k-th order intelligences: Learning to learn to do.

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Learning and doing

➡ How can we make machines **learn by themselves**?

- Agents that learn with **no external intervention**.

- **A.G.I.**: The capability of adapting to any problem.
  Assumption: A.G.I. requires full self-modification.

➡ Related to [Bateson, G. (1972) Steps to an ecology of mind].

- **Zero learning**, Learning I, Learning II, etc.

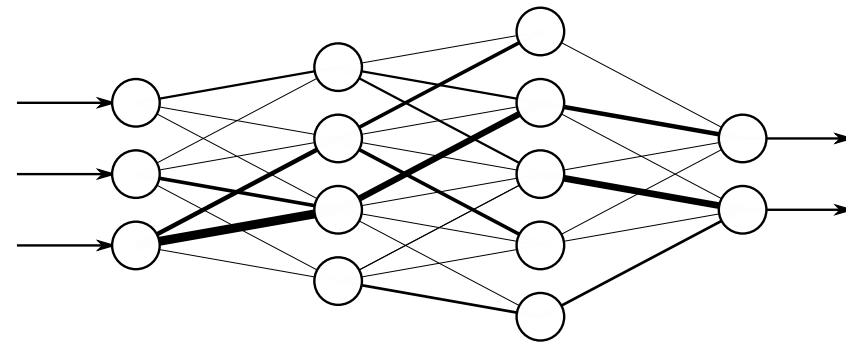- Extend and explore deeper orders of learning.

➡ Objectives:

- Propose ways to stop the infinite escalation of orders

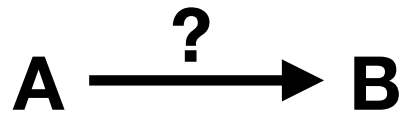- Evaluate the proposal.

$$A \xrightarrow{\ f\ } ?$$

➡ Input and method are known.

➡ Outcome is not known.

➡ No changes to the intelligent agent. "Doing"

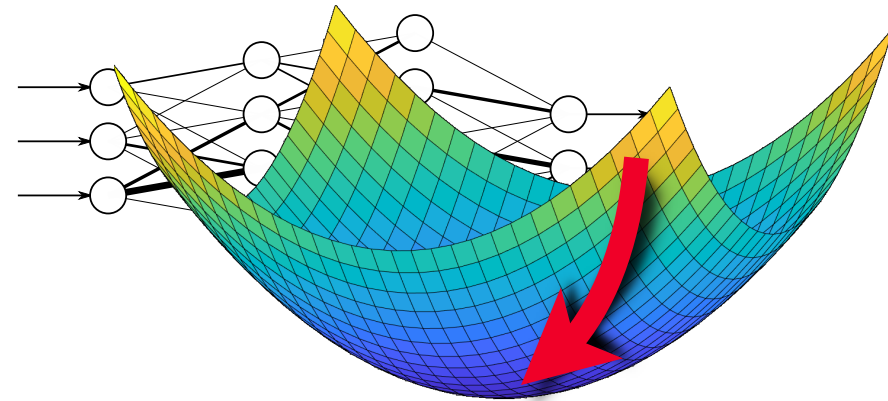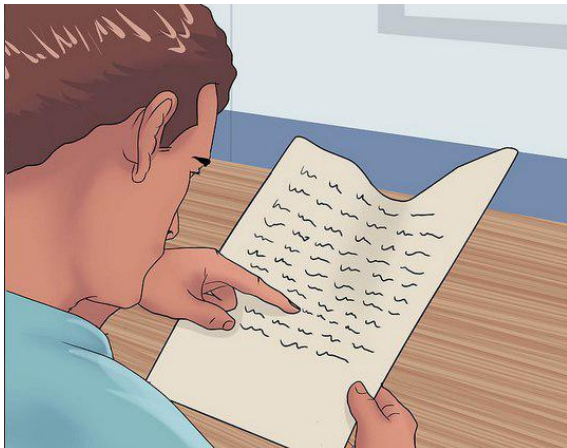➡ Corresponds to Bateson's Zero Learning.

➡ Resolution: Evaluate f(A).

Learning processes (order 2)

$$A \xrightarrow{\text{?}} B$$

➡ Input and outcome are known.

➡ Method is not known.

➡ No changes to the environment: partial self-modification. "Learning to do"

➡ Corresponds to Bateson's Learning I.

➡ Consider new agent-environment system:
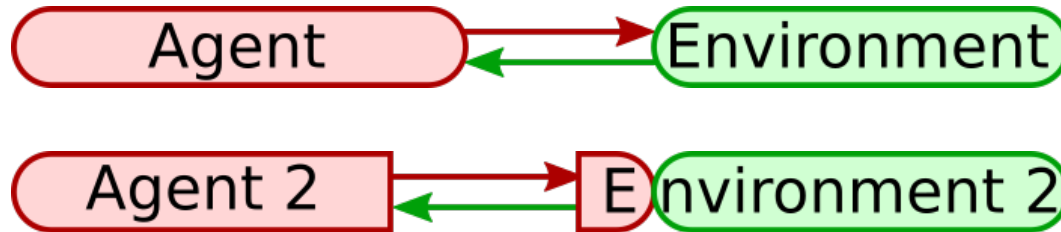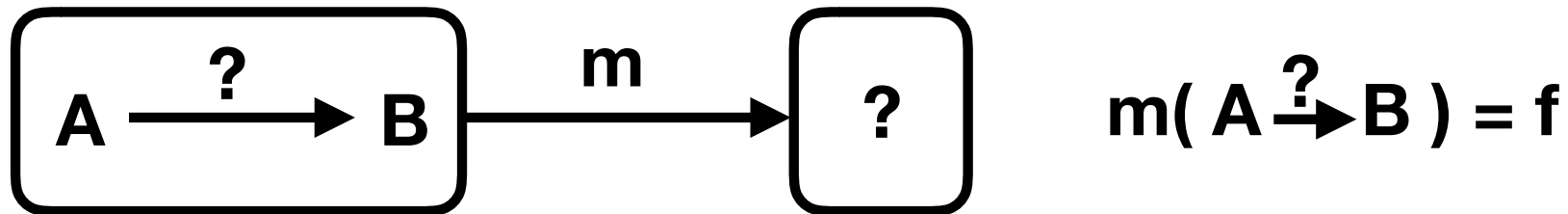

➡ Metacomputational processes.

$$m(A \xrightarrow{?} B) = f$$

➡ Meta-learning process: Learning in agent 2.

- Bateson's Learning II.

- *e.g.* Learning to read.

- *e.g.* Research on AI.
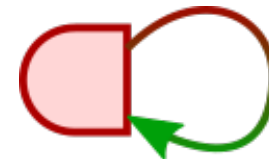
➡ Apply induction:

- First order interacts with the environment.

- Following orders discard parts of the agent into the environment.
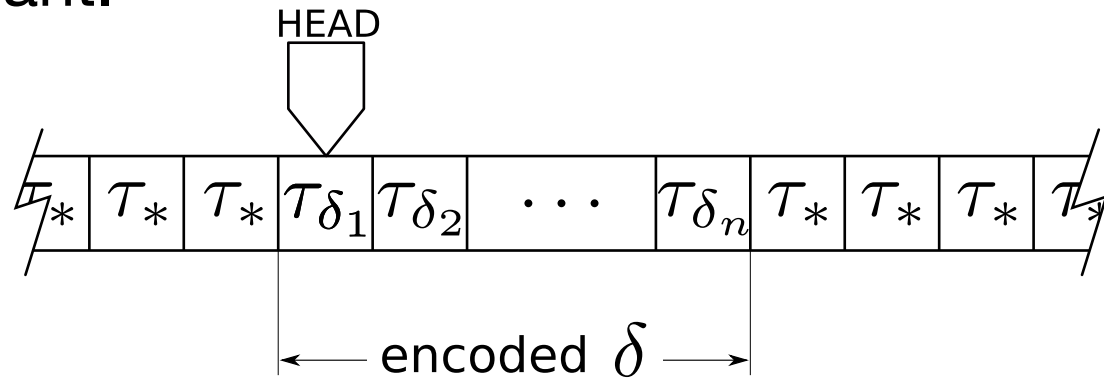
- Learning to learn to … to do.

Agent k

➡ There will always be a meta-system of a system (a smaller agent).

➡ Unless we consider a self-referential meta-system.

➡ Stops the infinite escalation of orders.

➡ Consider a Universal Turing Machine.

➡ With its action table δ stored in its own tape.

➡ The action table is variant.

$$\delta_{t+1} = \delta_t(\delta_t)$$

➡ The action table is a function of itself.

● Godel Incompleteness Theorems.

➡ Can the Turing Machine arrive at a specific action table?

● P vs NP problem. Undecided. No AGI?

Summary

➡ Learning processes output the methods used in computational processes, i.e. algorithms.

➡ Learning processes are meta-computational processes.

➡ By induction, we arrive at infinite orders of meta-processes.

➡ Unless we consider self-referential systems.
   e.g. Self-referential Universal Turing Machine.

➡ Artificial Intelligence is limited by its meta-models.

Thank you for your attention.
ご清聴ありがとうございました

➡ Unruh, A., & Rosenbloom, P. S. (1989). Abstraction in Problem Solving and Learning. In Proceedings of the 11th International Joint Conference on Artificial Intelligence (IJCAI) (pp. 681–687).

➡ Bateson, G. (1972). Steps to an Ecology of Mind.

➡ Turing, A. M. (1939). Systems of Logic Based on Ordinals. In Proceedings of the London Mathematical Society (pp. 161–228).

➡ Gödel, K. (1931). Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme I. Monatshefte Für Mathematik Und Physik, 38(1), 173–198.

➡ Naik, D. K., & Mammone, R. J. (1992). Meta-neural networks that learn by learning. In IJCNN International Joint Conference on Neural Networks (Vol. 1, pp. 437–442).

➡ Schmidhuber, J. (2005). Gödel Machines: Self-Referential Universal Problem Solvers Making Provably Optimal Self-Improvements. In Artificial General Intelligence (Vol. 5).