

ML Course Project 2-Page PDF Proposal Summary '25 – FEHU

A. Project Basic Information

<u>Project Title</u> Should be a clear and concise name that reflects the core of the project.	Multi-Agent Academic Learning Assistant
<u>Project Track</u> Indicate the specific track (e.g., Climate, Industrial, Smart Home).	Smart Education

B. Project Members

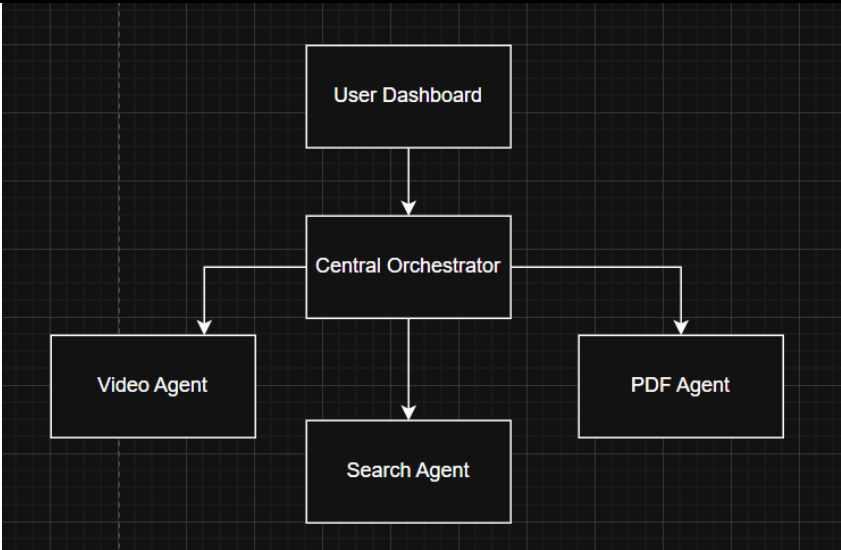
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3	Mariam Sherif Elsayed	ML/NLP Developer	Marriamsherrif56@gmail.com
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C. Project Detailed Information

Requirement	Information	
1. Project Title Should be a clear and concise name that reflects the core of the project.	English:	Multi-Agent Academic Learning Assistant (MAALA)
	Arabic:	المساعد الأكاديمي متعدد الوكلاء للطلاب
2. Abstract (150-200 words) Brief overview of the project, including the problem being addressed, solution, and potential impact.	<p>University students often struggle to efficiently manage and comprehend large volumes of learning materials, including PDFs, research papers, educational videos, and online articles. Manually searching for relevant content, summarizing key concepts, and answering questions can be time-consuming and cognitively demanding, which may negatively affect academic performance. The Multi-Agent Academic Learning Assistant (MAALA) addresses these challenges by integrating multiple intelligent agents into a unified platform.</p> <p>MAALA consists of three core agents: a PDF Explanation Agent that extracts and summarizes content from uploaded PDFs while providing question-answering capabilities; a Video and Website Summarization Agent that converts video speech to text and summarizes both video and web content using advanced language models such as Gamma and LLaMA; and a Search & Recommendation Agent that retrieves relevant educational resources using semantic search and LangChain-based tools. A central orchestrator coordinates these agents, consolidating outputs into a user-friendly dashboard for streamlined interaction.</p> <p>By leveraging machine learning and natural language processing techniques, MAALA significantly reduces the time and effort required for content comprehension, enhances knowledge retention, and supports personalized, multi-modal learning experiences. This project has the potential to improve students' academic efficiency, provide scalable AI-driven educational tools, and contribute to the growing EdTech ecosystem.</p>	
3. Problem Statement (100-150 words) -Detailed explanation of the problem the project addresses. -Why is it important from a technical and real-world perspective?	<p>Students today face an overwhelming amount of academic content spread across PDFs, research papers, online articles, and long educational videos. Manually extracting key ideas, connecting concepts, and finding relevant explanations often consumes hours of effort and leads to inefficient learning.</p> <p>Traditional study tools do not integrate multi-modal content processing, leaving students to juggle between separate applications for reading, summarizing, searching, and understanding complex topics.</p>	

	<p>From a technical perspective, the lack of unified AI-driven systems that coordinate multiple specialized models creates a gap in delivering accurate, context-aware assistance. Real-world learners need tools that can automatically analyze, summarize, and answer questions across multiple formats. Addressing this problem is essential because it directly impacts students' productivity, comprehension, and ability to prepare for exams effectively. A multi-agent AI system provides a scalable, intelligent solution capable of transforming raw content into clear, personalized learning guidance.</p>
<p>4. Objectives (Bullet Points)</p> <ul style="list-style-type: none"> -Clear and measurable goals of the project. -Break down into research, development, and implementation objectives. 	<p>A. Research Objectives</p> <ul style="list-style-type: none"> • Investigate multi-agent system architectures suitable for educational applications. • Analyze existing NLP models (LLaMA, Gamma) for performance in summarization, Q&A. • Study techniques for combining outputs from multiple agents through a central orchestrator. • Evaluate different embedding models and vector search methods for retrieving relevant content. <p>B. Development Objectives</p> <ul style="list-style-type: none"> • Build a PDF Agent capable of text extraction, summarization, and question answering. • Develop a Video/Website Agent that handles speech-to-text transcription and multi-modal summarization. • Implement a Search & Recommendation Agent for semantic search and resource retrieval. • Design a Central Orchestrator responsible for coordinating agents and merging results. • Create a unified user dashboard that visualizes summaries, answers, and recommended materials. <p>C. Implementation Objectives</p> <ul style="list-style-type: none"> • Integrate all agents into a single working system with smooth communication. • Optimize performance to ensure fast processing of long PDFs and videos. • Deploy the system as a functional prototype accessible to students. • Conduct user testing to measure usability, accuracy, and learning improvement. • Document the full workflow, models used, and the technical design for evaluation.

<p>5. Methodology (200-250 words)</p> <ul style="list-style-type: none"> -Describe the technical approach, tools, frameworks, and algorithms used. -Justify why this approach was chosen. -Mention any relevant research papers or studies. 	<p>The proposed system uses a multi-agent architecture, where each agent is designed to handle a specific type of educational content. This specialization makes the system more accurate, efficient, and scalable.</p> <p>The PDF Agent extracts text using PyPDF2 and applies transformer-based models such as LLaMA or Gamma to generate summaries and answer student questions.</p> <p>The Video/Website Agent uses Whisper to convert spoken content from YouTube videos into text, and the same summarization pipeline is applied to ensure consistent understanding across all content types.</p> <p>The Search & Recommendation Agent uses sentence-transformer embeddings and vector search tools like FAISS or AstraDB Vector Search to find related PDFs, videos, and learning materials.</p> <p>A Central Orchestrator connects all agents, manages the workflow, and combines their outputs into a single, coherent response. This orchestrator is built with Python and FastAPI, using routing ideas inspired by LangChain. Students interact with the system through a simple dashboard created with Streamlit or React.</p> <p>This approach was chosen because multi-agent systems provide modularity and task specialization, which improves performance and makes the system easier to expand. Recent research—such as “LLM Agents: A Survey” (Zhao et al., 2024) and studies on retrieval-augmented generation—supports the effectiveness of coordinated agents for complex reasoning. Together, these methods enable accurate, context-aware learning assistance.</p>
<p>6. Expected Outcomes</p> <ul style="list-style-type: none"> -Technical deliverables (e.g., software, models, systems, etc.) -Real-world applications and potential impact. 	<p>Technical Deliverables:</p> <ul style="list-style-type: none"> • A fully functional Multi-Agent Student Assistant platform integrating three core agents: <ol style="list-style-type: none"> 1. PDF Explanation Agent – Summarizes PDFs and answers user queries. 2. YouTube & Website Summarization Agent – Extracts and summarizes content from educational videos and websites. 3. Search & Recommendation Agent – Suggests relevant learning materials based on content and queries. • A central orchestrator that coordinates agent workflows and merges outputs.

	<ul style="list-style-type: none"> • A user-friendly interface/dashboard for seamless interaction with all <p>Real-World Applications and Impact:</p> <ul style="list-style-type: none"> • Improves student learning efficiency by reducing the time needed to process and understand diverse learning materials. • Enhances comprehension and knowledge retention through concise summaries and interactive Q&A. • Supports personalized and multi-modal learning experiences, integrating PDFs, videos, and web content. • agents.
<p>7. System Block Diagram</p> <p>A diagram that shows the overall system architecture, major components, and their interactions.</p>	 <pre> graph TD UD[User Dashboard] --> CO[Central Orchestrator] CO --> VA[Video Agent] CO --> SA[Search Agent] CO --> PA[PDF Agent] </pre>
<p>8. Industry Relevance</p> <p>-How does this project solve an industry-related issue or optimize a process? -Describe any collaboration with industry partners (if applicable).</p>	<p>The Multi-Agent Academic Learning Assistant addresses a major challenge faced by the EdTech industry: the need for automated, scalable, and personalized learning tools. Educational institutions, online learning platforms, and corporate training sectors often struggle with delivering tailored content to large numbers of learners. Manual content summarization, resource curation, and student support require significant time and human effort.</p> <p>This project optimizes these processes by providing AI-driven automation for summarization, content recommendation, and multi-modal understanding of PDFs, videos, and online materials.</p> <p>It reduces workload for educators, enhances accessibility of complex content, and supports adaptive learning—all of which are critical priorities in modern digital education.</p>

	<p>The system also aligns with industry trends toward intelligent tutoring systems, multi-agent automation, and retrieval-augmented learning platforms.</p> <p>While no formal industry collaboration is currently established, the system’s modularity makes it highly adaptable for integration with LMS platforms such as Moodle, Coursera, and Udemy, opening opportunities for future partnerships with EdTech companies or academic institutions.</p>					
<p>9. Business and Entrepreneurship Potential</p> <p>-Potential market applications or commercialization ideas.</p> <p>-Does the project have scalability potential or open the door for startups?</p>	<p>This project has strong commercialization potential within the rapidly growing EdTech market. MAALA can be developed into a subscription-based or freemium platform targeting university students, educators, and self-learners. Key market applications include:</p> <ul style="list-style-type: none">• AI-powered study assistant apps• Learning Management System (LMS) plugins• Tools for universities to support students with large academic workloads• Corporate training support systems <p>Its multi-agent architecture allows easy scaling by adding new agents (e.g., exam generator, plagiarism checker, or tutor chatbot), enabling continuous feature expansion.</p> <p>With cloud deployment and vector search optimization, the system can support thousands of users simultaneously, making it suitable for startup-level growth.</p> <p>The project can evolve into a full EdTech startup offering personalized learning, automated content understanding, and smart academic support—addressing real market demand and attracting potential investors or accelerator programs.</p>					
<p>10. List of Needed Software Components</p> <p>-Detailed list of all software (e.g., IDEs, libraries) required for the project.</p>	Item No.	Item Name	Item Specifications	Item Cost	No. of Items	Total Cost
	1	Python 3.10+	Main programming language for backend, agents, orchestrator	Free	1	0
	2	FastAPI	Framework for building API endpoints and orchestrator logic	Free	1	0

	<u>3</u>	PyPDF2	PDF text extraction for the PDF Agent	Free	1	0
	<u>4</u>	FAISS or AstraDB Vector Search	Vector database for storing and retrieving embeddings	Free	1	0
	<u>5</u>	LangChain	Routing, chains, and multi-agent workflow patterns	Free	1	0
11. References -Cite any academic papers, industry reports, or other materials used in the research.		<ul style="list-style-type: none"> • PyPDF2 Developers (2024). <i>PyPDF2 Library Documentation</i>. PyPI / GitHub. • Zhao, W., et al. (2024). <i>LLM Agents: A Survey</i>. arXiv:2402.01680. • Lewis, P., Perez, E., et al. (2020). <i>Retrieval-Augmented Generation for Knowledge-Intensive NLP Tasks</i>. Advances in Neural Information Processing Systems (NeurIPS). • Datastax (2024). <i>AstraDB Vector Search Documentation</i>. Datastax Technical Docs. 				