A MINI PROJECT REPORT

On

TEXT SUMMARIZATION SYSTEM FOR ENGLISH LANGUAGE

Submitted in partial fulfillment of the requirement of
University of Mumbai for the Course

Natural Language Processing
In
Computer Engineering (VIII SEM)

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CERTIFICATE

This is to certify that the requirements for the project report entitled '**Text Summarization System for English Language**' have been successfully completed by the following students:

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PROJECT APPROVAL

This project entitled "Text Summarization System for English Language" by Anoop Pillai, Nikhil Chandran, Mayuresh Pitale and P V Athira Chandran are approved for the course Natural Language Processing in Computer Engineering (VIII sem) of Mumbai University in the Department of Computer Engineering.

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DECLARATION

We declare that this written submission for Natural Language Processing mini project entitled "Text Summarization System for English Language" represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any ideas / data / fact / source in our submission. We understand that any violation of the above will cause disciplinary action by the institute and also evoke penal action from the sources which have not been properly cited or from whom prior permission has not been taken when needed.

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Abstract

A person uses the internet to access information available globally. While doing so, he uses search engines and browsing platforms to access information. However, the person may be looking for precise and summarized data, rather than huge documents of information.Due to an exponential growth in the generation of textual data, the need for tools and mechanisms for automatic summarization of documents has become very critical. Text documents are vital to any organization's day-to-day working and as such, long documents often hamper trivial work. Most of the text resources such as books, news articles, blog posts, research papers, emails, and tweets present on the internet have repetitive content which is vestigial to the day-to-day user. Tremendous amounts of information is available on the internet, it is important to develop a mechanism to extract concise and meaningful summary of text from multiple text resources quickly and most efficiently from document files and websites. Therefore, an automatic summarizer is vital towards reducing human effort. Text summarization is an important activity in the analysis of high volume text documents and is currently a major research topic in Natural Language Processing.

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Chapter 1

Introduction

Text summarization simply means the technique of shortening long pieces of text. The intention is to create a systematic and fluent summary having only the main points outlined in the document.With such a big amount of data circulating in the digital space, there is need to develop machine learning algorithms that can automatically shorten longer texts and deliver accurate summaries that can fluently pass the intended messages in very less time.

1.1 Fundamentals :

The following terms will be used for the discussion of automatic text summarization :

1.Extractive text summarization : Extractive technique involves retaining the keyphrases from the source document and combining them to make a summary.The extraction is made according to the defined metric without making any changes to the texts.

2.Abstractive text summarization : This algorithm creates new phrases and sentences that represent the most useful information of the original text. Abstractive text summarization overcomes the grammar inconsistencies of the extractive method and provides a much condensed summary.

3.Text preprocessing transforms the text into a more digestible form so that machine learning algorithms can perform better.

4.Tokenization : Tokenization is about splitting strings of text into smaller pieces, or tokens . Paragraphs can be tokenized into sentences(sentence tokenization) and sentences can be tokenized into words(word tokenization).

5.Stemming : It is the process of reducing a word to its word stem that affixes to suffixes and prefixes or to the roots of words

6.Lemmatization : Lemmatization converts a word into its lemma (root form). It usually refers to doing things properly with the use of a vocabulary and morphological analysis of words. Lemmatization is a technique in NLP that breaks a word in its root form, within the boundaries of linguistics.

7.TF-IDF (term frequency-inverse document frequency) is a statistical measure that evaluates how relevant a word is to a document in a collection of documents. This is done by multiplying two metrics: how many times a word appears in a document, and the inverse document frequency of the word across a set of documents.

1.2 Objectives :

The objective of this work is as follows:

1. Reduction of a given text to a smaller number of sentences
2. To summarize the document/text without leaving out the main ideas of the original text.
3. To identify the most important information from the given text and present it to the end users.
4. Provide the summarized text quickly and efficiently

1.3 Scope :

One of the plans is to apply the topic-focused summarization framework to news articles or blogs and to extend the work in the machine learning approaches. Topic Focused summaries of news articles would be a lot more accurate and valuable to users. It would be more interesting to work on topic modeling and summarization in the domain of social media in future. The rate at which the information is growing is tremendous. Hence it is very important to build a multilingual summarization system and this research could be a stepping stone towards achieving that goal

provided there is availability of online lexical databases in other languages. The work presented by the thesis can also be applicable to multi document summarization by using minimal extensions. The implemented system in this thesis can work as a framework for the research community to understand and extend the applicability of cognitive and symbolic approach in various domains of business needs. Research in summarization continues to enhance the diversity and information richness,and strive to produce coherent and focused answers to users' information needs.

1.4 Organization of the Report

The report is organized as follows :

Chapter 1 The introduction is given in Chapter 1. It describes the fundamental terms used in this project. It motivates to study and understand the different techniques used in this work. This chapter also presents the outline of the objective of the report.

Chapter 2 :It describes the review of the relevant various techniques in the literature systems. It describes the pros and cons of each technique.

Chapter 3 : This chapter presents the theory and proposed work. It describes the major approaches used in this project work.

Chapter 4 : The societal and technical applications are mentioned in Chapter 4.

Chapter 5 : The summary of the report is presented in Chapter 5.

Chapter 2

Literature Survey

2.1 Introduction :

Literature surveys provide brief overviews or a summary of the current research on topics.Literature surveys are used in ensuring that the used experiments, methodologies and experiments offer reliability and validity in the research being conducted.They are useful in validating or providing proof and also provides a base of moving a research idea forward on what researchers have done and exciting avenues that it opens for investigation during future work in the field.

In this literature survey research papers and articles on automatic text summarization were referred through for the project.

2.2 Literature Survey :

The following research papers and reports were used for the topic of Text Summarization System for English Language :

1.Automatic Text Summarization Using Natural Language Processing :

Authors Pratibha Devihosur, Naseer R implemented an automatic text summarization mechanism based on an unsupervised learning system.The significance of the generated summary was assessed with the assistance of Simplified Lesk calculation along with an online semantic lexicon WordNet.Based on their evaluation the algorithm provides best summarized outcome ranging from 25-50 percent with respect to the source data. In this project they also focussed on ambiguous words because a specific word may have distinctive significance in various setting.Hence they tried to inculcate the principle of word sense disambiguation to decide the right feeling of a word utilized as part of a specific setting.

2.Text Summarization using Natural Language Processing :

In this paper authors Ankit Kumar, Zixin Luo and Ming Xu created an end to end web application which can take an article as input and generate a summary.The model was trained using deep learning approach and trained on Juniper's datasets.Juniper is a corporate organization that develops and markets networking devices.In order to provide a better customer experience, Juniper Networks maintains large datasets of articles wherein each of these articles can be long and verbose.Hence these datasets were used to train the text summarization model.The model built used abstractive summarization technique and

significantly generated excellent human readable sentences from given inputs. However, it did not always generate summaries capturing all the important information in the input documents.

3. Text Summarization Techniques: A Brief Survey :

In this survey Mehdi Allahyari, Elizabeth D. Trippe, Saeid Safaei and others study the main approaches to automatic text summarization and also review the different processes for summarization and describe the effectiveness and shortcomings of different methods.Topics like the impact of context in summarization and semantic analysis are also mentioned.

4. NLP Based Text Summarization Using Semantic Analysis:

In this project paper authors Harsh Desai, Dhairya Pawar, Geet Agrawal reviewed the different methods for text summarization and provided a novel technique generating the summarization of domain specific text by using Semantic Analysis for text summarization.

5. Text Summarization:An Overview :

In this research paper author Samrat Babar provides an analysis about the meaning of text summarization in natural language processing and their types along with the technical and mathematical analysis of text summarization in detail. This paper basically is a documentation for all the information required to study as well refer through on the topic of automatic text summarization.

2.3 Literature Survey Summary :

The detailed summary of the above referred paper are mentioned in the table below **:**

SN	Techniques	Author & Year of Publication	Characteristics
1.	Automatic Text Summarization Using Natural Language Processing	Pratibha Devihosur , Naseer R.2017	1.Text summarization model based on unsupervised learning model 2.Includes word sense disambiguation to determine the sentiment of the word in that particular setting

			3. Generated summary ranges from 25-50 percent with respect to the source data.
2.	Text Summarization using Natural Language Processing	Ankit Kumar,Zixin Luo and Ming Xu.2018	1.Creates an end to end text summarization web application using the abstractive summarization technique. 2.Training datasets used contain long and verbose articles which increases the accuracy of the trained model. 3.The trained model usually generated significantly excellent human readable sentences.
3.	Text Summarization Techniques: A Brief Survey	Mehdi Allahyari, Elizabeth D. Trippe, Saeid Safaei and others.2017	1.Provides detailed description about the main approaches on automatic text summarization. 2.Reviews the different processes for summarization and also describes the effectiveness and shortcomings of different methods 3.Also includes topics like the impact of context in summarization and semantic analysis.
4.	NLP Based Text Summarization Using Semantic Analysis	Harsh Desai, Dhairya Pawar, Geet Agrawal.2016	1.Mentions the different methods used in text summarization. 2. Creates a .novel technique generating the summarization of domain specific text by using Semantic Analysis.
5.	Text Summarization: An Overview	Samrat Babar.2013	1.Comparatively provides a very detailed report about the process of text summarization in natural language processing. 2. The paper includes details about the meaning of summarization , their types and also includes the technical and mathematical analysis of the different approaches used.

Table 2.3 Literature survey summary

Chapter 3

Implementation Details

3.1 Overview :

With the dramatic growth of the internet in the modern times people are able to access a tremendous amount of information on any topic. This information can be overwhelming at times to go through since people require these information quickly and with ease. This expanding availability of documents has demanded an exhaustive research in the field of text summarization. Now a summary is a text that is produced from one or more texts, that conveys the important information in the original text but is shorter in format.So therefore automatic text summarization is the process of producing a concise and fluent summary while preserving the key information content and overall meaning of the text.

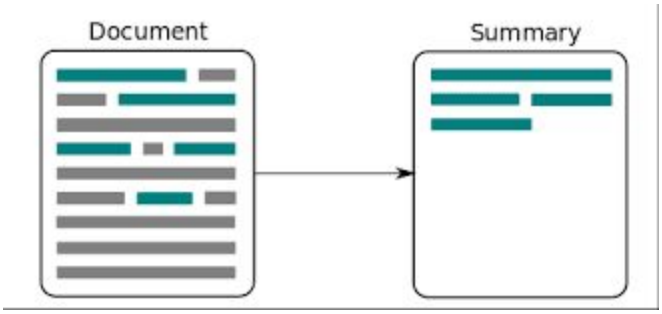

Fig : 3.1 Diagrammatic representation of text summarization

3.1.1 Existing Methodology and Systems :

There are a few ways of going about classifying automated text summarization techniques such as extractive and abstractive text summarization.While abstractive text summarization methods employ more powerful natural language processing techniques to interpret text and generate new summary text , it is a far more difficult method to approach. The majority of summarization processes today are extraction-based since much work is needed to produce a strong foothold in the abstractive technique.

Whereas extractive text summarization methods function by identifying the important sentences or excerpts from the text and reproducing them almost precisely as part of the summary. No new text is generated; only existing text is used in the summarization process. Now extractive text summarization techniques vary, yet they all share the same basic tasks:

1.Construct an intermediate representation of the input text (text to be summarized)

2.Score the sentences based on the constructed intermediate representation

3.Select a summary consisting of the top k most important sentence

Tasks 2 and 3 are straightforward enough; in sentence scoring, it is determined how well each sentence relays important aspects of the text being summarized, while sentence selection is performed using some specific optimization approach. Algorithms for each of these 2 steps can vary, but they are conceptually quite simple i.e assign a score to each sentence using some metric, and then select from the best-scored sentences via some well-defined sentence selection method.

Based on the above mentioned outline some of the summarization techniques are :

(1) Topic Words : This common technique aims to identify words that describe the topic of the input document. Generally speaking, there are two ways to compute the importance of a sentence as a function of the number of topic signatures it contains, or as the proportion of the topic signatures in the sentence. While the first method gives higher scores to longer sentences with more words, the second one measures the density of the topic words.

(2) Frequency-driven approaches : This approach uses frequency of words as indicators of importance. The two most common techniques in this category are: word probability and TFIDF (Term Frequency Inverse Document Frequency). The probability of a word w is determined as the number of occurrences of the word, f (w), divided by the number of all words in the input. Words with highest probability are assumed to represent the topic of the document and are included in the summary. TFIDF, a more sophisticated technique, assesses the importance of words and identifies very common words (that should be omitted from consideration) in the document by giving low weights to words appearing in most documents. After creation of

TFIDF vector representations of documents, the documents that describe the same topic are clustered together and centroids are computed — pseudo-documents that consist of the words whose TF IDF scores are higher than a certain threshold and form the cluster. Afterwards, the centroids are used to identify sentences in each cluster that are central to the topic.

(3) **Latent Semantic Analysis :** Latent semantic analysis (LSA) is an unsupervised method for extracting a representation of text semantics based on observed words. The first step is to build a term-sentence matrix, where each row corresponds to a word from the input (n words) and each column corresponds to a sentence. Each entry of the matrix is the weight of the word i in sentence j computed by TFIDF technique. Then singular value decomposition (SVD) is used on the matrix that transforms the initial matrix into three matrices: a term-topic matrix having weights of words, a diagonal matrix where each row corresponds to the weight of a topic, and a topic-sentence matrix. If you multiply the diagonal matrix with weights with the topic-sentence matrix, the result will describe how much a sentence represents a topic, in other words, the weight of the topic i in sentence j.

(4) Discourse Based Method :

A logical development of analyzing semantics is performing discourse analysis, finding the semantic relations between textual units, to form a summary. The study on cross-document relations was initiated by Radev, who came up with the Cross-Document Structure Theory (CST) model. In his model, words, phrases or sentences can be linked with each other if they are semantically connected. CST was indeed useful for document summarization to determine sentence relevance as well as to treat repetition, complementarity and inconsistency among the diverse data sources. Nonetheless, the significant limitation of this method is that the CST relations should be explicitly determined by humans.

3.1.2 Proposed Methodology and System :

In the proposed model, we will use an extractive summarization approach for ease in extracting the most important and vital sentences, rather than abstractive text summarization techniques.

Step 1 - Importing necessary libraries and initializing WordNetLemmatizer

The most important library for working with text in python is NLTK. It stands for Natural Language toolkit. It contains methods such as sent_tokenize, word_tokenize in the corpus package, which can split the text into sentences and words respectively. Stem package of NLTK contains methods for lemmatization, namely WordNetLemmatizer. Stopwords contains a list of english stop words, which needs to be removed during the preprocessing step.

Step 2 - Text preprocessing

Text preprocessing is the most crucial step in getting consistent and good analytical results. The pre-processing steps applied in this algorithm include, removing special characters, digits and one letter word and stopwords from the text .

The first step includes, reading text from a file. Here we store the contents of the file in variable text. After reading the contents, remove_special_characters function removes special characters from the text. It is important to remove digits from the document, which can be done using regular expression. After eliminating special characters and digits, the individual words can be tokenized and one letter word, stop words can be removed.To avoid any ambiguity in case, we lowercase all the tokenized words.

Step 3 - Calculating the frequency of each word in the document

While working with text it becomes important to calculate the frequency of words, to find the most common or least common words based on the requirement of the algorithm.Here we take the list of words as input and append all the unique words in a new list.The unique words are stored in words_unique list. After finding the unique words, the frequency of the word can be found using the count function.

Step 4 - Calculating sentence score

As the score given to each sentence decides the importance of the sentence, it becomes extremely important to choose the correct algorithm to find the score. In this approach, we will be using the

TF IDF score of each word to calculate the total sentence score.The score of each sentence can be calculated using sentence_importance function. It involves POS tagging of words in the sentence by pos_tagging function.This function returns only the noun and verb tagged words. The returned words from pos_tagging function are sent to word_tfidf function to calculate the score of that word in the document by calculating its tfidf score.

Step 5 - Finding most important sentences

To find the most important sentences, take the individual sentences from tokenized sentences and compute the sentence score. After calculating the scores, the top sentences based on the retention rate provided by the user are included in the summary.

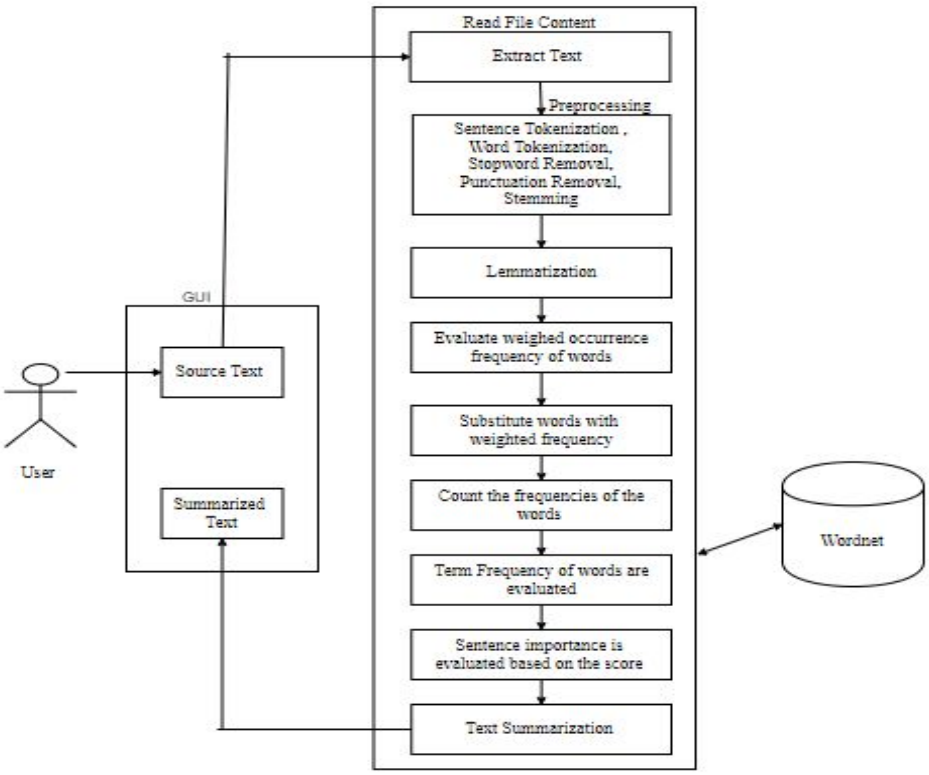

Fig : 3.2 Proposed Methodology

3.2 Implementation Details :

3.2.1 Methodology :

The various functions that are used to perform the summarization are as follows:

1.POS tagging function :This function uses nltk library to pos tag all the words in the text and returns only the nouns and verbs from the text.

2.Word tf idf function :The above function calls tf_score, idf_score and tf_idf function.tf_score calculates the tf score, idf_score calculates the idf score and tf_idf_score calculates the tfidf score. It returns the tfidf score.

3.tf score function : This function calculates the tf score of a word. tf is calculated as the number of times the word appears in the sentence upon the total number of words in the sentence.

4.idf score function : This function finds the idf score of the word, by dividing the total number of sentences by the number of sentences containing the word and then taking a log10 of that value.

5.fidf score function : This function returns the tfidf score, by simply multiplying the tf and idf values.

3.2.2 Details of packages used :

The packages used implementing automatic text summarization on the given text were :

1. nltk : NLTK stands for Natural Language Toolkit which is an open source python library for natural language processing. This toolkit is one of the most powerful NLP libraries which contains packages to make machines understand human language and reply to it with an appropriate response. It contains text processing libraries for tokenization, parsing, classification, stemming, tagging ,character count, word count and semantic reasoning.NLTK includes more than 50 corpora and lexical sources such as the Penn Treebank Corpus, Open Multilingual Wordnet, Problem Report Corpus, and Lin's Dependency

Thesaurus. A *corpus* is a collection of linguistic data (usually contained in a computer database) used for research, scholarship, and teaching.

2. os : The OS module in python provides functions for interacting with the operating system. OS, comes under Python's standard utility modules.The functions that the OS module provides allows you to interface with the underlying operating system that Python is running on – be that Windows, Mac or Linux.

3. re : Python has a built-in package called re which is used to work with Regular Expressions.A *regular expression* is a special sequence of characters that helps you match or find other strings or sets of strings, using a specialized syntax held in a pattern.The re package provides regular expression matching operations.It specifies a set of strings that matches it; the functions in this module checks if a particular string matches with a specific regular expression.

4. operator : The operator module exports a set of efficient functions corresponding to the intrinsic operators of Python.The operator module supplies functions that are equivalent to Python's operators. These functions are handy in cases where callables must be stored, passed as arguments, or returned as function results.

5. math : This module provides access to the mathematical functions.Mathematical concepts like linear algebra are required for pertaining to vector spaces, matrices, etc. Calculus is required in terms of understanding what a derivative is, gradients, working with multivariate functions and probability distributions.Statistical concepts are also used.

4. WordNetLemmatizer : nltk.stem is a package that performs stemming using different classes.It is a processing interface for removing morphological affixes from words leaving only the word stem. These stemming algorithms aim to remove those affixes required for eg. grammatical role, tense, derivational morphology leaving only the stem of the word which is known as stemming. WordnetLemmatizer is a module in nltk.stem that performs lemmatization on the input words using the wordnet's morphy functions.

5. Stopwords (nltk.corpus) : The nltk.corpus package defines a collection of corpus reader classes, which can be used to access the contents of a diverse set of corpora.from nltk.corpus import stopwords package downloads a directory that contains all the possible stopwords that can be used in text.Stop words are commonly used words such as “the”, “a”, “an”, “in” and more.These words are not essential while summarizing the input text and so all the stopwords are removed from the text if not these words take up unnecessary space in the database and can also take up valuable processing time.

6. averaged_perceptron_tagger : This package contains the pre-trained English Part-of-Speech (POS).The perceptron part-of-speech tagger implements part-of-speech tagging using the averaged, structured perceptron algorithm.

Chapter 4

Project Inputs and Outputs

4.1 Input Details :

The input to the summarizer is the text which the user wants it to be summarized.The user has to type in the URL of the online summarizer to access it.

4.2 Output Details and Screenshots :

The output obtained is a summarized text which preserves the original meaning and effectiveness of the input text while leaving out unnecessary and extra details to sum up the text.

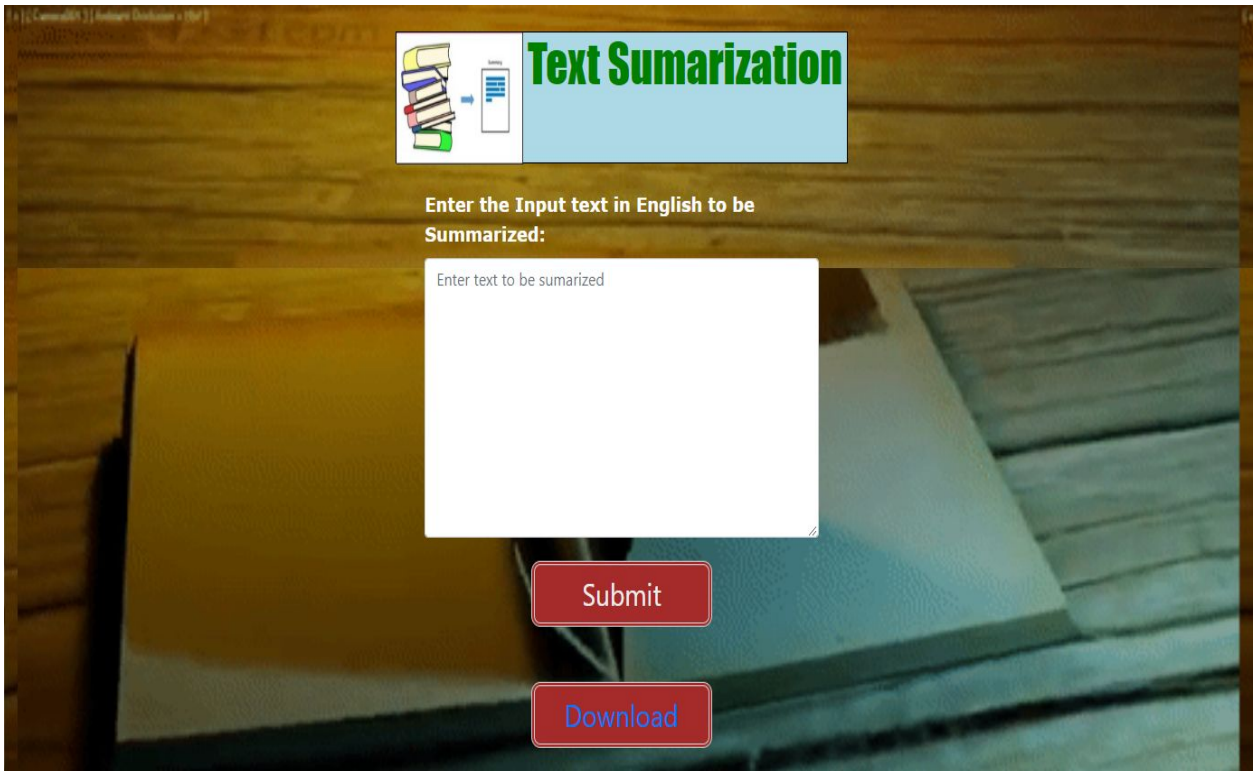

Fig. 4.2.1 Home page

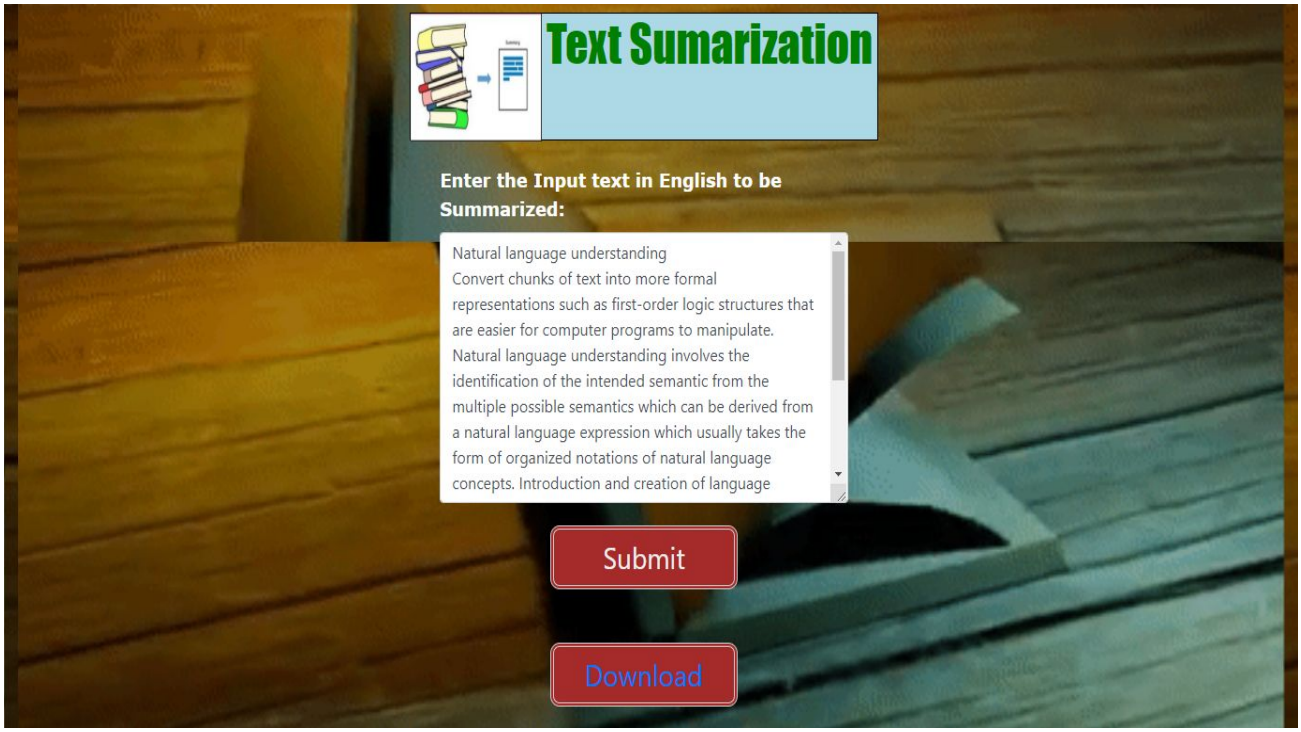

Fig. 4.2.2 Adding in the text to be summarized

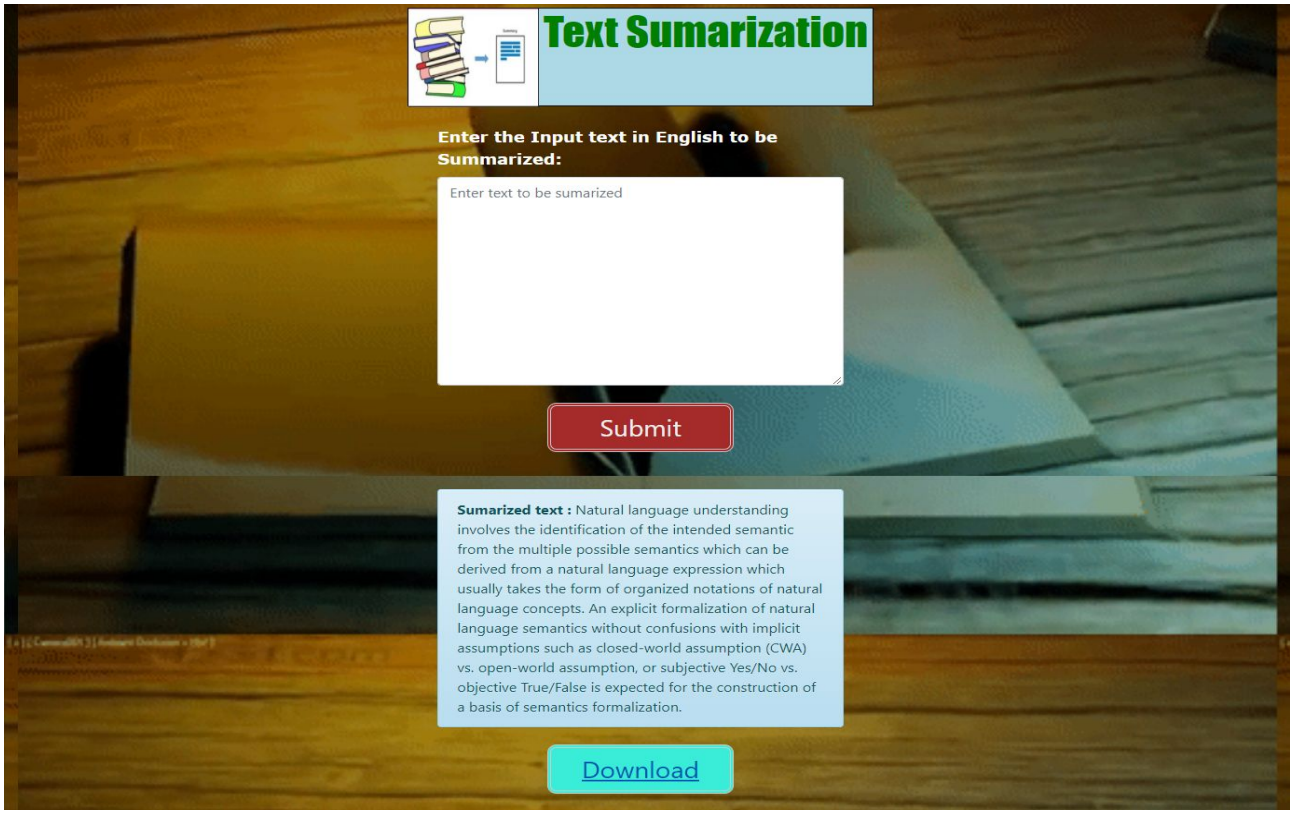

Fig 4.2.3 Summarized output text

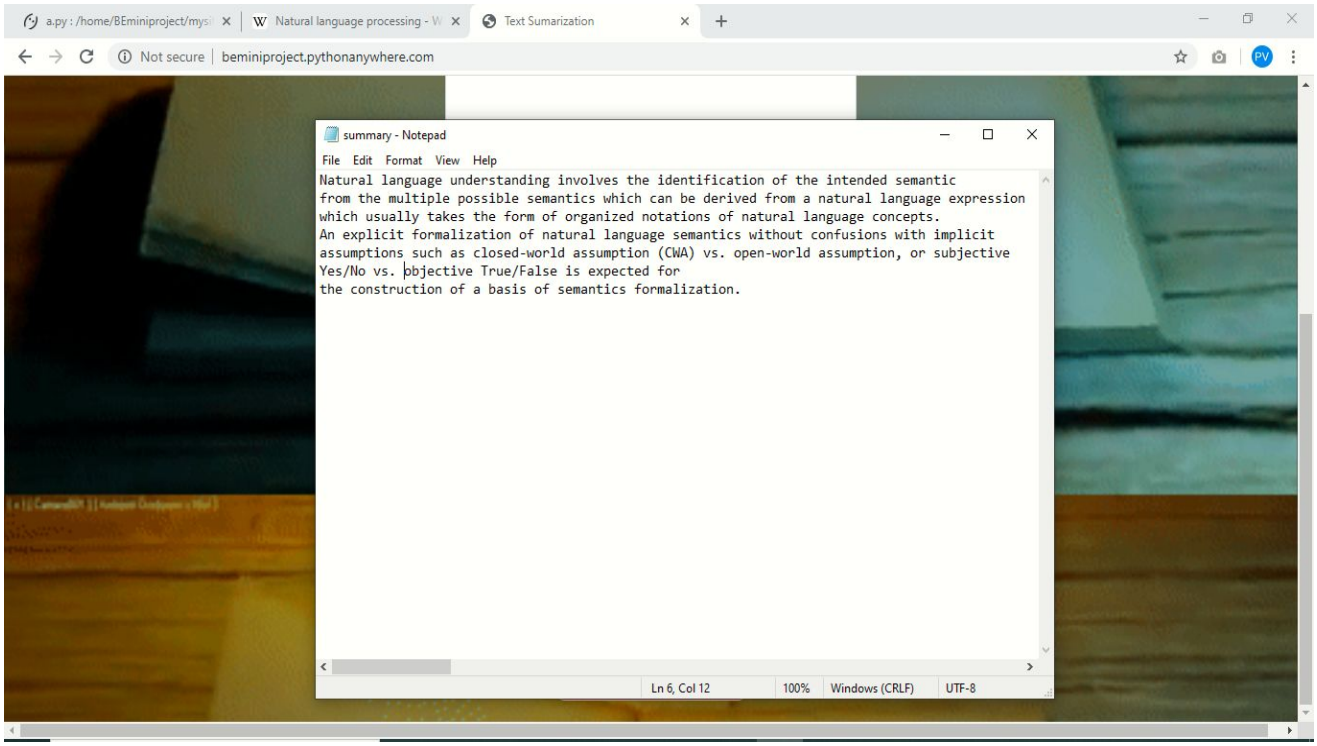

Fig.4.2.4 Downloading the summarized text in a file

Input text:

Natural language understanding

Convert chunks of text into more formal representations such as first-order logic structures that are easier for computer programs to manipulate. Natural language understanding involves the identification of the intended semantic from the multiple possible semantics which can be derived from a natural language expression which usually takes the form of organized notations of natural language concepts. Introduction and creation of language metamodel and ontology are efficient however empirical solutions. An explicit formalization of natural language semantics without confusions with implicit assumptions such as closed-world assumption (CWA) vs. open-world assumption, or subjective Yes/No vs. objective True/False is expected for the construction of a basis of semantics formalization.

Output text:

Natural language understanding involves the identification of the intended semantic from the multiple possible semantics which can be derived from a natural language expression which usually takes the form of organized notations of natural language concepts. An explicit formalization of natural language semantics without confusions with implicit assumptions such as closed-world assumption (CWA) vs. open-world assumption, or subjective Yes/No vs. objective True/False is expected for the construction of a basis of semantics formalization.

Chapter 5

Summary and Future Scope

5.1 Summary :

Thus, we have observed the project uses various libraries to provide a summary of the given text while preserving the original meaning of the input document. For the automatic text summarizer to be more accessible the summarizer project is hosted over the web, so a user can easily access the website with ease and mobility by typing in just the URL.Thus the user can access the website anytime and anywhere.Once the website is accessed the required text can be copy pasted onto the site and it summarizes and provides it back to the user.The summarized report can also be downloaded from the website onto the user's personal device and be saved as a file.

The analysis of the summarized report revealed that the project acquires a 50 percent retention rate over the input text. Though there is some distortion in the continuity of the information the summarizer preserves the overall idea of the input text.

5.2 Future Scope :

Text summarization can be further developed and used for the following purposes -

1. .Integration with news websites - Summarization can be used to provide a quick read of lengthy news documents to users who cannot read the additional details.
2. Multi-document summarization - Text Summarization can be made more effective for professional personnel by adding an option to summarize multiple documents in a single go, thus saving time and effort.
3. E-Books and literature - Summarization can help in providing a short synopsis to consumers to quickly understand what a book is about as part of their buying process.
4. Multi-language support - The summarizer can be further used to provide summary in multiple languages for the ease of native language speakers.

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Nikhil Chandran
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PV Athira Chandran