The Reflex Arc Concept in Cognitive Science

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Hutchins' *Cognition in the Wild* [1995] calls to connectionism to see "human cognitive activity as an integral part of ... a larger system ..." where modeling cognition from this perspective offers "a sense of the nature of individual cognition" This call of "the Wild", beckons in the right direction, but an accompanying model of cognitive activity in context embodies what Dewey [1896] termed the "reflex arc" concept in psychology, eschewing the benefits of Dewey's more complete "organic circuit" model. My Deweyan criticism of Hutchins' model of learning a sequential procedure shows benefits to understanding human cognition as a cyclic activity of building and reconstituting a coordination, even where the content seems to be a fixed monotonic linear sequence of steps.

James' [1890] reflex arc concept as basis of cognitive action in an environment endures even in Hutchins[1995], who emphasizes the interaction of agents in a distributed cognitive system, but characterizes a cognitive agent's learning of a sequential procedure (Navy Standard Steaming Watch) as development of a lattice of mutually constraining mediated state transitions. Hutchins' explicit comparisons with and well made criticisms of the PDP paradigm should influence future neural net cognition modeling pivotally, and therefore deserves serious critical attention. An analysis like Dewey's[1896] criticism of James can prove as salutary now for Hutchins, and hence cognitive science, as did the original for psychology.

Hutchins characterizes learning the Standard Steaming Watch (SSW), a 12-step sequence of steps, as internalization of mediated state transitions (MST) as building blocks, each consisting of initial and final states and a medium / controlling structure for transition from initial to final state. One constructs linear sequences by final state of one block serving as initial state for the next. Different kinds of MST form sequences orthogonally to each other. These interlocking linear sequences form a lattice of mutually constraining state transitions (Figure 1) -- very much a system of interlocking reflex arcs.

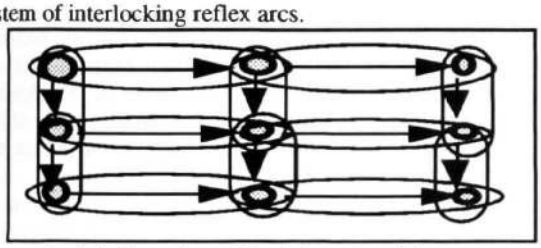

Figure 1: A lattice of mediated state transitions: sequences of mediated state transitions reinforce each other.

But SSW, like learned sequences in general, is, when learned, cyclic and not really monotonic. In SSW, Step 12 is "go to Step 2 and repeat", and Step 6 "plot observed bearings on chart" can be followed by return to Step 4 "observe landmark bearings" if the plot is unacceptable, instead of the usual Step 7 "compare fix to projected fix position". Hutchins' lattice of meditated state transitions is strictly unidirectional, and so cannot account for this.

In learning a sequential procedure one really develops coordinations for resolving and maintaining an assortment of elements. In Step 6 there are unresolved bearing observations, and one recoordinates by plotting their intersection as ship location. When this can be done satisfactorily, we have unresolved elements for Step 7: a position and a projected position, so Coordination of Step 7 takes over. But when this cannot be done, the bearing observations are called into question, and so the coordination for Step 4 becomes unresolved.

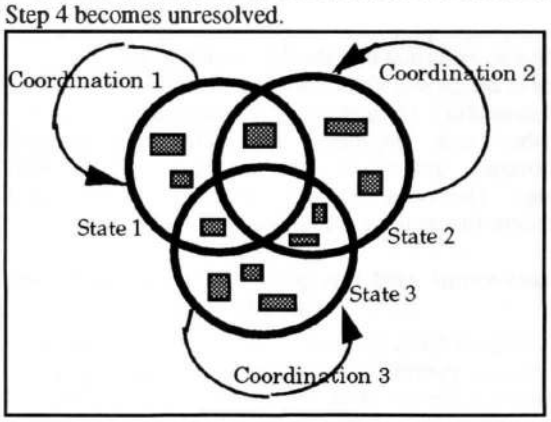

Figure 2: A "state" (ellipse) is a configuration of elements (rectangles) which, in the context of a coordination, need to be recoordinated (arc with arrowhead). Some elements come under several coordinations, so reconstituting one coordination can cause a state (in the context of another coordination) to need recoordination.

If we model the environment with the agent in it, not just the agent as passive input recipient, we model that which is learned and known as organic circuits, capturing the cyclic, active, interactive nature of knowledge, even of apparent monotonic, linear sequences.

References

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