Objects: Tokens for (Eigen-)Behaviors

by von Foerster (2003)

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Overview

- Sensorimotor interaction as being circular.
- Recursion: $s_i = S(m_k)$ and $m_k = M(s_i)$. Cross applying s_i and m_k results in:

$$s_i = S(M(s_j)) = SM(s_j)$$

$$m_k = M(S(m_i)) = MS(m_i)$$

Main Thesis

... what is referred to as "objects" in an observer-excluded (linear, open **[feedforward]**) epistemology, appears in an observer-included (circular, closed **[feedback]**) epistemology as "tokens for stable behaviors" ...

YC: **Bold** are my additions.

Piaget's Initial Idea

Equilibrium of cognitive structures

Obs.O ⟶ Obs.S ⟶ Coord.S ⟶ Coord.O ⟶ Obs.O ⟶ etc.

- Let's collapse all Obs into **obs**, and all Coords into **COORD**.

COORD, Through a Loop

- obs_1 = COORD(obs_0)
- obs_2 = COORD(obs_1) = COORD(COORD(obs_0))
- ...
- obs_∞ = COORD(COORD(COORD(COORD(...
- From the above, we can see that adding an extra COORD still gives you obs_∞:

$$\begin{aligned} \text{Obs}_\infty &= \text{Obs}_\infty \\ \text{Obs}_\infty &= \text{COORD}(\text{Obs}_\infty) \\ \text{Obs}_\infty &= \text{COORD}(\text{COORD}(\text{Obs}_\infty)) \\ \text{Obs}_\infty &= \text{COORD}(\text{COORD}(\text{COORD}(\text{Obs}_\infty))) \end{aligned}$$

Examples

- $\text{Op}_1(x) = \frac{x}{2} + 1$

$$x_0 = 4, x_1 = 3, ..., x_{11} = 2.001, ...x_\infty = 2.0$$

- $\text{Op}_3(x) = \frac{d}{dx}$

$$\text{Op}_3(\exp) = \exp, \text{ since } \frac{de^x}{dx} = e^x$$

obs_∞

- A new feature emerged: obs_∞ is **self-determining**.
- YC: What about COORD? Isn't it also self-determining?

  COORD(obs_∞) = COORD(COORD(obs_∞))
- YC: Also, does this mean the object (obs_∞) can be equivalent with the operation (COORD($\cdot$))? Now apply that thought to perception/action.

The Concept of "Eigen-Values"

- obs_∞ is self-defining, or self-reflecting through COORD.
- These values $\text{obs}_{\infty i}$ (let's say Obs_i) will be called "Eigen-Values", or "Eigen-Functions/Operators/Algorithms/Behaviors"
- Properties:
  - Eigenvalues are **discrete** (unlike obs_0 which is continuous): perturbations will be brought back to Obs_i.
  - Thus, eigenvalues represent **equilibria**.
  - Obs_i and COORD are **complementary**: Obs_i represent the externally observable manifestations of the cognitive computations COORD.
  - **Composable** (next slide).

Composition of Obs_i/COORD

- $\text{Obs}_1 * \text{Obs}_2 = \text{Obs}_3$ then

  $\text{COORD}(\text{Obs}_1 * \text{Obs}_2) = \text{COORD}(\text{Obs}_1) * \text{COORD}(\text{Obs}2)$

  since

  $$\begin{aligned} \text{COORD}(\text{Obs}_1 * \text{Obs}_2) &= \text{COORD}(\text{Obs}_3) \\ &= \text{Obs}_3 \\ &= \text{Obs}_1 * \text{Obs}_2 \\ &= \text{COORD}(\text{Obs}_1) * \text{COORD}(\text{Obs}_2) \end{aligned}$$

- The whole is the composition of the parts.
- This is dubbed the "principle of cognitive diversity".
- YC: this seems to be **against** emergence, or self-organization.

Nature of Eigenvalues/Objects

... Eigenvalues and objects, and ... stable behavior and the manifestation of a subject's "grasp" of an object cannot be distinguished. In both cases "objects" appear to reside exclusively in the subject's own experience of his sensori-motor coordinations; that is "object" appear to be exclusively subjective. ...

- This leads to the question of "objectivity" of these objects.

Extending the Loop: Gaining Objectivity

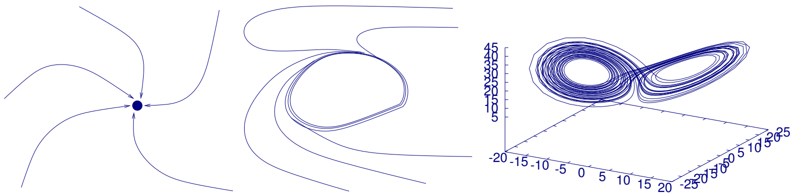
- When two subjects each stipulate about each other.
- There may be shared Obs_i, available in the public.
- Operators may act on these Obs_i and produce Obs_j, to be consumed by the partner.
- Properties:
  - Alone, you cannot reach an eigen-state.
  - The operators (say COORD_i) may have to be the same in both subjects.

Atomic Social Eigen-Value: Example

Example: $\text{Op}_2(x) = \exp(\cos(x))$

- $\text{Op}_2(2.4452..) = 0.4643..$
- $\text{Op}_2(0.4643..) = 2.4452..$
- Thus, $\text{Op}_2(\text{Op}_2(2.4452..)) = 2.4452..$
- and $\text{Op}_2(\text{Op}_2(0.4643..)) = 0.4643..$

Discussion (YC)



- Relation to stable fixed points, limit cycle attractors, and chaotic attractors in dynamical systems theory.
- Relation to the idea of "invariance".
- How object and operation (or data and program code, or representation and cognition) can become inhabitants of the same space.
- How can different individuals come to have the same operator?

References

von Foerster, H. (2003). *Understanding Understanding*. New York: Springer.