2025.4.27 Yokohama

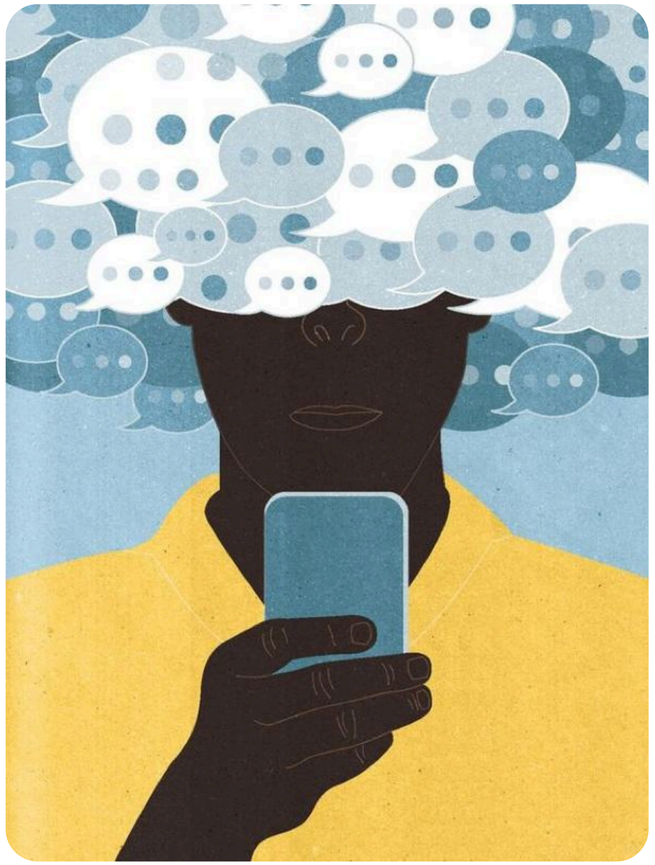
Brain Cache:
Generative AI as a Cognitive Exoskeleton for Externalizing, Structuring, and Activating Knowledge

Long Ling, Intelligent Big Data Visualization Lab, Tongji University, China

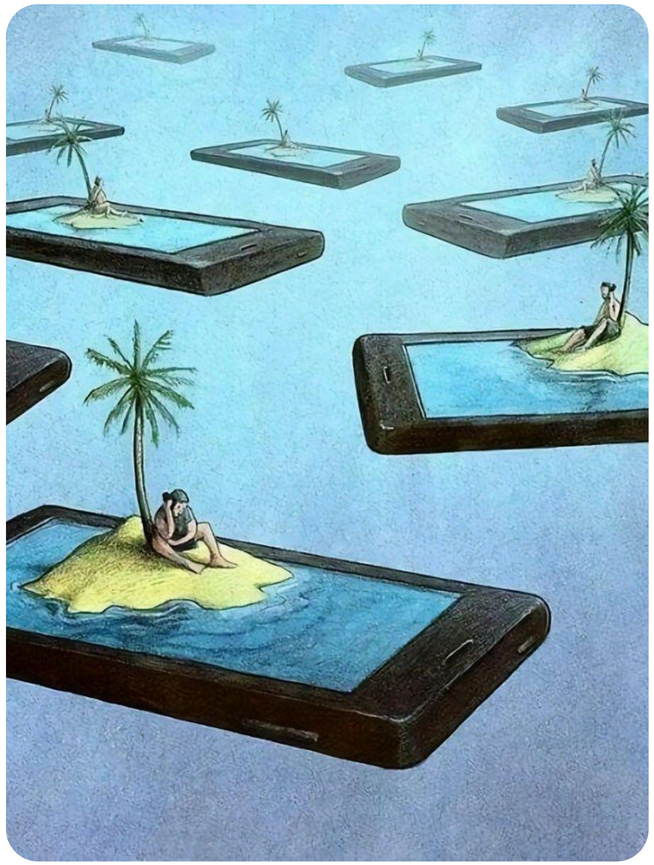
CHI 2025
April 26–May 1, 2025 in Yokohama, Japan

Background

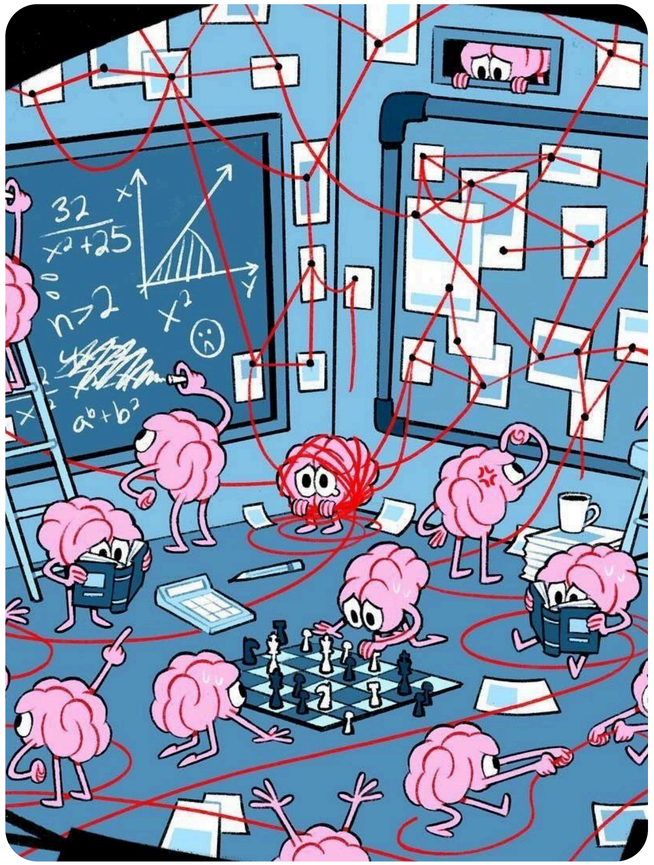
What’s the main problems?



Memory system overwhelmed by large data



Different platforms split up knowledge and thinking



Saved content is hard to find again

Background

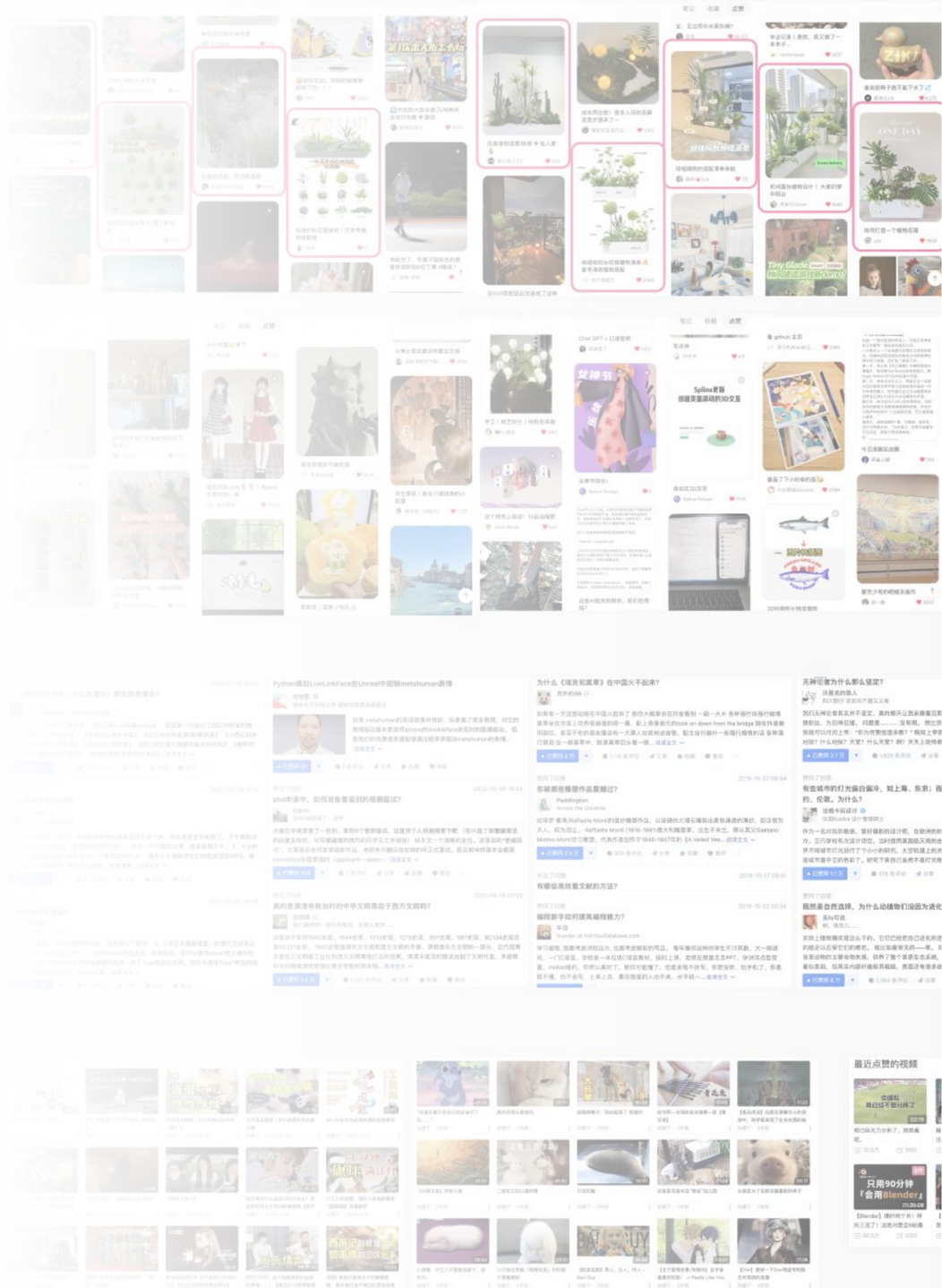
What’s the main problems?

We encounter too much fragmented information

The useful parts are scattered across different platforms

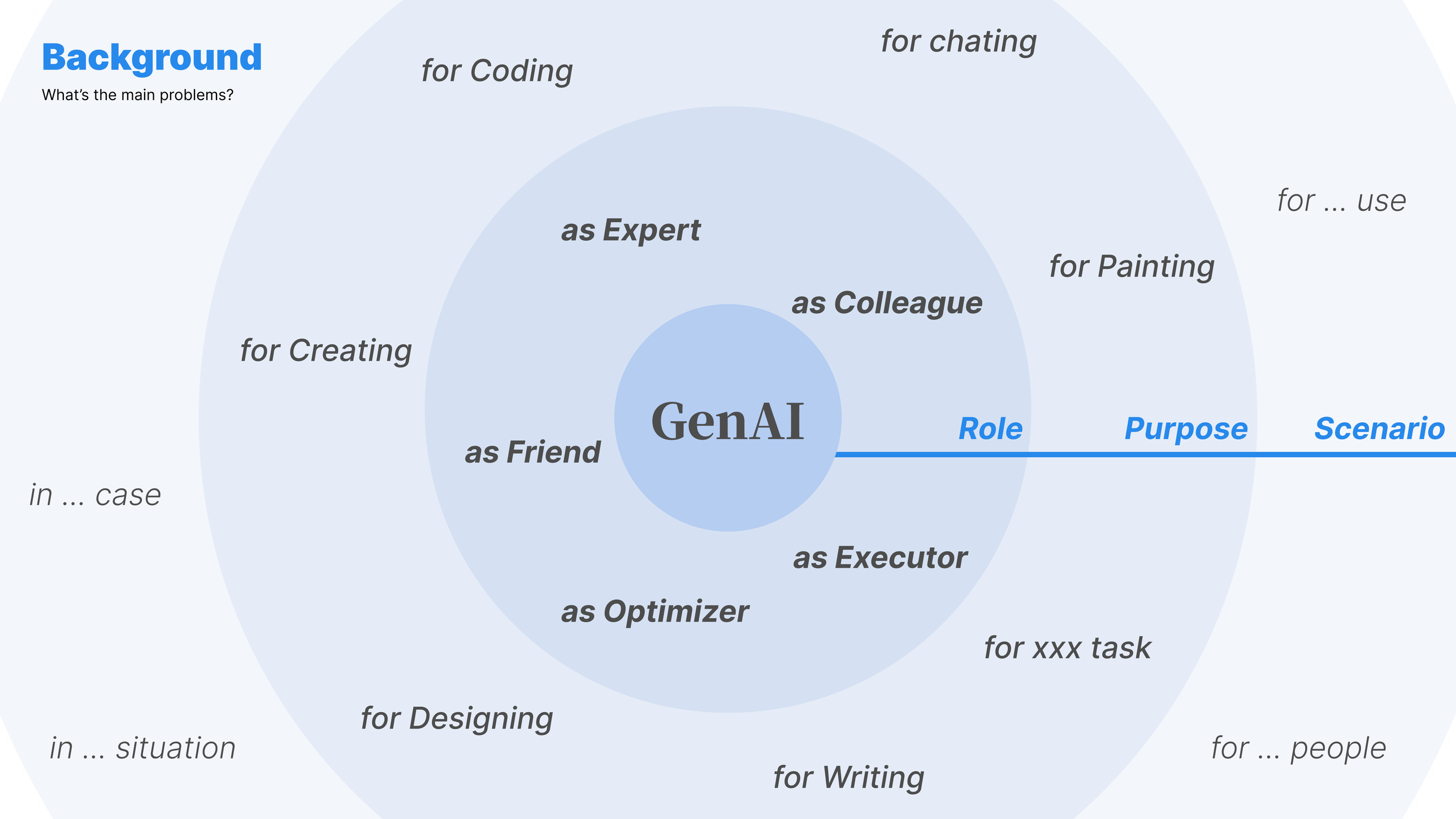
We save them somewhere, but it's hard to find them again.

> “Cognitive poverty in the age of information abundance”



Background

What's the main problems?



Background

What’s the main problems?

GenAI

as
Cognitive
Exoskeleton

Role

for externalizing,
structuring, and
activating knowledge

Purpose

in
cognitive
augmentation scenario

Scenario

?

Brain Cache

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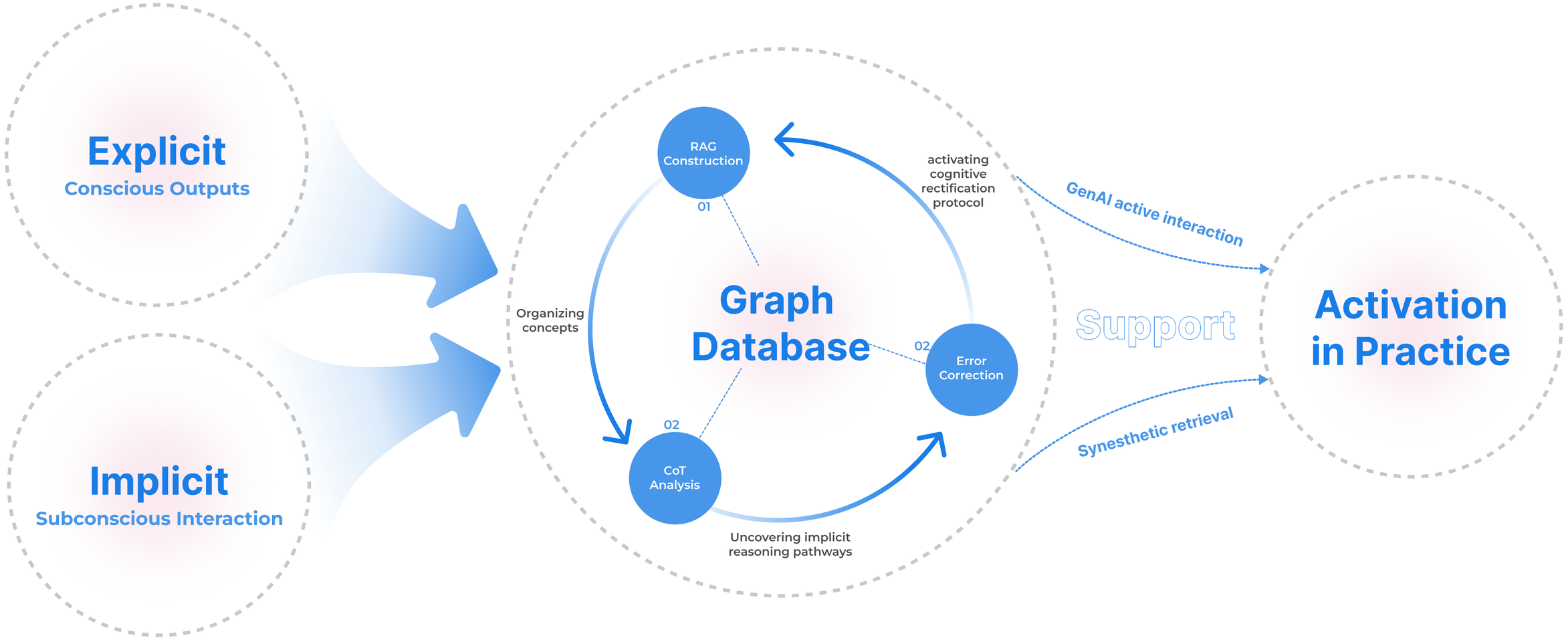
Brain Cache

A Cognitive Augmentation Framework



Externalization

Structuring

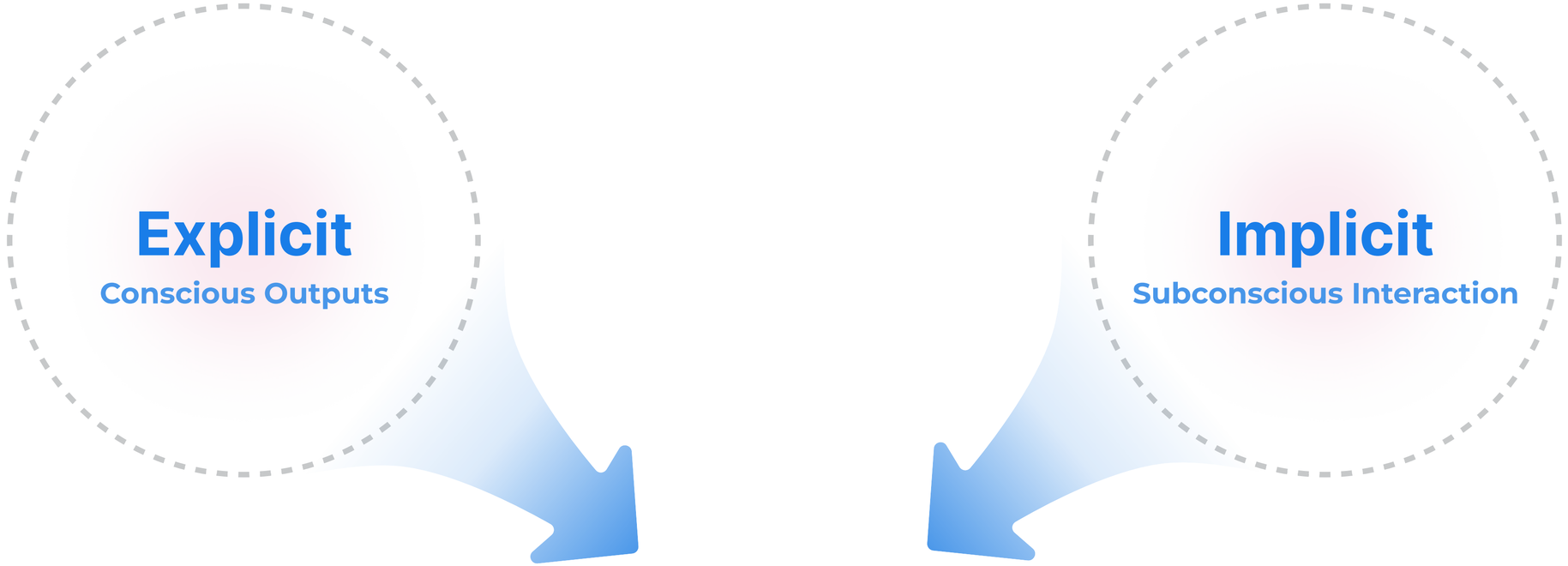
Activation

Externalization: Vectorized Memory Scaffolds

Transform the traces of thinking into external storage

Such as research notes, annotated diagrams, and lecture recordings with detailed contextual metadata

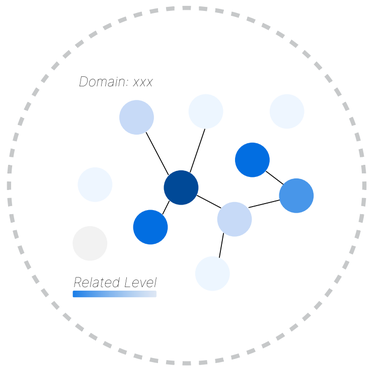
Such as interaction records, eye-tracking heatmaps, and EEG patterns



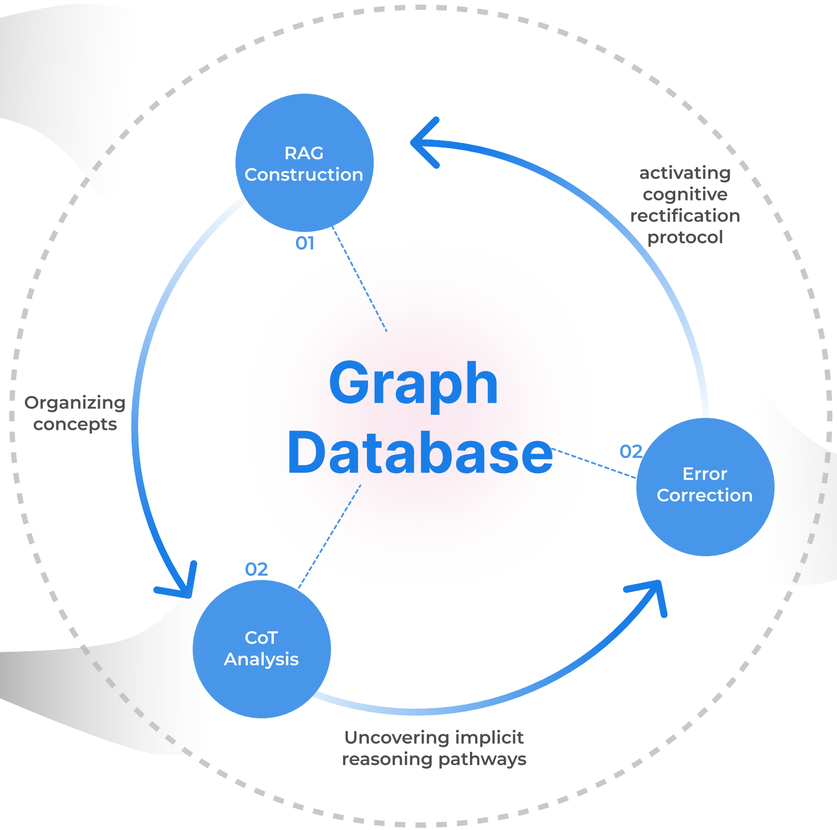
Merging both channels, the system creates a vector space that preserves the continuity of thought

Structuring: Iterative Cognitive Graphs

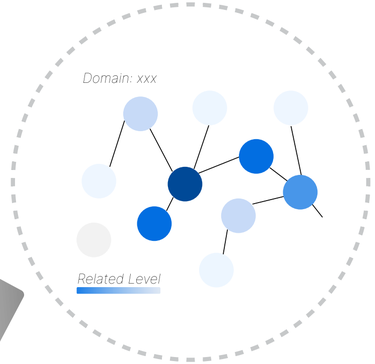
Organize the fragments into a cognitive map



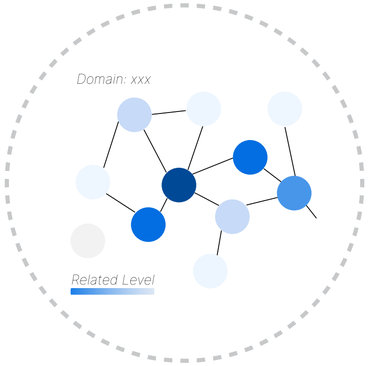
Construct the raw database by Retrieval-Augmented Generation(RAG)



Error detection and bias correction



Extract the implicit reasoning path through Chain Thinking (CoT)



Dynamically evolving cognitive network: The originally chaotic nodes are organized into a causal chain

Activation: Associative Priming Engine

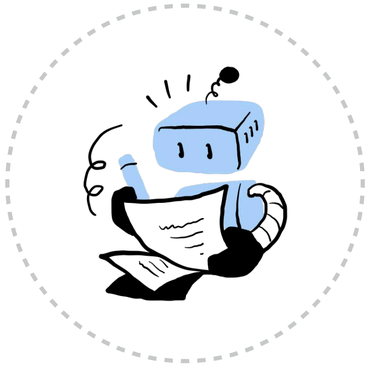
Organize the fragments into a cognitive map

GenAI active interaction

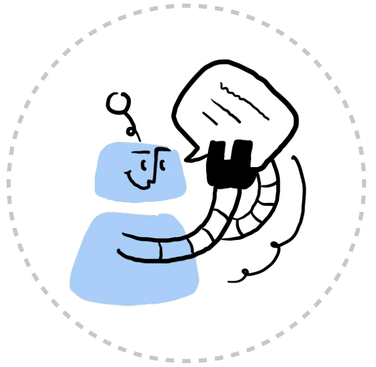
Support

Synesthetic retrieval

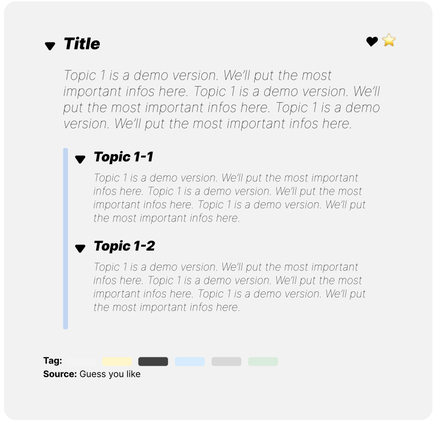
Activation in Practice

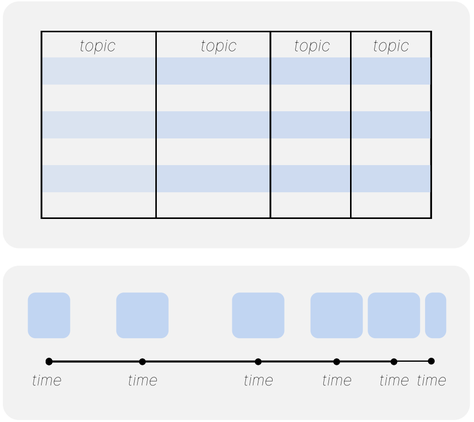


Predict useful knowledge



Provide information proactively



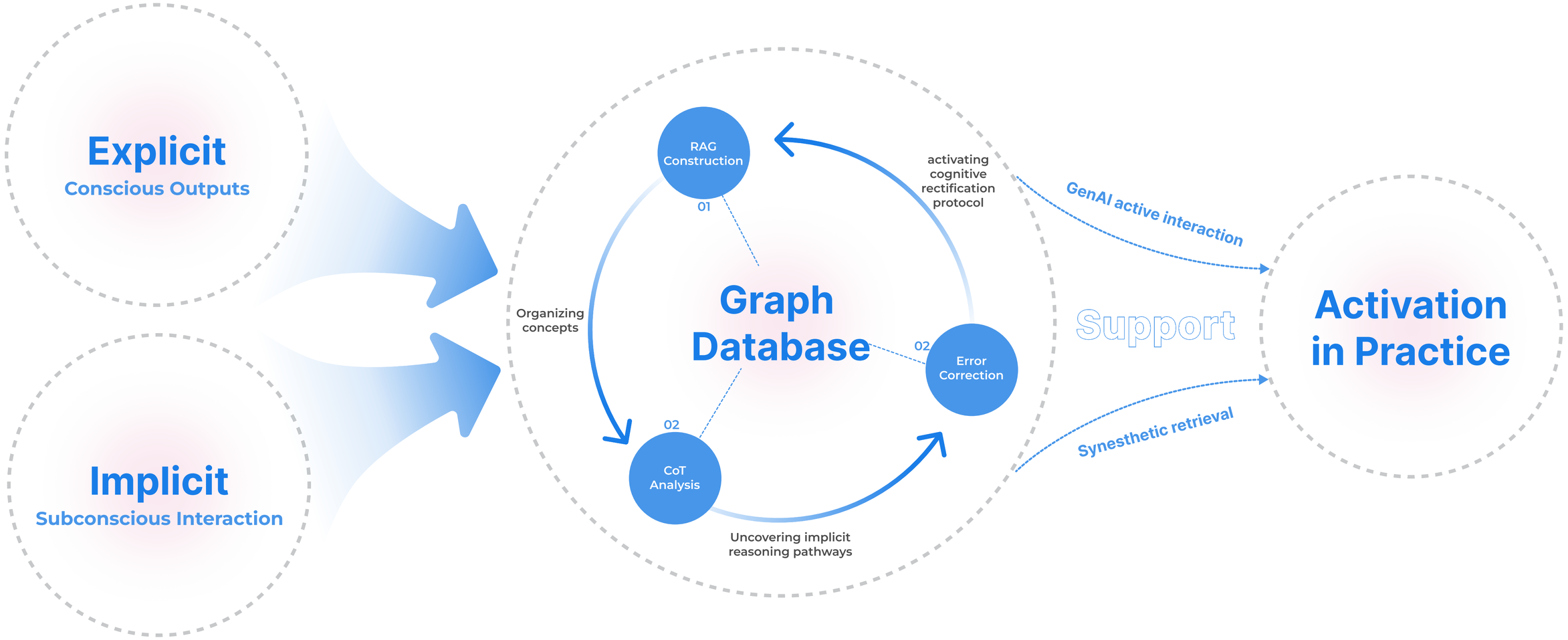


Push content based on users' unique cognitive styles

Making the structured knowledge actionable and relevant in practice

Brain Cache

A Cognitive Augmentation Framework



Externalization

Structuring

Activation

Challenges and Reflections

Excessive reliance on external systems?

Is capturing implicit thinking legal and reasonable?

To whom does the externally generated knowledge belong?

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Thanks for Watching

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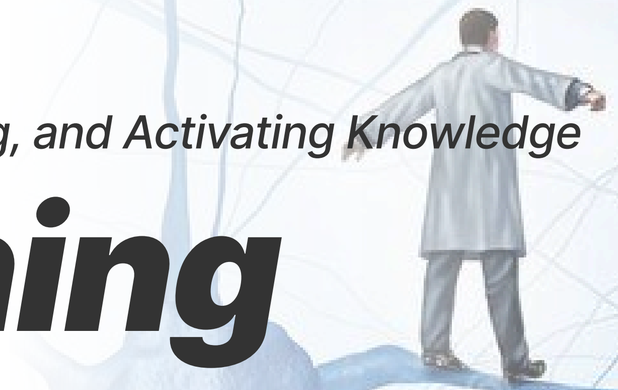

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