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Communication As An Ecological Learning System:
Defining A Research Space for Multi-Agent Problems

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In the past decade, challenges to the dominance of the individual agent divorced from society approach to cognition and artificial intelligence have increased in number and volume. While scientists have made some forays into exploring the effects of interaction between humans in terms of cognition, the major focus has remained on the manifestation of the results of an interaction on the single agent of interest. With the inclusion of at least one additional human full-participant in a model of multi-agent learning in the world however, we must not only develop novel methods for handling the challenges of this complex, dynamic scenario, but rethink some of the traditional individually-centered assumptions as well.

If the relationship between human thought, human action and the environment is tightly interwoven, then studies of "the mind" cannot take place independently of social and cultural settings in which the humans function. While the ecological approach to cognition is hardly new, defining research problems that satisfy these criteria and retain inferential power has proven to be difficult.

This paper addresses this issue by proposing that communication provides a cross-fertilization ecological domain that is particularly appropriate for studying learning in a multi-agent environment comprised of artifacts and social structures. The assumptions of this approach include autonomous, self-interested agents that use communication as local expectation-matching process within a dynamic social system.

The actions of the agents, executed and observable in all communication practices, occur at interpersonal, organizational and mass levels. This paper holds that in each of these increasingly complex domains, news and frame function as data and mechanism that allow learning to occur. These common communication concepts can be defined computationally in a similar manner whether they operate at a micro or macro level. This scalability is essential to any investigation of learning within a multi-agent environment because of the requirement to address the micro-macro link problem. This long recognized dilemma in the social sciences seeks to define the connections between observable macro-social systems and their members.

News is commonly described as that which is novel. Meno's paradox states that "Novel knowledge cannot be derived completely from old knowledge, or it would not be new. Yet the transcending part of it cannot be completely new either, for then it would not be understood." Thus news or novelty must exist between what we think we know and what we do not yet know. In other words, agents make a prediction or generate and expectation about reality and news

if the difference between that expectation and the reality. The production of news occurs in the minute-by-minute actions of agents generating expectations in a dynamic environment of agents, artifacts and their dynamic interactions. News is the feedback or back propagation within a system of perpetual learning. And among humans, this learning is executed through communicative practices. These practices include the gossip exchange among neighbors, the e-mail of organizations, and the routinized arrival of the daily paper on the front lawn. In each case, news is not the information contained in the message, but the difference between the agent's expectation about that information and the information itself. This definition is not, however simply another subjectivist interpretation of an active agent. The range of probable values of news are set by its frame.

As an integral part of a learning system, frames can be thought to represent an organizing structure for information expressed as an expectation. In a multi-agent world, frames are created, used, organized and shared culturally to set expectations for standardized knowledge construction. These basic expectations make it possible for agents existing within a common community to coordinate their actions or to act locally within some commonly held range of predictions. Thus frames are "twice-born", in the mind of the individual agent and in culturally accessible or instituted forms within the social community (Shore, 1996).

Frames defined in this manner can be seen as analogous to the mechanisms of internal models and tags in the complex adaptive system described by Holland (1995). This system of systems is hierarchically organized with vast differences in modification or learning times, but operates subject to the same or similar laws. Communication appears to be such a system in that it depends more on interactions than actions, maintains coherence under change, operates without central direction and that has lever points that let small inputs produce cascading magnified effects. Thus situating multi-agent research problems within this domain could provide an opportunity to combine an existing body of knowledge with new hypotheses on cognition and AI.

References

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