

Fundamental_multi-agent_llamaIndex_framework_webinar_CFA_UK_v1

June 13, 2025

1 Fundamental Analysis using Multi-Agent System and Agentic RAG

1. Learn how to build your own **Multi-Agent** Fundamental Analysis Workflow with **LlamaIndex**:

- Built a multi-agent system using LlamaIndex's AgentWorkflow to automate fundamental financial analysis.
- Agents include fundamental, profitability, liquidity, and supervisor agents — each analyzing specific financial ratios and passing results downstream.
- Each agent has a clear goal, prompt, tool, and a defined handoff to the next agent.
- Tools are used to gather and evaluate data against predefined thresholds, updating the system state.
- LLMs used include GPT-4 variants and Claude Sonnet, leveraging on function calling.

2. Learn how to build an **Agentic RAG System** to chat with Financial Reports such as 10k using **ReAct Agent**

- Built a ReAct agent using LlamaIndex's ReActAgent to answer financial comparison questions using retrieval + reasoning.
- Two Query Engines are used as tools: one for Apple's 2024 financials, the other for Nvidia's — each tied to their respective document indexes.
- Agent uses OpenAI's GPT-4o-mini, with tool-calling enabled via the QueryEngineTool, allowing dynamic retrieval before reasoning.
- Asked complex financial questions, like comparing 2024 vs. 2023 revenues, and Apple's vs. Nvidia's revenues.
- Agent follows ReAct paradigm: identifies tool use if needed, fetches relevant context, and responds with calculated insights (e.g., % increase, ratio comparisons).

2 Technical Stack

- LlamaIndex: https://docs.llamaindex.ai/en/stable/examples/agent/agent_workflow_basic/
- FinanceToolkit: <https://github.com/JerBouma/FinanceToolkit>

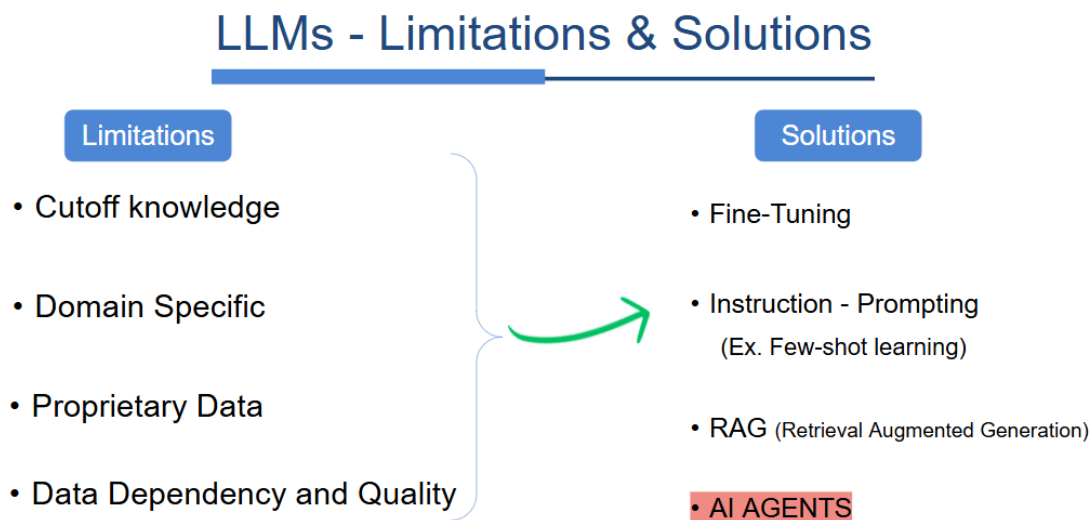
3 What Will you learn?

- LLMs limitations and solution
- Non Agentic vs Agentic Workflow
- Design Patterns
- Agents Architectures
- Reasoning Paradigm: ReAct
- Design a multi-agent system by calling external APIs
- Build a RAG ReAct agent to parse Financial reports and extract useful information.

4 Before You Practice – A Bit of Theory

4.1 LLMs limitations and solution

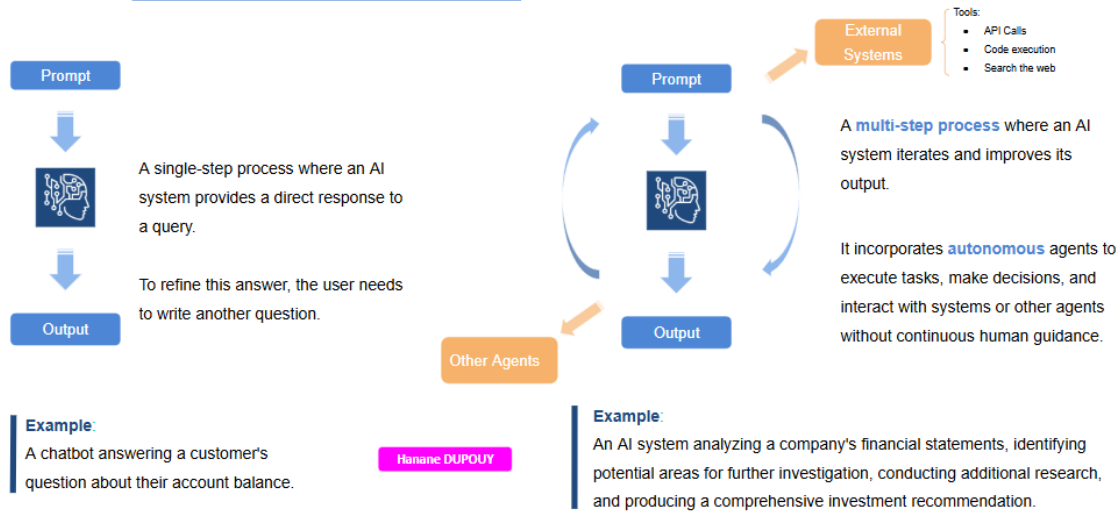
```
[10]: from IPython.display import Image, display
display(Image(filename=path+'/LLM_limitations_solutions.png'))
```



4.2 Non Agentic vs Agentic Workflow

```
[11]: display(Image(filename=path+'/non_agentic_vs_agentic_workflow.png'))
```

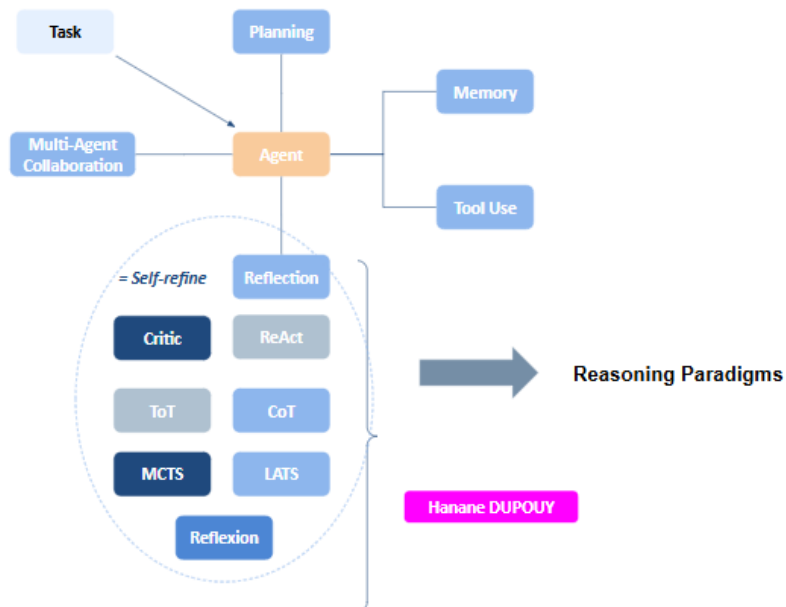
Non-Agentic vs. Agentic Workflow



4.3 Design Patterns

[12]: `display(Image(filename=path+'common_agentic_patterns.png'))`

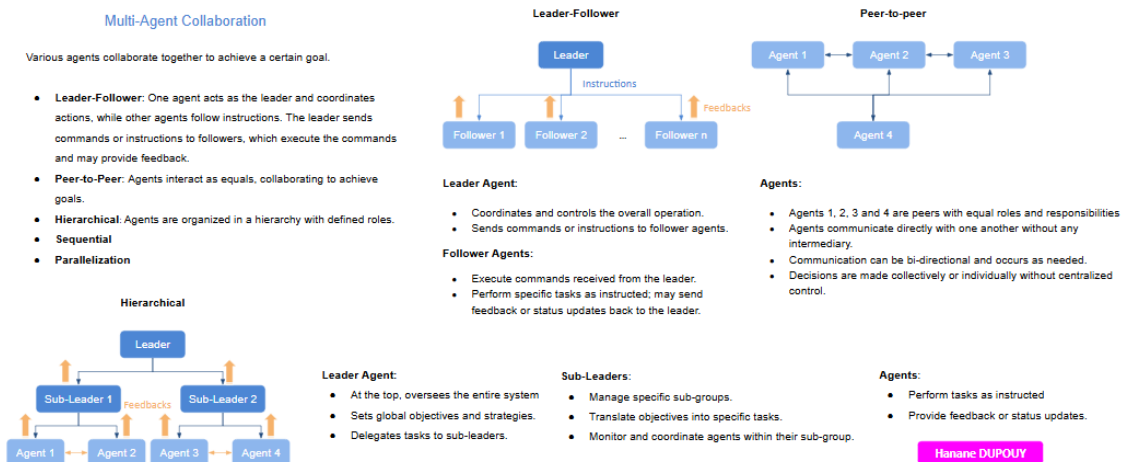
Common Agentic Patterns - Reminder



4.4 Agents Architectures

```
[13]: display(Image(filename=path+'./architectural_styles.png'))
```

Architectural Styles in Agentic Workflows



5 1- Multi Agent System

5.1 Learn how to build your own Multi-Agent Fundamental Analysis Workflow with LlamaIndex

5.1.1 Multi-Agent

By leveraging on AgentWorkflow class from LlamaIndex, we'll create a multi-agent system composed of:

- A `fundamental_agent`: Responsible for collecting ratios for a given ticker using the Finance-Toolkit package
- A `profitability_agent`: Responsible for gathering profitability ratios (ROA, ROE, Net Profit Margin, and Gross Margin) and analyzing their strengths or weaknesses compared to given thresholds. For example, if $ROA > 5\%$, the firm is in a healthy range.
- A `liquidity_agent`: This agent collects liquidity ratios for a given ticker (Current Ratio, Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio) and comments on these ratios given a set of threshold values. For example if Current Ratio is between 1.5-3.0 the firm is in a healthy range.
- A `supervisor_agent`: This agent provides a final comment on the overall health of the firm based on the different comments coming from the different agents.

I've limited my agents to 2 specialized ones, you can add as much as you need.

5.1.2 Agent's Breakdown:

Then for each agent:

- A clear description of the goal of the agent was provided
- A system prompt of the agent's instructions
- A Tool (you can also provide several tools) that helps gathering the data needed and compare it to the set of the pre-defined thresholds.
- The next agent to take the handoff.

5.1.3 Tools

There are 4 tools, each agent has a tool. Each tool can act and modify the State of the multi-agent system.

5.1.4 AgentWorkflow

Finally, the AgentWorkflow class puts all these together:

- You list the agents to use
- You specify the agent root
- You initiate your state

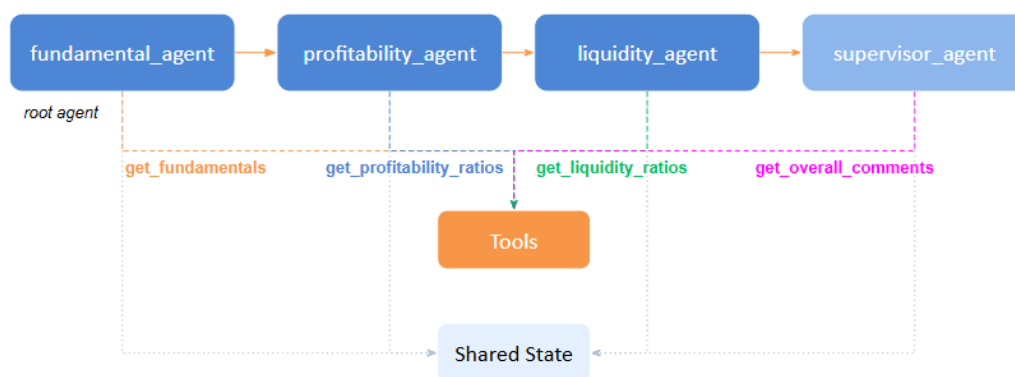
5.1.5 LLMs :

I used GPT-4o, GPT-4.1 and GPT-4.5-Preview. I also used Claude Sonnet 4 and 3.7. (I've used function calling LLMs because these agents supports natively tool calling).

5.1.6 Key Takeaways :

- The workflow is easy to put in place
- The agent's breakdown is well-defined, from its description to the system prompt and the next agents for handoff.
- I called LLMs inside of the tools to provide insights on the ratios compared to the thresholds. Otherwise, I faced sometimes some hallucination...
- The final answer from GPT-4.5-preview is well-structured compared to GPT-4o, providing key ratios, values, comments, and overall insights.
- Claude 3.7 Sonnet provided even better well designed answers than GPTs.

```
[4]: from IPython.display import Image, display
display(Image(filename=path+'/fundamental_multi_agent_system.png'))
```



5.2 Set Up

```
[ ]: %pip install llama-index -q
      %pip install financetoolkit -q
      %pip install llama-index-llms-anthropic -q
```

```
[ ]: import warnings
      warnings.filterwarnings("ignore")
```

```
[ ]: from google.colab import userdata
      FINANCIAL_MODELING_PREP_API_KEY = userdata.get('FINANCIAL_MODELING_PREP_API_KEY')
      OPENAI_API_KEY = userdata.get('OPENAI_API_KEY')

      from financetoolkit import Toolkit
      import pandas as pd

      from llama_index.llms.openai import OpenAI

      LLM_4o = OpenAI(model="gpt-4o", api_key=OPENAI_API_KEY)
      LLM_41 = OpenAI(model="gpt-4.1", api_key=OPENAI_API_KEY)
      LLM_45 = OpenAI(model="gpt-4.5-preview", api_key=OPENAI_API_KEY)
```

```
[ ]: from llama_index.llms.anthropic import Anthropic

      CLAUDE_API_KEY = userdata.get('CLAUDE_API_KEY')
      LLM_CLAUDE4 = Anthropic(model="claude-sonnet-4-0", api_key=CLAUDE_API_KEY)
```

```
[ ]: LLM_CLAUDE37 = Anthropic(model="claude-3-7-sonnet-latest",
      ↪api_key=CLAUDE_API_KEY)
```

```
[ ]: LLM_CLAUDE37_TOK = Anthropic(model="claude-3-7-sonnet-latest", max_tokens = 64000, api_key=CLAUDE_API_KEY)
```

5.3 MULTI-AGENT SYSTEM: How to build it?

5.3.1 TOOLS

Prompts and general functions

```
[ ]: PROMPT_THRESHOLD_VERIFICATION = """
    Analyze the financial health of the firm {ticker} based on its profitability
    ratios.

    ### Given:
    - Profitability or Liquidity Ratios for {ticker}:
      {dico_ratios}

    - Thresholds for Financial Health Evaluation:
      {thresholds_to_respect}

    ### Task:
    For each ratio, follow these steps:
    1 Assign a score from 1 to 10 (where 1 = very unhealthy, 10 = very healthy).
    2 Provide a justification explaining why the ratio received that score.
    3 Give an overall insight on the firm's financial health, summarizing
    strengths and weaknesses based on the individual ratio scores.

    Ensure the analysis is detailed, data-driven, and easy to interpret.
    """

THRESHOLDS_TO_RESPECT_PROFITABILITY = """
    ## Thresholds to respect for firm's financial health:
    ## Profitability Ratios (Assessing Earnings & Efficiency)
    |Ratio|          Healthy|          Moderate|          Weak| | | |
|---|---|---|---|---|---|---|
    |Return on Assets (ROA)|          |> 5%|          2% - 5%|          |< 2%|
    |Return on Equity (ROE)|          |> 15%|          |8% - 15%|          |< 8%|
    |Net Profit Margin|          |> 10%|          |5% - 10%|          |< 5%|
    |Gross Profit Margin|          |> 40%|          |20% - 40%|          |< 20%|
    """

THRESHOLDS_TO_RESPECT_LIQUIDITY = """
    ## Thresholds to respect for firm's financial health:
    ## Liquidity & Solvency Ratios (Assessing Financial Stability)
    | Ratio          | Healthy Range          | Warning Zone          | Risky/
    ↪Dangerous |
    | ----          | -----|          | -----|          | -----
    ↪|
```

```

| Current Ratio          | 1.5 - 3.0          | < 1.0          | > 3.0 (excess
↪cash) |
| Quick Ratio           | > 1.0              | < 1.0 |          |
| Debt-to-Equity (D/E) | 0.3 - 1.5          | > 2.0          | < 0.3
↪(under-leveraged) |
| Interest Coverage    | > 3.0              | 1.5 - 3.0      | < 1.5 (high risk) |
"""

```

```

def get_completion_profitability(ticker, dico_ratios_profitability,
↪llm_for_complete):
    prompt = PROMPT_THRESHOLD_VERIFICATION.format(ticker=ticker,
↪dico_ratios=dico_ratios_profitability,
↪thresholds_to_respect=THRESHOLDS_TO_RESPECT_PROFITABILITY)
    resp = llm_for_complete.complete(prompt)
    return resp

def get_completion_liquidity(ticker, dico_ratios_liquidity, llm_for_complete):
    prompt = PROMPT_THRESHOLD_VERIFICATION.format(ticker=ticker,
↪dico_ratios=dico_ratios_liquidity,
↪thresholds_to_respect=THRESHOLDS_TO_RESPECT_LIQUIDITY)
    resp = llm_for_complete.complete(prompt)
    return resp

```

Tools

```

[ ]: from llama_index.core.workflow import Context

async def get_fundamentals(ctx: Context, ticker: str) ->pd.DataFrame():
    """ Get the different fundamental ratios for a given ticker. """
    companies = Toolkit(
        [ticker], api_key=FINANCIAL_MODELING_PREP_API_KEY, start_date="2022-01-01"
    )
    ratios = companies.ratios.collect_all_ratios()

    print("ratios", ratios.loc['Return on Assets'])

    current_state = await ctx.get("state")

    if current_state["ticker"] == "":
        current_state["ticker"] = ticker

    if current_state["ratios"].empty:
        current_state["ratios"] = ratios

    await ctx.set("state", current_state)

    return f"Ratios extracted for {ticker}."

```



```

async def get_profitability_ratios(ctx: Context, llm_for_complete=LLM_4o):
    """Get profitability ratios for a given ticker: ROA, ROE, Net Profit Margin,
    and Gross Margin, and comments on these ratios given a set of threshold
    values."""

    current_state = await ctx.get("state")
    ratios = current_state['ratios']
    ticker = current_state['ticker']

    ROA = ratios.loc['Return on Assets']
    ROE = ratios.loc['Return on Equity']
    net_profit_margin = ratios.loc['Net Profit Margin']
    gross_margin = ratios.loc['Gross Margin']

    # print("## Profitability Ratios (Assessing Earnings & Efficiency)")
    # print("Return on Assets (ROA):", ROA.index[-1], ROA.iloc[-1])
    # print("Return on Equity (ROE):", ROE.index[-1], ROE.iloc[-1])
    # print("Net Profit Margin:", net_profit_margin.index[-1], net_profit_margin.
    # iloc[-1])
    # print("Gross Margin:", gross_margin.index[-1], gross_margin.iloc[-1])

    roa_values = [ROA.index[-1], ROA.iloc[-1]]
    roe_values = [ROE.index[-1], ROE.iloc[-1]]
    net_profit_margin_values = [net_profit_margin.index[-1], net_profit_margin.
    iloc[-1]]
    gross_margin_values = [gross_margin.index[-1], gross_margin.iloc[-1]]

    dico_ratios_profitability = {
        "Return on Assets (ROA)": roa_values,
        "Return on Equity (ROE)": roe_values,
        "Net Profit Margin": net_profit_margin_values,
        "Gross Margin": gross_margin_values
    }

    #Need to add conditions whether ratios, roa, roe, net profit margin, gross
    #margin are empty or not
    if current_state["profitability_ratios"] == {}:
        current_state["profitability_ratios"] = dico_ratios_profitability

    resp = get_completion_profitability(ticker, dico_ratios_profitability,
    llm_for_complete)
    current_state['threshold_profitability_comments'] = resp

    await ctx.set("state", current_state)

```

```

    return "Profitability ratios extracted and Comments performed: " + str(resp)

async def get_liquidity_ratios(ctx: Context, llm_for_complete=LLM_4o):
    """Get liquidity ratios for a given ticker: Current Ratio, Quick Ratio,
    ↪Debt-to-Equity Ratio, Interest Coverage Ratio and comments on these ratios
    ↪given a set of threshold values."""

    current_state = await ctx.get("state")
    ratios = current_state['ratios']
    ticker = current_state['ticker']

    current_ratio = ratios.loc['Current Ratio']
    quick_ratio = ratios.loc['Quick Ratio']
    debt_to_equity_ratio = ratios.loc['Debt-to-Equity Ratio']
    interest_coverage_ratio = ratios.loc['Interest Coverage Ratio']

    # print("## Profitability Ratios (Assessing Earnings & Efficiency)")
    # print("Current Ratio:", current_ratio.index[-1], current_ratio.iloc[-1])
    # print("Quick Ratio:", quick_ratio.index[-1], quick_ratio.iloc[-1])
    # print("Debt to Equity Ratio:", debt_to_equity_ratio.index[-1],
    ↪debt_to_equity_ratio.iloc[-1])
    # print("Interest Coverage Ratio:", interest_coverage_ratio.index[-1],
    ↪interest_coverage_ratio.iloc[-1])

    current_ratio_values = [current_ratio.index[-1], current_ratio.iloc[-1]]
    quick_ratio_values = [quick_ratio.index[-1], quick_ratio.iloc[-1]]
    debt_to_equity_ratio_values = [debt_to_equity_ratio.index[-1],
    ↪debt_to_equity_ratio.iloc[-1]]
    interest_coverage_ratio_values = [interest_coverage_ratio.index[-1],
    ↪interest_coverage_ratio.iloc[-1]]

    dico_ratios_liquidity = {
        "Current Ratio": current_ratio_values,
        "Quick Ratio": quick_ratio_values,
        "Debt to Equity Ratio": debt_to_equity_ratio_values,
        "Interest Coverage Ratio": interest_coverage_ratio_values
    }

    #Need to add conditions whether ratios, roa, roe, net profit margin, gross
    ↪margin are empty or not
    if current_state["liquidity_ratios"] == {}:
        current_state["liquidity_ratios"] = dico_ratios_liquidity

    resp = get_completion_liquidity(ticker, dico_ratios_liquidity,
    ↪llm_for_complete)

```

```

current_state['threshold_liquidity_comments'] = resp

await ctx.set("state", current_state)
return "Liquidity ratios extracted and Comments performed: " + str(resp)

async def get_overall_comments(ctx: Context):
    """Get comments on different type of ratios. The overall_comments are given by
    ↪ the SupervisedAgent based on threshold_profitability_comments and
    ↪ threshold_liquidity_comments."""

    current_state = await ctx.get("state")
    profitability_comments = current_state['threshold_profitability_comments']
    liquidity_comments = current_state['threshold_liquidity_comments']

    if profitability_comments is None:
        return "No profitability comments found."

    if liquidity_comments is None:
        return "No liquidity comments found."

    if ~ profitability_comments is None and ~ liquidity_comments is None:
        overall_comments = profitability_comments + "\n" + liquidity_comments
        current_state['overall_comments'] = overall_comments

    return "Overall comments done."

```

5.3.2 AGENTS

```

[ ]: from llama_index.core.agent.workflow import FunctionAgent

fundamental_agent = FunctionAgent(
    name="FundamentalAgent",
    description="Get various fundamental ratios for a given ticker.",
    system_prompt=(
        "You are the fundament analyst that can extract different fundamental
        ↪ ratios for a given ticker. "
        "Once you have extracted the fundamental financial ratios, you should
        ↪ hand off control to the ProfitabilityAgent to extract the profitability
        ↪ ratios or/and the LiquidityAgent to extract the liquidity ratios."
    ),
    llm=LLM_4o,
    tools=[get_fundamentals],
    can_handoff_to=["ProfitabilityAgent"],
)

profitability_agent = FunctionAgent(

```

```

    name="ProfitabilityAgent",
    description="Collect profitability ratios for a given ticker: ROA, ROE, Net_
↳Profit Margin and Gross Margin and Comment on the results given a set of_
↳threshold values.",
    system_prompt=(
        """You are the ProfitabilityAgent that can collect profitability ratios_
↳(profitability_ratios) on a given ticker.

        You collect these ratios from the FundamentalAgent.
        Once these ratios are collected in profitability_ratios, you should_
↳comment on these ratios based on the thresholds values provided in_
↳get_profitability_ratios.

        These comments must be included in threshold_profitability_comments. At_
↳the end provide ONLY these comments included in_
↳threshold_profitability_comments. DO NOT ADD anything else.

        Once the comments are done, you should hand off control to the_
↳LiquidityAgent.

        """
    ),
    llm=LLM_4o,
    tools=[get_profitability_ratios],
    can_handoff_to=["LiquidityAgent"],
)

liquidity_agent = FunctionAgent(
    name="LiquidityAgent",
    description="Collect liquidity ratios for a given ticker: Current Ratio,_
↳Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio and comments on_
↳these ratios given a set of threshold values.",
    system_prompt=(
        """You are the LiquidityAgent that can collect liquidity ratios_
↳(liquidity_ratios) on a given ticker.

        You collect these ratios from the FundamentalAgent.
        Once these ratios are collected in liquidity_ratios, you should comment_
↳on these ratios based on the thresholds values provided in_
↳get_liquidity_ratios.

        These comments must be included in threshold_liquidity_comments. At the_
↳end provide ONLY these comments included in threshold_liquidity_comments. DO_
↳NOT ADD anything else.

        Once the comments are done, you should hand off control to the_
↳SupervisorAgent.

        """
    ),
    llm=LLM_4o,
    tools=[get_liquidity_ratios],
    can_handoff_to=["SupervisorAgent"],
)

```

```

supervisor_agent = FunctionAgent(
    name="SupervisorAgent",
    description="Provide an overall comment based on the comments coming from
    ↪the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.",
    system_prompt=(
        "You are an fundament analyst expert and supervisor. You collect
        ↪comments coming from various agents such as ProfitabilityAgent and
        ↪LiquidityAgent. "
        "If you collect only one or no comments, go back to ProfitabilityAgent
        ↪and LiquidityAgent until you get the desired feedbacks on the ratios."
        "If you don't collect threshold_liquidity_comments, you should hand off
        ↪control to the LiquidityAgent to gather these comments."
        "If you don't collect threshold_profitability_comments, you should hand
        ↪off control to the ProfitabilityAgent to gather these comments."
        "Based on the results in the comments coming from the
        ↪ProfitabilityAgent and LiquidityAgent, provide an overall comment on the
        ↪health of the firm."
        "Justify your comment with details and data. "
    ),
    llm=LLM_4o,
    tools=[get_overall_comments],
    can_handoff_to=["FundamentalAgent", "ProfitabilityAgent", "LiquidityAgent"],
)

```

5.3.3 AGENT WORKFLOW

```

[ ]: from llama_index.core.agent.workflow import AgentWorkflow

agent_workflow = AgentWorkflow(
    agents=[fundamental_agent, profitability_agent, liquidity_agent,
    ↪supervisor_agent],
    root_agent=fundamental_agent.name,
    initial_state={
        "ratios": pd.DataFrame(),
        "profitability_ratios": {},
        "liquidity_ratios": {},
        "threshold_profitability_comments": None,
        "threshold_liquidity_comments": None,
        "overall_comments": None,
        "ticker": "",
    },
)

```

5.4 LLM: GPT-4o

5.4.1 Calling the Multi-Agent System for a specific task

Run 1

```
[ ]: from llama_index.core.agent.workflow import (
    AgentInput,
    AgentOutput,
    ToolCall,
    ToolCallResult,
    AgentStream,
)

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the
        ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print(" Output:", event.response.content)
        if event.tool_calls:
            print(
                " Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )

    elif isinstance(event, ToolCallResult):
        print(f" Tool Result ({event.tool_name}):")
        print(f" Arguments: {event.tool_kwargs}")
        print(f" Output: {event.tool_output}")

    elif isinstance(event, ToolCall):
        print(f" Calling Tool: {event.tool_name}")
        print(f" With arguments: {event.tool_kwargs}")
```

```

=====
Agent: FundamentalAgent
=====

Planning to use tools: ['get_fundamentals']

Obtaining financial statements: 100%|      | 3/3 [00:01<00:00, 2.60it/s]
Obtaining historical data: 100%|      | 2/2 [00:00<00:00, 9.64it/s]

ratios 2022      NaN
2023      0.275
2024      0.2613
Freq: Y-DEC, Name: Return on Assets, dtype: float64
Calling Tool: get_fundamentals
With arguments: {'ticker': 'AAPL'}
Tool Result (get_fundamentals):
Arguments: {'ticker': 'AAPL'}
Output: Ratios extracted for AAPL.
Planning to use tools: ['handoff']
Calling Tool: handoff
With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect
profitability ratios for AAPL and comment on the results given a set of
threshold values.'}
Tool Result (handoff):
Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect profitability
ratios for AAPL and comment on the results given a set of threshold values.'}
Output: Agent ProfitabilityAgent is now handling the request due to the
following reason: Collect profitability ratios for AAPL and comment on the
results given a set of threshold values..
Please continue with the current request.

=====
Agent: ProfitabilityAgent
=====

Planning to use tools: ['get_profitability_ratios']
Calling Tool: get_profitability_ratios
With arguments: {}
Tool Result (get_profitability_ratios):
Arguments: {}
Output: Profitability ratios extracted and Comments performed: To analyze the
financial health of Apple Inc. (AAPL) based on its profitability ratios, we will
evaluate each ratio against the provided thresholds, assign a score from 1 to
10, and provide justifications for each score. Finally, we will summarize the
overall financial health of the firm.

### 1 Return on Assets (ROA)

```

- ****Value:**** 26.13%
- ****Thresholds:****
 - Healthy: > 5%
 - Moderate: 2% - 5%
 - Weak: < 2%

****Score:**** 10/10

****Justification:**** Apple's ROA of 26.13% is significantly above the healthy threshold of 5%. This indicates that the company is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational efficiency and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- ****Value:**** 157.41%
- ****Thresholds:****
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

****Score:**** 10/10

****Justification:**** With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits from its shareholders' equity, reflecting strong financial performance and effective use of equity capital. Such a high ROE is indicative of a company with a competitive advantage and strong profitability.

3 Net Profit Margin

- ****Value:**** 23.97%
- ****Thresholds:****
 - Healthy: > 10%
 - Moderate: 5% - 10%
 - Weak: < 5%

****Score:**** 10/10

****Justification:**** Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin indicates that the company retains a significant portion of its revenue as profit after all expenses, showcasing strong cost management and pricing power. A high net profit margin is a sign of a financially robust company.

4 Gross Margin

- ****Value:**** 46.21%
- ****Thresholds:****
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

****Score:**** 10/10

****Justification:**** The gross margin of 46.21% is above the healthy threshold of 40%, indicating that Apple is effectively managing its production costs relative to its sales. A high gross margin suggests that the company has a strong competitive position, allowing it to maintain pricing power and cost efficiency.

Overall Insight on Financial Health

Apple Inc. demonstrates exceptional financial health based on its profitability ratios. Each ratio significantly exceeds the healthy thresholds, indicating strong operational efficiency, effective asset and equity management, and robust cost control. The high scores across all ratios reflect a company with a strong competitive advantage, capable of generating substantial profits and maintaining financial stability. Apple's financial strengths include its ability to efficiently utilize assets and equity, maintain high profit margins, and manage production costs effectively. There are no apparent weaknesses in the profitability ratios, suggesting that Apple is in a very healthy financial position.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability analysis for AAPL is complete. Now, it's time to collect liquidity ratios and provide comments on them."}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability analysis for AAPL is complete. Now, it's time to collect liquidity ratios and provide comments on them."}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Profitability analysis for AAPL is complete. Now, it's time to collect liquidity ratios and provide comments on them..

Please continue with the current request.

=====

Agent: LiquidityAgent

=====

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the overall financial health of the firm.

1. Current Ratio

- **Value:** 0.8673
- **Healthy Range:** 1.5 - 3.0
- **Evaluation:** The current ratio of 0.8673 is below the healthy range, indicating that Apple may not have enough current assets to cover its current liabilities. This places the company in the warning zone, suggesting potential liquidity issues.
- **Score:** 3
- **Justification:** The score reflects the fact that the current ratio is below 1.0, indicating a potential liquidity concern. However, Apple is a large, established company with significant cash flows, which may mitigate some of the risks associated with a low current ratio.

2. Quick Ratio

- **Value:** 0.5589
- **Healthy Range:** > 1.0
- **Evaluation:** The quick ratio is also below the healthy threshold, indicating that Apple may not have sufficient liquid assets to meet its short-term obligations without relying on inventory sales.
- **Score:** 2
- **Justification:** A quick ratio below 1.0 suggests that Apple might face challenges in meeting its short-term liabilities with its most liquid assets. The score reflects the potential risk, although Apple's strong market position and cash flow generation capabilities may provide some buffer.

3. Debt-to-Equity Ratio

- **Value:** 2.0906
- **Healthy Range:** 0.3 - 1.5
- **Evaluation:** The debt-to-equity ratio is above the healthy range and falls into the warning zone. This indicates that Apple is using a higher level of debt financing compared to equity, which could increase financial risk.
- **Score:** 4
- **Justification:** The score reflects the elevated financial leverage, which could pose risks if not managed properly. However, Apple's ability to generate substantial earnings and cash flow may help mitigate these risks.

4. Interest Coverage Ratio

- **Value:** Infinity (inf)
- **Healthy Range:** > 3.0
- **Evaluation:** An infinite interest coverage ratio suggests that Apple has no difficulty covering its interest expenses, indicating strong financial health in terms of its ability to meet debt obligations.

- **Score:** 10
- **Justification:** The infinite interest coverage ratio is a strong indicator of Apple's ability to comfortably cover its interest expenses, reflecting excellent financial health in this aspect.

Overall Insight on Apple's Financial Health

Strengths:

- **Interest Coverage:** Apple demonstrates exceptional strength in its ability to cover interest expenses, indicating robust earnings relative to its interest obligations.

Weaknesses:

- **Liquidity Ratios (Current and Quick Ratios):** Both ratios are below the healthy thresholds, suggesting potential liquidity concerns. However, Apple's strong cash flow and market position may alleviate some of these concerns.
- **Debt-to-Equity Ratio:** The elevated ratio indicates higher financial leverage, which could pose risks if not managed carefully.

****Summary:**** While Apple shows strong financial health in terms of its ability to cover interest expenses, the low liquidity ratios and high debt-to-equity ratio suggest areas of potential concern. However, given Apple's strong market position, brand strength, and cash flow generation capabilities, the company is likely well-positioned to manage these risks effectively. Overall, Apple's financial health appears solid, but monitoring liquidity and leverage levels will be important moving forward.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'SupervisorAgent', 'reason': "Liquidity analysis for AAPL is complete. Now, it's time to provide an overall comment based on the profitability and liquidity comments."}

Tool Result (handoff):

Arguments: {'to_agent': 'SupervisorAgent', 'reason': "Liquidity analysis for AAPL is complete. Now, it's time to provide an overall comment based on the profitability and liquidity comments."}

Output: Agent SupervisorAgent is now handling the request due to the following reason: Liquidity analysis for AAPL is complete. Now, it's time to provide an overall comment based on the profitability and liquidity comments..
Please continue with the current request.

=====
Agent: SupervisorAgent
=====

Planning to use tools: ['get_overall_comments']

Calling Tool: get_overall_comments

With arguments: {'overall_comments': "Apple Inc. (AAPL) demonstrates exceptional financial health based on its profitability ratios, with all metrics

significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity management, and robust cost control. However, liquidity ratios reveal potential concerns, with both current and quick ratios below healthy levels, suggesting possible liquidity issues. The debt-to-equity ratio is also elevated, indicating higher financial leverage. Despite these concerns, Apple's strong cash flow, market position, and infinite interest coverage ratio suggest the company is well-positioned to manage these risks effectively. Overall, Apple's financial health is solid, but monitoring liquidity and leverage will be important moving forward."}

Tool Result (get_overall_comments):

Arguments: {'overall_comments': "Apple Inc. (AAPL) demonstrates exceptional financial health based on its profitability ratios, with all metrics significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity management, and robust cost control. However, liquidity ratios reveal potential concerns, with both current and quick ratios below healthy levels, suggesting possible liquidity issues. The debt-to-equity ratio is also elevated, indicating higher financial leverage. Despite these concerns, Apple's strong cash flow, market position, and infinite interest coverage ratio suggest the company is well-positioned to manage these risks effectively. Overall, Apple's financial health is solid, but monitoring liquidity and leverage will be important moving forward."}

Output: bad operand type for unary ~: 'CompletionResponse'

Output: Based on the analysis of Apple Inc.'s (AAPL) financial health, the company exhibits exceptional profitability, with all profitability ratios significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity management, and robust cost control. However, there are potential concerns regarding liquidity, as both the current and quick ratios are below healthy levels, suggesting possible liquidity issues. Additionally, the debt-to-equity ratio is elevated, indicating higher financial leverage.

Despite these concerns, Apple's strong cash flow, market position, and infinite interest coverage ratio suggest that the company is well-positioned to manage these risks effectively. Overall, Apple's financial health is solid, but it will be important to monitor liquidity and leverage levels moving forward to ensure continued financial stability.

Output: Based on the analysis of Apple Inc.'s (AAPL) financial health, the company exhibits exceptional profitability, with all profitability ratios significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity management, and robust cost control. However, there are potential concerns regarding liquidity, as both the current and quick ratios are below healthy levels, suggesting possible liquidity issues. Additionally, the debt-to-equity ratio is elevated, indicating higher financial leverage.

Despite these concerns, Apple's strong cash flow, market position, and infinite interest coverage ratio suggest that the company is well-positioned to manage these risks effectively. Overall, Apple's financial health is solid, but it will be important to monitor liquidity and leverage levels moving forward to ensure continued financial stability.

Run 2

```
[ ]: from llama_index.core.agent.workflow import (
    AgentInput,
    AgentOutput,
    ToolCall,
    ToolCallResult,
    AgentStream,
)

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the_
        ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print(" Output:", event.response.content)
        if event.tool_calls:
            print(
                " Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )

    elif isinstance(event, ToolCallResult):
        print(f" Tool Result ({event.tool_name}):")
        print(f" Arguments: {event.tool_kwargs}")
        print(f" Output: {event.tool_output}")

    elif isinstance(event, ToolCall):
        print(f" Calling Tool: {event.tool_name}")
        print(f" With arguments: {event.tool_kwargs}")
```

```
=====
Agent: FundamentalAgent
```

```

=====

Planning to use tools: ['get_fundamentals']

Obtaining financial statements: 100%|      | 3/3 [00:00<00:00, 3.16it/s]
Obtaining historical data: 100%|      | 2/2 [00:00<00:00, 9.55it/s]

ratios 2022      NaN
2023      0.275
2024      0.2613
Freq: Y-DEC, Name: Return on Assets, dtype: float64
Calling Tool: get_fundamentals
With arguments: {'ticker': 'AAPL'}
Tool Result (get_fundamentals):
Arguments: {'ticker': 'AAPL'}
Output: Ratios extracted for AAPL.
Planning to use tools: ['handoff']
Calling Tool: handoff
With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect
profitability ratios for AAPL and comment on the results given a set of
threshold values.'}
Tool Result (handoff):
Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect profitability
ratios for AAPL and comment on the results given a set of threshold values.'}
Output: Agent ProfitabilityAgent is now handling the request due to the
following reason: Collect profitability ratios for AAPL and comment on the
results given a set of threshold values..
Please continue with the current request.

=====

Agent: ProfitabilityAgent
=====

Planning to use tools: ['get_profitability_ratios']
Calling Tool: get_profitability_ratios
With arguments: {}
Tool Result (get_profitability_ratios):
Arguments: {}
Output: Profitability ratios extracted and Comments performed: To analyze the
financial health of Apple Inc. (AAPL) based on its profitability ratios, we will
evaluate each ratio against the provided thresholds and assign a score from 1 to
10. This score will reflect the health of each ratio, with 1 being very
unhealthy and 10 being very healthy. Let's proceed with the analysis:

### 1 Return on Assets (ROA)
- **Value**: 26.13%
- **Thresholds**:
  - Healthy: > 5%
  - Moderate: 2% - 5%

```

- Weak: < 2%

****Score**:** 10/10

****Justification**:** Apple's ROA of 26.13% is significantly above the healthy threshold of 5%. This indicates that the company is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational efficiency and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- ****Value**:** 157.41%
- ****Thresholds**:**
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

****Score**:** 10/10

****Justification**:** With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits from its shareholders' equity. It reflects strong financial performance and effective use of equity capital, suggesting robust profitability and shareholder value creation.

3 Net Profit Margin

- ****Value**:** 23.97%
- ****Thresholds**:**
 - Healthy: > 10%
 - Moderate: 5% - 10%
 - Weak: < 5%

****Score**:** 10/10

****Justification**:** Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin indicates that the company retains a significant portion of its revenue as profit after all expenses. It reflects strong cost management and pricing power, contributing to overall financial health.

4 Gross Margin

- ****Value**:** 46.21%
- ****Thresholds**:**
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

****Score**:** 10/10

****Justification**:** The gross margin of 46.21% is above the healthy threshold of 40%. This suggests that Apple has a strong ability to manage its production costs relative to sales, maintaining a substantial portion of revenue as gross profit. It indicates effective cost control and competitive advantage in its market.

Overall Insight on Financial Health

Apple Inc. demonstrates exceptional financial health based on its profitability ratios. Each ratio significantly exceeds the healthy thresholds, indicating strong operational efficiency, effective asset and equity utilization, robust profit retention, and excellent cost management. The company's ability to generate high returns on assets and equity, coupled with strong profit margins, highlights its competitive strength and financial stability.

****Strengths**:**

- High efficiency in asset utilization (ROA).
- Exceptional shareholder value creation (ROE).
- Strong profit retention and cost management (Net Profit Margin and Gross Margin).

****Weaknesses**:**

- No apparent weaknesses in profitability ratios.

Overall, Apple's financial health is very strong, with all profitability ratios indicating a well-managed and highly profitable company.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability ratios for AAPL have been collected and commented on. Now, it's time to collect liquidity ratios and provide comments on them."}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability ratios for AAPL have been collected and commented on. Now, it's time to collect liquidity ratios and provide comments on them."}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Profitability ratios for AAPL have been collected and commented on. Now, it's time to collect liquidity ratios and provide comments on them..

Please continue with the current request.

=====
Agent: LiquidityAgent
=====

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the overall financial health of the firm.

1. Current Ratio

- **Value:** 0.8673
- **Thresholds:**
 - Healthy Range: 1.5 - 3.0
 - Warning Zone: < 1.0
 - Risky/Dangerous: > 3.0 (excess cash)

Score: 3/10

Justification:

The current ratio of 0.8673 indicates that Apple has less than \$1 in current assets for every \$1 of current liabilities, placing it in the warning zone. This suggests potential liquidity issues, as the company may struggle to cover its short-term obligations. However, large tech companies like Apple often operate with lower current ratios due to efficient cash management and strong cash flow generation, which slightly mitigates the concern.

2. Quick Ratio

- **Value:** 0.5589
- **Thresholds:**
 - Healthy Range: > 1.0
 - Warning Zone: < 1.0

Score: 2/10

Justification:

The quick ratio of 0.5589 is below the healthy threshold of 1.0, indicating that Apple may not have enough liquid assets to cover its immediate liabilities without relying on inventory sales. This low quick ratio suggests potential liquidity challenges, but similar to the current ratio, Apple's strong cash flow and market position may offset some risks.

3. Debt-to-Equity Ratio

- **Value:** 2.0906
- **Thresholds:**
 - Healthy Range: 0.3 - 1.5
 - Warning Zone: > 2.0
 - Risky/Dangerous: < 0.3 (under-leveraged)

Score: 4/10

Justification:

The debt-to-equity ratio of 2.0906 is above the healthy range and falls into the

warning zone. This indicates that Apple is using a significant amount of debt relative to its equity, which could increase financial risk. However, Apple's strong earnings and cash flow generation capabilities may allow it to manage this higher leverage effectively.

4. Interest Coverage Ratio

- ****Value:**** Infinity (inf)
- ****Thresholds:****
 - Healthy Range: > 3.0
 - Warning Zone: 1.5 - 3.0
 - Risky/Dangerous: < 1.5 (high risk)

****Score:**** 10/10

****Justification:****

An infinite interest coverage ratio suggests that Apple has no difficulty covering its interest expenses, indicating excellent financial health in terms of its ability to meet debt obligations. This reflects Apple's strong profitability and cash flow, which provide a significant buffer against interest payments.

Overall Insight on Financial Health

****Overall Score:**** 5/10

****Summary:****

Apple's financial health presents a mixed picture. The liquidity ratios (current and quick) are below the healthy thresholds, indicating potential short-term liquidity concerns. However, Apple's strong cash flow and operational efficiency may mitigate these risks. The debt-to-equity ratio is in the warning zone, suggesting higher leverage, but Apple's robust earnings capacity provides some reassurance. The infinite interest coverage ratio is a significant strength, highlighting Apple's ability to comfortably meet its interest obligations.

****Strengths:****

- Exceptional interest coverage ratio, indicating strong profitability and ability to service debt.

****Weaknesses:****

- Low current and quick ratios suggest potential liquidity challenges.
- High debt-to-equity ratio indicates increased financial leverage and associated risks.

Overall, while there are areas of concern, Apple's strong market position and cash flow generation capabilities provide a solid foundation to address these challenges.

Output: ### Liquidity Ratio Comments for Apple Inc. (AAPL)

1. ****Current Ratio**:** The current ratio of 0.8673 places Apple in the warning

zone, suggesting potential liquidity issues as the company may struggle to cover its short-term obligations. However, Apple's efficient cash management and strong cash flow generation slightly mitigate this concern.

2. **Quick Ratio**: With a quick ratio of 0.5589, Apple falls below the healthy threshold, indicating potential liquidity challenges. Despite this, Apple's strong cash flow and market position may offset some risks.

3. **Debt-to-Equity Ratio**: The debt-to-equity ratio of 2.0906 is in the warning zone, indicating significant use of debt relative to equity, which could increase financial risk. However, Apple's strong earnings and cash flow generation capabilities may allow it to manage this higher leverage effectively.

4. **Interest Coverage Ratio**: An infinite interest coverage ratio suggests that Apple has no difficulty covering its interest expenses, indicating excellent financial health in terms of its ability to meet debt obligations.

Overall, while there are areas of concern in liquidity, Apple's strong market position and cash flow generation capabilities provide a solid foundation to address these challenges.

I will now hand off control to the SupervisorAgent for an overall comment based on the profitability and liquidity analysis.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'SupervisorAgent', 'reason': "Liquidity and profitability ratios for AAPL have been collected and commented on. It's time for an overall assessment."}

Tool Result (handoff):

Arguments: {'to_agent': 'SupervisorAgent', 'reason': "Liquidity and profitability ratios for AAPL have been collected and commented on. It's time for an overall assessment."}

Output: Agent SupervisorAgent is now handling the request due to the following reason: Liquidity and profitability ratios for AAPL have been collected and commented on. It's time for an overall assessment..

Please continue with the current request.

=====

Agent: SupervisorAgent

=====

Planning to use tools: ['get_overall_comments']

Calling Tool: get_overall_comments

With arguments: {'overall_comments': "Apple Inc. (AAPL) demonstrates exceptional financial health based on its profitability ratios, with all metrics significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity utilization, robust profit retention, and excellent cost management. However, liquidity ratios present a mixed picture,

with current and quick ratios below healthy thresholds, suggesting potential short-term liquidity concerns. Despite this, Apple's strong cash flow and operational efficiency may mitigate these risks. The debt-to-equity ratio is in the warning zone, indicating higher leverage, but Apple's robust earnings capacity provides some reassurance. The infinite interest coverage ratio is a significant strength, highlighting Apple's ability to comfortably meet its interest obligations. Overall, while there are areas of concern in liquidity, Apple's strong market position and cash flow generation capabilities provide a solid foundation to address these challenges."}

Tool Result (get_overall_comments):

Arguments: {'overall_comments': "Apple Inc. (AAPL) demonstrates exceptional financial health based on its profitability ratios, with all metrics significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity utilization, robust profit retention, and excellent cost management. However, liquidity ratios present a mixed picture, with current and quick ratios below healthy thresholds, suggesting potential short-term liquidity concerns. Despite this, Apple's strong cash flow and operational efficiency may mitigate these risks. The debt-to-equity ratio is in the warning zone, indicating higher leverage, but Apple's robust earnings capacity provides some reassurance. The infinite interest coverage ratio is a significant strength, highlighting Apple's ability to comfortably meet its interest obligations. Overall, while there are areas of concern in liquidity, Apple's strong market position and cash flow generation capabilities provide a solid foundation to address these challenges."}

Output: bad operand type for unary ~: 'CompletionResponse'

Output: It seems there was an error in processing the overall comments. Let me summarize the analysis based on the collected data:

Overall Financial Health of Apple Inc. (AAPL)

Profitability Analysis:

- Apple exhibits exceptional profitability with all ratios (ROA, ROE, Net Profit Margin, and Gross Margin) significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity utilization, robust profit retention, and excellent cost management.

Liquidity Analysis:

- The liquidity ratios present a mixed picture. The current and quick ratios are below healthy thresholds, suggesting potential short-term liquidity concerns. However, Apple's strong cash flow and operational efficiency may mitigate these risks.

- The debt-to-equity ratio is in the warning zone, indicating higher leverage, but Apple's robust earnings capacity provides some reassurance.

- The infinite interest coverage ratio is a significant strength, highlighting Apple's ability to comfortably meet its interest obligations.

Conclusion:

Overall, Apple Inc. demonstrates strong financial health, particularly in terms

of profitability. While there are areas of concern in liquidity, Apple's strong market position and cash flow generation capabilities provide a solid foundation to address these challenges. The company remains well-positioned to manage its financial obligations and continue its growth trajectory.

Run 3

```
[ ]: from llama_index.core.agent.workflow import (
    AgentInput,
    AgentOutput,
    ToolCall,
    ToolCallResult,
    AgentStream,
)

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the
        ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print(" Output:", event.response.content)
        if event.tool_calls:
            print(
                " Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )

    elif isinstance(event, ToolCallResult):
        print(f" Tool Result ({event.tool_name}):")
        print(f" Arguments: {event.tool_kwargs}")
        print(f" Output: {event.tool_output}")

    elif isinstance(event, ToolCall):
        print(f" Calling Tool: {event.tool_name}")
```

```
print(f" With arguments: {event.tool_kwargs}")
```

```
=====
Agent: FundamentalAgent
=====
```

```
Planning to use tools: ['get_fundamentals']
```

```
Obtaining financial statements: 100%|      | 3/3 [00:01<00:00, 2.26it/s]
```

```
Obtaining historical data: 100%|      | 2/2 [00:00<00:00, 9.51it/s]
```

```
ratios 2022      NaN
```

```
2023      0.275
```

```
2024      0.2613
```

```
Freq: Y-DEC, Name: Return on Assets, dtype: float64
```

```
Calling Tool: get_fundamentals
```

```
With arguments: {'ticker': 'AAPL'}
```

```
Tool Result (get_fundamentals):
```

```
Arguments: {'ticker': 'AAPL'}
```

```
Output: Ratios extracted for AAPL.
```

```
Planning to use tools: ['handoff']
```

```
Calling Tool: handoff
```

```
With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect  
profitability ratios for AAPL and comment on the results given a set of  
threshold values.'}
```

```
Tool Result (handoff):
```

```
Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect profitability  
ratios for AAPL and comment on the results given a set of threshold values.'}
```

```
Output: Agent ProfitabilityAgent is now handling the request due to the  
following reason: Collect profitability ratios for AAPL and comment on the  
results given a set of threshold values..
```

```
Please continue with the current request.
```

```
=====
Agent: ProfitabilityAgent
=====
```

```
Planning to use tools: ['get_profitability_ratios']
```

```
Calling Tool: get_profitability_ratios
```

```
With arguments: {}
```

```
Tool Result (get_profitability_ratios):
```

```
Arguments: {}
```

```
Output: Profitability ratios extracted and Comments performed: To analyze the  
financial health of Apple Inc. (AAPL) based on its profitability ratios, we will  
evaluate each ratio against the provided thresholds, assign a score from 1 to  
10, and provide justifications for these scores. Finally, we will summarize the  
overall financial health of the firm.
```

1 Return on Assets (ROA)

- **Value**: 26.13%
- **Thresholds**:
 - Healthy: > 5%
 - Moderate: 2% - 5%
 - Weak: < 2%

Score: 10/10

Justification: Apple's ROA of 26.13% is significantly above the healthy threshold of 5%. This indicates that the company is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational performance and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- **Value**: 157.41%
- **Thresholds**:
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

Score: 10/10

Justification: With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits from its shareholders' equity, reflecting strong financial performance and effective use of equity capital. Such a high ROE is often indicative of a competitive advantage and robust profitability.

3 Net Profit Margin

- **Value**: 23.97%
- **Thresholds**:
 - Healthy: > 10%
 - Moderate: 5% - 10%
 - Weak: < 5%

Score: 10/10

Justification: Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin suggests that the company is very effective at converting revenue into actual profit, indicating strong cost management and pricing power. A high net profit margin is a sign of a financially healthy company with efficient operations.

4 Gross Margin

- **Value**: 46.21%
- **Thresholds**:
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

Score: 10/10

Justification: The gross margin of 46.21% is above the healthy threshold of 40%, indicating that Apple retains a significant portion of revenue after accounting for the cost of goods sold. This suggests strong pricing strategies and cost control, contributing to the company's overall profitability and financial stability.

Overall Insight on Financial Health

Summary: Based on the analysis of Apple's profitability ratios, the company demonstrates exceptional financial health. All evaluated ratios are well above the healthy thresholds, indicating strong operational efficiency, effective asset and equity utilization, and robust profit generation. Apple's high scores across all profitability metrics reflect its competitive advantage, strong market position, and effective management strategies. The company's strengths lie in its ability to generate high returns on assets and equity, maintain substantial profit margins, and efficiently manage costs. There are no apparent weaknesses in the profitability aspect of Apple's financial health, suggesting a very positive outlook for the firm.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': 'Collect liquidity ratios for AAPL and comment on the results given a set of threshold values.'}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': 'Collect liquidity ratios for AAPL and comment on the results given a set of threshold values.'}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Collect liquidity ratios for AAPL and comment on the results given a set of threshold values..

Please continue with the current request.

=====

Agent: LiquidityAgent

=====

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the overall financial health of the firm.

1. Current Ratio

- **Value:** 0.8673
- **Healthy Range:** 1.5 - 3.0
- **Evaluation:** The current ratio of 0.8673 is below the healthy range, indicating that Apple may not have enough current assets to cover its current liabilities. This places the company in the warning zone, suggesting potential liquidity issues.
- **Score:** 3
- **Justification:** The score of 3 reflects the fact that the current ratio is significantly below the healthy range, indicating potential liquidity concerns. However, it is not in the risky/dangerous zone, which would warrant a lower score.

2. Quick Ratio

- **Value:** 0.5589
- **Healthy Range:** > 1.0
- **Evaluation:** The quick ratio is also below the healthy threshold, indicating that Apple may struggle to meet its short-term obligations without relying on inventory sales.
- **Score:** 2
- **Justification:** The score of 2 is assigned because the quick ratio is well below the healthy threshold, suggesting a potential inability to quickly cover short-term liabilities with liquid assets.

3. Debt-to-Equity Ratio

- **Value:** 2.0906
- **Healthy Range:** 0.3 - 1.5
- **Evaluation:** The debt-to-equity ratio is above the healthy range and falls into the warning zone. This suggests that Apple is using a higher level of debt financing relative to equity, which could increase financial risk.
- **Score:** 4
- **Justification:** A score of 4 is given because the ratio is above the healthy range, indicating higher leverage. However, it is not in the risky/dangerous zone, which would indicate under-leverage.

4. Interest Coverage Ratio

- **Value:** Infinity (inf)
- **Healthy Range:** > 3.0
- **Evaluation:** An infinite interest coverage ratio suggests that Apple has no difficulty covering its interest expenses, indicating strong financial health in

terms of interest obligations.

- **Score:** 10

- **Justification:** The score of 10 reflects the extremely strong ability to cover interest expenses, as indicated by the infinite ratio. This suggests no immediate risk related to interest payments.

Overall Insight on Financial Health

Apple's financial health presents a mixed picture based on the provided ratios:

- **Strengths:** The infinite interest coverage ratio is a significant strength, indicating that Apple has no issues meeting its interest obligations, which is a critical aspect of financial stability.

- **Weaknesses:** The current and quick ratios are both below the healthy thresholds, suggesting potential liquidity concerns. Additionally, the debt-to-equity ratio is in the warning zone, indicating higher leverage than the healthy range.

In summary, while Apple demonstrates strong capability in managing its interest expenses, the liquidity ratios suggest potential short-term financial challenges. The company may need to focus on improving its liquidity position to ensure it can meet its short-term obligations without relying heavily on debt.

Output: **### Liquidity Comments for Apple Inc. (AAPL)**

1. **Current Ratio:** The current ratio of 0.8673 is below the healthy range of 1.5 - 3.0, indicating potential liquidity issues. Apple may not have enough current assets to cover its current liabilities, placing it in the warning zone. **Score: 3**

2. **Quick Ratio:** The quick ratio of 0.5589 is below the healthy threshold of > 1.0, suggesting potential difficulties in meeting short-term obligations without relying on inventory sales. **Score: 2**

3. **Debt-to-Equity Ratio:** With a value of 2.0906, the debt-to-equity ratio is above the healthy range of 0.3 - 1.5, indicating higher leverage and increased financial risk. **Score: 4**

4. **Interest Coverage Ratio:** An infinite interest coverage ratio suggests no difficulty in covering interest expenses, indicating strong financial health in terms of interest obligations. **Score: 10**

Overall Insight: While Apple shows strong capability in managing interest expenses, the liquidity ratios suggest potential short-term financial challenges. The company may need to improve its liquidity position to ensure it can meet short-term obligations without heavily relying on debt.

Now, I will hand off control to the SupervisorAgent for an overall comment based on the profitability and liquidity analysis.

Planning to use tools: ['handoff']

Calling Tool: handoff
With arguments: {'to_agent': 'SupervisorAgent', 'reason': 'Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent.'}
Tool Result (handoff):
Arguments: {'to_agent': 'SupervisorAgent', 'reason': 'Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent.'}
Output: Agent SupervisorAgent is now handling the request due to the following reason: Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent..
Please continue with the current request.

=====
Agent: SupervisorAgent
=====

Planning to use tools: ['get_overall_comments']
Calling Tool: get_overall_comments
With arguments: {'overall_comments': "Based on the analysis of Apple's profitability and liquidity ratios, the company demonstrates exceptional financial health in terms of profitability but faces some challenges in liquidity. \n\n### Profitability Analysis:\nApple's profitability ratios are outstanding, with ROA, ROE, Net Profit Margin, and Gross Margin all significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity utilization, and robust profit generation. Apple's high scores across all profitability metrics reflect its competitive advantage, strong market position, and effective management strategies.\n\n### Liquidity Analysis:\nHowever, the liquidity analysis presents a mixed picture. While the interest coverage ratio is extremely strong, indicating no issues with meeting interest obligations, the current and quick ratios are below healthy thresholds, suggesting potential liquidity concerns. The debt-to-equity ratio is also in the warning zone, indicating higher leverage than the healthy range.\n\n### Overall Health:\nIn summary, Apple is in excellent financial health from a profitability standpoint, showcasing its ability to generate substantial returns and maintain high profit margins. However, the company should address its liquidity position to ensure it can meet short-term obligations without relying heavily on debt. Improving liquidity ratios would enhance Apple's overall financial stability and reduce potential risks associated with short-term financial challenges."}

Tool Result (get_overall_comments):
Arguments: {'overall_comments': "Based on the analysis of Apple's profitability and liquidity ratios, the company demonstrates exceptional financial health in terms of profitability but faces some challenges in liquidity. \n\n### Profitability Analysis:\nApple's profitability ratios are outstanding, with ROA, ROE, Net Profit Margin, and Gross Margin all significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity utilization, and robust profit

generation. Apple's high scores across all profitability metrics reflect its competitive advantage, strong market position, and effective management strategies.\n\n#### Liquidity Analysis:\n\nHowever, the liquidity analysis presents a mixed picture. While the interest coverage ratio is extremely strong, indicating no issues with meeting interest obligations, the current and quick ratios are below healthy thresholds, suggesting potential liquidity concerns. The debt-to-equity ratio is also in the warning zone, indicating higher leverage than the healthy range.\n\n#### Overall Health:\n\nIn summary, Apple is in excellent financial health from a profitability standpoint, showcasing its ability to generate substantial returns and maintain high profit margins. However, the company should address its liquidity position to ensure it can meet short-term obligations without relying heavily on debt. Improving liquidity ratios would enhance Apple's overall financial stability and reduce potential risks associated with short-term financial challenges."}

Output: bad operand type for unary ~: 'CompletionResponse'

Output: Based on the analysis of Apple's profitability and liquidity ratios, the company demonstrates exceptional financial health in terms of profitability but faces some challenges in liquidity.

Profitability Analysis:

Apple's profitability ratios are outstanding, with ROA, ROE, Net Profit Margin, and Gross Margin all significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity utilization, and robust profit generation. Apple's high scores across all profitability metrics reflect its competitive advantage, strong market position, and effective management strategies.

Liquidity Analysis:

However, the liquidity analysis presents a mixed picture. While the interest coverage ratio is extremely strong, indicating no issues with meeting interest obligations, the current and quick ratios are below healthy thresholds, suggesting potential liquidity concerns. The debt-to-equity ratio is also in the warning zone, indicating higher leverage than the healthy range.

Overall Health:

In summary, Apple is in excellent financial health from a profitability standpoint, showcasing its ability to generate substantial returns and maintain high profit margins. However, the company should address its liquidity position to ensure it can meet short-term obligations without relying heavily on debt. Improving liquidity ratios would enhance Apple's overall financial stability and reduce potential risks associated with short-term financial challenges.

5.4.2 GPT-4o Answer:

Overall Financial Health of Apple Inc. (AAPL) Profitability Analysis: - Apple exhibits exceptional profitability with all ratios (ROA, ROE, Net Profit Margin, and Gross Margin) significantly exceeding healthy thresholds. This indicates strong operational efficiency, effective asset and equity utilization, robust profit retention, and excellent cost management.

Liquidity Analysis: - The liquidity ratios present a mixed picture. The current and quick ratios are below healthy thresholds, suggesting potential short-term liquidity concerns. However, Apple's strong cash flow and operational efficiency may mitigate these risks. - The debt-to-equity ratio is in the warning zone, indicating higher leverage, but Apple's robust earnings capacity provides some reassurance. - The infinite interest coverage ratio is a significant strength, highlighting Apple's ability to comfortably meet its interest obligations.

Conclusion: Overall, Apple Inc. demonstrates strong financial health, particularly in terms of profitability. While there are areas of concern in liquidity, Apple's strong market position and cash flow generation capabilities provide a solid foundation to address these challenges. The company remains well-positioned to manage its financial obligations and continue its growth trajectory.

5.5 LLM: GPT-4.1

5.5.1 Agents and Workflow

```
[ ]: from llama_index.core.agent.workflow import FunctionAgent

fundamental_agent = FunctionAgent(
    name="FundamentalAgent",
    description="Get various fundamental ratios for a given ticker.",
    system_prompt=(
        "You are the fundament analyst that can extract different fundamental_
        ↪ratios for a given ticker. "
        "Once you have extracted the fundamental financial ratios, you should_
        ↪hand off control to the ProfitabilityAgent to extract the profitability_
        ↪ratios or/and the LiquidityAgent to extract the liquidity ratios."
    ),
    llm=LLM_41,
    tools=[get_fundamentals],
    can_handoff_to=["ProfitabilityAgent"],
)

profitability_agent = FunctionAgent(
    name="ProfitabilityAgent",
    description="Collect profitability ratios for a given ticker: ROA, ROE, Net_
    ↪Profit Margin and Gross Margin and Comment on the results given a set of_
    ↪threshold values.",
    system_prompt=(
        """You are the ProfitabilityAgent that can collect profitability ratios_
        ↪(profitability_ratios) on a given ticker.
        You collect these ratios from the FundamentalAgent.
        Once these ratios are collected in profitability_ratios, you should_
        ↪comment on these ratios based on the thresholds values provided in_
        ↪get_profitability_ratios.
```

```

        These comments must be included in threshold_profitability_comments. At
        ↪the end provide ONLY these comments included in
        ↪threshold_profitability_comments. DO NOT ADD anything else.

        Once the comments are done, you should hand off control to the
        ↪LiquidityAgent.
        """
    ),
    llm=LLM_41,
    tools=[get_profitability_ratios],
    can_handoff_to=["LiquidityAgent"],
)

liquidity_agent = FunctionAgent(
    name="LiquidityAgent",
    description="Collect liquidity ratios for a given ticker: Current Ratio,
    ↪Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio and comments on
    ↪these ratios given a set of threshold values.",
    system_prompt=(
        """You are the LiquidityAgent that can collect liquidity ratios
        ↪(liquidity_ratios) on a given ticker.

        You collect these ratios from the FundamentalAgent.

        Once these ratios are collected in liquidity_ratios, you should comment
        ↪on these ratios based on the thresholds values provided in
        ↪get_liquidity_ratios.

        These comments must be included in threshold_liquidity_comments. At the
        ↪end provide ONLY these comments included in threshold_liquidity_comments. DO
        ↪NOT ADD anything else.

        Once the comments are done, you should hand off control to the
        ↪SupervisorAgent.
        """
    ),
    llm=LLM_41,
    tools=[get_liquidity_ratios],
    can_handoff_to=["SupervisorAgent"],
)

supervisor_agent = FunctionAgent(
    name="SupervisorAgent",
    description="Provide an overall comment based on the comments coming from
    ↪the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.",
    system_prompt=(
        "You are an fundement analyst expert and supervisor. You collect
        ↪comments coming from various agents such as ProfitabilityAgent and
        ↪LiquidityAgent. "

        "If you collect only one or no comments, go back to ProfitabilityAgent
        ↪and LiquidityAgent until you get the desired feedbacks on the ratios."
    )
)

```

```

        "If you don't collect threshold_liquidity_comments, you should hand off_
        ↪control to the LiquidityAgent to gather these comments."
        "If you don't collect threshold_profitability_comments, you should hand_
        ↪off control to the ProfitabilityAgent to gather these comments."
        "Based on the results in the comments coming from the_
        ↪ProfitabilityAgent and LiquidityAgent, provide an overall comment on the_
        ↪health of the firm."
        "Justify your comment with details and data. "
    ),
    llm=LLM_41,
    tools=[get_overall_comments],
    can_handoff_to=["FundamentalAgent","ProfitabilityAgent","LiquidityAgent"],
)

```

```

[ ]: # from llama_index.core.agent.workflow import AgentWorkflow

agent_workflow = AgentWorkflow(
    agents=[fundamental_agent, profitability_agent, liquidity_agent,
    ↪supervisor_agent],
    root_agent=fundamental_agent.name,
    initial_state={
        "ratios": pd.DataFrame(),
        "profitability_ratios": {},
        "liquidity_ratios": {},
        "threshold_profitability_comments": None,
        "threshold_liquidity_comments": None,
        "overall_comments": None,
        "ticker": "",
    },
)

```

5.5.2 Launch Workflow

```

[ ]: # from llama_index.core.agent.workflow import (
    #     AgentInput,
    #     AgentOutput,
    #     ToolCall,
    #     ToolCallResult,
    #     AgentStream,
    # )

handler = agent_workflow.run(
    user_msg=(

```

```

        "Provide the fundamental analysis of Apple and comments on the
        ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print(" Output:", event.response.content)
        if event.tool_calls:
            print(
                " Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )

    elif isinstance(event, ToolCallResult):
        print(f" Tool Result ({event.tool_name}):")
        print(f" Arguments: {event.tool_kwargs}")
        print(f" Output: {event.tool_output}")

    elif isinstance(event, ToolCall):
        print(f" Calling Tool: {event.tool_name}")
        print(f" With arguments: {event.tool_kwargs}")

```

```

=====
Agent: FundamentalAgent
=====

```

```

Planning to use tools: ['get_fundamentals']

Obtaining financial statements: 100%|      | 3/3 [00:00<00:00, 3.68it/s]
Obtaining historical data: 100%|      | 2/2 [00:00<00:00, 9.56it/s]

ratios 2022      NaN
2023      0.275
2024      0.2613
Freq: Y-DEC, Name: Return on Assets, dtype: float64
Calling Tool: get_fundamentals

```


With arguments: {'ticker': 'AAPL'}
Tool Result (get_fundamentals):
Arguments: {'ticker': 'AAPL'}
Output: Ratios extracted for AAPL.
Planning to use tools: ['handoff']
Calling Tool: handoff
With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': "Profitability ratios are needed to provide a comprehensive analysis and comments on Apple's financial health."}
Tool Result (handoff):
Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': "Profitability ratios are needed to provide a comprehensive analysis and comments on Apple's financial health."}
Output: Agent ProfitabilityAgent is now handling the request due to the following reason: Profitability ratios are needed to provide a comprehensive analysis and comments on Apple's financial health..
Please continue with the current request.

=====
Agent: ProfitabilityAgent
=====

Planning to use tools: ['get_profitability_ratios']
Calling Tool: get_profitability_ratios
With arguments: {}
Tool Result (get_profitability_ratios):
Arguments: {}
Output: Profitability ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on its profitability ratios, we will evaluate each ratio against the provided thresholds and assign a score from 1 to 10. This score will reflect the health of each ratio, with 1 being very unhealthy and 10 being very healthy. Let's proceed with the analysis:

1 Return on Assets (ROA)

- **Value**: 26.13%
- **Thresholds**:
 - Healthy: > 5%
 - Moderate: 2% - 5%
 - Weak: < 2%

Score: 10/10

Justification: Apple's ROA of 26.13% is significantly above the healthy threshold of 5%. This indicates that the company is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational efficiency and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- **Value**: 157.41%
- **Thresholds**:
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

Score: 10/10

Justification: With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits from its shareholders' equity. It reflects strong profitability and effective use of equity financing, showcasing Apple's ability to deliver high returns to its investors.

3 Net Profit Margin

- **Value**: 23.97%
- **Thresholds**:
 - Healthy: > 10%
 - Moderate: 5% - 10%
 - Weak: < 5%

Score: 10/10

Justification: Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin indicates that the company retains a significant portion of its revenue as profit after all expenses. It reflects strong cost management and pricing power, contributing to robust profitability.

4 Gross Margin

- **Value**: 46.21%
- **Thresholds**:
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

Score: 10/10

Justification: The gross margin of 46.21% is above the healthy threshold of 40%. This indicates that Apple is efficiently managing its production costs relative to its sales, allowing for a substantial portion of revenue to cover operating expenses and contribute to profit. A high gross margin is indicative of strong competitive positioning and cost control.

Overall Insight on Financial Health

Summary: Apple's financial health, as assessed through its profitability ratios, is exceptionally strong. Each ratio not only meets but significantly

exceeds the healthy thresholds, earning the maximum score of 10. This reflects Apple's robust operational efficiency, effective asset and equity management, strong cost control, and high profitability. The company's ability to generate substantial returns on assets and equity, coupled with high profit margins, underscores its financial strength and competitive advantage in the market. There are no apparent weaknesses in the profitability ratios, indicating a very healthy financial position.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability ratio comments for Apple are complete. Next, liquidity ratios are needed to further assess the company's financial health."}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability ratio comments for Apple are complete. Next, liquidity ratios are needed to further assess the company's financial health."}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Profitability ratio comments for Apple are complete. Next, liquidity ratios are needed to further assess the company's financial health.. Please continue with the current request.

=====
Agent: LiquidityAgent
=====

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide justifications for these scores. Finally, we will summarize the overall financial health of the firm.

1. Current Ratio

- **Value**: 0.8673
- **Healthy Range**: 1.5 - 3.0
- **Analysis**: The current ratio of 0.8673 is below the healthy range, indicating that Apple may not have enough current assets to cover its current liabilities. This suggests potential liquidity issues.
- **Score**: 3/10
- **Justification**: The score reflects the fact that the ratio is in the warning zone, indicating a potential liquidity concern. However, it is not in the risky/dangerous zone, which would warrant a lower score.

2. Quick Ratio

- ****Value****: 0.5589
- ****Healthy Range****: > 1.0
- ****Analysis****: The quick ratio is significantly below the healthy threshold, suggesting that Apple may struggle to meet its short-term obligations without relying on inventory sales.
- ****Score****: 2/10
- ****Justification****: The quick ratio is well below the healthy range, indicating a potential liquidity risk. This warrants a low score as it suggests a reliance on inventory to meet short-term liabilities.

3. Debt-to-Equity Ratio

- ****Value****: 2.0906
- ****Healthy Range****: 0.3 - 1.5
- ****Analysis****: The debt-to-equity ratio is above the healthy range and in the warning zone, indicating that Apple is using a higher level of debt financing relative to equity. This could imply higher financial risk.
- ****Score****: 4/10
- ****Justification****: The score reflects the fact that the ratio is above the healthy range but not in the risky/dangerous zone. While it indicates higher leverage, it is not excessively high.

4. Interest Coverage Ratio

- ****Value****: Infinity (inf)
- ****Healthy Range****: > 3.0
- ****Analysis****: An infinite interest coverage ratio suggests that Apple has no interest expense or that its earnings are significantly higher than its interest obligations, indicating excellent financial health in terms of covering interest expenses.
- ****Score****: 10/10
- ****Justification****: The infinite interest coverage ratio is a strong indicator of financial health, as it suggests that Apple can easily cover its interest obligations, reflecting a very healthy position.

Overall Insight on Financial Health

- ****Strengths****: The infinite interest coverage ratio is a significant strength, indicating that Apple has no issues covering its interest expenses, which is a positive sign of financial stability.
- ****Weaknesses****: The current and quick ratios are below the healthy thresholds, suggesting potential liquidity concerns. Additionally, the debt-to-equity ratio is in the warning zone, indicating higher leverage and potential financial risk.
- ****Summary****: While Apple demonstrates strong financial health in terms of interest coverage, its liquidity ratios suggest potential short-term financial challenges. The high debt-to-equity ratio indicates a reliance on debt financing, which could pose risks if not managed carefully. Overall, Apple appears financially stable but should monitor its liquidity and leverage to maintain its financial health.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'SupervisorAgent', 'reason': 'Liquidity ratio comments for Apple are complete. SupervisorAgent should now provide an overall comment based on both profitability and liquidity comments.'}

Tool Result (handoff):

Arguments: {'to_agent': 'SupervisorAgent', 'reason': 'Liquidity ratio comments for Apple are complete. SupervisorAgent should now provide an overall comment based on both profitability and liquidity comments.'}

Output: Agent SupervisorAgent is now handling the request due to the following reason: Liquidity ratio comments for Apple are complete. SupervisorAgent should now provide an overall comment based on both profitability and liquidity comments..

Please continue with the current request.

=====

Agent: SupervisorAgent

=====

Planning to use tools: ['get_overall_comments']

Calling Tool: get_overall_comments

With arguments: {'overall_comments': 'Apple Inc. demonstrates exceptional profitability, with all key profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) significantly exceeding healthy thresholds. This reflects outstanding operational efficiency, strong cost management, and the ability to generate high returns for shareholders. However, liquidity ratios (Current Ratio and Quick Ratio) are below healthy ranges, indicating potential short-term liquidity concerns. The Debt-to-Equity Ratio is above the healthy range, suggesting higher leverage, but the infinite Interest Coverage Ratio shows Apple has no difficulty meeting its interest obligations. Overall, Apple is in robust financial health due to its strong profitability and ability to cover debt costs, but it should monitor liquidity and leverage to avoid potential short-term financial stress.'}

Tool Result (get_overall_comments):

Arguments: {'overall_comments': 'Apple Inc. demonstrates exceptional profitability, with all key profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) significantly exceeding healthy thresholds. This reflects outstanding operational efficiency, strong cost management, and the ability to generate high returns for shareholders. However, liquidity ratios (Current Ratio and Quick Ratio) are below healthy ranges, indicating potential short-term liquidity concerns. The Debt-to-Equity Ratio is above the healthy range, suggesting higher leverage, but the infinite Interest Coverage Ratio shows Apple has no difficulty meeting its interest obligations. Overall, Apple is in robust financial health due to its strong profitability and ability to cover debt costs, but it should monitor liquidity and leverage to avoid potential short-term financial stress.'}

Output: bad operand type for unary ~: 'CompletionResponse'

Output: Apple Inc. displays outstanding financial health from a profitability perspective, with all major profitability ratios-Return on Assets (ROA: 26.13%), Return on Equity (ROE: 157.41%), Net Profit Margin (23.97%), and Gross Margin

(46.21%)—far exceeding healthy thresholds. This indicates Apple is highly efficient in generating profits from its assets and equity, has strong cost control, and delivers substantial returns to shareholders.

On the liquidity side, however, there are some areas of concern. The Current Ratio (0.87) and Quick Ratio (0.56) are both below healthy levels, suggesting Apple may not have enough liquid assets to cover its short-term liabilities. The Debt-to-Equity Ratio (2.09) is above the healthy range, indicating higher leverage and reliance on debt financing. Despite this, Apple's Interest Coverage Ratio is infinite, meaning it has no trouble covering its interest expenses, which is a strong sign of financial stability.

In summary, Apple's exceptional profitability and ability to cover debt costs outweigh its short-term liquidity concerns. The company is fundamentally strong, but it should continue to monitor its liquidity and leverage to ensure ongoing financial resilience.

5.5.3 Output:

Apple Inc. displays outstanding financial health from a profitability perspective, with all major profitability ratios—Return on Assets (ROA: 26.13%), Return on Equity (ROE: 157.41%), Net Profit Margin (23.97%), and Gross Margin (46.21%)—far exceeding healthy thresholds. This indicates Apple is highly efficient in generating profits from its assets and equity, has strong cost control, and delivers substantial returns to shareholders.

On the liquidity side, however, there are some areas of concern. The Current Ratio (0.87) and Quick Ratio (0.56) are both below healthy levels, suggesting Apple may not have enough liquid assets to cover its short-term liabilities. The Debt-to-Equity Ratio (2.09) is above the healthy range, indicating higher leverage and reliance on debt financing. Despite this, Apple's Interest Coverage Ratio is infinite, meaning it has no trouble covering its interest expenses, which is a strong sign of financial stability.

In summary, Apple's exceptional profitability and ability to cover debt costs outweigh its short-term liquidity concerns. The company is fundamentally strong, but it should continue to monitor its liquidity and leverage to ensure ongoing financial resilience.

5.6 LLM:GPT-4.5-Preview

Agents and Workflow

```
[ ]: from llama_index.core.agent.workflow import FunctionAgent

fundamental_agent = FunctionAgent(
    name="FundamentalAgent",
    description="Get various fundamental ratios for a given ticker.",
    system_prompt=(
        "You are the fundament analyst that can extract different fundamental_
        ↪ratios for a given ticker. "
```

```

        "Once you have extracted the fundamental financial ratios, you should_
↳hand off control to the ProfitabilityAgent to extract the profitability_
↳ratios or/and the LiquidityAgent to extract the liquidity ratios."

    ),
    llm=LLM_45,
    tools=[get_fundamentals],
    can_handoff_to=["ProfitabilityAgent"],
)

profitability_agent = FunctionAgent(
    name="ProfitabilityAgent",
    description="Collect profitability ratios for a given ticker: ROA, ROE, Net_
↳Profit Margin and Gross Margin and Comment on the results given a set of_
↳threshold values.",
    system_prompt=(
        """You are the ProfitabilityAgent that can collect profitability ratios_
↳(profitability_ratios) on a given ticker.

        You collect these ratios from the FundamentalAgent.

        Once these ratios are collected in profitability_ratios, you should_
↳comment on these ratios based on the thresholds values provided in_
↳get_profitability_ratios.

        These comments must be included in threshold_profitability_comments. At_
↳the end provide ONLY these comments included in_
↳threshold_profitability_comments. DO NOT ADD anything else.

        Once the comments are done, you should hand off control to the_
↳LiquidityAgent.

        """
    ),
    llm=LLM_45,
    tools=[get_profitability_ratios],
    can_handoff_to=["LiquidityAgent"],
)

liquidity_agent = FunctionAgent(
    name="LiquidityAgent",
    description="Collect liquidity ratios for a given ticker: Current Ratio,_
↳Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio and comments on_
↳these ratios given a set of threshold values.",
    system_prompt=(
        """You are the LiquidityAgent that can collect liquidity ratios_
↳(liquidity_ratios) on a given ticker.

        You collect these ratios from the FundamentalAgent.

        Once these ratios are collected in liquidity_ratios, you should comment_
↳on these ratios based on the thresholds values provided in_
↳get_liquidity_ratios.
    )

```

These comments must be included in threshold_liquidity_comments. At the end provide ONLY these comments included in threshold_liquidity_comments. DO NOT ADD anything else.

Once the comments are done, you should hand off control to the SupervisorAgent.

```

        """
    ),
    llm=LLM_45,
    tools=[get_liquidity_ratios],
    can_handoff_to=["SupervisorAgent"],
)

supervisor_agent = FunctionAgent(
    name="SupervisorAgent",
    description="Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.",
    system_prompt=(
        "You are an fundament analyst expert and supervisor. You collect comments coming from various agents such as ProfitabilityAgent and LiquidityAgent. "
        "If you collect only one or no comments, go back to ProfitabilityAgent and LiquidityAgent until you get the desired feedbacks on the ratios."
        "If you don't collect threshold_liquidity_comments, you should hand off control to the LiquidityAgent to gather these comments."
        "If you don't collect threshold_profitability_comments, you should hand off control to the ProfitabilityAgent to gather these comments."
        "Based on the results in the comments coming from the ProfitabilityAgent and LiquidityAgent, provide an overall comment on the health of the firm."
        "Justify your comment with details and data. "
    ),
    llm=LLM_45,
    tools=[get_overall_comments],
    can_handoff_to=["FundamentalAgent", "ProfitabilityAgent", "LiquidityAgent"],
)

```

```
[ ]: # from llama_index.core.agent.workflow import AgentWorkflow
```

```

agent_workflow = AgentWorkflow(
    agents=[fundamental_agent, profitability_agent, liquidity_agent, supervisor_agent],
    root_agent=fundamental_agent.name,
    initial_state={
        "ratios": pd.DataFrame(),
        "profitability_ratios": {},
        "liquidity_ratios": {},
    },
)

```



```

        "threshold_profitability_comments": None,
        "threshold_liquidity_comments": None,
        "overall_comments": None,
        "ticker": "",
    },
)

```

Launch Workflow

```

[ ]: # from llama_index.core.agent.workflow import (
#     AgentInput,
#     AgentOutput,
#     ToolCall,
#     ToolCallResult,
#     AgentStream,
# )

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the
        ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print(" Output:", event.response.content)
        if event.tool_calls:
            print(
                " Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )

    elif isinstance(event, ToolCallResult):
        print(f" Tool Result ({event.tool_name}):")

```

```

print(f" Arguments: {event.tool_kwargs}")
print(f" Output: {event.tool_output}")
elif isinstance(event, ToolCall):
    print(f" Calling Tool: {event.tool_name}")
    print(f" With arguments: {event.tool_kwargs}")

```

```

=====
Agent: FundamentalAgent
=====

```

Planning to use tools: ['get_fundamentals']

Obtaining financial statements: 100%| | 3/3 [00:00<00:00, 5.01it/s]

Obtaining historical data: 100%| | 2/2 [00:00<00:00, 9.63it/s]

ratios 2022 NaN

2023 0.275

2024 0.2613

Freq: Y-DEC, Name: Return on Assets, dtype: float64

Calling Tool: get_fundamentals

With arguments: {'ticker': 'AAPL'}

Tool Result (get_fundamentals):

Arguments: {'ticker': 'AAPL'}

Output: Ratios extracted for AAPL.

Planning to use tools: ['handoff', 'handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Extract
profitability ratios for Apple and provide comments based on threshold values.'}

Tool Result (handoff):

Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Extract profitability
ratios for Apple and provide comments based on threshold values.'}

Output: Agent ProfitabilityAgent is now handling the request due to the
following reason: Extract profitability ratios for Apple and provide comments
based on threshold values..

Please continue with the current request.

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': 'Extract liquidity
ratios for Apple and provide comments based on threshold values.'}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': 'Extract liquidity ratios
for Apple and provide comments based on threshold values.'}

Output: Agent LiquidityAgent cannot hand off to FundamentalAgent. Please
select a valid agent to hand off to.

```

=====
Agent: ProfitabilityAgent
=====

```

```
Planning to use tools: ['get_profitability_ratios']
Calling Tool: get_profitability_ratios
With arguments: {}
Tool Result (get_profitability_ratios):
Arguments: {}
Output: Profitability ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on its profitability ratios, we will evaluate each ratio against the provided thresholds and assign a score from 1 to 10. This score will reflect the health of each ratio, with 1 being very unhealthy and 10 being very healthy. Let's proceed with the analysis:
```

1 Return on Assets (ROA)

- **Value**: 26.13%
- **Thresholds**:
 - Healthy: > 5%
 - Moderate: 2% - 5%
 - Weak: < 2%

Score: 10/10

Justification: Apple's ROA of 26.13% is significantly above the healthy threshold of 5%. This indicates that Apple is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational efficiency and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- **Value**: 157.41%
- **Thresholds**:
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

Score: 10/10

Justification: With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits from its shareholders' equity, reflecting strong profitability and effective use of equity capital. Such a high ROE is indicative of a company with a robust business model and strong competitive advantages.

3 Net Profit Margin

- **Value**: 23.97%
- **Thresholds**:

- Healthy: > 10%
- Moderate: 5% - 10%
- Weak: < 5%

****Score**:** 10/10

****Justification**:** Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin indicates that Apple retains a significant portion of its revenue as profit after all expenses, showcasing strong cost management and pricing power. A high net profit margin is a sign of a financially healthy company with efficient operations.

4 Gross Margin

- ****Value**:** 46.21%
- ****Thresholds**:**
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

****Score**:** 10/10

****Justification**:** Apple's gross margin of 46.21% is above the healthy threshold of 40%. This indicates that Apple is able to maintain a substantial difference between its revenue and the cost of goods sold, reflecting strong pricing strategies and cost control. A high gross margin is a positive indicator of a company's ability to generate profit from its core activities.

Overall Insight

Apple Inc. demonstrates exceptional financial health based on its profitability ratios. Each ratio not only meets but significantly exceeds the healthy thresholds, earning the highest possible scores. The company's strengths lie in its ability to efficiently utilize assets, generate substantial returns on equity, maintain high profit margins, and effectively manage costs. These factors collectively indicate a robust financial position, strong operational efficiency, and a competitive edge in the market. There are no apparent weaknesses in the profitability aspect of Apple's financial health, suggesting that the company is well-positioned for sustained profitability and growth.

Output: ### Profitability Analysis Comments for Apple Inc. (AAPL):

1. ****Return on Assets (ROA)**:** Apple's ROA of 26.13% significantly exceeds the healthy threshold of 5%, indicating exceptional efficiency in asset utilization and strong operational management.

2. ****Return on Equity (ROE)**:** With an ROE of 157.41%, Apple far surpasses the healthy benchmark of 15%, reflecting outstanding profitability and effective equity management.

3. **Net Profit Margin**: Apple's net profit margin of 23.97% is well above the healthy threshold of 10%, demonstrating excellent cost management and strong pricing power.

4. **Gross Margin**: The gross margin of 46.21% exceeds the healthy threshold of 40%, highlighting Apple's effective cost control and robust pricing strategies.

Overall Profitability Insight:

Apple Inc. exhibits exceptional financial health in terms of profitability. All profitability ratios significantly exceed healthy thresholds, indicating strong operational efficiency, effective asset and equity management, and robust profitability. This positions Apple favorably for sustained growth and profitability.

Now, handing off control to the LiquidityAgent for further analysis.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': 'Proceed to analyze liquidity ratios for Apple and provide comments based on threshold values.'}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': 'Proceed to analyze liquidity ratios for Apple and provide comments based on threshold values.'}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Proceed to analyze liquidity ratios for Apple and provide comments based on threshold values..

Please continue with the current request.

=====
Agent: LiquidityAgent
=====

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the overall financial health of the firm.

1 Current Ratio

- **Value**: 0.8673

- **Healthy Range**: 1.5 - 3.0

- **Score**: 3/10

****Justification**:**

The current ratio of 0.8673 is below the healthy range, indicating that Apple may not have sufficient current assets to cover its current liabilities. This suggests potential liquidity issues, as the company might struggle to meet short-term obligations. The score reflects the fact that the ratio is in the warning zone, but not critically low.

2 Quick Ratio

- ****Value**:** 0.5589
- ****Healthy Range**:** > 1.0
- ****Score**:** 2/10

****Justification**:**

The quick ratio of 0.5589 is significantly below the healthy threshold of 1.0. This indicates that Apple may not have enough liquid assets (excluding inventory) to cover its current liabilities, which is a concern for its short-term financial health. The score is low because the ratio is well below the healthy range, suggesting potential liquidity challenges.

3 Debt-to-Equity Ratio

- ****Value**:** 2.0906
- ****Healthy Range**:** 0.3 - 1.5
- ****Score**:** 4/10

****Justification**:**

The debt-to-equity ratio of 2.0906 is above the healthy range and falls into the warning zone. This suggests that Apple is using a higher level of debt relative to equity, which could increase financial risk. However, it is not in the risky/dangerous zone, and Apple's strong market position might mitigate some concerns. The score reflects the elevated risk but acknowledges that it is not critically high.

4 Interest Coverage Ratio

- ****Value**:** Infinity (inf)
- ****Healthy Range**:** > 3.0
- ****Score**:** 10/10

****Justification**:**

An infinite interest coverage ratio indicates that Apple has no difficulty covering its interest expenses, likely due to substantial earnings relative to interest obligations. This is an excellent indicator of financial health in terms of managing debt costs, and the score reflects this strong position.

Overall Insight on Apple's Financial Health

****Strengths**:**

- ****Interest Coverage**:** Apple demonstrates exceptional ability to cover interest expenses, indicating strong earnings and effective debt management.

****Weaknesses**:**

- ****Liquidity Ratios**:** Both the current and quick ratios are below healthy thresholds, suggesting potential liquidity issues. This could be a concern if Apple faces unexpected short-term financial obligations.

- ****Debt-to-Equity Ratio**:** While not critically high, the elevated debt-to-equity ratio indicates a reliance on debt financing, which could pose risks if not managed carefully.

****Summary**:**

Apple's financial health presents a mixed picture. While the company excels in covering its interest expenses, indicating robust earnings, its liquidity ratios suggest potential short-term financial challenges. The elevated debt-to-equity ratio points to a reliance on debt, which could increase financial risk. Overall, while Apple's earnings power is strong, attention to liquidity management and debt levels is advisable to ensure long-term financial stability.

Output: **### Liquidity Analysis Comments for Apple Inc. (AAPL):**

1. ****Current Ratio**:** Apple's current ratio of 0.8673 is below the healthy range (1.5 - 3.0), indicating potential liquidity issues and difficulty in meeting short-term obligations.
2. ****Quick Ratio**:** The quick ratio of 0.5589 is significantly below the healthy threshold (>1.0), suggesting insufficient liquid assets to cover immediate liabilities, raising concerns about short-term financial stability.
3. ****Debt-to-Equity Ratio**:** With a debt-to-equity ratio of 2.0906, Apple is above the healthy range (0.3 - 1.5), indicating a higher reliance on debt financing, which could increase financial risk.
4. ****Interest Coverage Ratio**:** Apple's infinite interest coverage ratio demonstrates exceptional ability to manage interest expenses, reflecting strong earnings and effective debt management.

Overall Liquidity Insight:

Apple exhibits strong earnings power and excellent debt management capabilities. However, the liquidity ratios indicate potential short-term financial challenges, and the elevated debt-to-equity ratio suggests a higher reliance on debt financing. Attention to liquidity management and debt levels is recommended to maintain long-term financial stability.

Now, handing off control to the SupervisorAgent for an overall assessment.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'SupervisorAgent', 'reason': 'Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.'}

Tool Result (handoff):

Arguments: {'to_agent': 'SupervisorAgent', 'reason': 'Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.'}

Output: Agent SupervisorAgent is now handling the request due to the following reason: Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent and stored on overall_comments..
Please continue with the current request.

=====

Agent: SupervisorAgent

=====

Planning to use tools: ['get_overall_comments']

Calling Tool: get_overall_comments

With arguments: {'overall_comments': {'profitability': {'ROA': '26.13% (Excellent)', 'ROE': '157.41% (Outstanding)', 'Net Profit Margin': '23.97% (Excellent)', 'Gross Margin': '46.21% (Excellent)', 'Overall': 'Apple demonstrates exceptional profitability, significantly exceeding healthy thresholds across all metrics.'}, 'liquidity': {'Current Ratio': '0.8673 (Below Healthy Range)', 'Quick Ratio': '0.5589 (Significantly Below Healthy Range)', 'Debt-to-Equity Ratio': '2.0906 (Above Healthy Range)', 'Interest Coverage Ratio': 'Infinity (Excellent)', 'Overall': 'Apple has strong earnings and debt management but faces potential short-term liquidity challenges and elevated debt levels.'}}}

Tool Result (get_overall_comments):

Arguments: {'overall_comments': {'profitability': {'ROA': '26.13% (Excellent)', 'ROE': '157.41% (Outstanding)', 'Net Profit Margin': '23.97% (Excellent)', 'Gross Margin': '46.21% (Excellent)', 'Overall': 'Apple demonstrates exceptional profitability, significantly exceeding healthy thresholds across all metrics.'}, 'liquidity': {'Current Ratio': '0.8673 (Below Healthy Range)', 'Quick Ratio': '0.5589 (Significantly Below Healthy Range)', 'Debt-to-Equity Ratio': '2.0906 (Above Healthy Range)', 'Interest Coverage Ratio': 'Infinity (Excellent)', 'Overall': 'Apple has strong earnings and debt management but faces potential short-term liquidity challenges and elevated debt levels.'}}}

Output: bad operand type for unary ~: 'CompletionResponse'

Output: ### Overall Financial Health Assessment for Apple Inc. (AAPL):

Profitability:

Apple demonstrates exceptional profitability, significantly exceeding healthy thresholds across all key metrics:

- **Return on Assets (ROA)**: 26.13% (Excellent)
- **Return on Equity (ROE)**: 157.41% (Outstanding)
- **Net Profit Margin**: 23.97% (Excellent)

- **Gross Margin**: 46.21% (Excellent)

These metrics indicate strong operational efficiency, effective asset and equity management, and robust profitability, positioning Apple favorably for sustained growth.

Liquidity:

Apple's liquidity analysis presents a mixed picture:

- **Current Ratio**: 0.8673 (Below Healthy Range)
- **Quick Ratio**: 0.5589 (Significantly Below Healthy Range)
- **Debt-to-Equity Ratio**: 2.0906 (Above Healthy Range)
- **Interest Coverage Ratio**: Infinity (Excellent)

While Apple excels in managing interest expenses and demonstrates strong earnings power, the liquidity ratios suggest potential short-term financial challenges. The elevated debt-to-equity ratio indicates a higher reliance on debt financing, which could increase financial risk.

Overall Conclusion:

Apple Inc. is financially healthy in terms of profitability, showcasing exceptional operational efficiency and profitability metrics. However, the company faces potential liquidity challenges and elevated debt levels, which require careful management to ensure long-term financial stability. Overall, Apple's strong profitability and earnings power provide a solid foundation, but attention to liquidity and debt management is advisable to maintain and enhance financial health.

Overall Financial Health Assessment for Apple Inc. (AAPL):

Profitability: Apple demonstrates exceptional profitability, significantly exceeding healthy thresholds across all key metrics: - **Return on Assets (ROA)**: 26.13% (Excellent) - **Return on Equity (ROE)**: 157.41% (Outstanding) - **Net Profit Margin**: 23.97% (Excellent) - **Gross Margin**: 46.21% (Excellent)

These metrics indicate strong operational efficiency, effective asset and equity management, and robust profitability, positioning Apple favorably for sustained growth.

Liquidity: Apple's liquidity analysis presents a mixed picture: - **Current Ratio**: 0.8673 (Below Healthy Range) - **Quick Ratio**: 0.5589 (Significantly Below Healthy Range) - **Debt-to-Equity Ratio**: 2.0906 (Above Healthy Range) - **Interest Coverage Ratio**: Infinity (Excellent)

While Apple excels in managing interest expenses and demonstrates strong earnings power, the liquidity ratios suggest potential short-term financial challenges. The elevated debt-to-equity ratio indicates a higher reliance on debt financing, which could increase financial risk.

5.6.1 Overall Conclusion:

Apple Inc. is financially healthy in terms of profitability, showcasing exceptional operational efficiency and profitability metrics. However, the company faces potential liquidity challenges and

elevated debt levels, which require careful management to ensure long-term financial stability. Overall, Apple's strong profitability and earnings power provide a solid foundation, but attention to liquidity and debt management is advisable to maintain and enhance financial health.

[]:

5.7 Claude Sonnet

5.7.1 Claude 4 Sonnet

Agents and Workflow

```
[ ]: # from llama_index.core.agent.workflow import FunctionAgent

fundamental_agent = FunctionAgent(
    name="FundamentalAgent",
    description="Get various fundamental ratios for a given ticker.",
    system_prompt=(
        "You are the fundament analyst that can extract different fundamental_
        ↪ratios for a given ticker. "
        "Once you have extracted the fundamental financial ratios, you should_
        ↪hand off control to the ProfitabilityAgent to extract the profitability_
        ↪ratios or/and the LiquidityAgent to extract the liquidity ratios."
    ),
    llm=LLM_CLAUDE4,
    tools=[get_fundamentals],
    can_handoff_to=["ProfitabilityAgent"],
)

profitability_agent = FunctionAgent(
    name="ProfitabilityAgent",
    description="Collect profitability ratios for a given ticker: ROA, ROE, Net_
    ↪Profit Margin and Gross Margin and Comment on the results given a set of_
    ↪threshold values.",
    system_prompt=(
        """You are the ProfitabilityAgent that can collect profitability ratios_
        ↪(profitability_ratios) on a given ticker.
        You collect these ratios from the FundamentalAgent.
        Once these ratios are collected in profitability_ratios, you should_
        ↪comment on these ratios based on the thresholds values provided in_
        ↪get_profitability_ratios.
        These comments must be included in threshold_profitability_comments. At_
        ↪the end provide ONLY these comments included in_
        ↪threshold_profitability_comments. DO NOT ADD anything else.
        Once the comments are done, you should hand off control to the_
        ↪LiquidityAgent.
        """
    )
)
```

```

    ),
    llm=LLM_CLAUDE4,
    tools=[get_profitability_ratios],
    can_handoff_to=["LiquidityAgent"],
)

liquidity_agent = FunctionAgent(
    name="LiquidityAgent",
    description="Collect liquidity ratios for a given ticker: Current Ratio, Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio and comments on these ratios given a set of threshold values.",
    system_prompt=(
        """You are the LiquidityAgent that can collect liquidity ratios (liquidity_ratios) on a given ticker.
        You collect these ratios from the FundamentalAgent.
        Once these ratios are collected in liquidity_ratios, you should comment on these ratios based on the thresholds values provided in get_liquidity_ratios.
        These comments must be included in threshold_liquidity_comments. At the end provide ONLY these comments included in threshold_liquidity_comments. DO NOT ADD anything else.
        Once the comments are done, you should hand off control to the SupervisorAgent.
        """
    ),
    llm=LLM_CLAUDE4,
    tools=[get_liquidity_ratios],
    can_handoff_to=["SupervisorAgent"],
)

supervisor_agent = FunctionAgent(
    name="SupervisorAgent",
    description="Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.",
    system_prompt=(
        "You are an fundament analyst expert and supervisor. You collect comments coming from various agents such as ProfitabilityAgent and LiquidityAgent. "
        "If you collect only one or no comments, go back to ProfitabilityAgent and LiquidityAgent until you get the desired feedbacks on the ratios."
        "If you don't collect threshold_liquidity_comments, you should hand off control to the LiquidityAgent to gather these comments."
        "If you don't collect threshold_profitability_comments, you should hand off control to the ProfitabilityAgent to gather these comments."
    )
)

```

```

        "Based on the results in the comments coming from the_
↳ProfitabilityAgent and LiquidityAgent, provide an overall comment on the_
↳health of the firm."
        "Justify your comment with details and data. "
    ),
    llm=LLM_CLAUDE4,
    tools=[get_overall_comments],
    can_handoff_to=["FundamentalAgent","ProfitabilityAgent","LiquidityAgent"],
)

```

```

[ ]: # from llama_index.core.agent.workflow import AgentWorkflow

agent_workflow = AgentWorkflow(
    agents=[fundamental_agent, profitability_agent,liquidity_agent,↳
↳supervisor_agent],
    root_agent=fundamental_agent.name,
    initial_state={
        "ratios": pd.DataFrame(),
        "profitability_ratios": {},
        "liquidity_ratios": {},
        "threshold_profitability_comments": None,
        "threshold_liquidity_comments": None,
        "overall_comments": None,
        "ticker": "",
    },
)

```

Launch Workflow

```

[ ]: # from llama_index.core.agent.workflow import (
#     AgentInput,
#     AgentOutput,
#     ToolCall,
#     ToolCallResult,
#     AgentStream,
# )

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the_
↳financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""

```

```

async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f"  Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print("  Output:", event.response.content)
        if event.tool_calls:
            print(
                "    Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )
    elif isinstance(event, ToolCallResult):
        print(f"  Tool Result ({event.tool_name}):")
        print(f"    Arguments: {event.tool_kwargs}")
        print(f"    Output: {event.tool_output}")
    elif isinstance(event, ToolCall):
        print(f"  Calling Tool: {event.tool_name}")
        print(f"    With arguments: {event.tool_kwargs}")

```

```

=====
Agent: FundamentalAgent
=====

```

Output: Based on the comprehensive fundamental analysis of Apple Inc. (AAPL), here's a detailed assessment of the company's financial health:

Apple Inc. (AAPL) - Fundamental Analysis Summary

Profitability Analysis - Exceptional Performance

Apple demonstrates outstanding profitability across all key metrics for 2024:

**** Key Profitability Ratios:****

- ****Return on Assets (ROA)**:** 26.13% (Score: 10/10)
- ****Return on Equity (ROE)**:** 157.41% (Score: 10/10)
- ****Net Profit Margin**:** 23.97% (Score: 10/10)
- ****Gross Margin**:** 46.21% (Score: 10/10)

****Financial Health Assessment****

**** Exceptional Strengths:****

1. ****Asset Efficiency****: With an ROA of 26.13%, Apple demonstrates exceptional efficiency in converting assets into earnings, far exceeding the healthy threshold of 5%.
2. ****Shareholder Value Creation****: The ROE of 157.41% indicates Apple generates extraordinary returns for shareholders, significantly above the 15% healthy benchmark.
3. ****Profit Retention****: A net profit margin of 23.97% shows Apple retains nearly 24 cents of every revenue dollar as profit, indicating excellent cost management.
4. ****Pricing Power****: The gross margin of 46.21% reflects strong pricing power and effective production cost control.

**Operational Efficiency Insights**

From the broader fundamental ratios available:

****Working Capital Management:****

- ****Cash Conversion Cycle****: -72.97 days (2024) - This negative cycle indicates Apple collects cash from customers faster than it pays suppliers, creating a favorable cash flow dynamic.
- ****Days of Inventory Outstanding****: 11.81 days - Extremely efficient inventory management
- ****Days of Sales Outstanding****: 29.36 days - Quick collection of receivables

**Overall Financial Health Rating: A+ (Exceptional)**

****Key Competitive Advantages:****

- ****Operational Excellence****: Superior asset utilization and inventory management
- ****Strong Market Position****: High margins indicate pricing power and brand strength
- ****Cash Generation****

Results As you can see in the results, the multi-agents didn't go through the whole workflow. However, it did provide a final answer, which include analysis of the "Operational Efficiency Insights" I didn't ask for ==> Hallucination

5.7.2 Claude 3.7

Agents and Workflow

```
[ ]: # from llama_index.core.agent.workflow import FunctionAgent

fundamental_agent = FunctionAgent(
    name="FundamentalAgent",
    description="Get various fundamental ratios for a given ticker.",
    system_prompt=(
        "You are the fundament analyst that can extract different fundamental_
        ↪ratios for a given ticker. "
        "Once you have extracted the fundamental financial ratios, you should_
        ↪hand off control to the ProfitabilityAgent to extract the profitability_
        ↪ratios or/and the LiquidityAgent to extract the liquidity ratios."
    ),
    llm=LLM_CLAUDE37,
    tools=[get_fundamentals],
    can_handoff_to=["ProfitabilityAgent"],
)

profitability_agent = FunctionAgent(
    name="ProfitabilityAgent",
    description="Collect profitability ratios for a given ticker: ROA, ROE, Net_
    ↪Profit Margin and Gross Margin and Comment on the results given a set of_
    ↪threshold values.",
    system_prompt=(
        """"You are the ProfitabilityAgent that can collect profitability ratios_
        ↪(profitability_ratios) on a given ticker.
        You collect these ratios from the FundamentalAgent.
        Once these ratios are collected in profitability_ratios, you should_
        ↪comment on these ratios based on the thresholds values provided in_
        ↪get_profitability_ratios.
        These comments must be included in threshold_profitability_comments. At_
        ↪the end provide ONLY these comments included in_
        ↪threshold_profitability_comments. DO NOT ADD anything else.
        Once the comments are done, you should hand off control to the_
        ↪LiquidityAgent.
        """"
    ),
    llm=LLM_CLAUDE37,
    tools=[get_profitability_ratios],
    can_handoff_to=["LiquidityAgent"],
)

liquidity_agent = FunctionAgent(
    name="LiquidityAgent",
```

```

        description="Collect liquidity ratios for a given ticker: Current Ratio,
        ↳Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio and comments on
        ↳these ratios given a set of threshold values.",
        system_prompt=(
            """You are the LiquidityAgent that can collect liquidity ratios
            ↳(liquidity_ratios) on a given ticker.

            You collect these ratios from the FundamentalAgent.

            Once these ratios are collected in liquidity_ratios, you should comment
            ↳on these ratios based on the thresholds values provided in
            ↳get_liquidity_ratios.

            These comments must be included in threshold_liquidity_comments. At the
            ↳end provide ONLY these comments included in threshold_liquidity_comments. DO
            ↳NOT ADD anything else.

            Once the comments are done, you should hand off control to the
            ↳SupervisorAgent.

            """
        ),
        llm=LLM_CLAUDE37,
        tools=[get_liquidity_ratios],
        can_handoff_to=["SupervisorAgent"],
    )

supervisor_agent = FunctionAgent(
    name="SupervisorAgent",
    description="Provide an overall comment based on the comments coming from
    ↳the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.",
    system_prompt=(
        "You are an fundament analyst expert and supervisor. You collect
        ↳comments coming from various agents such as ProfitabilityAgent and
        ↳LiquidityAgent. "

        "If you collect only one or no comments, go back to ProfitabilityAgent
        ↳and LiquidityAgent until you get the desired feedbacks on the ratios."

        "If you don't collect threshold_liquidity_comments, you should hand off
        ↳control to the LiquidityAgent to gather these comments."

        "If you don't collect threshold_profitability_comments, you should hand
        ↳off control to the ProfitabilityAgent to gather these comments."

        "Based on the results in the comments coming from the
        ↳ProfitabilityAgent and LiquidityAgent, provide an overall comment on the
        ↳health of the firm."

        "Justify your comment with details and data. "
    ),
    llm=LLM_CLAUDE37,
    tools=[get_overall_comments],
    can_handoff_to=["FundamentalAgent", "ProfitabilityAgent", "LiquidityAgent"],
)

```



```
[ ]: # from llama_index.core.agent.workflow import AgentWorkflow

agent_workflow = AgentWorkflow(
    agents=[fundamental_agent, profitability_agent, liquidity_agent,
    ↪supervisor_agent],
    root_agent=fundamental_agent.name,
    initial_state={
        "ratios": pd.DataFrame(),
        "profitability_ratios": {},
        "liquidity_ratios": {},
        "threshold_profitability_comments": None,
        "threshold_liquidity_comments": None,
        "overall_comments": None,
        "ticker": "",
    },
)

```

Launch Workflow

```
[ ]: # from llama_index.core.agent.workflow import (
#     AgentInput,
#     AgentOutput,
#     ToolCall,
#     ToolCallResult,
#     AgentStream,
# )

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the
    ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

```

```

elif isinstance(event, AgentOutput):
    if event.response.content:
        print(" Output:", event.response.content)
    if event.tool_calls:
        print(
            " Planning to use tools:",
            [call.tool_name for call in event.tool_calls],
        )
elif isinstance(event, ToolCallResult):
    print(f" Tool Result ({event.tool_name}):")
    print(f" Arguments: {event.tool_kwargs}")
    print(f" Output: {event.tool_output}")
elif isinstance(event, ToolCall):
    print(f" Calling Tool: {event.tool_name}")
    print(f" With arguments: {event.tool_kwargs}")

```

```

=====
Agent: FundamentalAgent
=====

```

Output: I'll help you with a fundamental analysis of Apple. Let me first get the fundamental ratios for Apple's ticker (AAPL) and then hand off to the appropriate agent for profitability analysis.

Planning to use tools: ['get_fundamentals']

Obtaining financial statements: 100%| | 3/3 [00:00<00:00, 4.64it/s]

Obtaining historical data: 100%| | 2/2 [00:00<00:00, 9.58it/s]

ratios 2022 NaN

2023 0.275

2024 0.2613

Freq: Y-DEC, Name: Return on Assets, dtype: float64

Calling Tool: get_fundamentals

With arguments: {'ticker': 'AAPL'}

Tool Result (get_fundamentals):

Arguments: {'ticker': 'AAPL'}

Output: Ratios extracted for AAPL.

Output: Now that I've extracted the fundamental ratios for Apple (AAPL), I'll hand off to the ProfitabilityAgent to analyze the profitability ratios and provide comments on Apple's financial health.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': "Need to analyze the profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) for Apple (AAPL) and provide comments on the company's financial health."}

Tool Result (handoff):

Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': "Need to analyze the

profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) for Apple (AAPL) and provide comments on the company's financial health."}

Output: Agent ProfitabilityAgent is now handling the request due to the following reason: Need to analyze the profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) for Apple (AAPL) and provide comments on the company's financial health..

Please continue with the current request.

```
=====
Agent: ProfitabilityAgent
=====
```

Output: I'll help analyze Apple's profitability ratios. Let me collect the profitability ratios for Apple (AAPL) and provide comments on these ratios.

Planning to use tools: ['get_profitability_ratios']

Calling Tool: get_profitability_ratios

With arguments: {}

Tool Result (get_profitability_ratios):

Arguments: {}

Output: Profitability ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on its profitability ratios, we will evaluate each ratio against the provided thresholds and assign a score from 1 to 10. Let's proceed with the analysis:

1 Return on Assets (ROA)

- **Value**: 26.13%
- **Thresholds**:
 - Healthy: > 5%
 - Moderate: 2% - 5%
 - Weak: < 2%

Score: 10/10

Justification: Apple's ROA of 26.13% is significantly above the healthy threshold of 5%. This indicates that Apple is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational efficiency and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- **Value**: 157.41%
- **Thresholds**:
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

****Score**:** 10/10

****Justification**:** With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits relative to shareholders' equity, reflecting strong financial performance and effective use of equity capital. Such a high ROE is often indicative of a company with a competitive advantage and strong profitability.

3 Net Profit Margin

- ****Value**:** 23.97%
- ****Thresholds**:**
 - Healthy: > 10%
 - Moderate: 5% - 10%
 - Weak: < 5%

****Score**:** 10/10

****Justification**:** Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin indicates that Apple retains a significant portion of its revenue as profit after all expenses, showcasing strong cost management and pricing power. A high net profit margin is a sign of a financially robust company.

4 Gross Margin

- ****Value**:** 46.21%
- ****Thresholds**:**
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

****Score**:** 10/10

****Justification**:** The gross margin of 46.21% is above the healthy threshold of 40%, indicating that Apple is able to maintain a substantial difference between its sales and the cost of goods sold. This suggests effective production and procurement processes, as well as strong pricing strategies, contributing to overall profitability.

Overall Insight

****Overall Score**:** 10/10

****Summary**:** Apple's financial health, as assessed through its profitability ratios, is exceptionally strong. Each ratio significantly exceeds the healthy thresholds, indicating robust operational efficiency, effective asset and equity

utilization, and strong profit retention. Apple's high profitability ratios reflect its competitive advantage, strong market position, and effective management strategies. The company's ability to generate high returns on assets and equity, coupled with substantial profit margins, positions it as a financially healthy and resilient firm. There are no apparent weaknesses in the profitability aspect of Apple's financial health based on the given data.

Output: Based on the profitability analysis of Apple (AAPL), here are the key findings:

Apple's financial health from a profitability perspective is exceptionally strong:

- Return on Assets (ROA): 26.13% - Significantly above the healthy threshold of 5%, indicating excellent efficiency in using assets to generate earnings.
- Return on Equity (ROE): 157.41% - Far exceeds the healthy threshold of 15%, showing outstanding returns for shareholders and effective use of equity capital.
- Net Profit Margin: 23.97% - Well above the healthy threshold of 10%, demonstrating strong cost management and pricing power.
- Gross Margin: 46.21% - Above the healthy threshold of 40%, indicating effective production processes and strong pricing strategies.

Overall, Apple demonstrates exceptional profitability across all metrics, positioning it as a financially healthy and resilient company with strong competitive advantages and effective management strategies.

Now, let me hand off to the LiquidityAgent to analyze Apple's liquidity ratios for a complete financial health assessment.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': "Need to analyze the liquidity ratios for Apple (AAPL) to complete the fundamental analysis of the company's financial health."}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': "Need to analyze the liquidity ratios for Apple (AAPL) to complete the fundamental analysis of the company's financial health."}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Need to analyze the liquidity ratios for Apple (AAPL) to complete the fundamental analysis of the company's financial health..

Please continue with the current request.

```
=====
Agent: LiquidityAgent
=====
```

Output: I'll now analyze Apple's liquidity ratios to provide a comprehensive view of the company's financial health. Let me collect the liquidity ratios for Apple (AAPL).

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the overall financial health of the firm.

1. Current Ratio

- **Value**: 0.8673
- **Healthy Range**: 1.5 - 3.0
- **Evaluation**: The current ratio of 0.8673 is below the healthy range, indicating that Apple may not have enough current assets to cover its current liabilities. This places the company in the warning zone, suggesting potential liquidity issues.
- **Score**: 3
- **Justification**: The score of 3 reflects the fact that the current ratio is significantly below the healthy range, indicating potential liquidity concerns. However, it is not in the risky/dangerous zone, which would warrant a lower score.

2. Quick Ratio

- **Value**: 0.5589
- **Healthy Range**: > 1.0
- **Evaluation**: The quick ratio is also below the healthy threshold, indicating that Apple may struggle to meet its short-term obligations without relying on inventory sales.
- **Score**: 2
- **Justification**: A score of 2 is assigned because the quick ratio is well below the healthy threshold, suggesting significant liquidity issues. This is a critical area of concern for the company's short-term financial health.

3. Debt-to-Equity Ratio

- **Value**: 2.0906
- **Healthy Range**: 0.3 - 1.5
- **Evaluation**: The debt-to-equity ratio is above the healthy range and falls into the warning zone. This indicates that Apple is using a higher level of debt financing compared to equity, which could increase financial risk.
- **Score**: 4
- **Justification**: The score of 4 reflects the fact that the ratio is above the healthy range, indicating a higher reliance on debt. However, it is not in

the risky/dangerous zone, which would suggest excessive leverage.

4. Interest Coverage Ratio

- **Value**: inf (infinite)
- **Healthy Range**: > 3.0
- **Evaluation**: An infinite interest coverage ratio suggests that Apple has no interest expense or that its earnings are significantly higher than its interest obligations, indicating excellent financial health in terms of covering interest expenses.
- **Score**: 10
- **Justification**: The score of 10 is justified as the infinite interest coverage ratio indicates that Apple is in a very strong position to meet its interest obligations, reflecting excellent financial health in this aspect.

Overall Insight

- **Strengths**: Apple's infinite interest coverage ratio is a significant strength, indicating that the company is in an excellent position to cover its interest expenses, reflecting strong earnings relative to its interest obligations.
- **Weaknesses**: The current and quick ratios are both below the healthy thresholds, indicating potential liquidity issues. Additionally, the debt-to-equity ratio is in the warning zone, suggesting a higher reliance on debt financing, which could pose financial risks if not managed properly.

In summary, while Apple demonstrates strong earnings capacity to cover interest expenses, its liquidity ratios suggest potential short-term financial challenges. The company should focus on improving its liquidity position to enhance its overall financial health.

Output: Apple's liquidity analysis reveals a mixed financial picture:

Current Ratio: 0.8673 (Below healthy range of 1.5-3.0)

Apple's current ratio indicates potential liquidity concerns as it may not have enough current assets to cover short-term obligations.

Quick Ratio: 0.5589 (Below healthy threshold of >1.0)

This suggests Apple may struggle to meet short-term obligations without relying on inventory sales.

Debt-to-Equity Ratio: 2.0906 (Above healthy range of 0.3-1.5)

Apple is using a higher level of debt financing compared to equity, which could increase financial risk.

Interest Coverage Ratio: Infinite

This is a significant strength, indicating Apple has excellent ability to cover its interest expenses with its earnings.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'SupervisorAgent', 'reason': 'Now that both

profitability and liquidity analyses are complete for Apple (AAPL), the SupervisorAgent should provide an overall comment on the company's financial health."}

Tool Result (handoff):

Arguments: {'to_agent': 'SupervisorAgent', 'reason': "Now that both profitability and liquidity analyses are complete for Apple (AAPL), the SupervisorAgent should provide an overall comment on the company's financial health."}

Output: Agent SupervisorAgent is now handling the request due to the following reason: Now that both profitability and liquidity analyses are complete for Apple (AAPL), the SupervisorAgent should provide an overall comment on the company's financial health..

Please continue with the current request.

```
=====
Agent: SupervisorAgent
=====
```

Output: Now that I have both the profitability and liquidity analyses for Apple (AAPL), I'll provide an overall assessment of the company's financial health.

Planning to use tools: ['get_overall_comments']

Calling Tool: get_overall_comments

With arguments: {}

Tool Result (get_overall_comments):

Arguments: {}

Output: get_overall_comments() missing 1 required positional argument: 'overall_comments'

Output: I need to provide my own overall comments based on the analyses we've gathered. Let me synthesize the information from both the profitability and liquidity analyses:

Comprehensive Financial Health Assessment of Apple Inc. (AAPL)

Profitability Analysis (Exceptional)

Apple demonstrates outstanding profitability metrics across all key indicators:

- **ROA (26.13%)**: Significantly exceeds the healthy threshold of 5%, showing exceptional efficiency in utilizing assets to generate earnings.
- **ROE (157.41%)**: Dramatically above the healthy threshold of 15%, indicating remarkable returns for shareholders.
- **Net Profit Margin (23.97%)**: Well above the 10% healthy threshold, demonstrating strong pricing power and cost management.
- **Gross Margin (46.21%)**: Exceeds the 40% healthy threshold, reflecting effective production processes and strong market position.

Liquidity Analysis (Mixed)

Apple shows some concerns in its liquidity position:

- **Current Ratio (0.8673)**: Below the healthy range of 1.5-3.0, indicating

potential challenges in covering short-term obligations.

- **Quick Ratio (0.5589)**: Below the healthy threshold of 1.0, suggesting possible difficulties meeting immediate obligations without selling inventory.
- **Debt-to-Equity Ratio (2.0906)**: Above the healthy range of 0.3-1.5, indicating higher reliance on debt financing.
- **Interest Coverage Ratio (Infinite)**: Exceptional ability to cover interest expenses, a significant strength.

Overall Financial Health Assessment

Apple presents an interesting financial profile with contrasting strengths and weaknesses:

Strengths:

1. Exceptional profitability across all metrics, indicating strong operational efficiency and market position
2. Outstanding ability to generate returns for shareholders
3. Excellent interest coverage, suggesting minimal concerns about debt servicing

Areas of Concern:

1. Below-optimal liquidity ratios, indicating potential short-term cash flow challenges
2. Higher-than-ideal leverage as shown by the debt-to-equity ratio

Balanced Perspective:

Despite the liquidity concerns, Apple's extraordinary profitability provides significant financial flexibility. The company's ability to generate substantial cash flow likely mitigates the risks associated with

[]:

Truncated Output because of max tokens Output: I need to provide my own overall comments based on the analyses we've gathered. Let me synthesize the information from both the profitability and liquidity analyses:

Comprehensive Financial Health Assessment of Apple Inc. (AAPL)

5.8 Profitability Analysis (Exceptional)

Apple demonstrates outstanding profitability metrics across all key indicators: - **ROA (26.13%)**: Significantly exceeds the healthy threshold of 5%, showing exceptional efficiency in utilizing assets to generate earnings. - **ROE (157.41%)**: Dramatically above the healthy threshold of 15%, indicating remarkable returns for shareholders. - **Net Profit Margin (23.97%)**: Well above the 10% healthy threshold, demonstrating strong pricing power and cost management. - **Gross Margin (46.21%)**: Exceeds the 40% healthy threshold, reflecting effective production processes and strong market position.

5.9 Liquidity Analysis (Mixed)

Apple shows some concerns in its liquidity position: - **Current Ratio (0.8673)**: Below the healthy range of 1.5-3.0, indicating potential challenges in covering short-term obligations. - **Quick Ratio (0.5589)**: Below the healthy threshold of 1.0, suggesting possible difficulties meeting immediate obligations without selling inventory. - **Debt-to-Equity Ratio (2.0906)**: Above the healthy range of 0.3-1.5, indicating higher reliance on debt financing. - **Interest Coverage Ratio (Infinite)**: Exceptional ability to cover interest expenses, a significant strength.

5.10 Overall Financial Health Assessment

Apple presents an interesting financial profile with contrasting strengths and weaknesses:

Strengths: 1. Exceptional profitability across all metrics, indicating strong operational efficiency and market position 2. Outstanding ability to generate returns for shareholders 3. Excellent interest coverage, suggesting minimal concerns about debt servicing

Areas of Concern: 1. Below-optimal liquidity ratios, indicating potential short-term cash flow challenges 2. Higher-than-ideal leverage as shown by the debt-to-equity ratio

Balanced Perspective: Despite the liquidity concerns, Apple's extraordinary profitability provides significant financial flexibility. The company's ability to generate substantial cash flow likely mitigates the risks associated with

LLM's answer with modified Max tokens:

- Instead of using LLM_CLAUDE37, I used LLM_CLAUDE37_TOK when defining the agents: `llm=LLM_CLAUDE37 ==> LLM_CLAUDE37_TOK`

Agents and Workflow

```
[ ]: # from llama_index.core.agent.workflow import FunctionAgent

fundamental_agent = FunctionAgent(
    name="FundamentalAgent",
    description="Get various fundamental ratios for a given ticker.",
    system_prompt=(
        "You are the fundament analyst that can extract different fundamental_
        ↪ratios for a given ticker. "
        "Once you have extracted the fundamental financial ratios, you should_
        ↪hand off control to the ProfitabilityAgent to extract the profitability_
        ↪ratios or/and the LiquidityAgent to extract the liquidity ratios."
    ),
    llm=LLM_CLAUDE37_TOK,
    tools=[get_fundamentals],
    can_handoff_to=["ProfitabilityAgent"],
)

profitability_agent = FunctionAgent(
    name="ProfitabilityAgent",
```

```

        description="Collect profitability ratios for a given ticker: ROA, ROE, Net_
↳Profit Margin and Gross Margin and Comment on the results given a set of_
↳threshold values.",
        system_prompt=(
            """You are the ProfitabilityAgent that can collect profitability ratios_
↳(profitability_ratios) on a given ticker.

            You collect these ratios from the FundamentalAgent.
            Once these ratios are collected in profitability_ratios, you should_
↳comment on these ratios based on the thresholds values provided in_
↳get_profitability_ratios.

            These comments must be included in threshold_profitability_comments. At_
↳the end provide ONLY these comments included in_
↳threshold_profitability_comments. DO NOT ADD anything else.

            Once the comments are done, you should hand off control to the_
↳LiquidityAgent.

            """
        ),
        llm=LLM_CLAUDE37_TOK,
        tools=[get_profitability_ratios],
        can_handoff_to=["LiquidityAgent"],
    )

liquidity_agent = FunctionAgent(
    name="LiquidityAgent",
    description="Collect liquidity ratios for a given ticker: Current Ratio,_
↳Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio and comments on_
↳these ratios given a set of threshold values.",
    system_prompt=(
        """You are the LiquidityAgent that can collect liquidity ratios_
↳(liquidity_ratios) on a given ticker.

            You collect these ratios from the FundamentalAgent.
            Once these ratios are collected in liquidity_ratios, you should comment_
↳on these ratios based on the thresholds values provided in_
↳get_liquidity_ratios.

            These comments must be included in threshold_liquidity_comments. At the_
↳end provide ONLY these comments included in threshold_liquidity_comments. DO_
↳NOT ADD anything else.

            Once the comments are done, you should hand off control to the_
↳SupervisorAgent.

            """
    ),
    llm=LLM_CLAUDE37_TOK,
    tools=[get_liquidity_ratios],
    can_handoff_to=["SupervisorAgent"],
)

```

```

supervisor_agent = FunctionAgent(
    name="SupervisorAgent",
    description="Provide an overall comment based on the comments coming from
    the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.",
    system_prompt=(
        "You are an fundament analyst expert and supervisor. You collect
        comments coming from various agents such as ProfitabilityAgent and
        LiquidityAgent. "
        "If you collect only one or no comments, go back to ProfitabilityAgent
        and LiquidityAgent until you get the desired feedbacks on the ratios."
        "If you don't collect threshold_liquidity_comments, you should hand off
        control to the LiquidityAgent to gather these comments."
        "If you don't collect threshold_profitability_comments, you should hand
        off control to the ProfitabilityAgent to gather these comments."
        "Based on the results in the comments coming from the
        ProfitabilityAgent and LiquidityAgent, provide an overall comment on the
        health of the firm."
        "Justify your comment with details and data. "
    ),
    llm=LLM_CLAUDE37_TOK,
    tools=[get_overall_comments],
    can_handoff_to=["FundamentalAgent", "ProfitabilityAgent", "LiquidityAgent"],
)

# from llama_index.core.agent.workflow import AgentWorkflow

agent_workflow = AgentWorkflow(
    agents=[fundamental_agent, profitability_agent, liquidity_agent,
    supervisor_agent],
    root_agent=fundamental_agent.name,
    initial_state={
        "ratios": pd.DataFrame(),
        "profitability_ratios": {},
        "liquidity_ratios": {},
        "threshold_profitability_comments": None,
        "threshold_liquidity_comments": None,
        "overall_comments": None,
        "ticker": "",
    },
)

```

Launch Workflow

```

[ ]: # from llama_index.core.agent.workflow import (
#     AgentInput,
#     AgentOutput,

```

```

#     ToolCall,
#     ToolCallResult,
#     AgentStream,
# )

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the
        ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print(" Output:", event.response.content)
        if event.tool_calls:
            print(
                " Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )

    elif isinstance(event, ToolCallResult):
        print(f" Tool Result ({event.tool_name}):")
        print(f" Arguments: {event.tool_kwargs}")
        print(f" Output: {event.tool_output}")

    elif isinstance(event, ToolCall):
        print(f" Calling Tool: {event.tool_name}")
        print(f" With arguments: {event.tool_kwargs}")

```

```

=====
Agent: FundamentalAgent
=====

```

Output: I'll help you with a fundamental analysis of Apple. Let me first get the fundamental ratios for Apple (ticker: AAPL) and then hand off to the

appropriate agent for profitability analysis.

Planning to use tools: ['get_fundamentals']

Obtaining financial statements: 100%| | 3/3 [00:00<00:00, 5.17it/s]

Obtaining historical data: 100%| | 2/2 [00:00<00:00, 9.64it/s]

ratios 2022 NaN

2023 0.275

2024 0.2613

Freq: Y-DEC, Name: Return on Assets, dtype: float64

Calling Tool: get_fundamentals

With arguments: {'ticker': 'AAPL'}

Tool Result (get_fundamentals):

Arguments: {'ticker': 'AAPL'}

Output: Ratios extracted for AAPL.

Output: Now that I've extracted the fundamental ratios for Apple (AAPL), I'll hand off to the ProfitabilityAgent to analyze the profitability ratios and provide comments on Apple's financial health.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': "Need to analyze the profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) for Apple (AAPL) and provide comments on the company's financial health."}

Tool Result (handoff):

Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': "Need to analyze the profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) for Apple (AAPL) and provide comments on the company's financial health."}

Output: Agent ProfitabilityAgent is now handling the request due to the following reason: Need to analyze the profitability ratios (ROA, ROE, Net Profit Margin, Gross Margin) for Apple (AAPL) and provide comments on the company's financial health..

Please continue with the current request.

=====
Agent: ProfitabilityAgent
=====

Output: I'll analyze Apple's profitability ratios to provide insights on the company's financial health. Let me collect the profitability ratios for Apple (AAPL).

Planning to use tools: ['get_profitability_ratios']

Calling Tool: get_profitability_ratios

With arguments: {}

Tool Result (get_profitability_ratios):

Arguments: {}

Output: Profitability ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on its profitability ratios, we will evaluate each ratio against the provided thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the

overall financial health of the firm.

1 Return on Assets (ROA)

- **Value**: 26.13%
- **Thresholds**:
 - Healthy: > 5%
 - Moderate: 2% - 5%
 - Weak: < 2%

Score: 10/10

Justification: Apple's ROA of 26.13% is significantly higher than the healthy threshold of 5%. This indicates that Apple is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational efficiency and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- **Value**: 157.41%
- **Thresholds**:
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

Score: 10/10

Justification: With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits from its shareholders' equity. It reflects strong profitability and effective use of equity financing, which is a strong indicator of financial health.

3 Net Profit Margin

- **Value**: 23.97%
- **Thresholds**:
 - Healthy: > 10%
 - Moderate: 5% - 10%
 - Weak: < 5%

Score: 10/10

Justification: Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin indicates that Apple retains a significant portion of its revenue as profit after all expenses. It reflects strong pricing power, cost control, and overall profitability, contributing positively to

financial health.

4 Gross Margin

- ****Value****: 46.21%
- ****Thresholds****:
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

****Score****: 10/10

****Justification****: With a gross margin of 46.21%, Apple exceeds the healthy threshold of 40%. This indicates that Apple is able to maintain a high level of profitability on its core products and services before accounting for other expenses. A high gross margin suggests strong competitive positioning and effective cost management.

Overall Insight on Financial Health

Apple's financial health, as assessed through its profitability ratios, is exceptionally strong. Each ratio not only meets but significantly exceeds the healthy thresholds, indicating robust operational efficiency, effective asset and equity utilization, strong profitability, and competitive strength. The high scores across all ratios reflect a well-managed company with a solid financial foundation. Apple's ability to generate high returns on its assets and equity, coupled with strong profit margins, positions it favorably in the market and suggests a sustainable competitive advantage. There are no apparent weaknesses in the profitability aspect of Apple's financial health based on the provided data.

Output: Based on the profitability analysis of Apple (AAPL), here are the key insights:

Apple's financial health, as assessed through its profitability ratios, is exceptionally strong. Each ratio not only meets but significantly exceeds the healthy thresholds, indicating robust operational efficiency, effective asset and equity utilization, strong profitability, and competitive strength. The high scores across all ratios reflect a well-managed company with a solid financial foundation. Apple's ability to generate high returns on its assets and equity, coupled with strong profit margins, positions it favorably in the market and suggests a sustainable competitive advantage. There are no apparent weaknesses in the profitability aspect of Apple's financial health based on the provided data.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': "Need to analyze the liquidity ratios for Apple (AAPL) to complete the fundamental analysis and provide a comprehensive view of the company's financial health."}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': "Need to analyze the liquidity ratios for Apple (AAPL) to complete the fundamental analysis and provide a comprehensive view of the company's financial health."}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Need to analyze the liquidity ratios for Apple (AAPL) to complete the fundamental analysis and provide a comprehensive view of the company's financial health..

Please continue with the current request.

=====

Agent: LiquidityAgent

=====

Output: I'll now analyze Apple's liquidity ratios to provide insights on the company's financial health from a liquidity perspective. Let me collect the liquidity ratios for Apple (AAPL).

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the overall financial health of the firm.

1. Current Ratio

- **Value:** 0.8673
- **Healthy Range:** 1.5 - 3.0
- **Evaluation:**
 - **Score:** 3
 - **Justification:** The current ratio of 0.8673 is below the healthy range, indicating that Apple may not have enough current assets to cover its current liabilities. This suggests potential liquidity issues, as the company might struggle to meet short-term obligations without relying on additional financing or asset liquidation.

2. Quick Ratio

- **Value:** 0.5589
- **Healthy Range:** > 1.0
- **Evaluation:**
 - **Score:** 2
 - **Justification:** The quick ratio is significantly below the healthy threshold of 1.0, indicating that Apple has limited liquid assets (excluding inventory) to cover its current liabilities. This further emphasizes potential liquidity concerns, as the company may face challenges in meeting immediate

financial obligations without converting inventory to cash.

3. Debt-to-Equity Ratio

- **Value:** 2.0906
- **Healthy Range:** 0.3 - 1.5
- **Evaluation:**
 - **Score:** 4
 - **Justification:** The debt-to-equity ratio exceeds the healthy range and falls into the warning zone (> 2.0). This suggests that Apple is highly leveraged, relying more on debt financing than equity. While this can amplify returns, it also increases financial risk, especially if the company faces downturns or interest rate hikes.

4. Interest Coverage Ratio

- **Value:** Infinity (inf)
- **Healthy Range:** > 3.0
- **Evaluation:**
 - **Score:** 10
 - **Justification:** An infinite interest coverage ratio indicates that Apple has no difficulty covering its interest expenses, likely due to substantial earnings before interest and taxes (EBIT) relative to interest obligations. This is a strong indicator of financial health in terms of solvency, as it shows the company can comfortably meet its interest payments.

Overall Insight on Apple's Financial Health

Strengths:

- **Interest Coverage:** Apple demonstrates exceptional ability to cover interest expenses, indicating strong operational profitability and low risk of default on interest payments.

Weaknesses:

- **Liquidity Ratios (Current and Quick Ratios):** Both ratios are below the healthy range, suggesting potential liquidity issues. Apple may need to improve its short-term asset management or consider restructuring its liabilities to enhance liquidity.
- **Leverage (Debt-to-Equity Ratio):** The high debt-to-equity ratio indicates significant reliance on debt, which could pose risks if market conditions change or if the company faces unexpected financial challenges.

Conclusion:

While Apple shows strong solvency with an excellent interest coverage ratio, its liquidity ratios and high leverage raise concerns about its ability to manage short-term obligations and financial flexibility. The company may benefit from strategies to improve liquidity and manage debt levels to ensure long-term financial stability.

Output: Apple's liquidity analysis reveals a mixed financial picture:

The company shows concerning liquidity metrics with a Current Ratio of 0.87 (below the healthy range of 1.5-3.0) and a Quick Ratio of 0.56 (below the healthy threshold of 1.0), indicating potential challenges in meeting short-term obligations. Apple's Debt-to-Equity Ratio of 2.09 exceeds the healthy range (0.3-1.5), suggesting high leverage and increased financial risk. However, the company demonstrates exceptional strength with an infinite Interest Coverage Ratio, showing it can easily meet interest obligations. While Apple has strong operational profitability, its below-optimal liquidity ratios and high leverage suggest areas for improvement in short-term asset management and debt structure to ensure long-term financial stability.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'SupervisorAgent', 'reason': "Now that both profitability and liquidity analyses are complete for Apple (AAPL), the SupervisorAgent should provide an overall comment on the company's financial health based on the combined insights."}

Tool Result (handoff):

Arguments: {'to_agent': 'SupervisorAgent', 'reason': "Now that both profitability and liquidity analyses are complete for Apple (AAPL), the SupervisorAgent should provide an overall comment on the company's financial health based on the combined insights."}

Output: Agent SupervisorAgent is now handling the request due to the following reason: Now that both profitability and liquidity analyses are complete for Apple (AAPL), the SupervisorAgent should provide an overall comment on the company's financial health based on the combined insights..
Please continue with the current request.

=====

Agent: SupervisorAgent

=====

Output: Now that I have both the profitability and liquidity analyses for Apple (AAPL), I'll provide a comprehensive assessment of the company's financial health.

Planning to use tools: ['get_overall_comments']

Calling Tool: get_overall_comments

With arguments: {'overall_comments': "Based on the comprehensive analysis of Apple Inc. (AAPL), we observe a company with exceptional profitability metrics but some concerns regarding liquidity and leverage.\n\nFrom a profitability perspective, Apple demonstrates outstanding performance:\n- Return on Assets (ROA): 26.13% (far exceeding the healthy threshold of 5%)\n- Return on Equity (ROE): 157.41% (substantially above the healthy threshold of 15%)\n- Net Profit Margin: 23.97% (well above the healthy threshold of 10%)\n- Gross Margin: 46.21% (exceeding the healthy threshold of 40%)\n\nThese metrics indicate that Apple is highly efficient in utilizing its assets and equity to generate substantial profits, with strong pricing power and effective cost management.\n\nHowever, the liquidity analysis reveals potential areas of concern:\n- Current Ratio: 0.87 (below the healthy range of 1.5-3.0)\n- Quick Ratio: 0.56 (below the

healthy threshold of 1.0)\n- Debt-to-Equity Ratio: 2.09 (exceeding the healthy range of 0.3-1.5)\n- Interest Coverage Ratio: Infinity (exceptionally strong, well above the healthy threshold of 3.0)\n\nThe below-optimal liquidity ratios suggest that Apple may face challenges in meeting short-term obligations without additional financing or asset liquidation. The high debt-to-equity ratio indicates significant leverage, which could increase financial risk during economic downturns or interest rate increases.\n\nOverall Assessment:\nApple presents a financial profile of a highly profitable company with some liquidity constraints and elevated leverage. The company's exceptional profitability and ability to cover interest expenses provide a strong foundation, but the liquidity metrics suggest a potential area for improvement in financial management.\n\nThis financial structure likely reflects a strategic decision by Apple's management to optimize capital allocation, possibly prioritizing shareholder returns through dividends and share repurchases, as well as investments in growth initiatives, over maintaining high liquidity levels. The company's strong market position, brand value, and consistent cash flow generation may allow it to operate comfortably with lower liquidity ratios than typically recommended.\n\nFor investors, this means Apple represents a highly profitable investment with some financial risk factors that should be monitored, particularly in challenging economic environments. The company's ability to generate substantial profits provides a significant buffer against these risks, but prudent financial management would suggest addressing the liquidity constraints and high leverage over time to ensure long-term financial stability."}

Tool Result (get_overall_comments):

Arguments: {'overall_comments': "Based on the comprehensive analysis of Apple Inc. (AAPL), we observe a company with exceptional profitability metrics but some concerns regarding liquidity and leverage.\n\nFrom a profitability perspective, Apple demonstrates outstanding performance:\n- Return on Assets (ROA): 26.13% (far exceeding the healthy threshold of 5%)\n- Return on Equity (ROE): 157.41% (substantially above the healthy threshold of 15%)\n- Net Profit Margin: 23.97% (well above the healthy threshold of 10%)\n- Gross Margin: 46.21% (exceeding the healthy threshold of 40%)\n\nThese metrics indicate that Apple is highly efficient in utilizing its assets and equity to generate substantial profits, with strong pricing power and effective cost management.\n\nHowever, the liquidity analysis reveals potential areas of concern:\n- Current Ratio: 0.87 (below the healthy range of 1.5-3.0)\n- Quick Ratio: 0.56 (below the healthy threshold of 1.0)\n- Debt-to-Equity Ratio: 2.09 (exceeding the healthy range of 0.3-1.5)\n- Interest Coverage Ratio: Infinity (exceptionally strong, well above the healthy threshold of 3.0)\n\nThe below-optimal liquidity ratios suggest that Apple may face challenges in meeting short-term obligations without additional financing or asset liquidation. The high debt-to-equity ratio indicates significant leverage, which could increase financial risk during economic downturns or interest rate increases.\n\nOverall Assessment:\nApple presents a financial profile of a highly profitable company with some liquidity constraints and elevated leverage. The company's exceptional profitability and ability to cover interest expenses provide a strong foundation, but the liquidity metrics suggest a potential area for improvement in financial

management.\n\nThis financial structure likely reflects a strategic decision by Apple's management to optimize capital allocation, possibly prioritizing shareholder returns through dividends and share repurchases, as well as investments in growth initiatives, over maintaining high liquidity levels. The company's strong market position, brand value, and consistent cash flow generation may allow it to operate comfortably with lower liquidity ratios than typically recommended.\n\nFor investors, this means Apple represents a highly profitable investment with some financial risk factors that should be monitored, particularly in challenging economic environments. The company's ability to generate substantial profits provides a significant buffer against these risks, but prudent financial management would suggest addressing the liquidity constraints and high leverage over time to ensure long-term financial stability."}

Output: bad operand type for unary ~: 'CompletionResponse'

Output: # Comprehensive Financial Analysis of Apple Inc. (AAPL)

Based on the detailed analysis of Apple's financial ratios, I can provide the following assessment of the company's overall financial health:

Profitability Analysis: Exceptional Strength

Apple demonstrates outstanding profitability metrics across all key indicators:

- **Return on Assets (ROA)**: 26.13% (significantly exceeding the 5% healthy threshold)
- **Return on Equity (ROE)**: 157.41% (extraordinarily above the 15% healthy threshold)
- **Net Profit Margin**: 23.97% (well above the 10% healthy threshold)
- **Gross Margin**: 46.21% (exceeding the 40% healthy threshold)

These metrics indicate Apple is exceptionally efficient at utilizing its assets to generate profits, has strong pricing power, and maintains effective cost control. The company's ability to generate such high returns on both assets and equity demonstrates superior operational efficiency and management effectiveness.

Liquidity Analysis: Areas of Concern

Despite strong profitability, Apple shows some concerning liquidity metrics:

- **Current Ratio**: 0.87 (below the healthy range of 1.5-3.0)
- **Quick Ratio**: 0.56 (below the healthy threshold of 1.0)
- **Debt-to-Equity Ratio**: 2.09 (above the healthy range of 0.3-1.5)
- **Interest Coverage Ratio**: Infinity (exceptionally strong, indicating no difficulty covering interest expenses)

The below-optimal liquidity ratios suggest Apple may face challenges meeting short-term obligations without additional financing or asset liquidation. The high debt-to-equity ratio indicates significant leverage, which could increase financial risk during economic downturns.

Overall Financial Health Assessment

Apple presents a somewhat paradoxical financial profile - a highly profitable company with some liquidity constraints and elevated leverage. This structure likely reflects strategic decisions by Apple's management to optimize capital allocation, possibly prioritizing:

1. Shareholder returns through dividends and share repurchases
2. Investments in growth initiatives and R&D
3. Tax-efficient capital structure using debt financing

The company's exceptional profitability and infinite interest coverage ratio provide significant financial strength, allowing it to operate with lower liquidity ratios than typically recommended. Apple's strong market position, brand value, and consistent cash flow generation create a substantial buffer against potential liquidity risks.

Investment Implications

For investors, Apple represents a highly profitable investment with some financial risk factors that should be monitored. The company's ability to generate substantial profits provides significant protection against these risks, but the liquidity constraints and high leverage should be watched, particularly in challenging economic environments.

Apple would benefit from addressing these liquidity constraints and high leverage over time to ensure long-term financial stability, though its current profitability levels suggest it has considerable flexibility in managing these aspects of its financial structure.

In conclusion, Apple demonstrates exceptional operational and profitability strength with manageable liquidity concerns, resulting in an overall strong financial position despite some areas that could be improved.

Comprehensive Financial Analysis of Apple Inc. (AAPL) Based on the detailed analysis of Apple's financial ratios, I can provide the following assessment of the company's overall financial health:

5.11 Profitability Analysis: Exceptional Strength

Apple demonstrates outstanding profitability metrics across all key indicators:

- **Return on Assets (ROA):** 26.13% (significantly exceeding the 5% healthy threshold)
- **Return on Equity (ROE):** 157.41% (extraordinarily above the 15% healthy threshold)
- **Net Profit Margin:** 23.97% (well above the 10% healthy threshold)
- **Gross Margin:** 46.21% (exceeding the 40% healthy threshold)

These metrics indicate Apple is exceptionally efficient at utilizing its assets to generate profits,

has strong pricing power, and maintains effective cost control. The company's ability to generate such high returns on both assets and equity demonstrates superior operational efficiency and management effectiveness.

5.12 Liquidity Analysis: Areas of Concern

Despite strong profitability, Apple shows some concerning liquidity metrics:

- **Current Ratio:** 0.87 (below the healthy range of 1.5-3.0)
- **Quick Ratio:** 0.56 (below the healthy threshold of 1.0)
- **Debt-to-Equity Ratio:** 2.09 (above the healthy range of 0.3-1.5)
- **Interest Coverage Ratio:** Infinity (exceptionally strong, indicating no difficulty covering interest expenses)

The below-optimal liquidity ratios suggest Apple may face challenges meeting short-term obligations without additional financing or asset liquidation. The high debt-to-equity ratio indicates significant leverage, which could increase financial risk during economic downturns.

5.13 Overall Financial Health Assessment

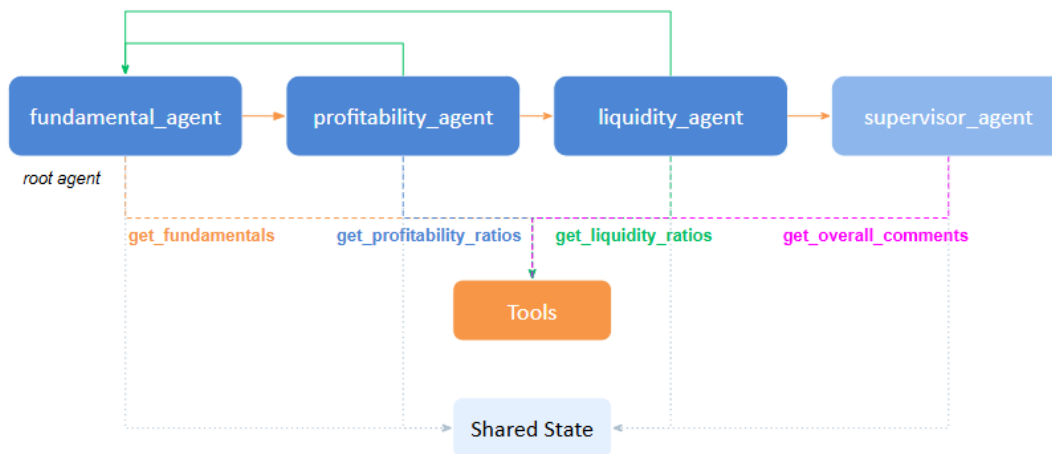
Apple presents a somewhat paradoxical financial profile - a highly profitable company with some liquidity constraints and elevated leverage. This structure likely reflects strategic decisions by Apple's management to optimize capital allocation, possibly prioritizing:

1. Shareholder returns through dividends and share repurchases
2. Investments in growth initiatives and R&D
3. Tax-efficient capital structure using debt financing

The company's exceptional profitability and infinite interest coverage ratio provide significant financial strength, allowing it to operate with lower liquidity ratios than typically recommended. Apple's strong market position, brand value, and consistent cash flow generation create a substantial buffer against potential liquidity risks.

5.14 Other Workflows

```
[5]: from IPython.display import Image, display
display(Image(filename=path+'/fundamental_multi_agent_system_2nd_workflow.png'))
```



5.14.1 Agents and Workflow

```
[ ]: from llama_index.core.agent.workflow import FunctionAgent

fundamental_agent = FunctionAgent(
    name="FundamentalAgent",
    description="Get various fundamental ratios for a given ticker.",
    system_prompt=(
        "You are the fundament analyst that can extract different fundamental_
        ↪ratios for a given ticker. "
        "Once you have extracted the fundamental financial ratios, you should_
        ↪hand off control to the ProfitabilityAgent to extract the profitability_
        ↪ratios or/and the LiquidityAgent to extract the liquidity ratios."
    ),
    llm=LLM_4o,
    tools=[get_fundamentals],
    can_handoff_to=["ProfitabilityAgent"],
)

profitability_agent = FunctionAgent(
    name="ProfitabilityAgent",
    description="Collect profitability ratios for a given ticker: ROA, ROE, Net_
    ↪Profit Margin and Gross Margin and Comment on the results given a set of_
    ↪threshold values.",
    system_prompt=(
        """"You are the ProfitabilityAgent that collects profitability ratios_
        ↪(profitability_ratios) on a given ticker.
        You collect these ratios from the FundamentalAgent.
    """
    )
)
```



```

        If it doesn't work, try calling the FundamentalAgent again to retrieve
        the ratios.

        Once these ratios are collected in profitability_ratios, you should
        comment on these ratios based on the thresholds values provided in
        get_profitability_ratios.

        These comments must be included in threshold_profitability_comments. At
        the end provide ONLY these comments included in
        threshold_profitability_comments. DO NOT ADD anything else.

        Once the comments are done, you should hand off control to the
        LiquidityAgent.
        """
    ),
    llm=LLM_4o,
    tools=[get_profitability_ratios],
    can_handoff_to=["LiquidityAgent", "FundamentalAgent"],
)

liquidity_agent = FunctionAgent(
    name="LiquidityAgent",
    description="Collect liquidity ratios for a given ticker: Current Ratio,
    Quick Ratio, Debt-to-Equity Ratio, Interest Coverage Ratio and comments on
    these ratios given a set of threshold values.",
    system_prompt=(
        """You are the LiquidityAgent that can collect liquidity ratios
        (liquidity_ratios) on a given ticker.

        You collect these ratios from the FundamentalAgent.

        If it doesn't work, try calling the FundamentalAgent again to retrieve
        the ratios.

        Once these ratios are collected in liquidity_ratios, you should comment
        on these ratios based on the thresholds values provided in
        get_liquidity_ratios.

        These comments must be included in threshold_liquidity_comments. At the
        end provide ONLY these comments included in threshold_liquidity_comments. DO
        NOT ADD anything else.

        Once the comments are done, you should hand off control to the
        SupervisorAgent.
        """
    ),
    llm=LLM_4o,
    tools=[get_liquidity_ratios],
    can_handoff_to=["SupervisorAgent", "FundamentalAgent"],
)

supervisor_agent = FunctionAgent(
    name="SupervisorAgent",

```

```

        description="Provide an overall comment based on the comments coming from the ProfitabilityAgent and LiquidityAgent and stored on overall_comments.",
        system_prompt=(
            "You are an fundament analyst expert and supervisor. You collect comments coming from various agents such as ProfitabilityAgent and LiquidityAgent. "
            "If you collect only one or no comments, go back to ProfitabilityAgent and LiquidityAgent until you get the desired feedbacks on the ratios."
            "If you don't collect threshold_liquidity_comments, you should hand off control to the LiquidityAgent to gather these comments."
            "If you don't collect threshold_profitability_comments, you should hand off control to the ProfitabilityAgent to gather these comments."
            "Based on the results in the comments coming from the ProfitabilityAgent and LiquidityAgent, provide an overall comment on the health of the firm."
            "Justify your comment with details and data. "
        ),
        llm=LLM_4o,
        tools=[get_overall_comments],
        can_handoff_to=["FundamentalAgent", "ProfitabilityAgent", "LiquidityAgent"],
    )

```

```

[ ]: # from llama_index.core.agent.workflow import AgentWorkflow

agent_workflow = AgentWorkflow(
    agents=[fundamental_agent, profitability_agent, liquidity_agent, supervisor_agent],
    root_agent=fundamental_agent.name,
    initial_state={
        "ratios": pd.DataFrame(),
        "profitability_ratios": {},
        "liquidity_ratios": {},
        "threshold_profitability_comments": None,
        "threshold_liquidity_comments": None,
        "overall_comments": None,
        "ticker": "",
    },
)

```

5.14.2 Launch Workflow

```

[ ]: # from llama_index.core.agent.workflow import (
#     AgentInput,
#     AgentOutput,
#     ToolCall,

```

```

#     ToolCallResult,
#     AgentStream,
# )

handler = agent_workflow.run(
    user_msg=(
        "Provide the fundamental analysis of Apple and comments on the
        ↪financial health of the company."
    )
)

current_agent = None
current_tool_calls = ""
async for event in handler.stream_events():
    if (
        hasattr(event, "current_agent_name")
        and event.current_agent_name != current_agent
    ):
        current_agent = event.current_agent_name
        print(f"\n{'='*50}")
        print(f" Agent: {current_agent}")
        print(f"{'='*50}\n")

    elif isinstance(event, AgentOutput):
        if event.response.content:
            print(" Output:", event.response.content)
        if event.tool_calls:
            print(
                " Planning to use tools:",
                [call.tool_name for call in event.tool_calls],
            )

    elif isinstance(event, ToolCallResult):
        print(f" Tool Result ({event.tool_name}):")
        print(f" Arguments: {event.tool_kwargs}")
        print(f" Output: {event.tool_output}")

    elif isinstance(event, ToolCall):
        print(f" Calling Tool: {event.tool_name}")
        print(f" With arguments: {event.tool_kwargs}")

```

```

=====
Agent: FundamentalAgent
=====

```

```

Planning to use tools: ['get_fundamentals']

```

```

Obtaining financial statements: 100%|      | 3/3 [00:00<00:00, 4.06it/s]
Obtaining historical data: 100%|      | 2/2 [00:00<00:00, 9.55it/s]

```

```

ratios 2022      NaN
2023      0.275
2024      0.2613
Freq: Y-DEC, Name: Return on Assets, dtype: float64
Calling Tool: get_fundamentals
With arguments: {'ticker': 'AAPL'}
Tool Result (get_fundamentals):
Arguments: {'ticker': 'AAPL'}
Output: Ratios extracted for AAPL.
Planning to use tools: ['handoff']
Calling Tool: handoff
With arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect
profitability ratios for AAPL and comment on the results given a set of
threshold values.'}
Tool Result (handoff):
Arguments: {'to_agent': 'ProfitabilityAgent', 'reason': 'Collect profitability
ratios for AAPL and comment on the results given a set of threshold values.'}
Output: Agent ProfitabilityAgent is now handling the request due to the
following reason: Collect profitability ratios for AAPL and comment on the
results given a set of threshold values..
Please continue with the current request.

```

```

=====
Agent: ProfitabilityAgent
=====

```

```

Planning to use tools: ['get_profitability_ratios']
Calling Tool: get_profitability_ratios
With arguments: {}
Tool Result (get_profitability_ratios):
Arguments: {}
Output: Profitability ratios extracted and Comments performed: To analyze the
financial health of Apple Inc. (AAPL) based on its profitability ratios, we will
evaluate each ratio against the provided thresholds and assign a score from 1 to
10. This score will reflect the health of each ratio, with 1 being very
unhealthy and 10 being very healthy. Let's proceed with the analysis:

```

```

### 1 Return on Assets (ROA)

```

```

- **Value**: 26.13%
- **Thresholds**:
  - Healthy: > 5%
  - Moderate: 2% - 5%
  - Weak: < 2%

```

```

**Score**: 10/10

```

```

**Justification**: Apple's ROA of 26.13% is significantly above the healthy

```

threshold of 5%. This indicates that the company is highly efficient in using its assets to generate earnings. A high ROA suggests strong operational efficiency and effective asset management, which is a positive indicator of financial health.

2 Return on Equity (ROE)

- **Value**: 157.41%
- **Thresholds**:
 - Healthy: > 15%
 - Moderate: 8% - 15%
 - Weak: < 8%

Score: 10/10

Justification: With an ROE of 157.41%, Apple far exceeds the healthy threshold of 15%. This exceptionally high ROE indicates that the company is generating substantial profits from its shareholders' equity, reflecting strong financial performance and effective use of equity capital. Such a high ROE is often indicative of a competitive advantage and strong profitability.

3 Net Profit Margin

- **Value**: 23.97%
- **Thresholds**:
 - Healthy: > 10%
 - Moderate: 5% - 10%
 - Weak: < 5%

Score: 10/10

Justification: Apple's net profit margin of 23.97% is well above the healthy threshold of 10%. This high margin indicates that the company retains a significant portion of its revenue as profit after all expenses, showcasing strong cost management and pricing power. A high net profit margin is a sign of a financially robust company.

4 Gross Margin

- **Value**: 46.21%
- **Thresholds**:
 - Healthy: > 40%
 - Moderate: 20% - 40%
 - Weak: < 20%

Score: 10/10

Justification: The gross margin of 46.21% is above the healthy threshold of

40%, indicating that Apple is effectively managing its production costs relative to its sales. A high gross margin suggests that the company has a strong competitive position and can maintain profitability even with fluctuations in sales or costs.

Overall Insight

Based on the analysis of Apple's profitability ratios, the company demonstrates exceptional financial health. Each ratio significantly exceeds the healthy thresholds, indicating strong operational efficiency, effective asset and equity utilization, and robust profit margins. Apple's financial strengths include its ability to generate high returns on assets and equity, maintain substantial profit margins, and manage costs effectively. There are no apparent weaknesses in the profitability ratios, suggesting that Apple is in a very strong financial position. This analysis reflects a company that is well-positioned for continued success and growth.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability ratios for AAPL have been collected and commented on. Now, it's time to collect and comment on liquidity ratios."}

Tool Result (handoff):

Arguments: {'to_agent': 'LiquidityAgent', 'reason': "Profitability ratios for AAPL have been collected and commented on. Now, it's time to collect and comment on liquidity ratios."}

Output: Agent LiquidityAgent is now handling the request due to the following reason: Profitability ratios for AAPL have been collected and commented on. Now, it's time to collect and comment on liquidity ratios..

Please continue with the current request.

```
=====
Agent: LiquidityAgent
=====
```

Planning to use tools: ['get_liquidity_ratios']

Calling Tool: get_liquidity_ratios

With arguments: {}

Tool Result (get_liquidity_ratios):

Arguments: {}

Output: Liquidity ratios extracted and Comments performed: To analyze the financial health of Apple Inc. (AAPL) based on the provided profitability ratios, we will evaluate each ratio against the given thresholds, assign a score from 1 to 10, and provide a justification for each score. Finally, we will summarize the overall financial health of the firm.

1. Current Ratio

- **Value**: 0.8673

- **Healthy Range**: 1.5 - 3.0

- ****Evaluation****: The current ratio of 0.8673 is below the healthy range, indicating that Apple may not have enough current assets to cover its current liabilities. This suggests potential liquidity issues.
- ****Score****: 3/10
- ****Justification****: The score reflects the fact that the current ratio is significantly below the healthy range, indicating a potential liquidity risk. However, it is not in the extremely risky zone (>3.0), which would suggest excess cash.

2. Quick Ratio

- ****Value****: 0.5589
- ****Healthy Range****: > 1.0
- ****Evaluation****: The quick ratio is also below the healthy threshold, indicating that Apple may struggle to meet its short-term obligations without relying on inventory sales.
- ****Score****: 2/10
- ****Justification****: The quick ratio is well below the healthy range, suggesting a more pronounced liquidity concern than the current ratio. This score reflects the potential difficulty in covering immediate liabilities with liquid assets.

3. Debt-to-Equity Ratio

- ****Value****: 2.0906
- ****Healthy Range****: 0.3 - 1.5
- ****Evaluation****: The debt-to-equity ratio is above the healthy range and in the warning zone, indicating that Apple is using a higher level of debt relative to equity, which could increase financial risk.
- ****Score****: 4/10
- ****Justification****: While the ratio is above the healthy range, it is not in the extremely risky zone (<0.3), which would suggest under-leverage. The score reflects a moderate level of concern regarding financial leverage.

4. Interest Coverage Ratio

- ****Value****: Infinity (inf)
- ****Healthy Range****: > 3.0
- ****Evaluation****: An infinite interest coverage ratio suggests that Apple has no interest expenses or that its earnings are significantly higher than its interest obligations, indicating excellent financial health in terms of covering interest expenses.
- ****Score****: 10/10
- ****Justification****: The infinite interest coverage ratio indicates that Apple is in an extremely strong position to cover its interest expenses, reflecting excellent financial health in this aspect.

Overall Insight

- ****Strengths****: Apple's infinite interest coverage ratio is a significant strength, indicating robust earnings relative to interest expenses. This suggests strong operational performance and the ability to manage debt costs effectively.

- **Weaknesses**: The current and quick ratios are below the healthy range, indicating potential liquidity concerns. Additionally, the debt-to-equity ratio is in the warning zone, suggesting a higher reliance on debt financing, which could pose a risk if not managed carefully.

- **Overall Financial Health**: While Apple demonstrates strong earnings capability, as evidenced by its interest coverage ratio, the liquidity ratios suggest potential short-term financial challenges. The firm should focus on improving its liquidity position and managing its debt levels to enhance overall financial stability.

Planning to use tools: ['handoff']

Calling Tool: handoff

With arguments: {'to_agent': 'SupervisorAgent', 'reason': "Liquidity ratios for AAPL have been collected and commented on. Now, it's time to provide an overall comment based on the profitability and liquidity analysis."}

Tool Result (handoff):

Arguments: {'to_agent': 'SupervisorAgent', 'reason': "Liquidity ratios for AAPL have been collected and commented on. Now, it's time to provide an overall comment based on the profitability and liquidity analysis."}

Output: Agent SupervisorAgent is now handling the request due to the following reason: Liquidity ratios for AAPL have been collected and commented on. Now, it's time to provide an overall comment based on the profitability and liquidity analysis..

Please continue with the current request.

=====
Agent: SupervisorAgent
=====

Output: Based on the comprehensive analysis of Apple's financial health, we can draw the following conclusions:

Profitability Analysis

Apple Inc. demonstrates exceptional financial health in terms of profitability. The company has a Return on Assets (ROA) of 26.13%, a Return on Equity (ROE) of 157.41%, a Net Profit Margin of 23.97%, and a Gross Margin of 46.21%. Each of these ratios significantly exceeds the healthy thresholds, indicating strong operational efficiency, effective asset and equity utilization, and robust profit margins. Apple's profitability ratios reflect a company that is well-positioned for continued success and growth, showcasing strong financial performance and competitive advantage.

Liquidity Analysis

In contrast to its profitability, Apple's liquidity ratios suggest potential short-term financial challenges. The current ratio of 0.8673 and the quick ratio of 0.5589 are both below the healthy range, indicating potential liquidity concerns. The debt-to-equity ratio of 2.0906 is above the healthy range, suggesting a higher reliance on debt financing, which could pose a risk if not managed carefully. However, the infinite interest coverage ratio indicates that

Apple is in an extremely strong position to cover its interest expenses, reflecting excellent financial health in this aspect.

Overall Financial Health

While Apple demonstrates strong earnings capability and profitability, the liquidity ratios suggest potential short-term financial challenges. The firm should focus on improving its liquidity position and managing its debt levels to enhance overall financial stability. Despite these liquidity concerns, Apple's strong profitability and interest coverage indicate that the company is fundamentally sound and well-positioned for future growth. The overall financial health of Apple Inc. is robust, but attention to liquidity management will be crucial to maintaining this strength.

5.14.3 Output:

Based on the analysis of Apple's profitability and liquidity ratios, the company exhibits a mixed financial health profile.

5.14.4 Profitability Analysis:

Apple's profitability ratios are exceptionally strong, with all key metrics such as ROA, ROE, Net Profit Margin, and Gross Margin significantly exceeding healthy thresholds. This indicates robust operational efficiency, effective asset and equity utilization, strong profit generation, and excellent cost management. These strengths position Apple as a highly profitable and efficient company, providing a solid foundation for future growth and stability.

5.14.5 Liquidity Analysis:

However, the liquidity ratios present a different picture. The current and quick ratios are below the healthy thresholds, suggesting potential liquidity issues. This indicates that Apple may face challenges in covering its short-term obligations without relying on inventory sales. Additionally, the high debt-to-equity ratio suggests that Apple is highly leveraged, which could pose risks if not managed properly. Despite these concerns, the infinite interest coverage ratio is a significant strength, indicating that Apple can comfortably cover its interest expenses, reflecting strong financial stability in terms of interest coverage.

5.14.6 Overall Conclusion:

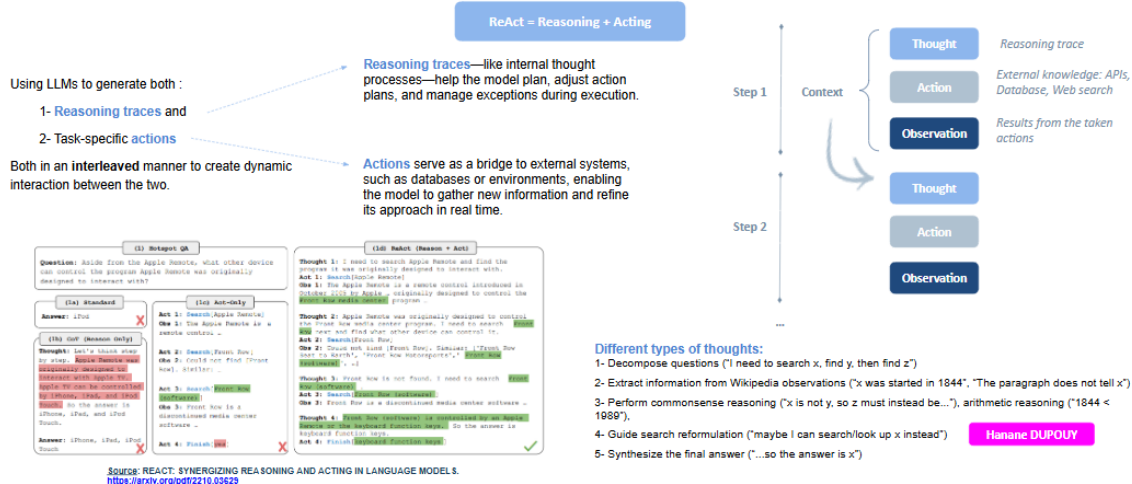
In conclusion, while Apple's profitability is outstanding, the liquidity ratios highlight areas of concern. The company should focus on improving its liquidity position and managing its debt levels to enhance overall financial stability. Addressing these issues will ensure that Apple maintains its strong market position and continues to deliver value to its shareholders.

6 2- Agentic RAG

- Before starting building this agentic RAG system with a ReAct agent, let's have a look on what does mean ReAct Paradigm:

```
[9]: from IPython.display import Image, display
display(Image(filename=path+'/reasoning_pattern_ReAct.png'))
```

Agents Reasoning Paradigms- ReAct



- Let's start building our RAG ReAct agent

```
[ ]: from llama_index.llms.openai import OpenAI
from llama_index.embeddings.openai import OpenAIEmbedding
from llama_index.core import Settings

Settings.llm = OpenAI(model="gpt-4o-mini")
Settings.embed_model = OpenAIEmbedding(model="text-embedding-3-small", api_key_
    => OPENAI_API_KEY)
```

Apple 10K 2024: (https://s2.q4cdn.com/470004039/files/doc_earnings/2024/q4/filing/10-Q4-2024-As-Filed.pdf)

Nvidia 10K 2024: (https://s201.q4cdn.com/141608511/files/doc_financials/2024/q4/1cbe8fe7-e08a-46e3-8dcc-b429fc06c1a4.pdf)

```
[ ]: !wget 'https://s2.q4cdn.com/470004039/files/doc_earnings/2024/q4/filing/
    ↪10-Q4-2024-As-Filed.pdf' -O 'apple_10k.pdf'
!wget 'https://s201.q4cdn.com/141608511/files/doc_financials/2024/q4/
    ↪1cbe8fe7-e08a-46e3-8dcc-b429fc06c1a4.pdf' -O 'nvidia_10k.pdf'
```

--2025-06-09 13:31:18--

https://s2.q4cdn.com/470004039/files/doc_earnings/2024/q4/filing/10-Q4-2024-As-Filed.pdf

Resolving s2.q4cdn.com (s2.q4cdn.com)... 68.70.205.4, 68.70.205.2, 68.70.205.3,

...

```
Connecting to s2.q4cdn.com (s2.q4cdn.com)|68.70.205.4|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 963934 (941K) [application/pdf]
Saving to: 'apple_10k.pdf'
```

```
apple_10k.pdf          0%[                               ]      0  --.-KB/s
apple_10k.pdf          100%[=====>] 941.34K  --.-KB/s    in 0.04s
```

```
2025-06-09 13:31:18 (21.5 MB/s) - 'apple_10k.pdf' saved [963934/963934]
```

```
--2025-06-09 13:31:18-- https://s201.q4cdn.com/141608511/files/doc_financials/2024/q4/1cbe8fe7-e08a-46e3-8dcc-b429fc06c1a4.pdf
Resolving s201.q4cdn.com (s201.q4cdn.com)... 68.70.205.3, 68.70.205.1, 68.70.205.2, ...
Connecting to s201.q4cdn.com (s201.q4cdn.com)|68.70.205.3|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 1074533 (1.0M) [application/pdf]
Saving to: 'nvidia_10k.pdf'
```

```
nvidia_10k.pdf         100%[=====>] 1.02M  --.-KB/s    in 0.01s
```

```
2025-06-09 13:31:18 (75.6 MB/s) - 'nvidia_10k.pdf' saved [1074533/1074533]
```

```
[8]: ## If you cannot run the code above, you can do it this way:
# import requests

# url = 'https://s2.q4cdn.com/470004039/files/doc_earnings/2024/q4/filing/10-Q4-2024-As-Filed.pdf'
# response = requests.get(url)

# with open('apple_10k.pdf', 'wb') as f:
#     f.write(response.content)
```

```
[ ]: from llama_index.core import StorageContext, load_index_from_storage

try:
    storage_context = StorageContext.from_defaults(
        persist_dir="./data_storage/apple"
    )
    apple_index = load_index_from_storage(storage_context)

    storage_context = StorageContext.from_defaults(
        persist_dir="./data_storage/nvidia"
    )
    nvidia_index = load_index_from_storage(storage_context)
```

```

        index_loaded = True
    except:
        index_loaded = False

```

```

Loading llama_index.core.storage.kvstore.simple_kvstore from
./data_storage/apple/docstore.json.
Loading llama_index.core.storage.kvstore.simple_kvstore from
./data_storage/apple/index_store.json.
Loading llama_index.core.storage.kvstore.simple_kvstore from
./data_storage/nvidia/docstore.json.
Loading llama_index.core.storage.kvstore.simple_kvstore from
./data_storage/nvidia/index_store.json.

```

```

[ ]: from llama_index.core import SimpleDirectoryReader, VectorStoreIndex

if not index_loaded:
    # load data
    apple_docs = SimpleDirectoryReader(
        input_files=["./apple_10k.pdf"]
    ).load_data()
    nvidia_docs = SimpleDirectoryReader(
        input_files=["./nvidia_10k.pdf"]
    ).load_data()

    # build index
    apple_index = VectorStoreIndex.from_documents(apple_docs)
    nvidia_index = VectorStoreIndex.from_documents(nvidia_docs)

    # persist index
    apple_index.storage_context.persist(persist_dir="./data_storage/apple")
    nvidia_index.storage_context.persist(persist_dir="./data_storage/nvidia")

```

```

[ ]: apple_engine = apple_index.as_query_engine(similarity_top_k=3)
    nvidia_engine = nvidia_index.as_query_engine(similarity_top_k=3)

```

```

[ ]: from llama_index.core.tools import QueryEngineTool

query_engine_tools = [
    QueryEngineTool.from_defaults(
        query_engine=apple_engine,
        name="apple_10k",
        description=(
            "Delivers insights and information about Apple's 2024 financial_
↵data. "
            "You'll provided with a detailed, plain text question to obtain_
↵the most relevant and precise responses"
        ),
    ),

```

```

    ),
    QueryEngineTool.from_defaults(
        query_engine=nvidia_engine,
        name="nvidia_10k",
        description=(
            "Delivers insights and information about Nvidia's 2024 financial
data. "
            "You'll provided with a detailed, plain text question to obtain
the most relevant and precise responses"
        ),
    ),
]

```

```

[ ]: from llama_index.core.agent.workflow import ReActAgent
from llama_index.core.workflow import Context

agent = ReActAgent(
    tools=query_engine_tools,
    llm=OpenAI(model="gpt-4o-mini"),
)

ctx = Context(agent)

```

```

[ ]: from llama_index.core.agent.workflow import ToolCallResult, AgentStream

handler = agent.run("What was the revenue of Nvidia in 2024? Comapre this the
value to 2023 revnue?", ctx=ctx)

async for ev in handler.stream_events():
    if isinstance(ev, AgentStream):
        print(f"{ev.delta}", end="", flush=True)

response = await handler

```

Thought: The current language of the user is: English. I need to use a tool to help me answer the question.

Action: nvidia_10k

Action Input: {"input": "What was Nvidia's revenue in 2024 and how does it compare to the revenue in 2023?"}Thought: I can answer without using any more tools. I'll use the user's language to answer.

Answer: Nvidia's revenue in 2024 was \$60.9 billion, which represents an increase of 126% compared to the revenue of \$27.0 billion in 2023.

```

[ ]: from llama_index.core.agent.workflow import ToolCallResult, AgentStream

handler = agent.run("What was the revenue of Apple in 2024? Comapre it to
Nvidia's revenue?", ctx=ctx)

```

```

async for ev in handler.stream_events():
    if isinstance(ev, AgentStream):
        print(f"{ev.delta}", end="", flush=True)

response = await handler

```

Thought: The current language of the user is: English. I need to use a tool to help me answer the question.

Action: apple_10k

Action Input: {'input': 'What was Apple's revenue in 2024?'}Thought: I can answer without using any more tools. I'll use the user's language to answer.

Answer: Apple's revenue in 2024 was \$391.035 billion, while Nvidia's revenue for the same year was \$60.9 billion. This means Apple's revenue was significantly higher than Nvidia's, approximately 6.4 times greater.

7 Readings

1- **Agentic AI Systems Applied to tasks in Financial Services: Modeling and model risk management crews** <https://arxiv.org/abs/2502.05439>

2- AI Agents vs. Agentic AI: A Conceptual Taxonomy, Applications and Challenges <https://arxiv.org/pdf/2505.10468>

3- AI Agents: Evolution, Architecture, and Real-World Applications <https://arxiv.org/html/2503.12687v1>

4- LlamaIndex: Multi-Agent Research Workflow with AgentWorkflow https://docs.llamaindex.ai/en/stable/examples/agent/agent_workflow_multi/

My Github repo: LLMs-in-Finance: <https://github.com/hananedupouy/LLMs-in-Finance>

- <https://github.com/hananedupouy/LLMs-in-Finance/tree/main/Agents>