Research project: Enactive learning

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Context

The Holy Grail of artificial intelligence is to implement learning as it occurs in humans and other organisms. Current AI learning systems use externally coded algorithms to optimise their processing of inputs according to the requirements of a human programmer; however, in biological learning, organisms make self-related choices about *what* they should learn. Biological learning is therefore *not* something that individuals do, but instead something that *autonomous collectives* of individuals do in order to survive. This *enactive* view defines learning in terms of *purpose*, making an important distinction between biological and physical systems:

- A group of many agents makes a ***choice*** when these agents collectively organise their behaviour in a way that preserves the integrity of that entire collective group.
- We say this choice has the ***purpose*** of preserving the group's integrity if the causal process leading to that particular choice exists *because* it has been successful in the past at preserving that group's integrity. In such cases, we say that the group is ***autonomous*** (i.e., preserves its own integrity).
- An autonomous group ***enacts*** its identity by adapting its structure so that dynamical flow processes do not destroy, but rather *preserve* that same structure.
- ***Learning*** is the process by which a group adapts its structure to enact an identity.

Methods

Agent-based systems possess ***structure***, in the form of the component agents' states and their relations to each other, and behaviour, in the ways that agents interact with local dynamical ***flows***. This suggests we might use an ABM simulation to demonstrate enactive learning:

- Agents' actions are conditioned by the local concentration of a flow F. In the initial prototype, their secretion rate is fixed at some constant positive value and consumption rate is fixed at zero. Agents' position is subject to constant mutation in the form of tiny movements whose direction is determined by stochastic tumbling.
- The flow F exhibits structurally implemented Turing dynamics with initially fixed inner-/outer-radius parameters. (In later iterations, agents may influence these parameters.)
- Agents possess variable genetic structure that defines whether and with what probability the agent tumbles when the local F concentration increases or decreases.
- Agents' genetic structure is subject to random mutation whose magnitude decreases slightly if the ambient flow F stays constant, and rises if F varies above a threshold.
- After testing and evaluating the initial prototype, the project will test whether the system can learn, recall and generalise Turing patterns presented to it.
- The system's complexity (e.g., agents' genetic structure) is very simple, and it is coded in compact, modular, pedagogically simple julia, using *only* the Anatta toolset.

Research question

Can a collection of simple agents enact structures that are capable of learning?