Report

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What can robots teach us about the brain?

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1. The first systematic studies on learning were reported by Thorndike in 1898. His most influential experiments were based on the "puzzle box". In the same period Pavlov developed his studies on conditioned reflexes. This paradigm refers to learning processes where initially neutral stimuli, or conditioned stimuli (CS), like lights and bells, are through their simultaneous presentation with food as a reward, Pavlov conditioned reflexes. A collision triggers an avoidance response.

2. DAC assumes that learning systems are constructed on the foundation of an internal state and external control structure, which consists of reflexes and stereotypic behavioral patterns. It provides the organism with a basis level of consciousness and control over learning processes.

3. DAC is our implementation of a Reactive Control System.

4. Bugworld is a 2-dimensional environment consisting of the control of a simulated robot. It proposes that a central element of classical conditioning is CS identification.

5. The adaptive control structure, DAC, learns to correlate CS events (distal sensors) with internal states (IS). It proposes that a central element of classical conditioning is CS identification.

6. The real-world version of DAC runs on a Khepera robot [K-cena, Lucerne]. The knowledge of the system is expressed in synapses connecting the CS and IS populations. In this example it correlated with collision and light events.

7. Learning about one action means to generate phase. DAC uses a short-term and a long-term memory system to acquire its knowledge and to make plans based on its experience. It is built on top of a DAC2 level of control.

8. By plotting the distribution of probabilities to find the robot at a certain location in the environment over 100 time steps we observe that DAC exhibits more structured behavior. This structuring of behavior affects the way perception is organized on both DAC1 levels.

9. DAC4 is a fully neural implementation of DAC where STM and LTM are implemented by recurrent networks where the temporal context is represented by a pattern of activity.

10. Human decision-making follows a so-called Bayesian inference principles. Bayesian theory provides a framework to choose optimal actions given all available information.

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