

An algebraic approach to modeling the emergence of representations through interaction

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Abstract

In this talk I will focus on modeling cognitive interactions as *closed systems that are, at the same time, open to exchanges with the environment*. (Piaget 1967, pp. 154–58). I will start by highlighting the following characteristics of universal algebra that make it a particularly apt formalism for modeling cognitive interactions. Firstly, the operational structure of algebras is naturally suited for modeling action-oriented cognition (Rizzolatti and Gallese 1997). Secondly, and more significantly, with algebraic structures containing circularity one can model cognitive systems that allow a multiple choice of primitives. In other words, a cognitive agent may choose to regard different sets of tokens (or representation units) to be considered as primitives — or as windows that are open to exchanges with the environment — and the environment manifests different structures to the cognitive agent accordingly. Thirdly, the notion of sub-algebras provide a way to capture the context effect so that the cognitive agent does not have to be aware of all the potentialities offered by a situation at any time (Indurkhya 1991).

Then I will present a detailed example, using a sorted algebra as not all actions are applicable to all objects, to illustrate how the emergence of representation through interaction can be modeled. The example will incorporate Barsalou's (1999) notion of simulators to outline a process model (Christensen 2003) which shows how grounded representations can emerge from the cognitive agent's actions (Philipona, O'Regan and Nadan 2003). Then I will show how the agent can detect errors in its own representations, and can take two possible measures to rectify an error. One, corresponding to Piaget's accommodation, is to modify the structure of the representation to correct the error. The other, referred to as projection (Indurkhya 1992), is to alter the grounding of the representations (this corresponds to redefining the tokens of the representations.) Finally, I will show how contexts can be modeled as sub-algebras that act as filters so that the cognitive agent sees only some of the possibilities inherent in a situation.

Finally, I will take a step back and discuss some implications of this approach for modeling creativity of metaphors (Indurkhya 1998, 1999a, 1999b). In particular, I will argue that if it is assumed that projection is a basic cognitive process by which the cognitive agent endows the environment with an ontology, then one can explain why metaphors play such a predominant role in various aspects of human creativity.

References: *This lists some references that are closely related to my talk, though not all of them are explicitly cited in the abstract above.*

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