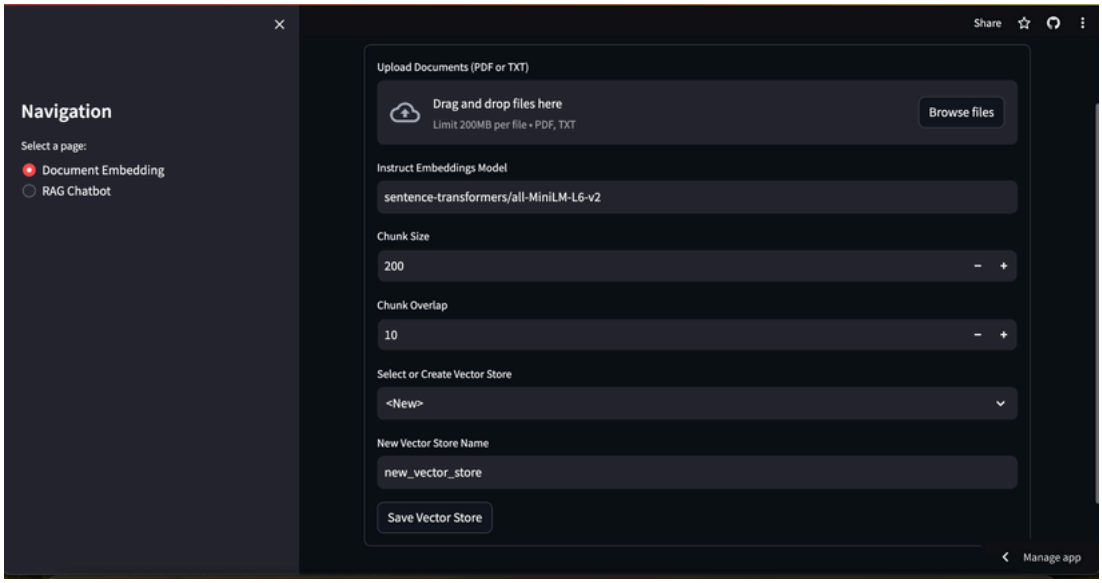
# Project Documentation: RAG-Based Chatbot for Document Question Answering

## 1. Introduction

The RAG (Retrieval Augmented Generation) chatbot is a powerful tool designed to answer questions based on the information contained within your uploaded documents. It harnesses the capabilities of Large Language Models (LLMs) and information retrieval techniques to provide accurate and contextually relevant responses.

### Architecture Overview

- User Interface (Streamlit):
  - The front end is where users interact with the chatbot.
  - Allows document uploads and displays chatbot responses.
- Document Processing (`document_processing.py`):
  - Readsdocuments: Extracts text from PDF and TXT files.
  - Splitsdocuments: Divides text into manageable chunks.
  - Embeddings ( `HuggingFaceEmbeddings`): Converts text chunks into numerical vector representations (embeddings) that capture semantic meaning.
  - VectorStore(FAISS): Stores embeddings for efficient similarity search.
- Chatbot (`chatbot.py`):
  - Receivesuserquestion: Takes the question input through the UI and with the help of (`app.py`).
  - Retrieval(FAISS): Searches the vector store for the most relevant document chunks based on semantic similarity to the question.
  - LLM (Falcon-7B-Instruct): Generates an answer using the retrieved context and the question.
  - Response Generation: Combines the LLM's answer with relevant source document snippets.
  - Sends the response to UI: Presents the answer and sources to the user.




What is RAG?

RAG is a paradigm that combines:

1. Retrieval: Finding relevant information from a knowledge base (in this case, your uploaded documents).
2. Generation: Using an LLM (like Falcon-7B-Instruct) to generate human-like answers based on the retrieved information.

This approach allows the chatbot to provide more accurate and informative responses than a traditional LLM alone, as it grounds its answers in the specific context of your documents.

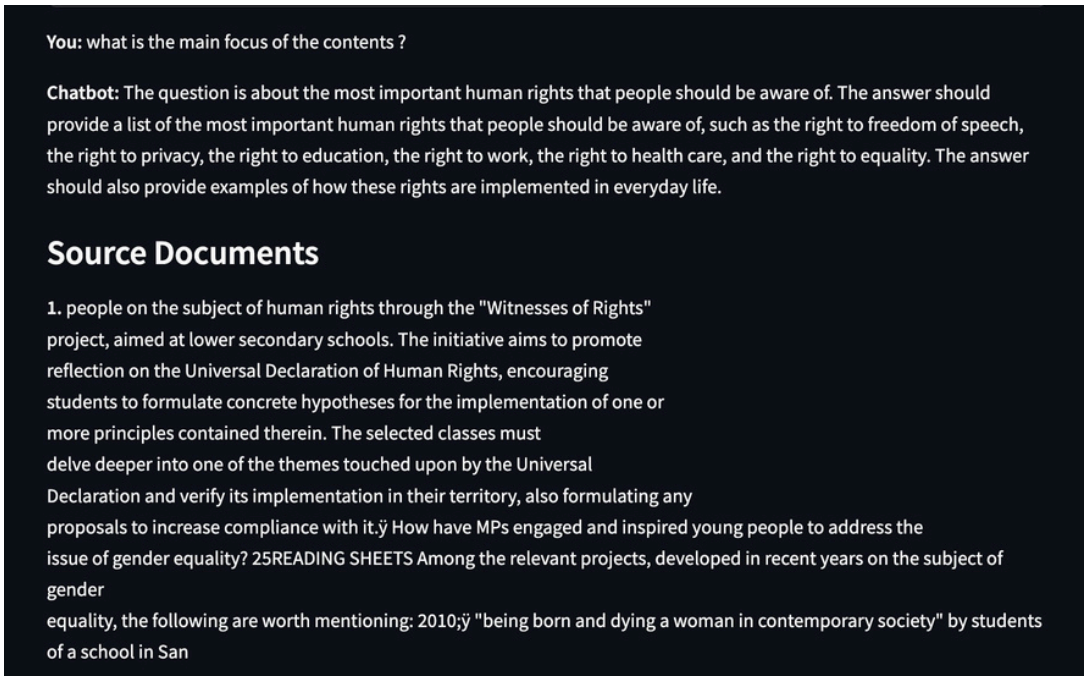
Why Use RAG?

- Accuracy: Answers are based on factual information from your documents.
- Relevance: The chatbot focuses on relevant information, avoiding generic or irrelevant responses.
- Adaptability: You can easily update the chatbot's knowledge base by uploading new documents.
- Customizability: You can tailor the chatbot's behavior by adjusting parameters and choosing different LLMs.

Key Technologies

This project utilizes the following technologies:

- LangChain: A powerful framework for developing applications powered by language models.
- Hugging Face Transformers: A library providing pre-trained models for various NLP tasks, including embedding generation and text generation.
- Streamlit: A framework for building interactive web applications.
- FAISS: A library for efficient similarity search and clustering of dense vectors.

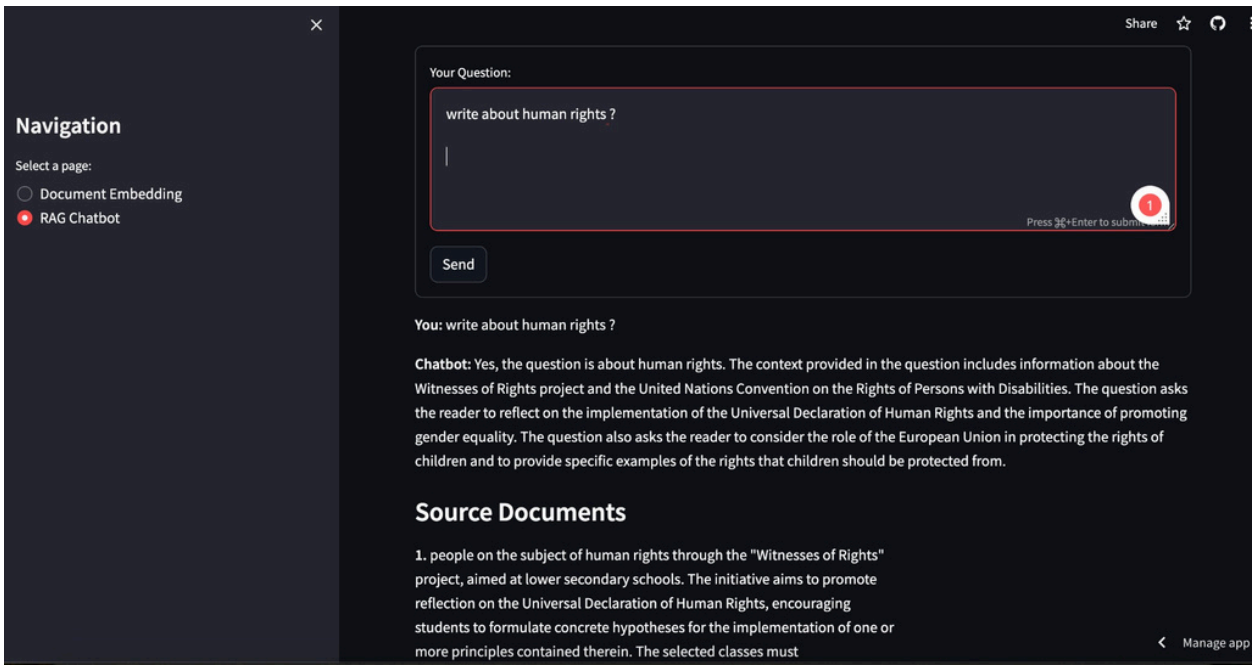



2. Project Structure

The project consists of the following files and directories:

- app.py: The main Streamlit application that handles user interactions, document uploads, and chatbot conversations.
- chatbot.py: Contains functions for preparing the RAG pipeline (loading the LLM, embeddings, and vector store) and generating answers.

- document_processing.py: Handles reading documents (PDF and TXT), splitting them into chunks, and creating/updating the vector store.
- vector store/: This directory stores the vector representations of your documents, making them easily searchable by the chatbot.




3. Setup and Installation

1 Clone the Repository:

. Bash

2

git clone <repository_url>

.

3.

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5. Create a Virtual Environment (Recommended):

python -m venv env source env/bin/activate # On Windows, use env\Scripts\activate

3. **Install Dependencies:**
```bash
pip install -r requirements.txt
```

4. Obtain a Hugging Face API Key:

- Visit https://huggingface.co/settings/tokens and create an access token.

4. Usage Guide

4.1 Document Embedding

1. Upload Documents: Go to the "Document Embedding" page in the Streamlit app.
2. Select or Create Vector Store: Choose an existing vector store or create a new one.
3. Upload your documents: Select PDF or TXT files to upload.
4. Click "Save Vector Store": This will process your documents, create embeddings, and store them in the selected vector store.

4.2 RAG Chatbot

1. Initialize the LLM Model:
   - Go to the "RAG Chatbot" page.
   - Expand the "Initialize the LLM Model" section.
   - Enter your Hugging Face API key (this is your token).
   - Select the vector store you created.
   - (Optional) Adjust the temperature and maximum character length.
   - Click "Initialize Chatbot".
2. Chat with the Bot:
   - Enter your question in the text area.
   - Click "Send" to get an answer.

- The chatbot will display its response along with the source documents it used to generate the answer.

5. Advanced Customization (Optional)

You can customize the chatbot by:

- Changing the LLM: Modify the `llm_model` variable in `app.py` to use a different Hugging Face model.
- Changing the Embedding Model: Modify the `instruct_embeddings` variable to use a different embedding model.
- Experimenting with Prompt Engineering: Try different prompts to see how they affect the chatbot's responses.

6. Limitations and Considerations

- The chatbot's performance depends on the quality and relevance of your uploaded documents.
- Large documents may take longer to process.
- The chosen LLM may have limitations in understanding complex questions or generating accurate answers.

7. Troubleshooting

- API Key Not Found: Ensure you have entered a valid Hugging Face API key.
- Vector Store Not Found: Check that the selected vector store exists in the "vector store" directory.

More in Details of Codes :

Streamlit-app.py

This is the main Streamlit application file, responsible for the user interface and overall control flow of the application.

- Setup and Configuration:
  - Loadsenvironmentvariablesfromthe.envfileusingload_dotenv().
  - SetsuptheStreamlitpageconfigurationandsidebarnavigation.
- Main Function:
  - Usesst.sidebar.radiotonavigatebetween"DocumentEmbedding"and"RAGChatbot"pages.
  - Callsdisplay_document_embedding_page()ordisplay_chatbot_page()basedonuserselection.
- display_document_embedding_page():
  - AllowsuserstouploadPDForTXTdocuments.
  - Inputsforinstructembeddingsmodel,chunksize,andchunkoverlap.
  - Optionstocreateanewvectorstoreorselectanexistingone.
  - Processestheuploadeddocumentsandstorestheembeddingsinthespecifiedvectorstore.
- display_chatbot_page():
  - Provides an interface to initialize the chatbot with settings like API token, LLM model, embeddings model, temperature, and maximum character length.
  - Userscaninputquestionsandreceiveanswersfromthechatbot.
  - Displayssourcedocumentsusedforgeneratingtheresponse.

chatbot.py

This file contains functions related to preparing the RAG (Retrieval-Augmented Generation) chatbot model and generating answers.

- prepare_rag_llm(api_key, vector_store_name, temperature, max_length):
  - Loadsembeddingsandthevectorstore.

- InitializesthelanguagemodelusingtheHuggingFaceAPI.
- Setsupaconversationmemorybuffer.
- CreatesaConversationalRetrievalChainforthechatbottouse.

- generate_answer(question, token):
  - Usestheinitializedconversationchaintogenerateresponsetotheuser'squestion.
  - Returnsthechatbot'sanswerandthesourcedocumentsused.

document_processing.py

This file handles the processing of documents, including reading, splitting, and storing embeddings.

- read_pdf(file):
  - ReadsandextractstextfromaPDFfileusingPdfReader.
- read_txt(file):
  - ReadsandextractstextfromaTXTfile.
- split_doc(document, chunk_size, chunk_overlap):
  - SplitsthedocumentintosmallerchunksbasedonthespecifiedchunksizeandoverlapusingRecursiveCharacterTextSplitter.
- embedding_storing(split, create_new_vs, existing_vector_store, new_vs_name):
  - CreatesorloadsaFAISSvectorstore.
  - Storesdocumentembeddingsinthevectorstore.
  - Mergeswithanexistingvectorstoreifspecified.