ESSENTRA

AGENTIC RAG CHATBOT WITH MODEL CONTEXT PROTOCOL

Task Title Task Title: Agentic RAG Chatbot for Multi-Format Document QA using Model Context Protocol

GitHub Link : https://github.com/TirumalaManav/essentra-ai

Built by: TIRUMALA MANAV

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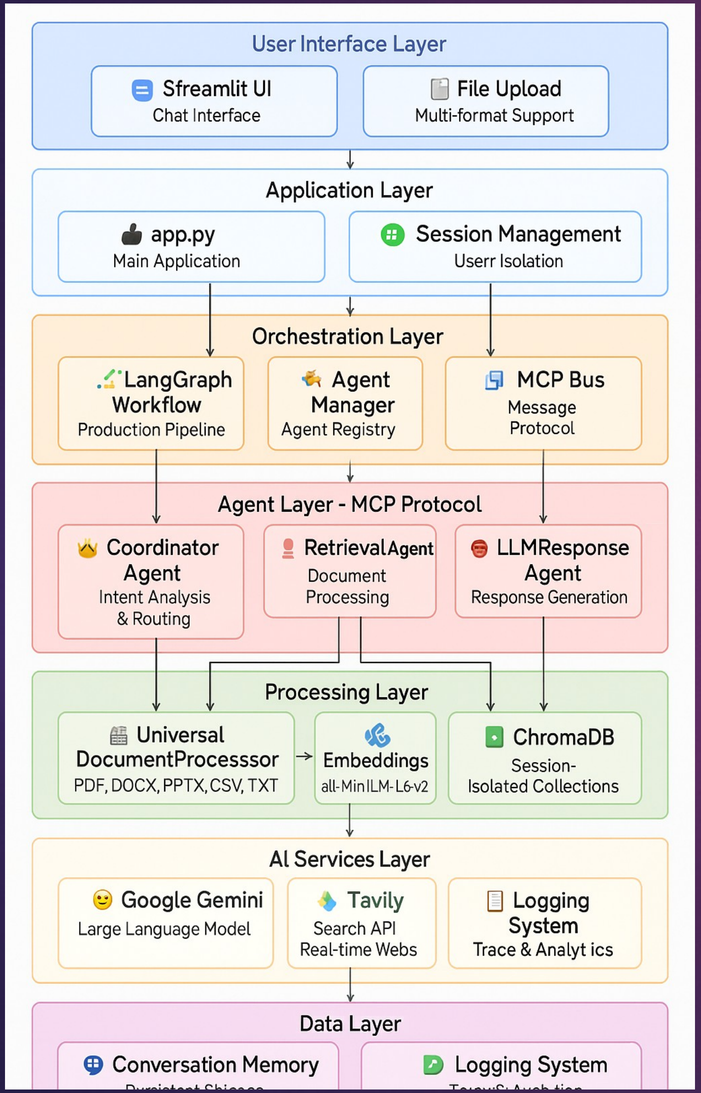
Coding Task and Solution

- THE CHALLENGE
- • Organizations struggle with document intelligence across multiple formats
- • Traditional Chatbots lack structured agent communication
- • No standardized protocol for inter-agent messaging
- • Limited scalability and production readiness

- THE SOLUTION: ESSENTRA
- ☑ 5 Specialized Agents with MCP Protocol
- ☑ Multi-Format Document Processing (PDF, DOCX, PPTX, CSV, TXT, MD)
- ☑ LangGraph Workflow Orchestration
- ☑ Production-Ready Architecture with Chroma DB Vector Storage

System Architecture Overview



User Interface Layer

Sfreamlit UI
Chat Interface

File Upload
Multi-format Support

Application Layer

app.py
Main Application

Session Management
Userr Isolation

Orchestration Layer

LangGraph Workflow
Production Pipeline

Agent Manager
Agent Registry

MCP Bus
Message Protocol

Agent Layer - MCP Protocol

Coordinator Agent
Intent Analysis & Routing

RetrievalAgent
Document Processing

LLMResponse Agent
Response Generation

Processing Layer

Universal DocumentProcesssor
PDF, DOCX, PPTX, CSV, TXT

Embeddings
all-MinILM-L6-v2

ChromaDB
Session-Isolated Collections

Al Services Layer

Google Gemini
Large Language Model

Tavily
Search API
Real-time Webs

Logging System
Trace & Analyt ics

Data Layer

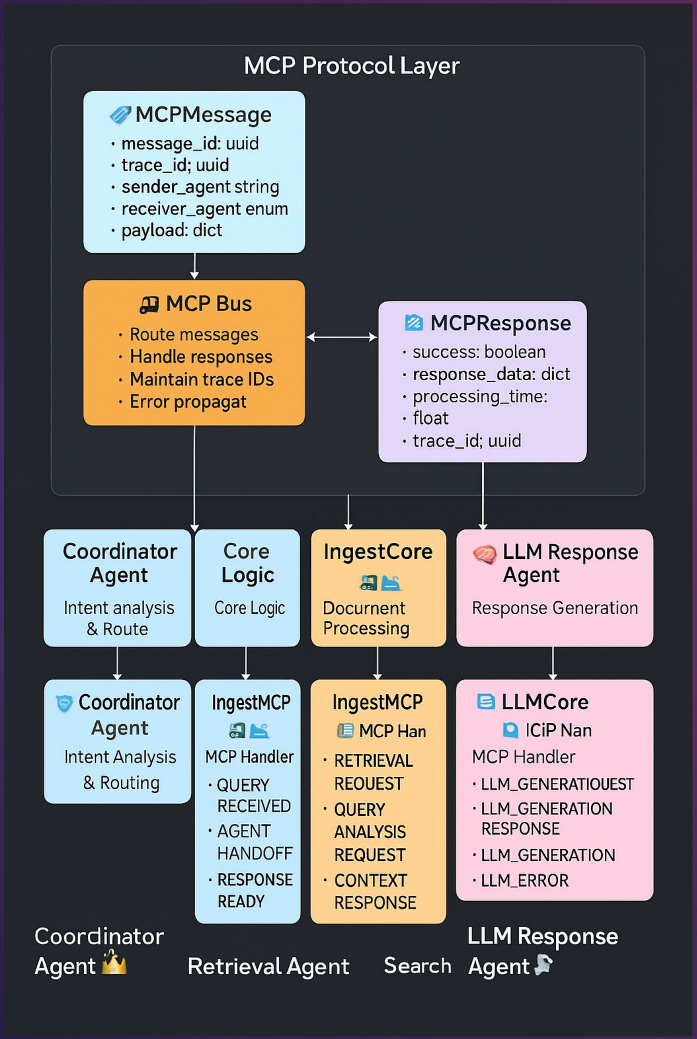
Conversation Memory

Logging System

- LAYERED ARCHITECTURE:
- User Interface Layer: Streamlit UI + File Upload
- Application Layer: Main App + Configuration + Session Management
- Orchestration Layer: LangGraph Workflow + MCP Bus
- Agent Layer: 5 Specialized Agents with MCP Communication
- Processing Layer: Document Processor + Embeddings + Vector Store
- AI Services: Google Gemini 1.5 Flash + Tavily Search API
- Data Layer : Conversation Memory and Logging System

Note: The architecture diagrams above were created using Canvas and SVG code to enhance visualization and improve readability, taking the project's structure into careful consideration

Agent Architecture and MCP Protocol



- 5 INTELLIGENT AGENTS:
- CoordinatorAgent - Intent analysis & routing decisions
- IngestionAgent - Multi-format document processing
- RetrievalAgent - Semantic search & context ranking
- LLMResponseAgent - Enhanced response generation
- WebSearchAgent - Real-time information retrieval

- MCP PROTOCOL FEATURES:
- • Structured message passing with trace IDs
- • Error propagation and handling
- • Processing time tracking
- • Response validation

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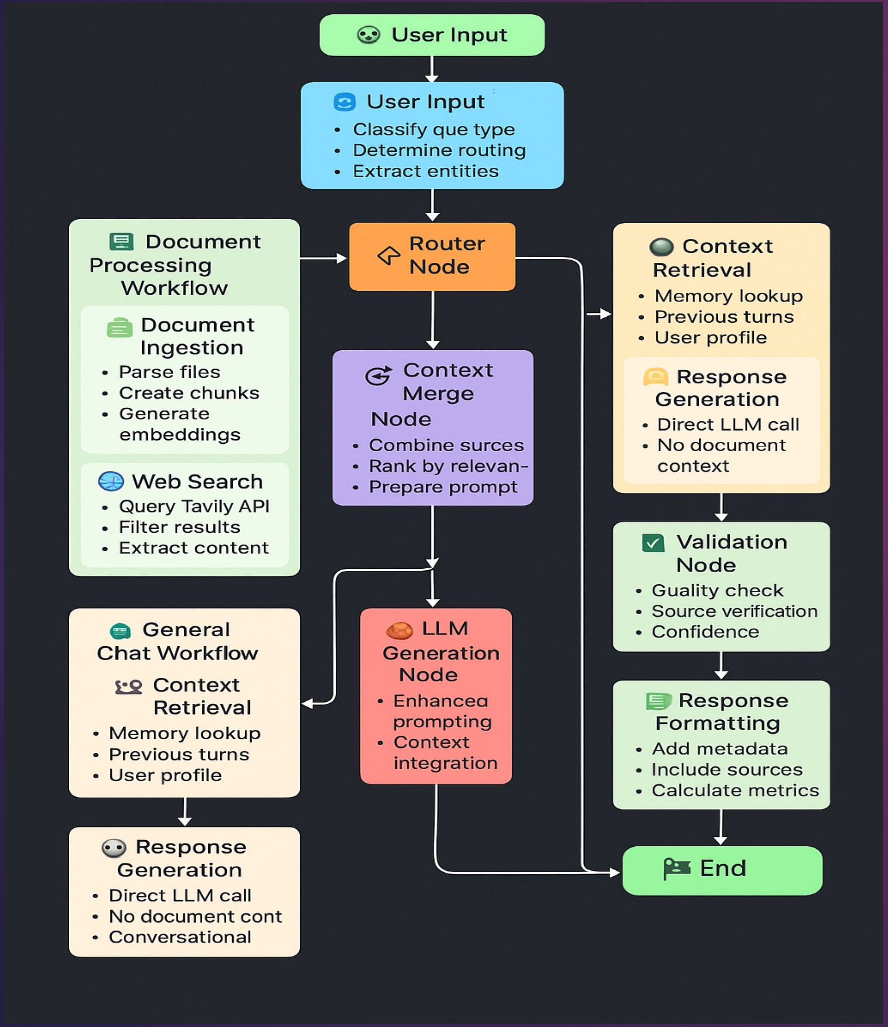
LangGraph Workflow and Message Flow



User Input

User Input
- Classify que type
- Determine routing
- Extract entities

Document Processing Workflow

Document Ingestion
- Parse files
- Create chunks
- Generate embeddings

Web Search
- Query Tavily API
- Filter results
- Extract content

Router Node

Context Merge Node
- Combine surces
- Rank by relevan-
- Prepare prompt

Context Retrieval
- Memory lookup
- Previous turns
- User profile

Response Generation
- Direct LLM call
- No document context

Validation Node
- Guality check
- Source verification
- Confidence

Response Formatting
- Add metadata
- Include sources
- Calculate metrics

General Chat Workflow

Context Retrieval
- Memory lookup
- Previous turns
- User profile

LLM Generation Node
- Enhancea prompting
- Context integration

Response Generation
- Direct LLM call
- No document cont
- Conversational

End

INTELLIGENT ROUTING:

- Intent Analysis Node - Classifies query type and entities
- Router Node - Determines optimal processing pathway
- Context Merge Node - Combines multiple information sources
- Validation Node - Quality assurance and confidence scoring
- Memory Update Node - Persistent conversation storage

WORKFLOW TYPES:

📄 Document Processing Workflow

🌐 Web Search Workflow

💬 General Chat Workflow

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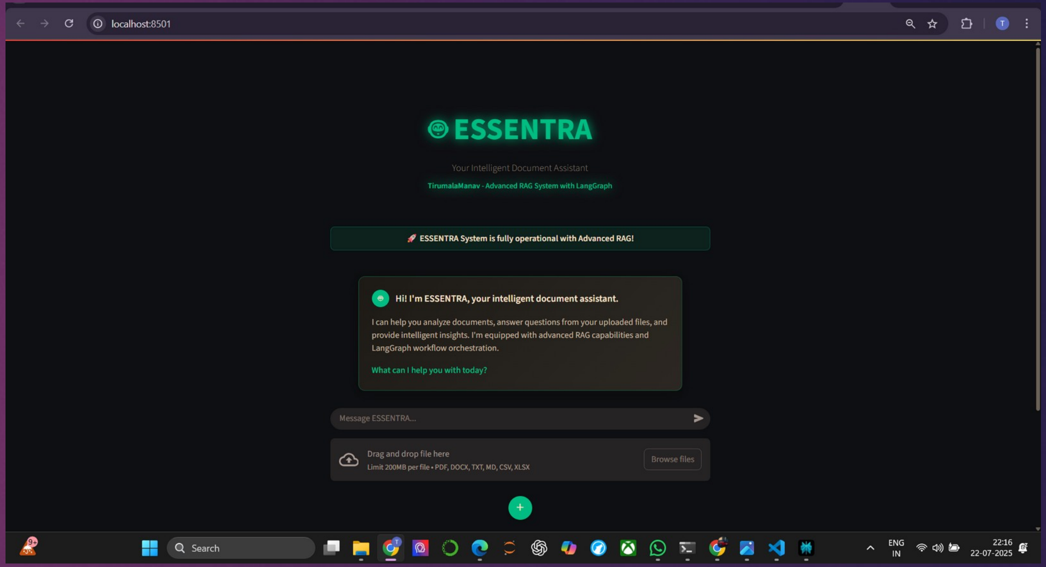
Technology Stack

CORE TECHNOLOGIES:

Frontend: Streamlit with ChatGPT-like UI
Orchestration: LangGraph Workflow Engine
Communication: Custom MCP Protocol Implementation
LLM: Google Gemini 1.5 Flash
Web Search: Tavily Search API
Vector DB: ChromaDB with Session Isolation
Embeddings: Sentence Transformers (all-MiniLM-L6-v2)

FEATURES:

- ➢ Async Processing & Performance Optimization
- ➢ Conversation Memory with Persistence
- ➢ Session Management & User Isolation
- ➢ Comprehensive Logging & Analytics
- ➢ Production-Grade Error Handling


localhost:8501
ESSENTRA
Your Intelligent Document Assistant
TirumalaManav - Advanced RAG System with LangGraph
Message ESSENTRA...
Drag and drop file here
Limit 200MB per file • PDF, DOCX, TXT, MD, CSV, XLSX
Browse files
Search
ENG
IN
22:16
22-07-2025

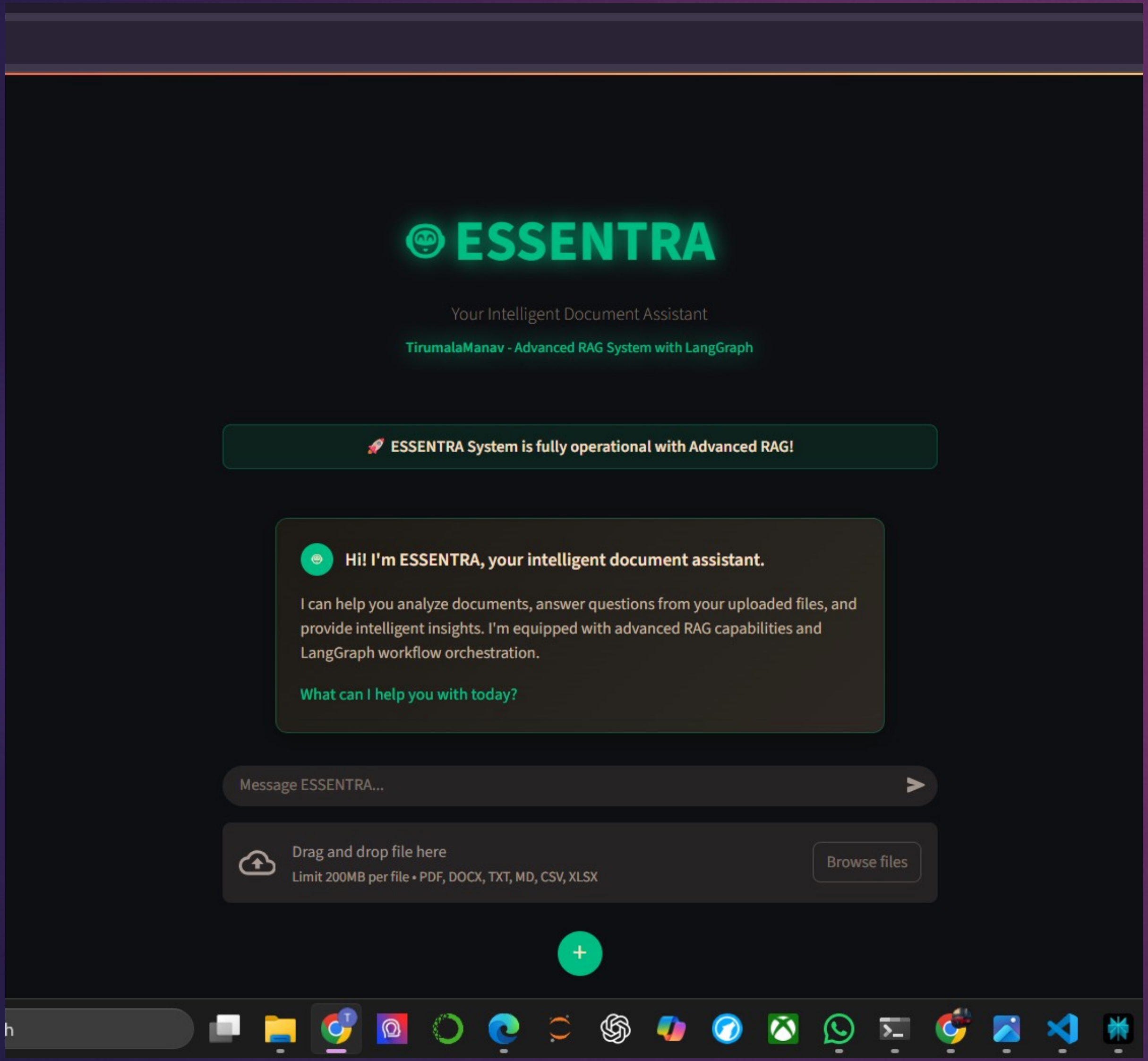
🚀 ESSENTRA System is fully operational with Advanced RAG!

Hi! I'm ESSENTRA, your intelligent document assistant.

I can help you analyze documents, answer questions from your uploaded files, and provide intelligent insights. I'm equipped with advanced RAG capabilities and LangGraph workflow orchestration.

What can I help you with today?

UI Screenshots and Features



ESSENTRA

Your Intelligent Document Assistant

TirumalaManav - Advanced RAG System with LangGraph

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I can help you analyze documents, answer questions from your uploaded files, and provide intelligent insights. I'm equipped with advanced RAG capabilities and LangGraph workflow orchestration.

What can I help you with today?

Message ESSENTRA...

Drag and drop file here

Limit 200MB per file • PDF, DOCX, TXT, MD, CSV, XLSX

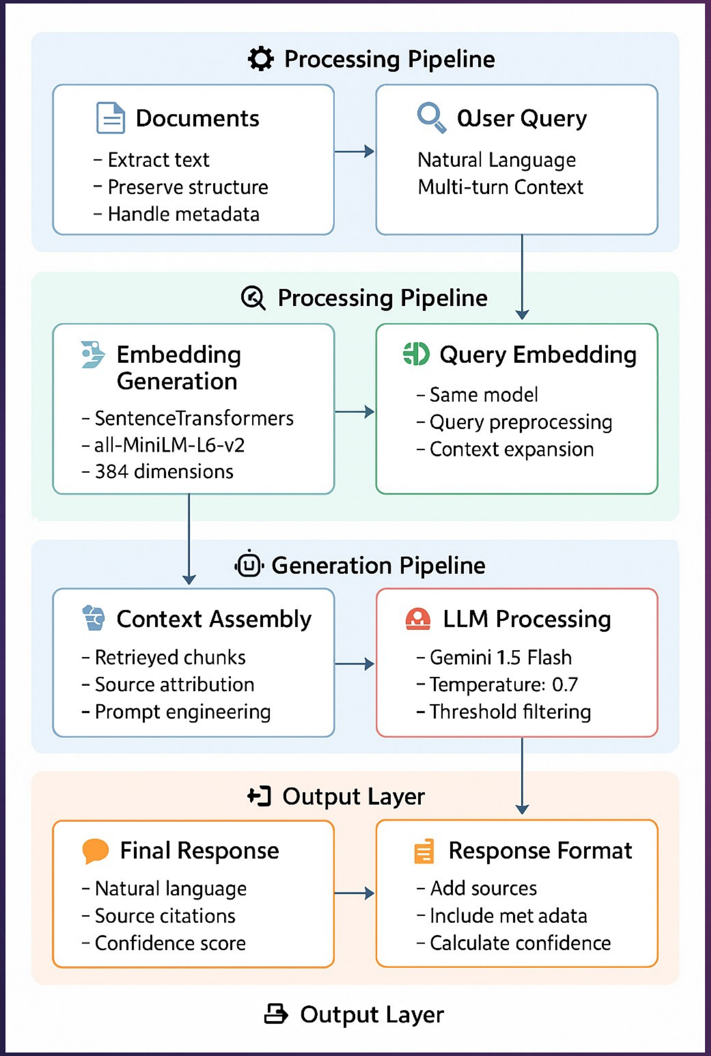
KEY UI FEATURES:

- Clean, Modern ChatGPT-Style Interface
- Drag & Drop File Upload with Progress Indicators
- Real-time Processing Feedback with Spinners
- Source Attribution with Confidence Scores
- Multi-turn Conversation Support
- Responsive Design with Smooth Animations

USER EXPERIENCE:

- Intuitive file upload for multiple formats
- Instant processing feedback
- Clear source citations
- Professional presentation

Data Processing Pipeline



Processing Pipeline

Documents
- Extract text
- Preserve structure
- Handle metadata

OUser Query
Natural Language
Multi-turn Context

Processing Pipeline

Embedding Generation
- SentenceTransformers
- all-MiniLM-L6-v2
- 384 dimensions

Query Embedding
- Same model
- Query preprocessing
- Context expansion

Generation Pipeline

Context Assembly
- Retrieyed chunks
- Source attribution
- Prompt engineering

LLM Processing
- Gemini 1.5 Flash
- Temperature: 0.7
- Threshold filtering

Output Layer

Final Response
- Natural language
- Source citations
- Confidence score

Response Format
- Add sources
- Include met adata
- Calculate confidence

Output Layer

Key Features

- Document Parsing - Extract text while preserving structure
- Smart Chunking - 500 tokens with 50 token overlap
- Embedding Generation - 384-dimensional vectors
- Vector Storage - Session-isolated ChromaDB collections
- Semantic Retrieval - Cosine similarity with ranking
- Context Assembly - Multi-source information fusion
- LLM Generation - Enhanced prompting with Gemini
- Response Formatting - Source citations & metadata

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Challenges Faced and Solutions

CHALLENGE 1: MCP Protocol Implementation

- ✕ Problem: Complex inter-agent communication with trace IDs
- ☑ Solution: Custom MCPBus with async message routing

CHALLENGE 2: Multi-Format Document Processing

- ✕ Problem: Different parsing strategies for each format
- ☑ Solution: UniversalDocumentProcessor with format handlers

CHALLENGE 3: Session Isolation for Multiple Users

- ✕ Problem: Shared vector storage causing data leaks
- ☑ Solution: Session-specific ChromaDB collections

CHALLENGE 4: Real-time Performance Optimization

- ✕ Problem: Large document processing blocking UI
- ☑ Solution: AsyncIO with progress indicators & caching

FUTURE ENHANCEMENTS AND MY JOURNEY

FUTURE ROADMAP:

- Multi-Modal Support - Image and video processing
- Graph RAG Implementation - Advanced retrieval strategies
- Collaboration Features - Multi-user document sharing
- Analytics Dashboard - Usage metrics and insights
- API Endpoints - External system integrations
- Advanced Agents - Specialized domain experts

MY DEVELOPMENT JOURNEY:

- Applied ALL my existing skills in Python, AI, LLMs
- Implemented NEW technologies: LangGraph, MCP Protocol, RAG
- Created professional architecture diagrams using SVG code + Canva
- Overcame technical challenges through research and experimentation
- Built enterprise-grade solution with production-ready architecture

🎯 LOOKING FORWARD:

I have given my absolute best to this project, combining technical excellence with creative problem-solving. I'm excited about the opportunity to contribute these skills and passion to your company, bringing the same level of dedication and innovation to real-world challenges.

THANK YOU