. The system shall use standard tree representation formats (e.g., Penn Treebank format) for generated syntax trees.
3. The system shall handle complex sentence structures, including coordination and subordination.
4. The system shall provide options for visualizing syntax trees, such as tree diagrams or textual representations.
5. The system shall process sentences efficiently, aiming for a tree generation speed of at least X trees per second.

2.4.5 Semantic Analysis

Description and Priority

Semantic Analysis is a critical feature of the system, with a high priority. It involves determining the meaning and interpretation of Malayalam text, capturing semantic relationships between words and phrases.

Stimulus/Response Sequences

Stimulus: User inputs Malayalam text for analysis.
Response: The system processes the text to extract meaning and semantic relationships.

Functional Requirements

1. The system shall identify subject-verb-object relationships in Malayalam sentences.
2. It shall detect and interpret negation, conjunctions, and other semantic features in the text.
3. The system shall extract key concepts and entities from the text.
4. It shall handle ambiguous phrases and provide contextually appropriate interpretations.
5. The system shall support the identification of sentiment and emotions expressed in the text.
6. It shall provide an API or interface for developers to access the semantic analysis results.
7. The system shall handle errors gracefully, providing informative messages for incorrect inputs.
8. It shall process text efficiently, aiming for a response time of less than 1 second for short to medium-length texts.
9. It shall be able to process text with a wide range of vocabulary and language complexity levels, including formal and informal language variants.

2.4.6 Part-of-Speech tagging

Description and Priority

Part-of-Speech Tagging is a critical feature of the system, with a high priority. It involves assigning grammatical tags to words in Malayalam sentences, indicating their syntactic role and category.

Stimulus/Response Sequences

Stimulus: User inputs Malayalam text for analysis.
Response: The system processes the text and assigns appropriate part-of-speech tags to each word.

Functional Requirements

1. The system shall identify the part of speech for each word in the input Malayalam text.
2. It shall handle compound words and inflected forms, assigning appropriate tags based on their usage in context.
3. The system shall support standard part-of-speech tag sets for Malayalam, ensuring compatibility with existing linguistic resources.
4. It shall provide an option to output the tagged text in a readable format for users.
5. The system shall be able to handle texts with varying levels of complexity and vocabulary.
6. It shall provide an API or interface for developers to access the tagged text and integrate it into their applications.
7. The system shall handle errors gracefully, providing informative messages for incorrect inputs.

2.4.7 Performance Requirements

Description and Priority

Performance optimization involves improving the efficiency and speed of the system. It is of low priority as it is desirable but not critical for basic functionality.

Stimulus/Response Sequences

Stimulus: System performance falls below specified thresholds.
Response: The system implements optimization techniques to improve performance

Functional Requirements

1. The system shall monitor performance metrics, such as processing speed and resource usage.
2. The system shall identify performance bottlenecks and areas for improvement.

3. The system shall implement optimizations, such as algorithmic improvements or resource management strategies, to enhance performance.

4. The system shall provide configuration options for adjusting performance settings based on user needs

2.5 Other Nonfunctional Requirements

2.5.1 Performance Requirements

Parsing Malayalam Text

Rationale: Parsing text should be fast to provide timely analysis for user interactions or batch processing.
Requirement: The system should be able to parse Malayalam text at a rate of at least 1000 characters per second.

Lemmatization and Morphological Analysis

Rationale: Lemmatization and morphological analysis are core linguistic processes that should not introduce significant delays.
Requirement: The system should be able to perform lemmatization and morphological analysis for at least 100 words per second.

Dependency Parsing

Rationale: Dependency parsing is computationally intensive but crucial for understanding sentence structures.
Requirement: The system should be able to perform dependency parsing for at least 50 sentences per second.

Syntax Tree Generation

Rationale: Syntax tree generation requires complex computations and should be efficient for real-time applications.
Requirement: The system should be able to generate syntax trees for at least 20 sentences per second.

Semantic Analysis

Rationale: Semantic analysis involves processing text to understand its meaning, requiring significant computational resources. Efficient performance is crucial for real-time or near real-time applications, such as chatbots or text summarization systems.
Requirement: The system should be able to perform semantic analysis for a minimum of 1000 words per second, ensuring timely and responsive processing for various use cases.

Part-of-Speech tagging

Rationale: Part-of-speech tagging is a fundamental task in natural language processing, providing essential grammatical information about words in a sentence. Efficient tagging is necessary for various downstream tasks such as parsing, machine translation, and information extraction.
Requirement: The system should be able to perform part-of-speech tagging for a minimum of 1000 words per second, ensuring fast and responsive tagging for different text lengths and complexities.

Performance Optimization

Rationale: Performance optimization ensures that the system meets its performance requirements under varying loads and conditions.
Requirement: The system should implement optimization strategies to maintain performance levels even under heavy loads, ensuring that response times do not exceed specified thresholds.

2.5.2 Safety Requirements

Loss, Damage, or Harm Concerns: The product must ensure user and property safety, preventing physical harm or damage. It must also safeguard sensitive data from unauthorized access.
Actions to be Taken: The product should provide clear instructions and warnings to prevent misuse or accidental damage. Regular maintenance and updates are crucial for safe operation.
Actions to be Prevented: Unauthorized modifications and operations that could lead to

data loss or corruption should be prevented.
External Policies or Regulations: Compliance with safety standards and regulations is essential, including guidelines from regulatory bodies and industry standards organizations.
Safety Certifications: Obtaining safety certifications demonstrates compliance with standards and builds user trust in the product's safety.

2.5.3 Security Requirements

The system must prioritize the security and privacy of the data used or created by the system. It should implement robust measures to prevent unauthorized access, disclosure, or modification of sensitive information, such as annotated dataset files. User identity authentication should be incorporated to verify the identity of users accessing the system, ensuring that only authorized users can access or modify the dataset files. The system must comply with external policies and regulations regarding security and privacy issues, adhering to guidelines set by regulatory bodies or industry standards organizations. Obtaining security and privacy certifications is essential to demonstrate compliance with these standards, reassuring users of the parser's commitment to data security and privacy protection.

2.5.4 Software Quality Attributes

The Malayalam parser for dataset creation must prioritize correctness and reliability, ensuring accurate parsing and consistent results. Maintainability is crucial for easy updates, while usability requires an intuitive interface. Portability enables the parser to run on different platforms, and interoperability allows integration with other NLP components. Testability ensures thorough testing, and adaptability allows for evolving requirements. These characteristics collectively ensure the parser's efficiency, effectiveness, and adaptability.

Chapter 3

System Architecture and Design

3.1 System Overview

The aim of the project to develop a Malayalam parser is to create a system that can effectively process Malayalam text for tasks such as sentiment analysis, named entity recognition, and part-of-speech (POS) tagging. The process begins with data collection, where Malayalam text is gathered from online sources using web scraping techniques. This collected text is then cleaned to remove any irrelevant information, errors, or special characters.

Language filtering is applied in the cleaning phase to ensure the text is in Malayalam. Following data cleaning, the text undergoes preprocessing, which includes tokenization to break the text into individual words or tokens. Stemming is then applied to reduce inflected words to their base form, simplifying the text for analysis. A crucial step is building a training corpus of preprocessed Malayalam text labeled with the desired information, such as sentiment labels, named entities, and part-of-speech tags. Features are extracted from the preprocessed text and serve as inputs to the machine learning model. A suitable machine learning model is selected and trained on the extracted features and labeled training data. The model's performance is evaluated on a separate set of data to assess its accuracy and effectiveness on new, unseen data. Finally, the trained model is used to process new Malayalam text, tagging it with sentiment labels, named entities, part-of-speech tags, or other relevant information. Linguists can add custom rules to refine the model's output for better accuracy.

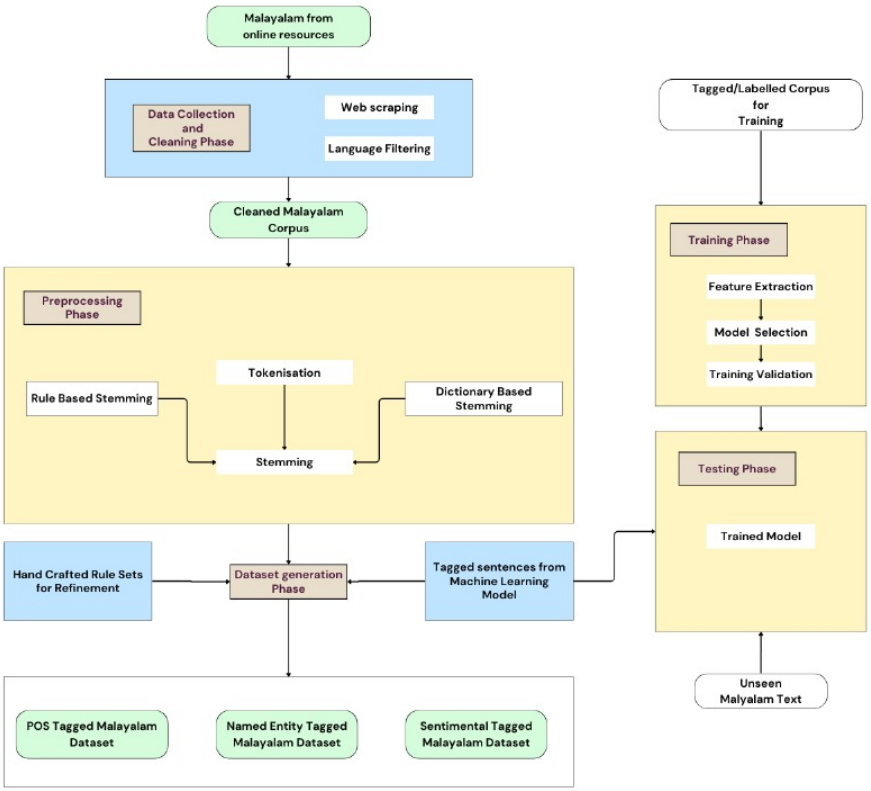
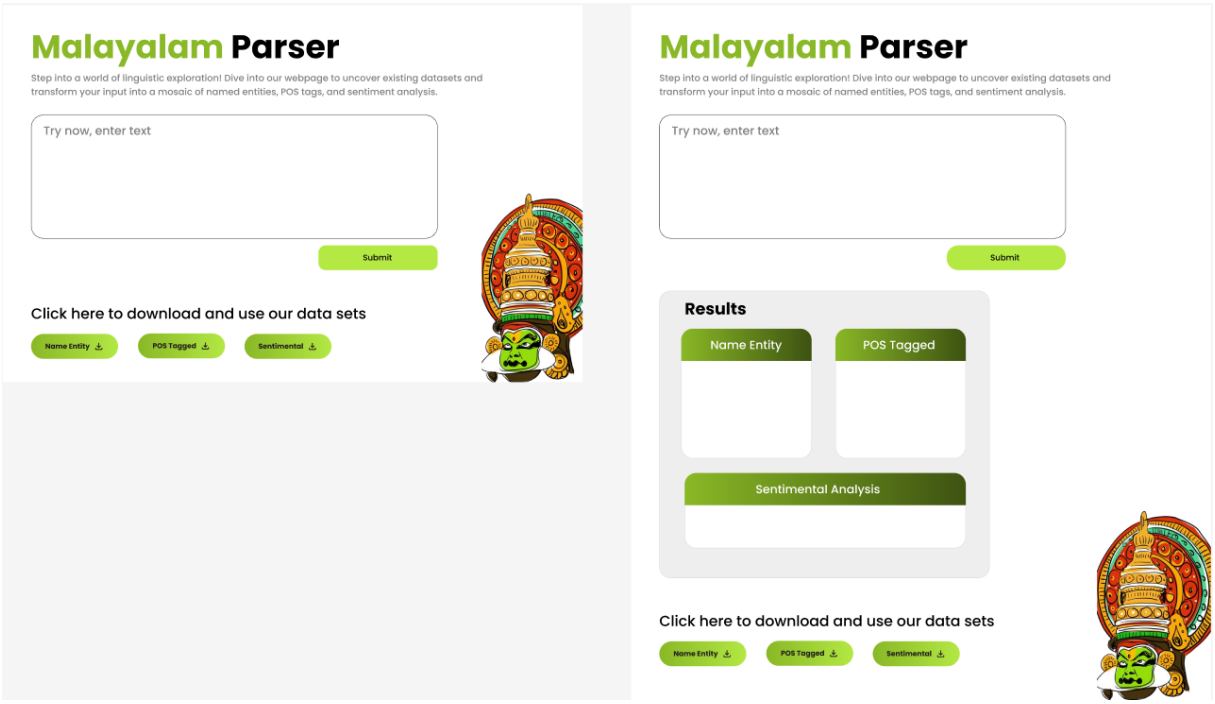


Figure 3.1: Architecture diagram

3.2 User Interface Design



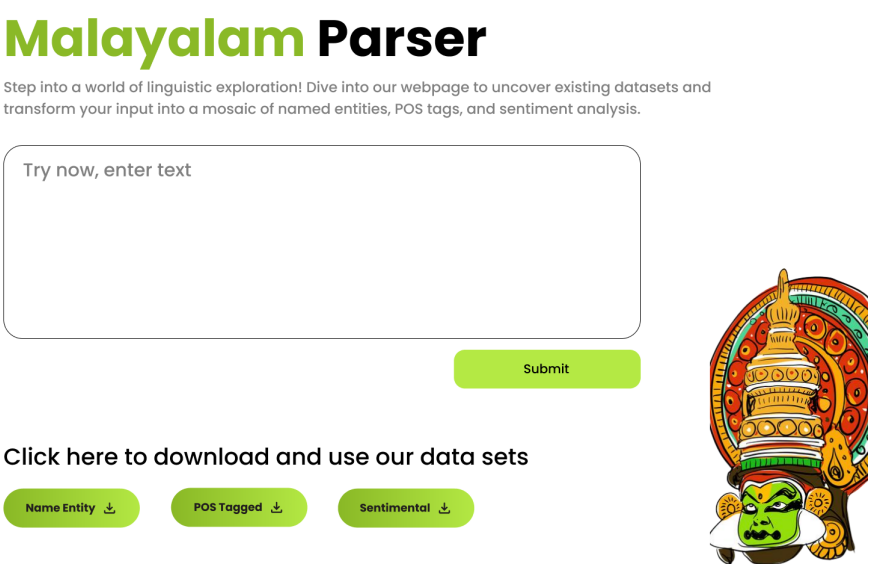


Figure 3.2: Landing page

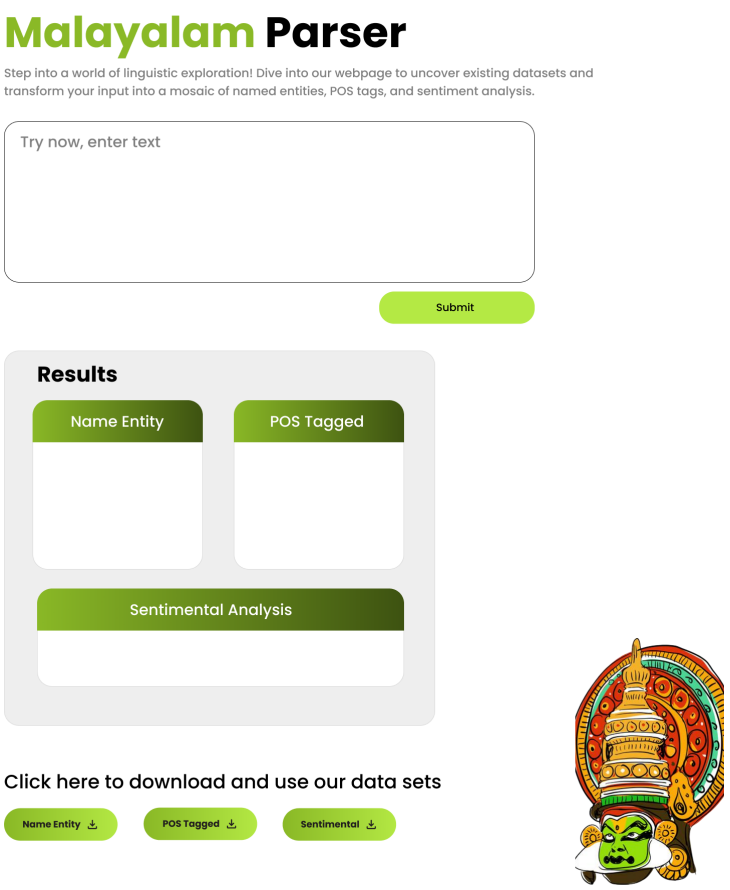


Figure 3.3: Result page

3.3 Description of Implementation Strategies

The implementation strategies for the project are as follows:

- Data Acquisition and Cleaning:

    1. Web Scraping:
        - Utilize libraries like BeautifulSoup or Scrapy (Python) to scrape relevant Malayalam websites.
        - Define target URLs and develop scraping logic for text extraction.
        - Implement techniques to handle pagination or dynamic content loading (if applicable).
    2. Language Filtering:
        - Implement language detection using libraries like langdetect or textblob (Python) to identify non-Malayalam text.
        - Set a threshold or confidence score to filter out content below a certain level of Malayalam probability.

- Data Preprocessing:

    1. Tokenization: Choose a suitable tokenization method (word-based, sentence-based, etc.) using libraries like NLTK or spaCy (Python).
    2. Handling Non-Textual Elements: Develop logic for managing emojis or other non-textual elements (e.g., removal, special token representation).
    3. Stop Word Removal: Implement stop word removal based on a created or located Malayalam stop word list.
    4. Stemming or Lemmatization: Use libraries like NLTK or spaCy for stemming (reducing words to root forms) or lemmatization (finding dictionary base forms). Explore specific stemming/lemmatization algorithms if necessary for Malayalam.

- Sentiment Analysis:

1. Model Selection (if applicable): Consider factors like data size, desired accuracy, and computational resources when choosing a model (e.g., Logistic Regression, Naive Bayes, SVM, RNNs).
2. Data Splitting (if applicable): Split the preprocessed data into training, validation, and testing sets for model development.
3. Model Training and Tuning (if applicable): Implement hyperparameter tuning to optimize model performance during training.
4. Evaluation (if applicable): Evaluate the trained sentiment analysis model's performance on the unseen testing data set. Analyze the results and identify areas for improvement in data quality or model architecture.

- Additional Considerations:

1. Data Storage and Management: Consider implementing data loading/saving functions for various formats (text files, CSV, etc.) if needed for further analysis.
2. Version Control: Utilize a version control system (e.g., Git) to track code changes and facilitate collaboration.
3. Testing: Implement unit tests for critical functions and integration tests to ensure the entire NLP pipeline functions as expected.
4. Logging: Implement logging functionalities to track code execution progress and identify potential issues.

3.4 Module Division

- Module 1: Data Collection and Preprocessing (Mohammed Basil)
  - Data Acquisition: Collect Malayalam text data from various sources such as websites, documents, or databases.
  - Data Cleaning: Preprocess collected data to remove noise, inconsistencies, or irrelevant information.
  - Language Identification: Determine the language of the text to ensure only Malayalam language text is processed.

  - Tokenization: Divide the preprocessed text into individual tokens or words following Malayalam language rules and conventions.

- Module 2: UI Design (Godwin Gino)
  - User Interface Components: Design and implement user interface elements such as input fields, buttons, text areas, and output displays.
  - Interaction Logic: Manage user interactions, including event handling, input validation, and feedback mechanisms.
  - Layout and Styling: Define layout structure, visual design, and styling for an intuitive and aesthetically pleasing user experience.

- Module 3: Rule Set Generation (Fathima Jennath)
  - Rule Extraction: Extract linguistic rules and patterns from annotated data or linguistic resources specific to Malayalam language parsing.
  - Rule Representation: Represent extracted rules in a formal format suitable for integration into the parsing module.
  - Rule Validation and Optimization: Validate generated rules for accuracy and completeness, optimizing them for efficient parsing of Malayalam text.

- Module 4: Machine Learning and Dataset Generation (Gautham C Sudheer)
  - Dataset Collection and Annotation: Acquire or generate a dataset of Malayalam text samples, annotating them with linguistic information.
  - Feature Extraction: Identify relevant features or attributes from the annotated dataset using techniques like bag-of-words or word embeddings.
  - Model Training and Evaluation: Train machine learning models for tasks such as part-of-speech tagging or named entity recognition, evaluating their performance using metrics like accuracy.

3.5 Work Schedule - Gantt Chart

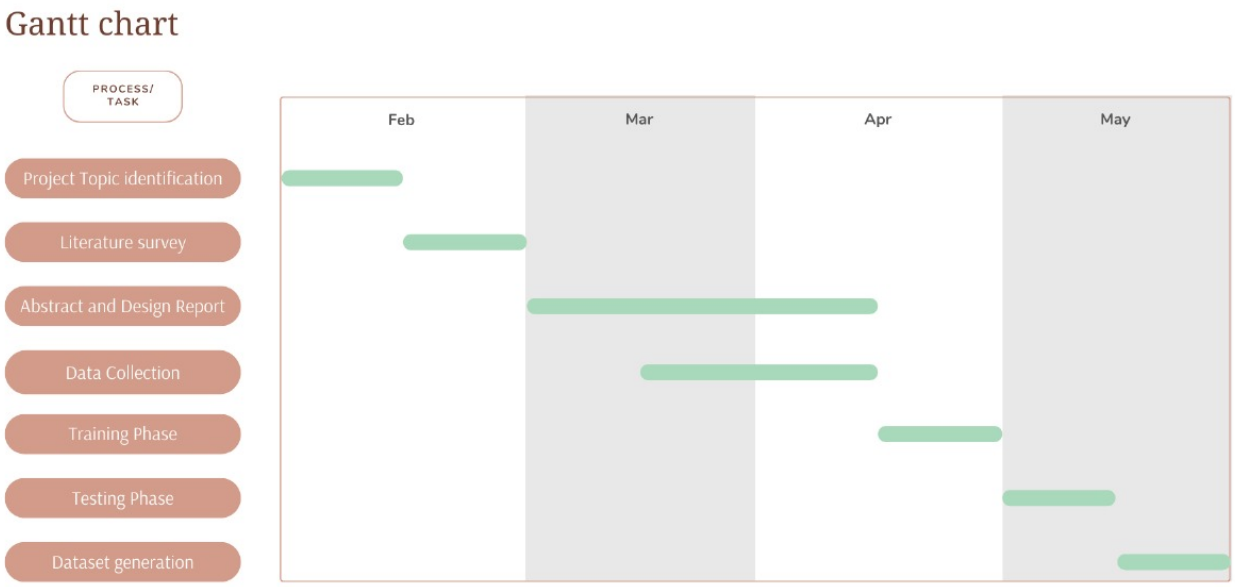


Figure 3.4: Work Schedule-Gantt chart

Chapter 4

Results and Discussions

4.1 Overview

Our project provides three essential datasets for Malayalam text analysis: POS-tagged,named entity labeled,and sentiment labeled. We include POS tag information along with dataset examples to enhance understanding.The implementation of the parser involved the use of the translation method. Although efforts to improve accuracy with rules and machine learning were not integrated due to accuracy concerns,this remains a future goal. Overall,the project has established a foundation for processing and analyzing Malayalam text,with potential implications for advancing NLP applications in Malayalam.

4.2 Testing

Figure 4.1: Malayalam Parser Output

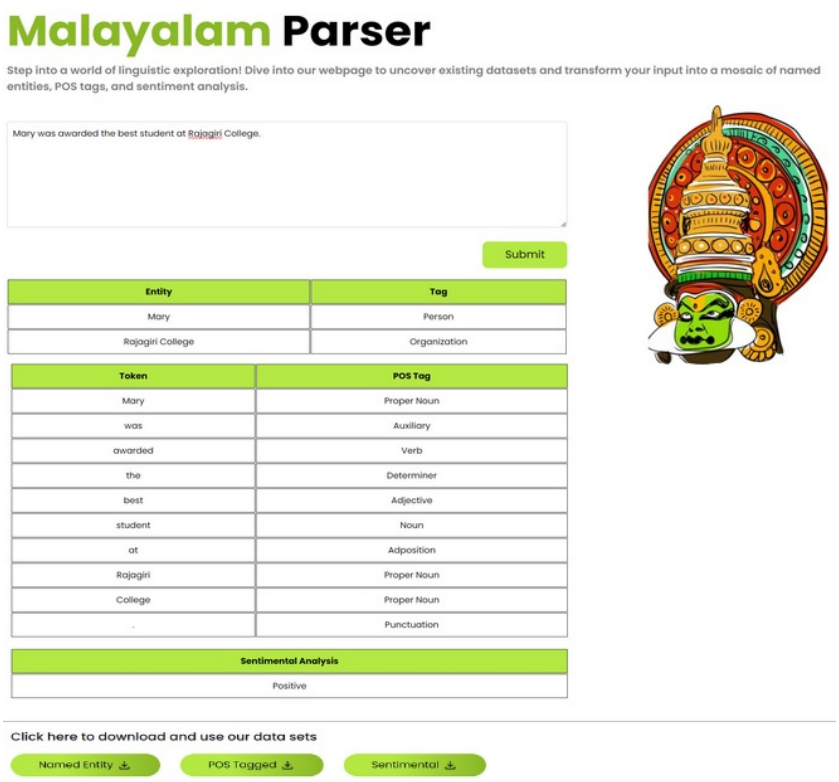


Figure 4.2: English Parser Output

Figure 4.3: Description of POS tags(eg-Noun)

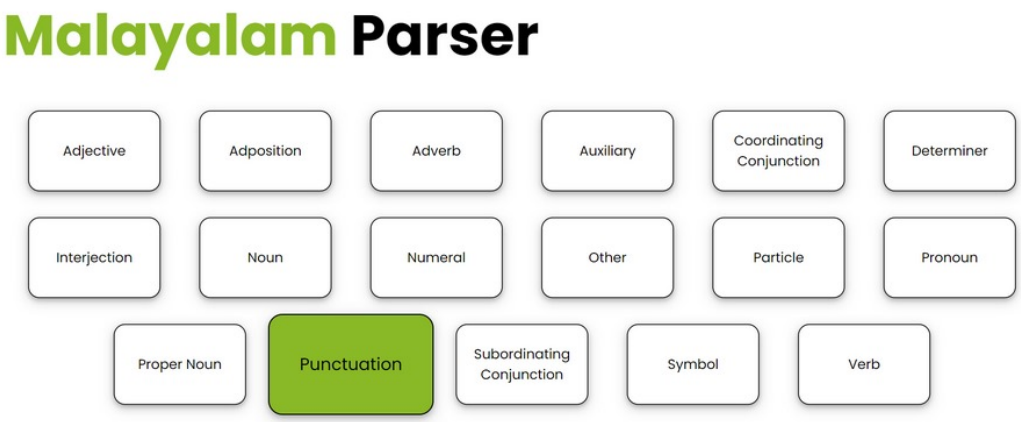


Figure 4.4: Different POS tags

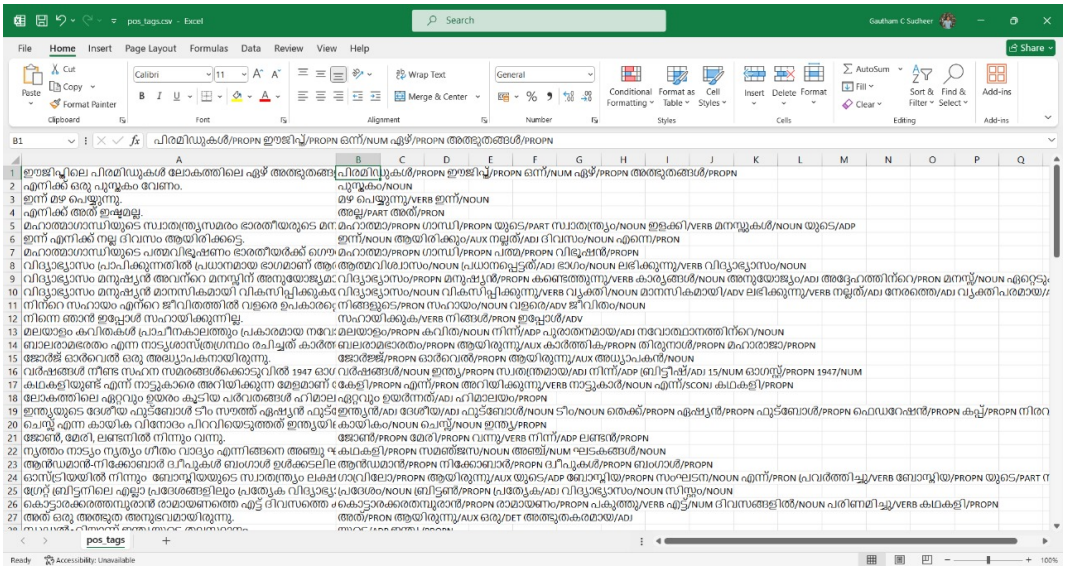


Figure 4.5: POS tagged malayalam text

4.3 Discussion

In summary,the project has developed a Malayalam Parser for Dataset Creation.However,due to timing constraints,integrating the rule-based and machine learning-based approach remains a future enhancement.

The project's deviation from its initial goal of integrating rules and machine learning underscores the challenges in accurately processing Malayalam text.Factors such as the

language's linguistic complexities and the limited availability of annotated data likely contributed to this deviation.Nevertheless,creating valuable datasets represents a significant step toward overcoming the shortage of resources for NLP in Malayalam.

Chapter 5

Conclusion

5.1 Conclusion

In conclusion,the project has developed a Malayalam language processing tool for dataset generation.It enables parsing and analysis of Malayalam text,determining grammatical structure,syntax, and semantics.The tool generates part-of-speech tagged, named entity, and sentiment-tagged datasets,which can be contributed to future NLP works.

5.2 Future Scope

In future developments,the Malayalam parser project could explore advanced parsing techniques such as dependency parsing or deep learning to enhance accuracy and robustness.Implementing a rule-based parsing approach specific to Malayalam,with defined grammatical rules and patterns, could further improve parsing accuracy.A hybrid approach that combines rule-based and machine learning techniques could be beneficial, leveraging the strengths of both methodologies.Implementing error correction mechanisms to handle inaccuracies in parsing results, along with user feedback options to improve the parser's quality, and engaging with linguists, researchers, and the local community for feedback and validation, will be essential for prioritizing future development efforts.

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Appendix A: Presentation