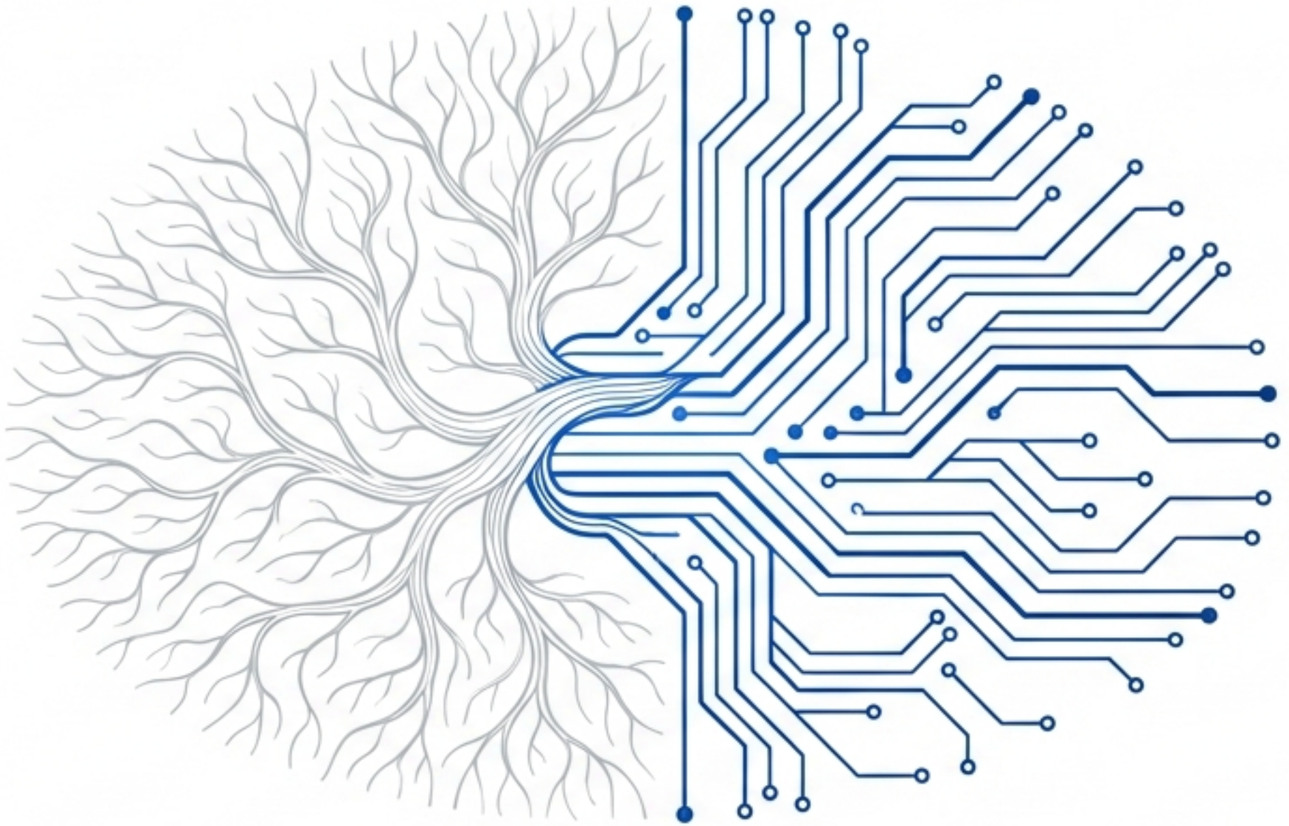
# The Next Step for AI: From Thinking to Knowing

A review of Agent Skills through the lens of Procedural Memory



Based on the survey by Yaxiong Wu & Yongyue Zhang

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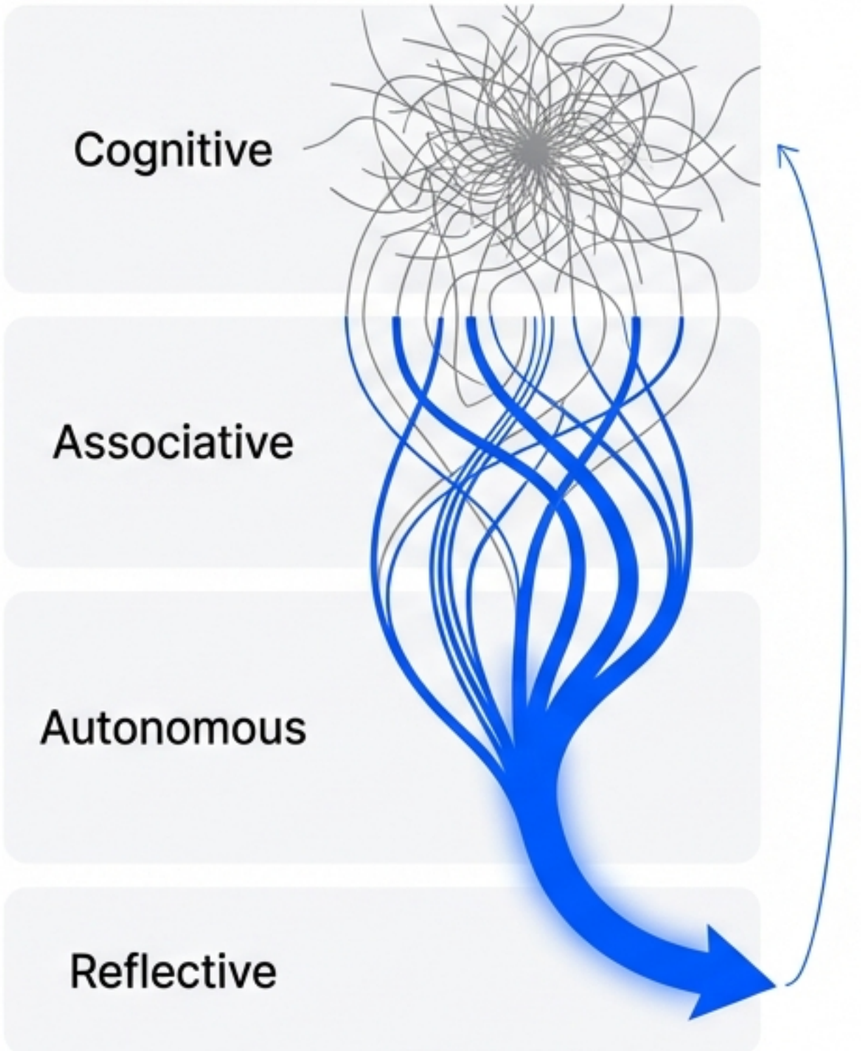
# We don’t re-learn how to ride a bicycle every single time.

Human skill mastery is a journey from **conscious effort to automatic execution**. This is the power of procedural memory—a system that encodes *how* to perform tasks, not just *what* to know. This progression follows distinct stages:




Conscious, rule-based learning requiring full attention.

Practice-driven reinforcement reduces reduces errors and streamlines behaviour.

Execution becomes automatic, flexible, and encoded in procedural memory.

Metacognition supports continual adaptation and improvement.

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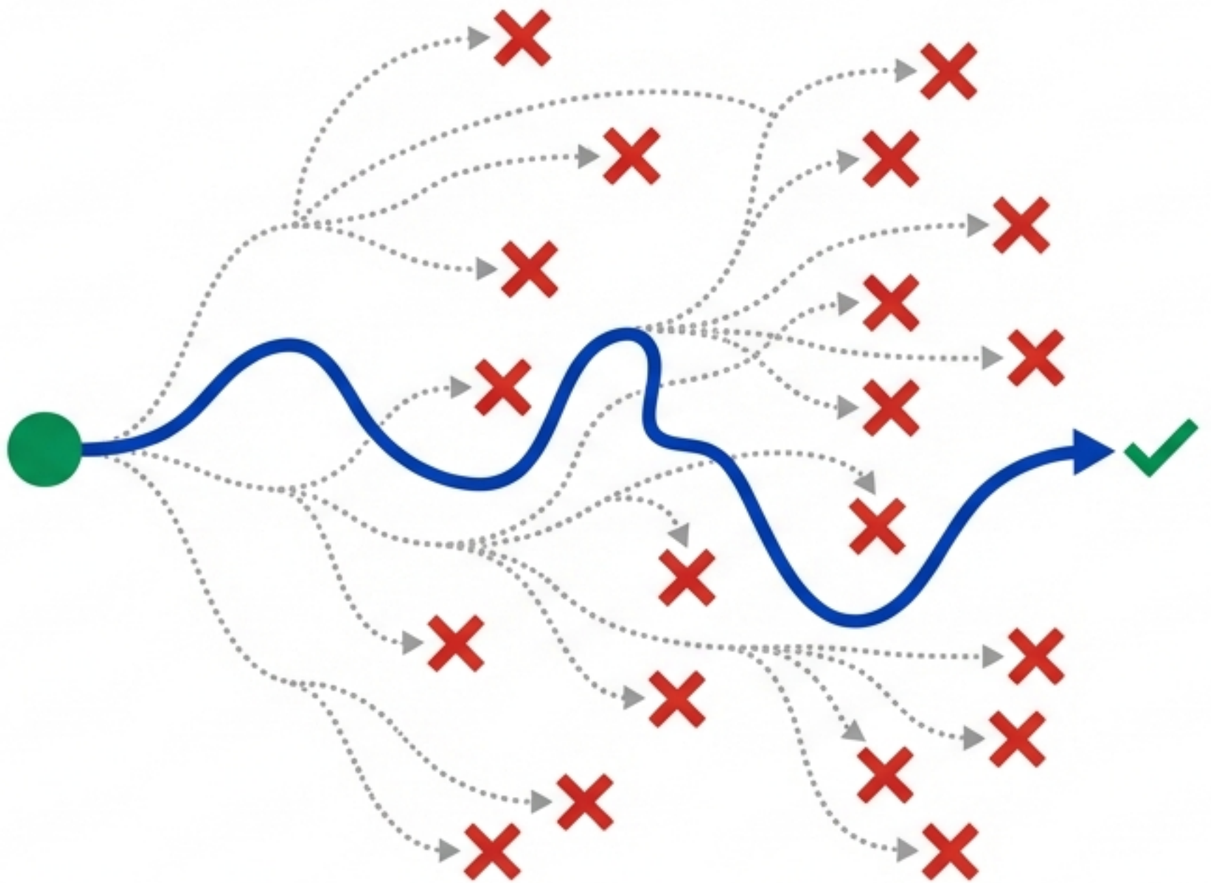
# Today’s LLM agents suffer from a form of amnesia.

Without a mechanism to retain procedures, current agents are limited in long-horizon, complex tasks. They rely heavily on inefficient and fragile “trial-and-error” exploration.

- Decisive error steps from which they cannot recover.
- Low overall success rates.
- Unstable and unpredictable performance.

Essentially, they are forced to re-derive solutions from scratch for every complex task.



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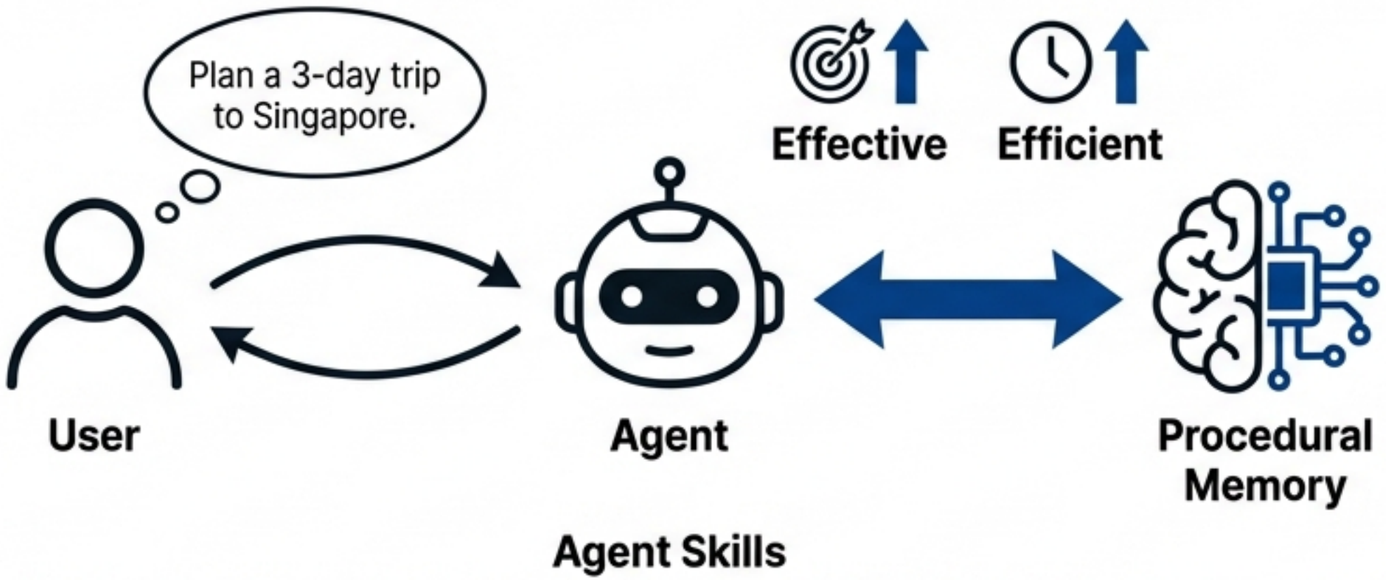
# The solution is a procedural memory for AI.




**Agent Skills**

**Name: PlanMultiDayCityTrip**
**Description:** Reusable procedure for planning a multi-day city trip by jointly optimizing itinerary structure, attractions, transportation, and budget.
**Steps:**

1. **Extract Constraints:** trip duration, preferences, budget.
2. **Select Attractions:** rank POIs by interest, distance, and diversity.
3. **Daily Itinerary Layout:** cluster activities by location and time.
4. **Transportation Planning:** estimate travel time and route between stops.
5. **Budget Allocation:** estimate costs and adjust plan to constraints.

Agent Skills are reusable, structured units of procedural knowledge that encode *how* to perform tasks.

They enable agents to internalise, retain, and reuse task-solving procedures gained from experience.

This mechanism parallels human skills, allowing agents to:

- Bypass repeated trial-and-error reasoning.
- Invoke experience-grounded action templates.
- Transition from one-shot reasoning towards sustained, experience-driven intelligence.

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# The Lifecycle of an Agent Skill: From Experience to Expertise.

Problem-solving with Agent Skills follows a structured lifecycle where procedural knowledge is acquired, stored, used, and improved through feedback.

## 1
### Acquisition

The agent's successful task trajectories and recurring action patterns are consolidated into a reusable skill.

## 2
### Representation

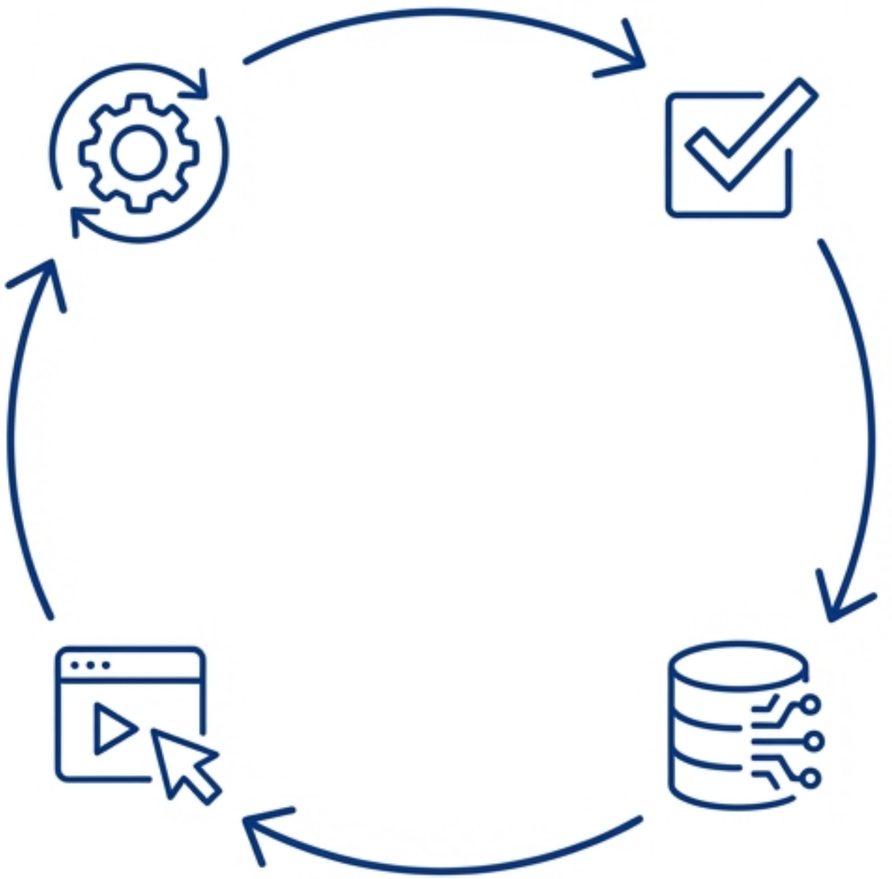
The acquired skill is stored as a modular, discoverable unit of procedural memory.

## 3
### Invocation

When a new task matches a skill's scope, the agent retrieves and executes the encoded procedure, avoiding re-derivation.

## 4
### Refinement

Based on execution outcomes and feedback, the skill is iteratively updated to correct errors and improve efficiency.



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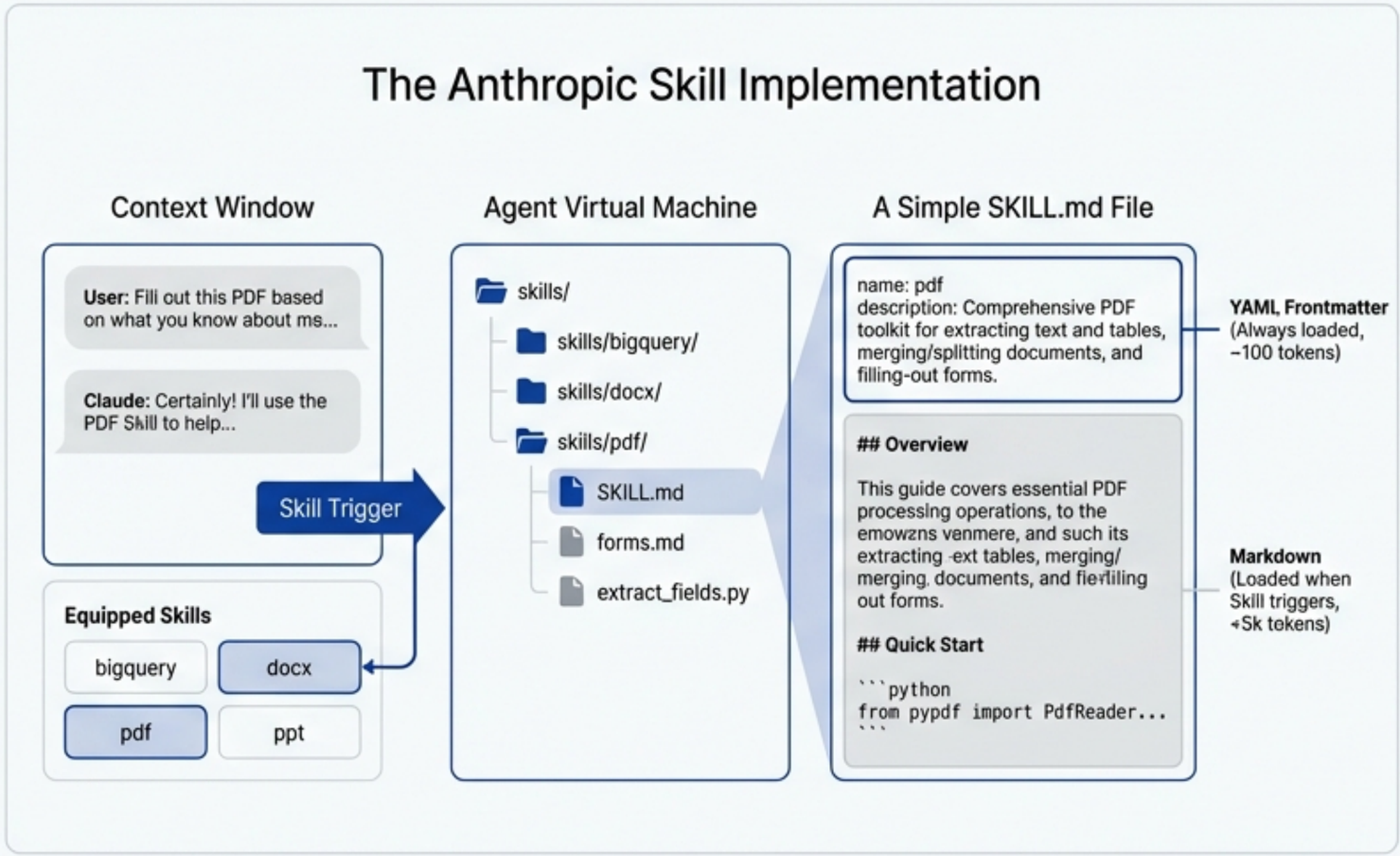
# The anatomy of a skill: The Anthropic implementation.

Anthropic's framework provides a concrete, lightweight implementation using a filesystem-based abstraction.

- **Skill Organisation:** A skill is a self-contained folder centred around a `SKILL.md` file. This file contains YAML frontmatter for metadata (name, description) and Markdown for procedural instructions. The folder can also include executable scripts and other resources.
- **Progressive Disclosure:** To manage context efficiently, the agent initially loads only the lightweight skill metadata. The full instructions inside `SKILL.md` and any associated files are loaded only when the skill is triggered by a matching task.
- **Runtime Invocation:** A compatible agent discovers skills, matches tasks to them based on metadata, and then activates them by loading instructions or executing bundled code.

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# The four pillars of value for skill-based agents.

Agent Skills provide a principled mechanism for encapsulating and reusing procedural knowledge, addressing key challenges in agent development.

## Reliability

Externalising procedures into consistent skills reduces reliance on fragile prompting and improves stability of long-horizon behaviour.

## Efficiency

Replacing repeated, ad-hoc reasoning with direct invocation of defined procedures reduces computation and lowers development costs.

## Scalability

Skills become portable, auditable units of organisational knowledge, ensuring consistent and interoperable behaviour across users, platforms, and agents.

## Self-Evolution

Skills provide a concrete substrate for agent improvement. Through reflection and refinement, they function as an operational memory that supports continual learning.

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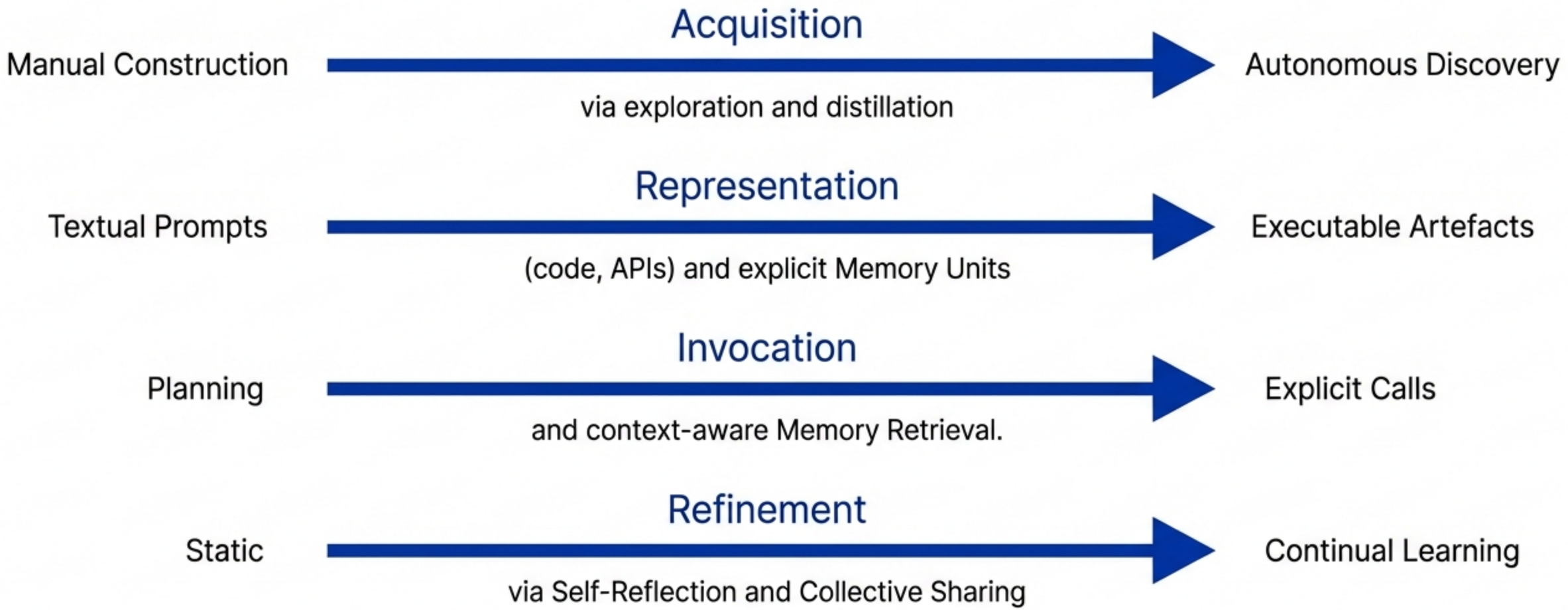
# The skill ecosystem is evolving towards autonomy and dynamism.

Across the research landscape, a clear evolutionary path is emerging for how Agent Skills are implemented. The field is progressing from manually engineered, static artefacts towards experience-driven, continually evolving systems.

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# Key design choices across the skill lifecycle.

Implementing a skill-based agent involves specific design choices across the four core dimensions.

## Acquisition Methods

From Demonstrations *(SkillAct)*

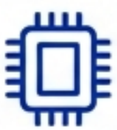
From Exploration & Task Proposal *(ASD, PAE)*

From Experience Distillation *(TAIRA, ReMe)*

## Representation Formats

Textual Prompts *(SkillAct)*

Executable Artefacts (Programs, APIs) *(ASI, SkillWeaver)*



Procedural Memory Units *(Memp, CER)*

## Invocation Mechanisms

Integrated into Planning *(SkillAct, ASD)*

Explicit Calls (APIs (APIs, tools) *(ASI, Anthropic Agent Skills)*

Memory Retrieval *(CER, ReMe)*

## Refinement Strategies

Reflection & Self-Correction *(CASCADE, ReMe)*

Continual Learning *(SAGE, Memp)*

Collective & Shared Learning *(LEGOMem, SkillWeaver)*

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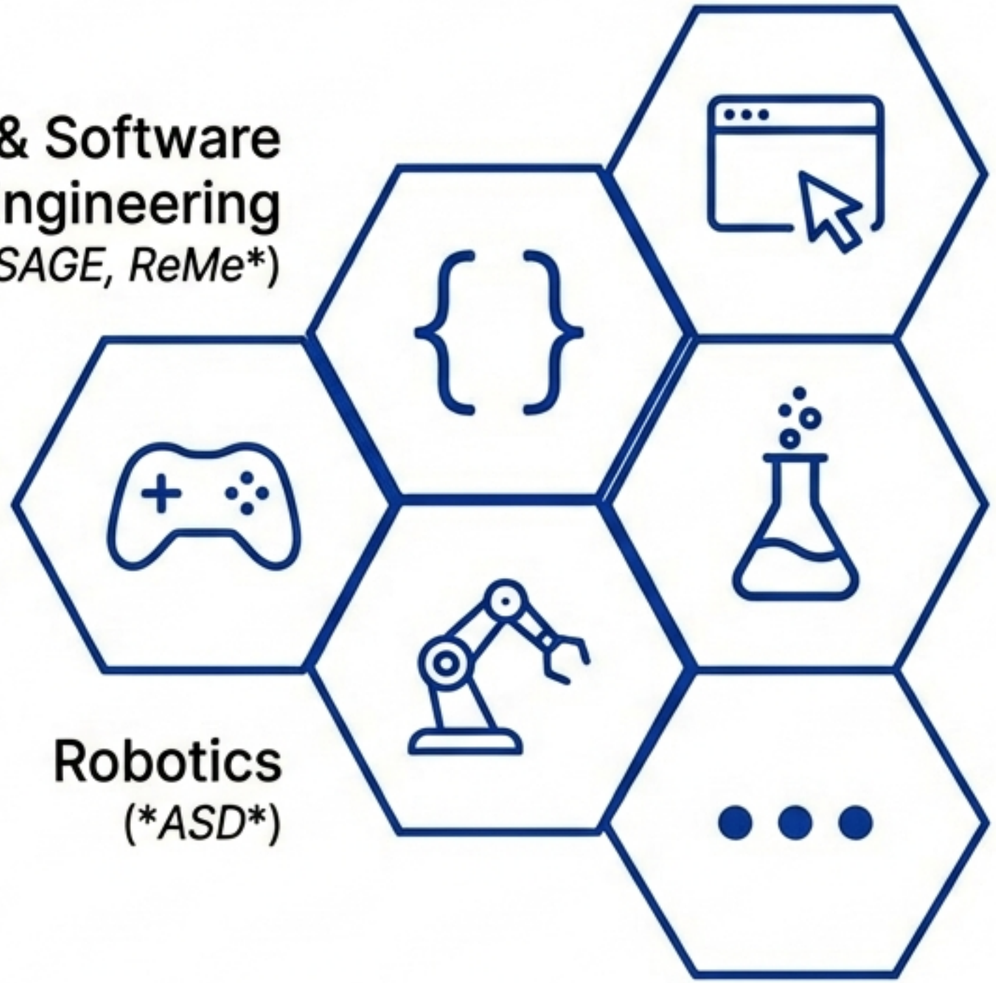
# Where Agent Skills are making an impact.

Agent Skills are effective in domains with recurring procedures, long-horizon tasks, and potential for experience reuse. Key applications include:



**Coding & Software Engineering**
(*SAGE, ReMe**)

**Web Navigation & Interaction**
(*PolySkill, ASI**)

**Gaming**
(**Voyager, Bottom-Up Agent**)

**Scientific Research**
(*CASCADE**)

**Robotics**
(**ASD**)

**Other Domains**
(Household tasks, RecSys, Office Automation)

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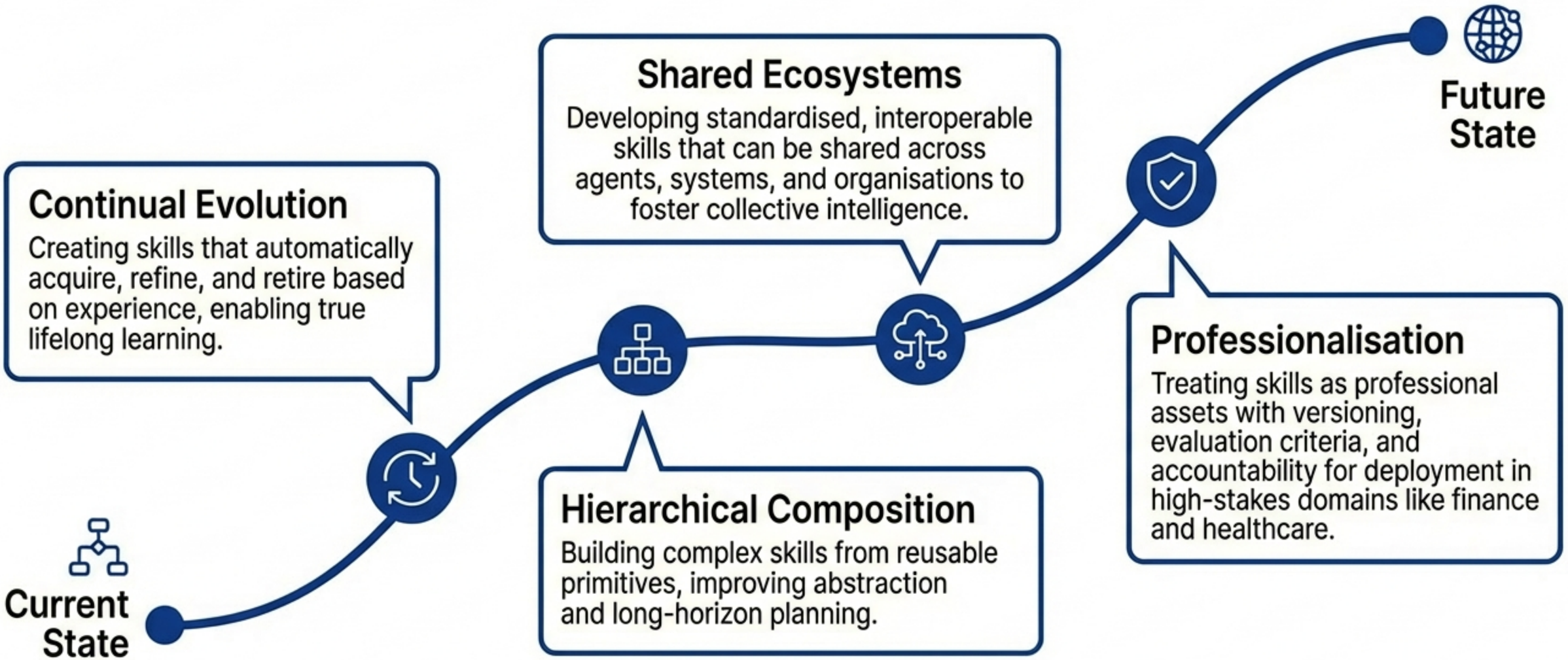
# The roadmap from ad-hoc artefacts to a mature foundation.

To realise their full potential, Agent Skills must evolve beyond isolated implementations. The future path involves addressing four key challenges:

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# Agent Skills are the bridge from one-shot reasoning to experience-driven intelligence.

Viewing skills as a form of procedural memory provides a principled foundation for building the next generation of autonomous systems. This approach is central to moving agents beyond isolated problem-solving and toward reliable, scalable, and self-improving intelligence.

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# Resources & Further Reading.

## Original Survey Paper

“Agent Skills from the Perspective of Procedural Memory: A Survey”
- Y. Wu, Y. Zhang.

## Key Implementations & Repositories

**Anthropic Agent Skills:**
github.com/anthropics/skills

**OpenAI Skills:**
github.com/openai/skills

**Hugging Face Skills:**
github.com/huggingface/skills

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