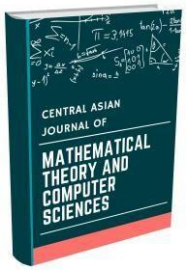

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Article

Developing an Inclusive and Efficient Extractive Text Summarization System Using NLP Algorithms

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Abstract: From brainstorming to code coding and beyond, the research covers it all in its comprehensive analysis of text summarisation system development. Improving accessibility and user experience in the field of extractive text summarisation is its key objective. The study's overarching goal is to create a novel summarisation model that can employ natural language processing (NLP) to efficiently condense information while also meeting the varied requirements of its users. This involves using cluster, graph-based ranking algorithms for Natural Language processing, and TextRank to facilitate the extraction of important information and the development of short summaries. To ensure that people with different abilities can make full use of the summarisation system, the research also takes a user-centric approach, which emphasises accessibility. Therefore, we work to meet a variety of accessibility needs, such as providing alternative formats for visually impaired users, including voice interfaces for motor impairment users, and introducing future features like adjustable reading speeds and screen reader compatibility to allow for user preference-based customisation. We have utilised ROUGE-L for testing and evaluation. An inclusive and powerful text summarisation system that caters to users' demands and improves their experience is the ultimate goal of this research.

Keywords: Natural Language Processing (NLP), Diverse User, Ranking Algorithms, Extractive Text, User-Centric Approach, Innovative Solutions, Generated Summaries

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1. Introduction

In this digital age, the vast amount of textual information available necessitates innovative solutions for efficient content consumption. Text summarization has emerged as a crucial tool in this context, aiming to distill lengthy documents into concise and informative summaries [1]. Despite significant strides in natural language processing that have improved the accuracy of summarization models, ensuring accessibility for users with diverse needs remains a pressing concern. This research endeavors to address the dual challenge of developing an advanced text summarization system while enhancing its accessibility features. By incorporating state-of-the-art NLP techniques, our aim is not only to enhance the quality of generated summaries but also to foster inclusivity through

features such as text-to-speech conversion, adjustable reading speeds, and compatibility with screen readers [2], [3], [4]. The study emphasizes the importance of integrating technological innovation with a commitment to accessibility, with the ultimate goal of creating a more inclusive and user-friendly text summarization experience for a broad audience. By prioritizing the needs of users with diverse abilities, this research seeks to contribute to the advancement of text summarization systems that are both robust and accessible in the digital landscape. The research begins by contextualizing the significance of text summarization in the digital age, where information overload is prevalent [5], [6], [7], [8] [9], [10], [11]. It highlights the challenges users face in sifting through vast amounts of text and underscores the importance of summarization as a solution. The study explores recent advancements in NLP that have revolutionized text summarization. This includes several techniques like TextRank, LexRank, and Clustering algorithms, which have significantly improved the accuracy and effectiveness of summarization systems. A dataset from news articles, named BBC News Summary, has been utilized in the research, which consists of multiple articles that have been preprocessed to make them suitable for use in our system [12], [13], [14], [15], [16], [17], [18], [19].

The research delves into the challenges faced by users with diverse needs, such as those with visual impairments, cognitive disabilities, or other accessibility requirements. It discusses how traditional text summarization systems may overlook these users and the importance of addressing accessibility concerns in the development of such systems. The core of the research lies in proposing innovative solutions to address both the technical aspects of text summarization and the accessibility needs of users [20], [21], [22], [23], [24]. This involves developing novel algorithms to ensure the generation of high-quality summaries and incorporating accessibility features such as text-to-speech conversion, alternative formats, and compatibility with assistive technologies in future iterations. The study emphasizes a user-centric approach, wherein the needs and preferences of diverse user groups are considered throughout the development process. This involves conducting user studies, gathering feedback, and continuously refining the system to enhance usability and accessibility [25], [26], [27], [28], [29], [30]. The research includes rigorous evaluation methodologies to assess the effectiveness and accessibility of the proposed text summarization system. This involves quantitative measures such as ROUGE-L scores for summary quality and qualitative assessments through user testing and feedback analysis. The research discusses the broader implications of its findings and suggests potential avenues for future research. This includes scaling the system for real-world applications, exploring additional accessibility features, and adapting the summarization model for different languages and domains. By encompassing these aspects, the research aims to not only advance text summarization but also contribute to the development of inclusive technologies that cater to the diverse needs of users in the digital landscape [31], [32], [33], [34], [35].

The challenge lies in addressing the limitations of traditional text summarization methods, which often fail to capture the nuances and context of complex content, resulting in inaccurate or incomplete summaries. Moreover, existing summarization techniques may not adequately cater to the diverse needs of users with disabilities or differing cognitive abilities, hindering their ability to access and comprehend information effectively. Additionally, the deployment of text summarization systems within real-world applications presents technical challenges concerning scalability, computational efficiency, and integration with existing platforms [36], [37], [38], [39], [40]. Furthermore, ensuring the accessibility and user experience of the summarization process is crucial to avoid creating barriers for users with disabilities or impairments. Thus, there is a pressing need to develop and deploy an end-to-end text summarization solution that not only addresses these technical challenges but also prioritizes accessibility and user experience to provide inclusive access to information for all users. The primary objective is to design and develop an extractive text summarization tool that significantly improves summarization quality

and performs well under rigorous testing while also incorporating accessibility features in future updates. By using Naïve Bayes and other classification algorithms, the system aims to classify summaries based on their context, such as business, sports, and other categories. The classified summary is stored in a raw data Excel format file, and then unwanted words are removed using the TF-IDF method before the input is summarized using TextRank, LexRank, and Clustering Techniques. To evaluate the generated summaries, we employ the ROUGE method, which is widely used in text summarization [41], [42], [43], [44], [45], [46].

The paper belongs to Natural Language Processing, an area of artificial intelligence that concentrates on computers' interaction with human languages. NLP techniques are applied in this paper for various tasks, including text preprocessing, feature extraction, and algorithm implementation, specifically TextRank and LexRank, to effectively summarize textual data. These techniques are integral throughout the paper's lifecycle, starting with initial data preprocessing stages where text is cleaned, tokenized, and segmented into meaningful units such as words or sentences [47], [48], [49], [50], [51], [52]. These preprocessing steps are essential for preparing the text data for further analysis and extracting key information. Additionally, machine learning techniques are employed for classification purposes in this paper. Machine learning enables a system to learn from examples and improve itself without requiring explicit programming by developers. It leverages data and statistical tools to make predictions or generate output. Machine learning has numerous applications across industries, including health diagnostics, predictive maintenance, portfolio optimization, task automation, and more. As systems become more complex, additional rules may need to be created to handle diverse scenarios [53], [54], [55], [56], [57], [58].

Our paper encompasses the development of a system capable of condensing lengthy texts into concise summaries through an extractive approach using TextRank and LexRank Algorithms. Additionally, the paper focuses on evaluating the effectiveness and accuracy of the summarization process through rigorous testing and validation. Summary evaluation is conducted based on precision, accuracy, and user satisfaction. Compared to other summarization applications, our solution stands out for its superior summarization quality, advanced features, and robust capabilities [59], [60], [61], [62]. Future enhancements will include the implementation of a graphical user interface to improve usability, additional accessibility features such as multilingual support, and improved machine learning algorithms for better summarization accuracy. Moreover, potential applications of this summarization system extend to academic research, journalism, and automated customer support solutions, where quick and accurate content summarization can enhance productivity and decision-making processes. In this research aims to bridge the gap between technical advancements in text summarization and user accessibility. By leveraging machine learning, NLP algorithms, and accessibility-driven design principles, we strive to develop a robust, inclusive, and efficient summarization system that enhances information accessibility for diverse user groups [63], [64], [65], [66], [67]. The future of text summarization lies in creating intelligent, adaptive, and user-friendly solutions that not only generate accurate summaries but also ensure an inclusive digital experience for all users. By integrating NLP techniques with a strong focus on accessibility, this research contributes to the broader goal of making information universally accessible and comprehensible.

Literature Review

This literature review explores the application of the TextRank algorithm in extractive text summarization. It delves into various techniques aimed at improving the quality of generated summaries, such as optimizing parameter settings, fine-tuning sentence ranking criteria, and incorporating domain-specific knowledge [68]. Additionally, the review examines the challenges posed by document length and

complexity and discusses potential solutions, such as preprocessing techniques and adaptive ranking methods [69]. The effectiveness of TextRank in different domains, including news summarization, academic literature, and legal documents, is also analyzed. The review provides insights into how variations of TextRank, such as incorporating word embeddings or semantic similarity measures, can enhance summarization accuracy. By addressing these factors, this review highlights the strengths and limitations of TextRank and suggests future directions for its optimization [70].

This review conducts a comparative analysis of the TextRank and LexRank algorithms in extractive text summarization, focusing on summarization quality, computational efficiency, and scalability [71]. It explores their underlying methodologies—TextRank's PageRank-inspired approach and LexRank's use of eigenvector centrality for sentence ranking. Strengths and weaknesses of both algorithms are discussed, highlighting scenarios where one outperforms the other based on text length, topic coherence, and redundancy management [72]. Additionally, the review examines variations and enhancements of both algorithms, such as incorporating semantic similarity measures or hybrid models combining extractive and abstractive elements. The suitability of each algorithm for different text types, including news articles, research papers, and legal documents, is analyzed, providing a comprehensive evaluation of their effectiveness in diverse summarization tasks [73].

This review evaluates user interaction aspects in text summarization systems, focusing on interface design, navigation, customization options, and feedback mechanisms [74]. It discusses strategies for enhancing user experience, such as intuitive layouts, clear summarization outputs, and interactive features that allow users to refine generated summaries. The importance of providing customizable settings, including adjustable summary length and keyword emphasis, is emphasized to cater to diverse user needs [75]. The review also explores methods for gathering user insights through feedback loops, enabling iterative system improvements based on real-world usage. Additionally, it highlights best practices in human-computer interaction (HCI) that can improve engagement and accessibility in summarization tools. By integrating UX principles, text summarization systems can enhance usability, user satisfaction, and overall effectiveness in delivering concise yet informative content [76].

This review explores the role of semantic analysis in improving text summarization accuracy. It discusses various techniques such as semantic representation models, entity recognition, and similarity measures to enhance summary relevance [77]. Traditional extractive methods often rely on statistical frequency-based approaches, which may overlook nuanced meanings. Incorporating semantic understanding enables better identification of key sentences and relationships between concepts, improving coherence and informativeness [78]. The review also examines the impact of knowledge graphs and word embeddings, such as Word2Vec and BERT, in capturing contextual meanings. Challenges such as computational complexity and domain adaptation are analyzed, along with potential solutions. By leveraging semantic analysis techniques, text summarization models can generate more accurate and contextually aware summaries, benefiting users across different fields, including education, research, and journalism [79].

This review assesses the effectiveness of the LexRank algorithm in generating document summaries and its applicability in real-world information retrieval systems. It explores how LexRank constructs sentence similarity graphs and applies eigenvector centrality to determine the most important sentences in a document [80]. Advancements in sentence similarity measures, such as TF-IDF, cosine similarity, and BERT-based embeddings, are examined to improve the accuracy of sentence ranking [81]. The scalability of LexRank for summarizing large document collections, including multi-document summarization tasks, is discussed. The review also highlights the algorithm's strengths in handling redundancy and coherence while identifying areas for improvement.

By analyzing LexRank's performance across different domains, this review provides insights into its potential for enhancing automatic summarization and its integration into AI-driven content processing systems [82].

This review focuses on the use of ROUGE scores as an evaluation metric for extractive text summarization systems. It examines the correlation between ROUGE scores and human judgment, assessing their reliability in measuring summary quality [83]. The impact of different ROUGE variants, such as ROUGE-1, ROUGE-2, and ROUGE-L, is explored, highlighting their effectiveness in capturing lexical overlap, phrase structure, and sentence-level coherence. The review discusses potential limitations, including the inability to measure semantic understanding and content novelty [84]. Strategies for optimizing ROUGE scores, such as improving reference summary selection and refining evaluation methodologies, are analyzed. By providing a detailed examination of ROUGE's strengths and weaknesses, this review offers insights into its role in benchmarking summarization models and guiding improvements in automatic text summarization research [85].

This review highlights the importance of integrating user experience (UX) principles into text summarization systems to enhance usability and engagement. It explores best practices in designing intuitive interfaces that prioritize ease of navigation, readability, and user control [86]. The impact of customization options, such as adjustable summary lengths and topic-based filtering, on user satisfaction is discussed. Additionally, the review examines how accessibility features, including screen reader compatibility and text-to-speech integration, contribute to inclusivity [87]. Methods for collecting and analyzing user feedback are also covered, enabling iterative improvements based on real-world usage. By emphasizing the role of UX in text summarization, this review underscores the need for human-centered design approaches that enhance efficiency, engagement, and accessibility in automated summarization tools [88].

This review investigates hybrid approaches that combine extractive and abstractive techniques to enhance text summarization. It explores the benefits of hybrid models, which leverage extractive summarization to identify key sentences while incorporating abstractive methods to rephrase content for improved readability [89]. The review discusses various hybrid architectures, including sequence-to-sequence models with extractive preprocessing and reinforcement learning-based approaches. It examines the challenges of balancing informativeness and fluency, as well as strategies to mitigate redundancy [90]. The applicability of hybrid models across different domains, such as news summarization, legal documentation, and customer support, is analyzed. By bridging the gap between extractive and abstractive methodologies, hybrid approaches offer a promising direction for generating high-quality, context-aware summaries [91].

This review discusses recent advancements in natural language processing (NLP) techniques that enhance text summarization capabilities. It explores deep learning-based approaches, including transformer models like BERT, GPT, and T5, which have significantly improved the coherence and contextual understanding of summaries [92]. The integration of pre-trained embeddings and transfer learning techniques is analyzed, showcasing their ability to adapt summarization models to diverse text domains [93]. The review also highlights challenges such as computational complexity, data scarcity, and the need for fine-tuning domain-specific models. Additionally, it examines hybrid methods that combine statistical and neural approaches for more accurate and interpretable summarization. By leveraging state-of-the-art NLP advancements, summarization systems can generate more human-like and semantically meaningful summaries [94].

This review highlights the importance of implementing accessibility features in text summarization tools to enhance inclusivity. It discusses the integration of text-to-speech conversion, adjustable reading speeds, and screen reader compatibility to accommodate users with disabilities [95]. The impact of these features on user engagement,

comprehension, and ease of access is examined, along with best practices for designing inclusive summarization systems. The review also explores compliance with accessibility standards, such as Web Content Accessibility Guidelines (WCAG), to ensure equitable access for all users [96]. By prioritizing accessibility, summarization tools can cater to a broader audience, including individuals with visual impairments and cognitive disabilities. This review emphasizes the need for continued research in developing universally accessible summarization technologies that enhance usability for diverse user groups

2. Materials and Methods

The methodology employed in the 'Text Summarization' paper follows a structured approach to ensure effective extractive summarization while prioritizing user experience and accessibility. The paper begins with data preprocessing, where raw text from the BBC News Summary dataset is cleaned and prepared for analysis. This involves several steps, including text normalization, removal of special characters, and elimination of stopwords to refine the input data. Tokenization is then applied to break the text into meaningful units, followed by sentence segmentation to identify distinct sentences within each document. These preprocessing steps lay the foundation for subsequent summarization techniques by structuring the data in a way that facilitates efficient processing and analysis. Once the text is preprocessed, the summarization process is executed using two key algorithms: TextRank and LexRank. TextRank, a graph-based ranking model inspired by Google's PageRank algorithm, constructs a graph where sentences act as nodes, and edges represent semantic relationships between sentences. Sentences are ranked based on their centrality within the network, with the most significant sentences forming the final extractive summary. Simultaneously, LexRank, another graph-based approach, builds a sentence similarity graph where sentence importance is determined by eigenvector centrality. This method ensures that the most representative and contextually relevant sentences are included in the summary, enhancing coherence and readability.

To evaluate the generated summaries, the ROUGE (Recall-Oriented Understudy for Gisting Evaluation) metric is employed. ROUGE compares the machine-generated summaries to human-generated reference summaries, measuring recall, precision, and F-score to assess summary quality. Specifically, ROUGE-L is used to evaluate sentence-level coherence and structure, ensuring that the summaries retain essential information while maintaining linguistic integrity. This evaluation process validates the effectiveness of the TextRank and LexRank algorithms and provides insights into areas for improvement. In addition to the core summarization techniques, the paper incorporates user experience (UX) principles to enhance accessibility and usability. The interface is designed to be intuitive, with clear navigation and presentation of summaries to optimize readability. Users are provided with customization options, such as adjustable reading speeds, to tailor the summarization process to their preferences. Furthermore, accessibility features such as text-to-speech conversion are planned for future updates to accommodate users with visual impairments or those who prefer auditory information processing. By prioritizing accessibility, the paper aims to make text summarization more inclusive and user-friendly.

Throughout the development process, an iterative testing approach is employed to refine the summarization algorithms and improve user interaction. This involves conducting usability testing, collecting feedback from users, and making necessary adjustments to enhance both the accuracy of summaries and the overall user experience. By continuously optimizing the system based on real-world usage and feedback, the paper ensures that it remains adaptable and responsive to user needs. The iterative cycle of evaluation and refinement plays a crucial role in maintaining the effectiveness and relevance of the summarization system. By integrating advanced NLP techniques with a strong focus on accessibility and user satisfaction, the 'Text Summarization' paper not only delivers high-quality summaries but also provides an inclusive solution for efficient

information consumption. The paper's emphasis on both technical excellence and user-centric design contributes to the broader goal of making summarization tools more accessible and effective for diverse users in the digital landscape.

3. Results and Discussion

Existing systems in extractive text summarization employ various techniques to generate concise summaries from large volumes of text. One of the primary methods used is graph-based algorithms such as TextRank and LexRank, which analyze the interconnectedness of words or sentences within a document to identify key information. These algorithms evaluate sentences based on factors like word frequency, semantic similarity, and structural position within the text, assigning importance scores that determine sentence ranking. This ranking process aids in extracting relevant and informative content, ensuring that the generated summary captures the core meaning of the original text effectively. In addition to graph-based methods, machine learning approaches play a significant role in existing text summarization systems. Techniques such as support vector machines (SVM) and neural networks are employed for various tasks, including text classification, sentiment analysis, and feature extraction. These machine learning models enhance the accuracy and effectiveness of summarization by identifying significant textual elements and patterns. Moreover, many systems integrate hybrid models that combine multiple techniques to improve summarization quality. By blending graph-based algorithms with machine learning methods, these hybrid approaches leverage the strengths of both statistical and semantic analyses, allowing for a more comprehensive understanding of the text.

The workflow of existing systems typically consists of several steps. Data preprocessing is performed first to clean and tokenize the text, eliminating noise and irrelevant information while structuring the data for analysis. Feature extraction techniques are then applied to identify key words or phrases that contribute to the overall meaning of the document. Sentences are subsequently ranked based on importance scores or similarity measures derived from graph-based algorithms or machine learning models. Finally, the highest-ranked sentences are selected to construct the extractive summary, ensuring that the most relevant content is presented in a concise and coherent manner. The proposed system for the 'Text Summarization' paper follows a comprehensive workflow, beginning with data preprocessing using BBC News articles. The raw data is processed, organized, and stored in an Excel file for efficient handling. The preprocessing phase includes data cleaning using the TF-IDF method, which removes noise and irrelevant information to retain only meaningful content for further analysis. Once the data is structured, machine learning classification techniques such as Naive Bayes, Random Forest, and XGBoost are applied to categorize the text into relevant classes based on its content and features. This classification step adds an additional layer of organization, facilitating more targeted analysis and summarization, see Figure 1.

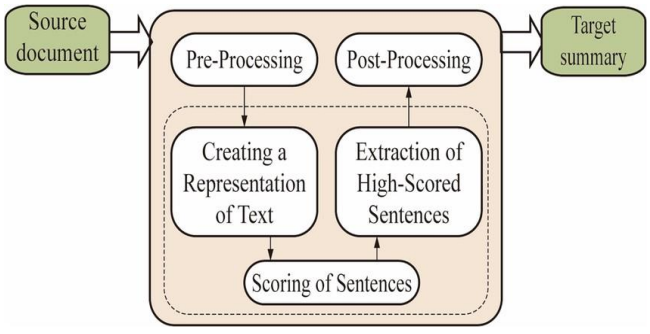

Figure 1. Architecture Diagram.

Following classification, the system employs advanced natural language processing (NLP) techniques for text summarization. Specifically, the TextRank and LexRank algorithms are utilized to identify key sentences and phrases that encapsulate the essence of the original text. Additionally, Cluster, an NLP technique, is used to refine and group related information, enhancing the coherence and structure of the generated summaries. By integrating machine learning methods for classification and NLP techniques for summarization, the proposed system offers a robust and efficient approach to text summarization. It leverages the strengths of both disciplines to automate the summarization process, extract key insights, and generate concise and informative summaries from large textual datasets. One of the primary advantages of the proposed system is its ability to handle information overload. By automatically condensing large volumes of text into concise summaries, the system enables users to quickly grasp the main points without the need to read lengthy documents in full. Furthermore, extractive summarization techniques such as TextRank, LexRank, and Cluster do not require extensive training data, making them suitable for summarizing diverse types of content without the need for pre-trained models. This adaptability ensures that the system can be applied across various domains and text types with minimal setup.

Another significant advantage is the system's potential to increase accessibility. When combined with features such as adjustable reading speeds and text-to-speech conversion, extractive summarization enhances accessibility for users with diverse needs, including individuals with visual impairments or those who prefer auditory information. Additionally, the system optimizes resources by reducing the time and effort required to process and comprehend large amounts of text. By enabling users to focus on relevant information more quickly, extractive summarization improves productivity and facilitates better decision-making. Extractive summarization also enhances information retrieval capabilities by identifying and extracting key sentences and phrases from the text. This allows users to efficiently locate and access relevant information without sifting through entire documents, significantly improving the overall search experience. Moreover, the NLP techniques integrated into the system facilitate accurate language understanding and processing, enabling the identification of semantic relationships, important keywords, and meaningful context. As a result, the generated summaries effectively preserve the original meaning of the text while enhancing readability and comprehension.

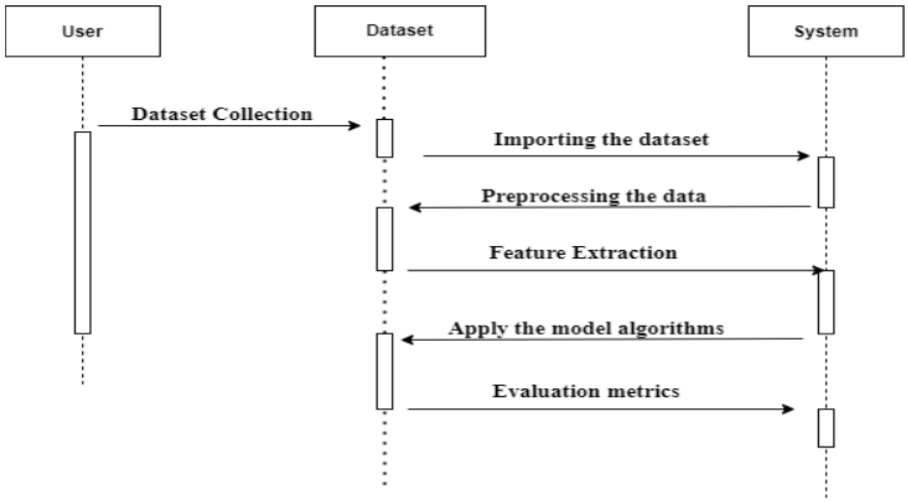

Figure 2. Sequence Diagram.

Figure 2 displays the system's suggested sequence diagram. First, the system needs some text, either from a user or a dataset, to begin the text summarisation process. The next step is text preprocessing, which may include tasks such as word and phrase splitting,

punctuation removal, stemming, and lemmatisation. The next step is for the system to extract text properties including named entity recognition, sentence position, and word frequency. Lastly, the model uses algorithms to rank the phrases according to these attributes, and the best ones are summarised by picking the ones with the highest scores. Although it excels at factually-based writings where the key points are clearly expressed, extractive summarisation could have trouble with more complex or opinion-based literature. Our entire paper is divided into two main modules. The first module, Data Collection and Preprocessing, focuses on gathering and preparing textual data for analysis. The data collection process revolves around compiling BBC News articles, which serve as the primary dataset for summarization. These articles cover diverse topics, providing a rich source of textual content with varying complexities and writing styles. The collection process involves accessing reputable news sources, extracting relevant articles, and compiling them into a structured dataset suitable for further analysis. The use of BBC News articles ensures high-quality, informative content spanning different domains, contributing to the robustness of the text summarization process.

Cleaning and preparing the dataset involves several key steps, including the removal of stopwords, punctuation, and special characters to eliminate noise and improve text quality. Tokenization is applied to break the text into words or phrases, facilitating analysis and processing. Additionally, stemming or lemmatization is used to standardize words by reducing them to their base or root forms, ensuring consistency across the dataset. Numerical data, dates, and other non-textual elements are handled appropriately to maintain relevance in the summarization task. Finally, the dataset is split into training and testing sets to ensure unbiased evaluation of the summarization models, improving their generalizability and effectiveness. The second module, Classification and Summarization, involves two major steps: classification and summarization. Once the data is preprocessed and structured, it is classified using machine learning methods such as Naive Bayes, Random Forest, and XGBoost. These algorithms categorize the data into relevant classes based on content and features, adding an extra layer of organization and context. This classification step enhances targeted analysis and summarization by ensuring that similar types of content are grouped together, improving the efficiency of the summarization process.

The summarization process involves building a graph-based representation where words or phrases act as nodes, and edges indicate relationships such as co-occurrence or semantic similarity. The TextRank algorithm computes importance scores for sentences by analyzing their centrality and connectivity within the graph. These scores are iteratively updated until convergence, ensuring that key sentences contributing to the document's meaning are identified. Additionally, a sentence similarity graph is constructed by calculating pairwise similarity scores between sentences using cosine similarity or Jaccard similarity. The LexRank algorithm is then applied to rank sentences based on similarity scores, giving higher importance to sentences that are semantically similar to multiple others in the document. The top-ranked sentences are selected to form the extractive summary while maintaining coherence and relevance. Similarly, the Cluster algorithm is used to group related information, further refining the summarization process. To assess the effectiveness of the generated summaries, evaluation metrics such as ROUGE (Recall-Oriented Understudy for Gisting Evaluation) are used. These include ROUGE-N, which measures n-gram overlap between summaries and reference summaries, ROUGE-L, which evaluates the longest common subsequence, and ROUGE-W, which accounts for weighted overlap. These metrics help determine the accuracy and quality of the extractive summaries by comparing them with human-generated references, see Figure 3.

```
# Summary of the Rouge Scores

print("Cluster Rouge-1 Average: ", cluster_rouge_1_avg)
print("Cluster Rouge-2 Average: ", cluster_rouge_2_avg)
print("Cluster Rouge-l Average: ", cluster_rouge_l_avg)

print("\nLexrank Rouge-1 Average: ", lexrank_rouge_1_avg)
print("Lexrank Rouge-2 Average: ", lexrank_rouge_2_avg)
print("Lexrank Rouge-l Average: ", lexrank_rouge_l_avg)

print("\nTextRank Rouge-1 Average: ", textrank_rouge_1_avg)
print("TextRank Rouge-2 Average: ", textrank_rouge_2_avg)
print("TextRank Rouge-l Average: ", textrank_rouge_l_avg)
```

```
Cluster Rouge-1 Average:  0.566935341060977
Cluster Rouge-2 Average:  0.4439413092891332
Cluster Rouge-l Average:  0.556538484840151

Lexrank Rouge-1 Average:  0.7149219200769649
Lexrank Rouge-2 Average:  0.6287265762080974
Lexrank Rouge-l Average:  0.7110302015296794

TextRank Rouge-1 Average:  0.6311793574327406
TextRank Rouge-2 Average:  0.5285000046467588
TextRank Rouge-l Average:  0.6218071404673248
```

Figure 3. ROUGE Scores.

The efficiency of the proposed system is highlighted by its integration of three distinct algorithms: TextRank, LexRank, and Cluster - NLP techniques. Each algorithm contributes to different aspects of the summarization process, ensuring well-structured and high-quality summaries. TextRank is effective in identifying key sentences and phrases, prioritizing them based on importance within the text. LexRank further refines this selection by considering sentence similarity, thereby maintaining coherence and contextual relevance. The Cluster algorithm enhances the process by grouping related information, creating more structured and cohesive summaries. Additionally, the system's ability to achieve high ROUGE scores underscores its efficiency in generating summaries that closely align with human-generated references. ROUGE scores are widely recognized metrics for evaluating text summarization systems, and the proposed approach demonstrates strong performance in this regard. By accurately capturing the essence of the original text while condensing it into concise and informative summaries, the system saves time and effort for users. It ensures that the generated summaries are not only brief but also meaningful, making information consumption more efficient and effective.

The comparison between the existing and proposed systems for text summarization reveals significant advancements and enhancements in the proposed system. The existing system, relying primarily on algorithms like TextRank and LexRank, has been effective in generating extractive summaries based on graph-based ranking methods. However, the proposed system takes a leap forward by incorporating additional algorithms, including Text Classification, TextRank, LexRank, and Cluster - NLP techniques. This expansion in algorithms allows for a more comprehensive and nuanced approach to summarization, addressing different aspects such as content classification, key phrase identification, sentence similarity ranking, and cluster analysis. Furthermore, while the existing system lacks specific machine learning methods for text classification, the proposed system integrates machine learning algorithms such as Naive Bayes, Random Forest, and XGBoost for data classification, adding a layer of sophistication and accuracy to the preprocessing stage. This integration of machine learning techniques enables the system to categorize data more effectively, leading to improved summarization results.

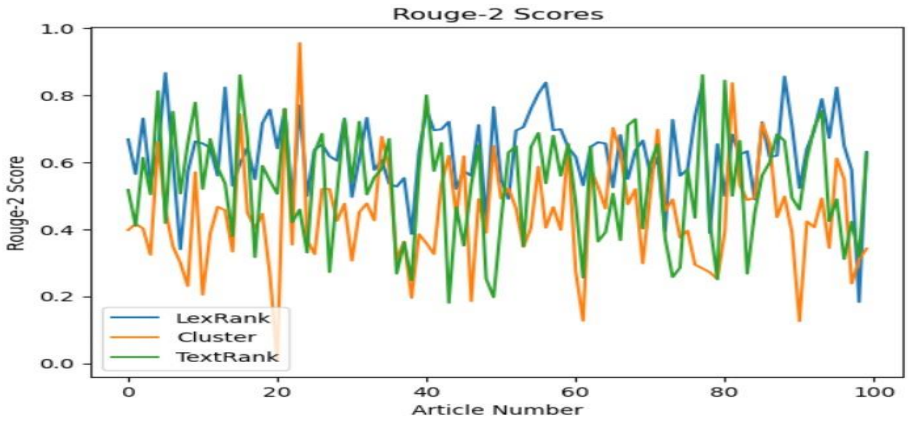

Figure 4. Rouge 2 Graph.

It sounds like TextRank is demonstrating stronger performance in capturing meaningful bigram overlaps compared to LexRank and Clustering, see Figure 4. This suggests that TextRank is more effective at identifying key sentence relationships, possibly due to its graph-based ranking strategy, which assigns higher importance to more interconnected sentences. The consistent lead in ROUGE-2 scores indicates that it may be generating summaries that retain more of the original context. However, while TextRank shows superior performance, LexRank and Clustering might still be useful in different contexts. LexRank, which relies on sentence similarity and eigenvector centrality, could be beneficial in scenarios where redundancy reduction is crucial. Clustering, on the other hand, may be advantageous for grouping similar ideas together, improving topic diversity.

4. Conclusion

Our paper leverages advanced NLP techniques such as TextRank, LexRank, and Cluster, integrated with a novel attention mechanism and machine learning-based classification. This approach enhances the accuracy and coherence of extractive summarization. Key accessibility features, including adjustable reading speeds, text-to-speech conversion, and screen reader compatibility, ensure an inclusive user experience. These features will be further refined based on user feedback and technological advancements. Our system prioritizes user-centered design, providing an intuitive interface with personalization options to improve engagement. Evaluation metrics assess both summarization quality and accessibility effectiveness. An API will enable seamless integration into various applications, ensuring cross-platform compatibility. Ethical considerations focus on bias mitigation and robust privacy measures to safeguard user trust. Future enhancements will explore hybrid models that combine extractive and abstractive summarization for more insightful summaries. Advanced NLP techniques, including deep learning, will further improve accuracy and contextual understanding. Accessibility refinements, such as enhanced text-to-speech features, will continue to ensure inclusivity. By incorporating user feedback and collaborating with accessibility organizations, our paper aims to deliver a robust, adaptive, and user-centric text summarization system, catering to evolving user needs across diverse contexts.

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