Deep Research Bot:

AI-Powered Research Paper Review Generator

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1. Introduction:

Academic research is a complex and time-consuming process that requires scholars to manually search, review, and summarize vast amounts of literature. The traditional approach involves searching databases like Google Scholar, manually extracting DOI numbers, downloading papers, and reading through large volumes of text to synthesize key findings. This process is not only inefficient but also prone to information overload and missed insights.

To address these challenges, we developed Deep Research Bot, an AI-powered system that automates the research process and generates structured review papers on any given topic. This system integrates Google Scholar for academic paper retrieval, DOI extraction and automatic downloading via Sci-Hub, recursive reference exploration up to 3 levels deep, and AI-driven summarization and review generation. The bot can process up to 100 research papers in a single research cycle, providing an efficient and comprehensive literature review experience.

The bot features a Streamlit-based user interface and is deployed on Google Cloud Platform (GCP) for seamless accessibility. By leveraging AI models like Gemini AI, Deep Research Bot enhances the efficiency and effectiveness of academic literature reviews, making it an invaluable tool for students, researchers, and professionals. The user-friendly Streamlit interface allows users to enter research topics manually or select from predefined topics using a dropdown menu, ensuring flexibility and ease of use.

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2. Existing Solutions in the Market and Their Limitations:

Existing Solutions

- **Google Scholar, IEEE Xplore, PubMed: Provide access to vast academic resources but do not automate summarization or structured review generation.**
- **Zotero & Mendeley: Assist in managing references but lack end-to-end research automation.**
- **Semantic Scholar: Uses AI to highlight key aspects of papers but does not generate comprehensive review papers.**
- **GPT-Based Summarization Tools: Offer general summarization but lack structured recursive research capabilities.**

Limitations of Existing Solutions

- **Manual effort: Users must manually search, download, and analyze each paper.**

- **Lack of automated reference exploration: Most tools do not recursively explore references for deeper insights.**
- **No structured review generation: AI summarization tools do not generate complete, academically formatted review papers.**
- **Limited accessibility: Some tools require expensive subscriptions, limiting access to research.**

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3. Key Features and Our Approach:

Deep Research Bot is designed as a multi-agent AI system that automates and optimizes the literature review process. Each agent plays a specialized role, ensuring efficiency and accuracy:

1. **Manager Agent: Oversees the research pipeline and workflow.**
2. **Research Agent: Searches for research papers using Google Scholar.**
3. **DOI Extractor Agent: Extracts DOI numbers from search results for direct paper access.**
4. **Paper Downloader Agent: Retrieves full-text papers from Sci-Hub or scrapes them from the web.**
5. **Reference Extractor Agent: Identifies references within papers and expands research up to 3 levels deep.**
6. **Summarization Agent: Uses Gemini AI to extract key insights, methodologies, and findings.**
7. **Review Writer Agent: Generates a structured academic review paper following research standards.**

Advantages of Our Approach

- **Automated DOI-based retrieval: Eliminates the need for manual downloads.**
- **Deep recursive research: Explores references within references for a comprehensive review.**
- **AI-powered summarization: Provides clear, concise, and academically structured summaries.**
- **Modular multi-agent design: Ensures each component functions independently for robustness.**
- **User-guided research process: Allows users to make selections and refine searches interactively.**
- **Seamless deployment on GCP: Ensures accessibility with a live Streamlit-based UI.**

- **Downloadable Review Paper: Users can download the review paper in Word (.docx) format for further editing and submission.**
- **Robust error handling – Handles API limits, missing papers, and download failures effectively.**

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4. Data Sources Used:

- **Google Scholar (via SerperDev API) – Fetches peer-reviewed academic papers.**
- **Sci-Hub – Enables access to research papers using DOI numbers.**
- **Web Scraping – Extracts PDFs if direct access is unavailable.**
- **Gemini AI – Used for summarization and structured review generation.**
- **YouTube & Blogs – Train the Manager Agent on effective review writing techniques.**
- **Future Scope: Integration with IEEE Xplore & PubMed for broader academic coverage.**

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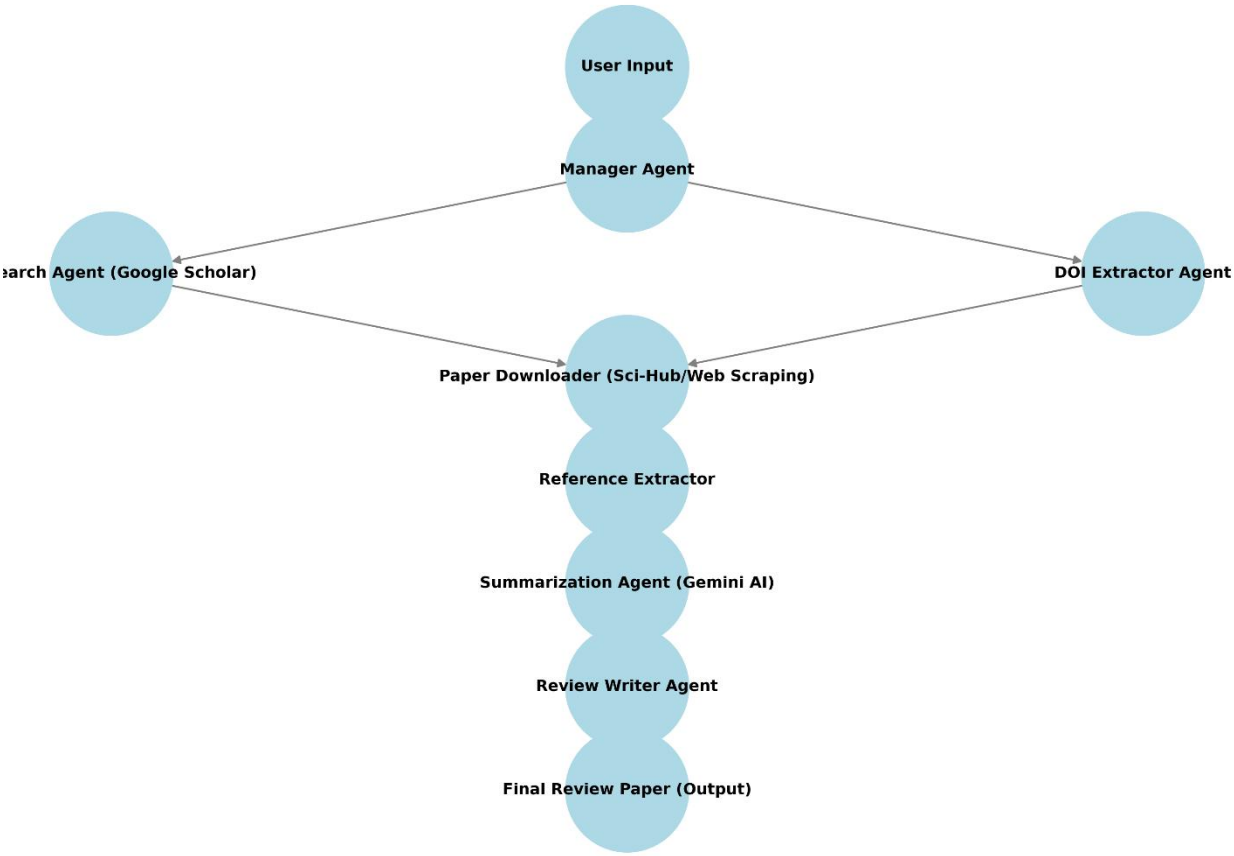
5. Explanation of the Code and System Design

Pipeline Flow:

1. **User Input: Users enter a research topic manually or select from a dropdown menu.**
2. **Manager Agent Training: The bot learns from external sources about academic review writing.**
3. **Paper Search: The bot retrieves papers using Google Scholar.**
4. **DOI Extraction & Paper Download: Extracts DOI numbers and downloads full papers via Sci-Hub.**
5. **Recursive Reference Analysis: Scrapes references to expand research up to 3 levels deep.**
6. **Summarization & Review Writing: AI extracts key findings and generates a structured review.**
7. **User Output: The final review paper is displayed and available for download in Word (.docx) format.**

Block Diagram:



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6. Sample Interactions with the System

Example Scenario:

User Input: ***"Artificial Intelligence in Healthcare"***

Bot Actions:

User Input:

- **The user navigates to the Streamlit application.**
- **In the “select a topic from the list:" dropdown, the user selects "Artificial Intelligence in Healthcare".**
- **The user clicks the " 🚀 Start Research" button.**

System Processing:

- **The system displays a spinner with the message: " Researching: Artificial Intelligence in Healthcare... Please wait."**
- **The ManagerAgent initiates the research process.**
- **The ResearchAgent uses the SerperDev API to search Google Scholar for papers related to "Artificial Intelligence in Healthcare".**
- **The DOIExtractorAgent extracts DOIs from the search results.**
- **The PaperDownloaderAgent attempts to download PDFs using Sci-Hub and/or web scraping.**
- **The system downloads a number of papers related to AI in healthcare, such as papers on:**
    - **AI-driven diagnostics.**
    - **Machine learning for drug discovery.**
    - **AI in personalized medicine.**
    - **AI in medical imaging.**
- **The ReferenceExtractorAgent extracts reference lists from the downloaded PDFs.**
- **The SummarizationAgent uses the Gemini API to generate summaries of each downloaded paper, focusing on key findings, methodologies, and implications.**
- **The system then begins to follow the references in the papers that have already been downloaded, and downloads more papers.**
- **The ReviewWriterAgent uses the Gemini API to synthesize the summaries and references into a coherent review paper. The review includes:**
    - **An introduction to the role of AI in healthcare.**
    - **A critical analysis of AI applications in diagnostics, drug discovery, personalized medicine, and medical imaging.**
    - **A discussion of the implications, benefits, and limitations of AI in healthcare.**
    - **A conclusion summarizing the main points.**
    - **A formatted list of references.**
- **The system displays the generated review paper in a text area on the Streamlit interface.**
- **The system provides a " Download Review Paper as .txt" button.**

User Output and Action:

- **The user sees the generated review paper in the Streamlit text area.**
- **The user reads through the review, noting the key findings and the organized structure.**
- **The user clicks the " Download Review Paper as .txt" button.**
- **The user saves the downloaded text file to their local device.**
- **The user now has a well formated review paper on the topic of AI in healthcare.**

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7. Limitations

- **API Dependencies – The bot relies on external APIs (SerperDev, Gemini), which have request limits.**
- **PDF Processing Accuracy – Quality of extracted text depends on PDF formatting.**
- **Web Scraping Fragility – Website changes may affect scraping functionality.**
- **Sci-Hub Availability – Reliant on Sci-Hub's uptime and accessibility.**
- **Processing Time – Recursive research increases processing time for broad topics.**

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8. Future Scope

- **Integration with IEEE Xplore & PubMed: Expanding data sources for broader academic coverage.**
- **Advanced Summarization Models: Utilizing GPT-4, BERT, or transformer-based AI models for enhanced text analysis.**
- **Graph-Based Research Mapping: Visualizing connections between research papers and references.**
- **Multi-User Collaboration: Enabling research teams to work together on a shared platform.**
- **Adaptive Learning System: Enhancing the Manager Agent to learn and refine review quality dynamically.**

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9. Conclusion

In conclusion, this project presents a robust and innovative AI-powered research paper review generator designed to streamline the literature review process. By integrating diverse data sources-including Google Scholar via the SerperDev API, Sci-Hub, web scraping, and PDF processing—with the advanced capabilities of the Gemini API, the system automates the

traditionally time-consuming tasks of paper discovery, summarization, and synthesis. The user-friendly Streamlit interface empowers researchers to quickly generate comprehensive review papers, significantly enhancing productivity.

This approach addresses the limitations of existing solutions by providing an end-to-end automated pipeline that not only gathers and organizes information but also leverages AI to produce coherent and well-structured reviews. While dependencies on external APIs and potential challenges with PDF processing and web scraping exist, the system's strengths—including robust error handling, effective reference management, and iterative research capabilities—make it a valuable tool for academic and professional researchers.

Looking forward, potential enhancements such as improved PDF processing, integration of additional data sources, advanced review customization, and the incorporation of local LLMs promise to further refine and expand the system's capabilities. This project represents a significant step towards leveraging AI to revolutionize the way literature reviews are conducted, ultimately fostering more efficient and effective research practices.