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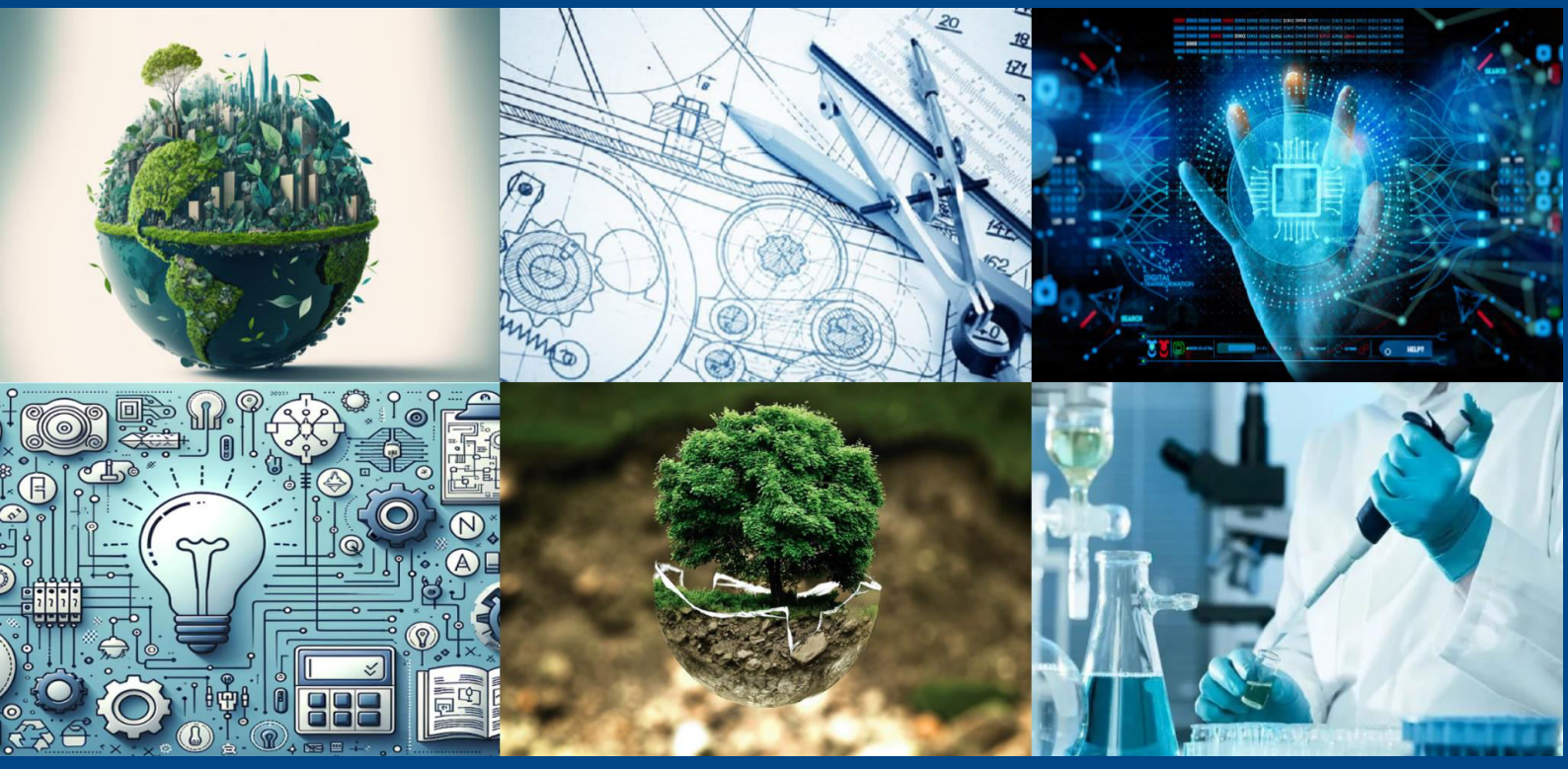

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Summarization of Legal Documents Using T5 and QLoRA

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ABSTRACT: The rapid growth of digital legal records has made it difficult for legal professionals, researchers, and the general public to quickly understand lengthy legal documents such as court judgments and case reports. These documents often contain complex legal language and large amounts of textual information, making manual analysis time- consuming. This project focuses on developing an **abstractive summarization system for Indian legal documents** using advanced Natural Language Processing (NLP) techniques.

The system uses the **Text-to-Text Transfer Transformer (T5)** model to generate concise and meaningful summaries from long legal texts while preserving the essential context. To improve efficiency and reduce computational requirements, the model is fine-tuned using **Quantized Low-Rank Adaptation (QLoRA)**, which enables efficient training with lower memory usage. The model is trained on datasets of Indian legal case documents and evaluated using **ROUGE metrics** such as ROUGE-1, ROUGE-2, and ROUGE-L to measure summarization performance. Additionally, a **sliding window segmentation technique** is used to process long documents by dividing them into smaller segments before summarization. The proposed system helps simplify complex legal information by generating concise summaries, thereby improving accessibility to legal knowledge and supporting legal research, automated legal assistance, and digital judiciary systems.

I. INTRODUCTION

The rapid growth of digital information in the legal domain has created challenges for legal professionals, researchers, and the public in understanding lengthy legal documents such as court judgments and case reports, which are often written in complex legal language. Manually reading and analyzing these documents requires significant time and effort. Natural Language Processing (NLP) provides effective solutions for processing large volumes of text, and one of its key applications is automatic text summarization, which generates shorter versions of documents while preserving their main meaning. Text summarization can be categorized into extractive summarization, which selects important sentences from the original text, and abstractive summarization, which generates new sentences that convey the core ideas in a more natural form. This project focuses on developing an abstractive summarization system for Indian legal documents using the Text-to-Text Transfer Transformer (T5) model, a powerful deep learning architecture designed for various NLP tasks. To improve training efficiency and reduce computational requirements, the model is fine-tuned using Quantized Low-Rank Adaptation (QLoRA), which minimizes memory usage while maintaining performance. The system is trained using datasets of Indian legal case documents and their summaries, enabling the model to learn legal terminology and document structures. By automatically generating concise summaries of lengthy legal texts, the proposed system helps legal professionals and researchers quickly understand key case details and improves accessibility to legal information.

II. OBJECTIVE

The objective of this project is to develop an automated system for summarizing lengthy Indian legal documents using advanced Natural Language Processing (NLP) techniques. The system aims to generate concise, meaningful, and human-readable summaries through an abstractive summarization approach rather than simply extracting sentences from the original text. It utilizes the Text-to-Text Transfer Transformer (T5) model to understand complex legal

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language and produce coherent summaries. To improve efficiency and reduce computational requirements, the model is fine-tuned using Quantized Low-Rank Adaptation (QLoRA). The system is trained using datasets of Indian legal case documents and evaluated using ROUGE metrics to measure summarization accuracy. Overall, the goal of the system is to help legal professionals, researchers, and the public quickly understand key information from lengthy legal documents.

III. EXISTING SYSTEM

In the existing systems for legal document summarization, most approaches rely on traditional text processing and extractive summarization techniques. These methods identify important sentences or keywords from the original document and combine them to create a summary. Common techniques used in these systems include frequency-based methods, keyword extraction, and graph-based algorithms such as TextRank. While these approaches can reduce the length of documents, they often fail to produce clear and coherent summaries because the selected sentences may not connect logically. In some cases, machine learning and deep learning models like BART and PEGASUS have also been used for summarization tasks, but many of these models are trained on general datasets such as news articles and may not perform effectively on legal documents due to complex legal terminology and document structure. Additionally, existing systems often require high computational resources and struggle to handle very long legal documents efficiently. As a result, the summaries generated by these systems may lack clarity, contextual understanding, and domain-specific accuracy.

IV. METHODOLOGY

The proposed system follows a structured methodology to generate abstractive summaries of Indian legal documents using deep learning techniques. Initially, legal documents are collected from domain-specific datasets and undergo preprocessing steps such as text cleaning, normalization, and tokenization to prepare the data for model training. Since legal documents are often lengthy, a sliding window segmentation technique is used to divide the documents into smaller segments that can be processed efficiently. The processed text is then provided as input to the Text-to-Text Transfer Transformer (T5) model, which is designed to perform summarization by converting input text into a concise summary. To improve training efficiency and reduce computational requirements, the model is fine-tuned using Quantized Low-Rank Adaptation (QLoRA), which updates only a small set of parameters while keeping the base model compressed. During training, the model learns patterns, legal terminology, and relationships within the documents to generate meaningful summaries. After training, the system performs inference to generate summaries for unseen legal texts. Finally, the performance of the model is evaluated using ROUGE metrics such as ROUGE-1, ROUGE-2, and ROUGE-L to measure the accuracy and quality of the generated summaries compared to reference summaries.

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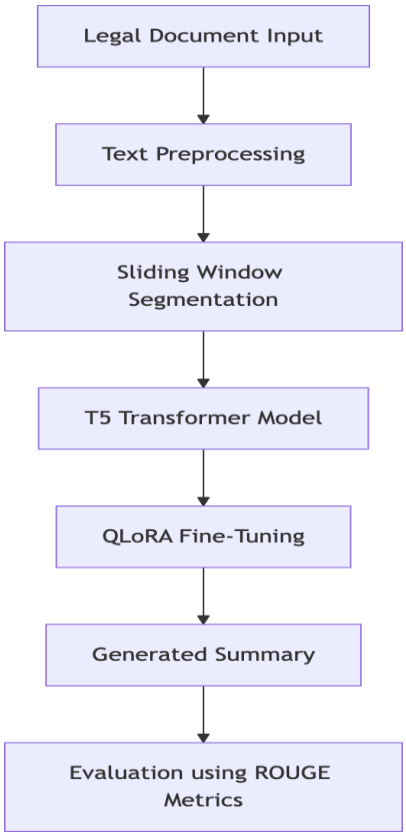
V. DATA FLOW DIAGRAM



VI. RESULT AND DISCUSSION

The proposed legal document summarization system was evaluated to measure its effectiveness in generating concise and meaningful summaries from lengthy legal texts. The model was trained using domain-specific datasets containing Indian legal case documents and their corresponding summaries. After training and fine-tuning the T5 model using QLoRA, the system was tested on unseen legal documents to generate summaries. The performance of the system was evaluated using ROUGE metrics such as ROUGE-1, ROUGE-2, and ROUGE-L, which measure the overlap between the generated summaries and reference summaries. The results showed that the model was able to capture important legal information and produce coherent summaries while significantly reducing the length of the original documents. The use of QLoRA helped improve training efficiency by reducing memory usage and computational requirements without affecting model performance. The sliding window segmentation technique also enabled the system to process long legal documents effectively by dividing them into smaller segments. Overall, the results demonstrate that the proposed system can successfully summarize complex legal documents and provide concise summaries that help users quickly understand key legal information.

VII. CONCLUSION

In this project, an abstractive summarization system for Indian legal documents was developed using advanced Natural Language Processing techniques. The system utilizes the Text-to-Text Transfer Transformer (T5) model to generate concise and meaningful summaries from lengthy legal texts. To improve training efficiency and reduce computational requirements, the model was fine-tuned using Quantized Low-Rank Adaptation (QLoRA). The system was trained using datasets containing legal case documents and evaluated using ROUGE metrics to measure the quality of the generated summaries. The results show that the model is capable of capturing important legal information and producing coherent summaries while significantly reducing document length. Additionally, the use of sliding window

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segmentation helped process long legal documents effectively. Overall, the proposed system demonstrates that transformer-based models combined with efficient fine-tuning techniques can effectively simplify complex legal documents and improve accessibility to legal information for professionals, researchers, and the general public.

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