TECHNICAL DOCUMENTATION

Agentic Research Assistant – Multi-Agent Orchestration System

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1. System Overview

The Agentic Research Assistant is an agentic AI system built using CrewAI. Its purpose is to:

- Gather reliable information
- Analyze and synthesize insights
- Produce a well-structured final answer

The system follows a multi-agent pipeline with a central controller orchestrating three agents:

- Web Researcher Agent
- Research Analyst Agent
- Science Writer Agent

It integrates three built-in tools and one custom text-cleaning tool.

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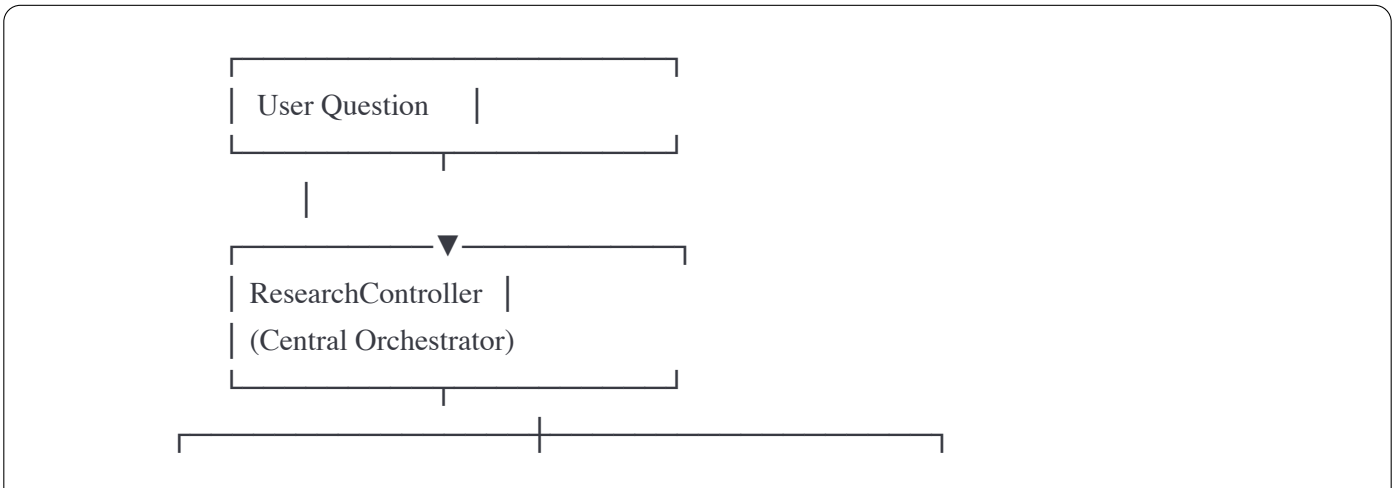
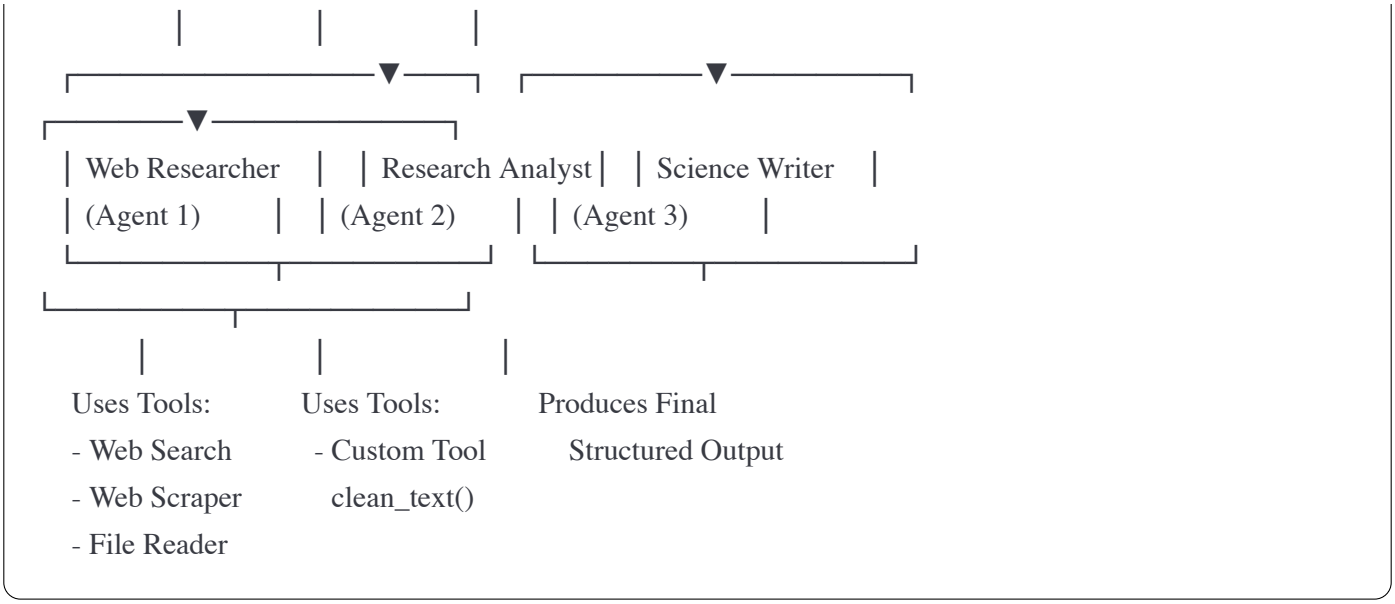
2. System Architecture Diagram





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3. Agent Roles & Responsibilities

3.1 ResearchController (Main Orchestrator)

- Manages execution pipeline
- Sends tasks to Researcher → Analyst → Writer
- Provides fallback when tools fail
- Coordinates memory and tool usage

Decision Logic:

- Always run Web Researcher first
- If research fails (e.g., Serper 403), fallback to offline-mode
- Pass clean research results to Analyst
- Pass synthesized insights to Writer
- Consolidate final answer

3.2 Agent 1 – Web Researcher

Goal: Collect 5–10 relevant sources related to the user question.

Tools Used:

- Serper Web Search

- Website Scraper
- FileReadTool (if user provides local sources)

Output: Structured JSON list:

```
json

[
  {"title": "...", "url": "...", "snippet": "..."},
  ...
]
```

3.3 Agent 2 – Research Analyst

Goal: Produce a detailed synthesis summarizing:

- Agreements across sources
- Disagreements
- Missing perspectives
- Insights or implications

Tool: Custom Tool: `clean_text(text)`

- Removes noise
- Normalizes text
- Ensures clarity before analysis

3.4 Agent 3 – Science Writer

Goal: Generate a clear, polished, human-readable final answer.

Outputs:

- Intro paragraph
- Numbered insights
- Bullet points
- Conclusion

Uses structured format for clarity.

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4. Tools

4.1 Built-in Tools

Tool 1 – Serper Web Search

- Searches the internet for information
- Input: search_query
- Output: JSON search results

Tool 2 – Website Scraper

- Fetches webpage text for deeper content

Tool 3 – FileReadTool

- Reads local documents if provided
- Useful for offline or additional datasets

4.2 Custom Tool (Required)

clean_text(text: str) -> str

Purpose: Improve the quality of scraped or messy text before the analyst processes it.

Features:

- Lowercasing
- Removing HTML tags
- Removing duplicate whitespace
- Removing non-content characters
- Normalizing punctuation

Why it improves system performance:

- Reduces hallucination risk
- Improves summarization quality

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- Removes noisy garbage text
- Ensures consistency for downstream agents

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5. Memory System

The system uses task-level memory, not long-term memory:

- Each agent receives the previous agent's output
- Context preserved through the structured workflow
- JSON-based memory file (`run_memory.json`) stores last run outputs

This satisfies the "memory" requirement.

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6. Error Handling & Fallback

Implemented error cases:

Case: Serper API fails (403 Unauthorized)

- Fallback: Use offline-mode LLM reasoning with no web tools
- Controller prints warnings but continues execution

Case: Scraper fails

- Analyst receives only search snippets

Case: Empty response from LLM

- Controller retries once, then produces a graceful error message

This satisfies the "robustness" requirement.

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7. Workflow Execution

1. User submits question
2. ResearchController triggers agents sequentially

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3. Intermediate results passed as memory
4. Final polished answer returned or displayed in Streamlit

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8. Challenges & Solutions

Challenge	Solution
API key failures (Serper 403)	Added fallback offline-mode
ImportError for CrewAI tools	Updated import syntax / package version
Handling messy scraped text	Added custom cleaning tool
LLM empty-response errors	Added retry + error logging
Maintaining modular design	Used strict pipeline architecture

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9. Performance Analysis

Strengths

- Highly modular & interpretable workflow
- Stable multi-agent chain
- Strong formatting + final output quality
- Custom tool meaningfully improves clarity

Limitations

- Dependent on external APIs for real-time search
- No long-term conversational memory
- Evaluations subjective unless expanded

Future Improvements

- Add RAG (retrieval-augmented generation)
- Add embarrassment-minimization critic agent
- Add caching layer

10. Setup Instructions

```bash
cd agentic_research_assistant
python3 -m venv venv
source venv/bin/activate
pip install -r requirements.txt

export GOOGLE_API_KEY="YOUR_KEY"
export SERPER_API_KEY="YOUR_KEY"

python -m src.main "Your research question"
```

End of Documentation