Evolutionary Simulations on the Adaptive Value of Connectionist Learning

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A proper understanding of the large diversity of mental processes and neural architectures shared by all members of the human species requires knowledge about the species' evolutionary history and the environmental demands placed on it. In Evolutionary Psychology, the outcomes of this development are primarily subjected to experimental research, but evolutionary computation appears to be the only means to empirically investigate the development process itself. Evolutionary simulations may show that some processing architectures are more likely to develop than others and may thus help to decide between alternative accounts. Continuing on the evolutionary simulations by den Dulk et al., (2003), we conduct research into the emergence of variants of LeDoux' (1996) dual-route network. Here, we present preliminary simulations investigating under which environmental conditions adding a learning faculty is adaptive.

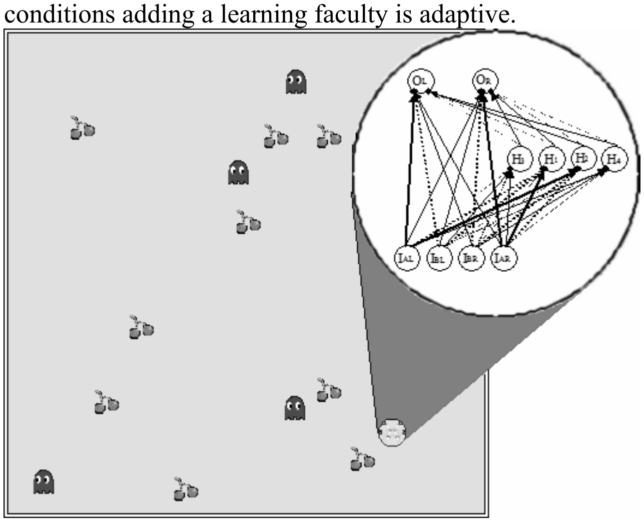

Figure 1. A three-layer feed-forward network, with input from food and predators, controlled the movements of agents that accumulated fitness by surviving in a simulated environment by searching for food and avoiding predators.

Evolutionary simulations were performed with a network in which connection weights could change either due to evolution, or to both evolution and (Hebbian) learning. The Hebbian learning parameter also formed a hereditary trait which the genetic algorithm optimized. We hypothesized that short-term weight changes would be adaptive when there were also short-term environmental changes. During the agents' 'lifetime' small random mutations in stimulus characteristics of food and predators were introduced.

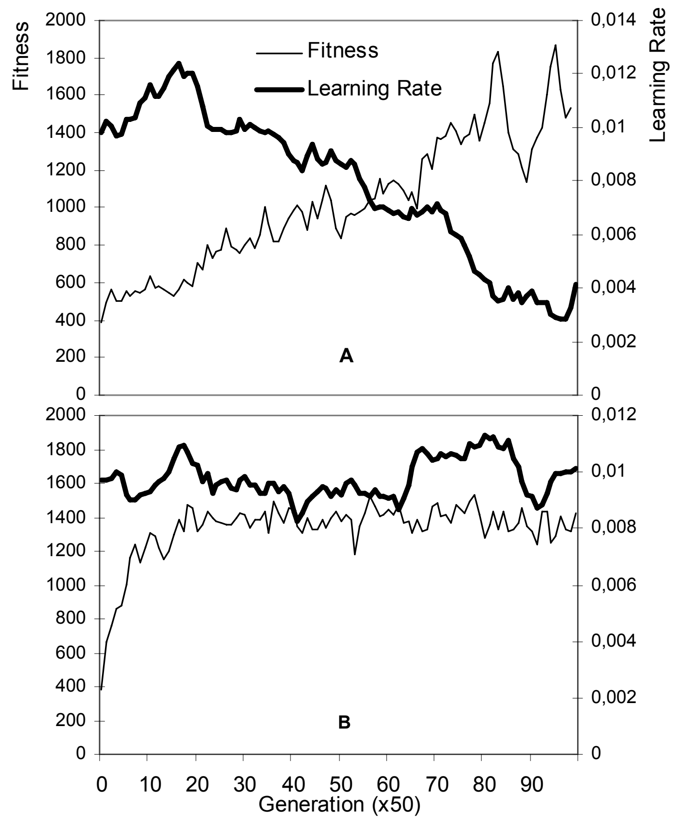

Figure 2: Development over generations of the agents' Fitness and Learning Rate in a stable environment (A) and with mutating input during the agents' lifetime (B).

Without environmental changes the learning rate evolved towards zero, whereas fitness increased. With environmental changes ontogenetic learning contributed to fitness and learning rate remained relatively high. Future simulations are planned in which the (modular) structure of the network is also driven by evolution, and type of learning and level of environmental changes are varied.

References

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LeDoux J.E. (1996). *The Emotional Brain*. New York: Simon & Schuster.