AURA

Autonomous RAG for Financial Analysis.

Presented by
Team 84

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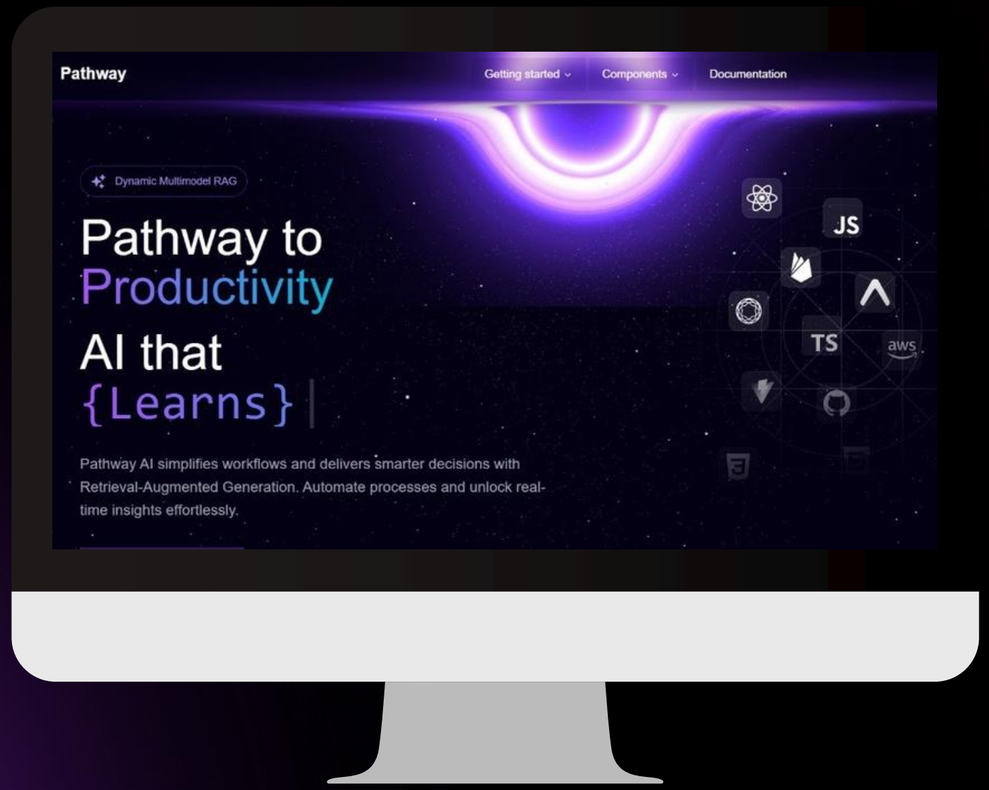

About AURA

We have proposed a novel, multi-agentic framework specifically designed for financial question and answer (Q&A) tasks. The framework leverages the power of large language models (LLMs) and incorporates a human-in-the-loop approach, leading to more accurate and adaptable results.

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Why Finance?

On average, professionals spend about 50% of their time searching for information, with an estimated 18 minutes spent locating each document

Around 20% of publicly traded companies have restated financial statements due to inaccuracies, highlighting systemic organizational issues.

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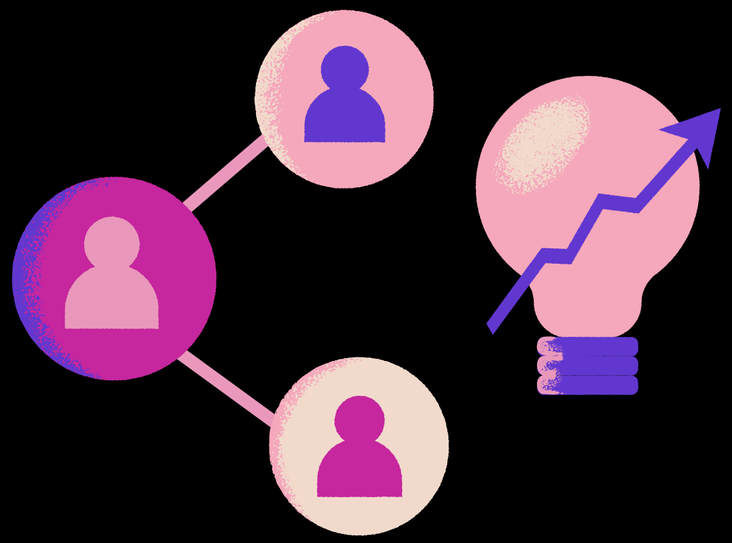
Use Case



Financial Document QnA

We have implemented a robust and efficient financial document QnA system for both local documents and sources on the web.

Report Generation

Our solution includes a key feature for industry professionals i.e report generation which generates a detailed financial report including realtime stats from trusted sources on any topic.

Generalizable and Scalable

The system we have built is highly generalizable and scalable, easily adaptable to other domains such as **law**, etc.. However, for this project, we chose the most challenging use case for current RAG systems: **finance**.

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Architecture Overview

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Architectural Components

User Interaction

Users interact with the framework by providing queries that initiate the processing pipeline.

Supervisor

The Supervisor orchestrates the system's operations by planning, scheduling, executing, and replanning tasks, and integrating human-in-the-loop functionality.

Core Tools

Specialized tools, including Data Retrieval, Financial Analysis, Math, and Report Generation, are coordinated by the Supervisor to accomplish various tasks.

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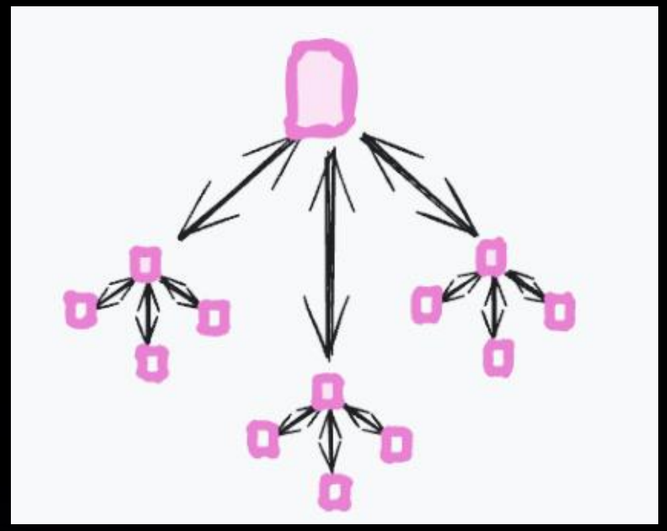
Multi-agent Architecture



Available Architectures

- **Fully connected**
- **Hierarchical Network**
- **Supervisor (with tools)**
- **Custom topology**
- **Supervisor (with agents)**

What we went with

We decided upon a modified supervisor with tools architecture with agents as tools and these agents further have a Hierarchical network.

Why ?

This architecture choice offered us more control over the whole flow while minimizing token usage as we can control the amount of context to be sent to lower level agents while not compromising on context awareness.

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Supervisor

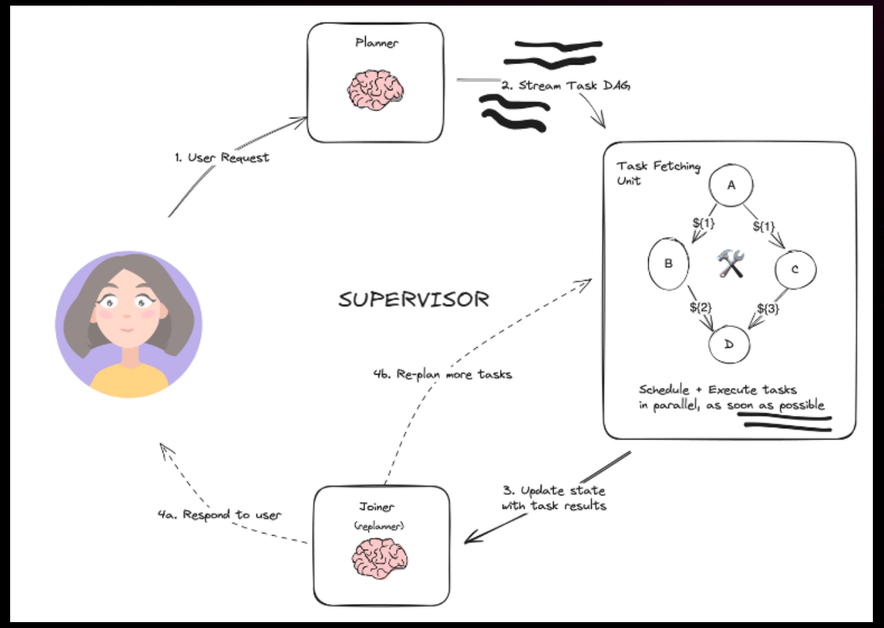
Supervisor manages **complex workflows** by organizing tasks parallelly into a **Directed Acyclic Graph** (DAG). Planner dynamically generates initial plans using tools provided and when necessary, replanning is triggered by system messages.

Specialized tool coordination

Supervisor coordinates access to Finance Analyst Group, Math Tool, Data Retrieval Tool, and Report Generation Tool.

Human in the loop (HITL)

The workflow pauses when human feedback is required enabling human input to refine subsequent planning.



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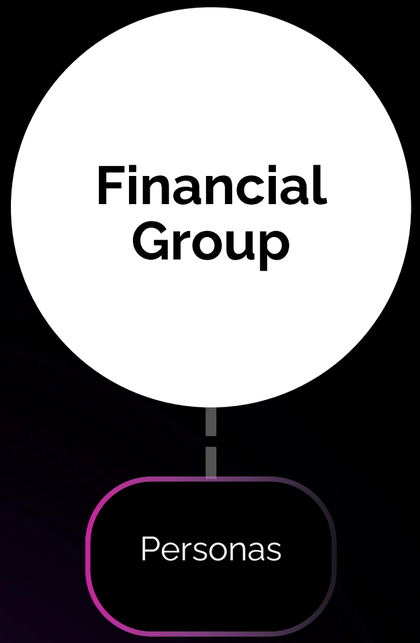
Financial Analyst Group is a specialized multi-agent system to simulate expert financial discussions and generate comprehensive financial analysis.



Financial Lead

- Oversees analysis.
- Summarizes findings.
- Ensures coherence.

Financial Analyst (Agent 1):

- Conducts core analysis.
- Examines financial statements.
- Identifies key metrics.

Complementary Analyst (Agent 2):

- Adds macroeconomic insights.
- Challenges assumptions.
- Refines findings.

Dynamic Role Assignment:

- Personas: Agents dynamically switch roles based on task needs.
- Flexibility: Ensures relevant expertise is applied.
- Enhanced Analysis: Improves depth and accuracy.

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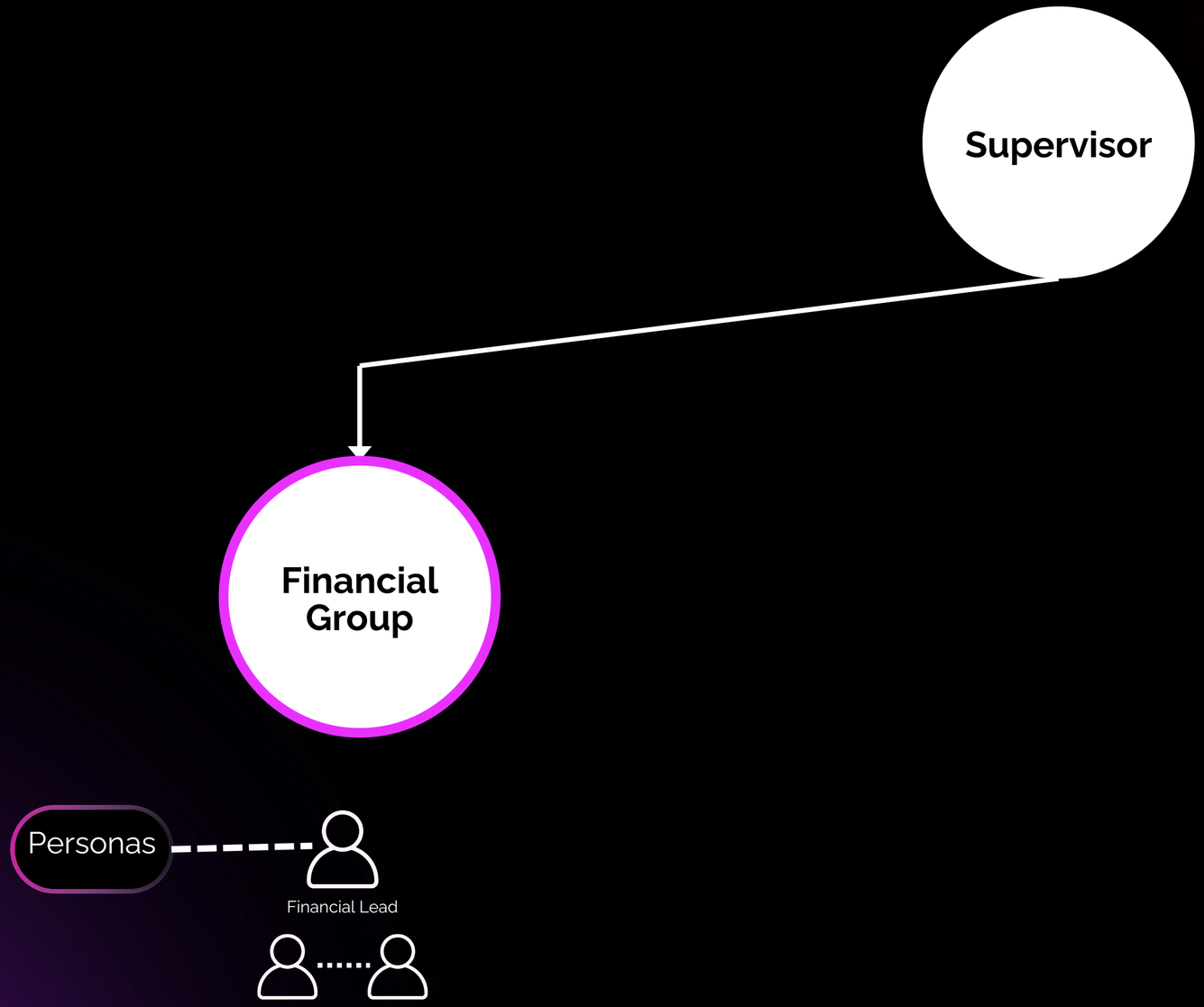

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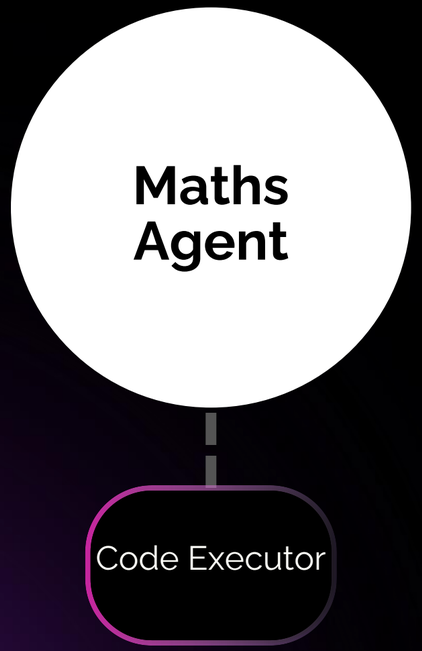
The Math Tool integrates **Natural Language Processing** (NLP) and **code writing capabilities** to solve complex **mathematical challenges**. It is ideal for financial modeling, risk assessment, and predictive analytics.



Key Features:

NLP Translation

Converts natural language queries into computable expressions.

Parallel Evaluation

Breaks down queries into sub-queries and evaluates them in parallel.

Efficient Reasoning

For simple and straightforward reasoning tasks, it autonomously opts to compute directly rather than expending resources on generating code.

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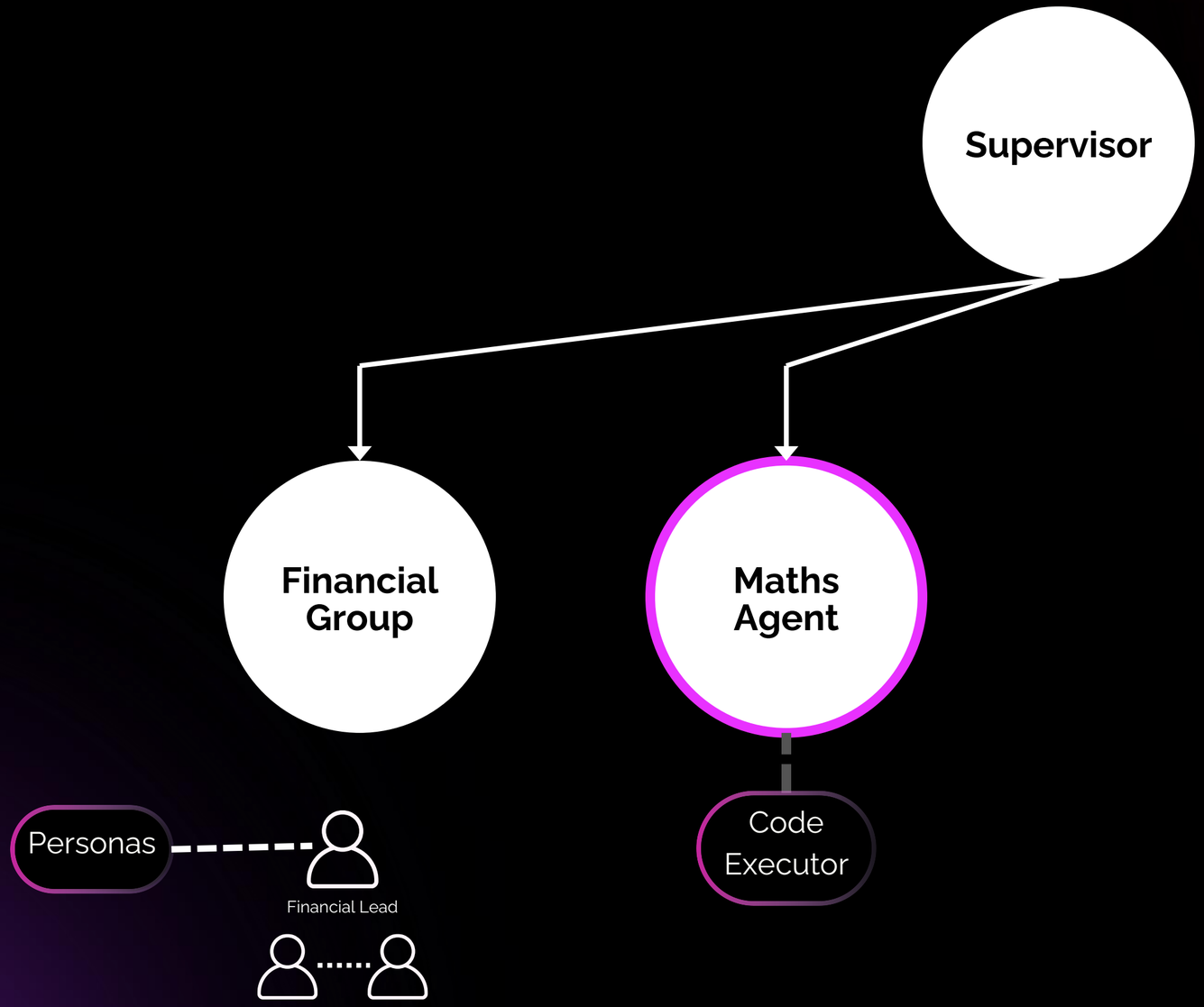
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Code Executor

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Adaptive RAG Module

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Decide whether queries relate to indexed data or need external web

Adaptive RAG Module

1

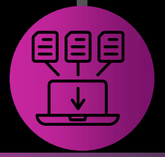
Next Slide

Adaptive RAG Module

Decide whether queries relate to indexed data or need external web

1

2



Multiple related queries generated to enhance data retrieval

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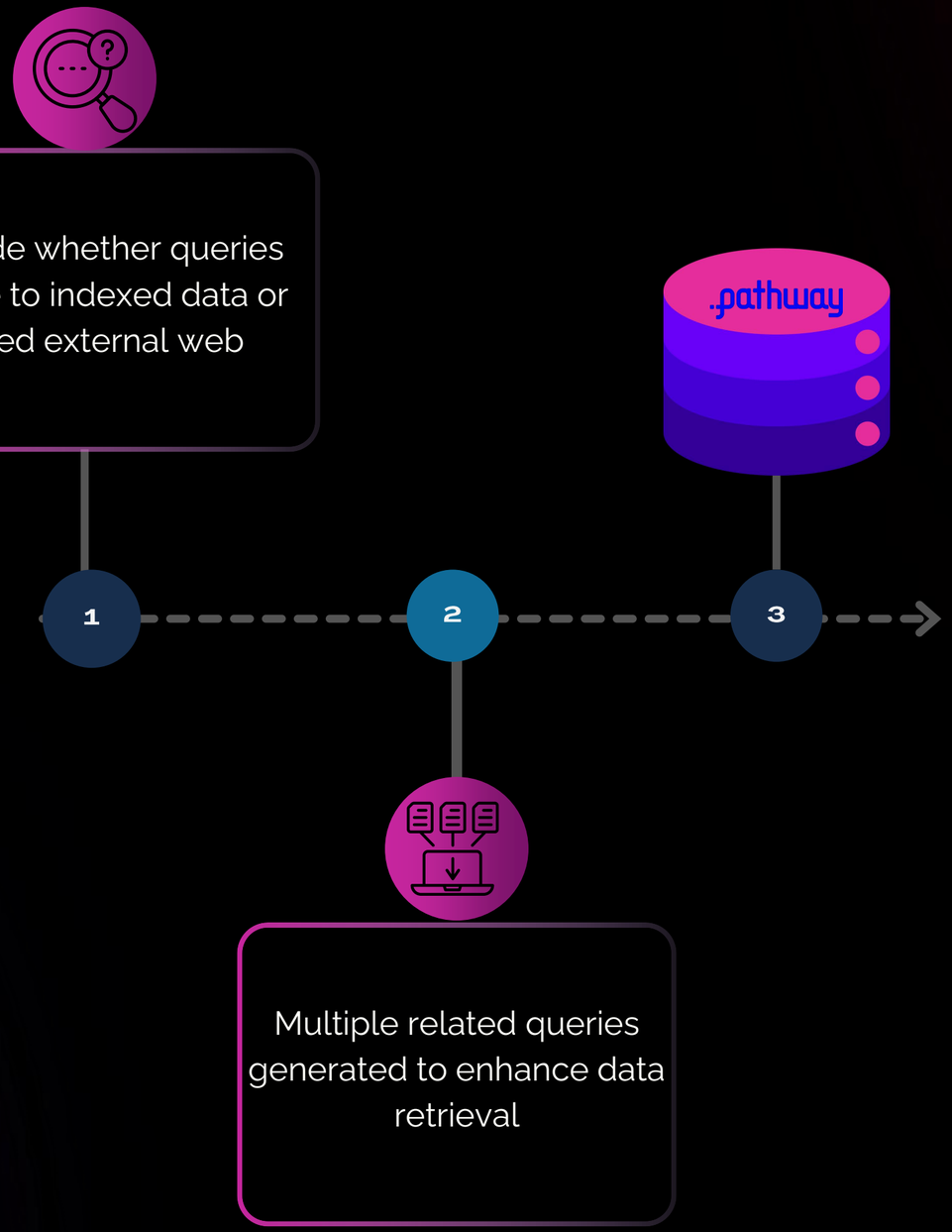
Adaptive RAG Module



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Adaptive RAG Module

1. Decide whether queries relate to indexed data or need external web
2. Multiple related queries generated to enhance data retrieval
3. .pathway
4. The Grader grades the relevance of retrieved data selecting the most relevant ones

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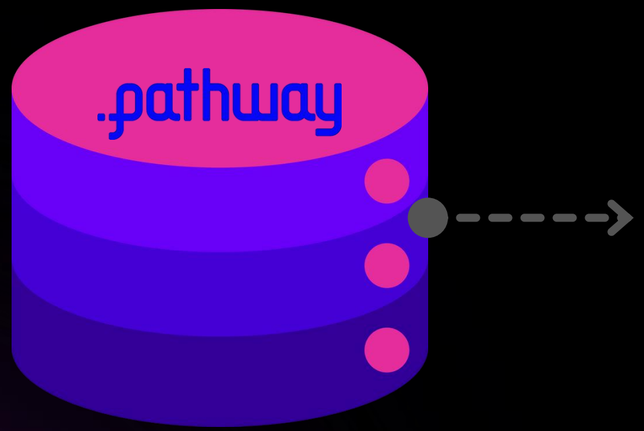
Adaptive RAG Module

1. Decide whether queries relate to indexed data or need external web
2. Multiple related queries generated to enhance data retrieval
3. .pathway
4. The Grader grades the relevance of retrieved data selecting the most relevant ones
5. A fallback mechanism retries if the Grader finds insufficient data. If still inadequate, the query is sent to the Web Search node.



Open Parse

- **PyMuPDF**: fast but fails to differentiate tables from normal text
- **LLM**: hallucinates when fails to recognize text accurately
- **Unitable**: limitations in table detection and cropping accuracy
- **Table Transformer**: computationally expensive and lacks a robust strategy for processing non-tabular text

Unstructured

- Element: creates chunks that are too small
- Single: single mode captures excessive information
- Paged: fails due to lack of distinction between heading, paragraphs and table.

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TableVision Mode: Novel proposed mode

To address the limitations in table retrieval, we introduced our custom mode that enriches the context for tables.
This mode generates:

- **Detailed Description**
- **Markdown formatted Table**: The table in Markdown format for enhanced usability.
- **Query-enriched indexing**: Relevant search queries derived from the table and its context, ensuring effective retrieval. This enriched information is stored alongside the table in the index, significantly improving its discoverability during retrieval operations

Context: Organic/Core (non-GAAP)1 First-Quarter 2023 Results

Description of the Table

The table presents key financial metrics from the first quarter of 2023, focusing on organic revenue growth, core earnings per share (EPS), and the change in core constant currency EPS. Organic Revenue Growth: The first-quarter 2023 organic revenue increased by 14.3%, excluding acquisitions, divestitures, and currency effects. Core EPS: The adjusted earnings per share (EPS) for Q1 2023 is $1.50, excluding certain items. Core Constant Currency EPS Change: The core EPS increased by 18% when excluding the impact of currency fluctuations.

Table in Markdown Format

Financial Metric	Value
First-Quarter Organic Revenue Growth	14.3%
Core EPS	$1.50
Core Constant Currency EPS Change	18%

Search Queries Answerable from the Table

1. What was the organic revenue growth for the first quarter of 2023?
2. What is the core EPS for the first quarter of 2023?
3. How much did the core constant currency EPS change in the first quarter of 2023?

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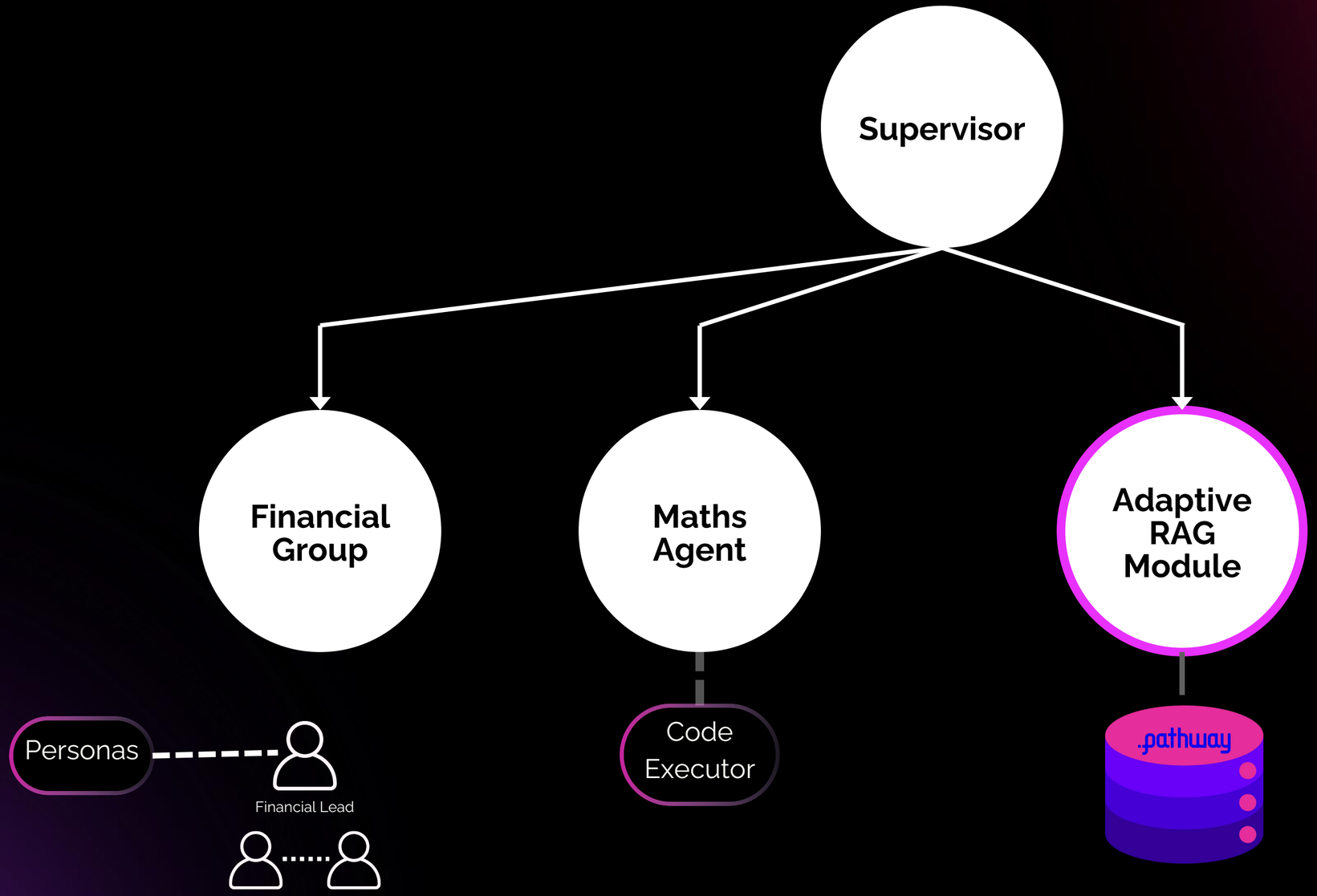
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Financial Report Generation

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User Query:

- Input query (e.g., "Generate report on Meta's Open Source AI initiatives.").
- Extract company ticker (e.g., "META") using GPT-4o-mini.

LLM Analysis:

- Use GPT-4o-mini to generate detailed financial insights.
- Include current market snapshot, historical performance, and predictive scenarios.

Fetch Data:

- Retrieve 10 years of historical stock data using yfinance api.
- Fetch company information (e.g., market cap, P/E ratio).

Generate Charts:

Create financial charts (e.g., stock price, RSI, MACD, Bollinger Bands, etc.).

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Financial Report Generation

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Financial Analysis: Meta Platforms, Inc.

Ticker: META | Sector: Communication Services | Market Cap: $1,537,237,712,896

Comprehensive Report on Meta Platforms, Inc. and Its Open Source AI Initiatives

Executive Summary

This report provides an in-depth analysis of Meta Platforms, Inc. (formerly known as Facebook, Inc.), focusing on its current financial status and the company's initiatives in the realm of open-source artificial intelligence (AI). Given the rapidly evolving landscape of technology and the increasing importance of AI, understanding Meta's efforts and financial health is crucial for stakeholders, investors, and industry analysts.

Key Financial Highlights

- Current Price: $608.93
- Market Capitalization: $1.54 trillion
- P/E Ratio: 28.74
- Dividend Yield: 0.33%

Meta has maintained a robust financial performance, reflecting its dominant position in the digital advertising market and its ongoing investments in innovative technologies, particularly in AI and virtual reality.

Introduction

Meta Platforms, Inc., headquartered in Menlo Park, California, is a leading technology company known for its social media platforms, including Facebook, Instagram, and WhatsApp. The firm has diversified its offerings to include virtual reality through Oculus, augmented reality, and various AI initiatives. This report will delve into Meta's financial performance, assess its strategic positioning, and analyze its commitments to open-source AI.

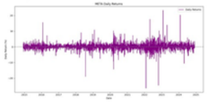
Financial Analysis

Revenue and Profitability

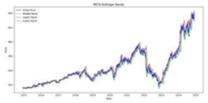
Meta has consistently reported strong revenue growth, driven primarily by its advertising business, which constitutes the majority of its income. In the latest fiscal reports, the company has shown resilience despite market fluctuations. The following factors have influenced Meta's revenue and profitability:

Stock Price:

Daily Returns:



Bollinger Bands:



Volume Analysis:

Rsi:

- Advertising Revenue: As digital marketing continues to expand, Meta benefits from its extensive user base and advanced targeting capabilities, maintaining its competitive edge.
- Investment in AI and VR: Meta's significant investments in AI technologies and virtual reality are expected to open new revenue streams, despite their initial costs.

Balance Sheet Overview

Meta's balance sheet reflects a solid financial position, characterized by substantial cash reserves and manageable debt levels. The company has undertaken strategic acquisitions that bolster its technological capabilities and market share:

- Assets: Meta's total assets have increased, driven by investments in technology and infrastructure.
- Liabilities: The company maintains a healthy debt-to-equity ratio, allowing for flexibility in financing future growth initiatives.

Market Performance

Meta's stock performance has been robust, showcasing resilience in the face of market volatility. The current price of $608.93 indicates investor confidence in the company's growth trajectory and strategic direction. The P/E ratio of 28.74 suggests that the market values Meta's future earnings potential highly, although it also indicates that the stock may be considered overvalued relative to earnings in some contexts.

Open Source AI Initiatives

Overview of Open Source AI

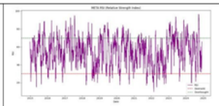
Meta has emerged as a pioneer in the open-source AI space, recognizing the importance of collaboration and transparency in advancing AI technologies. The company has launched several initiatives aimed at democratizing access to AI tools and fostering community engagement.

Key Initiatives

1. PyTorch: One of Meta's flagship contributions to the AI community, PyTorch is an open-source machine learning library that has gained significant traction among researchers and developers. It provides flexibility and scalability, making it a preferred choice for deep learning applications.

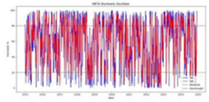
2. AI Research and Development: Meta's AI research arm focuses on advancing the field through open collaboration. By publishing research findings and sharing datasets, Meta encourages innovation and accelerates the development of new AI applications.

3. Community Engagement: Meta actively engages with the developer community through conferences, workshops, and online forums. This



Macd:

Stochastic Oscillator:



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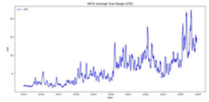

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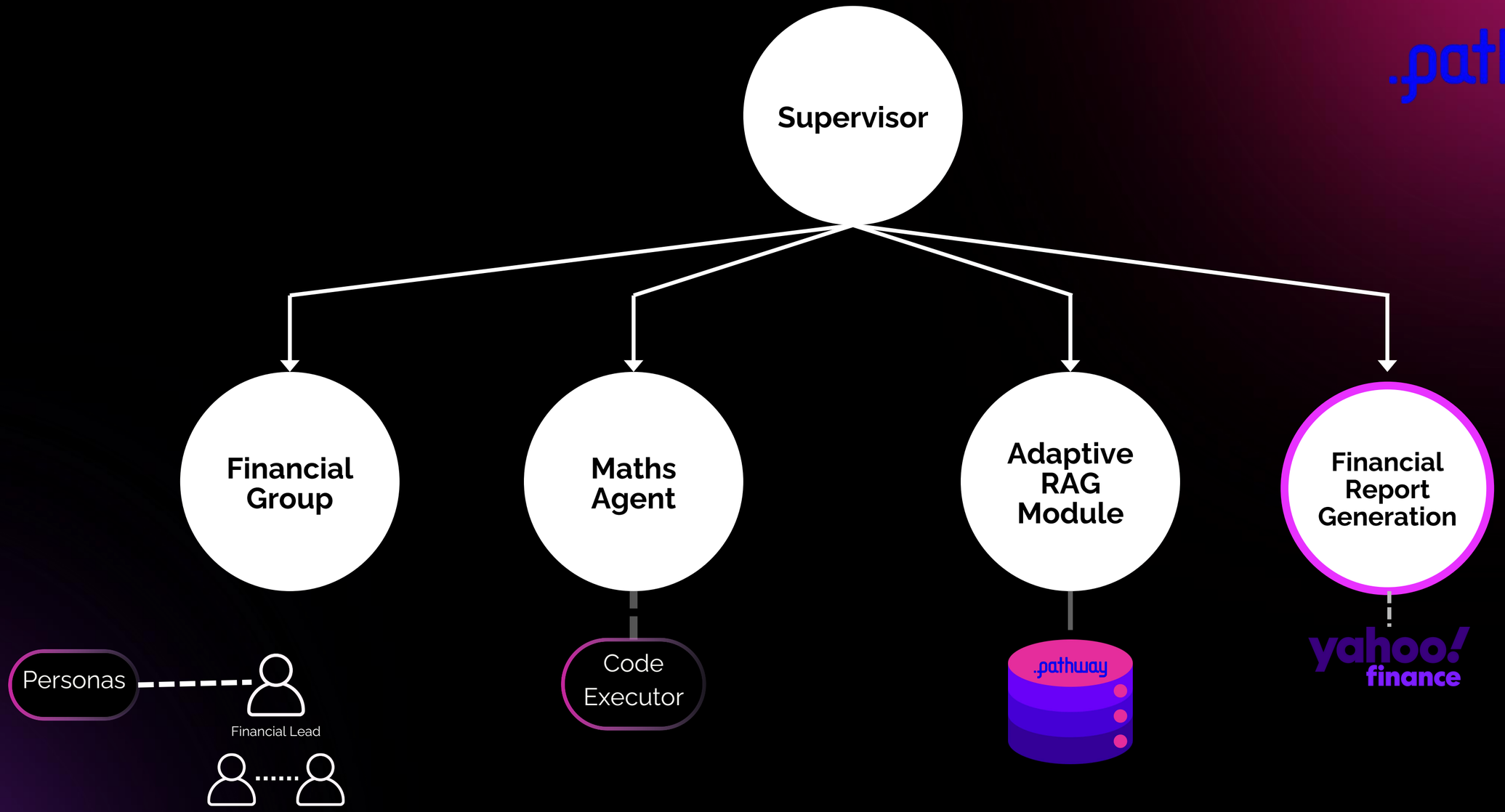
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Addressing Limitations in Existing Framework

Improved Table Parsing

Introduced **TableVision mode** in the Unstructured parser to enhance table retrieval accuracy by enriching table context with descriptions and relevant queries.

Real-Time Report Generation

Enabled real-time report generation by integrating tools like **yfinance** for data analysis and **python-docx** for report creation.

Human-in-the-Loop (HITL)

Integrated **HITL mechanisms** to allow users to provide feedback or clarification during ambiguous or complex queries, ensuring accurate results.

Token Minimization

Optimized the system to minimize token usage by dynamically generating and reusing embeddings, reducing computational overhead.

Dynamic Personas for Financial Groups

Implemented **dynamic role assignment** for the Financial Analyst Group, allowing agents to adapt their roles (e.g., Financial Lead, Analyst, Complementary Analyst) based on task complexity and requirements.

Fallback during Data Retrieval

Integrated a **fallback mechanism** in the Adaptive RAG framework to handle insufficient data by re-enhancing queries or escalating to external web search.

Reranking

Implemented **reranking mechanisms** in the Adaptive RAG framework to ensure the most relevant data is prioritized during retrieval.

CRAG + Self Reflection (Dynamic Replanning)

Enhanced the **Corrective Retrieval-Augmented Generation (CRAG)** framework with **self-reflection** and **dynamic replanning** to handle errors and improve task execution.

Parallel Execution

Optimized the system for **parallel execution** of tasks, reducing processing time and improving efficiency.

Guardrails

Implemented guardrails to prevent unethical or inappropriate queries, ensuring responsible AI practices. Our architecture integrates **dynamic content filtering** and **intelligent query reconstruction** to handle complex input scenarios, preventing fallbacks and ensuring seamless query processing while maintaining ethical standards.

Generalizable and Scalable Implementation:

Designed the framework to be **generalizable** and **scalable**, allowing it to handle diverse financial data processing tasks and large-scale datasets.

Addressing Limitations in Existing User Interface

Replay Conversations with Dynamic State Graphs

Enabled **replay functionality** in the UI to allow users to review past conversations and visualize the dynamic state graphs of the pipeline.

Real-Time Operations Sync

Provided a **real-time operations** sync feature in the UI to display ongoing processes, active agents, and tasks in the pipeline.

Interactive User-Agentic Setup

Designed an **interactive user-agentic setup** in the UI, allowing users to provide input, request clarifications, or intervene in the pipeline dynamically.

RESULTS

METHOD USED	ANSWER%	INCORRECT %	REFUSAL %
Llama 2 Shared Vector Store	19	70	11
GPT-4 Shared Vector Store	19	13	68
GPT-4 Turbo Oracle	85	15	0
Proposed System (No HITL)	42	49	9
Proposed System (With HITL)	56	37	7
Proposed System (Oracle Mode)	92	4	4

Dataset Used:

- FinanceBench:
  - Contains an open-source sample of 150 annotated examples.
  - Questions are ecologically valid and cover diverse scenarios.
- Question Types:
  - Domain Relevant: General financial analysis questions.
  - Novel Generated: Company or report-specific questions.
  - Metrics Generated: Questions requiring financial metric computation.

Results Inferred:

- Traditional methods struggle with tough benchmark questions requiring reasoning in addition to retrieval.
- Our approach improves accuracy and reliability, which is further improved using human-in-the-loop involvement.

Future Works

Generalizing the Use Case

By using **Dynamic Personas** we can generalize the framework to any scenario like legal etc.

Enhanced Agent Capabilities

Develop additional specialized agents for tax analysis, regulatory compliance, and ESG reporting.

Expanded Testing

Conduct comprehensive testing across diverse datasets and scenarios.

Automated Report Customization

Develop tools for user-specific report customization.

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Demo

Demo

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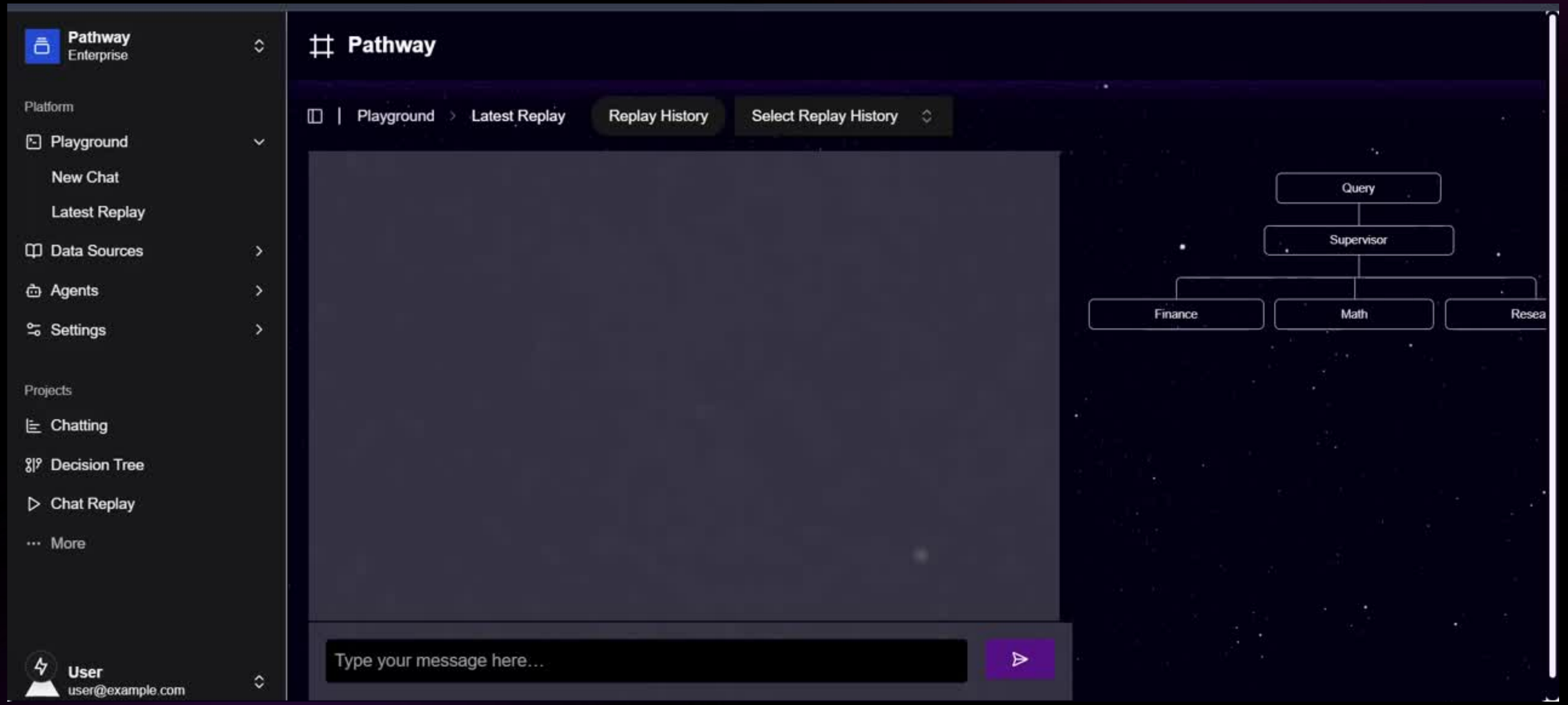

Demo

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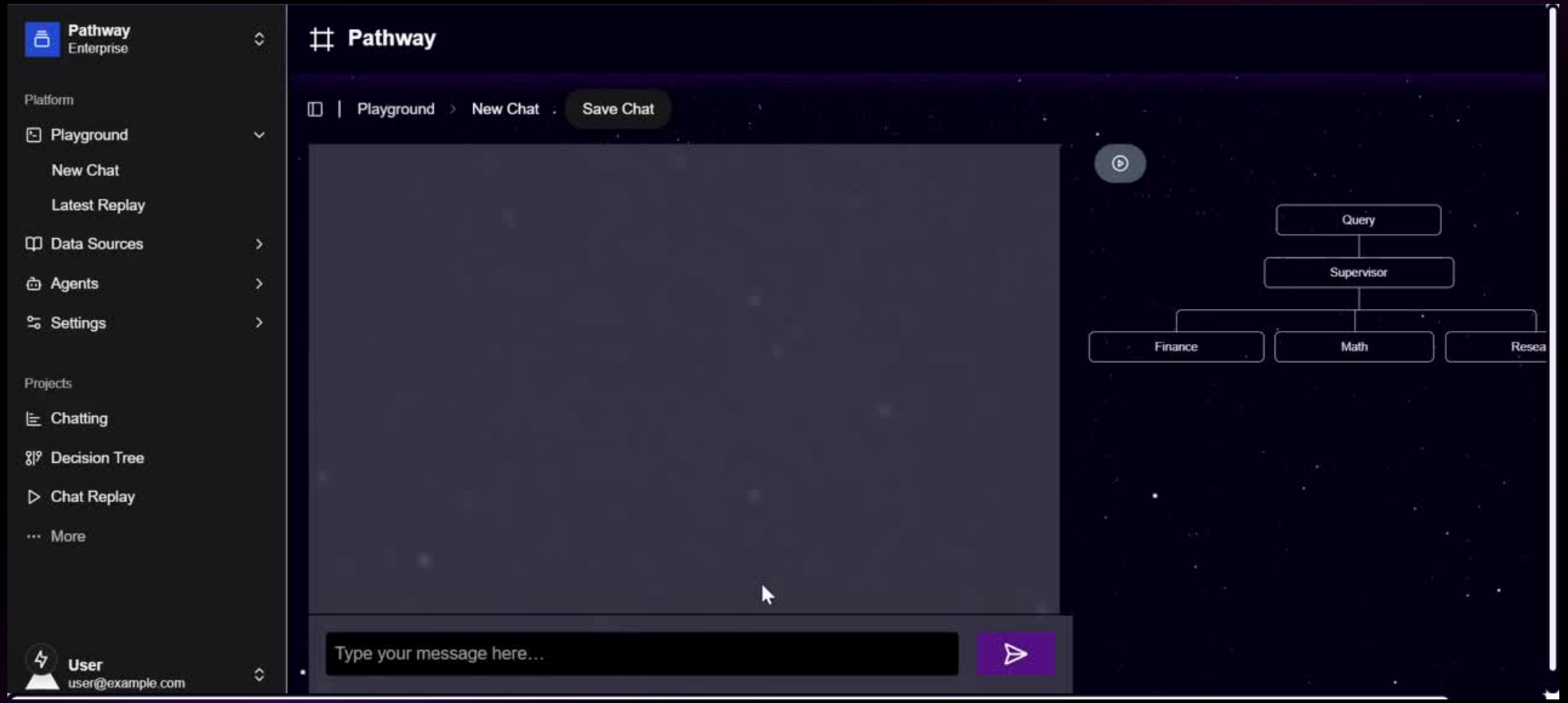

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QnA!

Appendix

References

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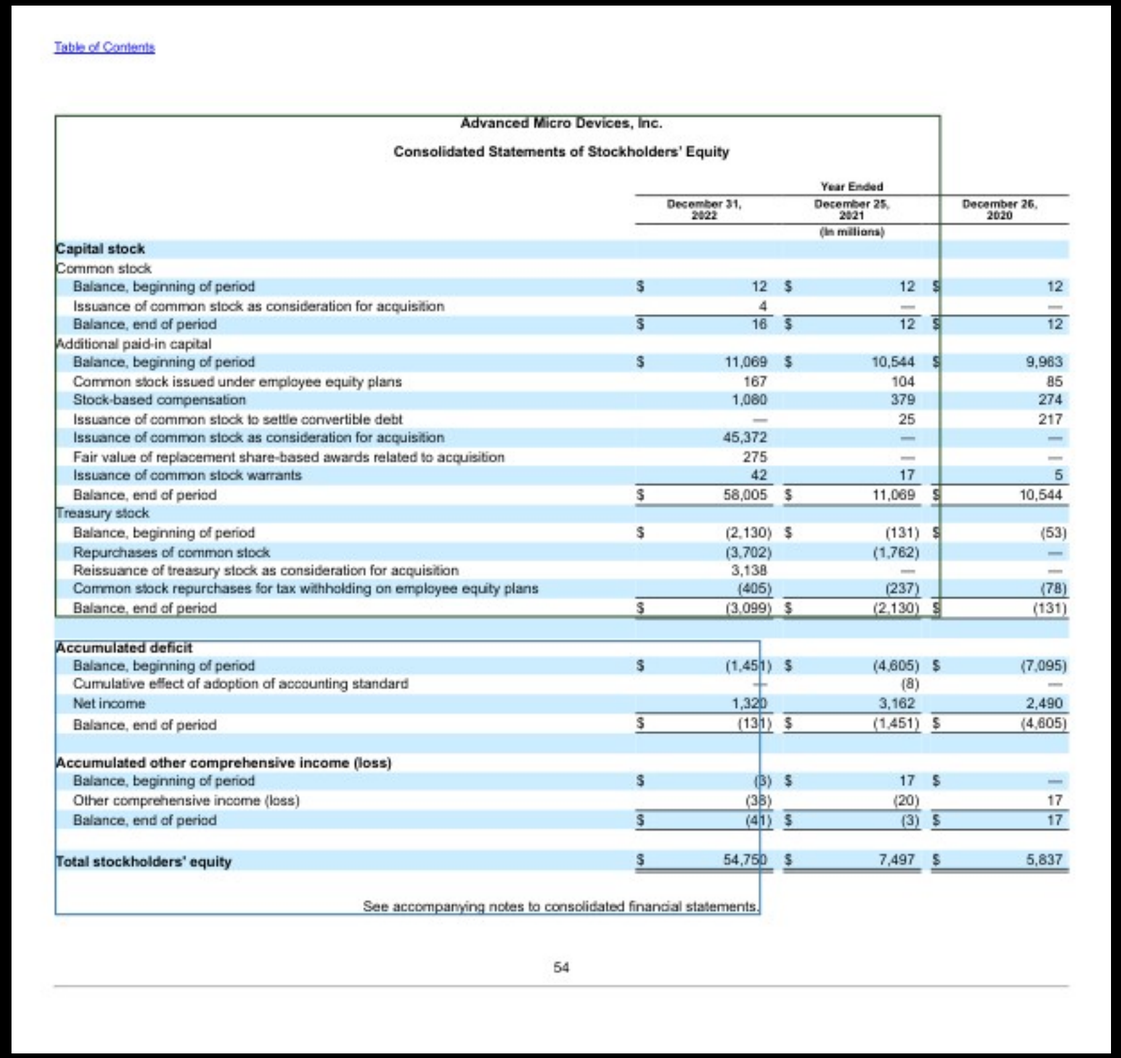

Table of Contents

Advanced Micro Devices, Inc.

Consolidated Statements of Stockholders' Equity

	Year Ended		
	December 31, 2022	December 25, 2021	December 26, 2020
		(In millions)	
Capital stock			
Common stock			
Balance, beginning of period	$ 12	$ 12	$ 12
Issuance of common stock as consideration for acquisition	4	—	—
Balance, end of period	$ 16	$ 12	$ 12
Additional paid-in capital			
Balance, beginning of period	$ 11,069	$ 10,544	$ 9,983
Common stock issued under employee equity plans	167	104	85
Stock-based compensation	1,080	379	274
Issuance of common stock to settle convertible debt	—	25	217
Issuance of common stock as consideration for acquisition	45,372	—	—
Fair value of replacement share-based awards related to acquisition	275	—	—
Issuance of common stock warrants	42	17	5
Balance, end of period	$ 58,005	$ 11,069	$ 10,544
Treasury stock			
Balance, beginning of period	$ (2,130)	$ (131)	$ (53)
Repurchases of common stock	(3,702)	(1,762)	—
Reissuance of treasury stock as consideration for acquisition	3,138	—	—
Common stock repurchases for tax withholding on employee equity plans	(405)	(237)	(78)
Balance, end of period	$ (3,099)	$ (2,130)	$ (131)
Accumulated deficit			
Balance, beginning of period	$ (1,451)	$ (4,605)	$ (7,095)
Cumulative effect of adoption of accounting standard	—	(8)	—
Net income	1,320	3,162	2,490
Balance, end of period	$ (131)	$ (1,451)	$ (4,605)
Accumulated other comprehensive income (loss)			
Balance, beginning of period	$ (3)	$ 17	$ —
Other comprehensive income (loss)	(38)	(20)	17
Balance, end of period	$ (41)	$ (3)	$ 17
Total stockholders' equity	$ 54,750	$ 7,497	$ 5,837

See accompanying notes to consolidated financial statements.

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Stats: https://www.m-files.com/how-long-does-it-actually-take-to-find-a-document-dissecting-the-many-stats-out-there/

https://www.accountingtute.com/addressing-human-error-financial-reporting/

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