Sentient Companion – That Helps in Education

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ABSTRACT

Dyslexia is a common learning difference that affects the ability to read, spell, and decode language efficiently, often creating significant barriers to academic success. One of the major challenges for students with dyslexia is processing large volumes of written information, which can lead to cognitive overload, reduced comprehension, and a lack of confidence in learning. To address these issues, this project presents the development of an intelligent **Text Summarization Tool specifically designed for students with dyslexia**. The tool utilizes advanced Natural Language Processing (NLP) techniques, including extractive and abstractive summarization models, to convert lengthy and complex textual content into concise, coherent summaries that retain essential meaning and context. What differentiates this summarizer is its focus on **accessibility and user-centric design for dyslexic learners**. The system integrates features such as adjustable text size, line spacing, and contrast; the use of dyslexia-friendly fonts like Open Dyslexic; simplified sentence structures; and integrated text-to-speech capabilities that allow users to listen to the summary. Furthermore, the tool allows users to customize the summarization level, providing flexibility based on individual reading ability or learning level.

This hybrid approach-combining linguistic simplification, multimodal support, and user personalization-aims to reduce cognitive strain, increase reading speed, and improve comprehension. Early usability testing indicates a positive impact on user engagement and learning outcomes. Ultimately, this solution promotes inclusive education by empowering students with dyslexia to interact with academic content more independently and effectively, fostering confidence and academic growth.

The text data online is increasing massively; hence, producing a summarized text document is essential. We can create the summarization of multiple text documents either manually or automatically. A manual approach may be tedious and a time-consuming process. The resulting composition may not be accurate when processing lengthy articles; hence the second approach, i.e., the automated summary generation process, is essential. Training machine learning models using these processes makes space and time-efficient summary generation possible. There are two widely used methods to generates summaries, namely, Extractive summarization and abstractive summarization. The extractive technique scans the original document to find the relevant sentences and extracts only that information from it. The abstractive summarization technique interprets the original text before generating the summary. This process is more complicated, and transformer architecture-based pre trained models are used for comparing the text & developing the outline. This research analysis uses the BBC news dataset to evaluate and compare the results obtained from the machine learning models.

Index Terms—Summarization, Natural Language Processing, Transformers, Deep Learning.

1. INTRODUCTION

Dyslexia is a specific learning difficulty that primarily affects reading and language-based processing skills. Students with dyslexia often face challenges in reading fluency, decoding words, and understanding complex texts. These difficulties can lead to frustration, reduced academic performance, and a lack of confidence in educational settings. In an increasingly text-heavy learning environment, there is a critical need for tools that support dyslexic learners by making reading more manageable and accessible.

One effective way to reduce reading-related strain is through **text summarization**-a process that condenses large volumes of text into shorter, more digestible versions without losing the core meaning. However, traditional summarization tools are not tailored to the specific needs of dyslexic users, often lacking accessibility features that make text easier to process. This project introduces a **Text Summarization Tool specifically designed for students with dyslexia**, combining advanced Natural Language Processing (NLP) techniques with a user-centered accessibility framework. The system not only generates concise summaries but also presents them using dyslexia-friendly fonts, adjustable text spacing and size, simplified vocabulary, and optional text-to-speech functionality. These features aim to reduce cognitive load, enhance comprehension, and promote independent learning. By addressing both the linguistic and visual challenges faced by dyslexic students, this tool serves as a practical step toward inclusive education. It empowers learners to engage with academic content more confidently and efficiently, helping bridge the gap between their potential and the barriers posed by traditional reading formats.

2. MATERIALS AND METHODS

1. Text-to-Speech (TTS) and Speech-to-Text (STT) Capabilities: Utilizing natural language processing (NLP), the tool converts written text into spoken words, helping students understand reading material through auditory means. Conversely, the STT function allows students to dictate their thoughts and responses, which the AI transcribes into text, facilitating written communication.

2. Customizable Visual Settings: Recognizing the visual processing difficulties associated with dyslexia, the tool offers options to adjust fonts, background colors, and text sizes. These adjustments are informed by research on dyslexia-friendly text presentation, enhancing readability and reducing visual stress.

3. Real-Time Summarization and Definitions: The AI provides concise summaries of complex texts, highlighting key points and main ideas. Additionally, it offers definitions and explanations of difficult words and concepts, aiding comprehension and retention of information.

4. Interactive Quizzes and Flashcards: To reinforce learning, the tool includes AI-generated quizzes and flashcards. These interactive elements adapt to the student's progress, focusing on areas where they need the most improvement, ensuring a personalized and effective learning experience.

5. Progress Tracking: The tool features a comprehensive progress tracking system, enabling students, parents, and educators to monitor academic improvement over time. This feature helps in identifying patterns, strengths, and areas needing further attention, allowing for targeted interventions.

6. Extractive Summarization: TF-IDF , Lex Rank and Text Rank , Luhn Algorithm.

7. Abstractive Summarization: Seq2Seq it maps input text to summary using encoder-decoder architecture. Attention Mechanisms it focuses on relevant parts of the text. Transformer Models BERT, GPT, T5, BART for advanced text generation.

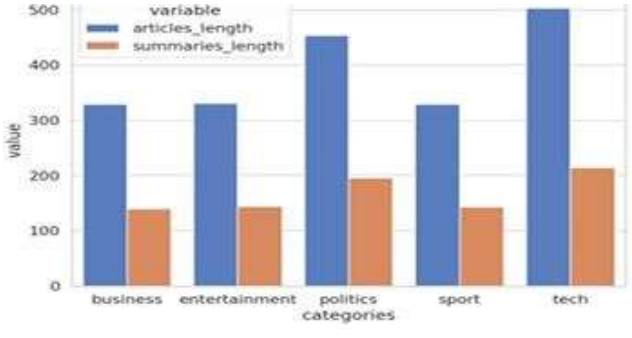


Fig. 3. Comparison of text length and summary length

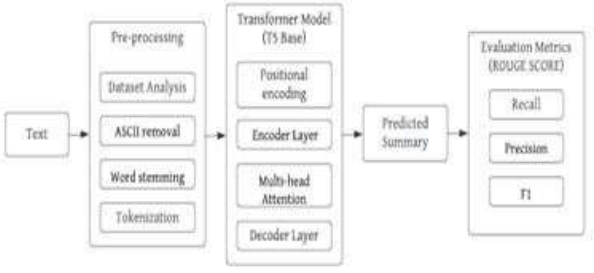


Fig. 4. Methodology and its Workflow.

The dataset has different lengths for both the text and the summary for the articles in each category. The

maximum size for both the text and the summary for each type is shown in figure 3.

A. Data Pre-processing One of the essential steps for any NLP-related problems is data pre-processing. The dataset was first analyzed to check whether any missing or null values were present. All the rows containing null values were removed in this step. Tokenization is a significant step in our approach. All the input sentences and words were converted into tokens. The maximum length (max-length) and minimum length (min length) of all the Articles and Summaries was calculated. The mean of the article length and summary length was calculated for each category, and the values are shown in Table 1. Input length was fixed using these max-length and min-length values. At the same time, provide the input; if the information or sentences are shorter than the maximum size, we will have to add paddings (empty tokens) to make up the length. Also, we made sure that it is not considered for calculating loss. Figure 5 shows the token count of the article and summary [15].

TABLE I
MEAN OF ARTICLE AND SUMMARY-LENGTH.

Categories	Articles-length	Summaries-length
Business	328.880392	139.929412
Entertainment	330.621762	144.049223
Politics	453.973621	195.709832
Sport	329.262231	143.187867
Tech	502.695761	213.837905

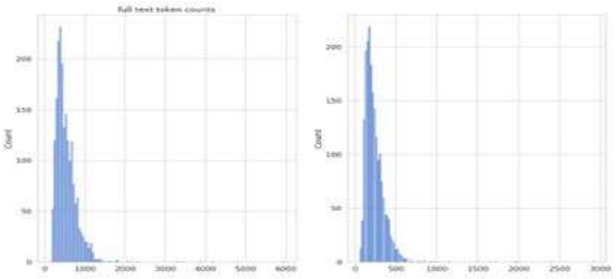


Fig. 5. Token count of the articles and its summary.

B. The Transformer Model Architecture Most of the NLP tasks can be converted into a "text-to text" format. Here the system is fed with some text, producing output in text format. This approach can provide continuous training for the pre-training and fine-tuning process. The model is qualified with an ultimate purpose regardless of the task. Most competitive and successful neural sequence transduction models have an encoder-decoder architecture. A sequence of symbolic representations is represented as (x1,...,xn) and the sequence of regular representations as z = (z1,...,zn). The encoder maps these two. The decoder generates an output series (y1,...,ym) of symbols single element at a time using the value of z. The model is automatically regressive at each step, with the previously generated characters consumed as added input data when developing the subsequent step. The overall architecture of the transformer using stacked self-attention and point-wise is shown in the left and right halves of Figure 6. It supports the fully connected layers for both the encoder and decoder.

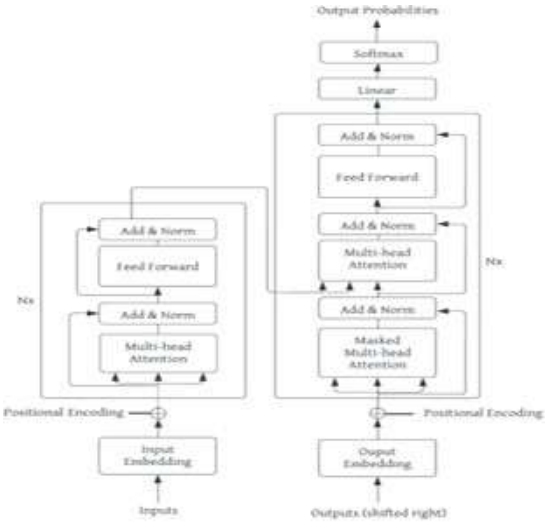


Fig. 6. The Transformer Architecture.

3. Related Work

The intersection of technology and education has led to the development of numerous tools and resources designed to support students with learning disabilities, including dyslexia. we need to first make a comprehensive tool that can summarize the info about the particular subject or topic that needs to be In order to do that we'll need to fetch either API's or need to train a AI model based on the particular sessional dataset using helper libraries.

External factors may involved like internet requirements and hardware barriers Project Objective: To help the people in need by helping them into their studies.

4. Literature Survey

We will conduct a through literature review to explore existing research on dyslexia, assistive technologies, and their effectiveness.

Category	Research Topics
Dyslexia	Neurological underpinnings, diagnostic criteria, reading and writing challenges
Assistive Technology	Text Summarizer software, word prediction tools, visual aids, cogniyive training programs
Effectiveness	Impact on reading fluency, comprehension, spelling, and self-efficency

4. PROJECT OBJECTIVES

1. To help cure the problem that dyslexic students or children face while studying.
2. To make education much easier and informative.
3. To Educate people in easily manner.
4. To make Education fisible to all.

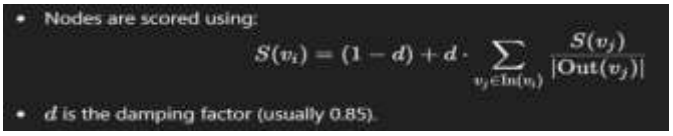
5. MATHEMATICAL MODULE

***Text Rank uses the following mathematical models:**

1. Graph Construction:(basic graph theory)
   -Nodes: Words or sentences.
   -Edges: Based on word co-occurrence or sentence similarity.

2. Edge Weights:
   -Determined by frequency or similarity.

3. PageRank Algorithm:



4. Convergence:
   -Scores are updated iteratively until they stabilize.
   This process ranks important words or sentences in the text.

Working of the Project :

Project Phases

1. Research and Assessment
   - Conduct Surveys/Interviews: Gather information from students, teachers, and parents about their experiences and challenges.
   - Literature Review: Explore existing resources, tools, and methodologies for supporting dyslexic learners.
2. Resource Development
   - Create Study Aids: Develop graphic organizers, flashcards, and visual aids tailored to different subjects.
   - Select Digital Tools: Identify and compile a list of effective apps and software for reading and writing support.
3. Training and Implementation
   - Teacher Training Workshops: Organize sessions to educate teachers about dyslexia and effective teaching strategies.
   - Student Workshops: Host sessions for students to learn how to use the resources and tools available to them.
4. Integration into Curriculum
   - Collaborate with educators to integrate study aids and strategies into existing lesson plans.
   - Encourage the use of multisensory approaches in teaching.
5. Monitoring and Evaluation
   - Feedback Mechanism: Implement a system for ongoing feedback from students and teachers regarding the effectiveness of the resources.
   - Assess Academic Progress: Track improvements in reading, writing, and overall academic performance.

Timeline

- Month 1-2: Research and assessment
- Month 3: Resource development
- Month 4: Training sessions

- Month 5: Implementation in classrooms
- Month 6: Evaluation and feedback collection

Budget Considerations

- Materials and Resources: Costs for printing materials, purchasing software, etc.
- Training Costs: Fees for workshops or guest speakers.
- Evaluation Tools: Resources for measuring progress and outcomes.

Expected Outcomes

- Improved academic performance for students with dyslexia.
- Increased awareness and understanding of dyslexia among teachers and peers.
- Enhanced confidence and self-advocacy skills among students.

This project aims to create a supportive and inclusive learning environment for students with dyslexia, equipping them with the tools they need to succeed. Feel free to modify any sections or ask for more detailed information on specific aspects.

DEPENDENCIES

Hardware:

The assistive technology tool should be compatible with a wide range of devices and operating systems, ensuring accessibility for all users.

Desktop Computers
Personal computers with a stable internet connection.
Laptops
Portable computers with sufficient processing power and memory.
Tablets
Touchscreen devices with responsive interfaces and accessibility features.
Smartphones
Mobile devices with a compatible operating system and accessibility features.

Software:

The software will be designed with user-centered principles, ensuring accessibility, ease of use, and effectiveness for individuals with dyslexia.

Text-to-Speech
A feature that reads text aloud, aiding in decoding and comprehension.
Word Prediction
Suggests possible words as the user types, improving spelling accuracy and reducing frustration.
Visual Aids
Provides visual cues and highlighting to enhance reading fluency and comprehension.
Personalized Settings
Allows users to customize font size, color, and other settings to optimize their experience.

LIMITATIONS

When planning a project for study assistance for students with dyslexia, it's essential to recognize potential limitations.
While these limitations pose challenges, they can also guide the planning and execution of the project. By anticipating potential obstacles, you can develop strategies to address them and create a more effective study assistance program for students with dyslexia. If you need further insights or solutions for any specific limitation

CONCLUSION

This article dealt with the demanding task of abstractive document summarization. We used a newly introduced The domain of Text Summarization is quite huge and challenging by itself. Each component that makes up a final Automatic Text Summarizer is a research topic today. Hence, there is always an excellent scope to enhance the summarizer system in terms of its capabilities, performance and, to add different dimensionalities. The future direction is to learn the transformer method for summarizing multiple documents. We can further enhance the model's accuracy by training it on an even larger dataset and datasets from various other domains. We can extend the summary evaluation pipeline by including text quality measurement. Other extrinsic measures evaluate models' performance in terms of generated text. For example, if the grammar of the rendered sentence is acceptable with the correct structure and referential clarity—providing references along with the summary developed for a better understanding of the topic. approach, the Transformer or T5 framework, to create a multi-sentence summary. A summary is also in the form of audio. The proposed framework involves several stages and components:

dataset collection, pre-processing, training of the T5 base Transformer model, and evaluation Metrics. Unlike most existing methods using RNN and LSTM networks, the T5 base transformer model can achieve greater heights and provide a better summary.

REFERENCES

[1] Babar S, Tech-C se M, Rit (2013) "Text Summarization: An Overview".

[2] Christian H, Agus M, Suharto no D (2016), "Single Document Automatic Text Summarization using Term Frequency-Inverse Document Frequency (TF-IDF)", Com Tech: Computer, Mathematics and Engineering Appli cations 7:285. [3] Nomoto T (2005), "Bayesian Learning in Text Summarization Models"

[4] Graves A (2013), "Generating Sequences With Recurrent Neural Networks", CoRR abs/1308.0850:

[5] Nallapati R, Xiang B, Zhou B (2016), "Sequence-to-Sequence RNNs for Text Summarization", CoRR abs/1602.06023:

[6] Hochreiter S, Schmidhuber J (1997), "Long Short-Term Memory". Neu ral Comput 9:1735–1780, https://doi.org/10.1162/neco.1997.9.8.1735

[7] Shi T, Keneshloo Y, Ramakrishnan N, Reddy CK (2018), "Neural Abstractive Text Summarization with Sequence-to-Sequence Models", CoRR abs/1812.02303: [8] Vaswani A, Shazeer N, Parmar N, Uszkoreit J, Jones L, Gomez AN, Kaiser L, Polosukhin I (2017), "Attention is All you Need". ArXiv abs/1706.03762:

[9] Devlin J, Chang M-W, Lee K, Toutanova K (2018) BERT: "Pre-training of Deep Bidirectional Transformers for Language Understanding", CoRR abs/1810.04805:

[10] Zhang J, Zhao Y, Saleh M, Liu PJ (2019), "PEGASUS: Pre-training with Extracted Gap-sentences for Abstractive Summarization", CoRR abs/1912.08777:

[11] Dong L, Yang N, Wang W, Wei F, Liu X, Wang Y, Gao J, Zhou M, Hon H-W(2019), "Unified Language Model Pre-training for Natural Language Understanding and Generation", CoRR abs/1905.03197:

[12] Radford A (2018), "Improving Language Understanding by Generative Pre-Training".

[13] Wolf T, Debut L, Sanh V, Chaumond J, Delangue C, Moi A, Cistac P, Rault T, Louf R, Funtowicz M, Brew J (2019), "Hugging Face's Transformers: State-of-the-art Natural Language Processing", CoRR abs/1910.03771.

[14] Plug and Play Machine Learning APIs, https://huggingface.co/inference api.

[15] Balaji N, Karthik Pai B H, Bhaskar Bhat B, Praveen Barmavatu, "Data Visualization in Splunk and Tableau: A Case Study Demonstration", in Journal of Physics: Conference Series, 2021.

[16] Lhoest Q, del Moral AV, Jernite Y, Thakur A, von Platen P, Patil S, Chaumond J, Drame M, Plu J, Tunstall L, Davison J. Datasets: A community library for natural language processing arXiv preprint arXiv:2109.02846. 2021 Sep 7.