Advances in Abstractive Text Summarization: A Comprehensive Review

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Abstract **- The exponential growth of scientific publications poses a challenge for researchers to stay updated on breakthroughs in their fields. Text summarization addresses this by providing concise summaries of important contributions. Abstractive Text Summarization (ATS) is a cutting-edge method that generates summaries by creating new sentences rather than extracting existing ones. It enables computers to understand text and produce unbiased, human-like summaries automatically. In this paper we intend to present the text summarization methods and procedures suggested in various research papers along with their pros, and future scope.**

Keywords— **Abstractive Summarization, pre-trained, rouge, accuracy**

I. INTRODUCTION

As society develops, people increasingly find themselves with fragmented time and less opportunity to read. Simultaneously, displays are becoming lighter, with narrower screens altering how people access information. In this fast-paced environment, there's a pressing need for tools to simplify vast amounts of information and enhance internet usage efficiency. Abstractive text summarization technology emerges as a solution to address this shift.

Abstractive text summarization involves paraphrasing and condensing original text, generating new words and phrases akin to human comprehension to convey essential information. Many researchers, professionals, and students require up-to-date information from scientific documents, often finding abstracts insufficient. Summarization becomes invaluable in aiding researchers to grasp study highlights without delving into entire texts or accessing PDF files.

This project introduces a framework employing an attention mechanism to consolidate information from multiple documents into a single summary. Our system serves as a valuable tool for researchers, professionals, and students, generating cohesive and concise summaries for knowledge acquisition or literature review purposes. By streamlining the research process, it saves time and enhances productivity.

II. LITERATURE SURVEY

Diverse collections of research papers provide a range of automated text summarizing perspectives, methods, and algorithms. The goals and difficulties encountered with a few studies are covered here.

The paper [1] demonstrates the effectiveness of using transformer-based pre-trained language models for automatic text summarization, yielding excellent results in producing practical summaries of text documents. The authors compare the performance of different pre-trained models and find that T5 and Pegasus models achieve the highest ROUGE scores, indicating their ability to generate accurate and relevant summaries. The use of transfer learning and pre-trained models proves beneficial in addressing the challenges of low-resource datasets and reducing training time. The T-BERTSum approach, based on BERTs, shows promising results in topic-aware extractive and abstractive summarization, delivering state-of-the-art performances. The paper highlights the importance of human evaluation and multiple tests to ensure the accuracy of the generated summaries, as well as the need for further research to develop more robust models. Further research should focus on developing more robust models for automatic text summarization. The technique employed in this paper can be expanded to generate summaries of varying lengths and to summarize multiple documents. Combining different approaches can potentially improve the precision, fluency, and coherence of the generated summaries. Emphasizing the use of human evaluations and conducting numerous tests can ensure the accuracy of the results and not solely relying on mathematical measures. Exploring the use of other pre-trained language models and comparing their performance in abstractive text summarization can provide further insights. Investigating the generalization and

performance of fine-tuned models on academic texts and datasets outside the news domain can contribute to a better understanding of their capabilities.

The paper [2] introduces a transfer learning technique for abstractive summarization, outperforming BART and Longformers by 12% and 20% respectively. It emphasizes the use of deep learning algorithms like Transformers and highlights the benefits of transfer learning with pre-trained models. The WPT-SPS system is a five-layered approach with a web application for obtaining scientific paper summaries based on author names or keywords. Experimental results using the ROUGE metric show that the proposed PEGASUS model improves ROUGE scores, with enhanced effectiveness from a Grammatical Error Correctness (GEC) model. In conclusion, the paper provides a comprehensive approach abstractive summarization, showing promising results in generating coherent and grammatically correct summaries for scientific documents. The proposed model can be further improved by exploring different transfer learning techniques and architectures. The model can be trained on larger datasets to enhance its performance and generalization capabilities. The application of the model can be extended to other domains such as legal documents and patents, enabling researchers to find relevant works in their field of study. Future research can focus on dynamically changing text summarization, taking into consideration the evolving nature of scientific articles and other documents. Further investigation can be done on the use of pre-trained models for sequence generation tasks, as they offer resource-efficient computations.

The paper [3] discusses the significance of abstractive text summarization in addressing time constraints and information overload. It reviews the evolution from word frequency-based to deep learning methods and distinguishes between extractive and abstractive summarization techniques. Key datasets like DUC/TAC and CNN/Daily Mail are highlighted for evaluation, along with evaluation metrics BLEU and ROUGE, adapted for summarization quality assessment. The core technology, the encoder-decoder framework in abstractive summarization, is detailed. The encoder processes and vectorizes the text, while the decoder, often using recurrent neural networks, generates the summary. Various decoder designs, including pointer networks, are explored to tackle challenges with rare words. The paper concludes by emphasizing advancements and challenges in abstractive summarization, particularly in Chinese text, and ongoing efforts to enhance its accuracy. The paper suggests that future research in abstractive text summarization should focus on improving the accuracy of summarization results for long texts by incorporating attention mechanisms, distraction methods, coverage, pointer networks, and copy mechanisms. It also recommends exploring preprocessing techniques such as named entity recognition and Chinese word segmentation to enhance the summarization effect for Chinese text. The paper highlights the need for more accurate evaluation methods for abstractive summarization, considering that different words or phrases can be used to achieve the same semantic vector, leading to deviations from manual summaries. Additionally, the paper suggests that future research should not directly compare scores for abstractive summaries to scores for extractive summaries due to the inherent differences in the decoding process.

In this paper [4], the authors present the DoS (Document Sharing) mechanism, an abstractive text summarization method that uses a pre-trained model and self-attention on multi-document input to improve summarization by incorporating information from various sources. The attention mechanism integrates information from multiple documents, allowing the model to learn common formats, grammatical structures, and infrequent phrases. Comparative results show the DoS mechanism with a modified attention mechanism achieves the best performance, with Rouge-1, Rouge-2, and Rouge-L scores of 41.3%, 27.4%, and 38.0%, respectively. The DoS mechanism's motivation is to enhance summarization quality by integrating information from multiple documents during training, contrasting with existing models that use external tips or examples. Experiments on the LCSTS dataset demonstrate that the GPT2-base-DoS-gelu model outperforms other baseline models in Rouge scores. The paper introduces the DoS mechanism as a significant improvement in abstractive text summarization without additional mechanisms, suggesting its potential applications in text generation tasks like machine translation. The conclusion emphasizes the DoS mechanism's versatility in generative text tasks and its ability to produce favorable results. The proposed DoS mechanism can be further explored and applied to various generative text tasks, such as machine translation, to achieve good results. The Dos module can be used as a reference for other tasks that require information absorption from multiple documents. Further research can be conducted to investigate the potential of the Dos module in improving the accuracy rate of abstractive text summarization tasks. The Dos module can be integrated with different pre-trained models to evaluate its effectiveness in enhancing the performance of text summarization. The attention mechanism used in the Dos module can be modified and optimized to improve the quality of the generated summaries.

The paper [5] presents a novel adversarial model for text summarization, addressing challenges in Generative Adversarial Networks (GANs) by incorporating a generative model (G), a discriminative model (D), and a Teacher model for entity relationship extraction. The Teacher model guides the generative model to optimize against the discriminative model, aiming to enhance convergence and reduce collapse risk. By extracting triples from real summaries and using them as keywords, the model achieves competitive ROUGE scores on the CNN/Daily Mail dataset. The proposed model involves pre-training the generative model with the Teacher model, pre-training the discriminative model, and adversarial training. Experiments show improved ROUGE scores compared to baseline methods and a 23% reduction in pre-training time. However, the conclusion notes reduced diversity and coherence in generated text, suggesting future work on enhancing diversity with a graph attention network. Introduce a graph attention network to influence the generator based on attention to ensure the diversity of the generated summary. Increase the dataset and training steps to mitigate the interference caused by the teacher model and improve the model's performance on ROUGE-2 and ROUGE-L. Explore the use of a relation extraction module to enhance the convergence speed and reduce the risk of model collapse in the generative adversarial network for text summarization. Modify the probability calculation method of the baseline model to reduce the

probability of keyword loss and increase the probability of generating important keywords and keyword-related words.

The paper [6] presents ConvS2S, an abstractive text summarization model that combines convolutional coding and multi-head attention to address issues of irrelevant or non-existent words in summaries. The model consists of an encoder, a decoder, and an output module. An improved pointer network is integrated to reduce the generation of invalid words. Experimental results on the LCSTS and Gigaword datasets show improved ROUGE-1, ROUGE-2, and ROUGE-N scores compared to other models, with significant reductions in invalid word generation and repetition rates. Using PyTorch with BERT-based word vectors, the model demonstrates the ability to produce more accurate and relevant summaries, suggesting potential for further research to enhance summary quality by addressing word repetition issues. Consider handling word repetition problems in the summary to improve the quality of the generated summary. Explore methods to avoid the generation of invalid words in the summary. Investigate the use of other models, such as transformers, to process text and improve the abstractive summary. Further enhance the ConvS2S model by incorporating the improved pointer network to reduce the possibility of generating invalid words and lower the repetition rate. Conduct experiments and evaluations on different datasets to validate the effectiveness of the proposed model.

The paper [7] presents the DoS (Document Sharing) mechanism, an abstractive text summarization method using a pre-trained GPT2 model with a self-attention mechanism on multi-document input to improve summarization effectiveness. Evaluated using Rouge-1, Rouge-2, and Rouge-L metrics on the LCSTS dataset, the DoS mechanism outperforms baseline models, particularly in Rouge scores. Applied to a transformer architecture with the GELU function for attention scores, the GPT2-base-DoS-gelu model shows promising results, suggesting potential applications beyond text summarization in text generation tasks like machine translation. The paper suggests that future research should focus on addressing the challenges and limitations of existing automatic text summarization (ATS) systems, such as extraction difficulties and the need for domain-specific information. Researchers are encouraged to explore new methodologies and techniques to improve the accuracy of single document summaries and domain-specific summaries. The study also highlights the importance of evaluating the performance of ATS systems using metrics such as precision, recall, F1 score, and G score. Future work could involve developing text summarization techniques for languages other than English, such as Hindi and Punjabi, using approaches like semantic graph, data clustering, particle swarm optimization, and extractive methods . Additionally, there is a need for further research on text summarization in languages like Arabic, Dutch, Telugu, and Chinese, using different approaches such as sentence scoring schemes, query-based document clusters, support vector machines (SVM), recurrent neural networks (RNN), and character-based approaches.

The paper [8] addresses the challenge of information overload on the internet and introduces text summarizers as a solution to condense text and eliminate redundancy. It distinguishes between "extractive" and "abstractive" text summarization methods. Extractive methods gather significant sentences from source materials without altering the original text, while abstractive methods use language creation algorithms to generate more generalized summaries. The literature review covers research on text summarization techniques, including Kneser Ney smoothing, semantic text summarization, query-based summarization, and deep learning-based multi-document summarization. Research gaps are identified, such as inaccuracies in extractive methods and flaws in abstractive methods, including factual inconsistency errors and a lack of contextual understanding. To address these challenges, the proposed system incorporates Kneser Ney Smoothing to improve contextual accuracy. The system features a user-friendly interface, a BART tokenizer, and a BART model trained on the 'facebook / bart-large' dataset. The algorithm uses a context-based approach to optimize user queries, aiming to develop a more accurate and contextually aware text summarization system. Investigate the use of topic keyword information and multidimensional information in the original text to guide the summary generation, which can effectively improve the summary effect of the existing RNN-based attentional mechanism of the abstractive summary model. Further explore the accuracy and readability of abstractive text summaries, addressing the long-distance dependency problem and the problem of unregistered words. Enhance the attention mechanism in the decoder to make the model focus more on important information and alleviate the impact of redundant information, thus improving the model's effectiveness. Conduct more experiments and evaluations on large-scale datasets to verify the effectiveness of the proposed Long-Short Transformer based text Summarization model (LSTS).

The paper [9] proposes a novel framework called IDCUOT (Improved Divide-and-Conquer Approach to Abstractive Summarization of Scientific Papers) for automated abstractive summarization of scientific papers. The framework is based on the theory of Unbalanced Optimal Transport (UOT) and divides the task of long document summarization into smaller-sized summarization problems based on the section structures of the source document. The paper introduces a delicate training objective that learns the alignment relationships between sections and their corresponding summary sentences, as well as the section-level summarizer. The authors investigate their framework on two publicly available scientific paper summarization benchmarks: PubMed and arXiv, and achieve significant improvements over existing methods. The proposed framework achieves better results compared to the existing method called DANCER, as well as several competitive baselines. The authors suggest exploring the use of different Neural Abstractive Text Summarization (NATS) models for the IDCUOT framework. Further investigation can be done to evaluate the performance of the proposed framework on other scientific paper summarization benchmarks. It would be interesting to explore the application of the IDCUOT framework in summarizing other types of long documents, beyond scientific papers. Future research can focus on improving the scalability of the underlying neural architectures of NATS to effectively handle longer sequences in document summarization.

The paper [10] proposes a content selector module that selects the top-n sentences from the source document using the TextRank algorithm and cosine similarity between sentence

embeddings obtained from the Universal Sentence Encoder (USE). Summaries produced by the abstractive text summarization models using the content selection module are akin to those generated by people. The paper highlights the need for evaluation metrics that can assess the semantic similarity of summaries generated by abstractive text summarization models with the content selector module, as the ROUGE metric fails to capture this aspect. Human evaluation is also conducted to assess the quality of the summaries generated by the abstractive text summarization models with and without the content selector module. The paper suggests the need for a new evaluation metric that can semantically evaluate the summaries on par with humans, as the ROUGE metric fails to capture the semantic similarity of the summaries generated by the abstractive text summarization models with the content selector module. The authors propose a content selector module for abstractive text summarization models, which helps generate quality summaries. Further research can focus on improving the effectiveness and efficiency of this module. The paper highlights the challenge of generating quality summaries in abstractive text summarization models. Future work can explore techniques to enhance the fluency, grammatical consistency, and overall quality of the generated summaries.

III. CONCLUSION

In conclusion, the literature review papers discussed various methodologies, techniques, and challenges in the domain of automatic text summarization. Transformer-based pre-trained language models such as T5 and Pegasus have shown promising results in producing accurate and relevant summaries, addressing challenges like low-resource datasets and reducing training time. Transfer learning techniques have also proven effective, outperforming existing models and offering potential applications in diverse domains. However, challenges such as word repetition, model diversity, and evaluation methods still need to be addressed. The proposed frameworks and mechanisms, such as the DoS mechanism and IDCUOT framework, present significant advancements in abstractive summarization, offering improved summarization effectiveness and scalability. Further research is needed to explore new methodologies, enhance model performance, and address emerging challenges, ultimately advancing the field of automatic text summarization and its applications across various domains.

- REFERENCES

[1] A. A. Al-Banna and A. K. Al-Mashhadany, "Automatic Text Summarization Based on Pre-trained Models," 2023 Al-Sadiq International Conference on Communication and Information Technology (AICCIT), Al-Muthana, Iraq, 2023, pp. 80-84, doi: 10.1109/AICCIT57614.2023.10218006.

2. [2] K. Girthana, S. Swamynathan, A. R. Nirupama, S. Sri Akshya and S. Adhithyan, "Web-based Pre-trained Transformer Model for Scientific Paper Summarization (WPT-SPS)," 2023 International Conference on Artificial Intelligence and Smart Communication (AISC), Greater Noida, India, 2023, pp. 298-302, doi: 10.1109/AISC56616.2023.10085409.

[3] Y. Chen, "Research on Abstractive Summarization Technology Based on Deep Learning," 2022 3rd International Conference on Computer Vision, Image and Deep Learning & International Conference on Computer Engineering and Applications (CVIDL & ICCEA), Changchun, China, 2022, pp. 474-478, doi: 10.1109/CVIDLICCEA56201.2022.9824030.

[4] X. Ding et al., "DoS: Abstractive text summarization based on pre-trained model with document sharing," 2022 4th International Conference on Intelligent Information Processing (IIP), Guangzhou, China, 2022, pp. 163-166, doi: 10.1109/IIP57348.2022.00040.

[5] L. Jing, L. Yang, X. Li and Z. Meng, "Abstractive Text Summarization Using Generative Adversarial Network and Relation Extraction," 2021 International Conference on Computational Science and Computational Intelligence (CSCI), Las Vegas, NV, USA, 2021, pp. 203-206, doi: 10.1109/CSCI54926.2021.00107.

[6] Y. Zhao, J. Wang, Y. Peng and X. Zhang, "An Abstractive Text Summarization Method Based on Improved ConvS2S," 2022 4th International Academic Exchange Conference on Science and Technology Innovation (IAECST), Guangzhou, China, 2022, pp. 999-1002, doi: 10.1109/IAECST57965.2022.10061897.

[7] G. MalarSelvi and A. Pandian, "Analysis of Different Approaches for Automatic Text Summarization," 2022 6th International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2022, pp. 812-816, doi: 10.1109/ICCMC53470.2022.9753732.

[8] S. Ji and B. Yang, "Abstractive Text Summarization Based on Long-Short Transformer," 2023 IEEE World AI IoT Congress (AIIoT), Seattle, WA, USA, 2023, pp. 0691-0700, doi: 10.1109/AIIoT58121.2023.10174260.

[9] A. B. Rao, S. G. Aithal and S. Singh, "Quality Enhancement of Abstractive Text Summaries with Content Selection," *2022 IEEE 6th Conference on Information and Communication Technology (CICT)*, Gwalior, India, 2022, pp. 1-5, doi: 10.1109/CICT56698.2022.9997835.

[10] X. Shen and W. Lam, "Improved Divide-and-Conquer Approach to Abstractive Summarization of Scientific Papers," 2022 4th International Conference on Natural

Language Processing (ICNLP), Xi'an, China, 2022, pp. 395-398, doi: 10.1109/ICNLP55136.2022.00073.

[11] K. S, S. R, S. R and T. S V, "Survey on Automatic Text Summarization using NLP and Deep Learning," 2023 International Conference on Advances in Electronics, Communication, Computing and Intelligent Information Systems (ICAECIS), Bangalore, India, 2023, pp. 523-527, doi: 10.1109/ICAECIS58353.2023.10170660.

[12] S. Badhe, M. Hasan, V. Rughwani and R. Koshy, "Synopsis Creation for Research Paper using Text Summarization Models," 2023 4th International Conference for Emerging Technology (INCET), Belgaum, India, 2023, pp. 1-5, doi: 10.1109/INCET57972.2023.10170144.