# FlashLearn

Abstract

Flashcard generation and document summarizing are essential strategies for enhancing efficiency of learning and memory retention. Even if they work well, traditional methods take a lot of time and work. This project generates brief summaries and turns them into question-and-answer flashcards by automatically extracting important ideas from PDF documents using the Google Gemini API. The solution ensures high-quality, context-aware content while reducing manual work by utilizing AI. Active recall combined with AI-driven tools improves learning and provides a scalable solution for effective knowledge retention in both professional and educational contexts.
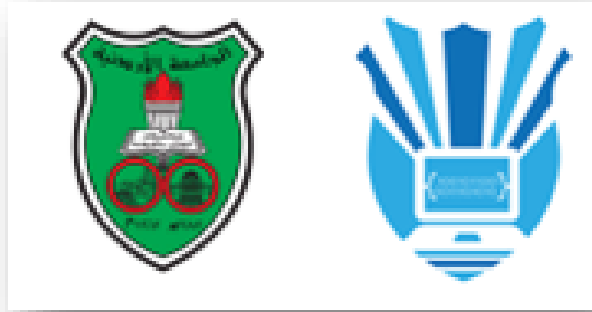
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Introduction

Document summary and the creation of **flashcards** are considered in education and learning as essential strategies for enhancing learning effectiveness and memory. Both strategies assist in teaching learner's key concepts by simplifying and making difficult knowledge easier to understand.

By condensing long texts into concise summaries that highlight the most important ideas, summarizing documents helps readers rapidly understand the core idea without having to go through large content. This procedure necessitates much study and understanding [1]. Also, flashcards are effective since they use active recall as the basis for learning. Active recall stimulation during learning improves neuronal connections and active memory retention [2]. Flashcards usually include the answer on one side and the question on the other. Research has indicated that mixing active recall combined with spaced repetition—reviewing material at increasingly longer intervals—significantly improves memory retention [3]. Because of such features, flashcards are an effective tool for enhancing understanding and maintaining the accuracy of knowledge over time [4].

As technology develops, artificial intelligence (AI) is being utilized as an effective tool for enhancing existing teaching strategies to overcome their limitations and improve their efficacy [5]. AI-enabled tools can read vast amounts of text, spot important features, and generate accurate summaries that are relevant to the context. AI can also generate flashcards automatically by turning text into pairs of questions and answers that each student can use. Reducing manual effort allows students to improve their performance and produce excellent results [6].

AI's integrating into flashcard creation and document summarizing has opened new possibilities for customized education, and simplify the procedure, allowing students to focus on learning more than creating study guides. This project explores these advancements, aiming to bridge the gap between traditional learning methods and modern AI-driven solutions.

Related Work

As mentioned before, the question-answer pairs are fundamental tool in education , therefore multiple works aimed to automized the process of generating them, such as in **WikiFlash** [7], where multistage process were used , starting with the summarization step – optional step depending on the user's decision if wants detailed content or not – then come the answer extraction from the context then they start with the question generation then the process ends with filtering step which filter out erroneous questions. T5 were used for answer extraction and question generation and DistilBERT for the text summarization and the filtering steps. While in **FlashMe** [8] , the process started with information extraction to identify the main concepts and ideas, followed by question generation based in the extracted concepts then corresponding answers were generated, set of LLMs were used such as BERT, GPT-3, BART and T5.

Similarly, in **flashcardsGPT** [9] LLMs were used to create flashcards from lecture slides, OpenAI's GPT-4 were utilized but they shifted to open-source models available on platform such as HuggingFace due to some challenges encountered related to data privacy with the GPT-4 model.

The blog **Generating Flashcards using AI** explains how to use LLMs, more precisely ChatGPT, for flashcard creation: flashcard set creation from lists of vocabulary items, multiple-choice question creation, and text summarization into flashcards. The effectiveness of the flashcards generated automatically versus those created manually is discussed here; a few pitfalls of this process are pointed out. The article gives concrete examples of how the prompts used with the LLM would result in a specific output; thus, it is a great source to show how LLMs are being applied in educational tools [10].

The program described in **Creating Flashcards with Generative AI** article uses generative AI in an effort to create flashcards for rote memorization of concepts. The idea is to summarize the content from documents and turn that information into flashcards appropriate for systems such as Anki. Specific details for implementation are described, including the way one could effectively format outputs so that they will be easily integrate into any learning system. The article highlights the automation of LLMs in generating educational resources, extending the practical application toward improving learning experiences [11].

Methodology

This section outlines the methodology used to generate summary and question-answer pairs from PDF documents using automated processes. The methodology is divided into three main stages: text extraction, question-answer generation, and user interface development.

1.1. Text Extraction

The initial step is extracting the text from the PDF document provided by the user, PyPDF2 library due to its robust capabilities in handling PDF files [12].

1.2. Text Summarization

There are three summarization models built into our text summarization application: SpaCy, T5, and Gemini. Each model is designed to generate concise and meaningful text summaries capable of handling a wide range of input texts with ease.

First, the text is extracted using the PyPDF2 library, thereby making it compatible with most of the file structures. Then, the SpaCy Model uses linguistic features and word frequency analysis to select and extract the most significant sentences for summarization. During testing, we found that SpaCy summaries with less than 65 words were mostly incoherent or incomplete. Hence, we have set a minimum of 65 words for SpaCy-based summaries to ensure that what is output will be a meaningful and complete idea.

The T5 model uses the Hugging Face Transformers library. This is a summarization technique that breaks down the input text into manageable pieces, processes them individually, and then puts together the results to yield a cohesive summary. That makes T5 quite effective at handling complicated or long input texts.

The Gemini model uses Generative AI techniques through its connection to Google's Gemini-1.5 model by using API keys provided by the user. It delivers complete and contextually appropriate summaries by generating prompts based on user-specified length parameters to provide results that meet requirements in terms of desired specifications.

These three models can collectively provide a powerful and flexible text summarizer, serving diverse text complexity and summarization needs.

1.3.   Question-Answer Generation

The extracted content from the previous step is used to generate the question-answers pairs using the model "gemini-1.5-flash" from the Google Gemini API, which is a powerful tool designed for developers to access Google's latest generative AI models [13]. This API has significant key capabilities that help in the automation of the generation process such as creating structured outputs based on input prompts using the generate_content method, its multimodal capability that allows users to send prompts includes text, images, and videos. Also, Gemini is Integration with Google Cloud which provide additional capabilities such as scalability and robust infrastructure support [14].

1.4.   User Interface

The user interface for this project was implemented using **Streamlit**, a powerful and easy-to-use framework for creating web applications in Python [15]. The interface allows users to upload a PDF document and choose between generating a summary or creating flashcards. If the flashcard option is selected, users can specify the number of flashcards they want to generate.

Prompt Engineering

Data preprocessing

Chunking in NLP is a generic preprocessing technique; it refers to the breaking of unstructured text into smaller, more manageable chunks. These may be phrases, sentences, or any other meaningful unit which can, directly or indirectly, enhance several NLP-related tasks such as parsing, information extraction, and classification. The essence of chunking lies in improving further efficiency and effectiveness of processing by reorganizing the text in a more comprehensible format.

There are two major methods of performing text chunking: rule-based and machine-learning-based. Rule-based methods rely on explicit patterns, such as punctuation or regular expressions that explicitly define the boundaries between chunks. For example, noun phrase chunking is usually based on some predefined grammatical rules which segment a sentence into meaningful phrases. In contrast, machine learning methods learn from annotated corpora using statistical models that predict chunks based on contextual features. This could also include such techniques as the IOB tagging system, which tags parts of speech within the text and has been shown to increase chunking performance dramatically [19].

In our implementation of text chunking, we utilized a specific configuration that optimized the chunking process for my dataset. The parameters used were Chunk Size: 500 tokens, Chunk Overlap: 50 tokens, and Length Function: len.

This configuration is important because it allows for the creation of overlapping chunks that might help retain the context between different segments. Using a chunk size of 500 tokens, we created big chunks that contain a substantial amount of information while being manageable in further downstream tasks. The overlap of 50 tokens provides continuity and retention of context across chunks, thus being quite useful for tasks such as information extraction and sentiment analysis.

Prompt Engineering and Magic Words

Prompt engineering is among the major research and practice areas in AI, let alone large language models such as GPT-3 and further developments. It is based on the systematic elaboration and optimization of input prompts-specific queries or instructions provided to AI systems-with the objective of raising the relevance and accuracy of the output.

Prompt engineering is becoming increasingly important with continuous improvement in AI technologies to tap the full capabilities of these complex models. Magic words in prompt engineering mean that some phrases or structures are placed inside prompts and changing them would drastically affect the output from AI. These are the magic words that provide the necessary guide for understanding and generation, enabling the model to closely generate outputs matching the intentions of users.

Putting in context, specification of formats, or using role-based prompts results in coherent and contextually appropriate responses. This approach is critical to realizing the full potential of AI systems across various applications, including chatbots, content generation, and many others. Recent literature has indicated the importance of prompt engineering in the optimization of AI performance. For example, a critical review underlines some foundational and advanced methods in prompt engineering; it discusses self-consistency and chain-of-thought prompting as ways to increase model efficacy [16].

Another study emphasizes the structured nature of prompt design, with an effect on improving output quality by refining the formats of prompts and choosing appropriate task data to go with the tasks at hand [17]. Furthermore, a systematic survey categorizes recent advancements in prompt engineering and provides insights into strengths, limitations, and future research opportunities within this fast-evolving field [18].

Comparing between different prompts and the results

Prompt_1: "Based on the following text chunks, create {num_of_cards} high-quality QA flashcards:\n\n{chunks}"
Magic words used: Create, High-quality.

The Generated output from prompt 1:

Here are 5 high-quality QA flashcards based on the provided text:

Flashcard	Question	Answer
1	What is unique about lion social structures compared to other big cats?	Lions are the only cats that live in social groups called prides, consisting of related females, their cubs, and a few males. Other big cats are solitary.
2	Describe the sexual dimorphism in lions and its significance.	Male lions are significantly larger than females, possessing prominent manes that indicate maturity and attractiveness. Males weigh up to 250 kg; females 130-180 kg.
3	How do lions conserve energy, and why is this important?	Lions sleep for up to 20 hours a day, conserving energy for hunting and territorial defense. This is crucial for survival in the hot African savannas.
4	What are the primary threats to lion populations, and what is their conservation status?	Habitat loss, human-wildlife conflict, and poaching are major threats. Lions are classified as vulnerable by the IUCN due to significant population decline.
5	What is the role of male and female lions in the pride's survival?	Female lions primarily hunt, working cooperatively. Male lions protect the pride and territory from rivals. Both roles are essential for survival and raising cubs.

Prompt_2: "Based on the following text chunks, create {num_of_cards} concise and well-structured QA flashcards suitable for active recall. Ensure the questions and answers are brief yet comprehensive for optimal retention:\n\n{chunks}"

Magic words used: Concise, Well-structured, Active recall, Brief yet Comprehensive, Optimal retention.

The Generated output from prompt 2:

Here are 5 flashcards based on the provided text:

Flashcard	Question	Answer
1	What is unique about lion social structures compared to other big cats?	Lions live in prides (social groups) unlike solitary big cats like leopards and tigers.
2	What is sexual dimorphism in lions, and how does it manifest?	Male and female lions differ in size and appearance; males have manes and are significantly larger.
3	What is the primary role of male and female lions within a pride?	Females hunt cooperatively; males protect the pride and territory.
4	How do lions conserve energy, and why is this important?	They sleep up to 20 hours daily, crucial for survival in hot savannas.
5	What is the current conservation status of lions, and why?	Vulnerable; due to habitat loss, human-wildlife conflict, and poaching.

Prompt_3: "Extract the most important insights from the following text chunks and generate {num_of_cards} effective QA flashcards. The flashcards should be clear, engaging, and designed for quick learning and enhanced memory retention:\n\n{chunks}"

Magic words used: Important, Effective, Clear, Engaging, Enhanced memory retention.

The Generated output from prompt 3:

Here are 5 QA flashcards based on the provided text, designed for efficient learning and memory retention:

Flashcard	Question	Answer
1	What is unique about lions' social structure compared to other big cats?	Lions are the only cats that live in prides – social groups consisting of related females, their cubs, and a few males. Unlike solitary cats like leopards and tigers.
2	Describe the role of male and female lions in a pride.	Female lions primarily hunt cooperatively, while male lions mainly focus on protecting the pride's territory and its members from rival males.
3	Why do lions sleep so much (up to 20 hours a day)?	Sleeping conserves energy, which is crucial for survival in their hot African savanna habitats, leaving energy for hunting and territorial defense.
4	How do lions communicate, and what is the purpose of their roar?	Lions communicate through roars, grunts, growls, and purrs. Their powerful roar (up to 8km range) helps establish territory, locate pride members, and deter threats.
5	What are the main threats to lion populations, and why is their conservation important?	Habitat loss, human-wildlife conflict, and poaching threaten lion populations. As apex predators, lions are vital for maintaining ecosystem balance, making their conservation a critical priority.

Prompt_4: "Using the following text chunks, generate {num_of_cards} interactive and impactful QA flashcards. Focus on making the questions thought-provoking and the answers concise yet meaningful for active recall:\n\n{chunks}"

Magic words used: Interactive, Impactful, Thought-provoking, Concise yet meaningful, Active recall.

The Generated output from prompt 4:

Here are 5 interactive QA flashcards designed for active recall, using the provided text:

Flashcard	Question	Answer
1	What unique social structure distinguishes lions from other big cats?	They live in prides – groups of related females, cubs, and a few males.
2	How do male lions use their manes, and what does a darker, fuller mane signify?	As a sign of strength and maturity; attractiveness to females.
3	Why do lions sleep up to 20 hours a day, and what environmental factor influences this behavior?	Energy conservation; the hot African savannas.
4	Beyond hunting, what other methods do lions use to obtain food, and who primarily hunts within the pride?	Scavenging; female lions.
5	What are the primary threats to lion populations, leading to their vulnerable conservation status?	Habitat loss, human-wildlife conflict, and poaching.

These flashcards use concise answers to encourage recall and focus on key concepts from the text. The questions are designed to be thought-provoking, prompting deeper engagement with the material than simple fact recall.

An issue occurred here involving commentary and framing. Framing refers to introductory sentences, such as: "Here are 5 QA flashcards designed for active recall, focusing on different aspects of lion behavior and biology from the provided text". Commentary, on the other hand, refers to concluding sentences like: "These flashcards use concise answers to encourage recall and focus on key concepts from the text. The questions are designed to be thought-provoking, prompting deeper engagement with the material than simple fact recall.

This issue is undesirable because our goal is to generate only the flashcards themselves without any additional framing or commentary. Including such elements can create problems when indexing the flashcards for the front end, so we aim to avoid them entirely.

Due to the issue of commentary and framing, we began experimenting with modified prompts where we explicitly instructed the model to exclude any commentary or framing.

Prompt_5: "Craft {num_of_cards} focused and precise QA flashcards from the following text chunks. Each flashcard should be highly relevant to active recall, with clear and concise questions and answers. Provide only the QA pairs, excluding any extra text or explanation:\n\n{chunks}"
Magic words used: Focused, Precise, highly relevant, Active recall, Clear, Concise.

The Generated output from prompt 5:

Here are 5 QA flashcards designed for active recall, focusing on different aspects of lion behavior and biology from the provided text:

Flashcard	Question	Answer
1	What is a unique characteristic of lion social structure compared to other big cats?	Lions live in prides, social groups consisting of related females, cubs, and a few males; unlike solitary big cats like leopards and tigers.
2	What is the primary function of a male lion's mane?	It's a sign of strength and maturity, with darker, fuller manes being more attractive to females.
3	How do female lions primarily contribute to the pride's survival?	They do most of the hunting, working cooperatively to bring down prey.
4	What is one adaptation that helps lions survive in hot savannas?	They sleep up to 20 hours a day to conserve energy.
5	What is the primary threat to lion populations globally?	Habitat loss, human-wildlife conflict, and poaching.

Prompt_6: "Design {num_of_cards} tailored QA flashcards from the following text chunks. The questions should be compelling, and the answers accurate and concise, aligned with active recall principles. Return only the QA pairs, without any additional commentary or framing:\n\n{chunks}"

Magic words used: Tailored, Compelling, Accurate, Concise, Active recall

The Generated output from prompt 6 (without framing):

Flashcard	Question	Answer
1	What distinguishes lions from other big cats regarding their social structure?	Lions are the only cats that live in social groups called prides.
2	What is the primary function of a male lion's mane?	It signifies strength and maturity, attracting females.
3	How do female lions primarily contribute to the pride's survival?	They hunt cooperatively to provide food.
4	Why do lions sleep up to 20 hours a day?	To conserve energy, especially crucial in hot savannas.
5	What is the biggest threat to lion populations globally?	Habitat loss, human-wildlife conflict, and poaching.

The Optimal Prompt Utilized in Our Project

After experimenting with various prompts, we decided on the following:

1. Output (QA) without framing, commentary.
2. Proper indexing
3. Concise yet comprehensive QA
4. QA that supports efficient active recall for the learner

To achieve that, this is the prompt that combines all our desired characteristics:

> **"Using the following text chunks, generate {num_of_cards} interactive and impactful QA flashcards. " "Focus on making the questions thought-provoking and the answers concise yet meaningful for active recall. " "Provide only the QA pairs in the following indexed format for consistency: \n\n" "1. Q: [Your question here] \n" " A: [Your answer here] \n\n" "2. Q: [Your question here] \n" " A: [Your answer here] \n\n" "... \n\n" "Ensure there is no additional text, framing, or commentary beyond the indexed QA pairs:\n\n" f"{chunks}""**

Results: of Generated Flashcards

Flashcard	Question	Answer
1	What unique social structure distinguishes lions from other big cats?	Lions live in prides—groups of related females, their cubs, and a few males.
2	How do male lions' manes contribute to their survival?	Darker, fuller manes attract females, indicating strength and increasing mating success.
3	Why do lions sleep up to 20 hours a day?	To conserve energy, especially crucial in their hot savanna habitats.
4	How do lions primarily communicate over long distances?	Through their powerful roars, audible up to 8 kilometers.
5	What is the biggest threat to lion populations globally?	Habitat loss, human-wildlife conflict, and poaching.

User Interface Implementation Details

A simple website design was chosen for simplicity. With the addition of sone effects when there is the right place.

Initial Setup

The project was initiated by creating a directory to house all project files and dependencies. A Python virtual environment was established using the command python **-m venv FlashCardsVenv** to ensure an isolated and manageable environment for package installations. This virtual environment was activated using the appropriate command for the operating **system (FlashCardsVenv\\Scripts\\activate for Windows or source FlashCardsVenv/bin/activate for macOS/Linux).** The necessary dependencies, including Streamlit, were installed via **pip install streamlit.** The project structure was meticulously organized, with a page's directory created to store the Streamlit scripts for individual application and an img directory dedicated to storing image assets utilized within the application. The project directory was then opened in Visual Studio Code (VS Code), and the virtual environment was configured as the Python interpreter to ensure seamless development. The application was executed using the command **streamlit run Home.py** to verify functionality, navigation between pages, and the overall user interface. This setup ensured a structured and scalable foundation for further development and deployment.

The user interface of FlashLearn contains 4 pages as follows:
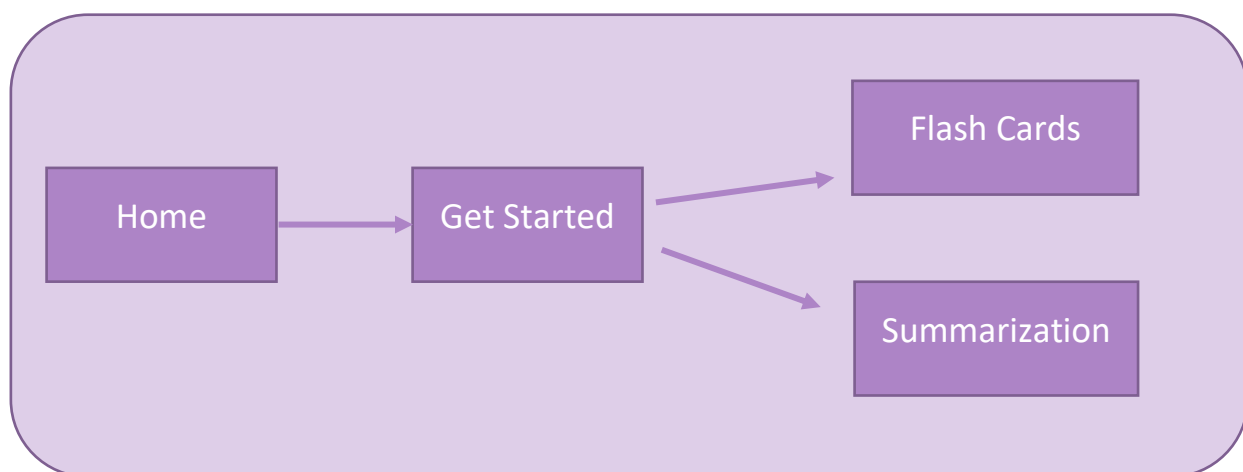
1. Home Page

The Home page contains two sections, the project title and get started button as the first section and about us section introducing and explaining the purpose of the site. The FlashLearn word is interactive and have some effect when hovering on it. User can click on **Get Started button** under the title this would direct the user to get started page to choose the desired task.
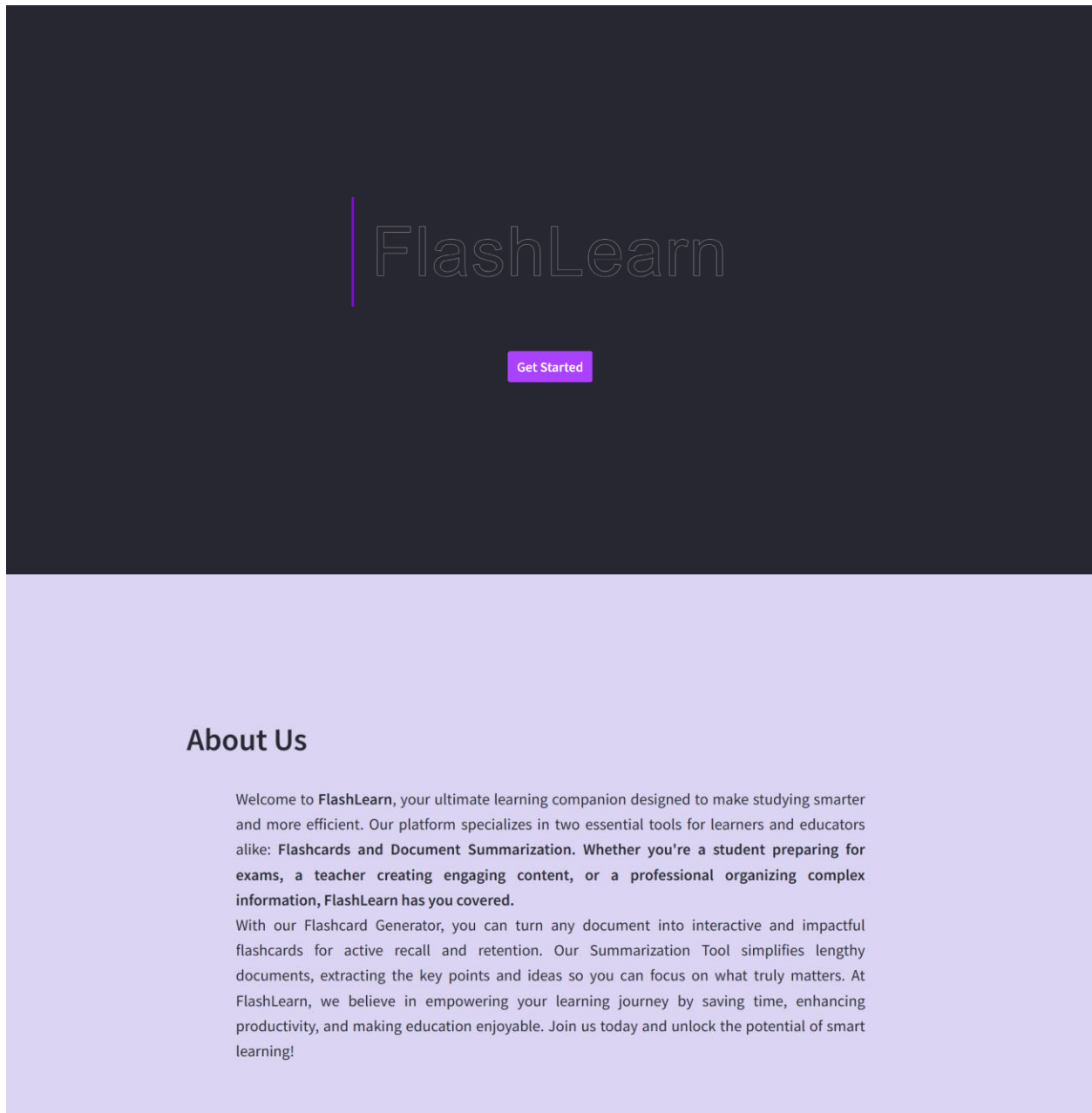
2- Get Started

Get started page simply have two cards. If the user wants to summarize a document clicking on **Summarize Your Document** button located on the first card would direct the user to the summarization page. If the user wants to generate a flash cards from a document, clicking on **Create Your FlashCards** button located in the second card would direct the user to the flash card page.
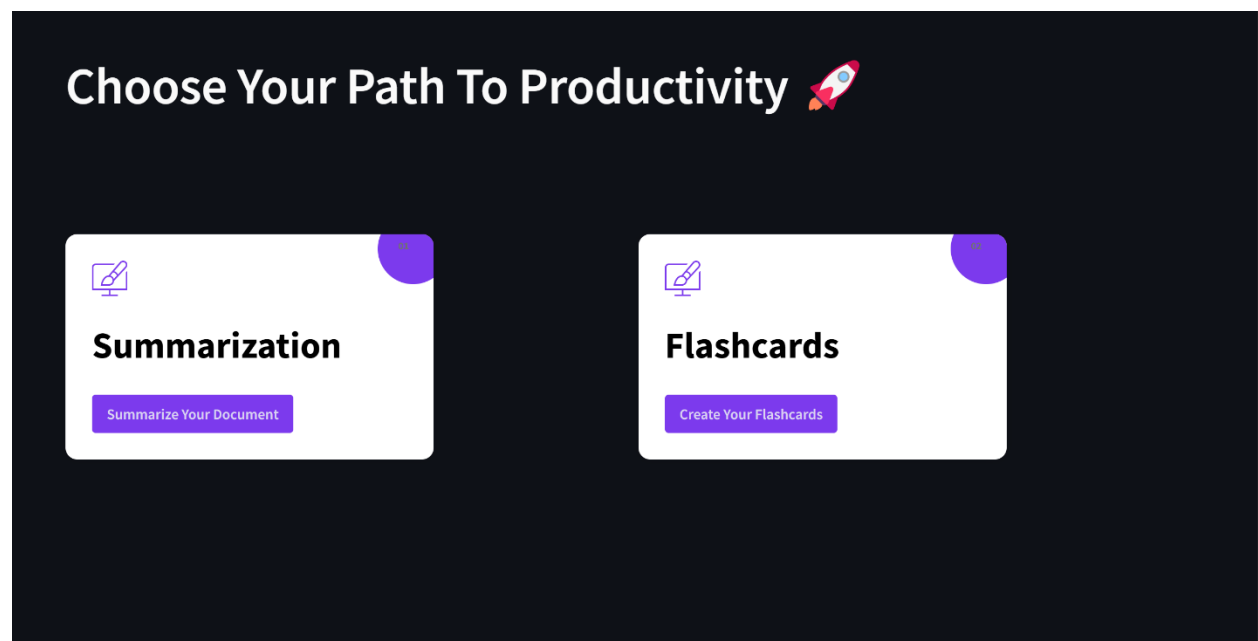
3- Summarization Page

To summarize a document, users have to download their PDF file they want to summarize and choose some parameters including the number of words the summarized text will be and the model that will summarize the text. Below is the page when first reached. Default parameters are the model SpaCy for summarization choice and 65 words as the number of words the user want the summarized text to be.
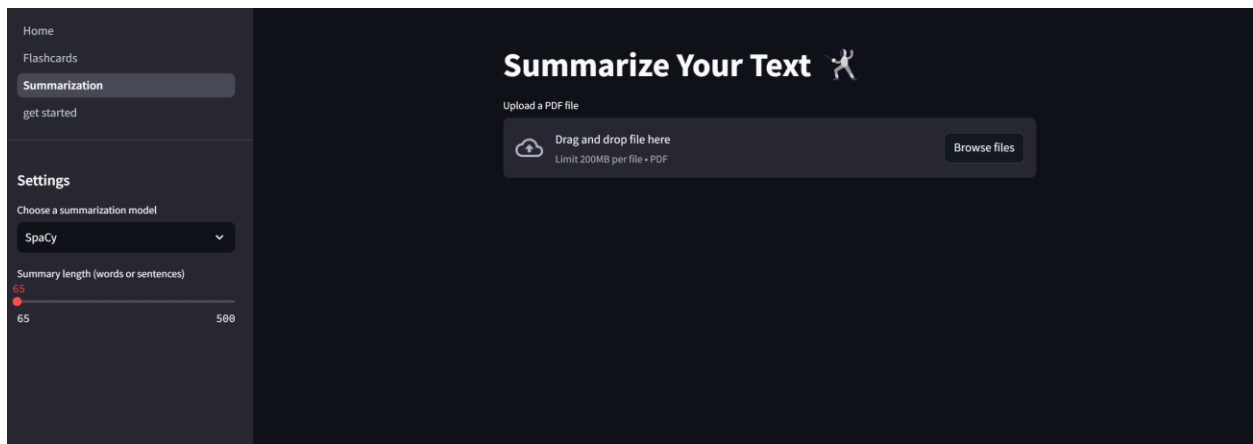
The user can download the file by pressing **Browse Files** button

Just after uploading the document the **Summarize** button will appear allowing the user to click on it and then depending on the model chosen the time of the result being display will vary.
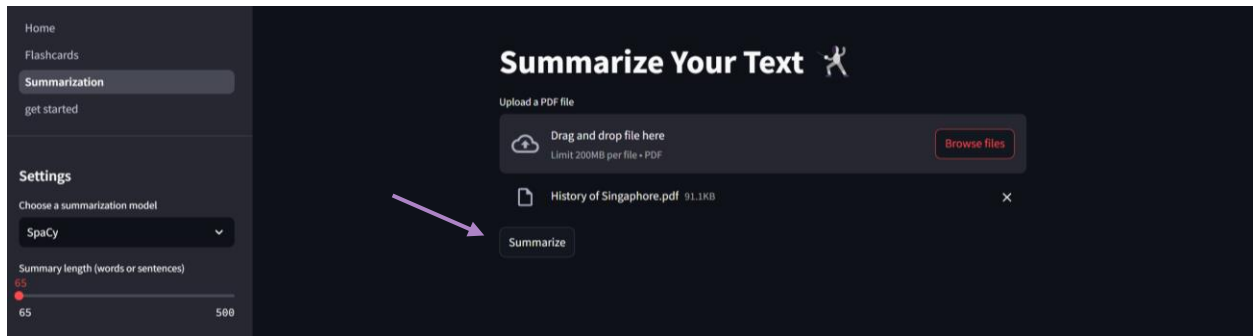
The choice of the model that summarize the text can be chosen by the user by selecting one option from a list of choices whether it is SpaCy, T5 or Gemini. The user interface element for this function called dropdown menu or select box.
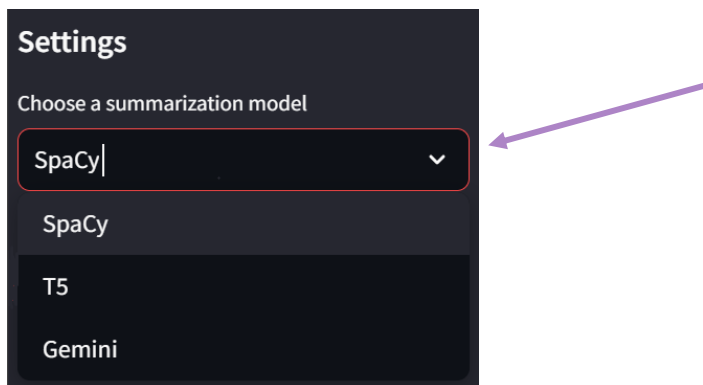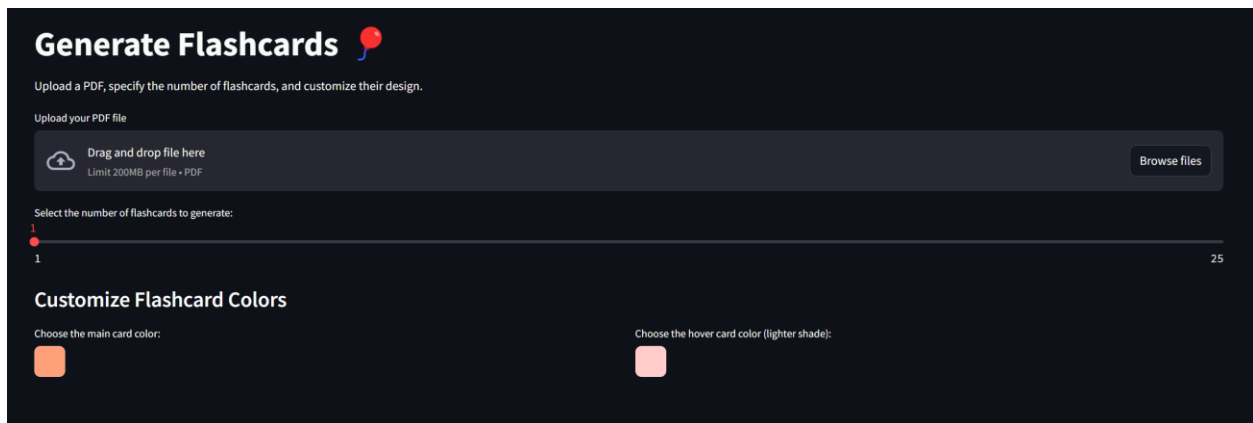

The users as mentioned before also allowed to select a value within a predefined range by sliding a handle along a track. The slider used for setting the desired summary length, with the minimum value being 65 and the maximum value being 500.
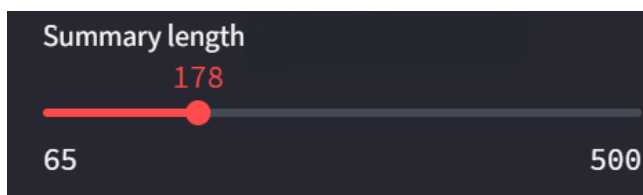
4-Flash Cards Page

To generate flashcards, users have to download their PDF file they want to summarize and choose some parameters including the number of flash cards to be generated and the color choice for the Cards.
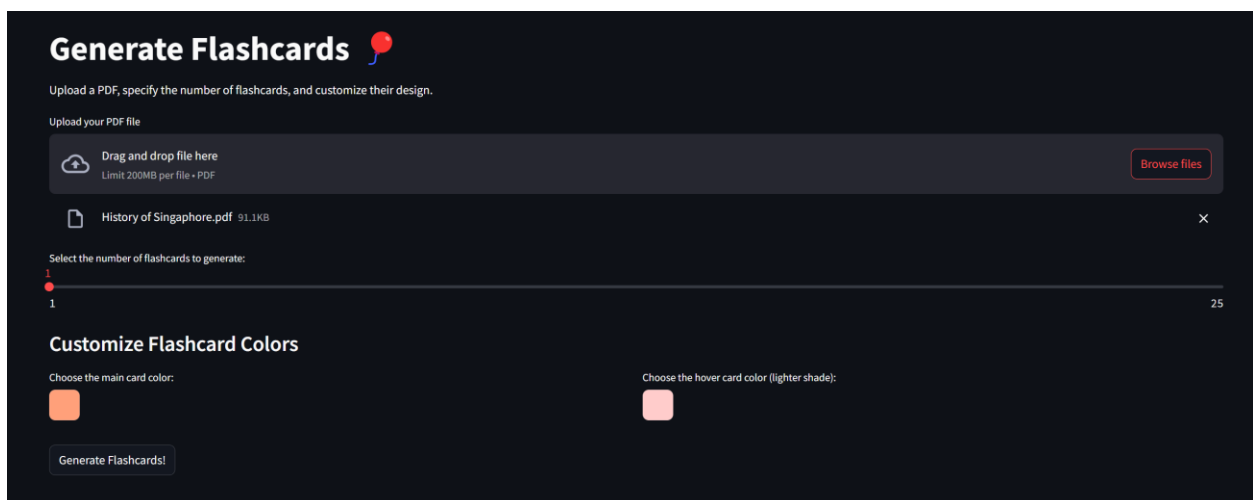

The user can download the file by pressing **Browse Files** button

Just after uploading the document the **Generate FlashCards** button will appear allowing the user to click on. The default flashcards number to be generated is 1 unless the user change it.

The user will adjust the slider to specify the number of flashcards to generate, selecting a value between 1 and 25. The user will either drag the slider knob or click along the scale to make their choice.

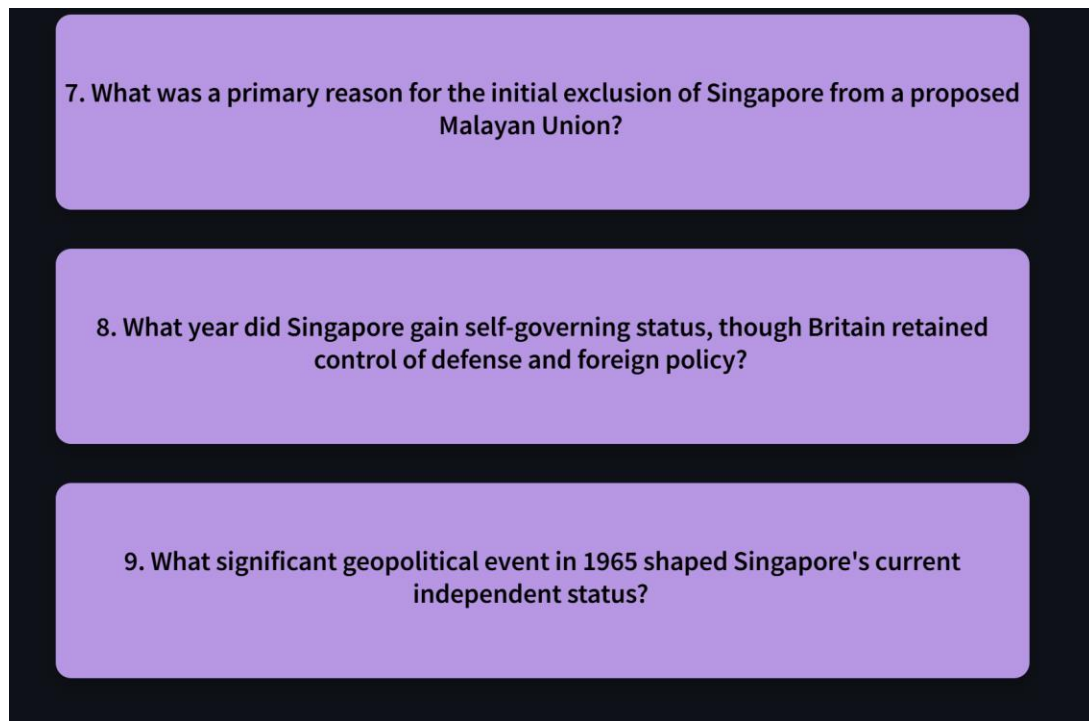The user will click on the color box to open the color picker tool. Using the tool, the user will either select a desired shade from the gradient palette, adjust the color hue using the slider, or enter a specific HEX color code in the provided input field.
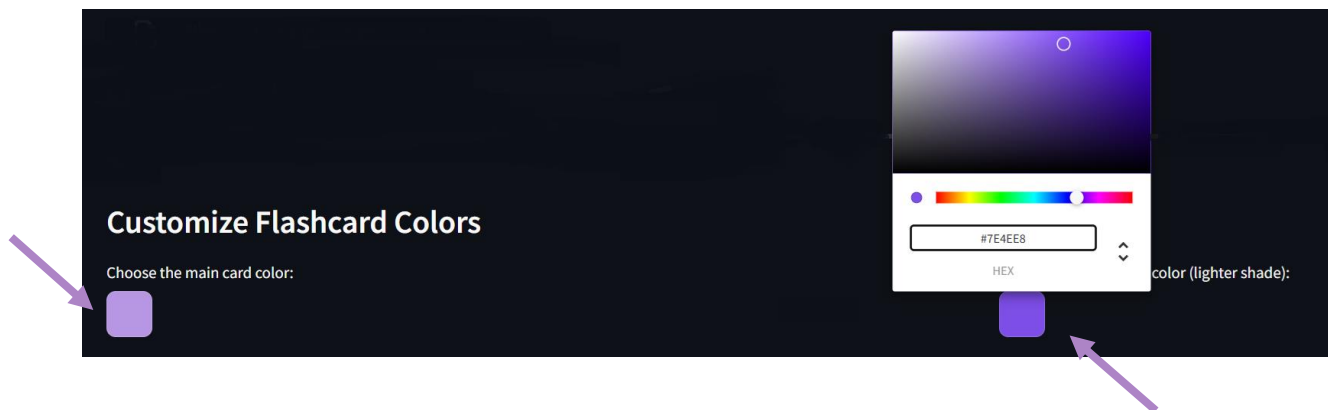
After selecting desired colors and number of cards user can click to generate cards and the cards will be generated in seconds under the button in the same page.

Here the cards from 7 to 9 as shown below.

> **7. What was a primary reason for the initial exclusion of Singapore from a proposed Malayan Union?**

> **8. What year did Singapore gain self-governing status, though Britain retained control of defense and foreign policy?**

> **9. What significant geopolitical event in 1965 shaped Singapore's current independent status?**

Just hovering the mouse on the card will flip it to show the answer as shown here the answer of card 8.

> **7. What was a primary reason for the initial exclusion of Singapore from a proposed Malayan Union?**

> 1959

> **9. What significant geopolitical event in 1965 shaped Singapore's current independent status?**
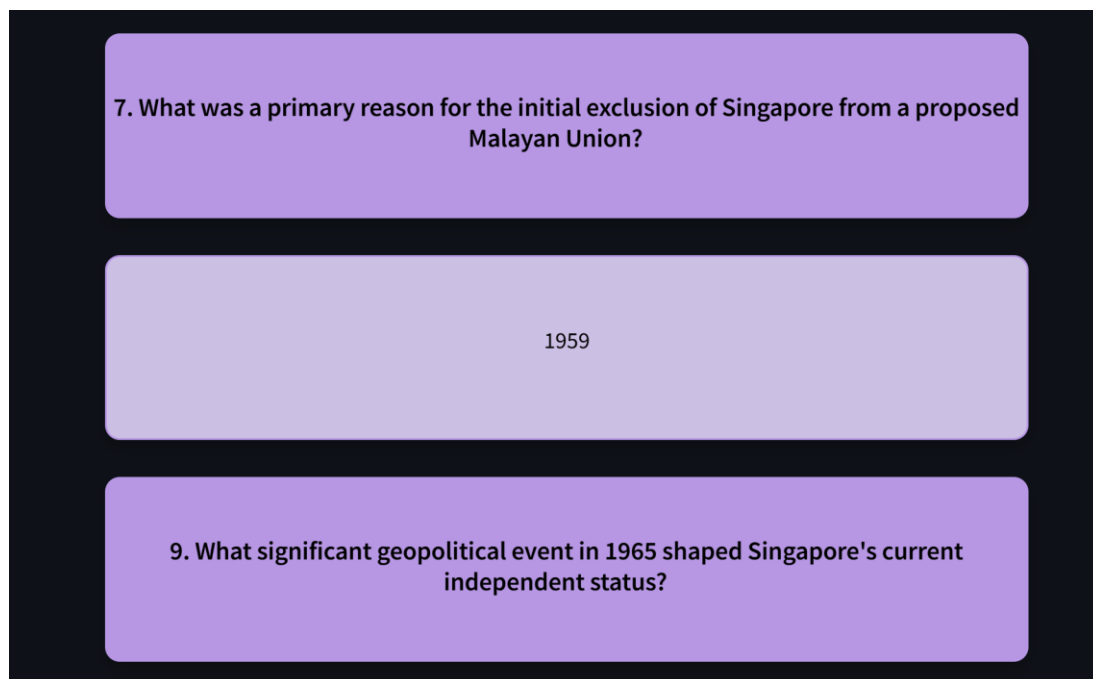
Results

In this project, a collection of tools and models were evaluated for generating concise summaries and flashcards from PDF documents. Google Gemini was the best option for our case, because it outperformed other models and technologies in key areas.

1. Comparison with OpenAI Models: even though OpenAI models, such as GPT-4, are very powerful and contextually aware, they have drawbacks, such as usage limits and expensive cost. With the high capacity offered by Gemini's free tier, we were able to handle many papers without paying extra costs. It was preferred for projects with limited resources because of its cost-effectiveness.

2. Comparison with T5 and SpaCy: For summarization and question-answer generating tasks, we investigated models such as T5 (Text-to-Text Transfer Transformer) and libraries like SpaCy. They were limited, however, in their ability to produce advanced and context-aware responses:

- T5: Generated logical summaries but lacked a full understanding of the context relevant to question-answer generation.
-
  SpaCy: Effective for simple text processing, but not made for creating relevant flashcards or complex summary.

3. Context Awareness of Gemini: Gemini did well in producing brief and contextually appropriate summaries. It was perfect for educational tools since it could comprehend complex prompts and give flashcards in an easy-to-understand question-answer style. The created flashcards closely matched the retrieved summaries due to the model's chatting and adaptive features, which increased their value for active recall.

Challenges and Solutions

1. **API Limitations and Usage Restrictions:**
Limitations on API usage limits during the development process were faced, especially for models such as OpenAI's GPT-4. These restrictions frequently caused delays in workflows when handling massive amounts of data. This were addressed by providing attention to models with greater free-tier resources, like Google Gemini, which worked well for the project's needs.

2. **Ensuring Contextual Accuracy:**

It was difficult to create correct and contextually aware summaries and flashcards, especially for simpler models like T5 and SpaCy that had trouble understanding complex language. The solution was Google Gemini, which performed very well in preserving contextual coherence after several alternatives were tested. In order to correctly guide the model during summarization and flashcard production, prompt engineering techniques were used.

3. **Model Selection and Performance Trade-offs:**

Selecting the best model involved balancing accuracy, cost, and processing time. While models like GPT-4 offered high accuracy, their cost and rate limits were prohibitive. Solution Also was the Google Gemini, which provided an optimal balance of performance and affordability, making it the most suitable choice for our use case.

4. **Spacy implementation challenge**

In testing, we found that SpaCy-generated summaries with less than 65 words were often incoherent and incomplete, so we implemented a minimum word count of 65 to ensure the summaries are meaningful and well-rounded.

Conclusion

The FlashLearn project demonstrates the transformative potential of AI in educational tools, particularly in document summarization and flashcard generation. By leveraging advanced AI models such as Google Gemini, along with T5 and SpaCy, we were able to automate complex tasks that traditionally required significant manual effort. This project has shown how effective AI can be in creating concise, contextually relevant summaries and question-answer flashcards that greatly enhance active recall and learning efficiency.

This system, through extensive testing and prompt engineering, is optimized to generate outputs that are at best accurate, personalized to the needs of the learner and educator alike. Moreover, the integration of an easy-to-use interface further ensures accessibility and ease with which FlashLearn is put to use, be it by students, teachers, or professionals.

API limitations, model performance trade-offs, and contextual accuracy were some of the challenges that were effectively addressed; Google Gemini came out to be the most reliable solution because of its cost efficiency, scalability, and context-aware capabilities. Key takeaways from this project include choosing the right AI tool and technique that strikes a balance among performance, cost, and usability.

FlashLearn is a major leap toward making educational resources modern, reducing manual work, and helping users focus on effective learning. The fact that it can merge advanced AI capabilities with practical applications shows the immense potential of AI-driven tools in education. Being scalable and customizable, FlashLearn provides a foundation for further development, paving the way for more personalized and impactful learning experiences.

Future work

In the future, the FlashLearn project will continue to expand in functionality and user experience manifold. One of the key tasks to be pursued will be the addition of more summarization models. By considering the BERT and DistilBERT models, for example, the quality and type of summaries provided can be enhanced. These models have shown promise in understanding context and producing coherent outputs, which would further enrich the learning experience for users.

We will also try to develop a mobile-compatible application for iOS and Android devices. The students can do summarization, and use the flashcard options with their cellular device anywhere, hence it will make life easy for the students to study anytime, anywhere. The navigations and features should be user-friendly so that the experience does not differ much with multiple devices.

Design and functionality of the website can be improved in order to make it catchier and more user-friendly. This includes making the interface beautiful and user-friendly; therefore, easy to use. We also want to add more types of documents that can be summarized, which means the users will be able to summarize not just PDF but other formats, such as Word, web pages, or even images. This will make the tool more applicable to a wide range of study materials, and enabling the user to import multiple PDFs, for example, for flashcards and summarization.

By integrating these enhancements, FlashLearn will offer not only a more complete and interactive learning tool but also one that adapts to the diverse needs of students in today's digital age.

References

[1] https://blog.tldrthis.com/importance-of-summarizing/.

[2] A. W. ,. C. F. ,. Z. P. ,. S. R. B. ,. R. T. ,. H. S. ,. T. K. Joy Xu, "Active recall strategies associated with academic achievement in young adults: A systematic review," 2024.

[3] M. A. M. T. M. Chelsea Lin, "Effects of Flashcards on Learning Authentic Materials: The Role of Detailed Versus Conceptual Flashcards and Individual Differences in Structure-Building Ability," 2018.

[4] https://doyounotes.com/space-repetition-and-active-recall-whats-the-best-studying-technique.

[5] T. J. MSR Mariyappan, "Exploring the Influence of Ai-Powered Learning Tools on Student Understanding and Academic Performance: A Comprehensive Analysis," 2024.

[6] S. Ou, "Transforming Education: The Evolving Role of Artificial Intelligence in The Students Academic Performance," 2024.

[7] Y. D. S. F. D. P. O. R. M. V. &. R. W. Yuang Cheng, "WikiFlash: Generating Flashcards from Wikipedia Articles," 2021.

[8] S. P. S. S. R. V. K. S. Nikhil Nair, "FlashMe: Automatic Flashcard Generation," 2023.

[9] V. J. S. I. K. A. R. Telesko, "AI POWERED FLASHCARD AND EXAM GENERATORS AT THE FHNW," 2024.

[10] M. v. d. Velde, "Flashcard Fundamentals #3: Generating Flashcards using AI," *https://www.memorylab.nl/blogs/flashcard-fundamentals-3-generating-flashcards-using-ai/,* 2023.

[11] D. Thole, "Creating Flashcards with Generative AI," *https://thedarktrumpet.com/programming/2024/01/02/generative-ai-flashcards/,* 2024.

[12] "Introduction to Python PyPDF2 Library," *https://www.geeksforgeeks.org/introduction-to-python-pypdf2-library/,* 2024.

[13] https://ai.google.dev/gemini-api/docs.

[14] https://cloud.google.com/vertex-ai/generative-ai/docs/model-reference/inference.

[15] https://streamlit.io/.

[16] Z. Z. N. L. S. Z. Banghao Chen, "Unleashing the potential of prompt engineering in Large Language Models: a comprehensive review," *arxiv,* 2024.

[17] J. W. K. C. H. A. R. G. G. S. A. G. S. A. A. P. M. J. C. G. K. I. S. Alec Radford, "Learning Transferable Visual Models From Natural Language Supervision," *arxiv,* 2021.

[18] A. K. S. S. S. V. J. S. M. A. C. Pranab Sahoo, "A Systematic Survey of Prompt Engineering in Large Language Models: Techniques and Applications," 2024.

[19] J. V. Erik F. Tjong Kim Sang, "Representing Text Chunks," 1999.