A Proposal for Algorithms in the Human Brain

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Algorithms on Non-symbolic Concepts

One of the interesting questions in cognitive science seems to be whether human beings are already programmed from birth or can be programmed after birth to do certain things. For example, can there be algorithms residing in the human brain that can carry out tasks, e.g. planning?

The traditional approaches of artificial intelligence suggest the use of physical symbol systems for representing domain knowledge (Newell & Simon, 1976; Anderson, 2005). The reasoning is carried out by rules and algorithms that manipulate symbols. To summarize, traditional AI has two important aspects which are 1) physical symbols and 2) rules and algorithms that operate on these symbols.

However, the physical symbols aspect of traditional AI has received criticisms because of the "symbol grounding" problem (Harnard, 1990). Barsalou proposes perceptual symbol systems as an alternative to physical symbols. In addition, connectionism proposes the use of interconnected neurons to obtain distributed representations (Hinton et al., 1986) as in the human brain which is different from physical symbol representations.

With respect to the "rules and algorithms" aspect of traditional AI, we will now consider - "If one chooses to disregard physical symbol systems, should also the possibility of rules and algorithms be disregarded". Pollack has shown that the same effects of symbolic rule manipulation can be achieved by a recursive auto-associative network without explicitly defining any symbolic rules. Dorffner replaces symbolic rule systems with Parallel Distributed Processing networks. These two works seem to support the idea that there can be rules even if they are not symbolically expressed. Also, Meeden et al. presents the emergence of a navigational plan by the use of a neural network without defining a symbolic navigational planning algorithm. However, there is psychological research that is in line with having algorithms in the human brain (Cantlon & Brannon, 2005). In addition to that, although a navigational plan has been generated through emergence (Meeden et al., 1993), more complicated tasks may require non-symbolic algorithms. As a result, we propose the possibility of "non-symbolic algorithms" in the human brain that operate on "non-symbolic concepts" (Yildirim & Beachell, 2006). These concepts are perceptually grounded (Goldstone & Johansen), distributed (Hinton et al., 1986), and non-linguistic (Jordan & Brannon, 2006; Yu et al., 2005). Non-symbolic algorithms are composed of a series of steps and a rule can be a step. Each step lasts for the period of time that various patterns of biological neuron activations occur to accomplish it. An example algorithm is a summation algorithm where multi-digit numbers are added by repetitive series of steps.

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