

CAUCE 2025

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Knowledge Knows No Boundaries



CAUCE

Canadian Association for
University Continuing Education



Navigating the Complexities of Knowledge, Skills, & Competence

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University of Manitoba – Extended Education

2025 CAUCE President



Background

GLOBAL WORKING GROUP: Large Language Models & Qualifications



PROJECT 1

- THE WHAT - Unpacking Semantic of knowledge, skills and competencies
- Collaboration with University College London & Open University

PROJECT 2

- THE WHAT - Use AI to translate and standardize National Qualifications Frameworks level descriptors
- THE HOW – convert text to machine language and use auto-correlative semantic analysis to automate process
- Collaboration with MIT (Comp Sci AI Lab)

Background

Widening Participation and Lifelong Learning
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On the Decoding of Skills and Competency in the Age of Atomized Education

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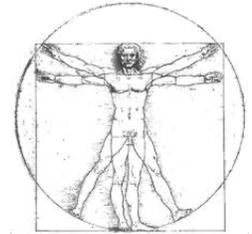
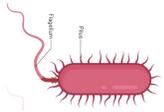
This paper critically examines the evolving landscape of knowledge, skills, and competence within university continuing education units, with a focus on the increasing atomization of lifelong education into micro-credentials and other short-cycle learning models. While these trends respond to workforce demands for skills-first employment, particularly in unregulated fields, they also raise concerns about the authenticity and coherence of educational outcomes. Drawing on insights from cognitive science, the paper explores the dynamic processes of learning, emphasizing the role of mental models (schemas and world models) in integrating and applying knowledge in novel contexts. The discussion highlights the challenges posed by semantic drift and inconsistent definitions of key educational terms, which complicate the alignment of educational outcomes with labour market needs. Furthermore, it critiques the limitations of micro-credentials in fostering the broader, adaptive competencies required to navigate complexity and uncertainty. The paper argues for a holistic and integrative approach to lifelong learning, emphasizing the social dimensions of education, clear definitions of skills and competencies, and authentic assessment practices. Ultimately, it advocates for reimagining educational frameworks to align with the biological and social realities of learning, ensuring that lifelong education achieves its transformative potential in an era defined by rapid technological and economic change.

The Science Of *Non-Artificial* Intelligence

Understanding how and why we learning

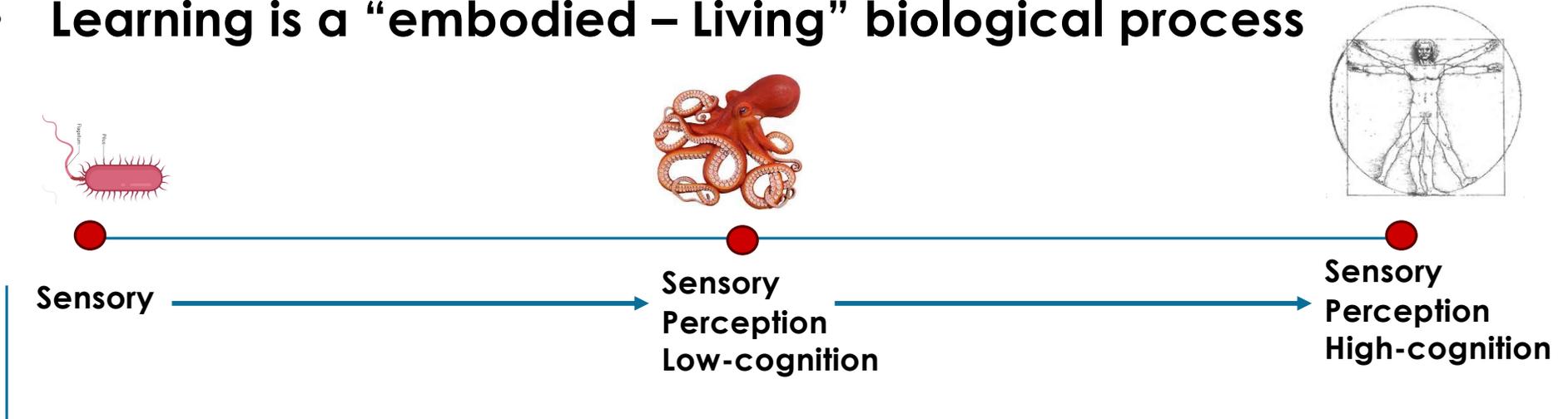
Understanding how and why we learning

- **Learning is a “embodied – Living” biological process**



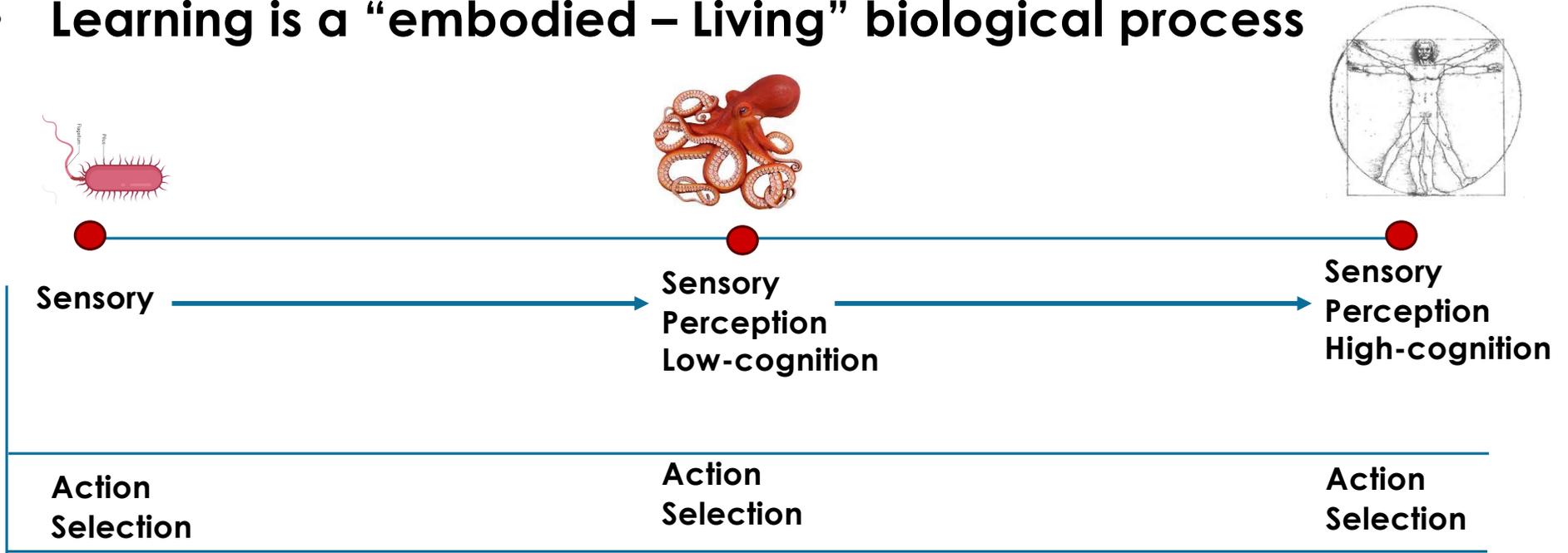
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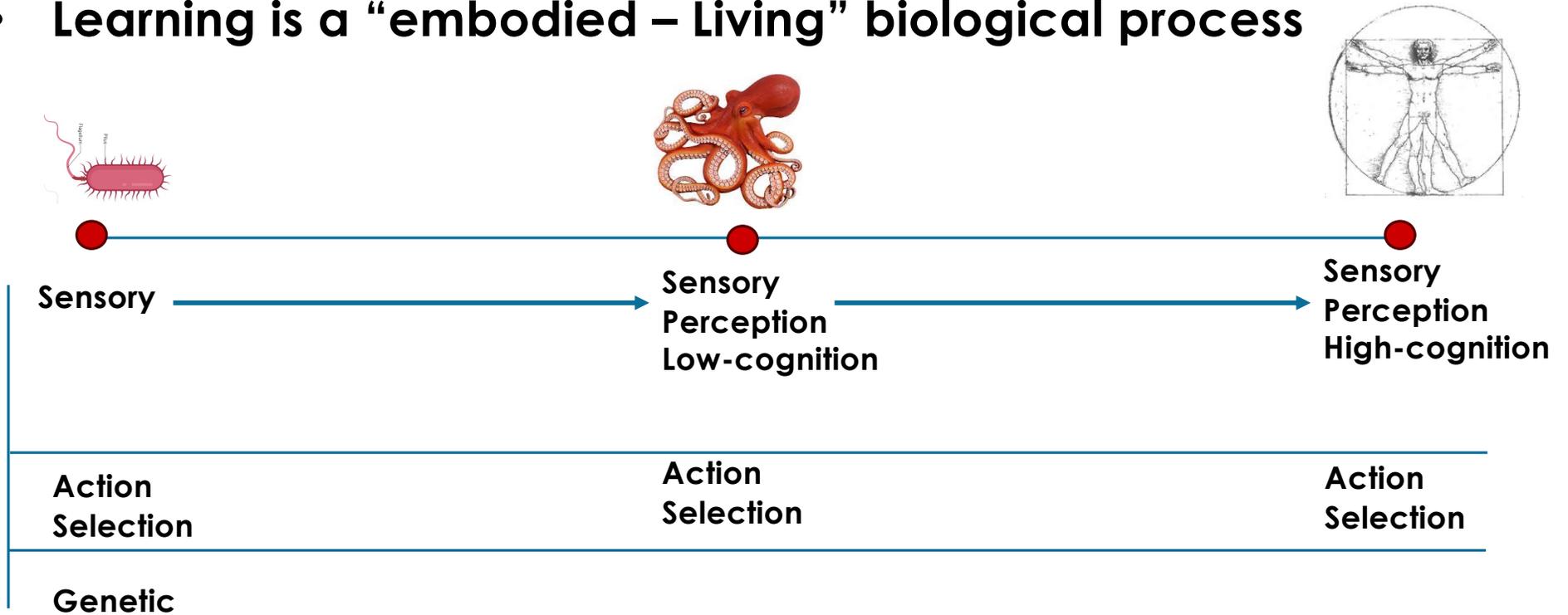
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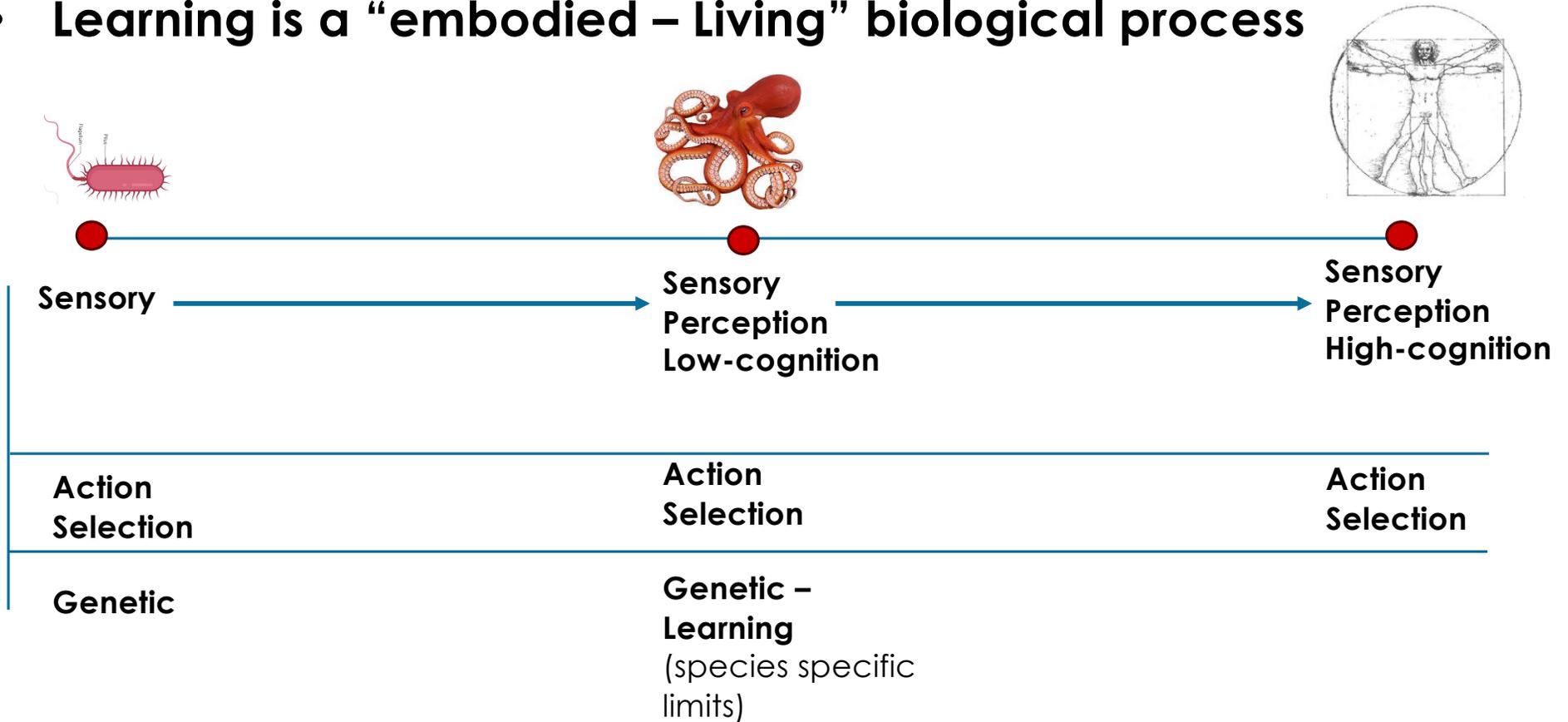
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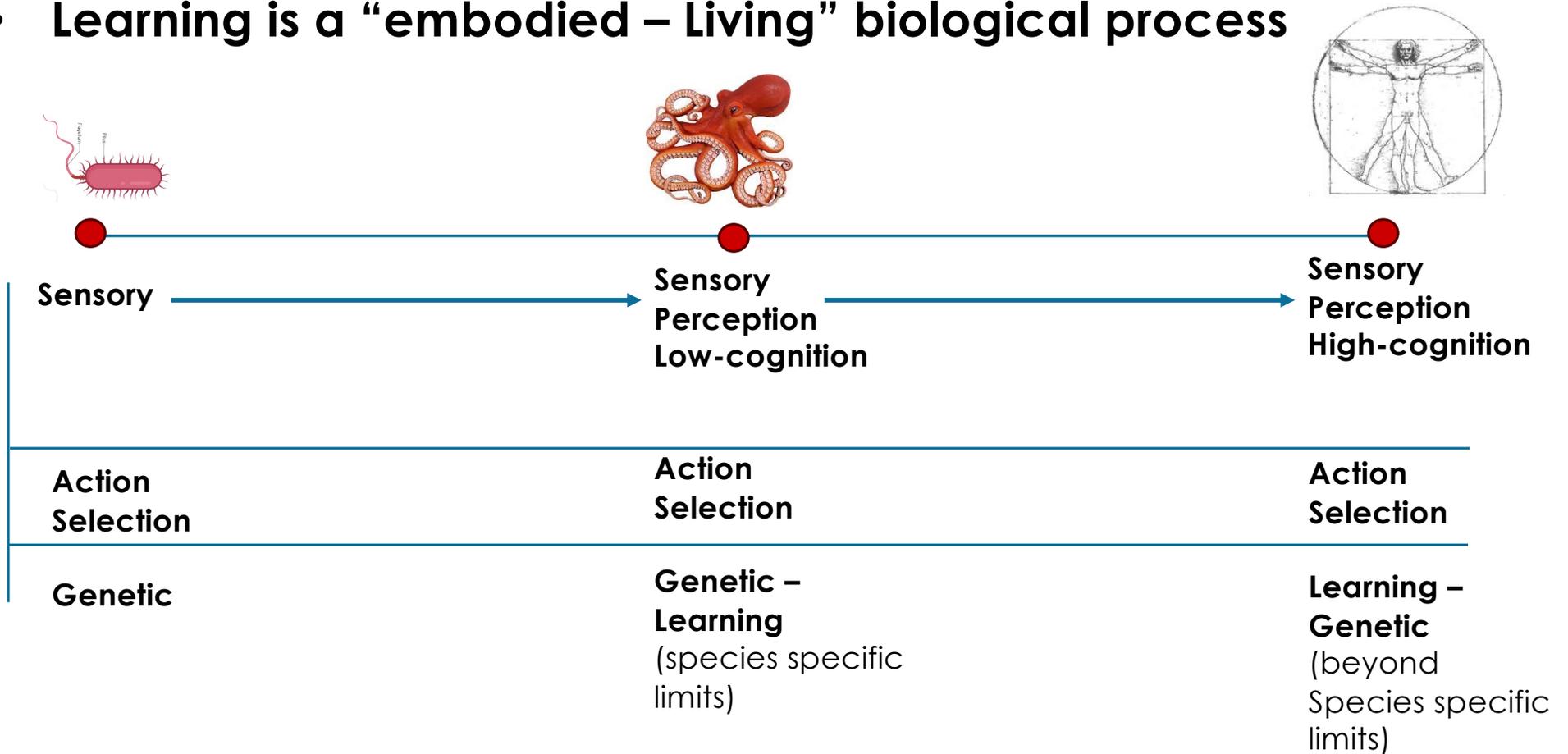
Understanding how and why we learning

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Understanding how and why we learning

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Understanding how and why we learning

- **Educable:** Humans (as far as we know) possess a uniquely **advanced capacity for learning** — enabling the acquisition of new knowledge and behaviours well beyond what is inherited through evolutionary processes encoded in our DNA.
- **Capacity for open-ended, Lifelong Learning;** perception → sensory processing → higher-order cognitive functions such as reasoning, problem-solving, abstraction, and symbolic communication.
- This makes human learning culturally and socially mediated, dynamic, and transformative in ways not observed in other species.

Understanding how and why we learning

- **What is sensation and perception?**

Understanding how and why we learning

- **Cartesian Theater** (Daniel Dennett 1991 – critique related to the homunculus & René Descartes's philosophy of dualism)

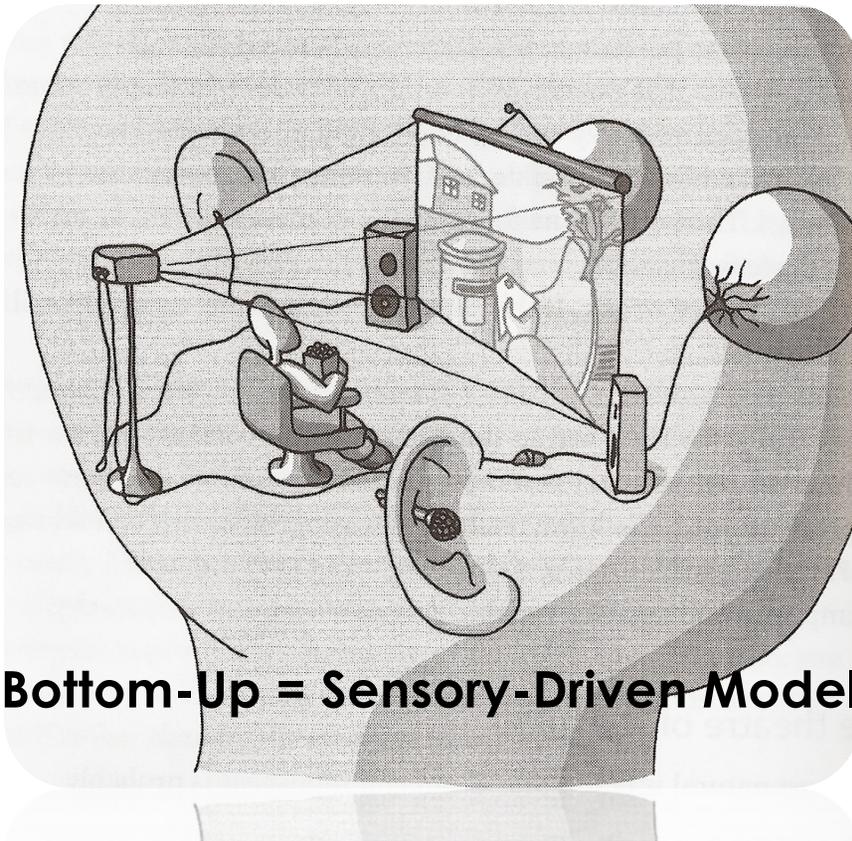


Image from (<https://www.thetripreport.com/p/notes-on-emergent-paradigms-part-4a1>)

The Science Of Meaning Making

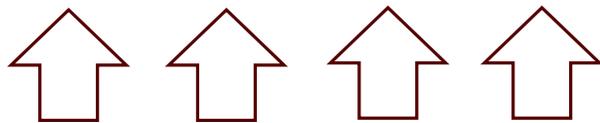
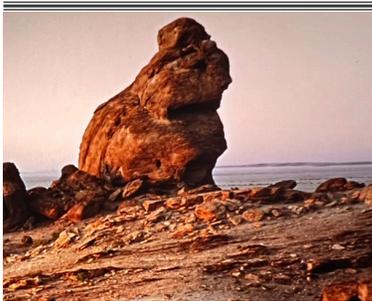
Understanding how and why we learning

- **Perception is not passive-** We do not simply "see" or "hear" the world as it is, our brains **construct reality** using both sensory input (bottom-up) and internal predictions (top-down).
- **Bottom-Up = Sensory-Driven** - Raw data from the environment (light, sound, touch) is processed by the brain to build a basic representation of the world. **This has been proven incorrect**
- **Top-Down = Prediction-Driven** - The brain uses prior experiences, expectations, and context to **interpret** sensory data—what Anil Seth calls a "controlled hallucination."

How does this work
and how does it relate
to Learning?



1 BILLION BYTES PER SECOND



RAW SENSORY INPUT
(unfiltered signals from the external world)

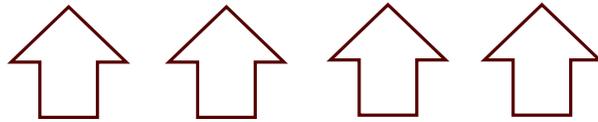


Genetic disposition



SATIENICE

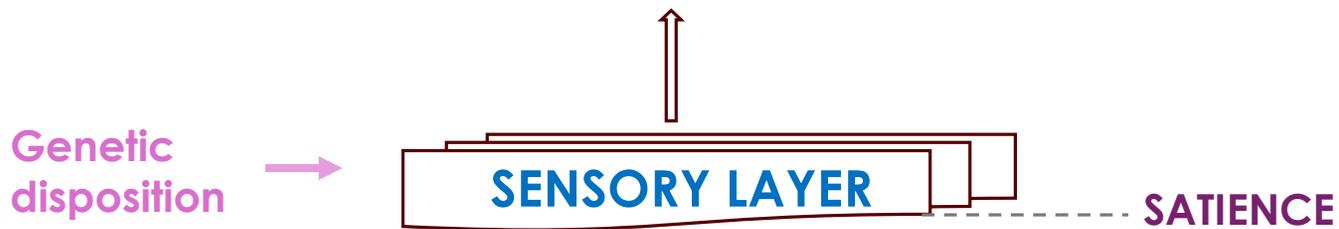
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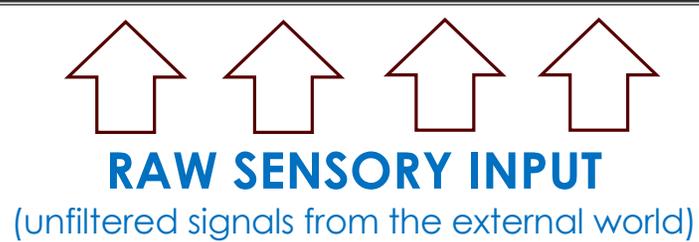
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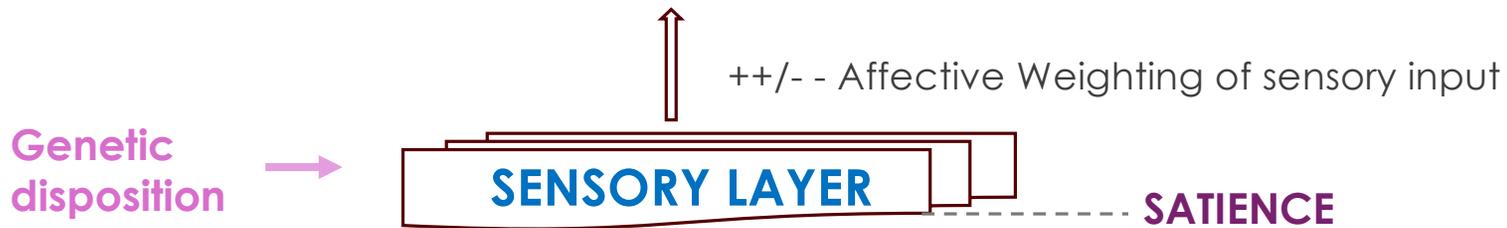
10 BYTES PER SECOND



Lastra 2025



10 BYTES PER SECOND



Lastra 2025



↑ ↑ ↑ ↑

RAW SENSORY INPUT
(unfiltered signals from the external world)





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Educability – Capacity for Lifelong Learning

MIND'S DIFFERENTIAL ENGINE

REASONING & INTELLIGENCE LAYER

Percept -> Memories -> Concepts -> Goals

SENTIANCE

PERCEPTION LAYER

SENTIANCE

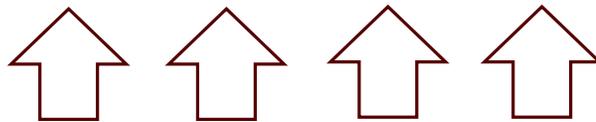
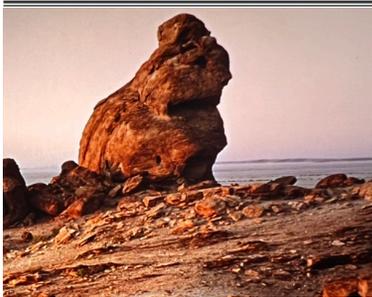
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SENSORY LAYER

SATIANCE

Genetic disposition →

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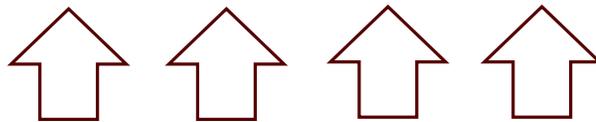
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Educability – Capacity for Lifelong Learning

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Percept -> Memories -> Concepts -> Goals

SENTIANCE

INPUT – EXPECTATION
ERROR CORRECTION
LOOP

PERCEPTION LAYER

SENTIANCE

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SENSORY LAYER

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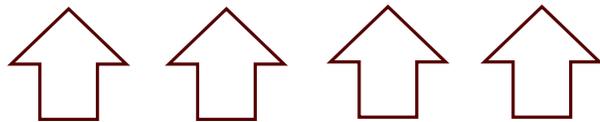
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Educability – Capacity for Lifelong Learning

MIND'S DIFFERENTIAL ENGINE
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Percept -> Memories -> Concepts -> Goals

SAPIENCE

*High-Level
Cognitive
Loop*

INPUT – EXPECTATION
ERROR CORRECTION
LOOP

PERCEPTION LAYER

SENTIANCE

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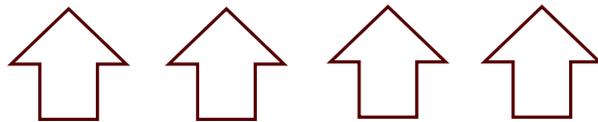
**Genetic
disposition**



SENSORY LAYER

SATIANCE

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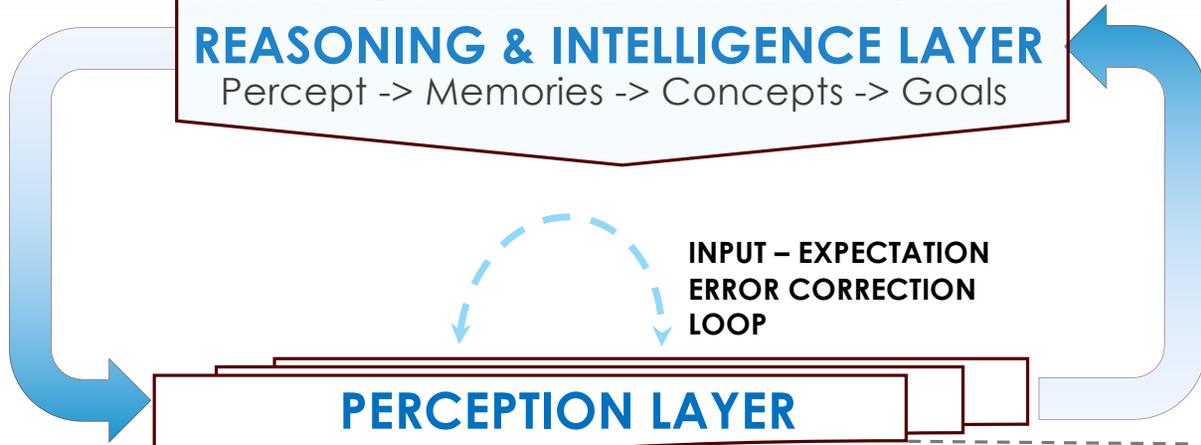


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Educability – Capacity for Lifelong Learning

MIND'S DIFFERENTIAL ENGINE
REASONING & INTELLIGENCE LAYER
Percept -> Memories -> Concepts -> Goals



SAPIENCE
High-Level Cognitive Loop

- Subjective Self-awareness Experience
- THINKING META-COGNITION
- REASONING
- AGENCY ACTION SELECTION

SENTIANCE

EMOTION, VALENCE

++/- - Affective Weighting of sensory input

Genetic disposition

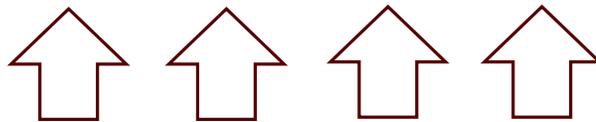
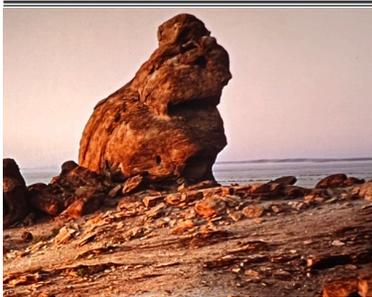


SENSORY LAYER

SATIANCE

REFLEX ACTIONS

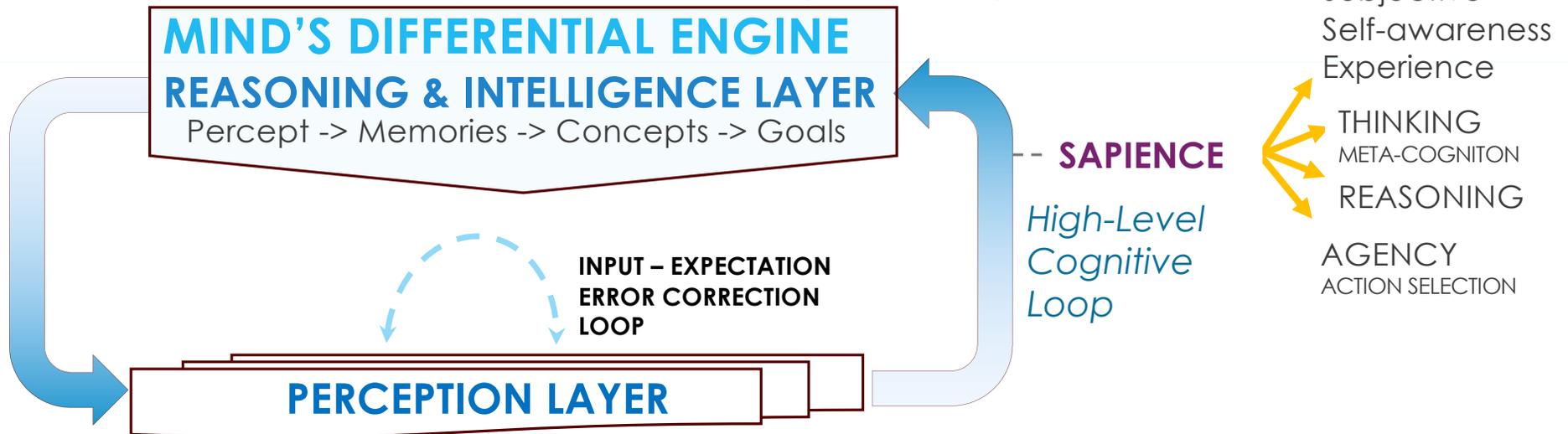
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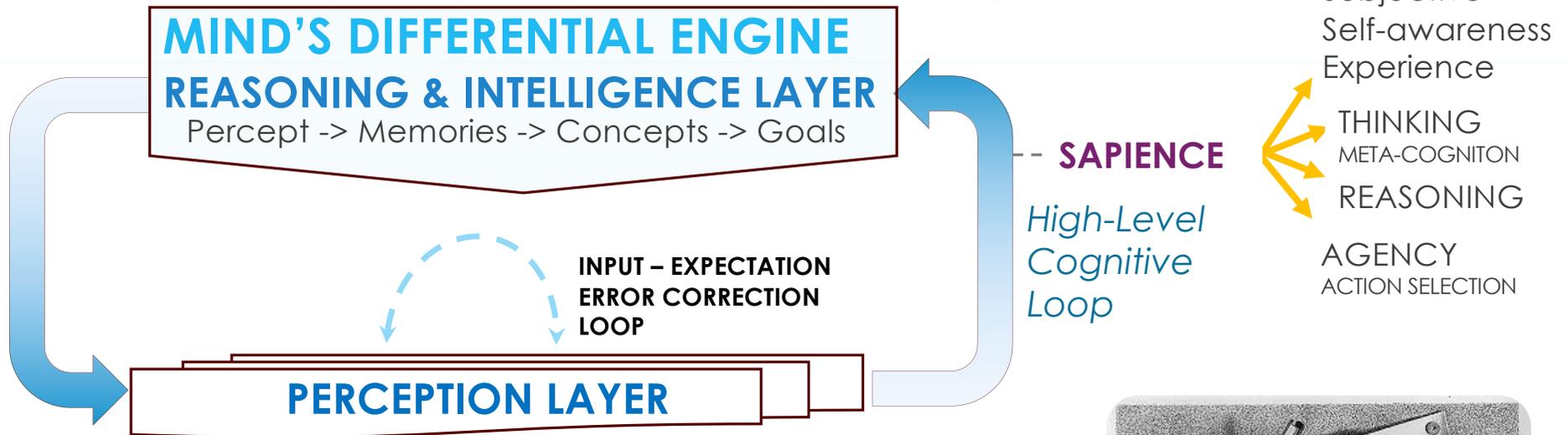
Educability – Capacity for Lifelong Learning



basis of Intelligent behaviour (Y. LeCun, 2025) =

- Understanding of the physical world (embodied experience),
- Having persistent and dynamic memory
- Being able to Reason
- Being able to Plan (complex actions)

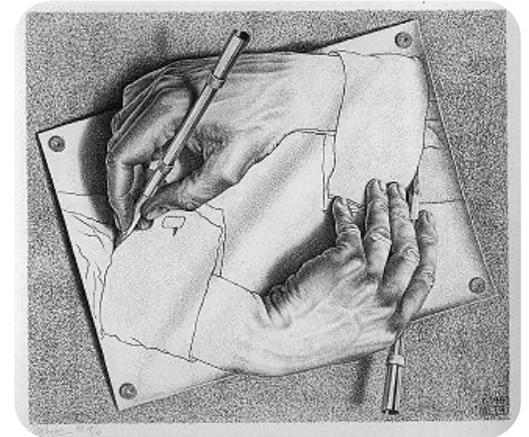
Educability – Capacity for Lifelong Learning



Self-referential Paradoxical feedback-Loop”

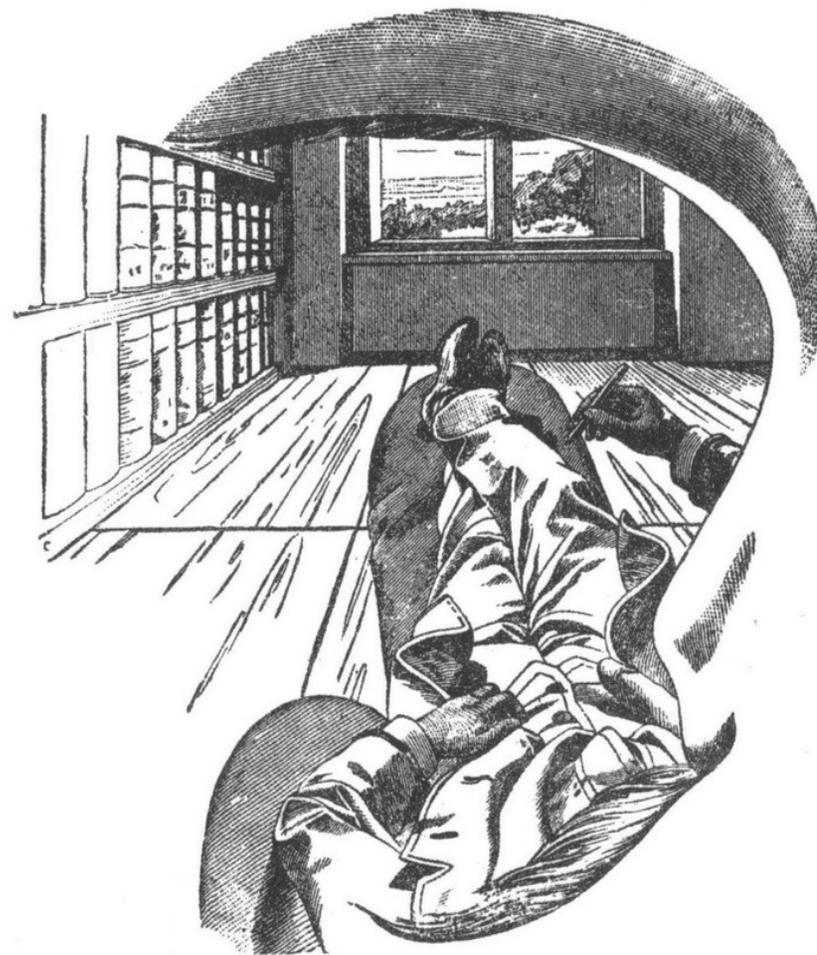
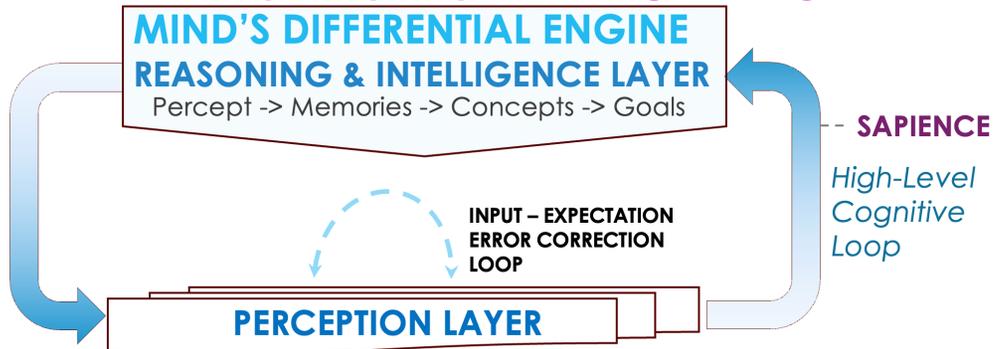
(Gödel theorem 1931; D. Hofstadter 1979)

Heuristics and Abstract thinking
-> Generalize -> Inductive reasoning -> extrapolation



Maurits Cornelis Escher

Educability – Capacity for Lifelong Learning



Ernst Mach, *Self-Portrait* (1886).

Stages of Learning and intelligence

YOUTH

Creation of new reasoning and learning (neuro-plasticity) **Basis of Pedagogy** (Minsky 1986; Solms 2024)

INFANTS

Genetically coded innate learning – Smell, faces, emotions.... (Minsky 1986)

Stages of Learning and intelligence

ADULTS

Established reasoning and learning subjective models (limited neuro-plasticity)
– Classification: cognitive wells **Basis of Andragogy**

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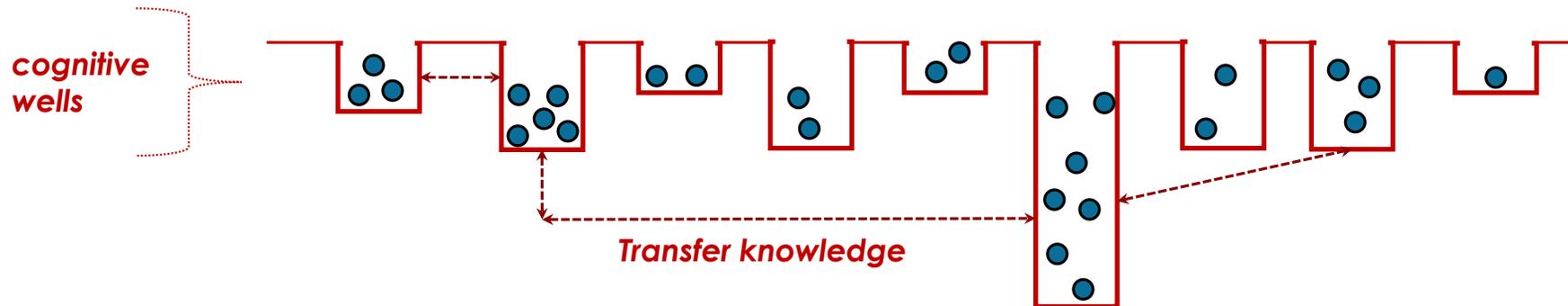
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When Does Learning Happen?

- **Edge of Prediction Error** Learning occurs when the brain's predictions about the world are violated.
- **Attention and Emotion Are Engaged**
- **Connect new information to existing knowledge,**
- **Tolerable Zone of Struggle**
- **Prediction Becomes Less Effortful Over Time** As we learn, the brain builds better models and requires less error correction

*"Learning is more than the accumulation of skills.
What ever we learn, there is always more to learn-
about how to use what was already learned"*

- Marvin Minsky, Society of Mind 1985

Learning as a Process of Building Mental Models

Science of Sense making

Learning as a Process of Building Mental Models

Cover Image



> 500 Pieces of
1:24 plane

Detailed
Instructions

<https://www.scalemodellingnow.com/hnaircraft-airfix-supermarine-spitfire-mkviii>

Learning as a Process of Building Mental Models



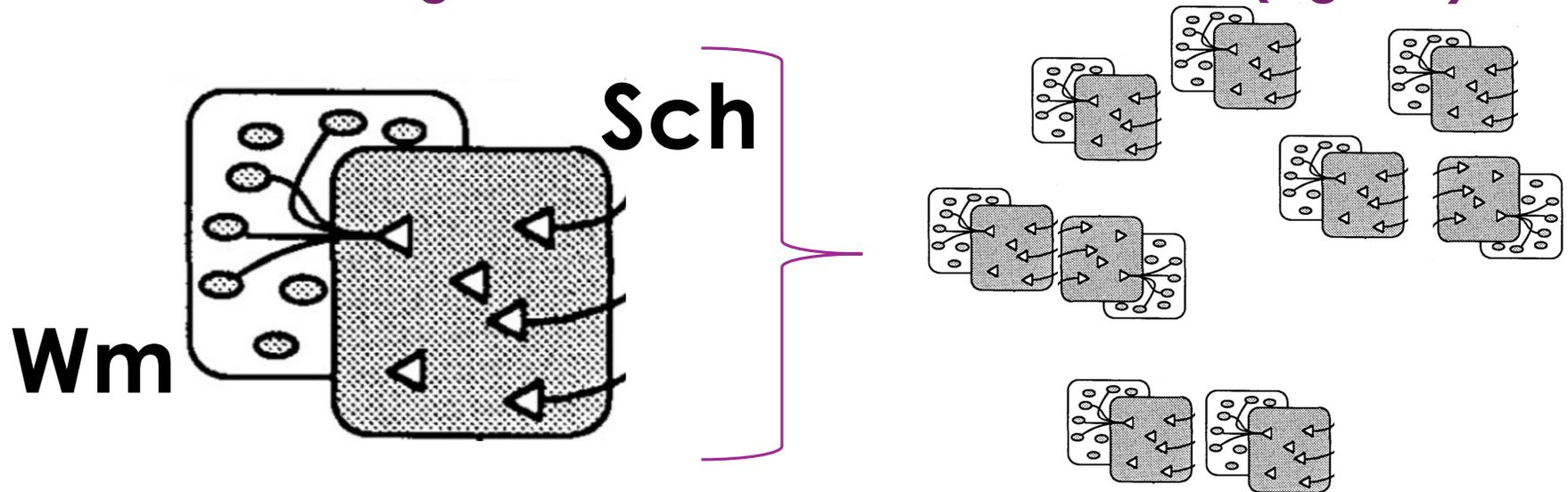
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Learning as a Process of Building Mental Models

**MIND'S DIFFERENTIAL ENGINE
REASONING & INTELLIGENCE LAYER**

Percept -> Memories -> Concepts -> Goals

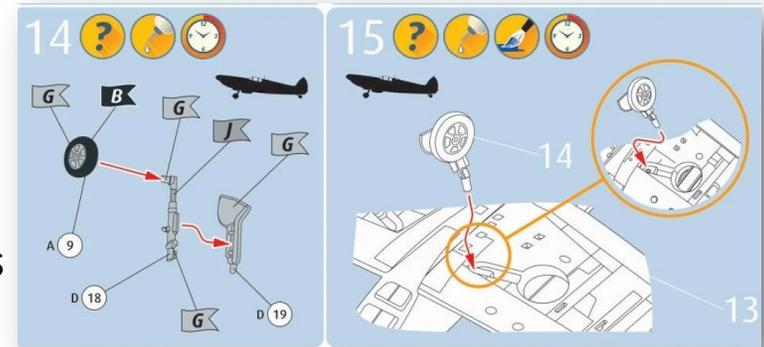
- Minds Differential Engine = Schemas + World Models (agents)



Schemas and World Models – How We Understand and Learn

Schemas (S) = Instruction Manual

- Mental blueprints based on past experience
- Shortcuts -- applying knowledge in predictable contexts
- Specific and task-focused
- Built from repeated patterns and reinforcement



World Models (WM) = Picture on the Box

- High-level mental representations of how the world works
- Integrate multiple schemas into a cohesive framework
- Help us reason, plan, and adapt in uncertain or novel situations
- Predict $T_n \dots\dots T_{n+1}$ (LeCun 2025)



S + WM = Our Internal Learning System

Decoding Knowledge, Skills, and Competencies

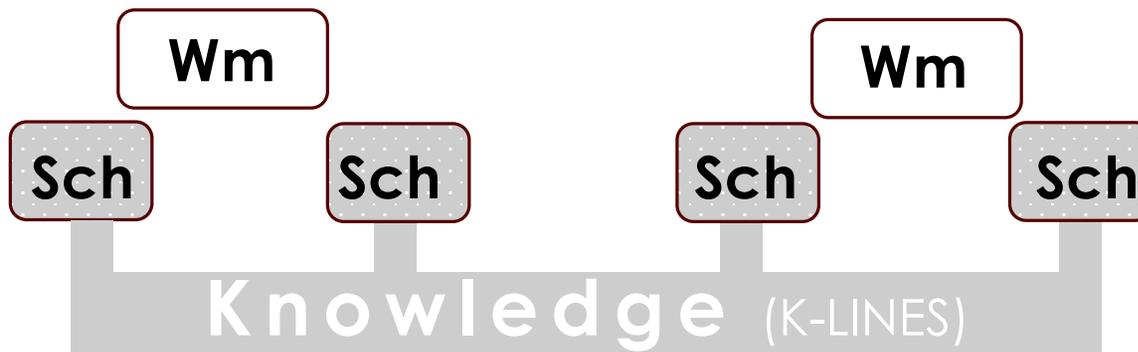
The elements of our Minds Difference Engine

What is Knowledge ?

What is Knowledge ?

Knowledge is the connective tissue

- It fills and links **schemas**; gives **world models** their depth, flexibility, and coherence.
- Without knowledge, **schemas would be empty** (no content to apply), and **world models would collapse** (no structure to simulate or predict).
- The knowledge we accumulate throughout life is **instantiated in our memories**
- Encompassing episodic, semantic, declarative, and non- declarative forms.
- These memories, however, are not static (Mitchell 2023).
- **SUBJECT to both CHANGE and LOSS over time**



What is Knowledge ?

- **The more we know, the more we perceive through our internal frameworks.**

Learning transforms how we interpret the world by shaping the mental models that guide perception (Clark, 2023).

- **Knowledge instantiated in memory's underpins traditional assessment.**

Standardized testing relies heavily on recall, reflecting how deeply ingrained knowledge-based evaluation is in educational practice.

What is Knowledge ?

- **The more we know, the more efficiently we learn....**

- Learning builds on prior knowledge—our cognitive “buckets” grow deeper and more precise with each experience. Until we hit cognitive maturity
- Post cognitive mature we developed well defined cognitive buckets – become better at transferring learning. New learning is difficult (cognitive dissonance)

Without the ability to acquire knowledge through learning and model building there is nothing.

What are Skills ?

"Narrow learning – attainment is fragile....[application] only to the context almost exactly as those that were learned"

- Jean Piaget

What Are Skills? A Deterministic View

Determinism

- Skills are the **direct application of knowledge** to achieve a set goal or solve a **predictable problem** (McGrew, 2009).
- Involves an **effortful process** when facing a novel but **predictable** situation.
- Often relies on **declarative memory** and **specific training** (e.g., HR professionals drawing on HR knowledge).
- Applied within a **narrow band of domain-specific knowledge**.

What Are Skills? A Deterministic View

From Effort to Intuition

- With repetition, skill use becomes more **automatic and intuitive** (*System 1 thinking* – Kahneman, 2011).

Examples:

- Solving basic arithmetic (e.g., $1 + 1$)
 - Driving a car
 - Reading a familiar sentence
-
- Leads to **intuitive judgment and action**
 - Skills help resolve **recurrent, deterministic problems** effectively.

From Skill to Expertise: The Path of Cognitive Integration

- **Skill begins with knowledge application.**

At the basic level, skills help us achieve specific goals by applying learned knowledge to predictable problems.

- **Proficiency develops through practice.**

With repetition and reinforcement, skills become more intuitive and efficient—allowing for smooth performance in familiar contexts.

- **Expertise is the culmination of deep learning.**

Through sustained immersion and reflection, skills evolve into adaptive responses, enabling critical judgment and handling of novel, complex challenges.

- **Mastery reduces cognitive effort.**

As we gain expertise, we require less conscious effort, often entering a **FLOW STATE**, where performance straddles conscious and unconscious processing (cf. Kahneman, 2011).

What is Competence?

"Some of the most crucial steps in mental growth are based NOT simply on acquiring new skills, but in acquiring new administrative ways to use what one already knows"

- Seymour Papert [Papert's Principle]

What is Competence?

- More than a list of behaviors or soft skills in a Competency Framework.
- Often confused with **proficiency**, **expertise**, or **ability**, but not interchangeable.
- Competence is about the **integration of skills, knowledge, and personal/social qualities**
- It enables individuals to respond **adaptively to complex, unpredictable situations** (Brock et al., 2011).

Competence vs. Skill

- **Skills** = application of knowledge to **predictable problems**.
- **Competence** = application of knowledge and skills to **indeterminate** and **unfamiliar problems** → **Adaptive** actions and behaviors within a life-time
 - Requires:
 - Higher **cognitive load**
 - **Trial-and-error** learning
 - **Holistic integration** across contexts
- Example: **A surgeon responding to a sudden power outage during surgery.**

Developing Competence

- Built through **real-world, supervised performance**, not micro-tasks or isolated training.
- Must include:
 - **Contextual** understanding
 - **Temporal** dynamics (*learning over time*)
 - **Social and mimetic learning** (Billet, 2024)
 - **Reflective and metacognitive** processes (Radović et al., 2024)
- Requires new **assessment models** that capture:
 - Interactions across time, space, and social settings
 - Continuous **feedback loops** (Bjork, 1999)

Skills and
Competencies =
Schemas and World
Models

Skills and Competencies = Schemas + World Models

- Skills and competencies are not static traits—they are embedded in our **cognitive architecture**.
- **Skills => schemas** (efficient responses in predictable contexts).
- **Competence => world models** (used to navigate uncertainty and adapt to complex environments).
 - Reflects a **continuum** of mental processes—from automatic to deliberate.

Skills and Competencies = Schemas + World Models

Implications for Assessment and Learning

- Skills and competencies must be assessed as **dynamic, evolving processes**.
- Not just about task completion, must evaluate:
 - **Integration across sensory systems**
 - **Real-time adaptation and learning**
 - **Contextual application and refinement**
- Learning design should foster **model-building, prediction, and reflection**, not just rote performance.

The Myth of Skills and Competency Attainment within Short Programs

The Myth of Skills and Competency Attainment within Short Programs

- Can short programs truly build skills and competencies?
→ **Reason suggests no.**
- Mastery in any domain—music, cooking, plant ID—requires:
 - **Sustained effort**
 - **Disciplined practice**
 - **Deliberate mental orientation**
- Short programs may **spark interest**, but:
 - They rarely produce **skillful or competent** professionals on their own.

Limitations of Short Programs

- **Micro-credentials** and short-cycle learning:
 - Offer **foundational knowledge**, not mastery
 - Serve as starting points for **reskilling** or **upskilling**
- Risk: **Myth of rapid skilling** and fragmented learning
- Genuine competence requires:
 - **Structured, varied, and verifiable** learning experiences

Limitations of Short Programs

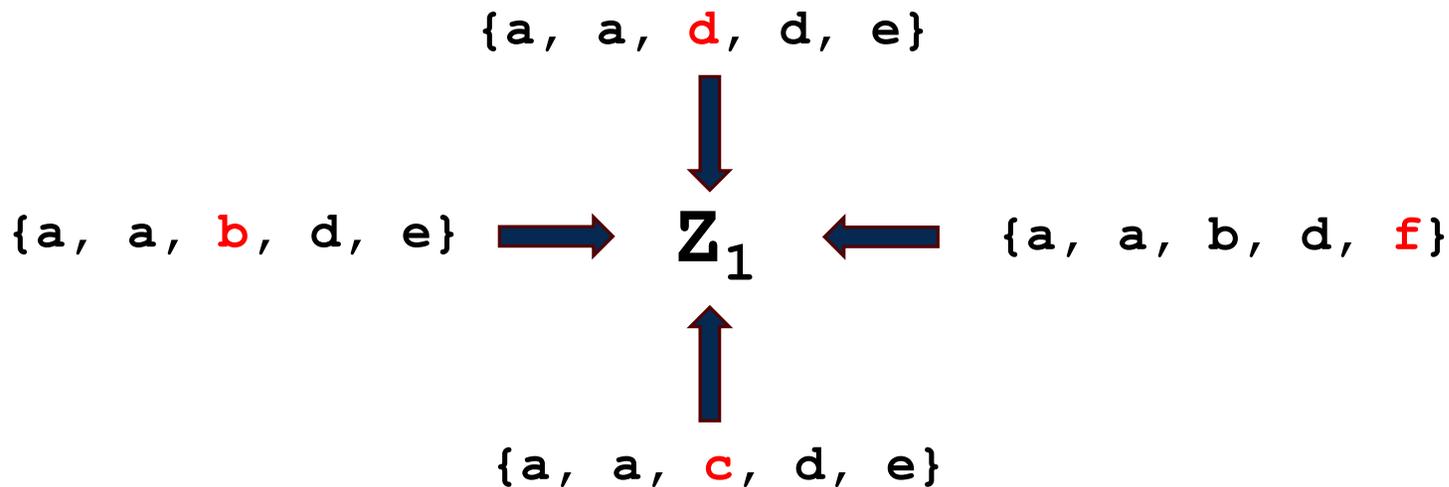
- **Achieving competence** is a dynamic, developmental process that requires sustained time, effort, and structured support.

Limitations of Short Programs

- **Achieving competence** is a dynamic, developmental process that requires sustained time, effort, and structured support.
- **Reinforcement learning** strengthens performance through practice and outcomes,
- **Supervised learning** provides the guidance and correction necessary for refinement.
- **Competence evolves over time**, deepening with experience, reflection, and increasing independence, especially in complex or unfamiliar contexts.
- consistent with the principles of **deep learning**, *not in the machine learning sense*, but in the educational and cognitive sense.

Limitations of Short Programs

- Because mental models are influenced by individual experience, culture, and interpretation, **the experience of competence is inherently subjective**, even when external standards or performance metrics exist!!



Neural-Correlates of Consciousness and Cognition (cf. Koch and Crick)

Toward a Reimagined Learning Ecosystem

- Effective skilling must:
 - Include **social learning**: collaboration, negotiation, shared outcomes
 - Move beyond superficial assessments (e.g., online group tasks)
 - Incorporate **real-world simulations** (e.g., *game theory*) for strategic thinking
- Programs should honour the **cognitive depth** of learning:

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Clarity, Integrity, and Ecosystems

- Next steps:
 - Clarifying definitions and frameworks align with developing understanding of cognitive and neuro-science
 - Ensuring **integrity in assessment**
 - Building **cohesive learning ecosystems**

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Clarity, Integrity, and Ecosystems

- Next steps:
 - Clarifying definitions and frameworks align with developing understanding of cognitive and neuro-science
 - Ensuring **integrity in assessment**
 - Building **cohesive learning ecosystems**
- By aligning education with **how humans actually learn**, we can prepare learners for **an era of transformation**.

QUESTIONS



CAUCE

Canadian Association for
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