Research Statement

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Broad Research Program

My philosophical research aims to develop a general theory of pragmatic embodied epistemology. Pragmatic embodied epistemology is the philosophical investigation of the possibility conditions and normative principles for embodied agents to represent their world and to utilize the representations in their interactions with the world. Pragmatic embodied epistemology differs from the traditional Cartesian epistemology and its modern counterpart, analytic epistemology, in that: (1) it holds that the agent is essentially an embodied system; (2) it replaces the notion of “rationality” with the more general and more widely applicable notion of “cognition”; (3) it does not assume doxastic representations but relies on a more general notion of information; and, (4) it is not centered on the concept of “knowledge”, but instead bases its normative principles on the role of the representation systems for goal-directed interactions of the agent with its world.

A development of a theory of pragmatic embodied epistemology requires four consecutive stages: (1) an account of information focusing on the emergence of information using systems; (2) an account of cognition which includes an account of (a) how cognitive systems emerge as systems in the world, (b) how they can extract and utilize information, and (c) how they organize the information into systematic behavior-guiding models of the world; (3) an account of the emergence and nature of modeling and representational systems, how such systems can be integrated in active cognitive agents, and how and what kinds of systems can be used for the generation of abstract scientific or mathematical models; (4) an account of how abstract models interact and change, and how they facilitate the production of technological artifacts, including scientific instruments, which conversely facilitate the changes of the models.

Dissertation Description

My doctoral dissertation titled “General Situated Cognition” and accompanying articles address the first two stages of the program. In it I develop a pragmatic account of pre-cognitive semantic information and use it as a base for a general account of cognitive systems as complex dynamical systems emerging within and operating in a complex environment. The dissertation is based on four papers that achieve four distinct tasks: (1) offering a pragmatic account of information systems; (2) describing a general minimal function of cognition; (3) offering a general theory of information media; and (4) developing an architectural framework for modeling cognitive systems based on networks of information media.

(1) The concept of information plays a central role in my account of cognition. I take a pragmatic approach to semantic information, inspired by the work of Nauta from the 1960s. The main idea is to define a notion of information system, as an open physical system interacting with an environment, and define information as the “currency” of the information system. Special effort is made to demonstrate that the notion of infor-
mation system can, in principle, be defined within the framework of dynamical systems theory, without any semantic or intentional notions. I offer a theory of meaning – the *interface theory of meaning* – where the content of an information state is specified by the interface role between the parts of the environment to which the medium is correlated, and the control mechanisms of the information system. This conception of meaning generalizes many different theories of meaning/content. Particularly, it collapses the externalist and internalist approaches to content, demonstrating that both offer viable theories of content, depending on the role of the medium. This theory is presented in the article “Pre-cognitive Semantic Information” appearing in the journal *Knowledge, Technology & Policy*, special issue: Luciano Floridi’s Philosophy of Technology.

(2) I analyze the question of the function of cognition. I ask two questions simultaneously: what is the design problem that cognition solves in a system? and, what systems need a solution to the design problem in the first place? I specify the design problem as follows: I observe that all natural information systems (which I call *agents*) that interact with the environment by extracting information and utilizing the information to control more effectively their behavior are severely informationally deprived. The complexity of the environment is vastly too great for an agent to cope with directly. This demands that the agent possesses *specialized internal mechanisms* for a more effective use of information to compensate for the informational limitation. I claim that those mechanisms make up the cognitive system of the agent. I justify this characterization by demonstrating that core cognitive capacities – learning, memory, feature detection, representation, and reasoning, all broadly construed – can be viewed as strategies for a solution to the design problem. The problem of describing the function of cognition is the subject of the article “The Cognitive Agent: Overcoming Informational Limits” appearing in the journal *Adaptive Behavior*.

(3) I offer a framework for investigating cognitive architectures based on the theory of information media networks. An informational medium is a dynamical system with sets of dynamical states interpreted as information-carrying states and a collection of information preserving transformations. An informational network is a collection of information media with information processing operations on each medium, and information management transformations among the media. By insisting that information media are dynamical systems, we can model information systems both at the functional level of information and at the dynamical/causal level of a system interacting with the world. This allows us to model the interactions between information and physical dynamics. The paper also addresses an independent problem in the philosophy of information related to the proper ontological place of (non-semantic) information. It endorses a *structural principle of information* whereby information transformations are more basic, and information is defined as invariance under information transformations. The theory of information media is presented in the article “The Information Medium” forthcoming in the journal *Philosophy & Technology*.

(4) Information media networks offer a powerful tool for modeling cognitive systems. The architecture is general enough to capture as special cases both symbol processing and connectionist cognitive architectures. The dynamical root of information media accommodate some of the insights of the dynamicist approach to cognition – the approach insisting that cognitive systems are best (or only) modeled with the machinery of dynamical systems theory – while interfacing the dynamical processes with (the sub-class) of informational processes. It also naturally encompasses modeling distributed and modular cognitive architectures. The architecture is developed in an article “Information Networks: A General Representational Framework for Situated Cognition” submitted for publication.
Future Research Goals
Currently I am expanding the dissertation into a research monograph provisionally titled “Information and Cognition”. The book offers a physically-grounded general theory of cognition consistent with recent theories of embodied cognition, and is based on the idea that cognition is an information-driven natural phenomenon. As such, the treatment applies both to naturally emerging biological agents and to artificial agents. An important problem in current foundational debates about cognition, identified in the book, is the overly simplistic conception of information that makes the gap between different programs in cognitive science appear wider than it is. In addition to the work of the dissertation, which makes up the first four chapters, the book includes two additional chapters devoted to the emergence of representations in cognitive systems and the formation of flexible symbolic representational systems. A book proposal with completed parts of the manuscript has been submitted to publishers.

My longer term research goals will focus on modeling the nature of scientific and mathematical practice. I view scientific model/theory construction as an extension of cognition. In cognition, models play only an intermediary control role in the interaction of the organism with the environment. Similarly, in science, model building and modification activity play an intermediary control role in the coordination between measurement/experimentation and technological development. Mathematics is viewed as a limiting case of this activity, where the role of external world is eliminated. Mathematical model building is characterized by maintaining representational invariance among representational systems, and not by a representational connection to an external world. Within this picture of mathematics, it is not difficult to see how a mathematical model can be integrated in an information network where (e.g.) a physical model is developed, and used as an informational interface to formulate a physical theory in a mathematical language.