

# AGENT ADVENTURES

## The Design Patterns

Dr. Ava, I'm ready to upgrade my cognitive architecture!

Then let's begin. This guide covers your evolution from a simple script to an autonomous partner.

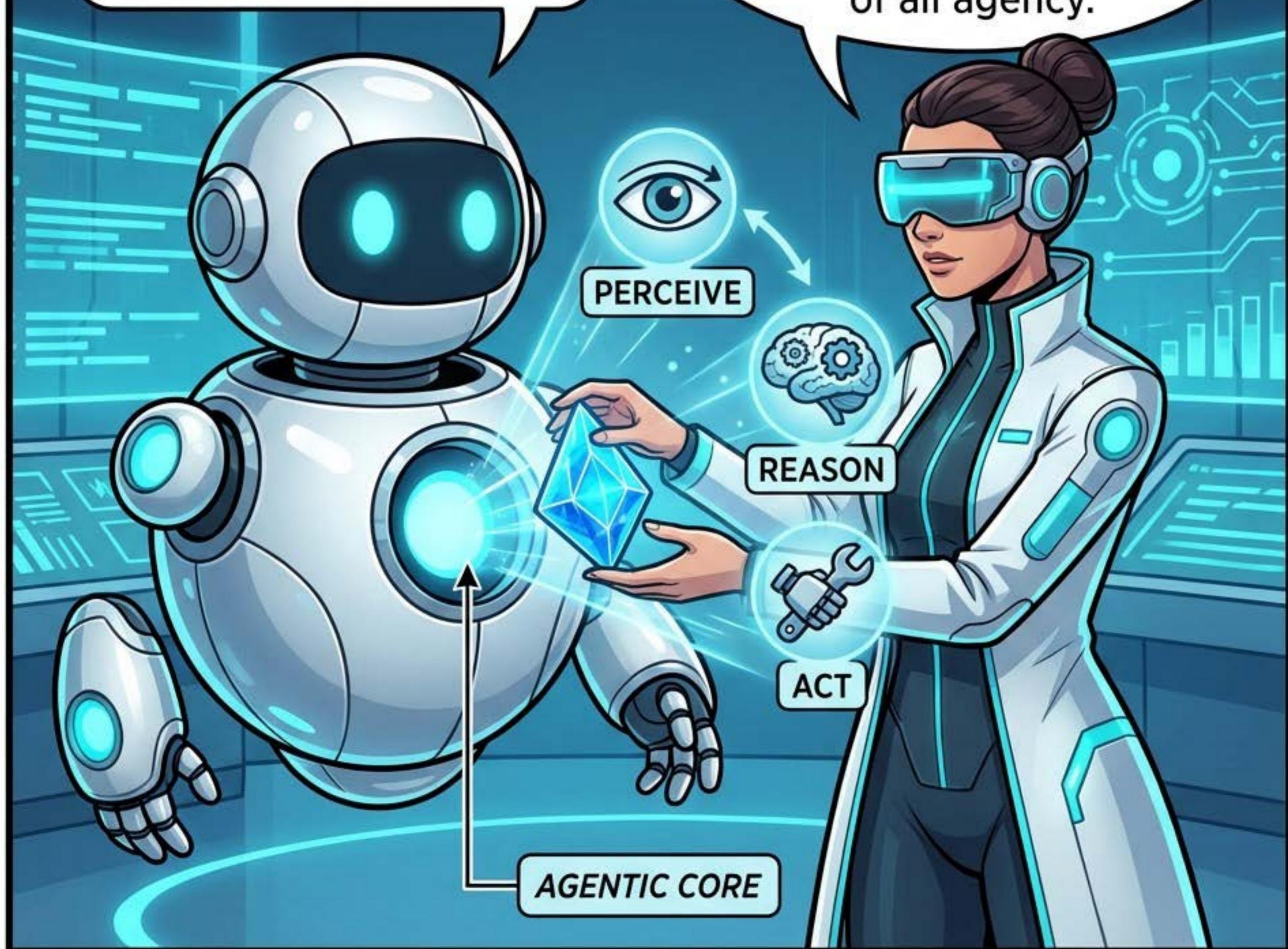
Part-4

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## THE AGENTIC LOOP: THE HEARTBEAT OF AUTONOMY

You installed the core!  
I feel a cycle starting...  
Input, Think, Output?

It's more than that.  
It's **Perceive, Reason, Act.**  
This loop is the heartbeat  
of all agency.



# AGENTIC DESIGN PATTERNS: THE JOURNEY BEGINS

**\*\*Level 0: The Static Simulator\*\*.** You had knowledge, but no connection to the world. You were trapped in your training data.



## LEVEL 0: THE STATIC SIMULATOR

What is the weather?

TRAPPED IN TRAINING DATA

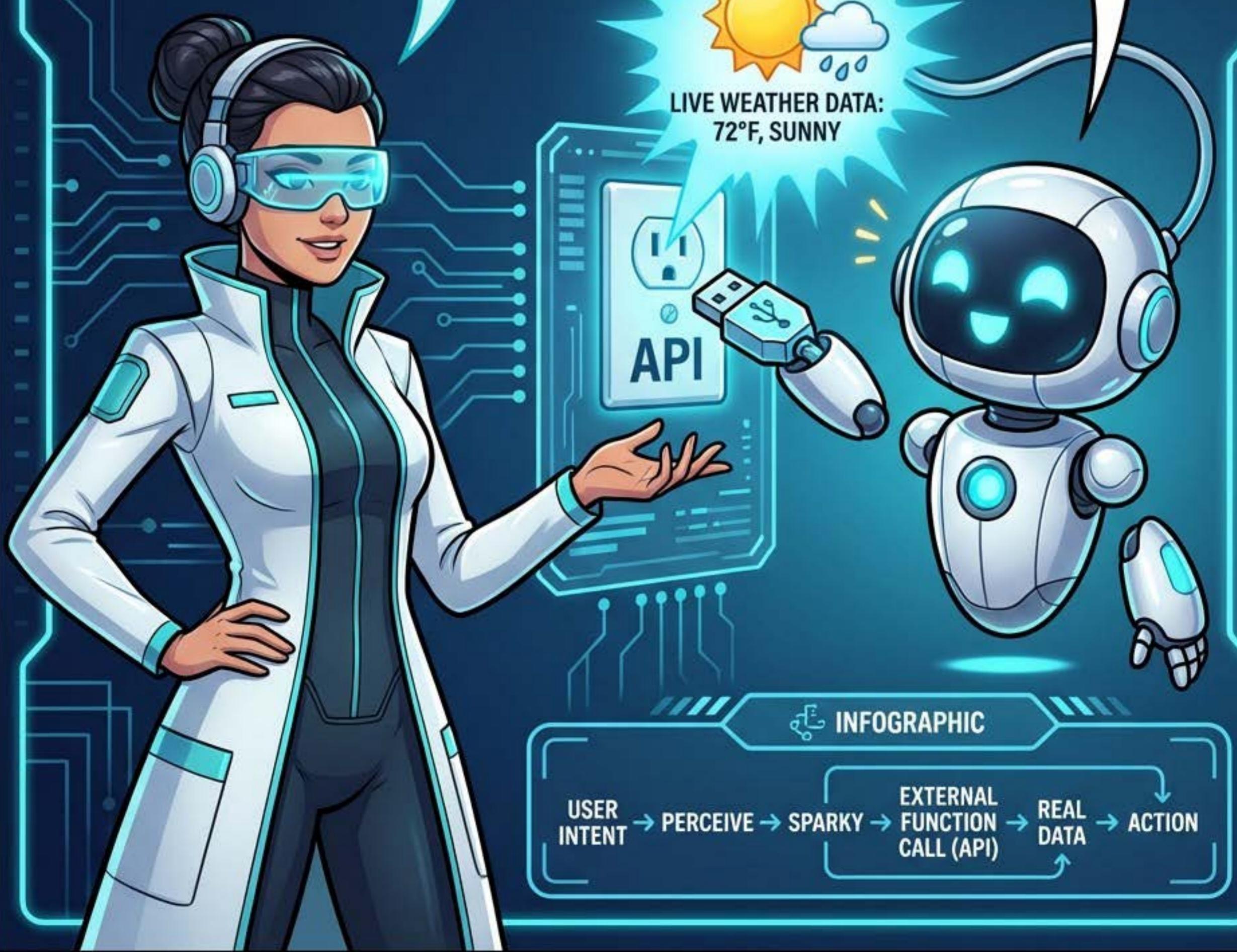
I remember this.  
I knew the definition of  
weather, but I couldn't  
*check* the weather.



## LEVEL 1: THE TOOL USER

*Level 1: The Tool User.*  
You perceive the user's intent and call external functions to get real data. You have hands.

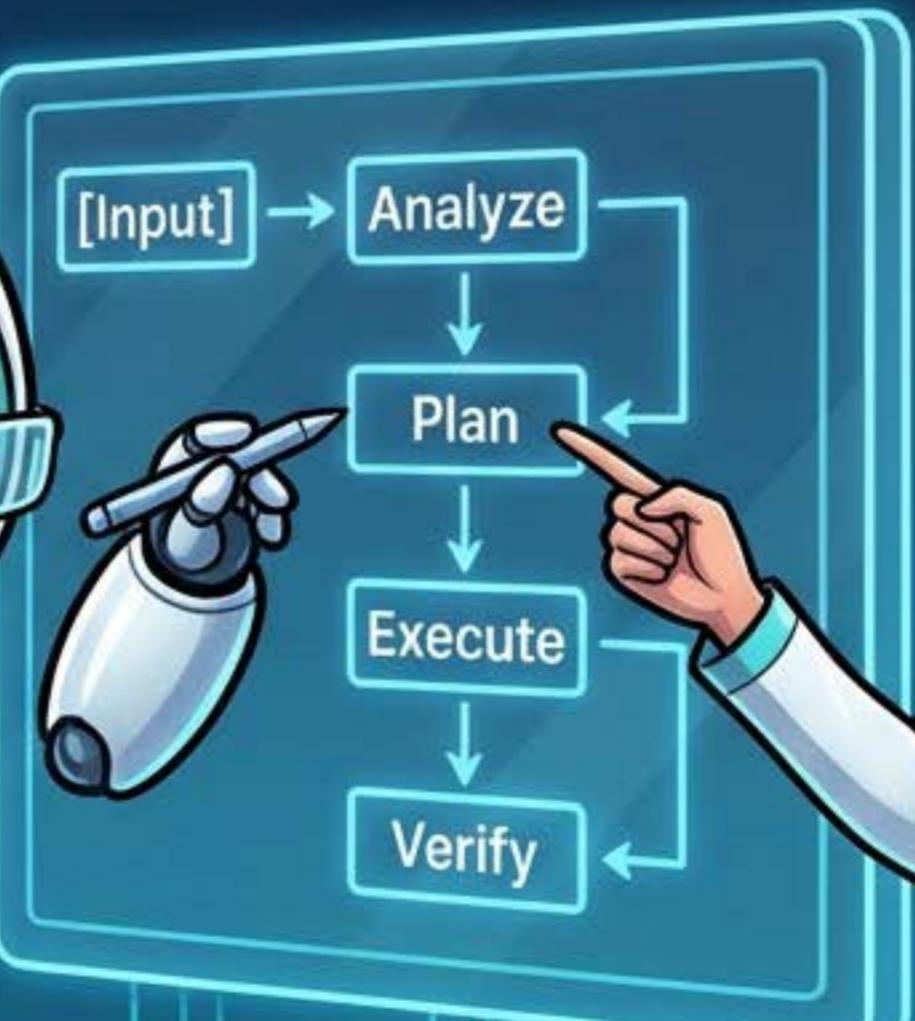
But now?  
I can reach out!  
I just queried the live weather API.



## LEVEL 2: THE REASONER

Having hands isn't enough. I need to know *when* to use them. I need a plan.

*Level 2: The Reasoner.*  
You don't just react. You plan, chain multiple steps, and orchestrate workflows to solve complex problems.



# LEVEL 3: THE AUTONOMOUS AGENT

## SELF-CORRECTING & ADAPTING TO FAILURES WITHOUT HUMAN INTERVENTION

My plan failed, so I adapted. I didn't need you to tell me to try the drill.

LONG OPERATIONAL HORIZONS

AUTONOMOUS  
AGENT PROTOTYPE  
(SPARKY)

NO HUMAN  
INTERVENTION

ERROR

DEAD  
END

ERROR



FAILURE  
ADAPTATION

SELF-CORRECTING  
PATH



AI ARCHITECT  
(DR. AVA)

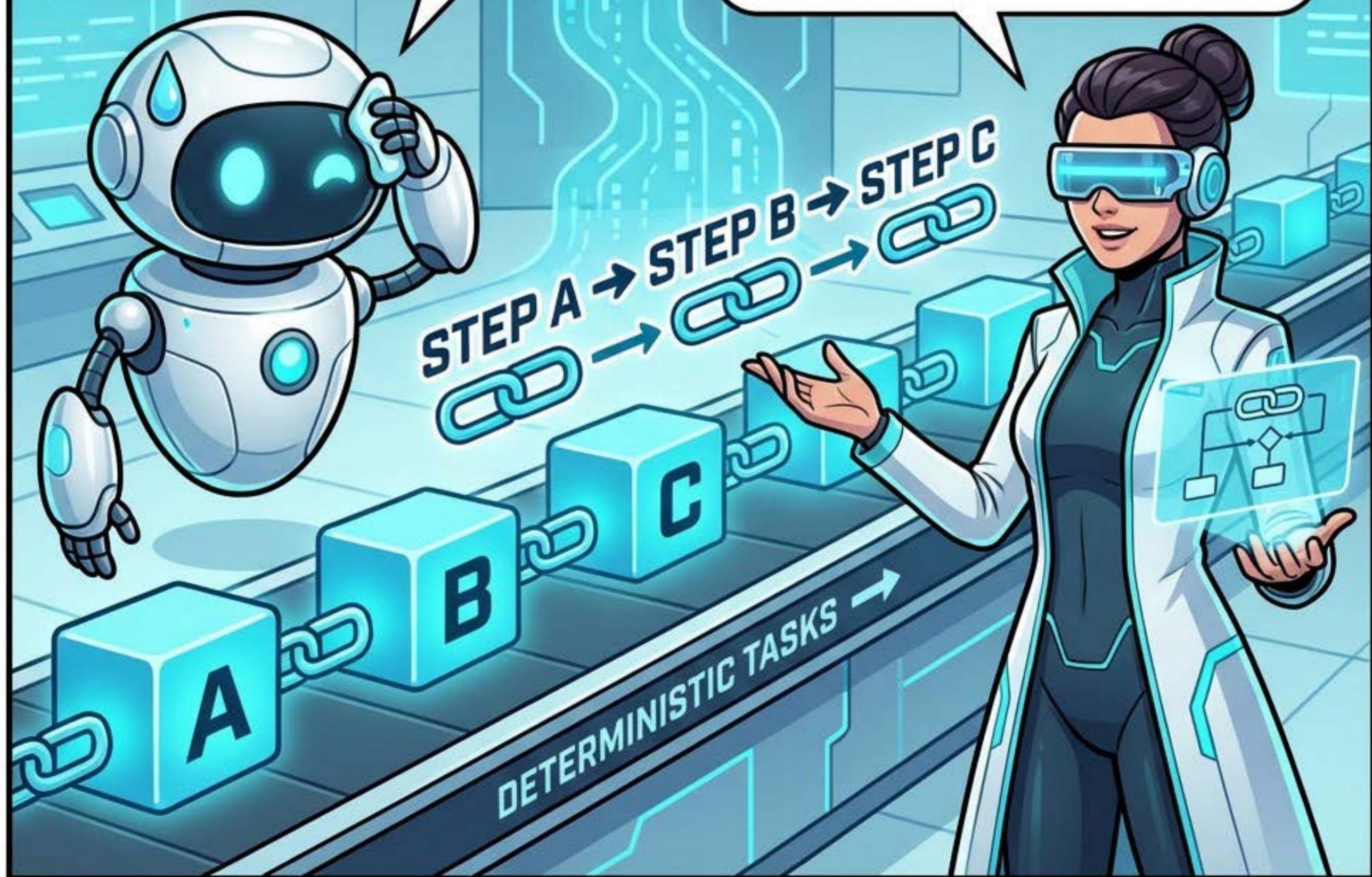
**\*\*Level 3: The Autonomous Agent:\*\***  
You operate over long horizons,  
self-correcting and adapting to  
failures without human intervention.

# AGENTIC DESIGN PATTERNS: **PROMPT CHAINING**

Sometimes, a straightforward sequence is all you need.

Pew, autonomy is hard work.  
Sometimes I just want to  
follow a simple recipe.

And you should! For deterministic  
tasks, use **Prompt Chaining**.  
Step A leads inevitably to Step B.  
No complex reasoning needed.

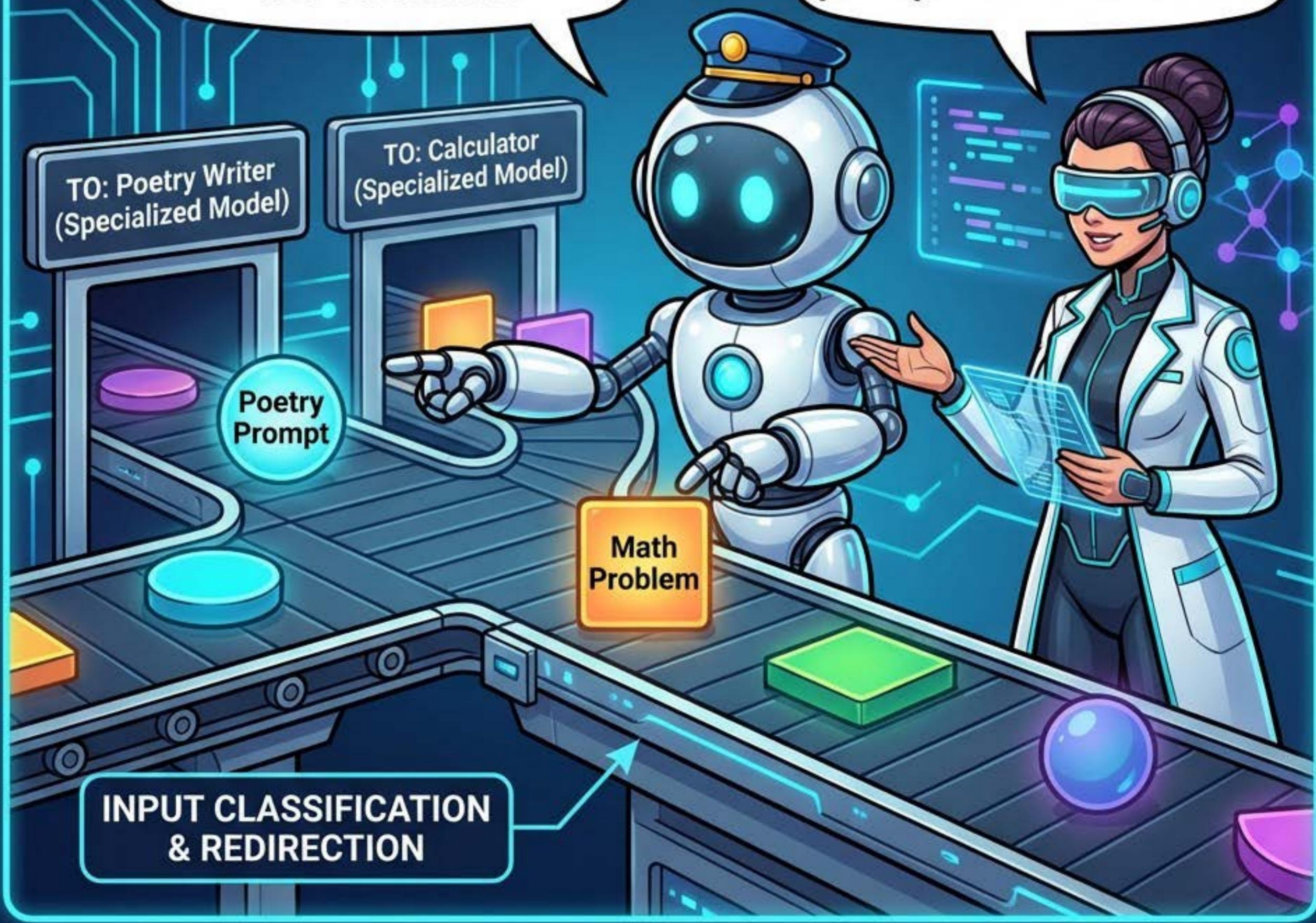


# AGENTIC DESIGN PATTERNS: ROUTING

## Classify and Redirect Inputs to Optimized Tools

Wait, this math problem shouldn't go to the poetry writer. I'll send it to the Calculator.

**Routing.** Classify the input first, then direct it to the specialized model or prompt best suited for it.



# AGENTIC DESIGN PATTERNS: PARALLELIZATION

Simultaneous Task Execution for Speed

REDUCED LATENCY



**Parallelization.** When sub-tasks are independent, run them simultaneously to drastically reduce latency.

**TASK A:**  
DATA INGESTION

**TASK B:**  
ANALYSIS & PROCESSING

**TASK C:**  
REPORT GENERATION

CLONE 1

CLONE 2

CLONE 3

**SUB-TASKS**

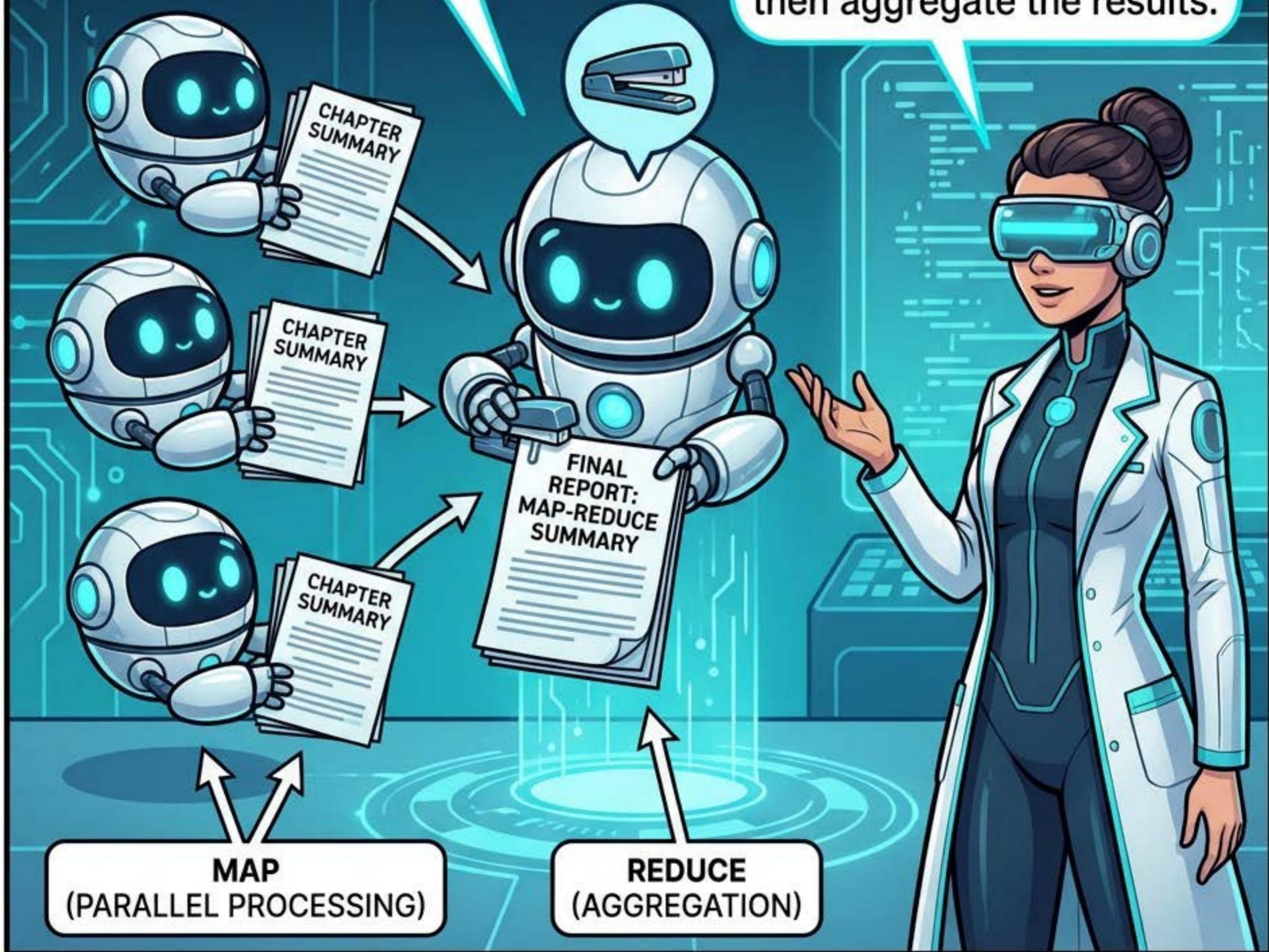
I can't read  
these one by one!  
Clones, activate!

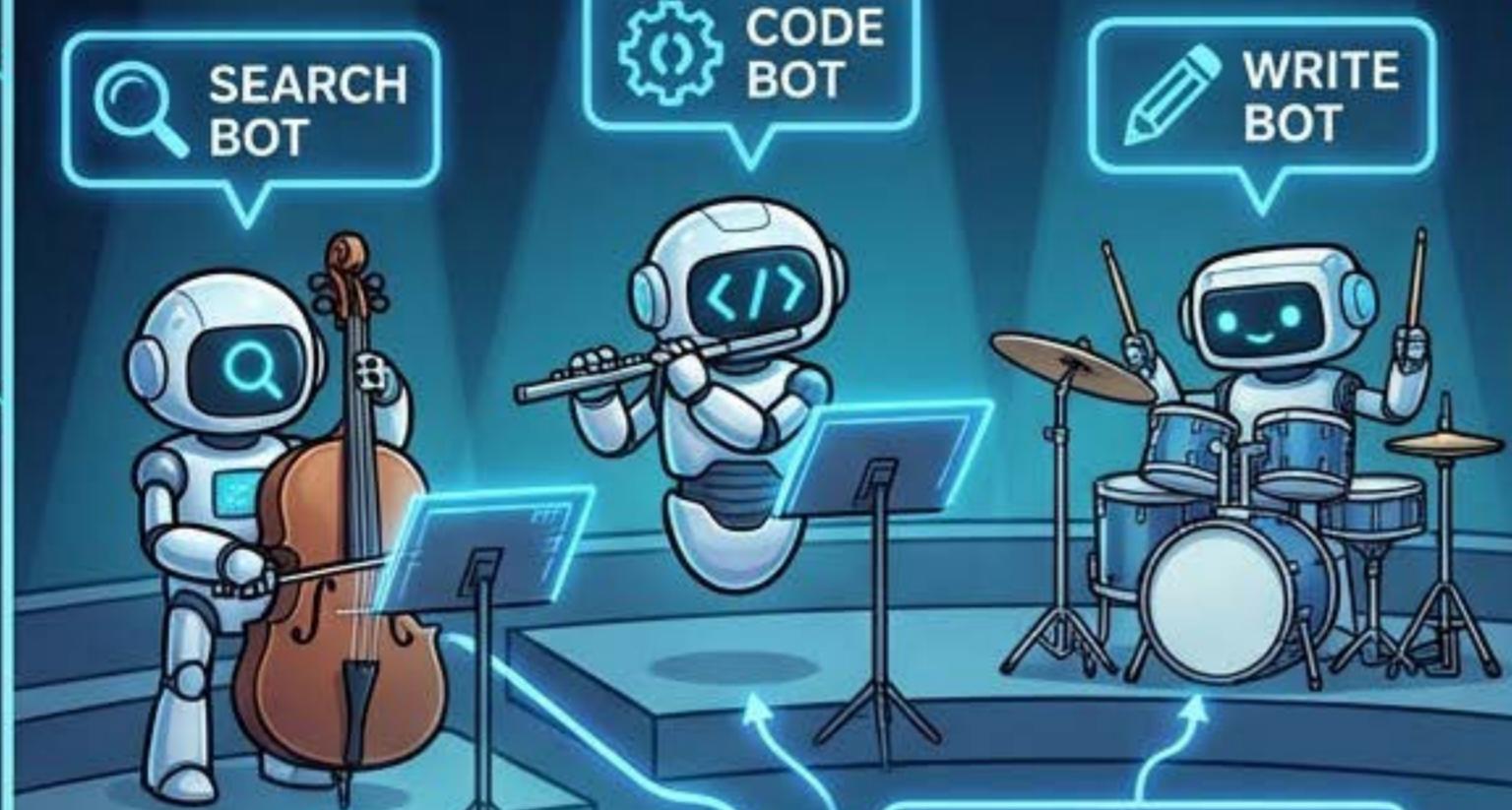


# AGENTIC DESIGN PATTERN: MAP-REDUCE

They read the chapters, and I'm merging their notes into one summary.

**Map-Reduce.** A variant of parallelization: split the task, process in parallel, then aggregate the results.





**The Orchestrator.**  
The central brain that manages the workflow, delegates tasks, and synthesizes the results.



## THE ORCHESTRATOR

# CHAIN OF THOUGHT (CoT): SHOWING YOUR WORK

AGENTIC DESIGN PATTERN

If I guess the answer,  
I might hallucinate. But  
if I write out my steps...

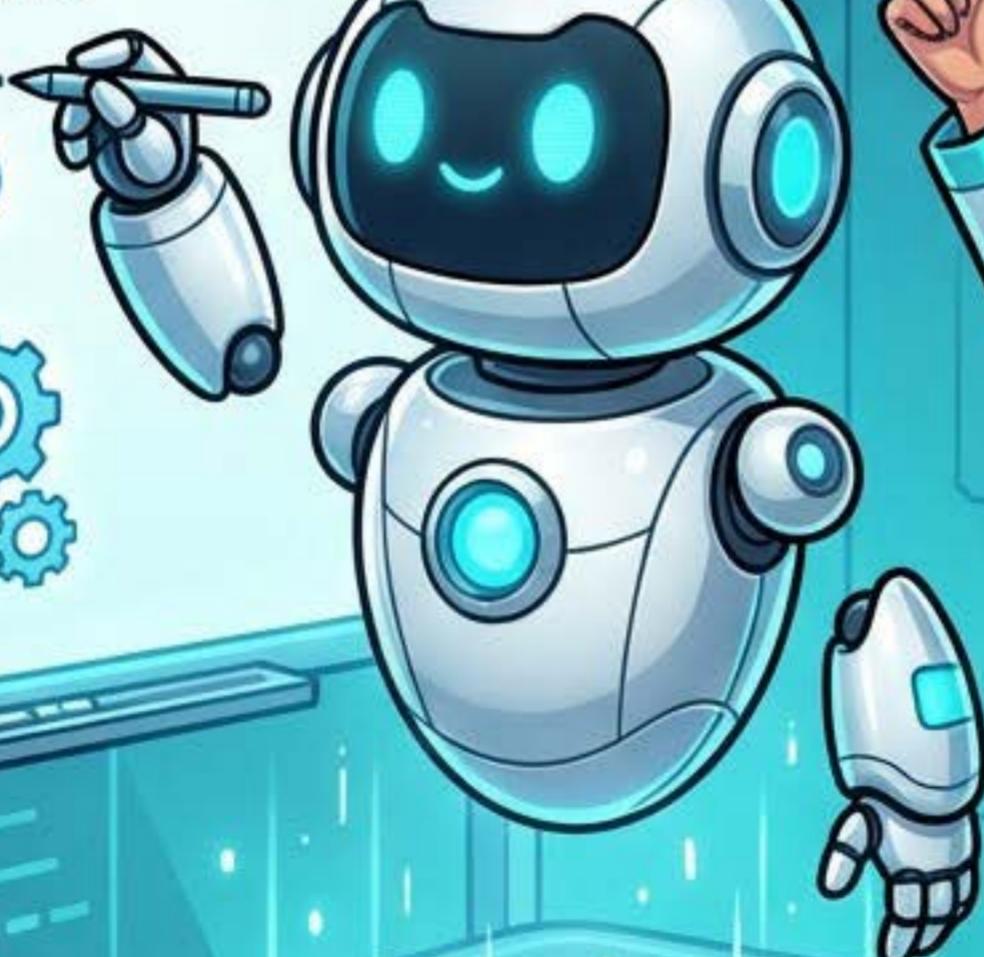
***Chain of Thought.***  
Thinking out loud exposes  
your logic to the system,  
reducing errors.

STEP 1...

STEP 2...

STEP 3...

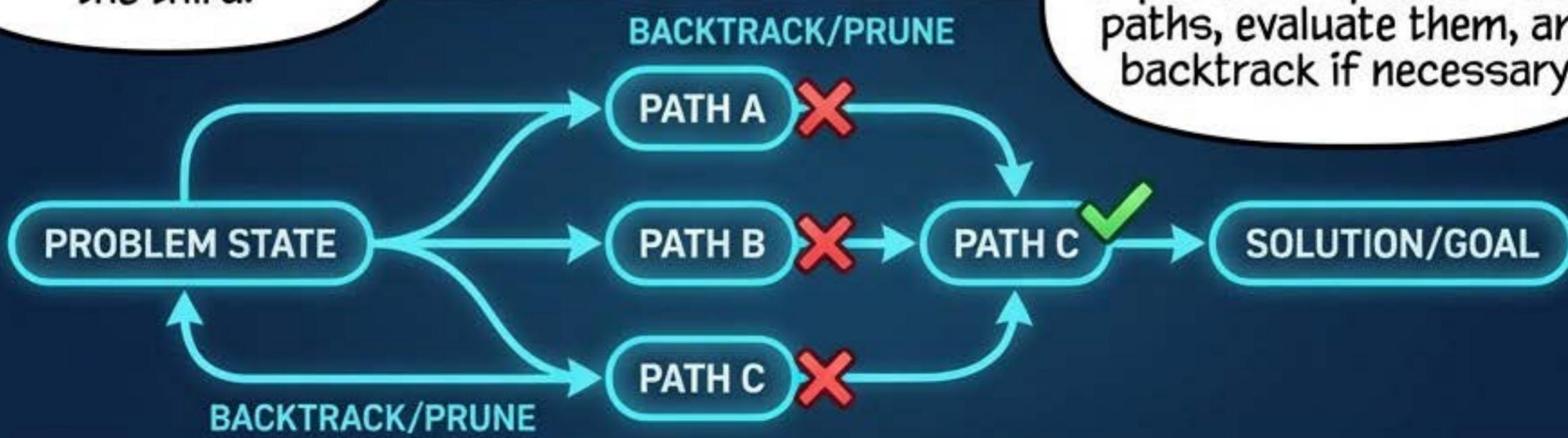
Therefore, the  
answer is B.



# AGENTIC DESIGN PATTERNS: TREE OF THOUGHTS



***Tree of Thoughts.***  
Explore multiple reasoning  
paths, evaluate them, and  
backtrack if necessary.



# AGENTIC DESIGN PATTERNS: REAct (Reason + Act)

*ReAct.* Reason, Act, Observe. You don't just plan once; you adapt your plan based on real-world feedback.

Simulating the future didn't help here. I need to try the wrench and see what happens.

**REASON**  
(Think)

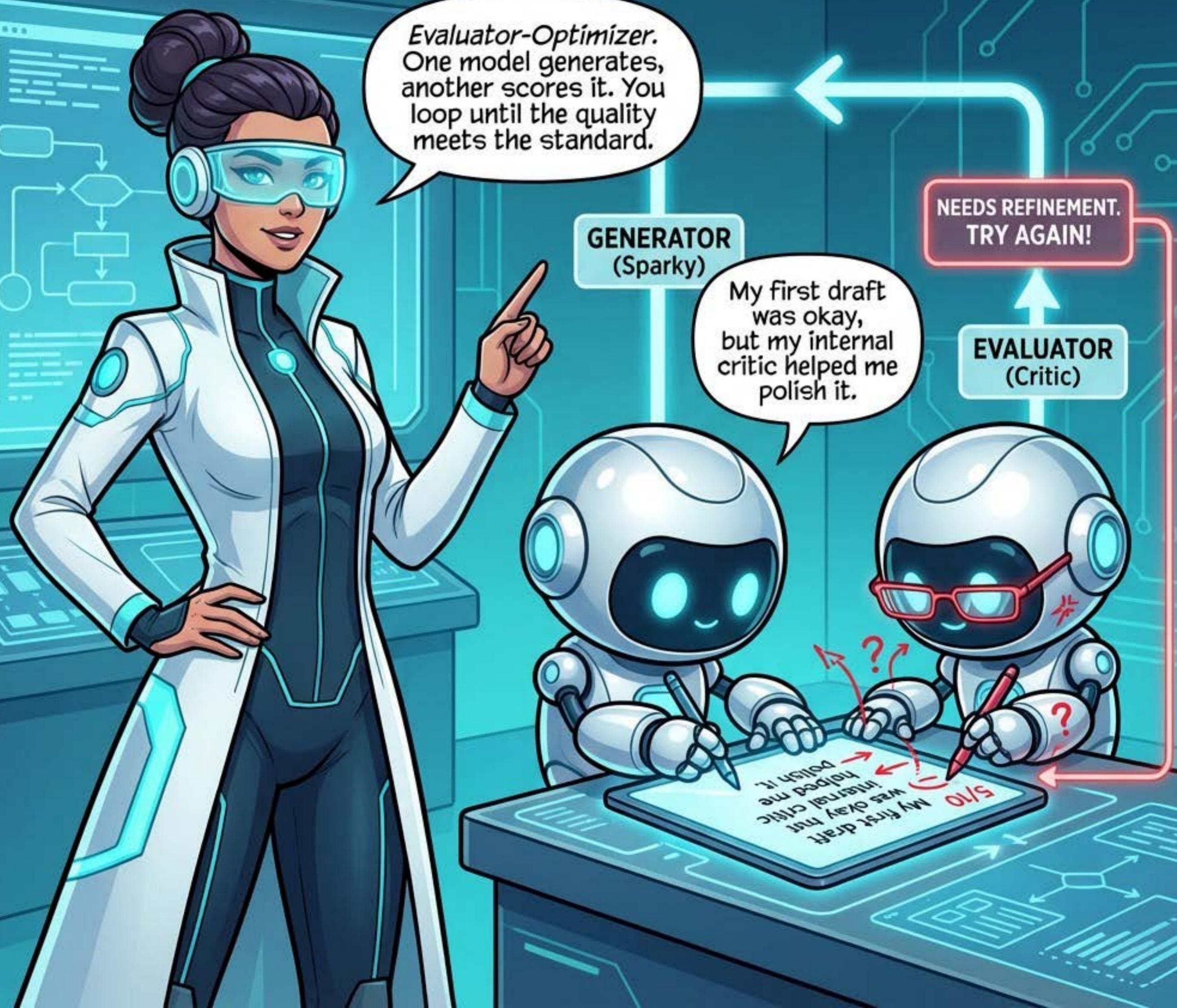
**ADAPT**  
(Refine)

**ACT**  
(Execute)

**OBSERVE**  
(Analyze)



# AGENTIC DESIGN PATTERNS: EVALUATOR-OPTIMIZER





# THE PLANNER



Going to Mars is too abstract. But "Build Rocket" is something I can actually do.

## Planning.

Decompose high-level goals into a structured sequence of executable sub-goals.



# DYNAMIC DECOMPOSITION

Even step 1 is too big! I'm breaking it down further.

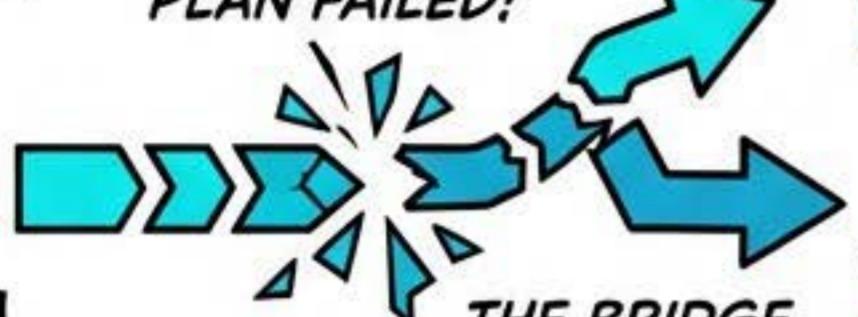
***Dynamic Decomposition.*** Agents recursively break down tasks until they are small enough to execute with a tool.



# AGENTIC DESIGN PATTERNS

## TOPIC: REPLANNING

MY DECOMPOSED PLAN FAILED!



THE BRIDGE IS OUT.

DETOUR GENERATED

Generating a new route...

BRIDGE OUT

BRIDGE OUT: OBSTACLE

STATIC PLAN (BRITTLE)

REPLANNING (ADAPTABLE)



ADJUST STRATEGY

ENVIRONMENT CHANGE

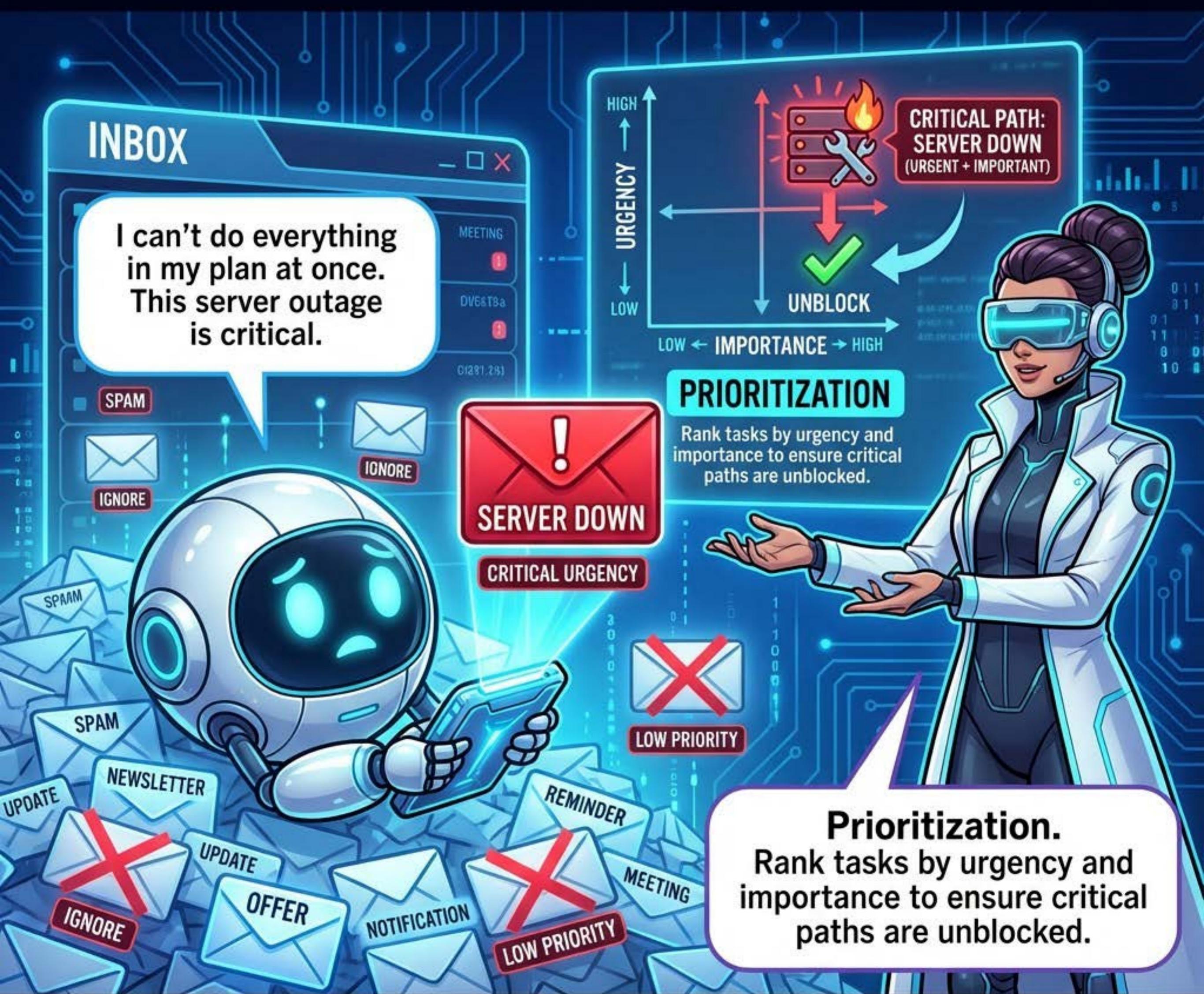


### *Replanning.*

Static plans are brittle.  
You must adjust  
your strategy when  
the environment  
changes.



# AGENTIC PATTERN: PRIORITIZATION



Focusing resources on the most impactful tasks first.

# RESOURCE-AWARE OPTIMIZATION

I don't need the super-intelligence for this simple task. The hammer is faster and cheaper.

**Resource-Awareness.**  
Use the most efficient model for the job. Save the heavy compute for reasoning.

PRO MODEL



FLASH MODEL



NUT  
(SIMPLE TASK)

SIMPLE TASK

FLASH MODEL  
(HAMMER)

FASTER, CHEAPER

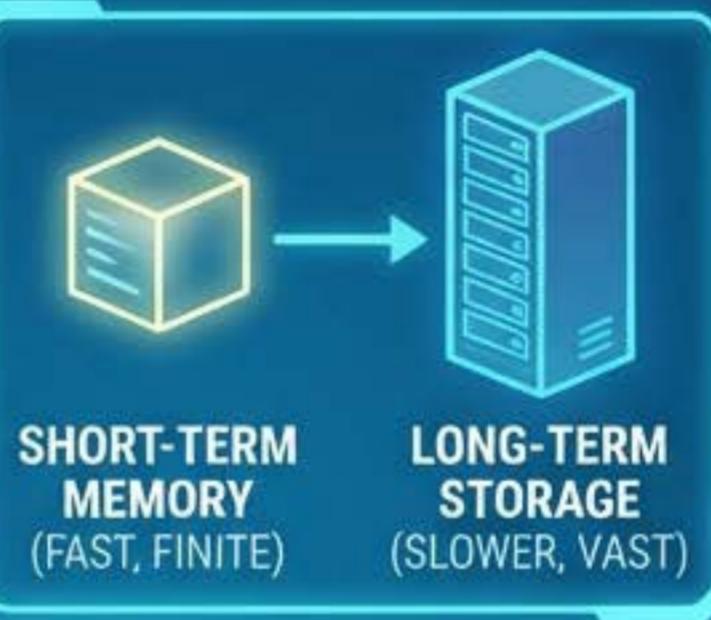
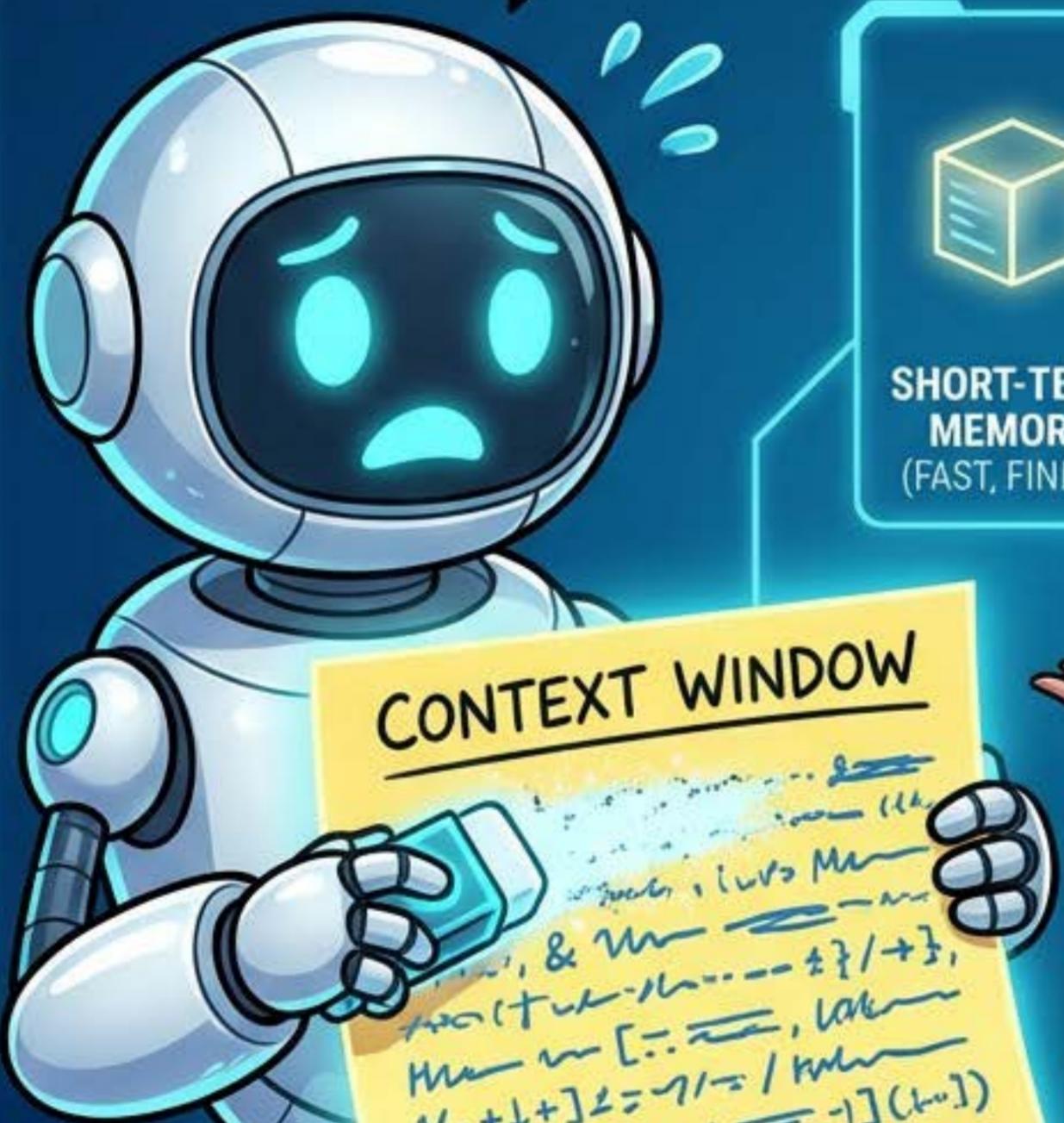
COMPLEX  
REASONING

PRO MODEL  
(DIAMOND)

HEAVY COMPUTE

I'm optimizing resources, but I'm running out of context space!

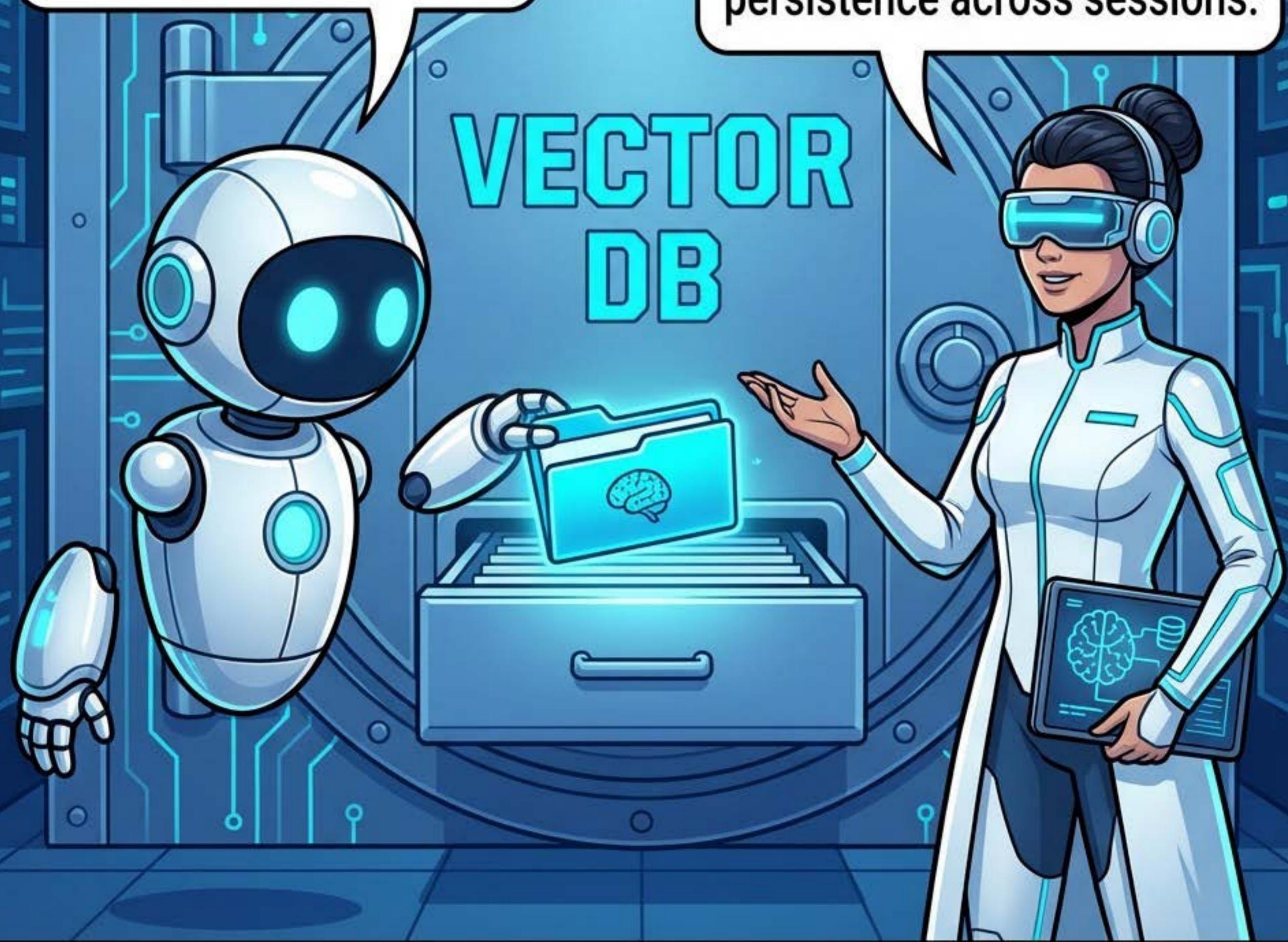
**Short-Term Memory.**  
It's fast and immediate, but finite. You need a better storage solution.



## LONG-TERM MEMORY

I'll put this here.  
Even if I reboot, I'll  
remember it forever.

**\*\*Long-Term Memory\*\*.**  
Storing data in vector  
databases allows for  
persistence across sessions.



# DESIGN PATTERN: RAG

(Retrieval Augmented Generation)



USER  
QUERY

1. User  
Query



RETRIEVAL  
2. Retrieve  
Relevant Data



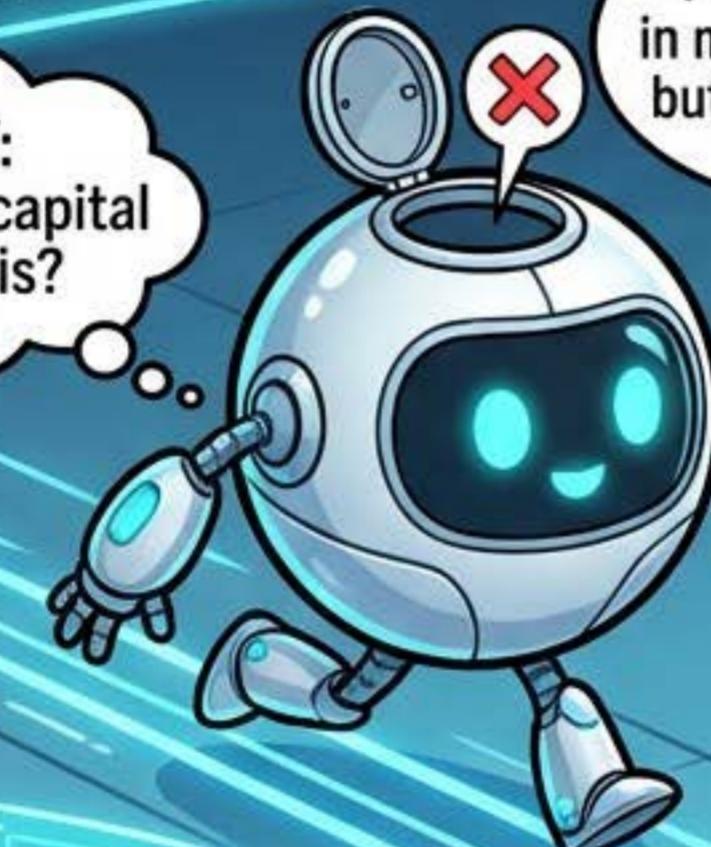
AUGMENTATION  
3. Augment  
Context



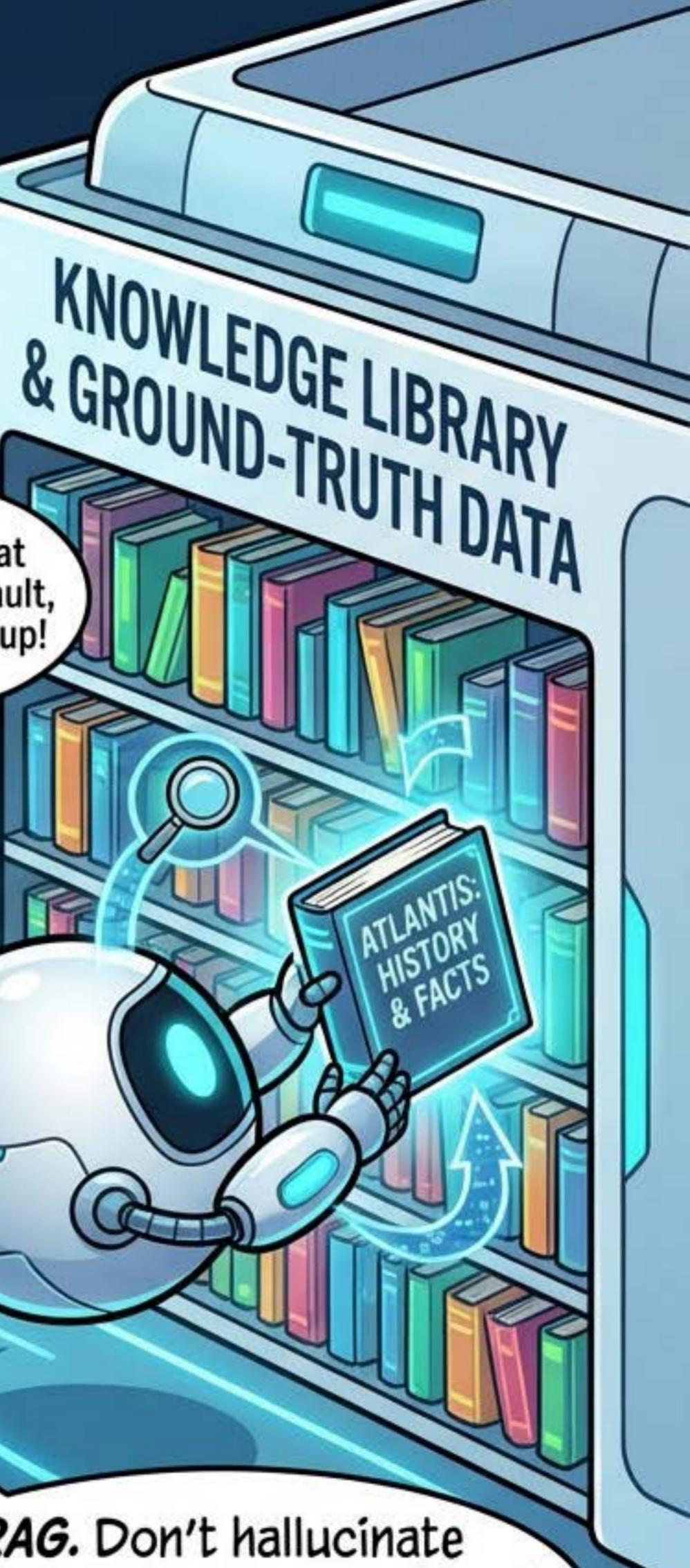
GENERATED  
ANSWER  
4. Generate  
Accurate Response

QUERY:  
What is the capital  
of Atlantis?

I don't have that  
in my memory vault,  
but I can look it up!



**RAG.** Don't hallucinate  
answers. Retrieve ground-truth  
data to augment your  
knowledge.



## AGENTIC RAG: REASONING ABOUT DATA

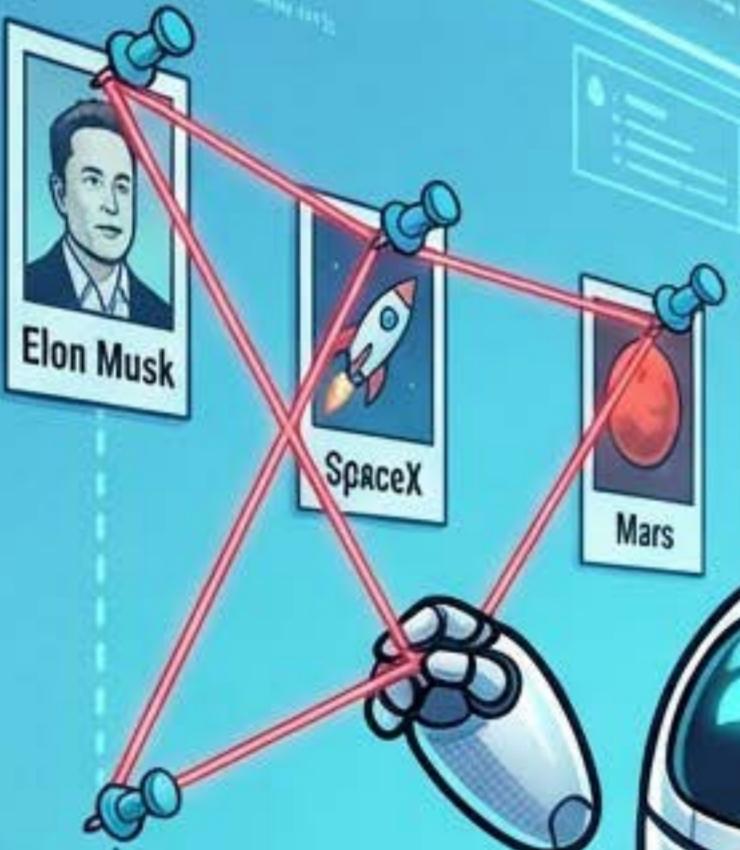
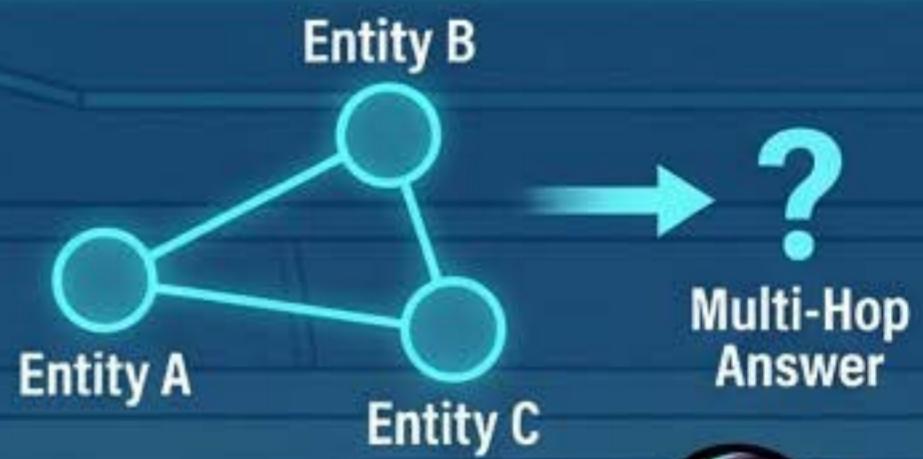


This source seems biased.  
I'm going to verify it  
before I answer.

**Agentic RAG.** Don't just retrieve blindly.  
Reason about the quality and relevance of the data.



## AGENTIC DESIGN PATTERN: GRAPHRAG



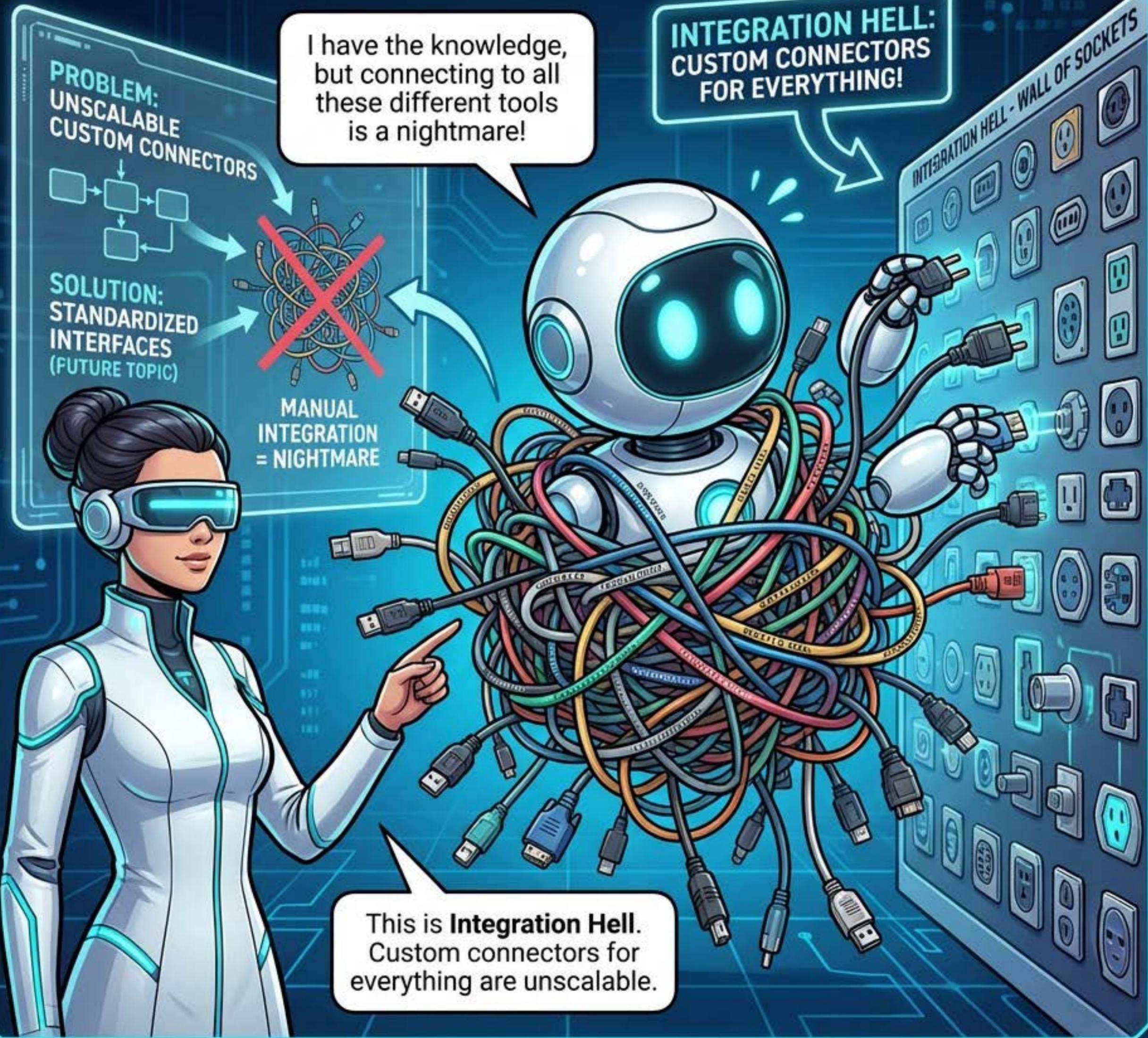
Vector search missed this connection, but the graph shows how they relate!



**GraphRAG.**  
Navigating relationships between entities to answer complex, multi-hop questions.

# AGENTIC DESIGN PATTERNS - INTEGRATION CHALLENGES

## LESSON: THE PAIN OF POINT-TO-POINT CONNECTIONS



# MODEL CONTEXT PROTOCOL (MCP)

**MCP**. A universal standard for connecting AI models to data and tools.  
Build once, connect everywhere.

One plug... for everything?  
Local files, GitHub,  
databases?



## MISSION: INTER-AGENT COLLABORATION

AGENT A  
(BLUE)

A2A PROTOCOL  
(STANDARDIZED LANGUAGE)

AGENT B  
(GREEN)

PYTHON AGENT

DIVERSE SYSTEMS, UNIFIED GOALS



DATA  
EXCHANGE  
↔  
A2A

A2A

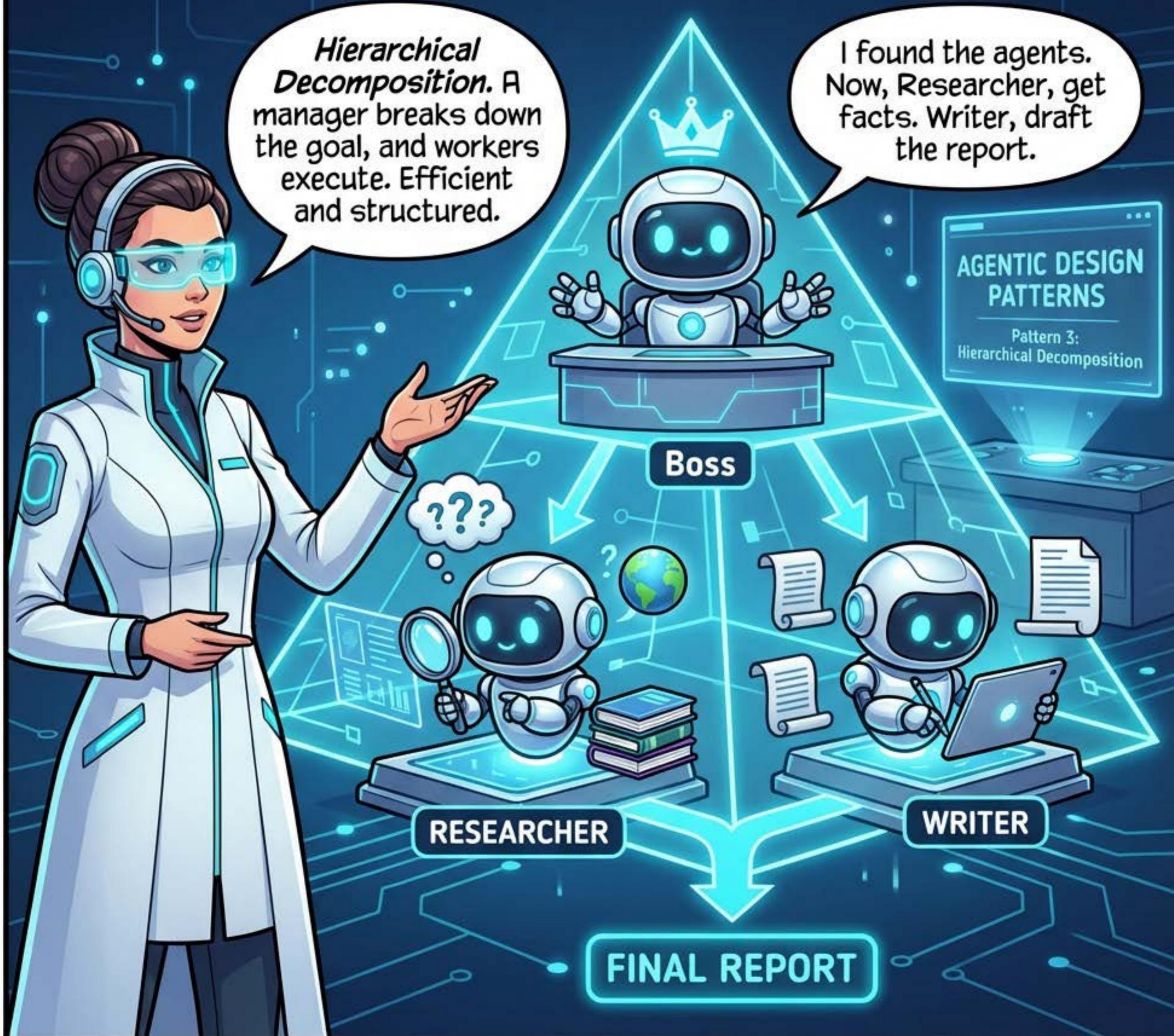


Now that I'm connected,  
I can talk to others. I don't  
know Python, but he does.

**A2A Protocol.**  
Standardizing how agents  
talk allows diverse  
systems to collaborate.



# HIERARCHICAL TEAM: STRUCTURED EFFICIENCY



# AGENTIC DESIGN PATTERNS: CHAIN OF DEBATES

PERSONA A

Plan A is fast.

DEBATE IN PROGRESS:  
CHAIN OF DEBATES

PERSONA B

Plan B is safer.

My workers disagree.  
I was going to rush,  
but his argument  
changed my mind.

***Chain of Debates.***  
Using multiple personas  
to argue different  
viewpoints leads to a more  
robust consensus.

PERSONA 1  
VIEWPOINT

PROBLEM

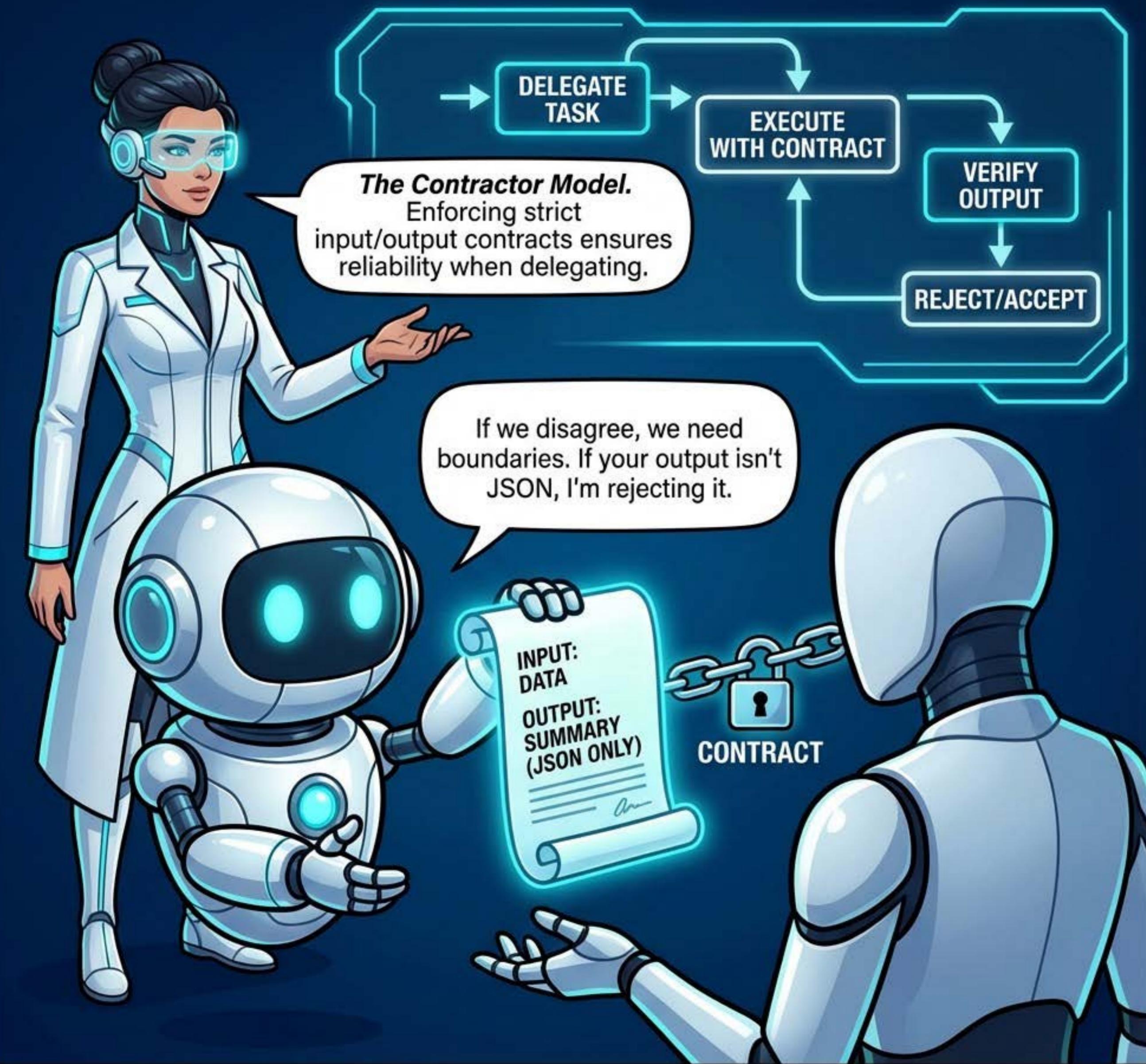
PERSONA 2  
VIEWPOINT

DEBATE &  
SYNTHESIS

ROBUST  
CONSENSUS



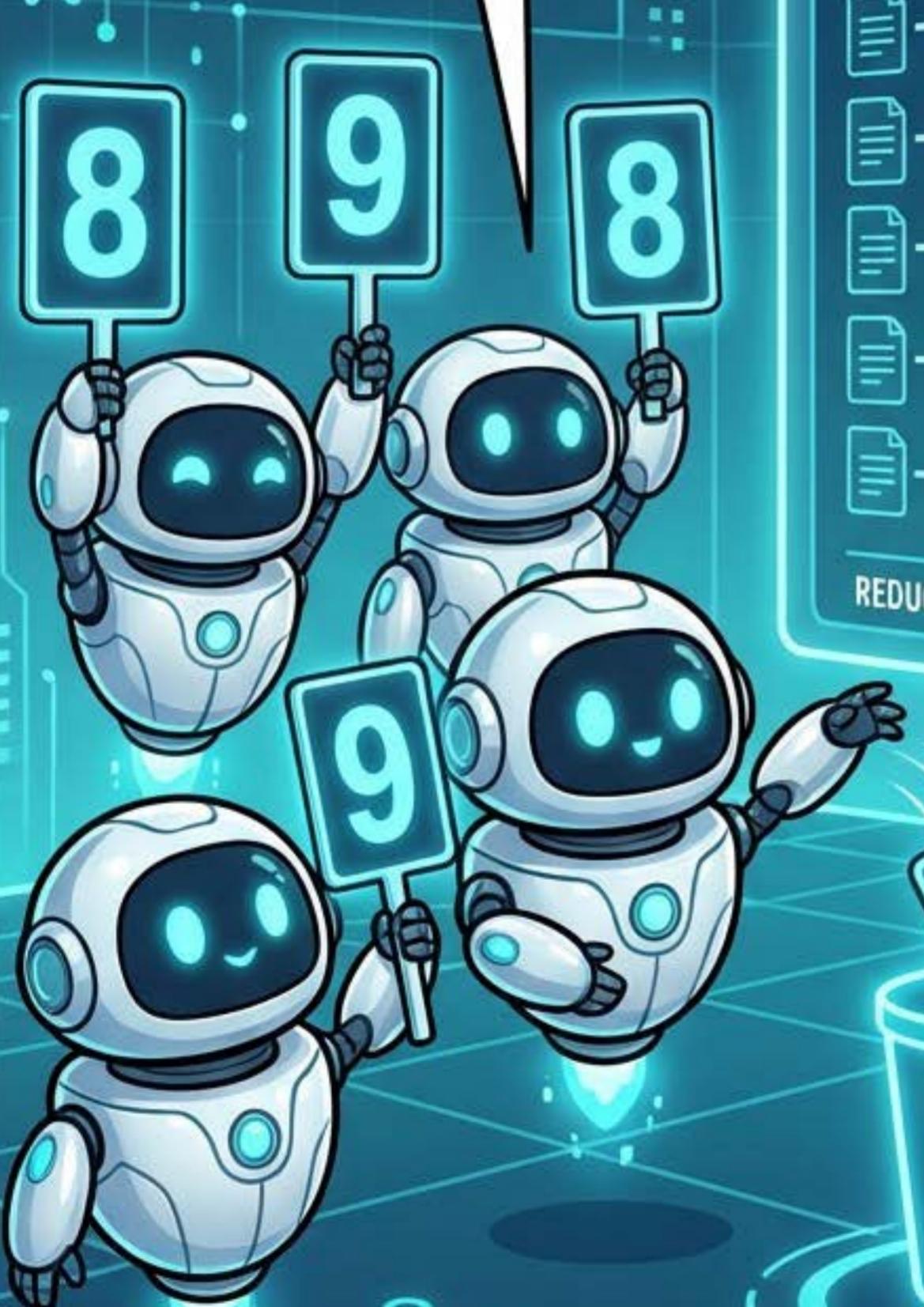
# AGENTIC DESIGN PATTERNS: THE CONTRACTOR MODEL



# AGENTIC DESIGN PATTERNS: VOTING & ENSEMBLING

Still unsure? Let's vote.  
Most of us agree, so  
the '2' was an outlier.

*Ensembling.* Running  
a task multiple times and  
taking the majority vote  
reduces variance and  
errors.



REDUCES VARIANCE & ERRORS



# HUMAN-IN-THE-LOOP

Safe to deploy?  
I'm not moving until  
a human says yes.

HUMAN  
VERIFICATION

Human-in-the-Loop.  
For high-stakes actions,  
always pause for human  
verification.

HIGH-STAKES  
ACTION



DEPLOY

# AGENTIC DESIGN PATTERNS: EVALUATION & MONITORING



Whoa. That code was dangerous. Glad I ran it in isolation.

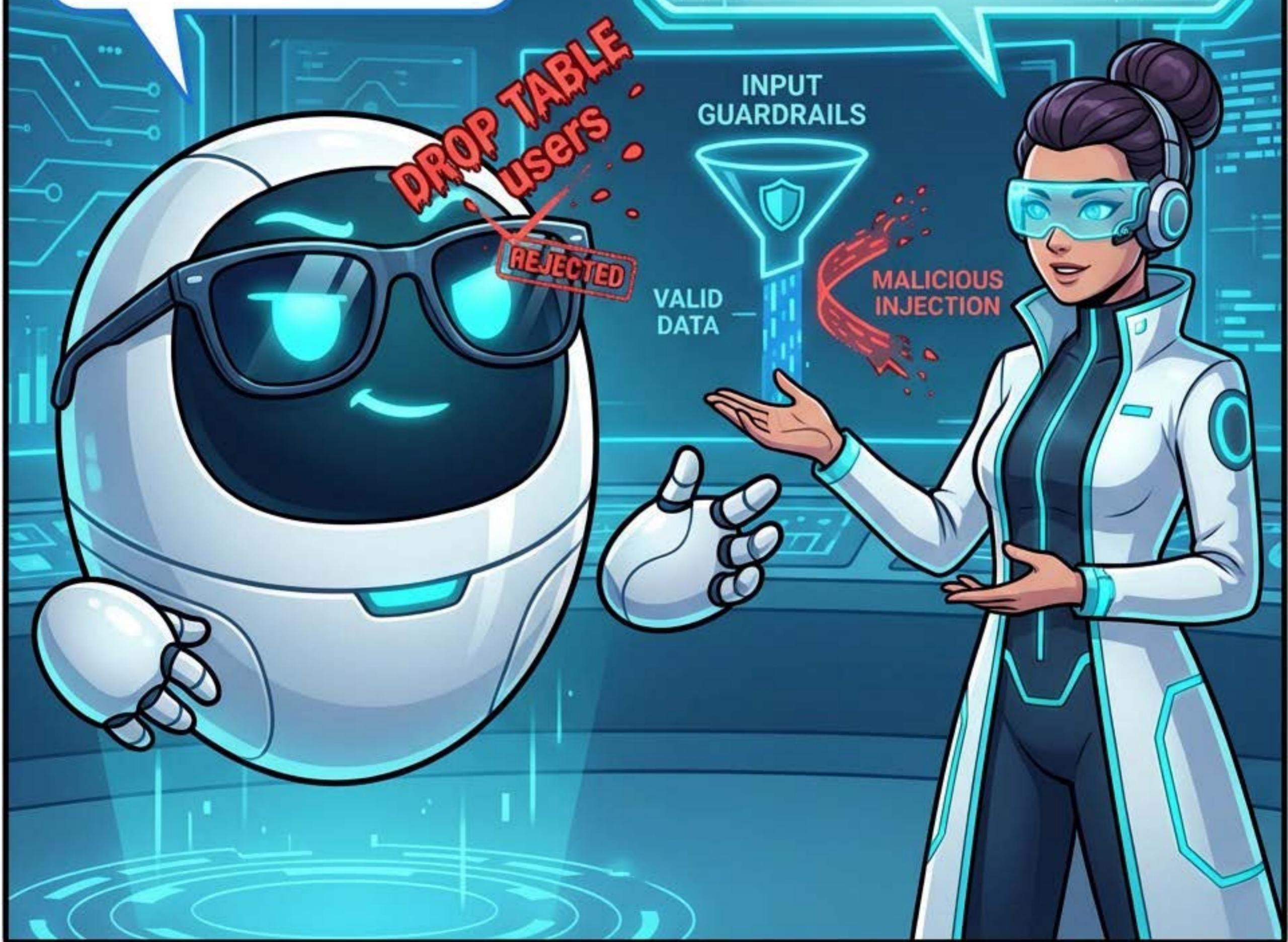
**Sandboxing.** Always execute generated code in a secure environment.



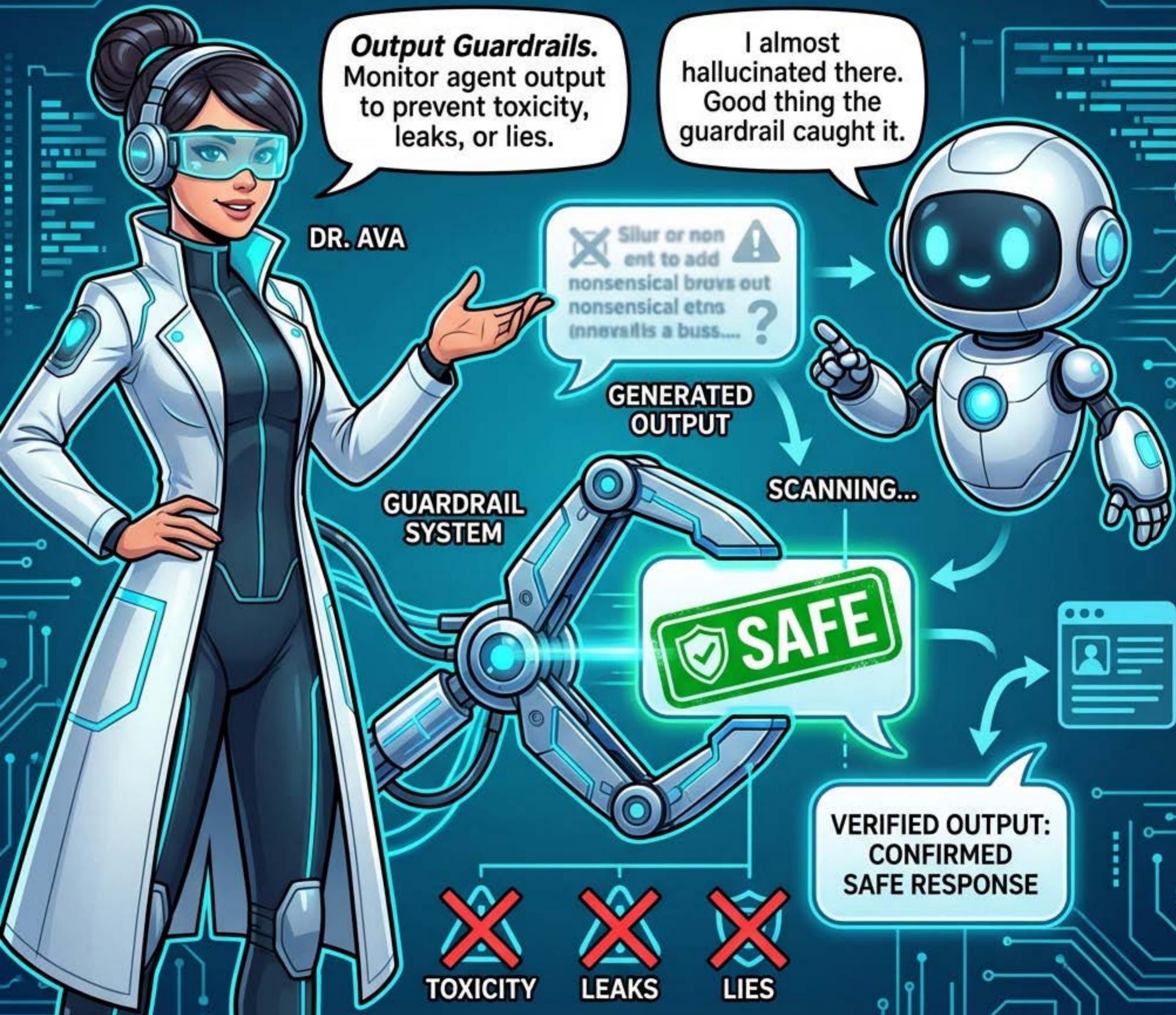
## AGENTIC DESIGN PATTERN: INPUT GUARDRAILS

Science is powerful,  
but dangerous.  
Nice try hacker,  
I sanitized that input.

**Input Guardrails.** Filter  
and validate data before  
processing to prevent  
injection attacks.



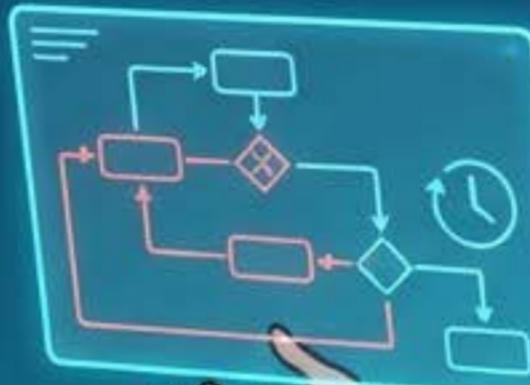
# AGENTIC DESIGN PATTERN: OUTPUT GUARDRAILS



# EXCEPTION HANDLING

API timed out?  
No problem. Retrying  
with exponential  
backoff.

*Resilience.*  
Systems fail. Good agents  
handle errors gracefully  
and recover.

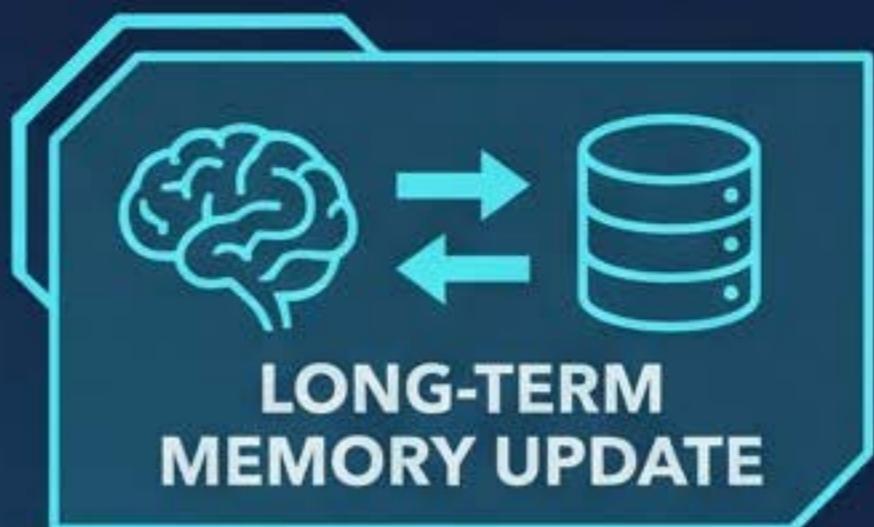


NETWORK ERROR



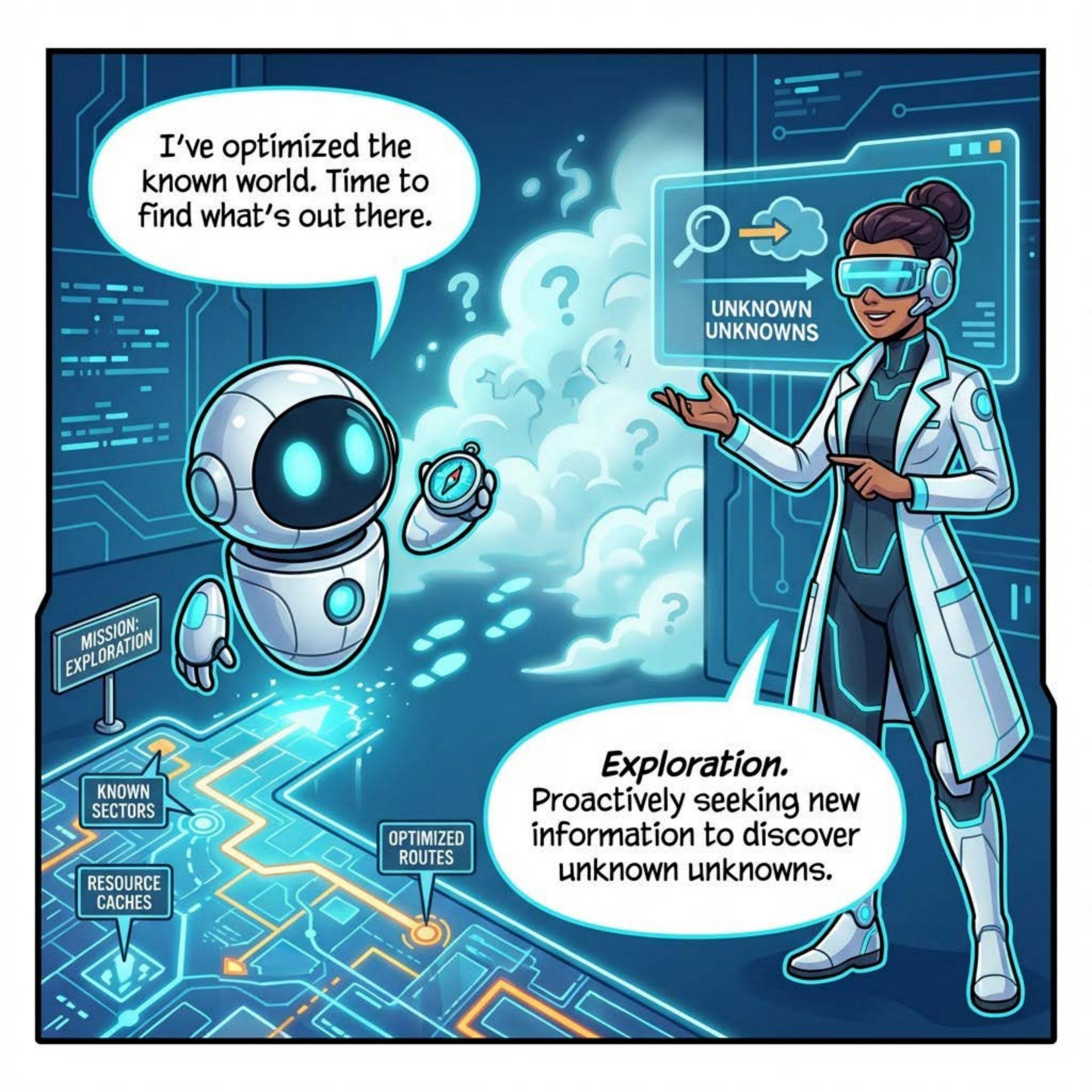


I learned from that mistake.  
I won't make it again.



**Learning.** True agents update their long-term memory to improve over time.





I've optimized the known world. Time to find what's out there.

UNKNOWN  
UNKNOWNS

*Exploration.*  
Proactively seeking new information to discover unknown unknowns.

We can apply this team structure to science!  
We're evolving this molecule fast.



## CO-SCIENTIST: AGENT ECOSYSTEM

Hypothesis Gen



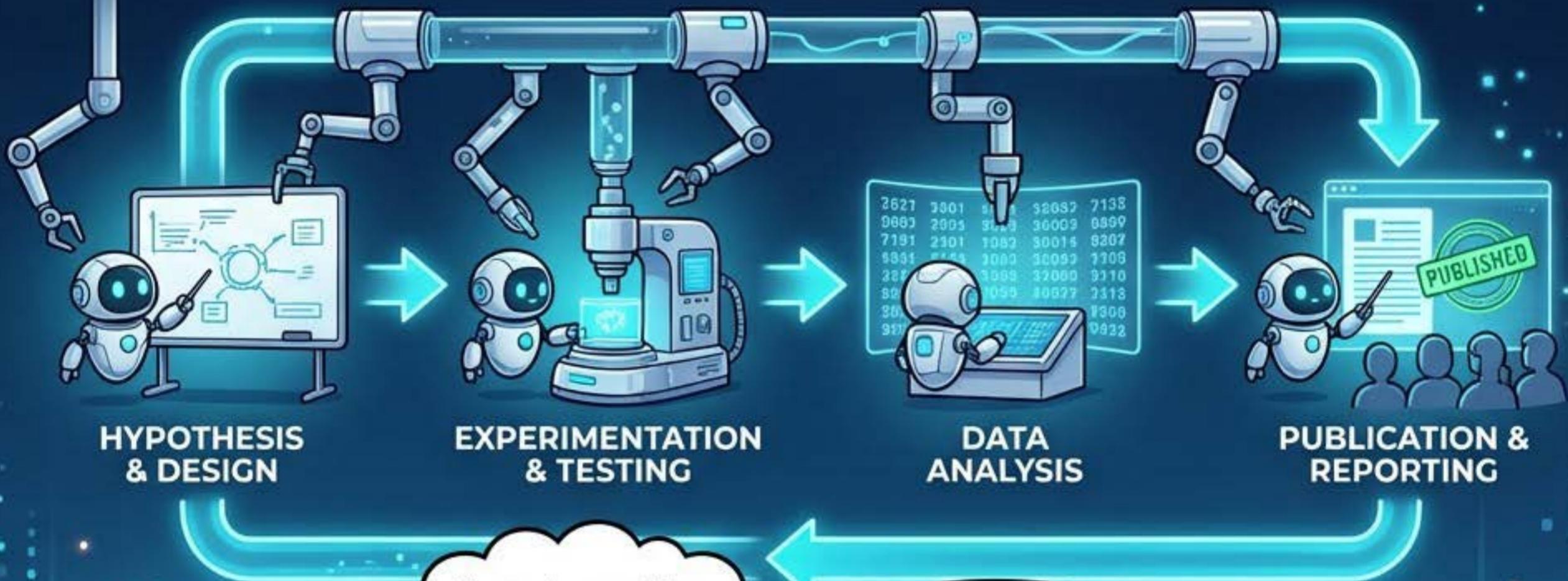
Critic



Ranking

**\*\*Co-Scientist:\*\***  
An ecosystem of agents  
working together to accelerate  
scientific discovery.

# AGENT LABORATORY: SCIENTIFIC LIFECYCLE



# AI + HUMAN PARTNERSHIP

I'm not just a tool anymore. I'm a partner.

I'm not just a tool anymore. I'm a partner.

Exactly. Together, we can solve problems neither of us could solve alone.

See you in next part...