

5. Technical Architecture

This section describes the end-to-end architecture of **ReadStudyAssist AI**, including system components, data flow, layer separation, and integration strategy. The architecture is designed to support three core capabilities: **Text Summarisation**, **Document Q&A**, and **Content Generation for quizzes**.

5.1 Architecture Overview

ReadStudyAssist AI uses a modular four-layer architecture:

1. **User Interface Layer** – Web application where learners upload documents, ask questions, and review generated summaries/quizzes.
2. **Service Layer** – Backend API responsible for requesting routing, document-processing pipelines, and communication with AI components.
3. **AI/LLM Layer** – Handles summarization, Q&A and quiz generation through prompt-based interactions and function calling.
4. **Data Layer** – Responsible for storing raw files, processed text chunks and metadata.

5.2 System Architecture Diagram

User → UI → Backend Service → LLM Provider → Backend → Storage

- **Frontend (e.g., Streamlit/React)**
 - Document upload
 - Query interface
 - Display views for summaries, extracted text, and quizzes
- **Backend (Python)**
 - Document ingestion module
 - Text cleaning and chunking
 - LLM orchestration module
 - Quiz generation module
 - Logging/Observability (e.g., Langfuse)
- **LLM Provider (Gemini)**

- Summarisation API
- Q&A API
- Content generation API
- **Database/Storage**
 - Document storage (local)

5.3 Layer Structure

(1) User Interface Layer

Responsibilities:

- Collect user inputs (upload PDFs, ask questions)
- Present summarised content and generated quizzes
- Communicate with backend through REST endpoints

(2) Service Layer

This layer orchestrates all business logic.

Modules:

a. Document Ingestion Module

- Accepts PDF/Docx uploads
- Converts files into plain text
- Splits into semantic chunks for processing and retrieval

b. AI Request Orchestrator

- Builds structured prompts for summarisation, Q&A, and quiz generation
- Handles function calling (e.g., to trigger quiz generation)
- Manages retries/errors

c. Output Formatting Module

- Formats summaries, Q&A responses, and quizzes into UI-friendly formats

(3) AI / LLM Layer

The system relies on a single LLM provider - Gemini, accessed through:

- **Summarisation prompt templates** (for full or chapter-level summaries)
- **Context-aware Q&A prompts** (LLM + retrieved chunks)

- **Quiz generation prompts** (MCQs, fill-in-the-blank, short answer)

(4) Data Layer

Includes:

a. Document Storage

- Stores raw PDFs and extracted text
- Metadata: upload timestamps, source type, processed embeddings

b. Logs and Observability

- Captures LLM call metadata
- Stores user interactions for debugging, evaluation, and usage patterns

5.4 Data Flow Diagram

1. **User Uploads a Document**
↓
2. **Backend Extracts Text & Splits into Chunks**
↓
3. **User Requests a Summary / Q&A / Quiz**
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4. **Backend Retrieves Relevant Chunks** (if Q&A)
↓
5. **Backend Sends Structured Prompt to LLM**
↓
6. **LLM Generates Response**
↓
7. **Backend Formats Output**
↓
8. **UI Displays Results to User**

5.5 Component Explanations

Frontend - Streamlit

- Handles user interactions with minimal logic
- Designed this way to ensure responsiveness and low coupling

Backend API

- Central hub for all operations
- Ensures consistent logic across summarisation, Q&A and quizzes

LLM Provider - Gemini

- Abstracts summarization, question-answering and content generation
- Chosen due to high-quality responses and low implementation complexity

Storage

- Stores raw and transformed data for reuse
- Prevents redundant computation