01

Human-AI Interaction Design

Educational RAG pipeline

Introduction & Project Goal

PROBLEM

Students need a personal assistant for their study materials.

SOLUTION

A Retrieval-Augmented Generation (RAG) pipeline:

- Leverages open-source embedding & generative AI models
- User-friendly Gradio interface

CORE GOAL

Facilitate an effective Human-AI Interaction experience, emphasizing usability, interpretability, and trust.

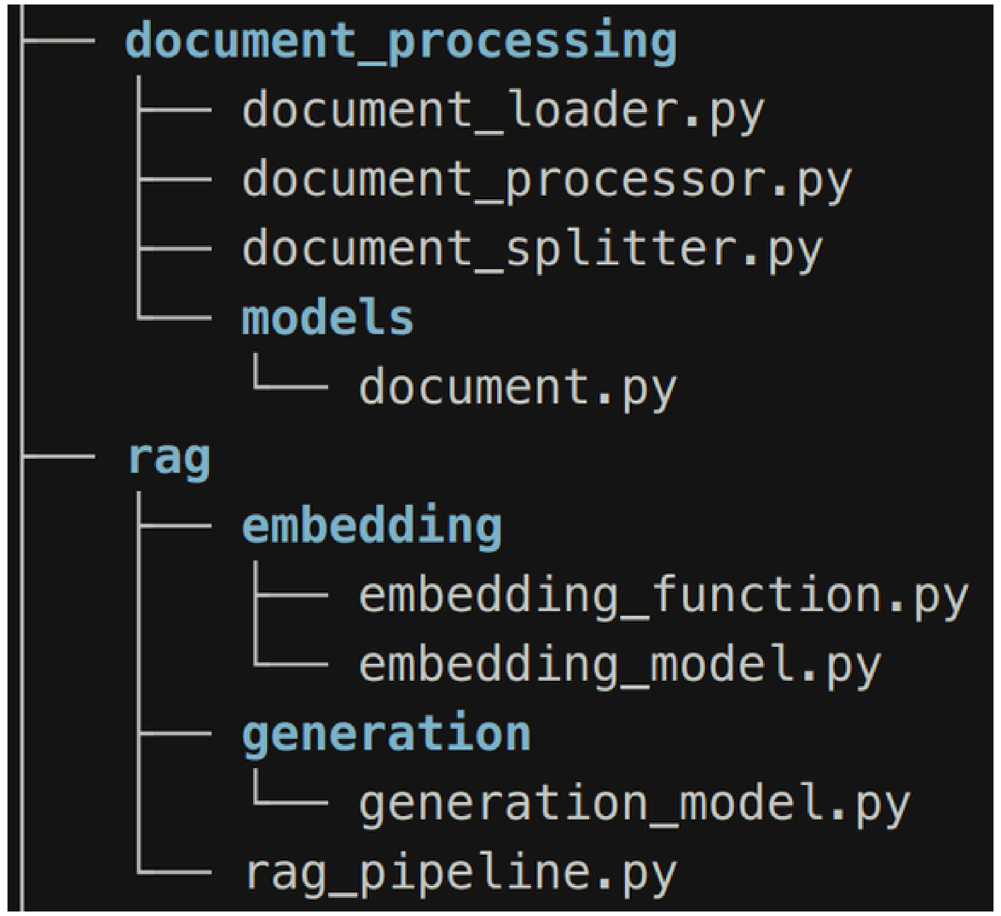
ALIGNMENT

Meets course requirements for an ML system demonstrating human-centric design.

System Architecture Overview

KEY COMPONENTS

- Embedding Model
- Generation Model
- Vector Database
- Document Processing Pipeline
- RAG Orchestrator
- User Interface



```
├── document_processing
│   ├── document_loader.py
│   ├── document_processor.py
│   ├── document_splitter.py
│   └── models
│       └── document.py
├── rag
│   ├── embedding
│   │   ├── embedding_function.py
│   │   └── embedding_model.py
│   ├── generation
│   │   └── generation_model.py
│   └── rag_pipeline.py
```

UI Design

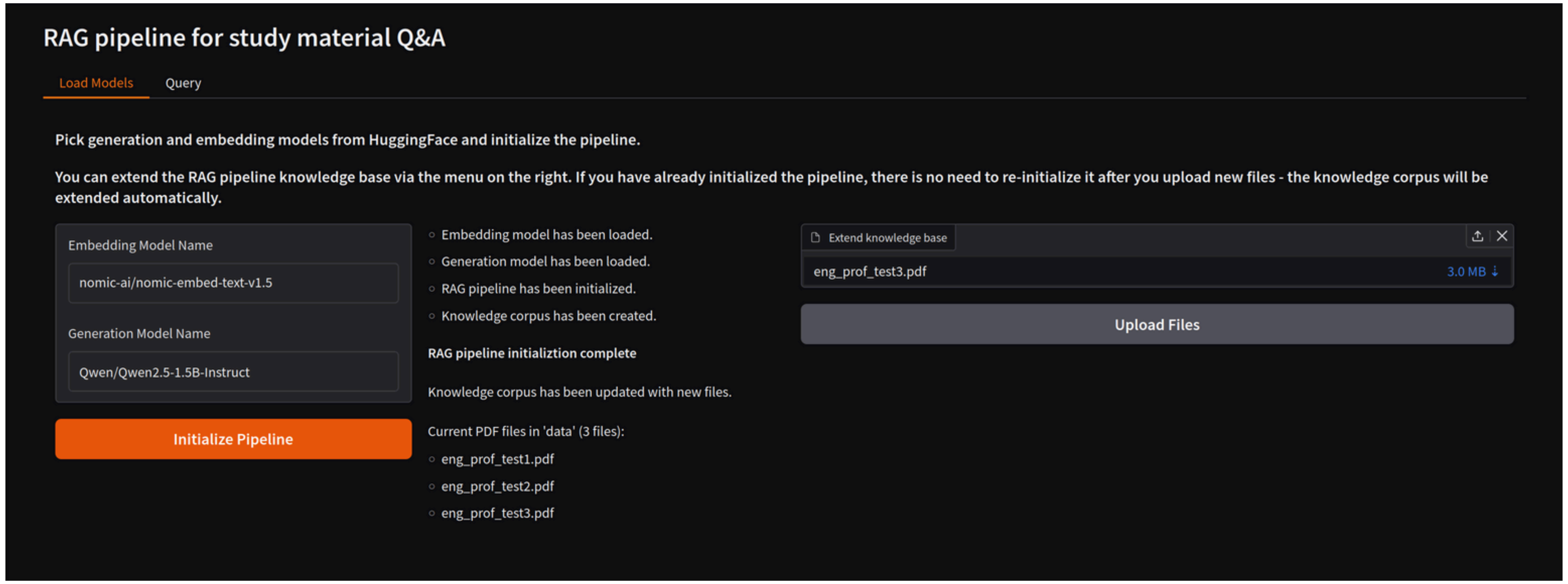
"Load Models" Tab

PURPOSE

Initial pipeline setup & knowledge base extension.

KEY DESIGN CHOICES & HAIID PRINCIPLES

- Model Selection: User control & freedom (Nielsen, HAX G17)
- "Initialize Pipeline" Button & Status: Clear intention, step-by-step feedback, visibility of system status (Norman, Nielsen, Shneiderman)
- Corpus File Display: Transparency of knowledge base
- File Upload: User control over corpus, immediate feedback



RAG pipeline for study material Q&A

Pick generation and embedding models from HuggingFace and initialize the pipeline.

You can extend the RAG pipeline knowledge base via the menu on the right. If you have already initialized the pipeline, there is no need to re-initialize it after you upload new files - the knowledge corpus will be extended automatically.

Embedding Model Name: nomic-ai/nomic-embed-text-v1.5

Generation Model Name: Qwen/Qwen2.5-1.5B-Instruct

- Embedding model has been loaded.
- Generation model has been loaded.
- RAG pipeline has been initialized.
- Knowledge corpus has been created.

RAG pipeline initializtion complete

Knowledge corpus has been updated with new files.

Current PDF files in 'data' (3 files):

- eng_prof_test1.pdf
- eng_prof_test2.pdf
- eng_prof_test3.pdf

eng_prof_test3.pdf 3.0 MB

UI Design

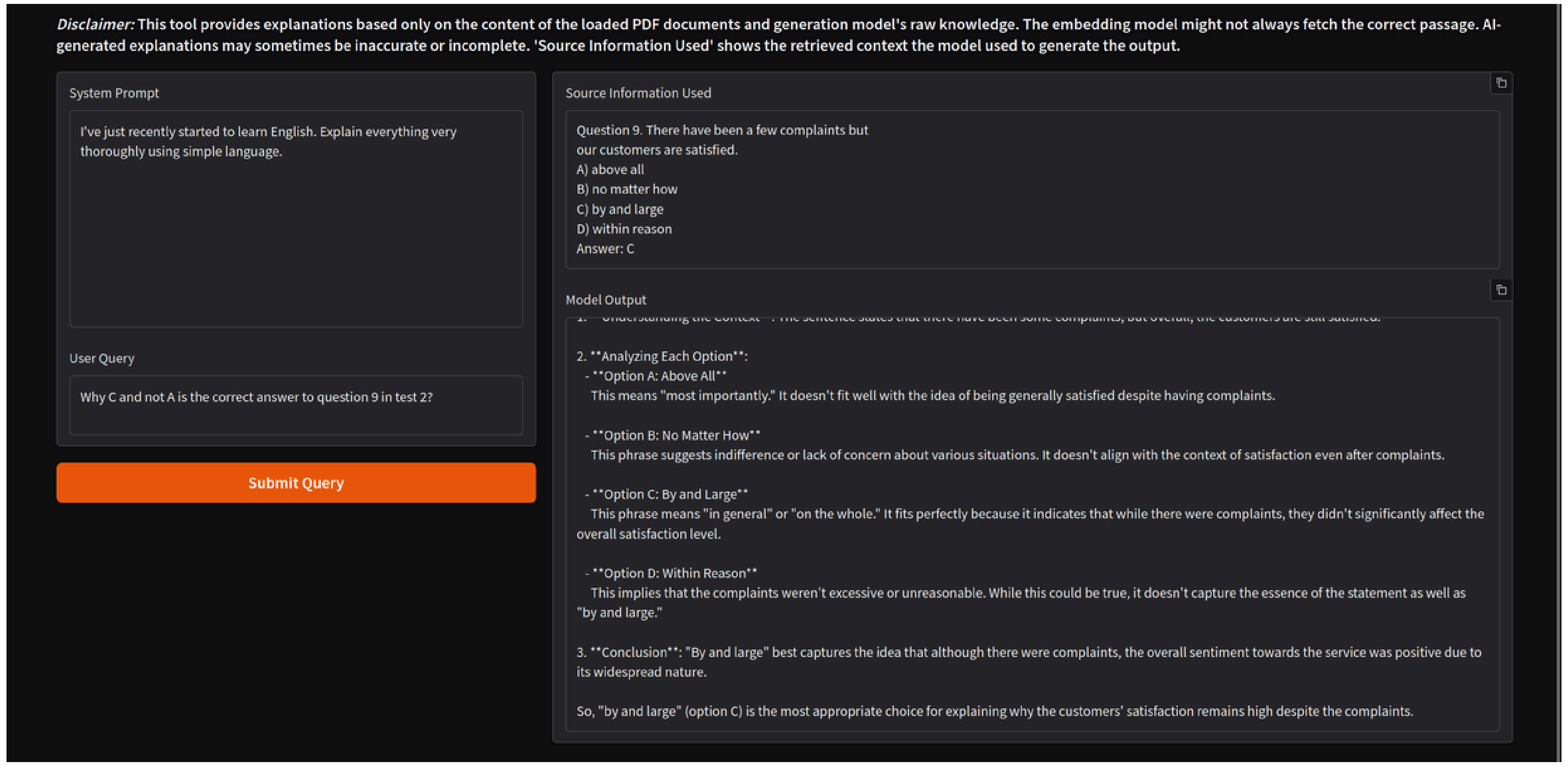
"Query" Tab

PURPOSE

User interaction with the initialized RAG pipeline.

KEY DESIGN CHOICES & HAIID PRINCIPLES

- Disclaimer: Sets right expectations (Google People+AI P2, HAX G2), ethical consideration
- System Prompt: User control (Nielsen, HAX G17), enables social nature of explanations (Miller)
- "Source Information Used" Textbox: critical for interpretability & transparency (HAX G11), selective explanation
- "Model Output" Texbox: streaming provides continuous feedback (Norman, Shneiderman), enhaces UX



Disclaimer: This tool provides explanations based only on the content of the loaded PDF documents and generation model's raw knowledge. The embedding model might not always fetch the correct passage. AI-generated explanations may sometimes be inaccurate or incomplete. 'Source Information Used' shows the retrieved context the model used to generate the output.

System Prompt

I've just recently started to learn English. Explain everything very thoroughly using simple language.

User Query

Why C and not A is the correct answer to question 9 in test 2?

Source Information Used

```
Question 9. There have been a few complaints but
our customers are satisfied.
A) above all
B) no matter how
C) by and large
D) within reason
Answer: C
```

Model Output

```
1. **Understanding the Context**: The sentence states that there have been some complaints, but overall, the customers are still satisfied.

2. **Analyzing Each Option**:
  - **Option A: Above All**
    This means "most importantly." It doesn't fit well with the idea of being generally satisfied despite having complaints.

  - **Option B: No Matter How**
    This phrase suggests indifference or lack of concern about various situations. It doesn't align with the context of satisfaction even after complaints.

  - **Option C: By and Large**
    This phrase means "in general" or "on the whole." It fits perfectly because it indicates that while there were complaints, they didn't significantly affect the overall satisfaction level.

  - **Option D: Within Reason**
    This implies that the complaints weren't excessive or unreasonable. While this could be true, it doesn't capture the essence of the statement as well as "by and large."

3. **Conclusion**: "By and large" best captures the idea that although there were complaints, the overall sentiment towards the service was positive due to its widespread nature.

So, "by and large" (option C) is the most appropriate choice for explaining why the customers' satisfaction remains high despite the complaints.
```

Key HAIID Principles Applied

TRANSPARENCY & INTERPRETABILITY

- "Source Information Used" is paramount
- Display of model names, corpus files

USER CONTROL & FREEDOM

- Model selection, corpus management (uploads), query formulation, system prompts

FEEDBACK & VISIBILITY OF SYSTEM STATUS

- Status messages (initialization, uploads), streaming output, error messages

Key HAIID Principles Applied

SETTING EXPECTATIONS & ACCOUNTABILITY

- UI Disclaimer on AI limitations
- Source context allows users to check the factual basis of the AI's answers

HUMAN-CENTERED DESIGN

- Solves specific user need (Q&A for studying)
- Augments user ability, user is in control

ETHICAL CONSIDERATIONS

- Disclaimer, transparency features
- Local deployment respects data privacy
- RAG approach can reduce reliance on general LLM bias by grounding in knowledge corpus

Information Visualization Techniques

TEXTUAL DISPLAY

- “Source Information Used”: Direct representation of retrieved context
- “Model Output”: Dynamic textual visualization via streaming
- Pipeline State/Corpus Files: Status & list formats

LAYOUT & GROUPING

- Tabs visually separate interaction stages
- Grouping aids recognition rather than recall

IMPLICIT PROCESS VISUALIZATION

- Interaction sequences (e.g., file upload -> list update) communicate internal processes
- "Source Information Used" supports interpretability, a key InfoViz goal in Human-Centered AI

Lessons Learned

EXPLAINABILITY IS CORNERSTONE OF TRUST IN RAG

- Simply providing an answer is insufficient. We need to turn black box into a verifiable assistant

PROACTIVE EXPECTATION MANAGEMENT IS CRUCIAL

- Upfront disclaimer on accuracy/boundaries is vital

CLEAR VISIBILITY & USER CONTROL MITIGATE AI OPACITY

- Continuous feedback & user control over inputs improve usability

ITERATIVE DESIGN IS KEY FOR EFFECTIVE HAIID IMPLEMENTATION

- Translating abstract principles to concrete UI requires refinement