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LLM-Driven Research Assistant for Automated Literature Analysis and Research Gap Detection

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Abstract.

In this project, an AI-driven Research Assistant is introduced to support researchers and students in finding relevant information related to their field of interest, identifying research trends, and creating research reports systematically. To accomplish this task, LLM-driven multi-agents are used along with semantic searching and automated research gap detection by using the LangChain framework. The research process includes literature review, finding research gaps, and preparing proposals. For user interaction, the app is designed with Streamlit to provide users with the ability to view their automatically created research report summaries, trends, and research direction suggestions. Moreover, the reports are created in PDF form and can be saved with cloud storage solutions such as Amazon S3.

Keywords. Large Language Models (LLMs), Semantic Retrieval, Research Gap Detection, Multi-Agent Systems, Academic Literature Analysis.

1. INTRODUCTION

In the past few years, the fast increase in scientific papers has made it harder for researchers to effectively look through current literature and find important research paths. The usual way of doing a literature review takes a lot of time and work because people have to look through many research papers by hand, find the main ideas, and figure out where there might be gaps in the research. Research helpers powered by AI can quickly look through a lot of academic papers and provide organized insights. This project suggests an AI-driven Research Assistant that helps users explore academic papers using an engaging interface built with Streamlit. The system uses workflows powered by LangChain with multiple agents to automatically summarize literature, identify research trends, find gaps in research, and generate reports based on PDFs. The suggested system offers automatic analysis of literature, helps find research trends, identifies gaps in research, and creates reports in PDF format using a flexible AI-powered process.

2. LITERATURE REVIEW

Recent advancements in LLMs and NLP have significantly improved automated literature analysis and research summarization systems. Existing studies mainly focus on scientific summarization and manuscript generation using AI-driven frameworks and LangChain based workflows [1–3]. Existing systems primarily focus on isolated tasks such as document summarization or recommendation systems. However, most lack integrated support for research trend analysis, research gap detection, automated report generation, and cloud-based storage. The proposed system addresses these limitations through a unified AI-driven research assistance framework.

3. METHODOLOGY

The proposed AI Research Assistant follows a modular architecture where different components work sequentially to analyze the user’s research topic and produce structured outputs.

3.1. *User Input and Query Processing*

The workflow begins when the user enters a research topic through an interactive web interface built using Streamlit. The system captures the user’s query and performs pre-processing before further analysis.

3.2. *AI Agent Pipeline and Task Coordination*

The main intelligence of the system is implemented using LangChain. Multiple LangChain based agents coordinate tasks such as semantic literature retrieval, LLM-driven summarization, embedding-based trend analysis, and automated research gap detection.

3.3. *Research Trend Identification*

The system performs semantic clustering of retrieved publications using sentence embeddings to identify emerging research trends. By analyzing topic similarity and keyword distributions, it highlights evolving research areas and assists users in understanding recent developments within the chosen domain.

3.4. *Research Gap Detection*

The system applies embedding similarity and semantic analysis to identify underexplored research areas and unresolved problems within the analyzed literature. The graph-based similarity analysis helps identify clusters of closely related research papers and detect underexplored regions with limited interconnections, supporting automated research gap identification.

3.5. *Automated Report Generation*

The generated summaries, research trends, and identified research gaps are compiled into a structured PDF report. The report includes topic summaries and citations and is securely stored in Amazon S3 for user access through the Streamlit interface.

4. SYSTEM ARCHITECTURE

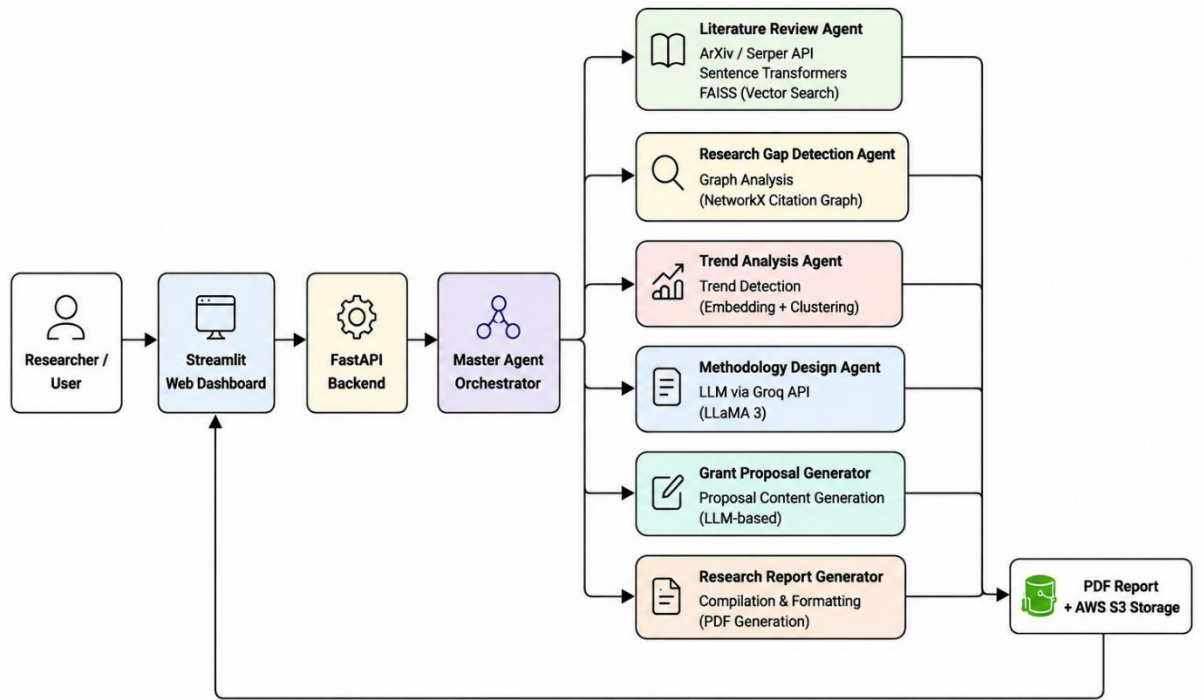


Figure 1: System Architecture of the AI Research Assistant system

The proposed AI Research Assistant comprises AI processing, web interface, auto-reporting feature, and cloud storage. For creating the user interface, we have used Streamlit whereas LangChain has been used to process the intelligent workflow. The generated reports are stored safely in Amazon S3 cloud storage.

5. IMPLEMENTATION

Large Language Models (LLMs), Streamlit, LangChain, and Python were used in the system's implementation. LangChain manages multi-agent AI workflows for summarization, trend analysis, and research gap spotting, while Streamlit supplies the interactive user interface. Amazon S3 cloud storage is used to safely keep generated reports after they are automatically translated into PDF format.

6. RESULTS AND DISCUSSION

The results from experimental analysis indicate a great improvement in the efficiency of academic research workflow processes. From Table 1, it is evident that the average time taken for literature analysis went down from **4.5 hours to 6.2 minutes**, while automated report generation took **18 seconds** against **45 minutes** in the case of traditional manual approaches. The semantic retrieval model, using **FAISS based vector search** and **Sentence**

Transformers embeddings, resulted in an average retrieval latency of **2.3 seconds**, making it possible to identify the research papers quickly. With the help of a custom-built LangChain inspired multi-agent pipeline, research gaps could be detected along with trend analysis, method generation and grant proposal writing. Additionally, the system generated comprehensive PDF reports and supported cloud-based storage through AWS S3, significantly reducing manual effort while improving the speed and quality of academic research planning.

Metric	Manual Process	Proposed System
Literature Review Time	4.5 hours	6.2 min
Average Retrieval Time	N/A	2.3 s
Report Generation Time	45 min	18 s
End-to-End Workflow Time	5 hours 15 min	9.8 min

Table 1: Experimental Performance Comparison of Manual and Proposed Research Workflow

7. CONCLUSION AND FUTURE SCOPE

This work presents an AI-powered academic research assistant capable of automated literature analysis, research trend identification, and research gap detection using LLM-based workflows. Based on experimental observations, it has been established that the system helps to decrease the amount of manual research work performed by researchers while at the same time producing efficient research insights and reports. This framework highlights the practical viability of research automation using LLMs for use in academic assistance systems. Future work will focus on integrating domain-specific LLMs, GraphRAG, and additional scholarly databases to further improve retrieval quality and research gap detection.

8. REFERENCES

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