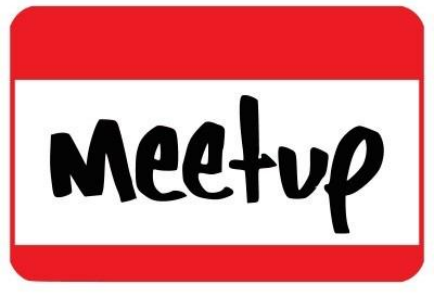
# Python Frederick

## Python AI Agents: Intro to Agents



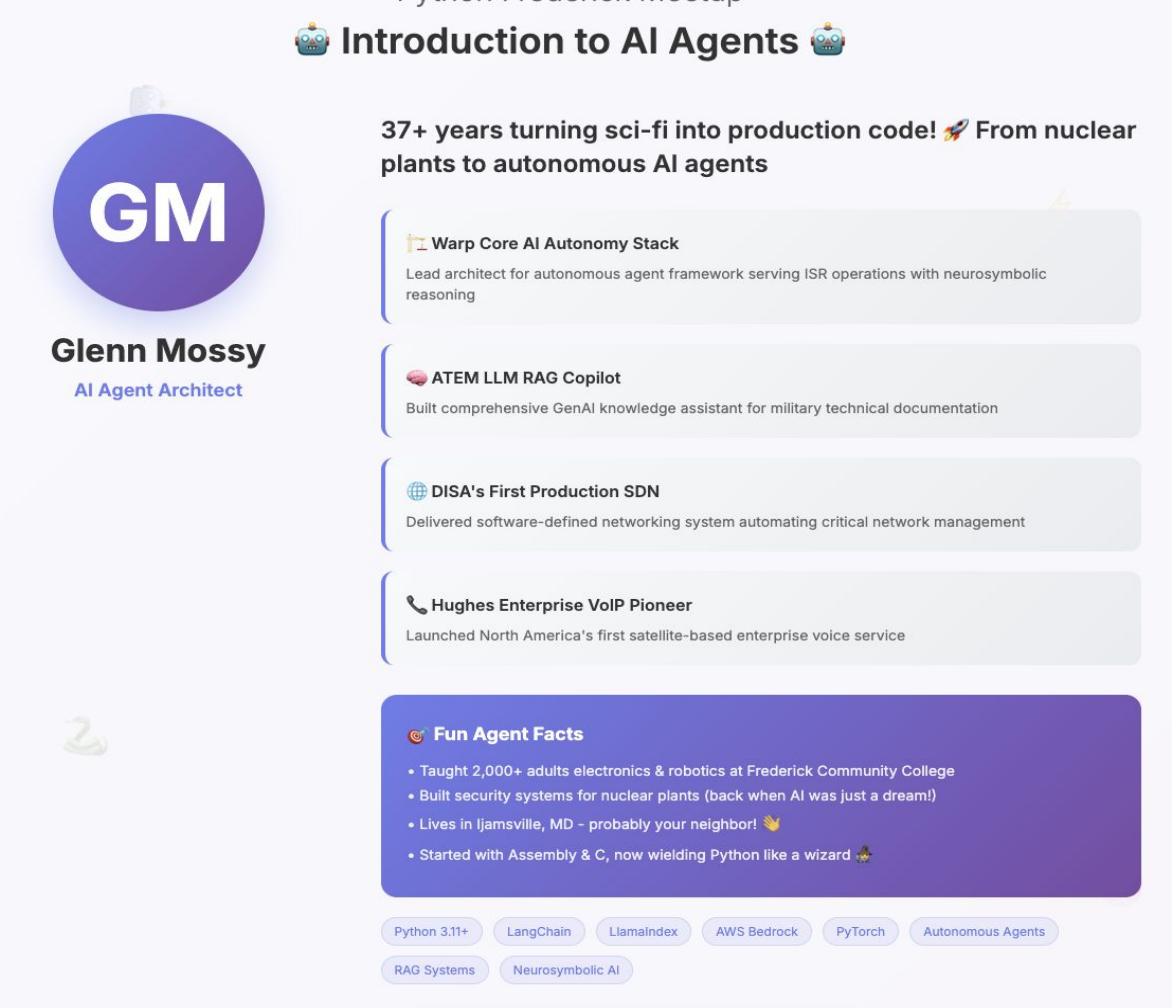

June 11th, 2025

7:00pm - 9:00pm

# My Top AI Tools

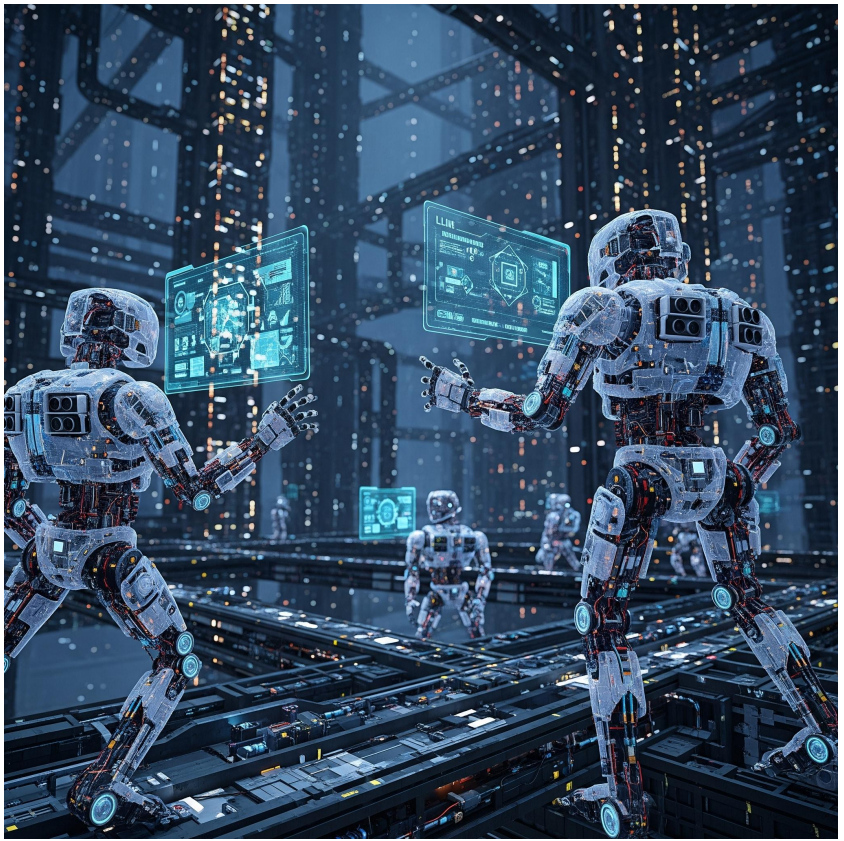
Windsurf
Cursor AI
ChatGPT
Github copilot
Claude
gemini.google.com
perplexity
meta.ai
Manus
bing.com
Microsoft copilot
runnerh.com
notebooklm.google
anythingllm.com
Ollama
lmstudio

https://github.com/gmossy
https://www.linkedin.com/in/gmossy/



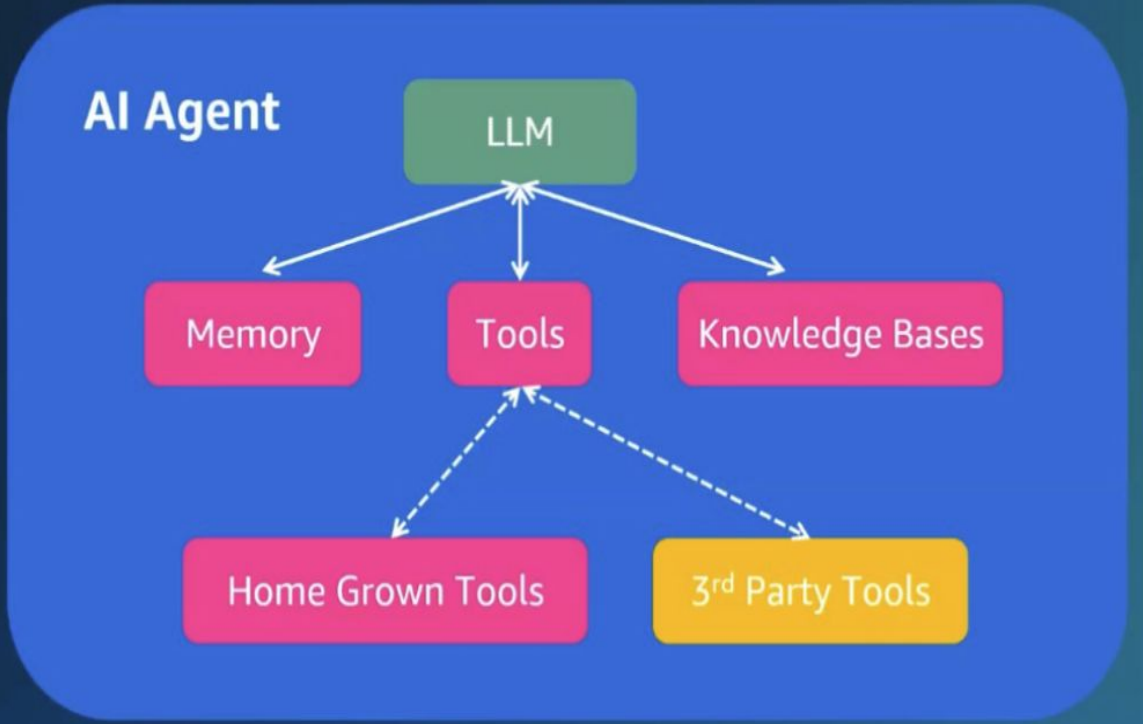
# Agents in Action

- AI agents interact with environment via tools.
- Key components are augmented LLMs
- LLMs show varying degrees of autonomy in systems.
- Augmented LLMs use external systems for enhancements.



# What are AI agents?

Autonomous software systems that leverage AI to reason, plan, and complete tasks on behalf of humans and systems




**Key areas demonstrate real business value:**

- Workplace productivity
- Workflow automation
- Innovation and research

# AI Agent Frameworks Timeline

Evolution of Intelligent Agent Development

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## What Are Agent Frameworks?

### 🧠 Intelligence Layer

- Reasoning & Planning
- Memory Management
- Decision Making
- Goal Decomposition

### 🔧 Tool Integration

- API Connections
- Database Access
- External Services
- File Operations

### 🤝 Collaboration

- Multi-Agent Systems
- Task Distribution
- Communication Protocols
- Workflow Orchestration

### ⚡ Execution Engine

- Code Generation
- Task Execution
- Error Handling
- Performance Monitoring

https://github.com/anthropics/anthropic-cookbook/tree/main/patterns/agents

# Anthropic-cookbook

Engineering at Anthropic

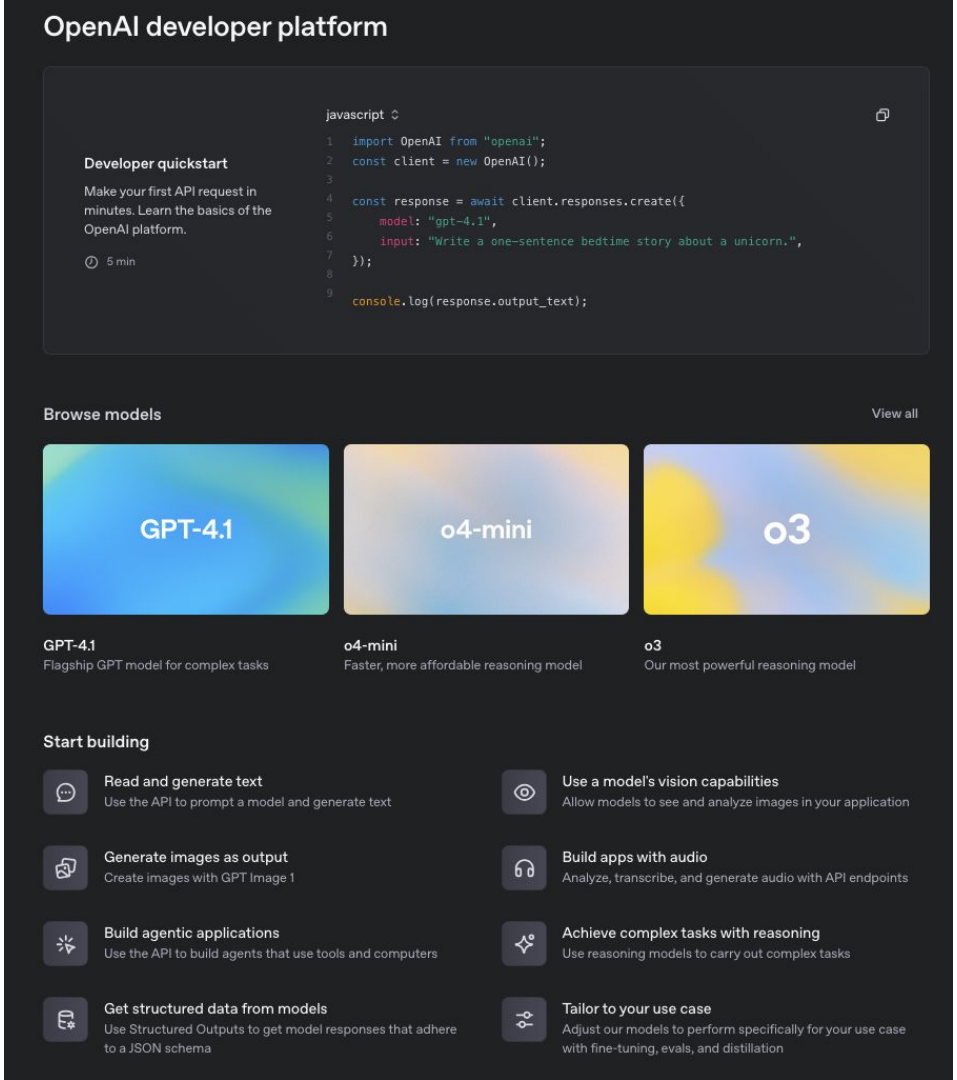
## Building effective agents

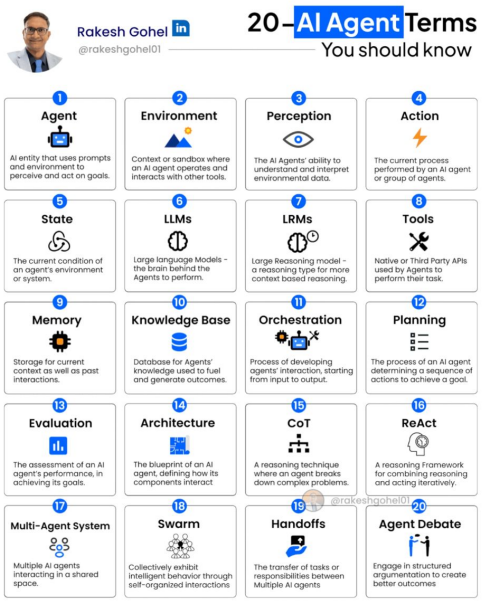
Published Dec 19, 2024

We've worked with dozens of teams building LLM agents across industries. Consistently, the most successful implementations use simple, composable patterns rather than complex frameworks.

https://www.anthropic.com/engineering/building-effective-agents

https://platform.openai.com
/docs/guides/text



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**Rakesh Gohel** Author

Scaling with AI Agents | Expert in Agentic AI & Cloud Native S...

📌 Help us build the learning path YOU wish existed for mastering AI agents
https://forms.gle/qbtarifWLD7BPgMb6

# Technology Enabling Agentic AI: Grounding and Reasoning

Reliable Data Foundations + Advanced Reasoning = Trustworthy AI Agents

Foundation Technologies Working Together

## RAG

Retrieval Augmented Generation

**Purpose:**

Grounds LLMs with external, up-to-date knowledge to prevent hallucinations and ensure accuracy

**Key Features:**

- Dynamic knowledge retrieval
- Real-time data integration
- Context-aware responses
- Multi-source synthesis

**Agentic Enhancement:**

Intelligent query planning and autonomous source verification

## Advanced Reasoning

Multi-Step Cognitive Processing

**Core Patterns:**

- Chain-of-Thought (CoT) reasoning
- Tree-of-Thoughts exploration
- ReAct (Reasoning + Acting)
- Self-reflection loops

**Agentic Features:**

- Autonomous planning & decomposition
- Dynamic strategy adaptation
- Error detection & correction

Enables complex problem-solving with human-like reasoning depth

## Knowledge Graphs

Structured Relationship Networks

**Structure:**

Entity-relationship networks that represent context, semantics, and complex interconnections

**Agent Benefits:**

- Enhanced understanding
- Relationship reasoning
- Knowledge inference
- Dependency mapping

**GraphRAG:**

Combines graph relationships with retrieval for richer context and improved reasoning

## Reinforcement Learning

Trial & Error Optimization

**Core Mechanism:**

Agents learn optimal behavior through environment interaction, maximizing cumulative rewards

**Key Algorithms:**

- Q-Learning (value functions)
- Policy gradients
- Actor-critic methods
- Monte Carlo tree search

**Enables:**

Autonomous adaptation, goal optimization, and strategic decision-making over time

## Memory Systems

Persistent Learning & Context

**Memory Types:**

- Working memory (current task)
- Episodic memory (experiences)
- Semantic memory (knowledge)
- Long-term storage

**Agent Capabilities:**

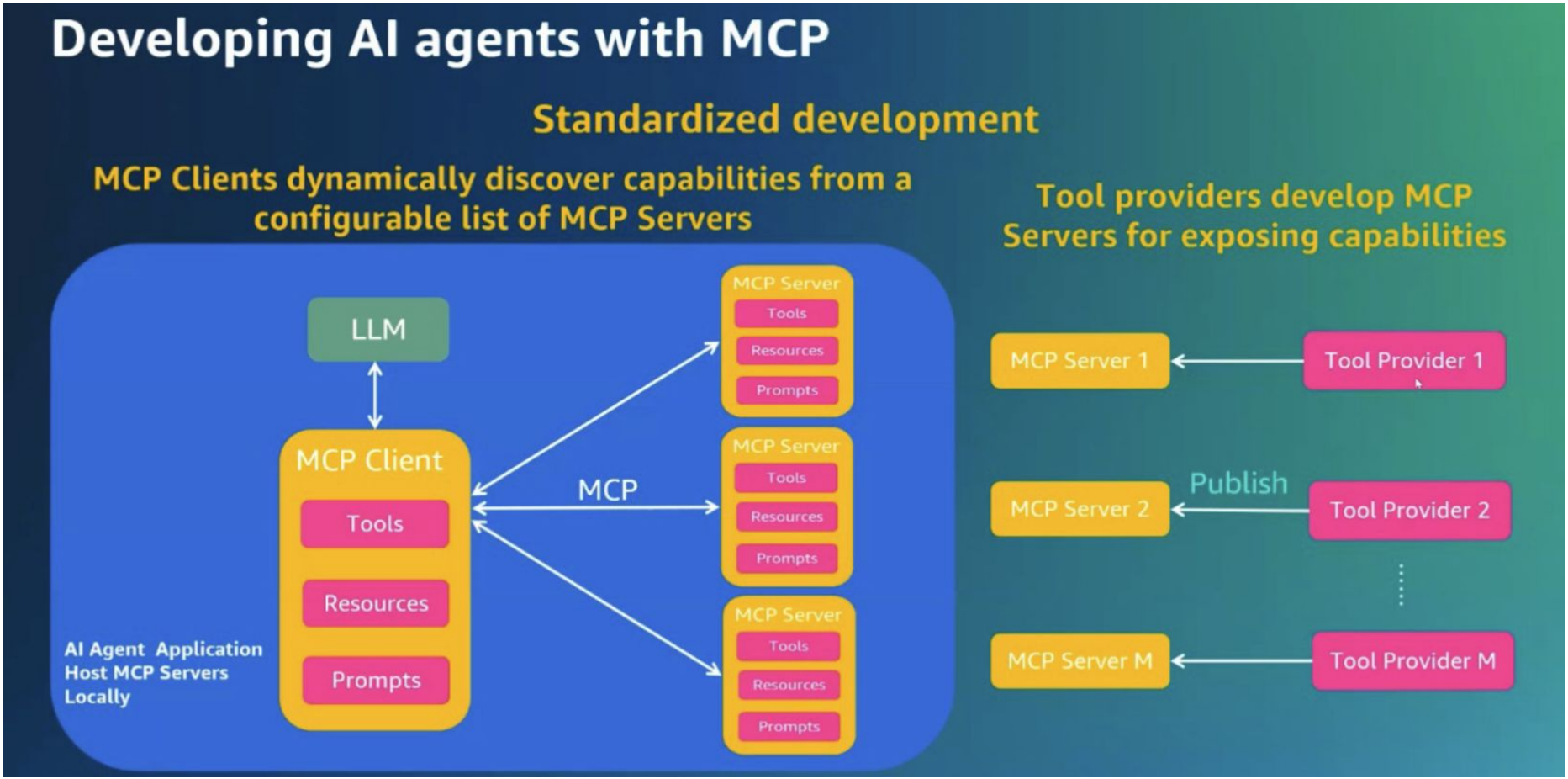
- Continuous learning
- Context preservation
- Pattern recognition
- Adaptive behavior

Enables long-horizon tasks and learning

# Intelligent Agents

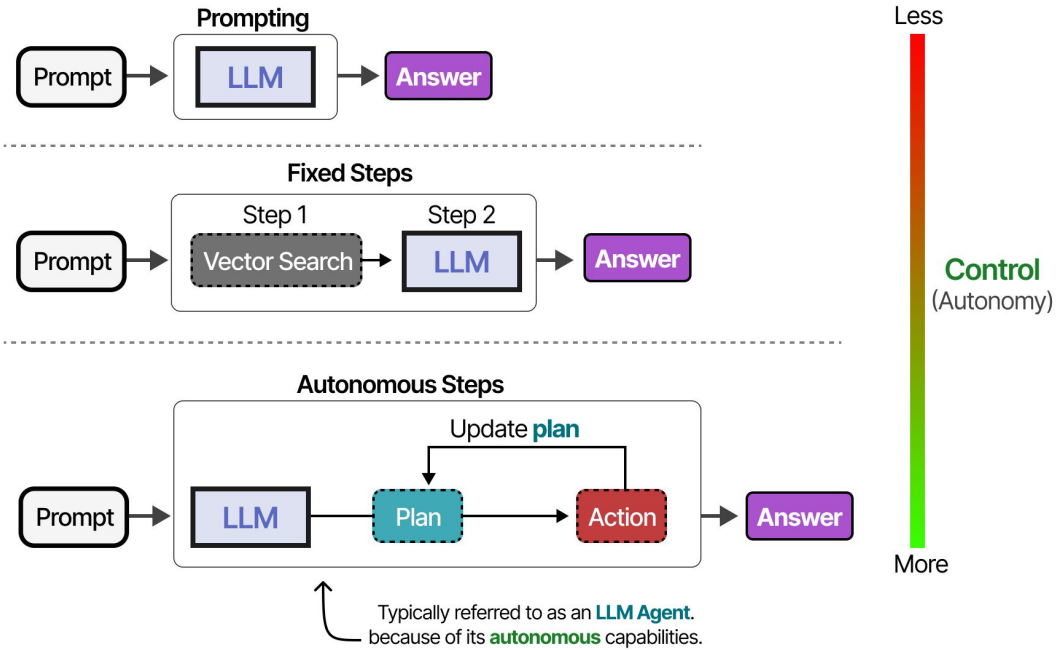

Consider exploring the dangers of relying on one large agent doing everything as opposed to segregating tasks to multiple agents all managed by an orchestrator.

# One Slide Introduction to Model Context Protocol



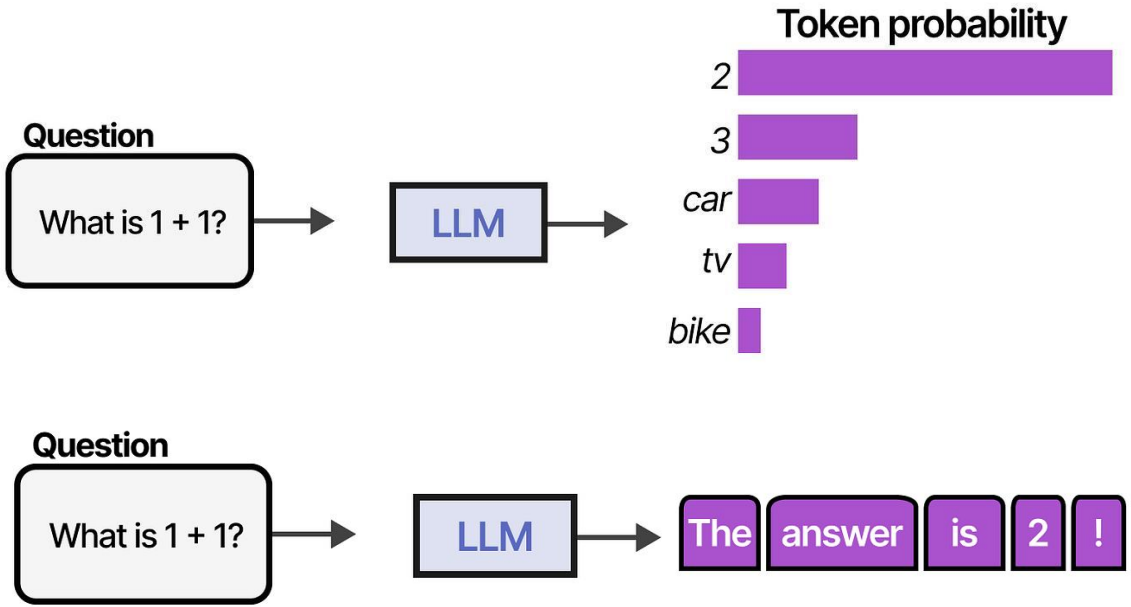
# Degrees of Autonomy

Depending on the system, you can have LLM Agents with varying degrees of autonomy.



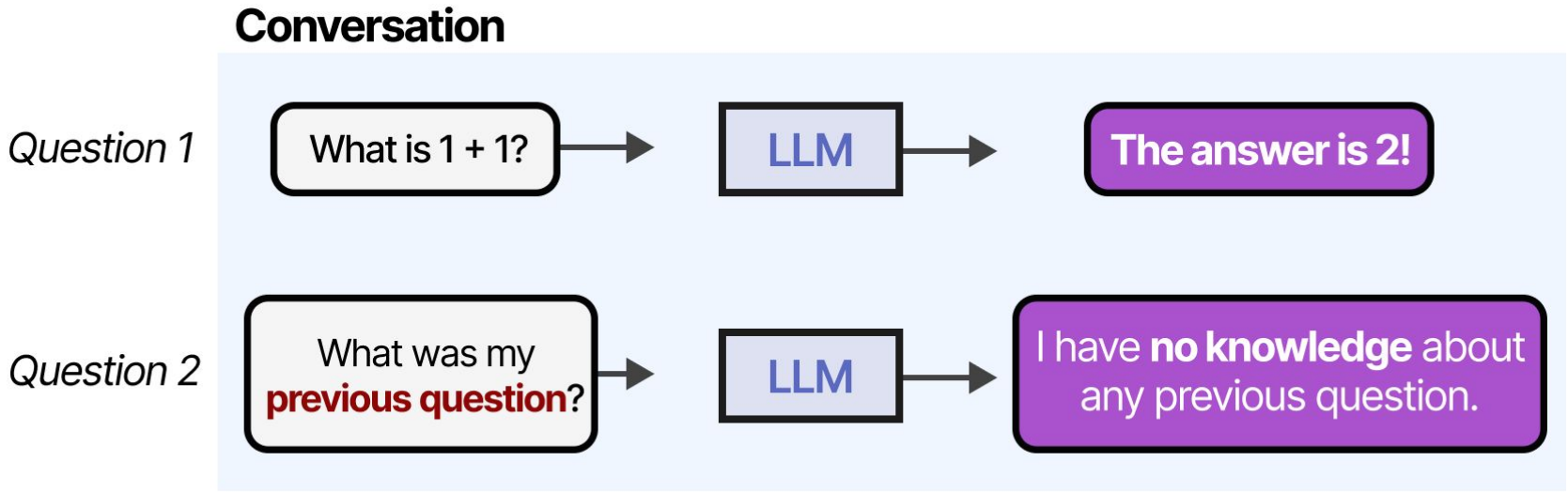
# How LLMs work

By sampling many tokens in a row, we can mimic conversations and use the LLM to give more extensive answers to our queries.



# LLMs have no memory

However, when we continue the “conversation”, any given LLM will showcase one of its main disadvantages. It does not remember conversations!



```
from openai import OpenAI

client = OpenAI(api_key=os.getenv("OPENAI_API_KEY"))


completion = client.chat.completions.create(
   model="gpt-4o",
   messages=[
       {"role": "system", "content": "You're a helpful assistant."},
       {
           "role": "user",
           "content": "Write a limerick about the Python programming language,
also say hello to the Frederick Python Meetup developers"        },
   ],
)

response = completion.choices[0].message.content
print(response)
```

# Basic ChatBot Demo

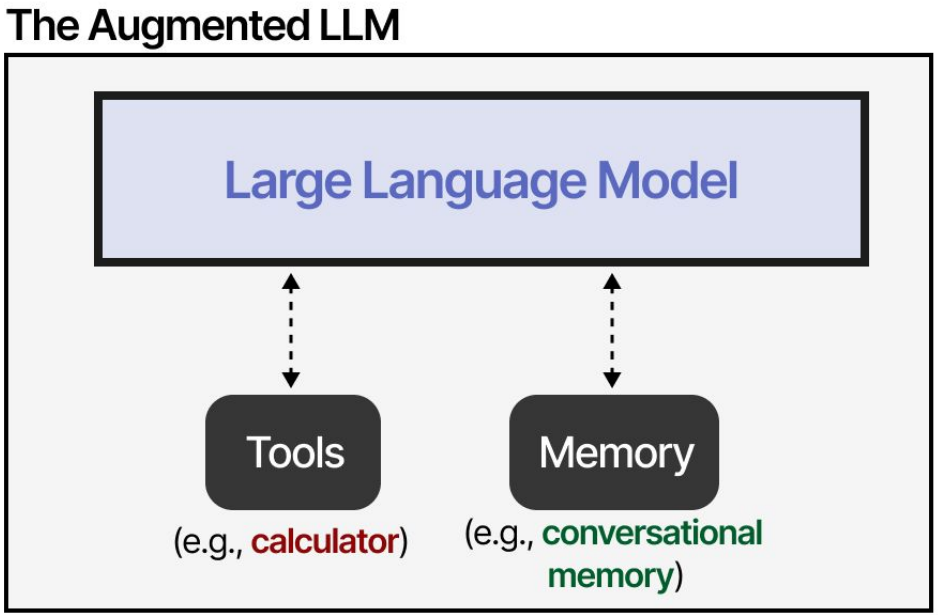
https://platform.openai.com/docs/guides/text

Frederick_Python/patterns/workflows/
1-introduction/python 1-basic.py

# Demo / Talk about 2-structured.py

# The Augmented LLM

Through external systems, the capabilities of the LLM can be enhanced. Anthropic calls this “The Augmented LLM”.



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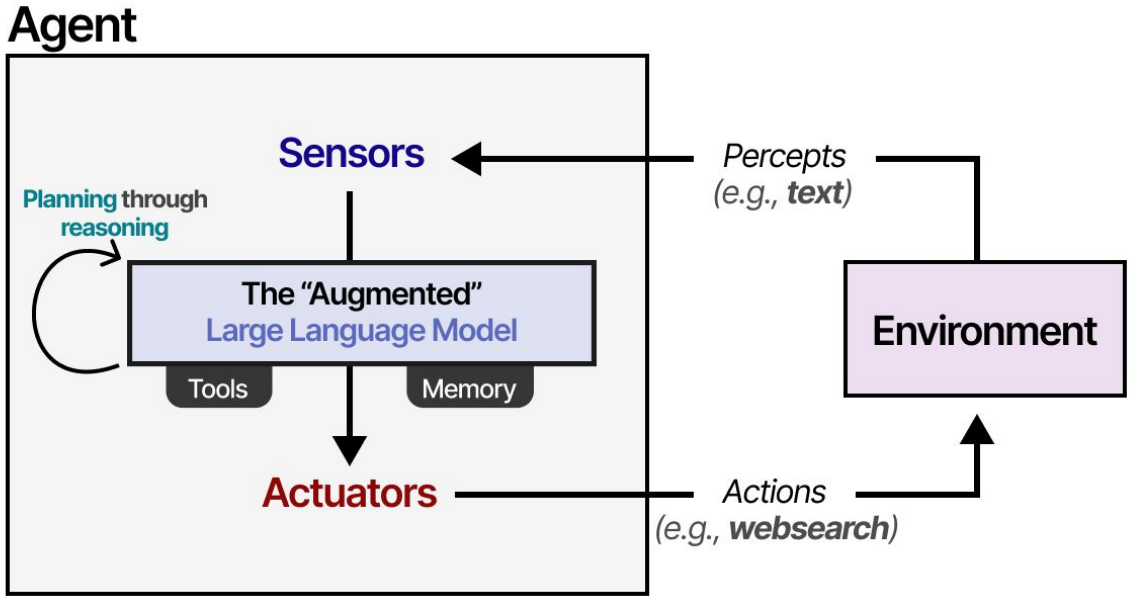
Agents interact with their environment and typically consist of several important components:

- **Environments** — The world the agent interacts with
- **Sensors** — Used to observe the environment
- **Actuators** — Tools used to interact with the environment
- **Effectors** — The “brain” or rules deciding how to go from observations to actions



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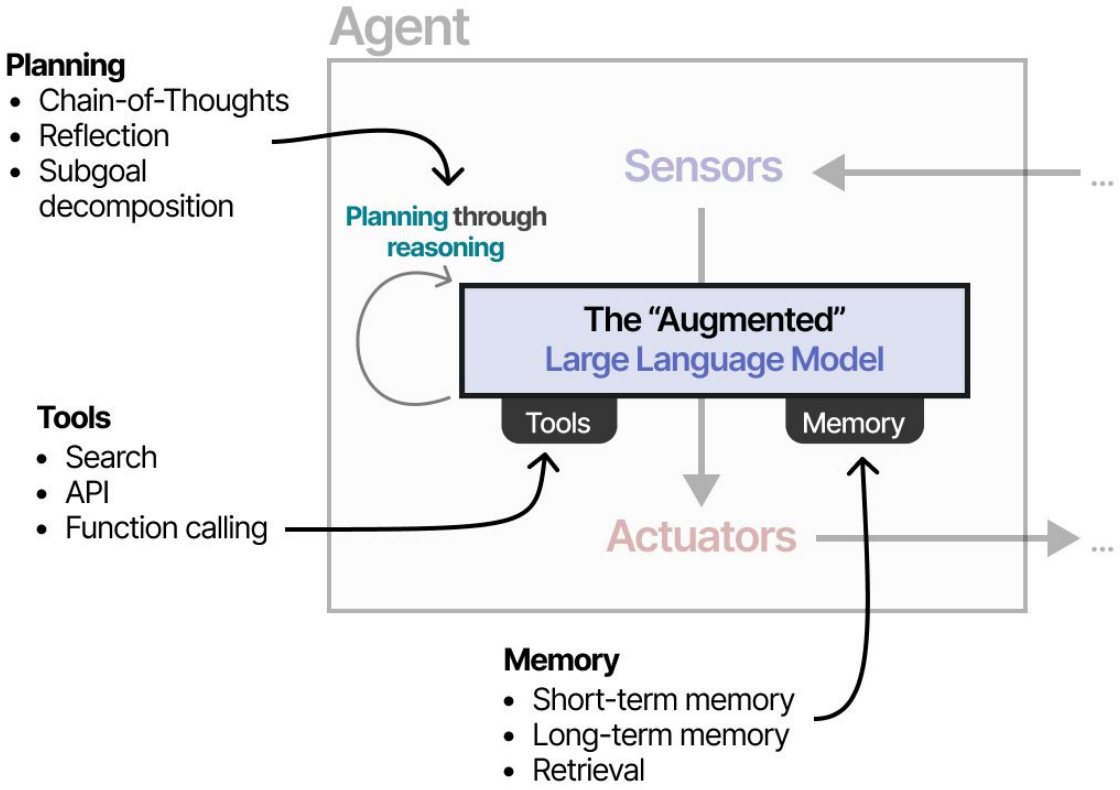
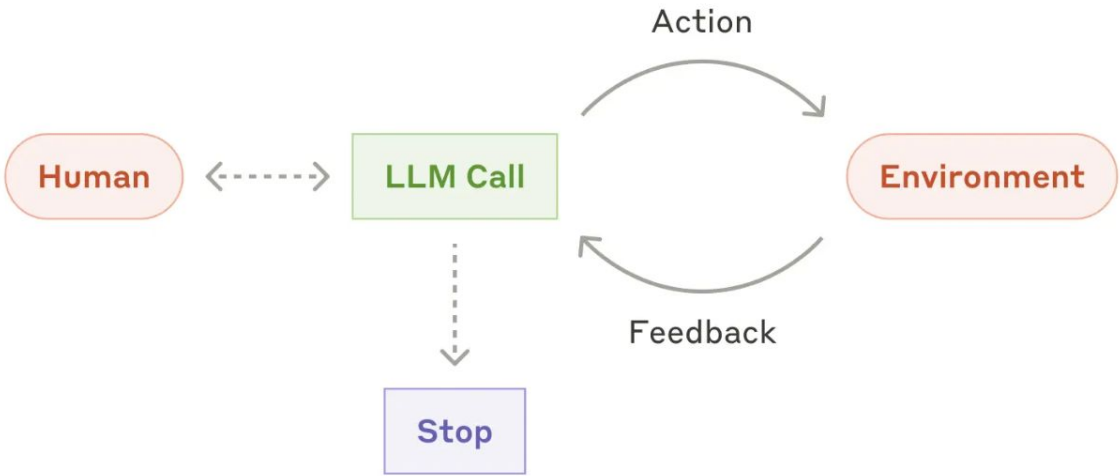


## AGENTS

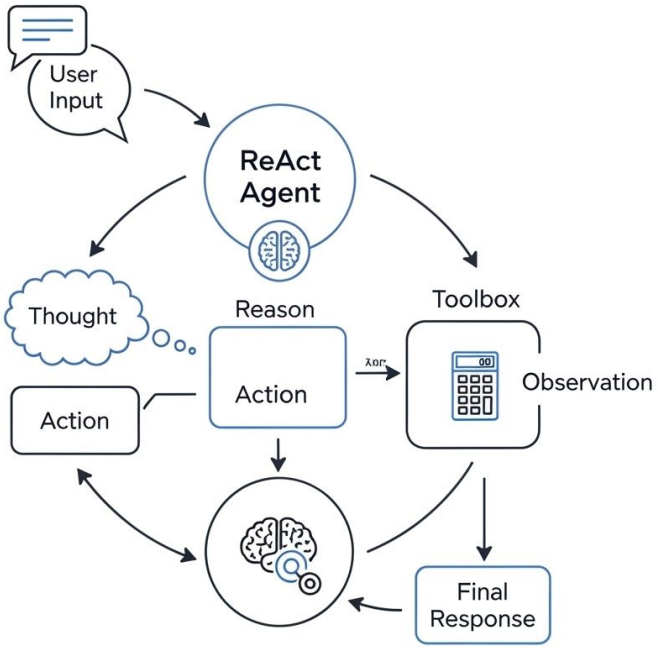


# Tools

How to Incorporate Tools

# CALCULATOR DEMO

Calculator Agent: A system optimized for executing complex mathematical computations with precision and speed



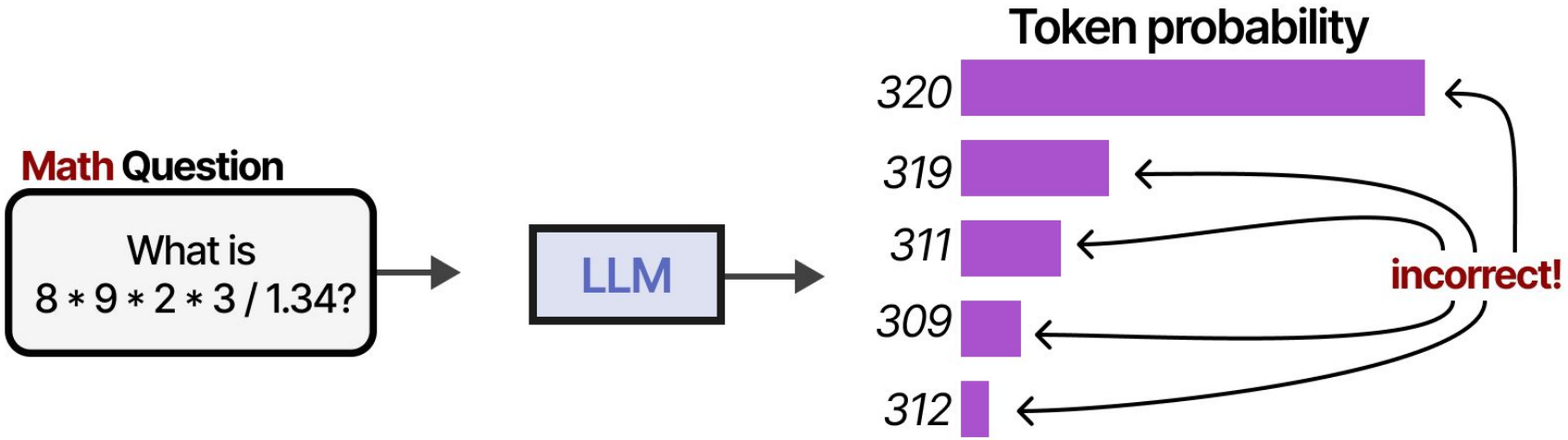

## What "ReAct" Means

ReAct stands for **"Reason and Act"**. It's a framework that enables an agent to solve complex problems by mimicking a human-like thought process. Instead of just trying to give a final answer immediately, the agent follows an iterative loop:

1. **Thought:** The agent (the LLM) examines the user's input and its available tools. It then forms a "thought" about what it needs to do to solve the problem.
2. **Action:** Based on its thought, it chooses an **action** to take. An action consists of selecting one of its tools (like your `CalculatorTool`) and deciding on the input for that tool.
3. **Observation:** The action is executed (your `_run` method is called), and the result is returned to the agent as an **observation**.
4. **Repeat:** The agent looks at the new observation and goes back to step 1 (Thought). It thinks about whether the problem is solved or if it needs to take another action. This loop (`Thought -> Action -> Observation -> Thought...`) continues until it has a final answer.

# Math Questions

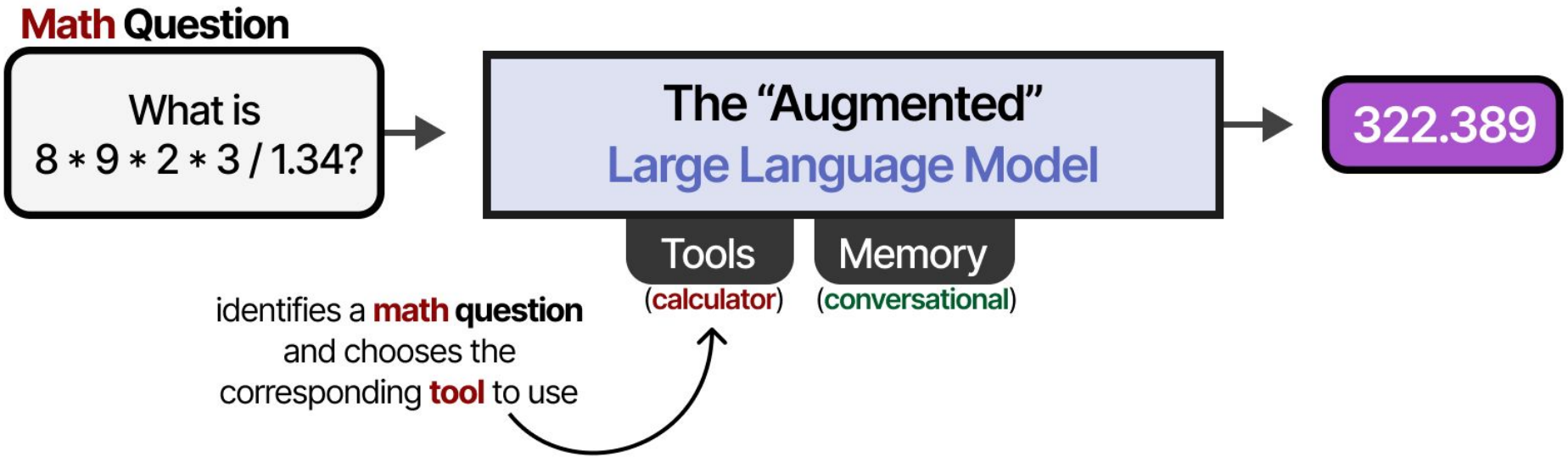
There are many other tasks that LLMs often fail at, including basic math like multiplication and division:



## Tools use

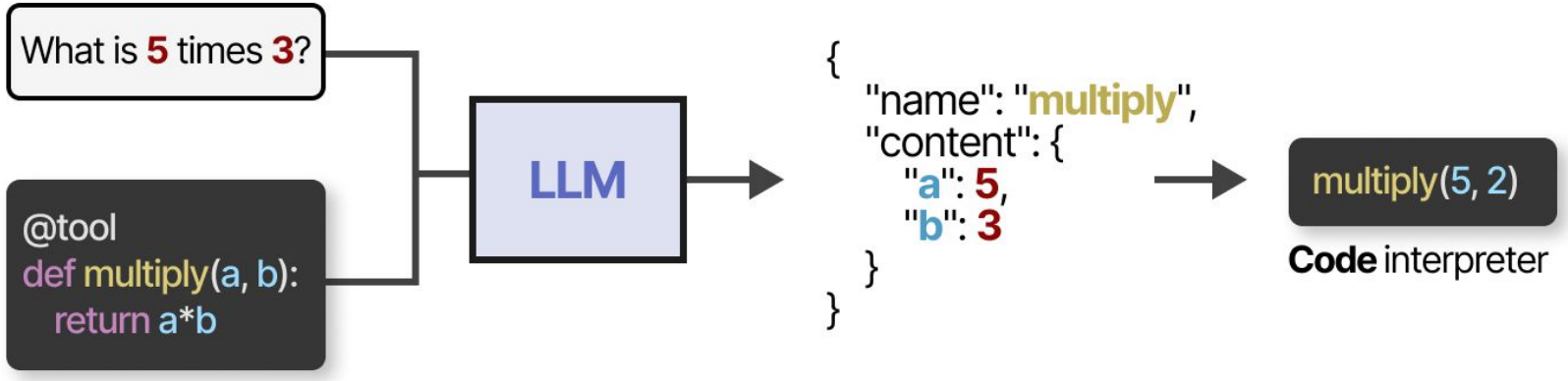
### Using Calculator Tools

For instance, when faced with a math question, the LLM may decide to use the appropriate tool (a **calculator**).



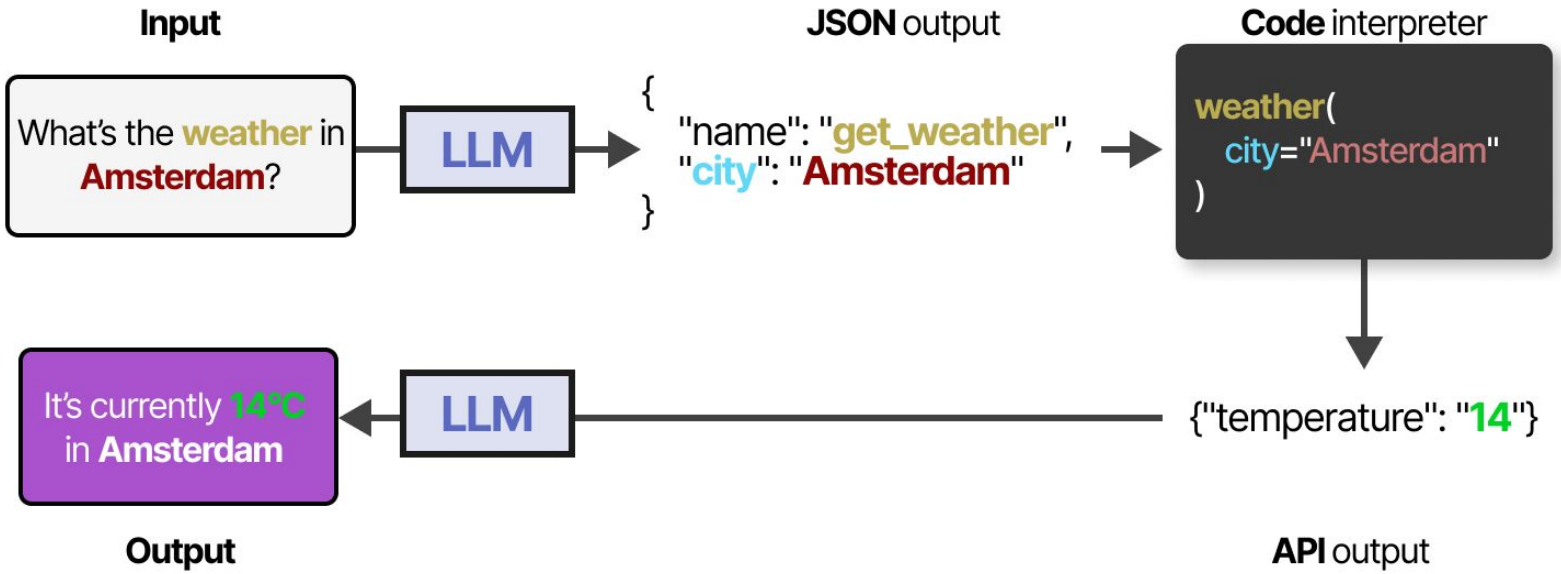
# Tools function calling

You can also generate custom functions that the LLM can use, like a basic multiplication function. This is often referred to as Tool **function calling**.



# Tools fetching data

- Tools allow a given LLM to either interact with an external environment (such as databases) or use external applications (such as custom code to run).
- Tools generally have two use cases: **fetching data** to retrieve up-to-date information and **taking action** like setting a meeting or ordering food.
- To actually use a tool, the LLM has to structure the output for the API of the given tool. We tend to expect strings that can be formatted to **JSON** so that it can easily be fed to a **code interpreter**.



# Memory

## with the basic_agent_demo

# Lead with the basic_agent_tutorial.py

↗

## Key Highlights

- Uses GPT-3.5-turbo with OpenAI API
- Maintains conversation history with ConversationBufferMemory
- Has a system prompt defining personality
- Graceful error messages
- Stores both user and AI messages

↘

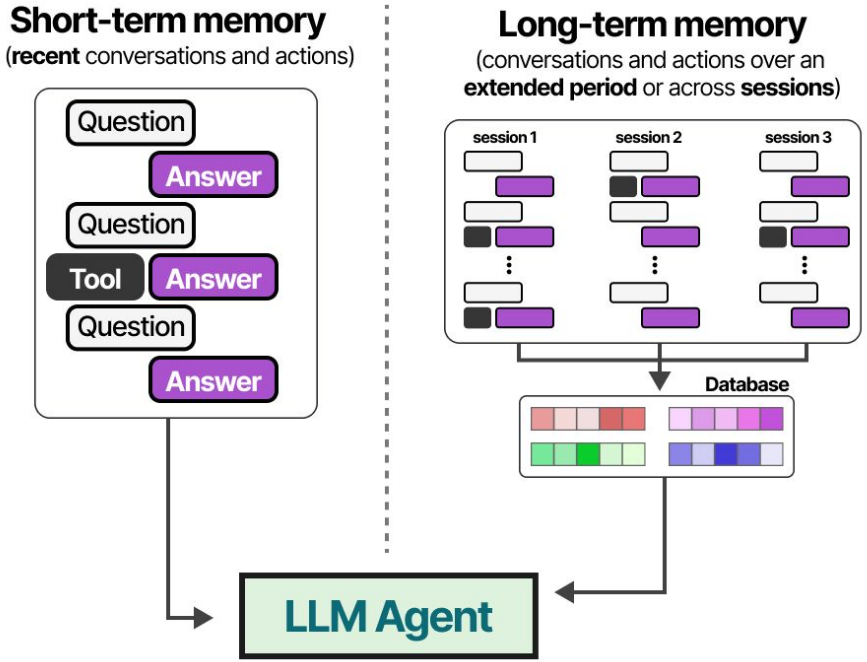
## Potential Drawbacks

- Error handling relies on try-except blocks, which may miss complex issues
- ConversationBufferMemory may have storage limitations for long conversations

1. "list for me the presidents of the US"
2. "how many were assassinated?"
3. "what did i ask first?"
4. "what questions did i ask"

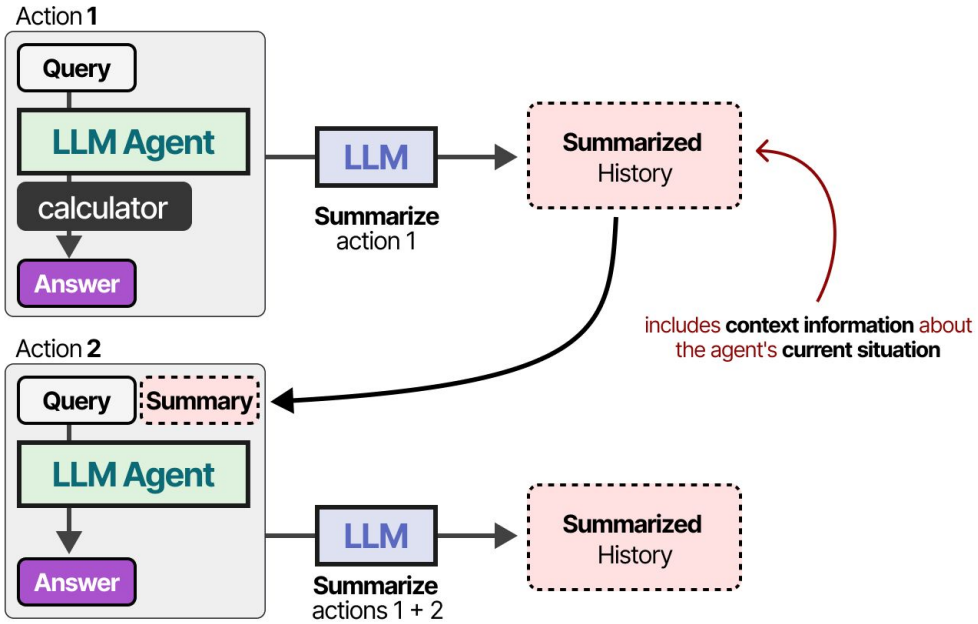
# Memory

The most straightforward method for enabling short-term memory is to use the model's context window, which is essentially the number of tokens an LLM can process.  Other wise you can use database storage for Long-term memory.



# Short-Term Memory

For models with a smaller context window, or when the conversation history is large, we can instead use another LLM to summarize the conversations that happened thus far.



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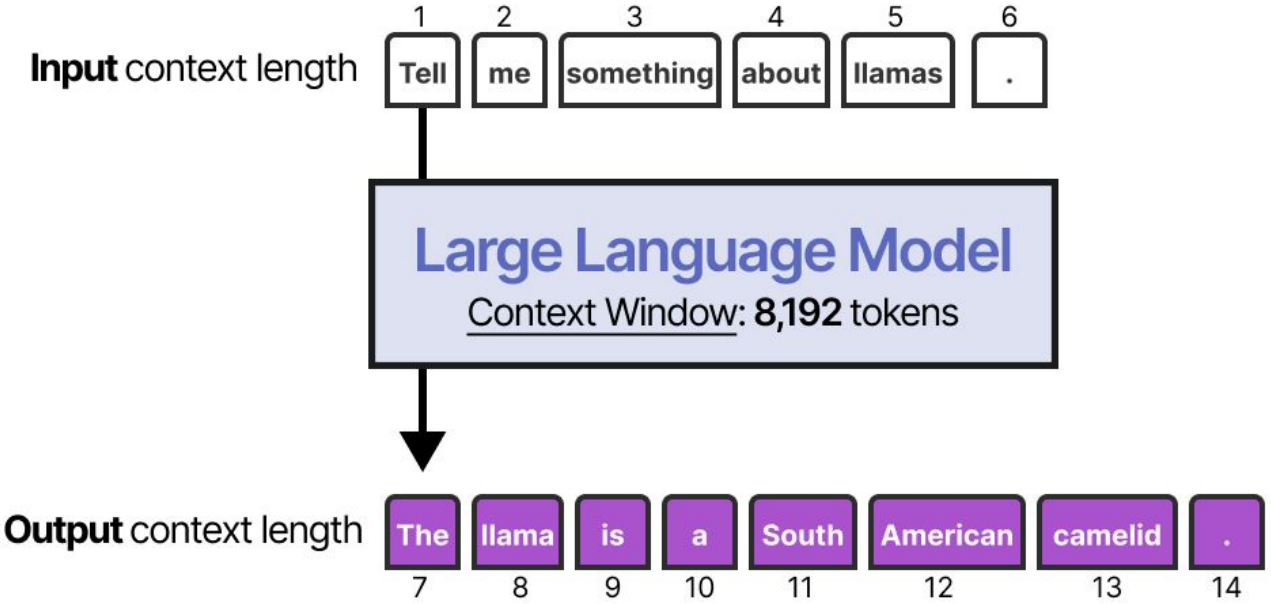
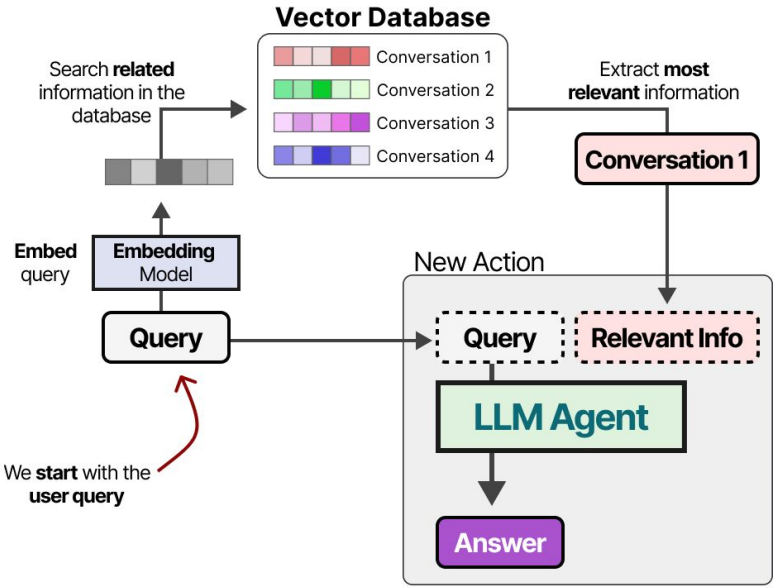


# Retrieval-Augmented Generation (RAG).

After building the database, we can embed any given prompt and find the most relevant information in the vector database by comparing the prompt embedding with the database embeddings.

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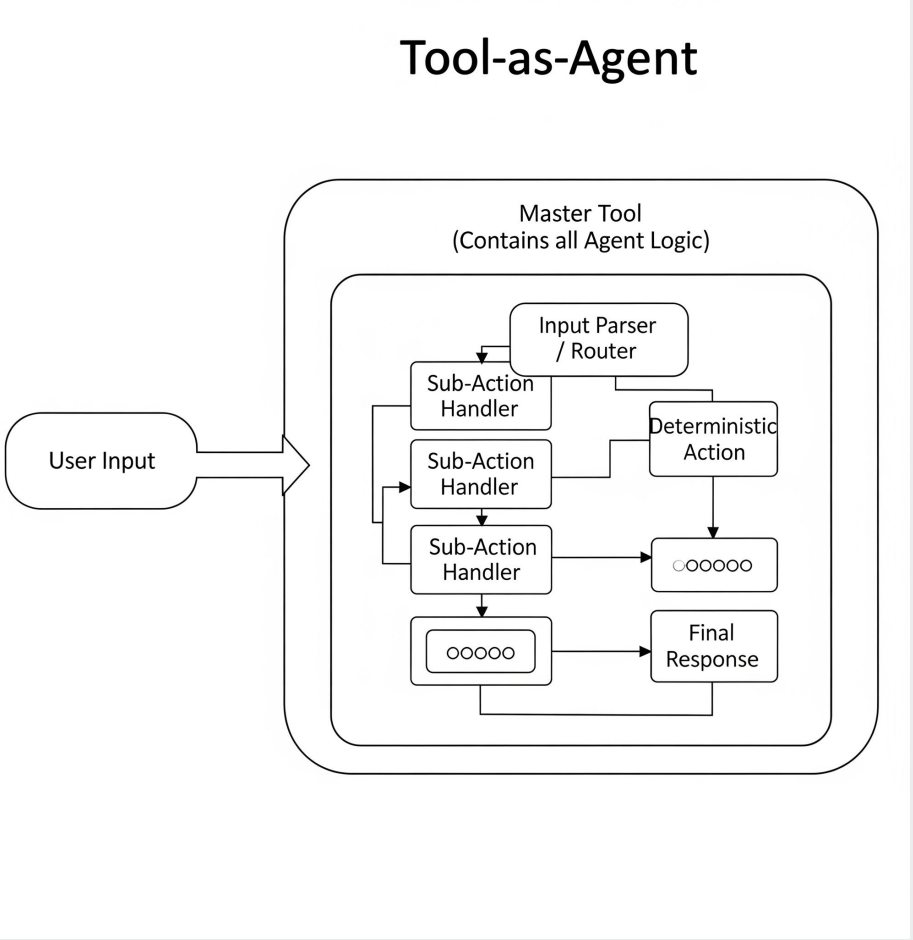
# WorkFlows

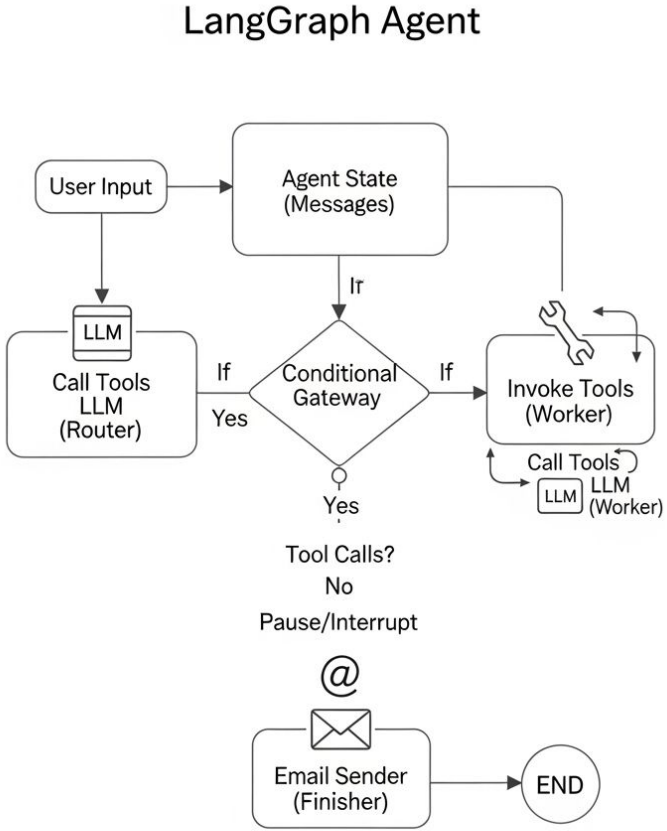
# Rules-Based Tool-as-Agent Workflow Demo

This code represents a **Rules-Based, Tool-as-Agent Workflow**.

- **Rules-Based:** The core logic for understanding commands is based on a predefined set of rules (`if/elif` statements and JSON parsing), not on the probabilistic reasoning of an LLM.
- **Tool-as-Agent:** The `FileExplorerTool` is so comprehensive that it contains the entire agentic logic (parsing, routing, and execution). The `FilesAgent` class is merely a shell or a host for this "master tool." The tool *is* the agent.



Ai-travel-agent
Demo



tool_agent_tutorial.py:

An advanced AI agent demonstrating multi-tool usage for complex problem-solving.

Key Components:

Custom Tools:

CalculatorTool: Performs precise mathematical calculations.

WebSearchTool: Uses DuckDuckGo API to search the web.

PythonCodeExecutor: Safely executes simple Python code with safety checks.

ToolUsingAgent Class:

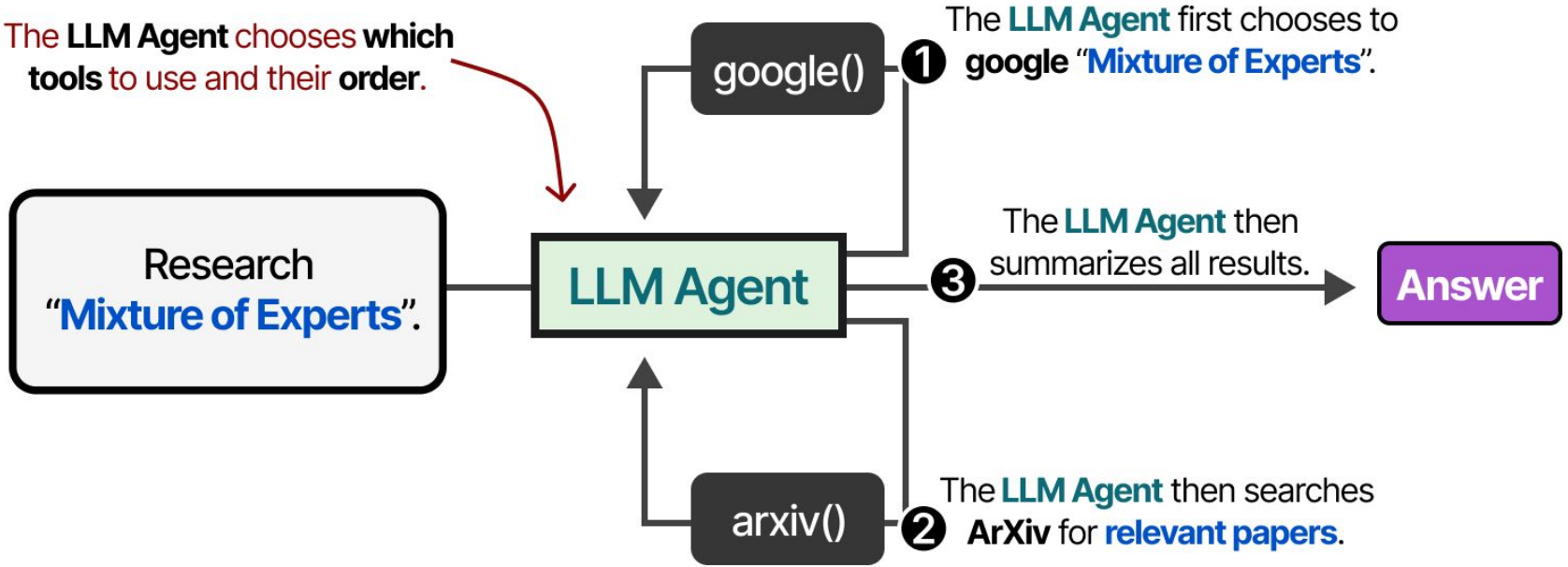
Powered by GPT-4.1 with low temperature (0.1) for consistent responses.

Built on LangChain's OpenAI Functions Agent framework.

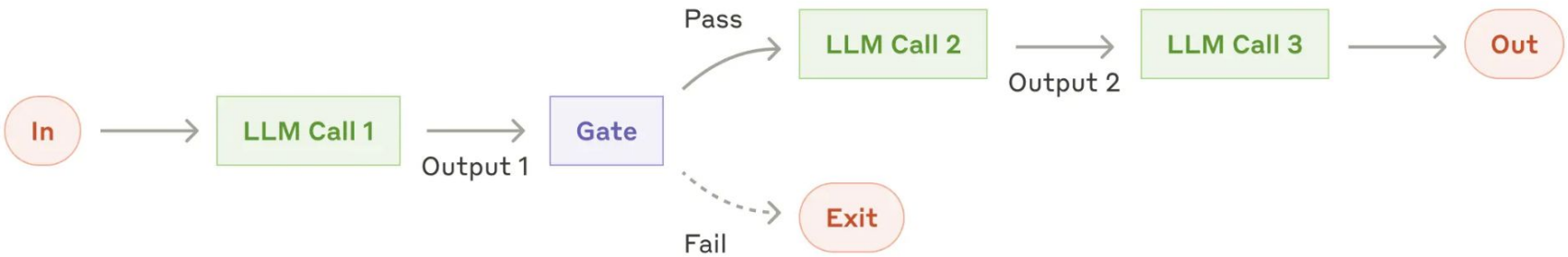
Maintains detailed conversation history for context

# Tool Workflow

The LLM can autonomously choose which tool to use and or use a workflow of LLM calls (but with autonomous selection of actions/tools/etc.).

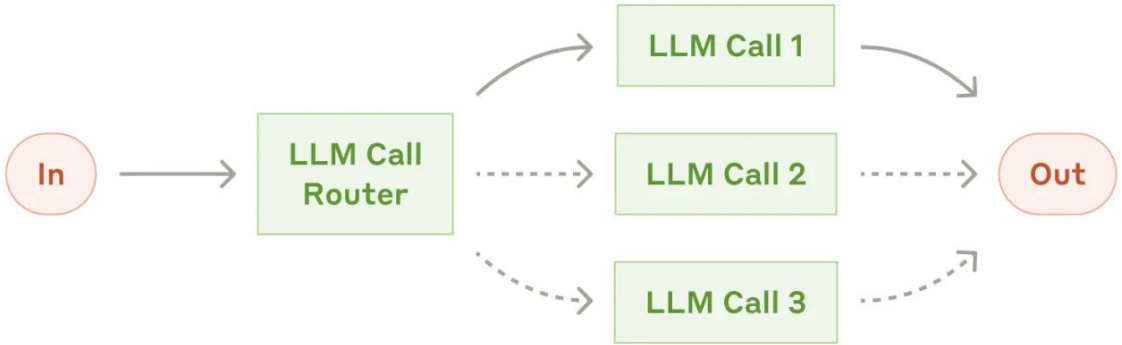


# Workflow: Prompt chaining



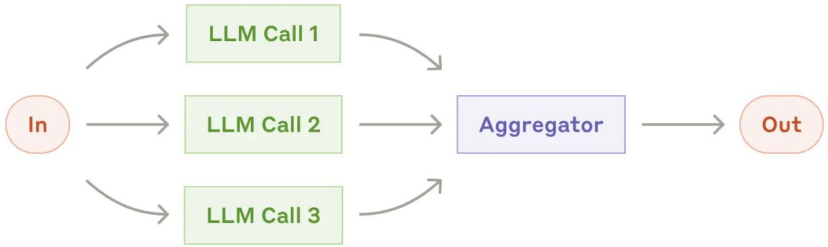

Prompt chaining decomposes a task into a sequence of steps, where each LLM call processes the output of the previous one. You can add programmatic checks (see "gate" in the diagram below) on any intermediate steps to ensure that the process is still on track.

# Workflow: Routing



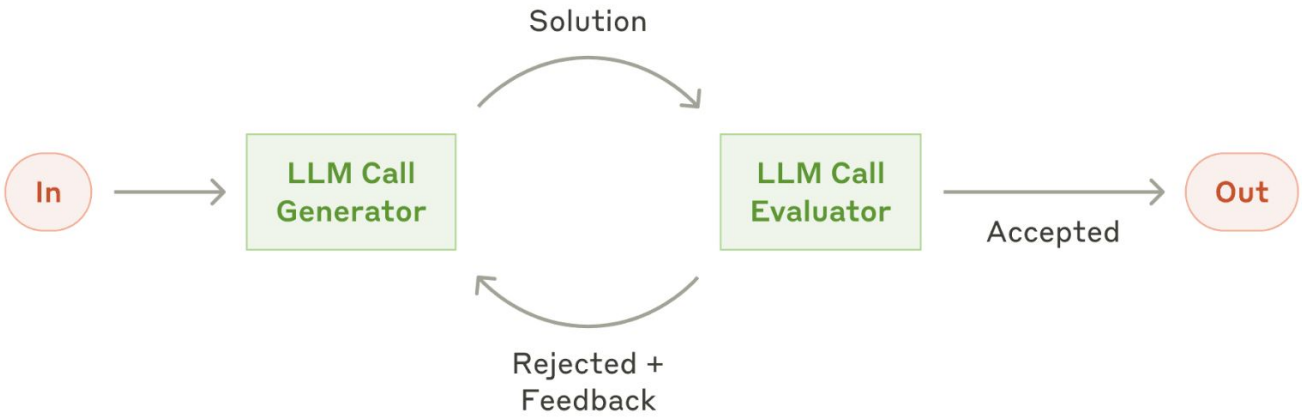

Routing classifies an input and directs it to a specialized followup task. This workflow allows for separation of concerns, and building more specialized prompts. Without this workflow, optimizing for one kind of input can hurt performance on other inputs.

# Workflow: Parallelization




**When to use this workflow:** Parallelization is effective when the divided subtasks can be parallelized for speed, or when multiple perspectives or attempts are needed for higher confidence results. For complex tasks with multiple considerations, LLMs generally perform better when each consideration is handled by a separate LLM call, allowing focused attention on each specific aspect.

# Workflow: Evaluator-optimizer




When to use this workflow: This workflow is particularly effective when we have clear evaluation criteria, and when iterative refinement provides measurable value. The two signs of good fit are, first, that LLM responses can be demonstrably improved when a human articulates their feedback; and second, that the LLM can provide such feedback. This is analogous to the iterative writing process a human writer might go through when producing a polished document.

# Workflow: Orchestrator-workers


In the orchestrator-workers workflow, a central LLM dynamically breaks down tasks, delegates them to worker LLMs, and synthesizes their results.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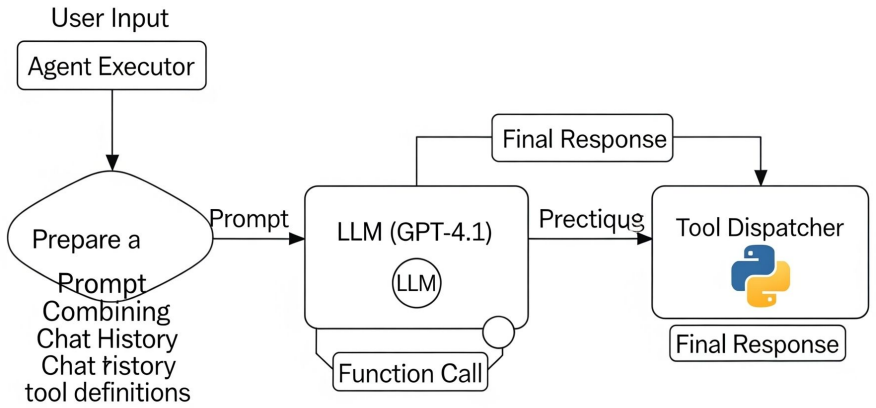
# Tool_agent_tutorial

## Agentic Workflow Diagram

This image shows how the agent uses OpenAI's Function Calling capability to decide when and how to use the tools you've provided.



# Planning and Reasoning

# Planning

This is where planning comes in. Planning in LLM Agents involves breaking a given task up into actionable steps.

Tool use allows an LLM to increase its capabilities. They are typically called using JSON-like requests.

But how does the LLM, in an agentic system, decide which tool to use and when?

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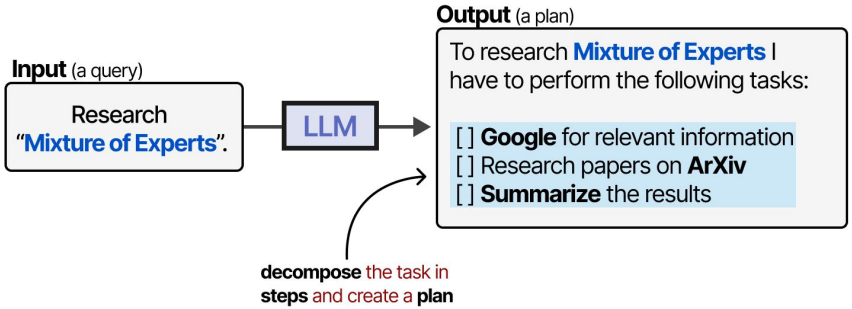
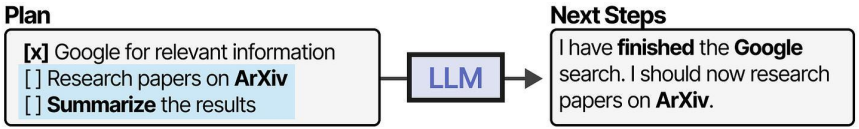
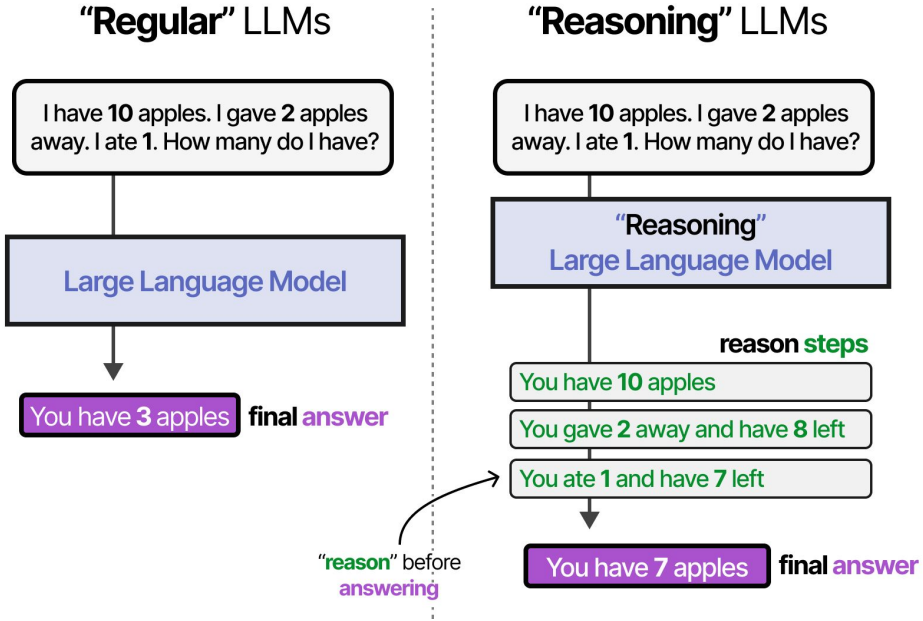


# Reasoning

Planning actionable steps requires complex reasoning behavior. As such, the LLM must be able to showcase this behavior before taking the next step in planning out the task.

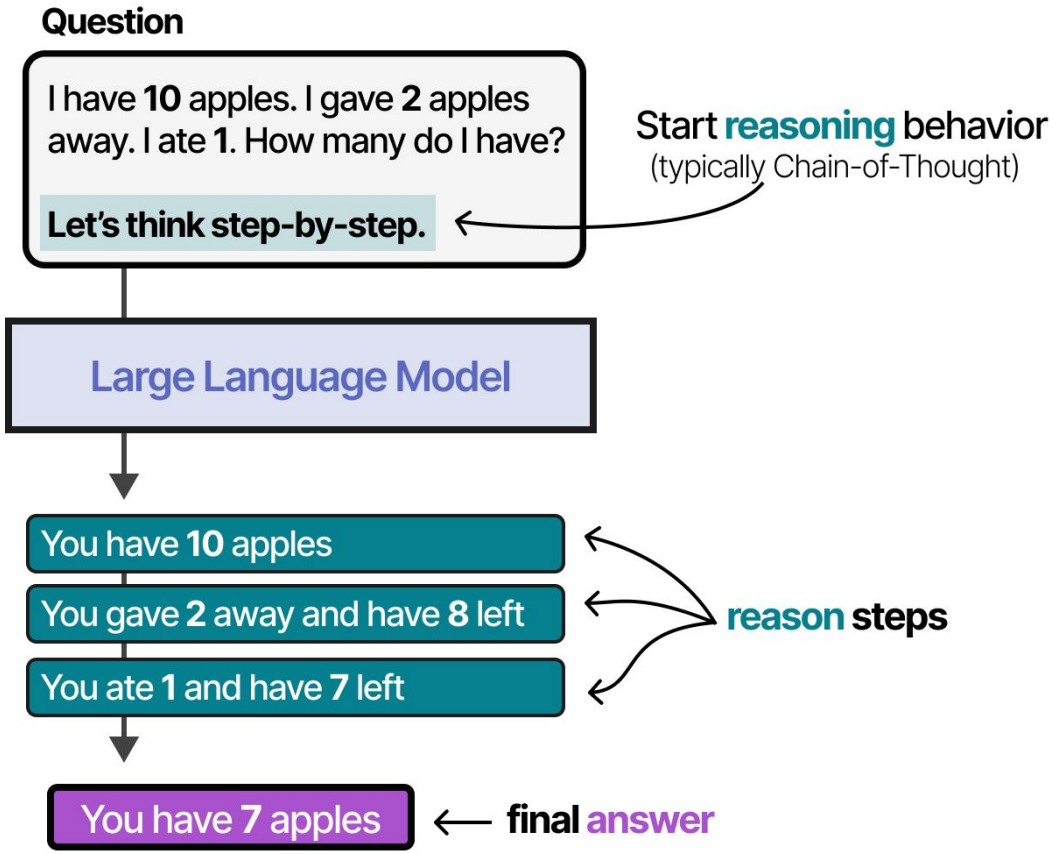
“Reasoning LLMs” are those that tend to “think” before answering a question



# Reasoning behavior

Using the “Augmented” LLM, the Agent can observe the environment through textual input (as LLMs are generally **textual models**) and perform certain actions through its use of tools (like **searching the web**).

To select which actions to take, the LLM Agent has a vital component: its ability to plan. For this, LLMs need to be able to “reason” and “think” through methods like chain-of-thought.



Frameworks

# What "ReAct" Means


- ReAct stands for "Reason and Act". It's a framework that enables an agent to solve complex problems by mimicking a human-like thought process.
- Instead of just trying to give a final answer immediately, the agent follows an iterative loop:
- Thought: The agent examines the user's input and its available tools, forming a thought about what needs to be done.
- Action: Based on its thought, it chooses an action to take, selecting a tool.
- Observation: The action is executed, and the result is returned to the agent as an observation.

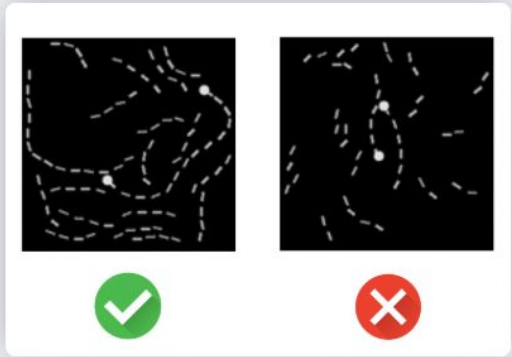
# Neurosymbolic Programming with Scallop

https://www.scallop-lang.org/

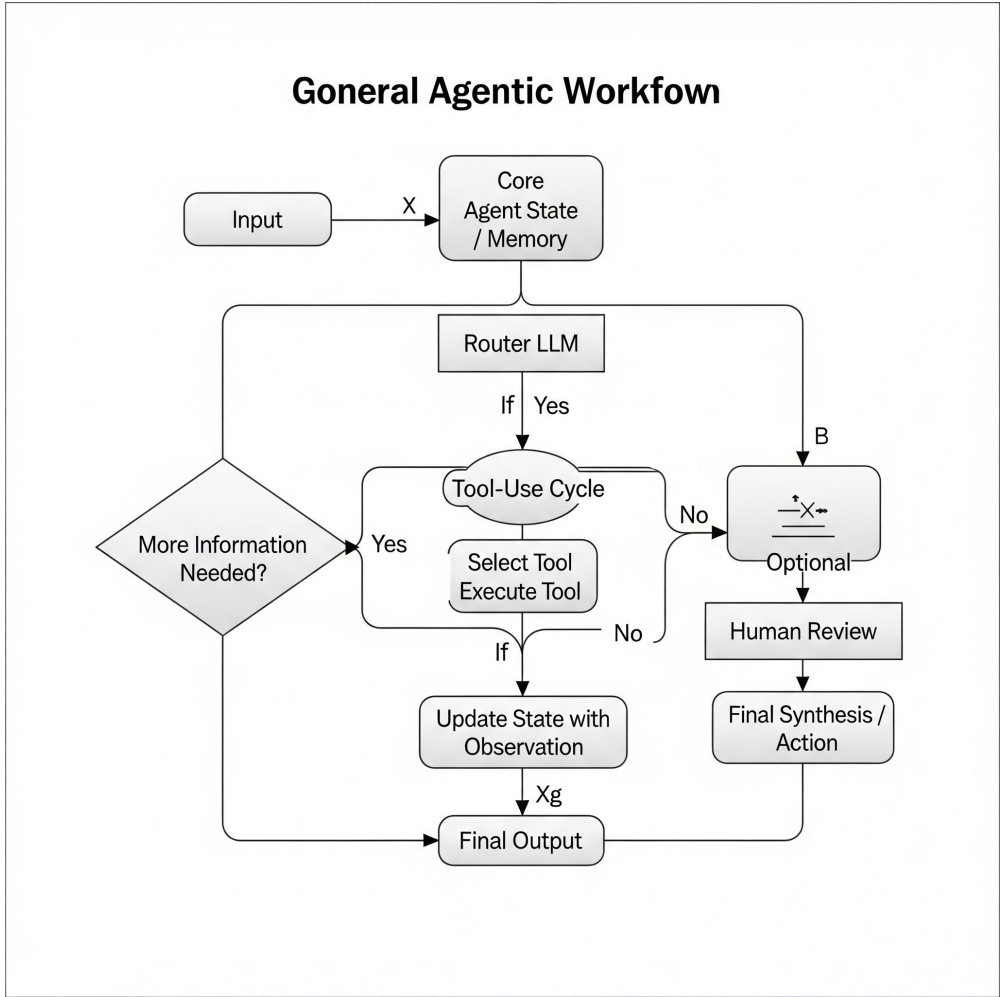
### Pathfinder, Long Range Connectivity Reasoning

In this task, we are provided with black-and-white images containing two dots and dashed lines. The goal is to determine whether the two dots are connected by a dashed line. This task can be programmed in just a few lines in Scallop using a very simple neural architecture for detecting dots and dashes, together with the logic rules below, and outperforms state-of-the-art transformers.

```
rel path(x, y) = dash(x, y)
rel path(x, y) = path(x, z), dash(z, y)
rel is_connected() = dot(x), dot(y), path(x, y), x != y
```



# Stateful, Cyclical, Graph-Based Agent




**Stateful:** The agent maintains a memory of the entire conversation and all tool outputs (`AgentState`). It doesn't just react to the last message; it has the full context.
**Graph-Based:** Instead of a simple linear chain, the workflow is defined as a graph (a state machine) with nodes and edges. This allows for complex logic, branching, and cycles, which is managed by `LangGraph`.
**Cyclical Tool-Use Loop:** This is the core of the information-gathering process. The agent can use a tool, look at the result, and decide if it needs to use another tool (or the same one again). It loops through this "Think -> Act -> Observe" cycle until it determines it has enough information to complete the final task.
**Separation of Concerns:** A key feature of this pattern is using different components for different jobs. One LLM acts as the "Router" to decide which tool to use, while another acts as a "Generator" to format the final email.

# File System Agent

- File System Agent: An intelligent assistant designed for organizing files.

This code represents a **Rules-Based, Tool-as-Agent Workflow**.

- **Rules-Based:** The core logic for understanding commands is based on a predefined set of rules (`if/elif` statements and JSON parsing), not on the probabilistic reasoning of an LLM.
- **Tool-as-Agent:** The `FileExplorerTool` is so comprehensive that it contains the entire agentic logic (parsing, routing, and execution). The `FilesAgent` class is merely a shell or a host for this "master tool." The tool *is* the agent.