Minisymposium 26 - Mathematics in the Biosciences

Predicitve Mechanisms in Closed-Loop Sensori-Motor Systems: The Convergence of Differential Hebbian Learning

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During the lifetime of a creature there are often events where two sensor signals follow each other in time, which refer to the same situation. Hence the earlier signal acts predictive in comparison to the later signal. For example, heat radiation predicts pain on touching a hot surface. This general situation is due to the fact that we have near sensors like touch, taste and far sensors, like smell, hearing and vision. It is evident that it is advantageous for a creature to react to the earlier far-sensor signal without having to wait for a (potentially damaging) near-sensor signal. Often this requires learning, because, prior to having experienced the first such sensor-signal sequence, the relevance of the correlation between paired signals is unknown to the animal. It is possible to employ differential hebbian plasticity at single simulated synapses to emulate such a learning process. We will specifically show that such a mechanism will lead to improved behavior in closed-loop sensori-motor systems, using some robots for demonstration. Furthermore, it can be proven that the employed mechanism will converge to appropriate synaptic weights which will stabilize as soon as the newly learned behavior has also become stable.