ScholarAI System Architecture

A multi-agent AI research assistant system.

Overview: ScholarAI's Intelligent Workflow

ScholarAI revolutionises academic research through a sophisticated multi-agent system, designed to efficiently navigate, analyse, and synthesise vast amounts of scholarly information. This innovative architecture integrates advanced machine learning for deep insights and gap analysis, enhancing research productivity and quality.

The User's Gateway: Initiating Research

👤 USER QUERY

Analyze recent advances in transformer models

The research journey begins with a clear, concise query from the user, which serves as the initial directive for the entire multi-agent system.

Controller Agent: Orchestrating the Research Flow

The Controller Agent acts as the central intelligence, meticulously managing the research process through a structured, four-phase workflow.

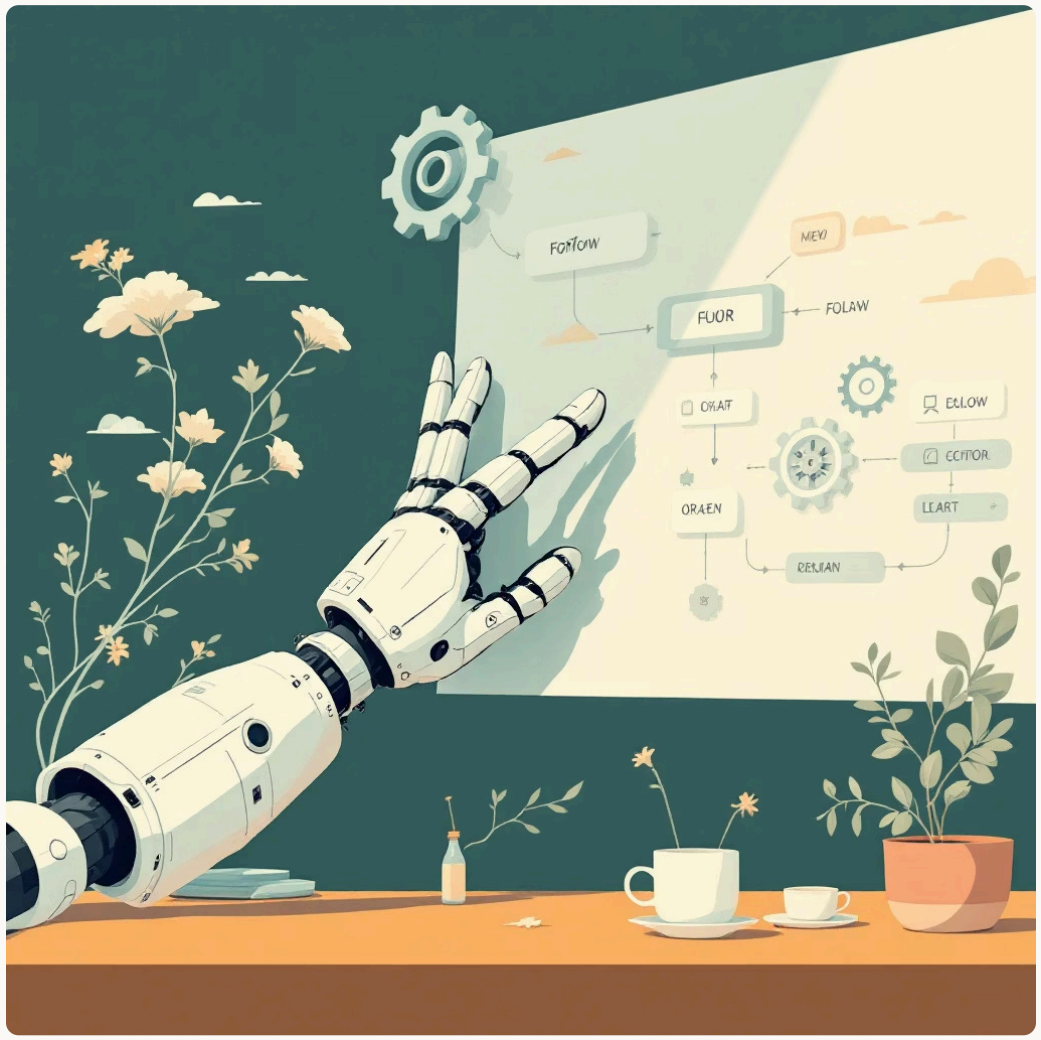
🎯 CONTROLLER AGENT

Workflow Orchestrator

- Manages 4-phase sequential workflow
- Implements validation gates
- Handles feedback loops (max 2 iterations)
- Error recovery strategies

Technology Stack:

- GPT-4o
- Temp: 0.1
- Allow Delegation: True



Phase 1: Paper Discovery – The Academic Librarian

The initial phase focuses on comprehensive paper discovery, leveraging specialised tools to unearth relevant academic literature.

📚 PHASE 1: PAPER DISCOVERY

Agent 1: Paper Hunter - Academic Research Librarian

Built-in Tools:

- SerperDevTool - Google Scholar search
- FileReadTool - File operations

OUTPUT:

10-15 papers with relevance scores

VALIDATION GATE:

✓ ≥5 papers? Relevance >0.2?

↓ PASS

Phase 2: Content Analysis – The Research Analyst

Once papers are discovered, Agent 2 meticulously analyses their content, extracting crucial information.

📖 PHASE 2: CONTENT ANALYSIS

Agent 2: Content Analyzer - PhD Research Analyst

Built-in Tools:

- ScrapeWebsiteTool - Content extraction

OUTPUT:

Key findings, methodologies, technical terms

VALIDATION GATE:

✓ ≥80% analysed?

↓ PASS

Phase 3: Research Synthesis – Uncovering Insights

This critical phase involves synthesising the analysed content and, crucially, identifying novel research gaps through advanced ML techniques.

🔬 PHASE 3: RESEARCH SYNTHESIS

Agent 3: Research Synthesizer - Senior Research Advisor

💎 CUSTOM TOOL: Research Gap Analyzer

- Generate Embeddings (384-dim)
- Cluster Papers (DBSCAN)
- Detect Gaps (4 methods)
- Find Contradictions
- Analyze Trends
- Build Citation Network
- Create Visualizations
- Generate Recommendations

OUTPUT:

5-8 research gaps, 3 visualizations, recommendations

VALIDATION GATE:

✓ ≥3 gaps? Confidence >0.6?

↓ PASS

Phase 4: Quality Review – Academic Peer Assessment

The final phase ensures the highest standards of academic rigour through a meticulous quality review process.

✅ PHASE 4: QUALITY REVIEW

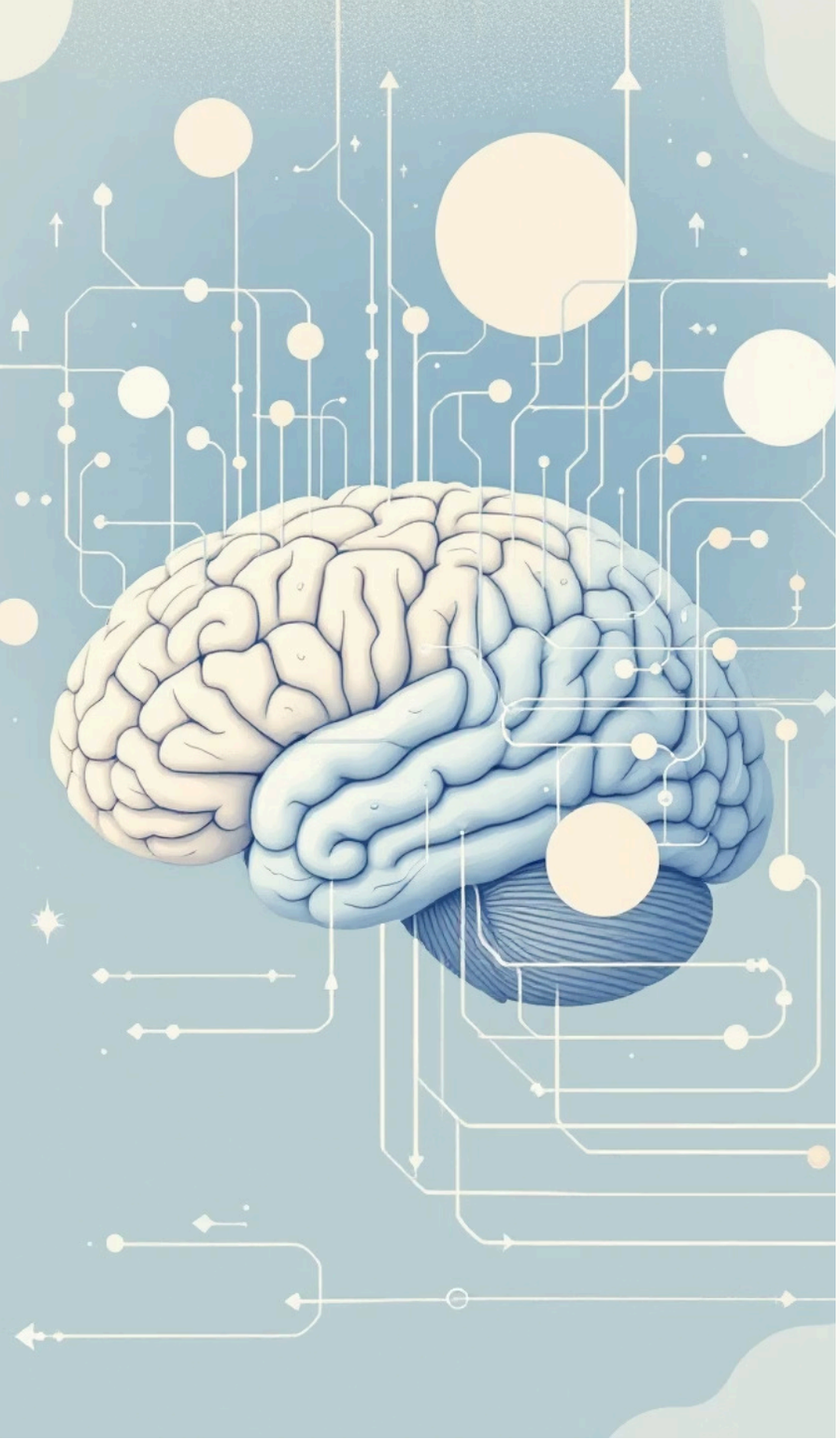
Agent 4: Quality Reviewer - Academic Peer Reviewer

Evaluation:

- Completeness (0-10)
- Evidence Quality (0-10)
- Logical Coherence (0-10)
- Gap Analysis Quality (0-10)

OUTPUT:

Overall score, refinement recommendations



Feedback Loops & Memory Systems

The system incorporates a robust feedback loop for continuous improvement and leverages a sophisticated memory system to inform future analyses.

🔄 FEEDBACK LOOP

IF score ≥7.5 → Finalise ✅

IF score <7.5 & iteration <2 → Return to Phase 1 🔄

IF iteration =2 → Finalise anyway

💾 MEMORY SYSTEM

Short-term: Query history, Agent outputs, Metrics

Long-term: Search patterns, Quality scores, Domain knowledge

Final Research Report: Actionable Insights

📊 FINAL RESEARCH REPORT

- ✓ JSON report with all data
- ✓ 10-15 analysed papers
- ✓ 5-8 research gaps with confidence
- ✓ 3 professional visualizations
- ✓ Quality assessment
- ✓ Actionable recommendations

The output is a comprehensive, structured research report, providing all the necessary data and actionable recommendations for the user.

CrewAI 1.5.0 • GPT-4o • Sentence Transformers • DBSCAN • NetworkX • Matplotlib • Python 3.13