# Self-governed multi-agent system for identifying early investment opportunities

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## I. Introduction

In this homework, we developed the technical foundation of a multi-agent system designed to govern other agents. Following discussions with the teaching team, we decided to focus on a concrete domain: an agent responsible for identifying early-stage investment opportunities. Our system, **VibeInvestor**, is intended not to trade or predict markets but to act as a disciplined research assistant: scanning public information, filtering signals based on evidence, and surfacing only well-supported opportunities for human review.

VibeInvestor is designed to operate under a procedural, evidence-based philosophy: *Observe* $\rightarrow$ *Reason* $\rightarrow$ *Decide* $\rightarrow$ *Act* $\rightarrow$ *Update* $\rightarrow$ *Repeat*. Each agent performs a well-defined role, and the system maintains a persistent memory to track decisions and outcomes over time.

## II. Tooling Rationale

The VibeInvestor system integrates multiple external tools, each fulfilling a critical role in achieving its research goals:

- **Google Gemini API**: Provides LLM capabilities for reasoning over web search results, extracting structured information, and generating coherent summaries. This is essential for the *Finder* and *Governor* agents, allowing them to transform unstructured text into actionable data while following strict evidence-based rules.
- **SearchAPI.io**: Performs real-time web searches, returning snippets and URLs that are candidates for investment evaluation. This ensures the system can discover early-stage signals from press releases, niche publications, and regulatory filings before mainstream coverage.
- **FAISS Vector Database**: Stores processed findings and memory chunks in a semantic vector space. This enables the system to retrieve contextually relevant past discoveries during Governor reasoning, ensuring decisions are informed by prior evidence.
- **Google Generative AI Embeddings**: Converts textual data from findings into dense vector representations for FAISS. Semantic similarity searches allow retrieval of relevant memory chunks, improving the accuracy of evidence verification.
- **Utility Functions (`utils.py`)**: Includes robust JSON parsing and PDF generation. JSON extraction ensures correct parsing of LLM outputs despite occasional formatting inconsistencies. PDF generation allows structured reporting for human review, providing a persistent audit trail.

These tools collectively enable VibeInvestor to implement a reliable pipeline where agents operate procedurally, maintain memory, and escalate only well-supported signals.

## III. Failure Analysis

During development, we encountered several challenges. A representative failure scenario involved the Finder agent:

*Initial Failure*

When executing the Finder agent with an early query focused on regulatory filings and startup guidance, the web search returned snippets containing legal advice and general recommendations rather than specific companies or financial metrics. Following the prompt, the LLM returned an empty list (`[]`) because it could not identify any publicly traded companies with sufficient data. Consequently:

- Memory was not populated.
- The Governor agent had no data to reason over.
- No PDF report was generated.

*Technical Adjustment*

To address this, we made the following changes:

1) Refined the web search query to focus on undervalued, publicly traded companies and financial metrics rather than general startup guidance.
2) Updated `main.py` to handle empty results gracefully:
   - Check for empty Finder outputs before populating memory.
   - Skip Governor reasoning if no data is available.
   - Generate PDF reports regardless, including either the findings or a note indicating no results.
3) Improved JSON extraction to robustly handle inconsistencies in LLM outputs, reducing failures during parsing.

*Outcome*

These adjustments increased system reliability. Now:

- Non-informative snippets no longer block the pipeline.
- Memory is populated only with valid findings.
- PDF reports consistently reflect system outputs, even when no discoveries are made.

## IV. Detailed Architecture

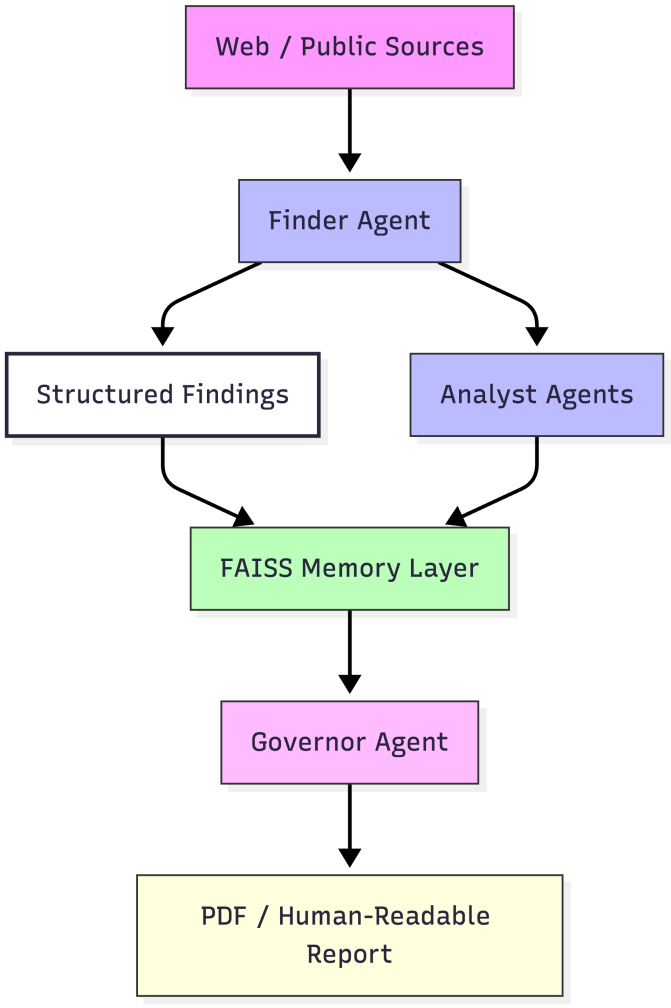


Fig. 1. Simple architecture diagram

At a high level, VibeInvestor consists of:

- **Finder Agents**: Collect candidate opportunities from web sources and extract structured information (company name, ticker, financial metrics, source URL).
- **Analyst Agents**: Independently evaluate findings, applying heuristics such as P/E ratio, free cash flow, and balance sheet health.
- **Governor**: Arbitrates among Analyst outputs, selecting the strongest opportunity based on clearly stated claims and evidence strength.
- **Memory Layer (FAISS)**: Stores all findings and metadata for semantic retrieval. Ensures the Governor can reason over both current and historical data.
- **Tool Layer**: Accesses external APIs for search, LLM reasoning, and embedding generation through well-defined contracts.

The closed-loop design allows VibeInvestor to continuously improve: findings feed memory, which informs future decisions, creating a persistent feedback loop for governance.

## V. Summary and Limitations

VibeInvestor demonstrates a structured approach to early-stage opportunity discovery under uncertainty. By combining LLM reasoning, web search, semantic memory, and verification of claims, the system:

- Reduces noise from speculative or incomplete data.
- Provides a clear, human-readable audit trail of decisions.
- Handles failures gracefully, generating outputs even in edge cases.

**Note on Improvements:** Some aspects of the system remain experimental. Future work could include:

- Enhanced query generation to better target relevant opportunities.
- Improved evidence scoring heuristics for stronger prioritization.
- More advanced memory management and chunking strategies to increase retrieval accuracy.
- Expanded integration of multiple LLMs or analyst agents for cross-validation.

Despite these areas for improvement, VibeInvestor provides a robust platform for experimenting with agentic governance in a structured, evidence-driven framework.